

M.Sc. (BOTANY)  
M. Sc. (ANNUAL PATTERN)

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M. Sc. Previous

|           |                                                 |
|-----------|-------------------------------------------------|
| Paper I   | Cell & Molecular Biology of Plants              |
| Paper II  | Cytology, Genetics & Cytogenetics               |
| Paper III | Biology & Diversity of Lower Plants: Cryptogams |
| Paper IV  | Taxonomy & Diversity of Seed Plants             |
| Paper V   | Plant Physiology & Metabolism                   |
| Paper VI  | Microbiology and Plant Pathology                |

M.Sc. Final

|            |                                                                  |
|------------|------------------------------------------------------------------|
| Paper VII  | Plant Morphology, Developmental Anatomy and Reproductive Biology |
| Paper VIII | Plant Ecology                                                    |
| Paper IX   | Plant Resource Utilization & Conservation                        |
| Paper X    | Biotechnology & Genetic Engineering of Plants & Microbes         |
| Paper XI   | Elective I                                                       |
| Paper XII  | Elective II                                                      |

Elective Papers XI & XII

|                  |                            |
|------------------|----------------------------|
| Papers XI (a) :  | Advanced Plant Pathology I |
| Papers XII (a) : | Advance Plant Pathology II |

OR

|                 |                                |
|-----------------|--------------------------------|
| Papers XI (b) : | Seed Science and technology I  |
| Paper XII (b) : | Seed Science and technology II |

OR

|                 |                   |
|-----------------|-------------------|
| Papers XI (c) : | Ecosystem Ecology |
|-----------------|-------------------|

  
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Paper XII (c) : Environmental Biology

OR

Papers XI (d) : Advanced Plant Physiology I

Paper XII (d) : Advanced Plant Physiology II

OR

Papers XI (e) : Advanced Morphology and Morphogenesis- I

Paper XII (e) : Advanced Morphology and Morphogenesis- II

OR

Papers XI (f) : Biosystematics of Angiosperms I

Paper XII (f) : Biosystematics of Angiosperms II

OR

Papers XI (g) : Biotechnology- I

Paper XII (g) : Biotechnology- II

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M.Sc. Botany

Scheme of Examination

M.Sc. (Previous)

There will be six papers in theory, each of three hours duration, 100 marks each and two practicals carrying 150 marks each (10% marks are reserved for viva and 15% records in each examination). Each practical examination will be of 6 hours duration to be completed in one day.

Each theory paper will have 9 questions, out of which a student has to attempt 5 questions and the question No. 1 will be compulsory. The question No.1 will carry 20 marks and will be of short type of questions with a limit of 20 words.

M.Sc. (Final)

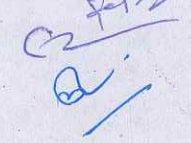
There will be six papers, four compulsory and two elective in theory of 3 hours duration carrying 100 marks each and two practicals each as follows:

- i. Practical for compulsory papers of 200 marks of 8 hours duration to be completed in two days.
- ii. Practical for elective papers-100 marks of 4 hours duration to be completed in one day.

Each theory paper will have 9 questions, out of which a student has to attempt 5 questions and the question No. 1 will be compulsory. The question No. 1 will carry 20 marks and will be of short type of questions with a limit of 20 words.



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1. Cell Wall of Plants

## M.Sc. Botany Scheme of Examination

### M.Sc. (Prev.)

There will be six papers in theory, each of three hours duration, 100 marks each and two practicals carrying 150 marks each (10% marks are reserved for viva and 10% records in each examination). Each practical examination will be of 6 hours duration to be completed in one day.

Each theory paper will have 9 questions, out of which a student has to attempt 5 questions and the question No. 1 will be compulsory. The question No. 1 will carry 20 marks and will be of several short objective type of questions such as multiple choice type, one line answer type, one word type and fill in the blanks type.

### M.Sc. (Final) with a Unit of 6 Papers

There will be six papers, four compulsory and two elective, in theory of 3 hours duration carrying 100 marks each and two practicals as follows:

(i) Practical for compulsory papers of 200 marks of 6 hours duration to be completed in two days.

(ii) Practical for elective papers of 100 marks of 4 hours duration to be completed in one day.

Each theory paper will have 9 questions, out of which a student has to attempt 5 questions and the question No. 1 will be compulsory. The question No. 1 will carry 20 marks and will be of several short objective type of questions such as multiple choice type, one line answer type, one word type and fill in the blanks type.

### M.Sc. Previous

- Paper-I : Cell and Molecular Biology of Plants
- Paper-II : Cytology, Genetics and Cytogenetics
- Paper-III : Biology and Diversity of Lower Plants: Cryptogams
- Paper-IV : Taxonomy and Diversity of Seed Plants
- Paper-V : Plant Physiology and Metabolism
- Paper-VI : Microbiology and Plant Pathology

### Paper-I : Cell and Molecular Biology of Plants

#### Scheme of Examination

Max. Marks : 100

The paper will have 9 questions, out of which a student has to attempt 5 questions including the question No. 1 which is compulsory.

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pulsory. The question No. 1 will carry 20 marks and will be of several short objective type questions such as multiple choice type, one line answer type, one word type and fill in the blanks type.

#### Unit-I

The dynamic cell: Structural organization of the plant cell, specialized plant cell types, chemical foundation, biochemical chargedos.

Cell wall: Structure and functions, biogenesis, growth.  
Plasma membrane: Structure, models and functions, sites for ATPases, ion carriers, channels and pumps, transport.  
Plasmodesmata: Structure, role in movement of molecules and macromolecules, comparison with gap junctions.

#### Unit-II

Chloroplast: Structure, genomic organization, gene expression, photosynthesis, nucleochloroplasmic interaction.

Mitochondria: Structure, genomic organization, biogenesis, plant vacuole: Tonoplast membrane, ATPase, transporters, as storage organelle.

Nucleus: Structure, nuclear pore, nucleosome organization, DNA structure, A, B and Z forms, replication, damage and repair, transcription, plant promoters and transcription factors, splicing, mRNA transport, nucleolar rRNA biosynthesis.  
Restriction enzymes: Cleavage of DNA into specific fragments, construction of a restriction map from the fragments, in detection sites, as genetic markers, RFLP and their use in plant breeding.

#### Unit-III

Ribosomes: Structure, site of protein synthesis, mechanism of translation, initiation, elongation and termination, structure and role of tRNA.

Protein sorting: Targeting of proteins to organelles.  
Cell shape and motility: The cytoskeleton, organization and role of microtubules and microfilaments, motor movements, implications in flagellar and other movements.

#### Unit-IV

Cell cycle and apoptosis: Control mechanisms, role of cyclins and cyclin-dependent kinases, cell proliferation and cell death, cytokinesis and cell plate formation, mechanism of programmed cell death.  
Other Cellular Organelles: Structure and functions of microbodies, Golgi apparatus, lysosomes, endoplasmic reticulum.

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Techniques in cell biology : Immunotechniques, in situ hybridization to locate transcripts, cell types, FISH, GISH, confocal microscopy.

Suggested Reading:

1. Lewis, B. 200. Genes VII. Oxford University Press, New York.
2. Albert, B., Bray, D., Lewis, J., Raff, M., Roberts, K and Watson, J., 1999. Molecular Biology of the Cell. Garland Publishing, Inc., New York.
3. Wolfe, S.L. 1993. Molecular and Cellular Biology. Wadsworth Publishing USA.
4. Rosli, T. *et al.* 1998. Plant Biology. Wadsworth Publishing Co., California USA.
5. Krishnamurthy, K.V. 2000. Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.
6. Buchanan, B.B., Gruissem, W. and Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
7. De, D.N. : 2000. Plant Cell Walls: An Introduction. CSIRO Publication Collingwood, Australia.
8. Kleinsmith, L.J. and Kishi, M.M. 1995. Principles of Cell and Molecular Biology (2nd Edition). Harper Collins College Publishers, New York, USA.
9. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology (4th Edition). W.H. Freeman and Co., New York, USA.

See the following Review Journals

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

Suggested Laboratory Exercises

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

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6. Restriction digestion of plant DNA, its separation by agarose gel electrophoresis and visualization by ethidium bromide staining.
  7. Isolation of RNA and quantitation by a spectrophotometric method.
  8. Separation of plant RNA by agarose gel electrophoresis and visualization by EtBr staining.
  9. Southern blot analysis using a gene specific probe.
  10. Northern blot analysis using a gene specific probe.
  11. Immunological techniques - Ouchterlony method, ELISA and Western blotting.
  12. Fluorescence staining with FDA for cell viability and cell wall staining with calcofluor.
  13. Demonstration of SEM and TEM.
- Note: Chemicals and kits for conducting some of the above molecular biology experiments are available in India, for example from IIS Bangalore, Centre for Biotechnology (CSIR) Mill Road, Delhi.
- Suggested reading: (For laboratory exercises)
1. Glick, B.R. and Thompson, J.E. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
  2. Glover, D.M. and Hawes, D.D. (Eds.) 1995. DNA Cloning: A Practical Approach, Core techniques, 2nd edition. IRL Press, Oxford University Press, Oxford.
  3. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology: Structure and Function. Jones and Bartlett Publishers, Boston, Massachusetts.
  4. Hickey, 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.
  5. Hall, J.E. and Moore, A.L. 1983. Isolation of Membranes and Organelles from Plant Cells. Academic Press, London, UK.
  6. Harris, N. and Oparik, J. 1994. Plant Cell Biology: A Practical Approach. IRL Press, at Oxford University Press, Oxford, UK.
  7. Shaw, G.H. (Ed.). 1988. Plant Molecular Biology: A Practical

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Approach: IRL Press, Oxford

Paper-II : Cytology, Genetics and Cyto-genetics

Scheme of Examination

MARKS: 100

Each paper will have 9 questions, out of which a student has to attempt 5 questions including the question No. 1 which will be compulsory. The question No. 1 will carry 20 marks and will be of short objective type of questions such as multiple choice type, one line answer type, one word type and fill in the blank type. Within a limit of 2000 words.

#### CYTOLOGY

Chromatin organization : Chromosome structure and packaging of DNA, molecular organization of centromere and telomere, nucleolus and ribosomal RNA genes, euchromatin and heterochromatin, karyotype analysis, banding pattern, karyotype evolution, specialized types of chromosomes, polytene, lampbrush, B-chromosomes and sex chromosomes, molecular basis of chromosome pairing.

Structural and numerical alterations in chromosomes : Origin, incision and breeding behaviour of duplication, deletion, inversion and translocation heterozygotes. Origin, occurrence, production and meiosis of haploids, aneuploids and euploids, origin and production of autopolyploids, chromosome and chromosomereproduction, allopolyploids, types, genetic constitution and analysis. Evolution of major crop plants, induction and characterization of trisomic and monosomics.

#### DA-II GENETICS

Genetics of prokaryotes and eukaryotes : Principles relating the bacteriophage genome, phage phenotypes, genetic recombination in phage, genetic transformation, conjugation and transduction in bacteria, genetics of mitochondria and chloroplasts, cytoplasmic male sterility.

Gene Structure and expression : Genetic fine structure, cis-trans test, fine structure analysis of eukaryotes, animals and their significance, RNA splicing, regulation of gene expression in prokaryotes and eukaryotes. Promoter, operator, enhancer, repression, attenuation and antitermination.

Genetic recombination and genetic mapping : Recombination

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

### Unit-III CYTOGENETICS

Mutations: Spontaneous and Induced mutations, physical and chemical mutagens, molecular basis of gene mutation, transposable elements in prokaryotes and eukaryotes, mutation induced by transposons, site directed mutagenesis, DNA damage and repair mechanisms, inherited diseases and defects in DNA repair, initiation of cancer at cellular level, proto-oncogenes and oncogenes. Sex determination, sex linked inheritance, sex limited characters and sex reversal, multiple alleles and blood groups in man. Cytogenetics of aneuploids and structural heterozygotes. Effect of aneuploidy on phenotype in plants, transmission of monosomics and trisomics and their use in chromosomal mapping in diploid and polyploid species, breeding behaviour and genetics of structural heterozygotes, complex translocation heterozygotes, translocation tester sets, Robertsonian translocations, B-A translocations.

### Unit-IV

Molecular cytogenetics: Nuclear DNA content, G-banding, FISH, C-banding and in situ hybridization, restriction mapping, concept and techniques, multiple probes and their application in in situ hybridization, concept and techniques, physical mapping of genes on chromosomes, computer assisted chromosome analysis, chromosome microdissection and microcloning, flow cytometry and confocal microscopy in cytotype analysis.

Alien gene transfer through chromosome manipulations: Transfer of whole genome, examples from wheat, *Atriplex* and *Lycopersicon*, transfer of individual chromosomes and chromosome segments, methods for detecting alien chromatin, production, characterization and utility of alien addition and substitution lines, genetic basis of introgression and heterosis, exploitation of hybrid vigour.

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## *Suggested Readings*

1. Albert B. Bray, D. Lewis, J. Raff, M. Roberts, K. and Watson, J.D. 1989. *Molecular Biology of the Cell* (2nd edition), Garland Publishing Inc, New York.
2. Atherly, A.G., Garton, J.R. and McDonald, J.F. 1999. *The Science of Genetics*. Saunders College Publishing, Fort Worth, USA.
3. Burnham, C.R. 1962. *Discussions in Cytogenetics*. Burgess Publishing Co. Minnesota.
4. Busch, H. and Rothblum, L. 1982. Volume X. *The Cell Nucleus rDNA*. Part A. Academic Press.
5. Hartl, D.L. and Jones, E.W. 1998. *Genetics: Principles and Analysis* (4th edition). Jones & Bartlett Publishers, Massachusetts, USA.
6. Khush, G.S. 1973. *Cytogenetics of Anceplids*. Academic Press, New York, London.
7. Karp, G. 1999. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons, Inc., U.S.A.
8. Lewin, B. 2000. *Gene VII*. Oxford University Press, New York, USA.
9. Lewis, R. 1997. *Human Genetics: Concepts and Applications* (2nd edition). WGB, McGraw Hill, USA.
10. Malacinski, G.M. and Freisfelder, D. 1998. *Essentials of Molecular Biology* (3rd edition). Jones and B. Arlet Publishers, Inc., London.
11. Russel, P.J. 1998. *Genetics* (5th edition). The Benjamin/Cummings Publishing Company Inc., USA.
12. Shustad, D.P. and Summons, M.S. 2000. *Principles of Genetics* (2nd edition). John Wiley & Sons, Inc., USA.

## *Suggested Laboratory Exercises*

1. Linear differentiation of chromosomes through banding techniques, such as G-banding, C-banding and Q-banding.
2. Silver banding for staining nucleolar organizing region, where 18S and 28S DNA are transcribed.
3. Orcein and Feulgen. Staining of the salivary gland chromosomes of Chironomas and Drosophila.
4. Characteristics and behavior of B chromosomes using maize or any other appropriate material.
5. Working out the effect of monosomy and trisomy on plant phenom.

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- type, fertility and meiotic behaviour.
6. Induction of polyploidy using colchicines, different methods of the application of Colchicines.
7. Effect of induced and spontaneous polyploidy on plant phenotype, meiosis, pollen and seed fertility and fruit set.
8. Effect of translocation heterozygosity on plant phenotype, chromosome pairing and chromosome disjunction and pollen and seed fertility.
9. Meiosis of complex translocation heterozygotes.
10. Isolation of chlorophyll mutants, following irradiation and treatment with chemical mutagens.
11. Estimation of nuclear DNA content through microdensitometry and flow cytometry.
12. Fractionation and estimation of repetitive and unique DNA sequences in nuclear DNA.

Suggested Readings:

1. Fukui, K. and Nakayama, S. 1996. Plant Chromosomes: Laboratory Methods. CRC Press, Boca Raton, Florida.
2. Sharma, A.K. and Sharma, A. 1999. Plant Chromosome Analysis: Manipulation and Engineering. Harwood Academic Publishers, Australia.

Paper III: Biology and Diversity of Lower Plants: Cryptogams

Scheme of Examination

Maximum Marks: 100

Each paper will have 9 questions, out of which a student has to attempt 5 questions including the question No.1 which will be compulsory. The question No.1 will carry 20 marks and will be of several short objective type of questions such as multiple choice type, one and answer type, one word type and fill in the blanks type.

Unit - I

Phycology: Algae in diversified habitats (terrestrial, freshwater, marine), thallus organization, cell ultrastructure, reproduction, (vegetative, asexual, sexual) criteria for classification of algae, pigments, reserve food, flagella, classification, salient features of Prochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta: with special reference to Microcystis, Hydrodictyon, Draparnaldiopsis, Cosmarium, algal blooms, algal biofertilizers, algae as food, seed and use in industry.

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Unit-II

**Mycology :** General characters of fungi, substrate relationship to fungi, cell ultrastructure, vegetative and fruiting cellular organization, cell wall composition, nutrition (saprobic, biotrophic, symbiotic), heterothallism, heterokaryosis, parasexuality, recent trends in classification: Phylogeny of fungi, general account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, deuteromycotina, with special reference to *Phytophthora*, *Chaetochytrium*, *Morchella*, *Metarhizium*, *Polyporus*, *Drechlera* & *Phoma*, fungi in industry, medicine and as food, fungal diseases in plants and humans, Mycorrhizae, fungi as biocontrol agents.

Unit-III

**Bryophyta :** Morphology, structure, reproduction and life history, distribution, classification, general account of Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Funariales and Polytrichales, with special reference to *Funaria*, *Notofunaria* and *Polytrichum*, economic and ecological importance.

Unit-IV

**Pteridophyta :** Morphology, anatomy and reproduction, classification, evolution of stele, heterospory and origin of seed habit, general account of fossil pteridophytes, introduction to Psalmodia, Lycopodiida, Sphenopsida and Pteropsida, with special reference to *Lycopodium*, *Gleichenia*, *Pteris*, *Isotria* & *Ophioglossum*.

Suggested Reading

- Alexopoulos, C.I., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology, John Wiley & Sons and  
Clifton, A. 1988. Introduction to the Bacteria, McGraw-Hill Book Co., New York  
Kumar, H.D. 1988. Introductory Phycology, Affiliate East-West Press Ltd., New Delhi.  
Mandahar, C.L. 1978. Introduction to Plant Viruses, Chand & Co. Ltd., Delhi.  
Mehrotra, R.S. and Abeja, R.S. 1998. An Introduction to Mycology, New Age Intermediate Press.  
Morris, I. 1986. An Introduction to the Algae, Cambridge University Press, U.K.  
Parthar, N.S. 1991. Bryophyta, Central Book Depot, Allahabad.  
Parthar, N.S. 1996. Biology & Morphology of Pteridophytes.

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Puri, P. 1930. Bryophytes. Ansa Ram & Sons, Delhi.

Rangaswamy, G. and Mahadevi, A. 1999, Diseases of Crop Plants in India (4th edition), Prentice Hall of India Pvt. Ltd., New Delhi.

Round, F.E. 1926. The Biology of Algae. Cambridge University Press. Cambridge.

Sporne, K.K., 1991. The Morphology of Platyophytes. B.T. Publishing Pvt. Ltd., Mumbai.

Stewart, W.N. and Ravenell, G.W. 1993. Paleobotany and the Evolution of Plants. Cambridge University Press.

Webster, J.: 1985, *Introduction to Fungi*, Cambridge University Press.

### Suggested Laboratory Exercises

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Symptoms of some disordered specimens: White rust, downy mildew, powdery mildew, rusts, smut, ergot, groundnut leaf spot, red rot of sugarcane, wilt, paddy blast, citrus canker, bacterial blight of paddy, angular leaf spot of cotton, tobacco mosaic, little leaf of brinjara, sesame fly, mango malformation.

Study of morphology, anatomy and reproductive structures of bryophytes and pteridophytes.

Gram staining of bacteria:

Identification of fungal cultures : *Rhizopus* *Mucor*

*Trillium*, *Peucedanum*, *Emicella*, *Chactomium*, *Drochster*

Scutellaria, Fungus, Phoma, Colletotrichum, Graphium.

Sterilization methods, preparation of media and stains.

## Economy and Diversity of Seed Plants

Max Marks: 100

Each paper will have 9 questions, out of which a

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## PAPER IV: TAXONOMY AND DIVERSITY OF SEED PLANTS

### Gymnosperms

#### Unit I

Introduction : Gymnosperms, the vessel-less and fruitless seed plants varying in the structure of their sperms, pollen grains, pollen germination and the complexity of their female gametophyte; Evolution of Gymnosperms. Classification of Gymnosperms and their distribution in India. Brief account of the families of Pteridospermales (Lyginopteridaceae, Medullosaceae, Caytoniaceae and Glossopteridaceae). General account of Cycadeoidales and Cordaitales. Structure and reproduction in Cycadales, Ginkgoales, Coniferales, Ephedrales, Welwitschiales and Gnetales.

#### Unit II

#### TAXONOMY OF ANGIOSPERMS

1. Aims, components, and principles of Taxonomy; Alpha and Omega Taxonomy, documentation and scope.
2. Systems of Angiosperm classification: Cronquist, Dahlgren, Thorne and APG-II.
3. International Code of Botanical Nomenclature: Principles, rules and recommendations; Taxonomic concept: Hierarchy, species, genus, family and other categories.

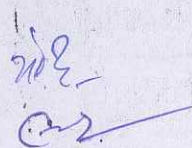
#### Unit III

Numerical Taxonomy- Principles, concepts, operational taxonomic units (OTU), data processing and taxonomic studies, taximetric methods for study of population variation and similarity- coding, cluster analysis, cladistics, cladogram.

Taxonomic literature: Floras, Monographs, Icons, Library, Manuals, Index, Taxonomic keys.

Taxonomic tools and techniques: Herbarium, serological, Molecular techniques, GIS and Mapping biodiversity.

  
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#### Unit IV

Taxonomic evidences: Morphology, Anatomy, Palynology, Embryology, Cytology, Phytochemistry and Genome analysis.

Phylogeny of Angiosperms: Ancestors of Angiosperms, time and place of origin of Angiosperms; habit of Angiosperm; primitive living Angiosperms, inter relationship among the major group of Angiosperms.

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### *Suggested Readings*

- Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms. New Age International Pvt. Ltd., New Delhi.
- Cole, A.J. 1969. Numerical Taxonomy, Academic Press, London.
- Davis, 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, New York.
- Grant, W.F. 1984. Plant Biosystematics. Academic Press London.
- Harrison, H.J. 1971. New Concepts in Flowering Plant Taxonomy. Hieman Educational Book Ltd., London.
- Heslop-Harrison, J. 1967. Plant Taxonomy - English Language Book Soc. & Edward Arnold Pub. Ltd. U.K.
- Heywood, V.H. and Moore, D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
- Jones, A.D. and Wilbins, A.D. 1971. Variations and Adaptations in Plant Species. Hiemand & Co. Educational Books Ltd., London.
- Jones, S.B. Jr. and Luchsinger, A.E. 1986. Plant Systematics (2nd edition). McGraw-Hill Book Co., New York.
- Nordenstam, B., El Gazaly, G. and Kassas, M. 2000 Plant Systematics for 21<sup>st</sup> Century. Portlant Press Ltd., London.
- Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper & Row Publications, USA.
- Singh, H. 1978, Embryology of Gymnosperms. Encyclopaedia of Plant Anatomy X. Gebruder Bortraeger, Berlin.
- Solbrig, O.T. 1970. Principles and Methods of Plant Biosystematics. The MacMillan Co - Collier-MacMillan Ltd., London.
- Solbrig, O.T. and Solbrig, D.J. 1979. Population Biology and Evolution, Addison-Wesley Publishing Co. Ind., USA.
- Stebbins, G.L. 1974. Flowering Plant - Evolution Above Species Level. Edward Arnold Ltd., London.
- Stace, C.A. 1989. Plant Taxonomy and Biosystematics (2nd edition). Edward Arnold Ltd., London.
- Takhtajan, A.L. 1997. Diversity and Classification of Flowering Plants. Columbia University Press, New York.
- Woodland, D.W. 1991. Contemporary Plant Systematics, Prentice Hall, New Jersey.

### *Suggested Laboratory Exercises*

#### **Gymnosperms**

1. Comparative study of the anatomy of vegetative and reproductive parts of cycas, Ginkgo, Cedrus, Abies, Picea, Cupressus, Araucaria, Cryptomeria, Taxodium, Podocarpus, Agathis, Taxus, Ephedra and Genetum.
2. Study of important fossil gymnosperms from prepared slides and specimens.

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Angiosperms

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

List of Locally Available Families :

(1) Ranunculaceae, (2) Capparidaceae, (3) Portulacaceae, (4) Caryophyllaceae, (5) Malvaceae, (6) Tiliaceae, (7) Sterculiaceae, (8) Zygophyllaceae, (9) Rhamnaceae, (10) Sapindaceae, (11) Leguminosae, (12) Combretaceae, (13) Myrtaceae, (14) Cucurbitaceae, (15) Umbelliferae, (16) Rubiaceae, (17) Asteraceae, (18) Primulaceae, (19) Plumbaginaceae, (20) Asclepiadaceae, (21) Convolvulaceae, (22) Solanaceae, (23) Boraginaceae, (24) Polemoniaceae, (25) Acanthaceae, (26) Pedaliaceae, (27) Martyniaceae, (28) Bignoniaceae, (29) Labiatae, (30) Nyctaginaceae, (31) Polygonaceae, (32) Chenopodiaceae, (33) Amaranthaceae, (34) Aizoaceae, (35) Molluginaceae, (36) Euphorbiaceae, (37) Commelinaceae and (38) Cyperaceae.

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

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

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

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

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

9. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.

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

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**Paper - V : Plant Physiology and Metabolism**  
**Scheme of Examination** **Max. Marks : 100**  
 Each paper will have 9 questions, out of which a student has to attempt 5 questions including the question No. 1 which will be compulsory. The question No. 1 will carry 20 marks and will be of short-answer type of questions such as multiple-choice, one-word-answer type, one-word type and fill in the blank type.

**Unit-I**  
 Water relation of plants : Uniqueness of water, physical and chemical properties of water, chemical potential, water potential, apparent free space, movement of water, Soil Plant Atmosphere Continuum (SPAC), regulation of transpiration, signal transduction in guard cells.  
 Membrane Transport : Passive - non-mediated transport and co-transport, Passive-mediated transport, ATP-driven active transport, Uniport, Symport, Antiport, Ion channels.  
 Amino acids, Proteins and Enzymes : Nod factor, root nodule and nitrogen fixation, structure of amino acids, stereochemistry, Apophysis properties, synthesis of amino acids by reductive amination, GS-GOGAT system and transamination.  
 Structure of proteins : Primary, secondary, tertiary, quaternary and domain structure, reverse turn and Ramchandran Plot, protein stability : electrostatic forces, hydrogen bonding, disulfide bonding and hydrophobic interaction.  
 Enzymes : Structure and properties, substrate specificity, classification and mechanism of enzymic action.

**Unit-II**  
 Carbohydrates : Classification, structure and function of monosaccharides, polysaccharides and glycoproteins including starch, cellulose and pectins.  
 Photosynthesis : Photosynthetic pigments, absorption and transformation of radiant energy, photo-oxidation, four complexes of

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Unit-III

thylakoid membranes : photosystem I, Cytochrome b<sub>6</sub>/f complex, photosystem II and coupling factors, photolysis of water and O<sub>2</sub> evolution, non-cyclic and cyclic transposition of electrons, water-water cycle, proton gradient and photophosphorylation, Calvin cycle, regulation of RUBISCO activity, control of Calvin cycle, C<sub>4</sub> pathway and its adaptive significance, CAM pathway, differences between C<sub>3</sub> and C<sub>4</sub> plants, glycolate pathway and photorespiration, chlororespiration and CO<sub>2</sub> concentrating mechanism in micro-organism.

#### Unit-III

Respiration : Anaerobic and aerobic respiration, amphibolic nature of TCA cycle, pentose phosphate pathway, glyoxylate pathway, oxidative phosphorylation, gluconeogenesis, high-energy compounds : their synthesis and utilization.

Fat metabolism : Synthesis of long chain fatty acids, lipid biosynthesis, and oxidation.

Secondary metabolites : Biosynthesis and function of secondary metabolites with special reference to terpenes, alkaloids and steroids.

#### Unit-IV

Plant growth regulators : Auxins - chemical nature, bioassay, physiological effects and mode of action.

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

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

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

Physiology of flowering : Photoperiodism and vernalization.

#### Suggested Readings :

1. Buchanan, B.B., Gruissem, W. and Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.
2. Dennis, D.T., Turpin, D.A., Lefebvre, D.D. and Layzell, D.B. (Eds) 1997. Plant Metabolism (second edition). Longman Essex, England.
3. Galston, A.W. 1989. Life Processes in Plants. Scientific American Library. Springer-Verlag, New York, USA.

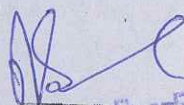
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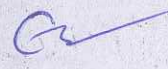
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1. Hooyman, P.J.J., Hall, M.A. and Libbenza, K.R. (eds) 1999. Biochemistry and Molecular Biology of Plant Hormones. Elsevier, Amsterdam, The Netherlands.
2. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons Inc., New York, USA.
3. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology (fourth edition). W.H. Freeman and Company, New York, USA.
4. Moore, J.C. 1989. Biochemistry and Physiology of Plant Hormones. (second edition). Springer-Verlag, New York, USA.
5. Nobel, P.S. 1999. Physicochemical and Environmental Plant Physiology (second edition). Academic Press, San Diego, USA.
6. Salisbury, W.B. and Ross, C.W. 1992. Plant Physiology (4th edition). Wadsworth Publishing Co., California, USA.
7. Singhal, G.S., Regeel, G., Sopory, S.K., Irigang, K.D. and Govindjee (1999) Concepts in Photobiology: Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
8. Taiz, J. and Zeiger, E. 1998. Plant Physiology (2nd edition). Sinauer Associates Inc., Publishers, Massachusetts, USA.
9. Thomas, B. and Vince-Prue, D. (1997) Photoperiodism in Plants (second edition). Academic Press, San Diego, USA.
10. Weibull, P. (1998) Molecular Plant Development from Gene to Plant. Oxford University Press, Oxford, UK.

Suggested Laboratory Experiments

1. Effect of time and enzyme concentration on the rate of reaction of enzyme (acid phosphatase) nitrate reductase.
2. Effect of substrate concentration on activity of any enzyme and determination of its  $K_m$  value.
3. Demonstration of the substrate inducibility of the enzyme nitrate reductase.
4. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids.
5. To determine the chlorophyll a, chlorophyll b ratio in  $C_3$  and  $C_4$  plants.
6. Isolation of intact chloroplasts and estimation of chloroplast proteins by spot protein assay.
7. To demonstrate photophosphorylation in intact chloroplasts, resolve the phosphoproteins by SDS-PAGE and perform autoradiography.

  
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8. Extraction of seed proteins depending upon the solubility.
9. Determination of succinate dehydrogenase activity, its kinetics and sensitivity to inhibitors.
10. Desalting of proteins by gel filtration chromatography employing Sephadex.
11. Preparation of the standard curve of protein (BSA) and Estimation of the protein content in extracts of plant material by Lowry's or Bradford's method.
12. Fractionation of proteins using gel filtration chromatography by Sephadex G100 or Sephadex G200.
13. SDS-PAGE for soluble proteins extracted from the given plant materials and comparison of their profile by staining with Coomassie Brilliant Blue or silver nitrate.
14. Separation of isozymes of catalase, peroxidases by native polyacrylamide gel electrophoresis.
15. Radioisotope methodology, autoradiography, instrumentation (GM count and Scintillation counter) and principles involved.
16. Principles of colorimetry, spectrophotometry and fluorimetry.

*Suggested Readings (for additional exercises)*

1. Bajracharya, D. 1999. Experiments in Plant Physiology : A Laboratory Manual, Narosa Publishing House, New Delhi.
2. Cooper, T.G. 1977. *Booth's Biochemistry*. John Wiley, New York, USA.
3. Copeland, R.A. 1996. *Enzymes : A Practical Introduction to Structure, Mechanism and Data Analysis*. VCH Publishers, New York.
4. Dennison, C. 1999. *A Guide to Protein Isolation*. Kluwer Academic Publishers, Dordrecht, The Netherlands.
5. Devi, P. 2000. *Principles and Methods of Plant Molecular Biology, Biochemistry and Biotechnology*. Anand Publishers, Jodhpur, India.
6. Dryer, R.L. and Lata, G.F. 1989. *Experimental Biochemistry*. Oxford University Press, New York.
7. Haines B.D. (Ed.) 1996. *Gel Electrophoresis of Proteins : A Practical Approach*, 3rd edition. IAS, Oxford University Press, Oxford, U.K.
8. Harborne, T.C. 1981. *Phytochemical Methods : A Guide to Modern Techniques of Plant Analysis*. Chapman & Hall, 1981.

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Moore, J.C. 1971. Research Experiences in Plant Physiology. A Laboratory Manual. Springer-Verlag, Berlin.

10. Nita, A. and Ballou, D.P. 1991. Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Fitzgerald Science Press, Inc. Maryland, USA.

11. Pimpler, D.L. 1991. An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd, New Delhi.

12. Scott, R.E.W. 1993. Techniques and Practice of Chromatography. Martel Dekker, Inc. New York.

13. Wilson, K. and Goulding, K.H. (Eds), 1936. A Biologist's Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, UK.

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

**Paper-V: Microbiology and Plant Pathology**

**Form of Examination** Max. Marks: 100.

Each paper will have 9 questions, out of which a student has to answer 5 questions including the question No.1 which will be compulsory. The question No.1 will carry 20 marks and will be of short answer type of questions such as multiple choice type, short answer type, fill in the blank type and fill in the blank type.

**Unit - I**

**Microbiology**

1. Important landmarks in the history of microbiology: Archaeobacteria and Eubacteria: General account, ultrastructure, nutrition and reproduction, biology and economic importance; Prokaryotes: cell structure and biological importance.
2. Viruses: Classification, characteristics and ultrastructure of virus; Isolation and purification of viruses; chemical nature, replication, transmission of viruses; cyanophages; economic importance.
3. Phytoplankton: General characteristics and role in causing plant diseases.

**Unit-II**

4. Scope and application of microbes in agriculture, industry, food, pollution and biological control of pests.
5. General account of immunity, allergy, properties of antigens and antibodies; antibody structure and function, affinity and anti-

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body specificity. Monoclonal antibodies and their uses, antibody engineering, serology, types of vaccines. Preliminary account of Biofilms, biochips, biosensors and biofactants.

#### Unit-III

##### Plant Pathology

6. History and scope of plant pathology : General account of diseases caused by plant pathogens. Pathogen attack and defense mechanisms. Physical, physiological, biochemical and molecular aspects.

Plant disease management : Chemical, biological, IPM systems, development of transgenics, biopesticides, plant disease clinics. Preliminary account of application of Biotechnology in plant pathology.

#### Unit-IV

Symptomatology, identification and control of following plant diseases:

Fungal diseases : Wheat (Rust, Smut, Bunt), Bajra (Green ear, ergot and smut), rice (rust).

Paddy (Paddy blight), Cotton (Wilt), Grapes (Downy mildew and powdery mildew).

Bacterial diseases : Wheat (Tundu), Citrus canker.

Viral diseases : Tobacco mosaic, Bindi yellow mosaic.

Phytoplasma disease : Little leaf of banyan.

Nematode disease : Root-knot of vegetables.

#### Suggested Readings

1. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. 1996. Introductory Mycology. John Wiley & Sons Inc.
2. Agrios, G.N. 1997. Plant Pathology. Academic Press, London.
3. Albajes, R., Gullibio, M.L., Van Lierden, J.C. and Elad, Y. 2000. Integrated Pest and Disease Management in Greenhouse Crops. Kluwer Academic Publishers.
4. Bridge, P., Moore, D.R. & Scott, P.R. 1997. Information Technology. Plant Pathology and Biodiversity. CAB International, U.K.
5. Clifton, A. 1958. Introduction to the Bacteria. McGraw Hill Book Co. New York.
6. Mandair, G. 1978. Introduction to plant viruses. Chand, & Co. Ltd. Delhi.

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Mehrotra R.S. Plant Pathology, Tata McGraw Hill.  
Rangaswamy G. & Mahadevan A. 1999. Diseases of crop plants in India (4th edition) Prentice Hall of India, Pvt. New Delhi.  
Hosnyally J.G. & A.L. Dimond. Plant Pathology Vols. 1, 2 & 3. Academic press, New York, London.

Privedi, P.C. 1998. Nematode Diseases in Plants. CBS Publisher & Distributor, New Delhi.

Field Laboratory Exercise (Microbiology):

Calibration of microscope, determination of dimensions of micro-organisms (suggested model organisms: yeast, *Lactobacilli*, *Cyanobacteria*).

Cultivation media for autotrophic and heterotrophic microorganisms (cleaning of glassware, mineral media, complex media, solid media, sterilization) (based on topic 1).

Isolation of microorganisms, streaking on agar plates/pour plate method, isolation of clones, preservation (based on topics 2 and 3).

Determination of growth of a microorganism (model organism: *Escherichia coli*, effects of nutrients, e.g. glucose, fructose, sucrose, principle of colorimetry/spectrophotometer) (based on topic 3).

Determination of microbial population size (suggested model organism: yeast, use of haemocytometer, serial dilution technique, relationship between dilution and cell count, determination of standard error, reliability in cell counts) (based on topic 3).

Preparation of Wilt-proneness column using pond-bottom mud. Observations on temporal sequence of appearance of microbes (visual appearance, microscopic observations) (based on topic 3).

Observation on virus infected plants (symptoms) (based on topic 3).

Fermentation by yeast (inerted tube method, use of different substrates, e.g. glucose, fructose, cane sugar, starch) (based on topic 3).

Plant Pathology I:  
Diseases as per theory syllabus.

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Skeleton Paper  
M.Sc. (Previous) Group-I Practical Examination  
Time : 6 Hours

TOTAL : 150

| Q.No. | Questions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Marks allotted |
|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| 1.    | (a) Perform the given molecular biology exercise.<br>(b) Perform the given exercise of cell biology/molecular biology.                                                                                                                                                                                                                                                                                                                                                                        | 16             |
| 2.    | (a) Perform the given exercise of Genetics/Mendel's Monohybrid Cross.<br>(b) Perform the given exercise of Cytogenetics/Polytene chromosome.                                                                                                                                                                                                                                                                                                                                                  | 16             |
| 3.    | (i) Identify two algae from the given mixture. A. Draw labelled diagrams. Comment upon their significant characters and systematic.<br>(ii) Make a suitable preparation of material B. so as show reproductive parts of the fungus.<br>(iii) Draw well labelled diagrams. Identify the fungus giving reasons.<br>(iv) Make a suitable preparation of vegetative reproductive parts of the material C. Draw labelled sketches. Write features of special interest and identify giving reasons. | 8              |
| 4.    | Identify the spots critically (6x3)                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 18             |
| 5.    | Sessional marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 22             |
| 6.    | Viva-voce                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 13             |

Skeleton Paper  
M.Sc. (Previous) Group-II Practical Examination  
Time : 6 Hours

TOTAL : 150

| Q.No. | Questions                                                                                                             | Marks allotted |
|-------|-----------------------------------------------------------------------------------------------------------------------|----------------|
| 1.    | (a) Describe the material in scientific language. Assign it to the relevant family with reasons. Draw floral diagram. |                |

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- (b) Prepare an artificial key of the given plant materials (A, B & C).  
(c) Make a suitable preparation of material 'D'.

|                                                                                                                                               |    |
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| special interest, if any.                                                                                                                     | 10 |
| (d) Make a suitable preparation of given material 'E' (reproductive part only) Draw labelled diagram. Identify it giving reasons.             | 6  |
| Perform the physiology experiments as assigned to you. Describe the methodology and record your observations.                                 | 20 |
| Exercise 'a'                                                                                                                                  | 10 |
| Exercise 'b'                                                                                                                                  | 10 |
| (i) Perform the microbiological exercise given to you. Draw suitable diagram describe methodology and record your observations.               | 10 |
| (ii) Prepare a suitable slide of the given microbiological exercise. Draw diagram, describe methodology and record your results.              | 7  |
| (iii) Prepare a suitable slide of the given material 'D' for histological study. Draw labelled diagram. Identify the pathogen giving reasons. | 12 |
| Spots (6x3)                                                                                                                                   | 18 |
| Herbarium                                                                                                                                     | 5  |
| Sectional Marks                                                                                                                               | 22 |
| Viva-voce                                                                                                                                     | 13 |

| Plant Morphology Developmental Biology |                                                                |
|----------------------------------------|----------------------------------------------------------------|
| Paper-VII                              | : Plant Development and Reproduction                           |
| Paper-VIII                             | : Plant Ecology                                                |
| Paper-IX                               | : Plant Resource Utilization and Conservation                  |
| Paper-X                                | : Biotechnology and Genetic Engineering of Plants and Microbes |
| Paper-XI(a)                            | : Advanced Plant Pathology-I                                   |
| Paper-XI(a)                            | : Advanced Plant Pathology-II                                  |
| Paper-XI(b)                            | : Seed Science and Technology-I                                |
| Paper-XI(b)                            | : Seed Science and Technology-II                               |

| Ecosystem Ecology |                                            |
|-------------------|--------------------------------------------|
| Paper-XI(c)       | : Environmental Biology-I                  |
| Paper-XI(c)       | : Environmental Biology-II                 |
| Paper-XI(d)       | : Advanced Plant Physiology-I              |
| Paper-XI(d)       | : Advanced Plant Physiology-II             |
| Paper-XI(e)       | : Advanced Morphology and Morphogenesis-I  |
| Paper-XI(e)       | : Advanced Morphology and Morphogenesis-II |
| Paper-XI(f)       | : Biostatistics of Angiosperms-I           |
| Paper-XI(f)       | : Biostatistics of Angiosperms-II          |
| Paper-XI(g)       | : Biotechnology-I                          |
| Paper-XI(g)       | : Biotechnology-II                         |

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