M.Sc. (BOTANY)

M. Sc. (ANNUAL PATTERN)

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

Paper 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

प्रभारी अधिकारी
अकादमिक–प्रथम

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

प्रभारी अधिकारी
अकादमिक-प्रथम

M.Sc. (Previous)

There will be six papers in theory, each of three hours duration, 100 marks each and two practical's 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.

प्रभारी अधिकारी
अकादमिक-प्रथम

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 (100 marks are reserved for viva and 50 for 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)

There will be six papers, four compulsory and two elective, in theory of 3 hours duration carrying 100 marks each and two practical 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 several short objective type of questions such as multiple choice type, one line answer type, one word type, 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 ...

प्रभारी अधिकारी
अकादमिक-प्रथम

pulsory. The question Nos. 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 energetics.

Cell wall : Structure and functions, biogenesis, growth.

Plasma membrane : Structure, models and functions, sites for ATPases, ion carriers, channels and pumps, receptors.

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

Unit—II

Chloroplast : Structure, genome organization, gene expression, RNA editing, nucleochloroplastic interactions.

Mitochondria : Structure, genome organization, biogenesis.

Plant vacuole : Tonoplast membrane, ATPase transporters, as storage organelle.

Nucleus : Structure, nuclear pores, nucleosome organization, DNA structure, A, B and Z forms, replication, repair and repair, transcription, plant promoters and transcription factors, splicing, mRNA transport, nucleolus, tRNA biogenesis.

Restriction enzymes : Cleavage of DNA into specific fragments, construction of restriction map from the fragments, restriction 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, cytokinesis and cell plate formation, mechanism of programmed cell death.

Other Cellular Organelles : Structure and functions of microbodies, Golgi apparatus, lysosomes, endoplasmic reticulum.

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

Suggested Readings:

1. Lewin, B. 200. Genes VII. Oxford University Press, New York.
2. Alberts, 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. Rost T, *et al*. 1998. Plant Biology. Wadsworth Publishing Co., California USA.
5. Khitamurthy, 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, Rockville, USA.
7. De, D.N. : 2000. Plant Cell Vacuoles : An Introduction. CSIRO Publication Collingwood, Australia.
8. Kleinsmith, L.J. and Kish, V.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.

सहायक कुलसचिव
अकादमिक-प्रथम

6

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 M/s Bangalore Genei and Centre for Biotechnology (CSIR), Mall Road, Delhi.

Suggested Readings (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 Hames, B.D. (Eds.), 1995. DNA Cloning 1: A Practical Approach. Core techniques. 2nd edition. PASTRL Press at 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. Hackett, P.B., Fuchs, J.A. and Messing, J.W. 1988. An Introduction to Recombinant DNA Techniques : Basic Experiments in Gene Manipulation. The Benjamin Cummings Publishing Co. Inc., Menlo Park, California.
5. Hall, J.L. and Moore, A.L. 1983. Isolation of Membranes and Organelles from Plant Cells. Academic Press, London, UK.
6. Harris, N. and Oparka, K.J. 1994. Plant Cell Biology : A Practical Approach. IRL Press, at Oxford University Press, Oxford, U.K.
7. Shaw, C.H. (Ed.), 1988. Plant Molecular Biology : A Practical

प्रभारी अधिकारी
अकादमिक-प्रथम

Approach. IRL Press, Oxford.

Paper II : Cytology, Genetics and Cytogenetics

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 mixed short objective type of questions such as multiple choice type, one line answer type, one word type and fill in the blanks type with a limit of 2 words.

Unit I

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

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

Unit II

GENETICS

Genetics of prokaryotes and eukaryotic organelles : Mapping 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, introns, and their significance, RNA splicing, regulation of gene expression in prokaryotes and eukaryotes. Panoply of operon, catabolite repression, attenuation and antitermination.

Genetic recombination and genetic mapping : Recom-

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

Unit-III

CYTOGENETICS

Mutations : Spontaneous and induced mutations, physical and chemical mutagens, molecular basis of gene mutations, 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, cellular [illegible] oncogenes and oncogenes.

Sex determination, sex linked inheritance, sex limited characters and sex controlled traits, multiple alleles and blood groups in man.

Cytogenetics of aneuploidy and structural heterozygotes : Effect of haploidy, polyploidy on phenotype in plants, transmission of monosomics and trisomics and their use in chromosome mapping in diploid and polyploid species, breeding behaviour and genetics of structural heterozygotes, complex translocations, heterozygotes, translocation tester sets, Robertsonian translocations, B-A translocations.

Unit-IV

Molecular basis of specificity : Nuclear DNA content, C-value paradox, cot curves and its significance, reiteration frequency, concept and nature of unique, multigene families and their evolution in animals, hybridization—concept and techniques, physical mapping of genes on chromosomes, concept of unique sequence in situ hybridization, fluorescence in situ hybridization and chromosome painting, flow cytometry and confocal microscopy in karyotype analysis.

Allele gene transfer through chromosome manipulations : Transfer of whole genome, examples from wheat, Aegilops and triticale, 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 inbreeding depression, exploitation of hybrid vigour.

Suggested Readings :

1. Albert B. Bray, D., Lewis, J., Raff, M., Robert, K. and Watson, J.D. 1989. Molecular Biology of the Cell (2nd edition). Garland Publishing Inc., New York.
2. Atherly, A.G., Girton, 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 Aneuploids. 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). WCB, McGraw Hill, USA.
10. Malacinski, G.M. and Freifelder, D. 1998. Essentials of Molecular Biology (3rd edition). Jones and B. Artlet Publishers, Inc., London.
11. Russel, P.J. 1998. Genetics (5th edition). The Benjamin/Cummings Publishing Company INd., USA.
12. Snustad, D.P. and Simmons, M.J. 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 nucleolus organizing region, where 18S and 28srDNA are transcribed.
3. Orcein and Feulgen. Staining of the salivary gland chromosomes of Chironomus and Drosophila.
4. Characteristics and behaviour of B chromosomes using maize or any other appropriate material.
5. Working out the effect of mono- and tri-somy on plant pheno-

प्रभारी अधिकारी
अकादमिक-प्रथम

(10)

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 Pub., Amsterdam, Australia.

Paper III : Biology and Diversity of Lower Plants : Cryptogams

Scheme of Examination Max.Marks : 100

There will be 3 papers. 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 word 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 Prolochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta : with special reference to *Microcystis, Hydrodictyon, Drapernaldiopsis, Cosmarium*, algal blooms, algal biofertilizers : algae as food, feed and use in industry.

Unit—II

Mycology : General characters of fungi, substrate relationship in fungi, cell ultrastructure, unicellular and multicellular 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 *Albugo, Claviceps, Morchella, Melampsora, Polyporus, Drechslera & 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, Jungermaniales, Anthocerotales, Sphagnales, Funariales and Polytrichales, with special reference to *Pleurochaena, Notochylus* 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 pteridophyta, introduction to Psilopsida, Lycopsida, Sphenopsida and Pteropsida, with special reference to *Lycopodium, Gleichenia, Pteris, Isoetes & Equisetum*.

Suggested Reading

Alexopoulus, C.J., Mims, C.W. and Blackwel, M. 1996. Introductory Mycology, John Wiley & Sons Ind.

Clifton, A. 1958. 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 Aneja, R.S. 1998. An Introduction to Mycology. New Age Intermediate Press.

Morris, I.1986. An Introduction to the Algae. Cambridge University Press, U.K.

Parihar, N.S. 1991. Bryophyta. Central Book Depot, Allahabad.

Parihar, N.S. 1996. Biology & Morphology of Pteridophytes.

Central Book Depot, Allahabad.

Puri, P. 1980. Bryophytes. Atma Ram & Sons, Delhi.

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

Round, F.E. 1986. The Biology of Algae. Cambridge University Press, Cambridge.

Sporne, K.R. 1991. The Morphology of Pteridophytes. B.I. Publishing Pvt. Ltd., Mumbai.

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

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

Suggested Laboratory Exercises

Morphological study of representative members of algae, fungi, bacteria, bryophytes and pteridophytes : *Microcystis, Aulosira, Oocystis, Pediastrum, Hydrodictyon, Ulva, Pithophora, Stigeoclonium, Draparnaldiopsis, Closterium, Cosmarium, Chara, Stemonitis, Peronospora, Albugo, Mucor, Pilobolus, Yeast, Emericella, Chaetomium, Pleospora, Morchella, Melampsora, Phallus, Polyporus, Drechslera, Phoma, Penicillium, Aspergillus, Colletotrichum, Marchantia, [illegible], Polytrichum, Psilotum, Lycopodium, Selaginella, Equisetum, Gleichenia, Pteris, Ophioglossum, Isoetes.*

Symptomology of some diseased specimens: White rust, downy mildew, powdery mildew, rusts, smuts, ergot, groundnut leaf spot, red rot of sugarcane, wilts, paddy blast, citrus canker, bacterial blight of paddy, angular leaf spot of cotton, tobacco mosaic, little leaf of brinjal, sesame phyllody, mango malformation.

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

Gram staining of bacteria.

Identification of fungal cultures : *Rhizopus, Mucor, Aspergillus, Penicillium, Emericella, Chaetomium, Drechslera, [illegible], Fusarium, Phoma, Colletotrichum, Graphium.*

Sterilization methods, preparation of media and stains.

~~Paper – IV : Taxonomy and Diversity of Seed Plants~~

~~Scheme of Examination~~ ~~Max. Marks : 100~~

~~Each paper will have 9 questions, out of which a [illegible]~~

प्रभारी अधिकारी
अकादमिक-प्रथम

13

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.

प्रभारी अधिकारी
अकादमिक-प्रशाख

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.

प्रभारी अधिकारी
अकादमिक-प्रथम

Suggested Readings

Bhatnagar, S.P. and Moitra, A. 1996. Gymnosprms. 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 21st Century. Portlant Press Ltd., London.

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

Singh, H. 1978, Embryology of Gymnosprms. 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-Weslley Publicating Co. Ind., USA.

Stebbings, 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 pans 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.

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 Apiaceae, (16) Rubiaceae, (17) Asteraceae, (18) Primulaceae, (19) Plumbaginaceae, (20) Asclepiadaceae, (21) Convolvulaceae, (22) Solanaceae, (23) Boraginaceae, (24) Polemoniaceae, (25) Acanthaceae, (26) Pedaliaceae, (27) Martyniaceae, (28) Bignoniaceae, (29) Labiatae, (30) Nyctaginaceae, (31) Polygonaceae, (32) Chenopodiaceae, (33) Amaranthaceae, (34) Aizoaceas, (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.

प्रभारी अधिकारी
अकादमिक-प्रभाग

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 several short objective type of questions such as multiple choice type, one line answer type, one word type and fill in the blanks type. Unit-I

Water relation of plants : Unique physicochemical properties of water, chemical potential, water potential, apparent free space, long distance movement of water, Soil Plant Atmosphere Continuum (SPAC), stomatal regulation of transpiration, signal transduction in guard cell.

Membrane Transport : Passive - non-mediated transport and facilitated, Passive-mediated transport, ATP-driven active transport, Uniport, Symport, Antiport Ion channels.

Amino Acids, Proteins and Enzymes : Nod factor, root nodulation and nitrogen fixation, structure of amino acids, stereoisomers, Amphoteric 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 enzyme 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

thylakoid membranes : photosystem I, cytochrome b-f complex, photosystem II and coupling factors, photolysis of water and O_2 evolution, non-cyclic and cyclic transportation of electrons, water-water cycle, proton gradient and photophosphorylation, Calvin cycle, regulation of RUBISCO activity, control of Calvin cycle, C_4 pathway and its adaptive significance, CAM pathway, differences between C_3 and C_4 plants, glycolate pathway and photorespiration, chlororespiration and CO_2 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 terpene, 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.H., Lefebvre, D.D. and Layzell, D.B. (Eds) 1997. Plant Metabolism (second edition). Longman Essex, England.
3. Galston, A.W. 1989. Life Processes in Plants. Scientific American Library, Springer-Verlag, New York, USA.

19

4. Hooykaas, P.J.J., Hall M.A. and Libbenga, K.R. (eds) 1999. Biochemistry and Molecular Biology of Plant Hormones. Elsevier, Amsterdam, The Netherlands.
5. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA.
6. 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.
7. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones. (second edition). Springer-Verlag, New York, USA.
8. Nobel, P.S. 1999. Physiochemical and Environmental Plant Physiology (second edition). Academic Press, San Diego, USA.
9. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4th edition). Wadsworth Publishing Co., California, USA.
10. Singhal, G.S., Renger, G., Sopory, S.K., Irrgang, K.D. and Govindjee. 1999. Concepts in Photobiology : Photosynthesis and Photomorphogenesis. Narosa Publishing House, New Delhi.
11. Taiz, L., and Zeiger, E. 1998. Plant Physiology (2nd edition). Sinauer Associates, Inc., Publishers, Massachusetts, USA.
12. Thomas, B. and Vince-Prue, D. (1997). Photoperiodism in Plants (second edition). Academic Press, San Diego, USA.
13. Westhoff, P. (1997). Molecular Plant Development: From Gene to Plant. Oxford University Press, Oxford, UK.

Suggested laboratory exercises :

1. Effect of time and enzymes 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 Km value.
3. Demonstration of the substrate inducibility of the enzyme nitrate reductase.
4. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids.
5. To determine the chlorophyll a, chlorophyll b ratio in C_3 and C_4 plants.
6. Isolation of intact chloroplasts and estimation of chloroplast proteins by any protein assay.
7. To demonstrate photophosphorylation in intact chloroplasts, resolve the phosphoproteins by SDS-PAGE and perform autoradiography.

प्रभारी अधिकारी
अकादमिक-प्रथम

20

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

Suggested Readings (for laboratory exercise)

1. bajracharya, D. 1999. Experiments in Plant Physiology : A Laboratory Manual. Narosa Publishing House, New Delhi.
2. Cooper, T.G. 1977. Tools in Biochemistry. John Wiley, New York, USA.
3. Copeland, R.A. 1998. 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 Genetics. Agrobios, Jodhpur, India.
6. Dryer, R.L. and Lata, G.F. 1989. Experimental Biochemistry. Oxford University Press, New York.
7. Haines B.D. (Ed.) 1998. Gel Electrophoresis of Proteins : A Practical Approach, 3rd edition, PAS, Oxford University Press, Oxford, U.K.
8. Harborne, T.C. 1981. Phytochemical Methods : A Guide to Modern Techniques of Plant Analysis. Chapman & Hall, London.

Moore, T.C. 1974. Research Experiences in Plant Physiology: A Laboratory Manual. Springer-Verlag, Berlin.
Nivia, A.J. and Ballou, D.P. 1998. Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Fitzgerald Science Press, Inc. Maryland, USA.
Plummer, D.T. 1991. An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd, New Delhi.
Scott, R.P.W. 1995. Techniques and Practice of Chromatography. Marcel Dekker, Inc. New York.
Wilson, K. and Goulding, K.H. (Eds), 1986. A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, UK.
Wilson, K. and Walker, J. 1994. Practical Biochemistry : Principles and Techniques. 4th edition. Combridge University Press, Cambridge, UK.

Paper-VI: Microbiology and Plant Pathology

Max. Marks : 100

Scheme of Examination

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, matching type and fill in the blanks type.

Unit - I

Microbiology

1. Important landmarks in the history of microbiology.
2. Bacteria and Archaebacteria : General account, ultrastructure, nutrition, reproduction, biology and economic importance, and their salient features and biological importance.
3. Viruses: Classification, characteristics and ultrastructure of virus, isolation and purification of viruses, chemical nature, replication, transmission of viruses, cyanophages, economic importance.
4. Phytoplasma : 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-

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

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

Symptomology, identification and control of following plant diseases.

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

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

Bacterial disease : Wheat (Tundu), Citrus canker.

Viral disease : Tobacco mosaic, Bhindi yellow mosaic.

Phytoplasma disease : Little leaf of brinjal.

Nematode disease : Root-knot of vegetables.

Suggested Readings

1. Alexopoulus, C.J., Minis, C.W. and Blackwel, M. 1996. Introductory Mycology. John Wiley & Sons Inc.
2. Agrios, G.N. 1997. Plant Pathology. Academic Press; London.
3. Albajes, R., Gullino, M.L., Van Lenteren, J.C. and Elad, Y. 2000. Integrated Pest and Disease Management in Greenhouse Crops. Kluwel Academic Publishers.
4. Bridge, P., Moore, D.R. & Scott, P.R. 1998. Information Technology. Plant Pathology and Biodiversity. CAB International, U.K.
5. Clifton, A. 0958. Introduction to the Bacteria. McGraw Hill Book Co. New York.
6. Mandahar, C.L. 1978. Introduction to plant viruses. Chand & Co. Ltd. Delhi.

Mehrotra R.S. Plant Pathology, Tata McGraw Hill.
Ringaswamy G. & Mahadevan, A. 1999. Diseases of crop plants in India. (4th edition) Prentice Hall of India P.t. New Delhi.
Horsfall, G. & A.E. Dimond. Plant Pathology Vols. 1, 2 & 3. Academic press, New York, London.
Tripathi, P.C. 1993. 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 glasswares, mineral media, complex media, solid media, sterilization) (based on topic 1).

Isolation of microorganisms streaking on agar plates/pour plate method, (solution 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/spectrocolorimeter), (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 Winogradsky column using pond bottom mud. Observations on temporal sequence of appearance of microbes (visual appearance, microscopic observations) (based on topic 4).

Observation on virus infected plants (symptoms) (based on topic 5).

Fermentation by yeast (inverted tube method, use of different substrates, e.g. glucose, fructose, cane sugar, starch) (based on topic 8).

Plant Pathology :
Diseases as per theory syllabus.

प्रभारी अधिकारी
अकादमिक-प्रथम

24

Skeleton Paper
M.Sc. (Previous) Group-I Practical Examination

Time : 6 Hours M.M. : 150

Q.No.	Questions	Marks allotted
1.	(a) Perform the given molecular biology exercise.	16
	(b) Perform the given exercise of cell biology/ molecular biology.	15
2.	(a) Perform the given exercise of Genetics/Mitosis/ Meiosis	16
	(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.	8
	(ii) Make a suitable preparation of material 'B' so as show reproductive parts of the fungus.	8
	(iii) Draw well labelled diagrams. Identify the fungus giving reasons.	8
	(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 (6×3)	18
5.	Sessional marks	22
6.	Viva-voce	15

Skeleton Paper
M.Sc. (Previous) Group-II Practical Examination

Time : 6 Hours M.M. : 150

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

प्रभारी अधिकारी
अकादमिक-प्रथम

25

(b) Prepare an artificial key of the given plant materials (A, B & C). 6

(c) Make a suitable preparation of material 'D'.

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.

Exercise 'a' 20

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

Spotting 18

Herbarium 5

Sessional Marks 22

Viva voce 15

Plant Morphology, Development and Reproductive Biology

M.Sc. Final

Paper-VII : Plant Development and Reproductive Biology

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-XII(a) : Advanced Plant Pathology-II

Paper-XI(b) : Seed Science and Technology-I

Paper-XII(b) : Seed Science and Technology-II

Ecosystem Ecology

Paper-XI(c) : Environmental Biology-I

Paper-XII(c) : Applied Zoology/Environmental Biology

Paper-XI(d) : Advanced Plant Physiology-I

Paper-XII(d) : Advanced Plant Physiology-II

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

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

Paper-XI(f) : Biosystematics of Angiosperms-I

Paper-XII(f) : Biosystematics of Angiosperms-II

Paper-XI(g) : Biotechnology-I

Paper-XII(g) : Biotechnology-II

26