

COURSES OF STUDIES

For
2007-2008

MASTER OF SCIENCE BOTANY



**RAVENSHAW UNIVERSITY
CUTTACK**

COURSES OF STUDIES

SYLLABUS

P.G - Part - I

Semester- I

Paper –I

Unit - I Cell & Molecular Biology of Plants - I

Unit - II Cell & Molecular Biology of Plants - II

Unit - III Protein Sorting

Cell Cycle & Apoptosis

Techniques in Cell Biology

Paper –II

Unit - I Microbiology & Plant Pathology

Unit -II Mycology

Unit -III Phycology

Paper -III

Unit – I Bioenergetics & Enzymology

Unit –II Transport & Signal transduction

Unit –III Photochemistry & Photosynthesis, Lipid Metabolism

Paper – IV & V

Practical

Semester-II

Paper -VI

Unit –I Cytogenetics

Unit –II Cytology

Unit –III Genetics

Paper VII**Unit - I** Bryophytes & Pteridophytes.**Unit - II** Gymnosperms, Fossil & Fossilization.**Unit - III** Taxonomy.**Paper –VIII****Unit - I** Plant respiration, Nitrogen fixation, Nitrogen & Sulphur Metabolism**Unit - II** Plant growth regulators & Stress Physiology**Unit - III** Biostatistics**Paper –IX&X**

Practical

P.G Part –I**Semester-I****Paper –I****Cell and Molecular Biology****FM-****Time: Hrs.****Unit - I Cell & Molecular Biology of Plants - I**

Structural Organization of the Plant cell : Cell Wall , Structure , Biogenesis & functions

Plasma membrane: Structure, function;

Plasmodesmata: Structure & its role in movement of macromolecules; Mitochondria: Structure, Genome organization, Biogenesis

Chloroplast: Structure, Genome organization,

Biogenesis

Ribosome: Structure & function

Plant Vacuole: Tonoplast membrane, Transporters, Vacuole as Storage organelle;

Structure & function of ER, Golgi apparatus,

Lysosomes & Microbodies (Peroxisome & Glyoxisomes) , Cytoskeleton.

Unit –II Cell & Molecular Biology of Plants - II

Nucleus : Structure & function , Nucleolus: Structure & function , Chromatin heterochromatin & Euchromatin, Morphology of Chromosomes ,Molecular organization of centromere and telomere, Molecular organization of Chromatin / Chromosome ,Special type of Chromosomes & Sex Chromosomes, Karyotype analysis, banding pattern.

Nucleic Acid: Structure of DNA , A , B , & Z forms of DNA, Replication, damage & repair of DNA; RNA : Types , Structure & Function , Transcription, Transcription factors , Promoters , Splicing of RNA

Unit - III Protein Sorting, Cell cycle, Apoptosis, Techniques in cell Biology

Translation & Post translational Modifications

Protein sorting: Targeting of Proteins to organelles.

Cell cycle: Control mechanism, Role of cyclin and

cyclin dependent kinases,
Apoptosis: Mechanism of programmed plant cell death.
Techniques in cell Biology : Cell fractionation,
Autoradiography, Electrophoresis, Immunotechniques,
Flow cytometry, Confocal microscopy

Semester-I

Paper –II

(Biology and Diversity of Plant Kingdom)

FM-

Time: Hrs.

Unit - I Microbiology:

Archaeobacteria, Eubacteria : General Account,
Ultrastructure, Nutrition, Reproduction, Economic
importance.

Cyanobacteria : Salient features and biological
importance

Virus : Characteristics and ultra structure of viruses ,
isolation & purification of viruses , chemical nature ,
replication , transmission of viruses , economic
importance

Mycoplasma: General Characteristics and role in
causing plant diseases. Pathology : General accounts
of disease caused by plant pathogens, physical,
physiological , biochemical and molecular aspects of

pathogen attack and defense mechanism.

Genes for virulence and avirulence, their application in
resistance & susceptibility.

Unit – II Mycology

Substrate relationship in fungi, Fungal cell:
ultrastructure, cell wall composition, nutrition (Saprobic,
Biotrophic, Symbiotic); reproduction (vegetative,
Asexual, Sexual), heterothallism in Fungi.

Classification and salient features of Mastigomycotina,
Zygomycotina, Ascomycotina, Basidiomycotina,
Deuteromycotina.

Fungi in industry, medicine and as food.

Fungi as biocontrol agent.

Unit –III Phycology

Algae in diversified habitat; Cell structure, thallus
organization, reproduction, Criteria for classification of
algae (Pigment, reserve food, flagella).

Classification, salient features of Protochlorophyta
Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta,
Phaeophyta; Rhodophyta .

Algal blooms, algae as biofertilizers, Algae as food,
feed, uses in Industry.

Semester-I**Paper – III****Unit - I Bioenergetics, Enzymology, Biochemistry, Photochemistry**

Principles of Thermodynamics, concept of free energy, Standard free energy, Free energy change, ATP as universal currency of free energy in biological systems, Free energy of hydrolysis of ATP and other organophosphates. Enzymology:

General aspects, Properties, Nomenclature, Classification, General Principles, Mechanism of enzyme reaction catalyzed by chymotrypsin, enzyme kinetics, Michaelis- Menten equation and its significance, Line weaver, Briggs-Haldane modifications, enzyme inhibition, regulation of enzyme action by allosteric mechanism.

Unit - II Transport & Signal transduction

Translocation of water and solutes: Plant water relations, absorption and translocation of water, mechanism of water transport through xylem, membrane transport, proteins, absorption of inorganic solutes, Translocation of organic solutes, phloem loading and unloading

Signal Transduction: General principles of cell

communication, Signaling through G- protein linked cell surface receptors, signaling through enzyme-linked cell surface receptors, signaling in plants.

Unit - III Photochemistry, Photosynthesis, Lipid metabolism

Photo chemistry and Photosynthesis: General concept, organizations of photosynthetic apparatus, organizations of light harvesting or absorbing antenna system, photo-oxidation of water, mechanism of electron transport, proton transport and ATP synthesis in chloroplast, calvin cycle, regulation of the calvin cycle, photorespiration, C₄-cycle, CAM pathway, biosynthesis of starch and sucrose.

Lipid Metabolism: Structure and Function of lipids, Fatty acid biosynthesis, oxidation of fatty acids, synthesis of membrane lipids.

Semester-I**Practical****Paper - IV**

1. Sterilization methods, preparation of media and stains.
2. Study of morphology of bacteria.
3. Isolation & staining of commonly occurring cyano bacteria.
4. Gram staining of bacteria.
5. Identification of bacterial cultures.

6. Study of mycoplasma infected plants.
7. Methodology of studying algae in the field and laboratory. Measurement of length, breadth and diameter of algal cells, spores, using ocular and stage micrometer.
8. Collection of algae from various habitat of the locality, their separation, preparation of temporary and permanent mounts & identification.
9. Study of thull-us and reproductive structure of members of all classes of algae (through permanent microscopic preparation and preserved specimens) for identification and determination of their systematic position.
10. Temporary and permanent preparation for microscopic observation of external features, internal structures and reproductive bodies of important genera belonging to all important classes of fungi.
11. Comparative study for demonstrating the evolution of sporangial structures in phycomycetes.
12. Histological study of the host parasite relation in some common fungal diseases.
13. Collection, identification and preservation of common plant diseased materials of the locality.

Practical**Paper - V**

1. Isolation of mitochondria and the study of activity of its marker enzyme, succinate dehydrogenases (SDH).

2. Isolation of chloroplast and the study of protein profile of RUBISCO by SDSPAGE.
3. Isolation of plant DNA and quantification of extracted DNA by spectrophotometric method.
4. Isolation of RNA and quantification of extracted RNA by spectrophotometric method.
5. Orcein and feulgen staining of the salivary gland chromosome of Drosophila.
6. Squashing technique for study of mitosis and meiosis. Use of camera Lucida to draw chromosome and calculating the magnification.
7. To find out the mitotic index of dividing cells of Allium cepa root tips.
8. Karyotypic analysis in two species of a genus and to establish distinction between them.
9. Study of principles of spectrophotometer and verification of Beer Lambert's law.
10. Effect of time and enzyme concentration on the rate of reaction of enzyme (Phosphatase and nitrate reductiase)
11. Effect of substrate concentration on activity of any enzyme and determination of its Km value.
12. Extraction of chlorophyll pigment from leaves and preparation of the absorption spectra for chlorophylls and carotenoids.

13. To determine chlorophyll-a:chlorophyll-b ratio in C3 & C4 plants.
14. Isolation of intact chloroplasts and demonstration of DCPIP reduction / photophosphorylation.

Semester - II**Paper-VI****FM-****Time: Hrs.****UNIT - I Cytogenetics**

Genetic recombination & chromosome mapping in prokaryotes: Genetic recombination & chromosome mapping in bacteriophage, Recombination and Chromosome mapping in bacteria through conjugation, transformation, transduction, sex-duction, mitochondrial genome mapping.

Genetic recombination & chromosome mapping in eukaryotes: linkage as deviation from independent assortment, chromosome mapping, coincidence coefficient, interference, cytological basis of genetic crossing over using marker chromosomes (correlation of genetic and physical map, molecular mechanism of recombination.

UNIT-II Chromosome number variation, structural alteration

Numerical alteration in chromosomes : Origin,

occurrence, production and breeding behavior of haploids, Origin, occurrence, meiosis & genetic significance of aneuploids with characterization of monosomics and trisomics; Origin, occurrence , meiosis and breeding behavior of polyploids (autopolyploids and allopolyploids), genome analysis in allopolyploids, role of polyploids in the evolution of some major crop plants.

Structur alteration in chromosomes:

Origin,meiosis, breeding behaviour and genetic significance of duplication, deficiency, inversion and translocation heterozygotes.

UNIT-III Genetics:

Mutation : Spontaneous & induced mutations, physical and chemical mutagens and their role in inducing mutation, molecular basis of gene mutation, transposable elements in prokaryotes and eukaryotes and their role in inducing mutations, site directed mutagenesis, Development of cancer at cellular level, proto oncogenes and oncogenes.

Molecular cytogenetics: Nuclear DNA content, C-Value paradox, cot curve and its significance, restriction mapping- concept and technique, multigene families and their evolution.

Semester – II**Paper-VII****Diversity of Plant Kingdom and
Taxonomy of Angiosperms.**

FM-

Time: Hrs.

UNIT - I Bryophytes & Pteridophytes

Origin of Bryophytes, morphological and anatomical diversities in Bryophytes, evolution of sporophyte in Bryophytes.

Classification and salient features of Hepaticopsida, Anthocerotopsida and Bryopsida. Economical and ecological importance of Bryophytes.

Pteridophytes:

Classification of Pteridophytes, evolution of stele in Pteridophytes, Heterospory and origin of seed habit, soral evolution in Filicales.

General structure, reproduction, phylogeny of Psilopsida, Lycopsida, Sphenopsida and Pteropsida.

UNIT - II Gymnosperms, Fossil & Fossilization

Gymnosperm : Classification of Gymnosperm, distribution Gymnosperm in India, origin and evolution of Gymnosperms, general structure , reproduction and Phylogeny in living Cycadopsida, Coniferopsida, Gnetopsida.

Fossil and Fossilization: Fossil and Fossilisation process, structure and phylogeny of Psilophytales, Lepidodendrales, structure and phylogeny of Pteridospermales, Cycadeoidales, Cordaitales.

UNIT-III Taxonomy

The species concepts, Taxonomic hierarchy- species, genus, family and other categories, delimitation of taxa and attribution of rank,

Salient Features of ICBN, Taxonomic evidence, Morphology, Anatomy, Palynology, Embryology, Cytology, Phyto-chemistry.

Systems of angiospermic classification: Phenetic versus Phylogenetic system, relative merits and demerits of major system of classification (Bentham and Hooker, Engler Prantle, Hutchinson, Cronquist, Takhatjan).

Concepts of phytogeography, Endemism: Phytography and Phylogeny of Ranales, Malvales, Geraniales, Sapindales, Rosales, Umbellales, Rubiales, Campanulales, Ericales, Ebenales, Gentianales, Lamiales, Microspermae, Scitamineae, Liliflorae and Glumiflorae

Paper-VIII**PLANT RESPIRATION, NITROGEN & SULPHUR METABOLISM, GROWTH REGULATOR, STRESS PHYSIOLOGY, BIostatISTICS****UNIT-I Plant Respiration, Nitrogen Fixation, Nitrogen and Sulphur Metabolism**

Plant Respiration: An overview, Glycolysis, TCA cycle, Regulation of Glycolysis and TCA cycle, Electron transport and ATP synthesis, Pentose Phosphate Pathway, Glyoxylate Cycle.

Nitrogen Fixation, Nitrogen and sulphur Metabolism: Nitrogen in environment, Biological N_2 - Fixation, Nodule formation and nod factors, Nitrogenase, Nif genes, Nitrate Assimilation, Ammonium Assimilation.

Sulphur uptake, Assimilation and reduction.

UNIT-II Plant Growth Regulators:and Stress Physiology

Plant Growth Regulators:Mechanism of action and Physiological effect of Auxins, Gibberellins, cytokinins, Ethylene, Abscissic acid, polyamines. Hormonal receptors, Signal transduction and gene action.

Floral induction and development: Genetics and molecular analysis, role of vernalization.

Stress Physiology: Plant responses to Biotic and Abiotic stress, Mechanism of Biotic and Abiotic stress

tolerance, water deficit and drought resistance, Salinity stress and Salinity resistance, metal toxicity, Freezing and heat stress, Oxidative stress.

UNIT-III Biostatistics

Laws of probability: Addition and multiplication rules; Probability distribution, Binomial distribution, poisson distribution, normal distribution, hypothesis testing, significance of means of large and small samples, T-test, F-test, Chi-square test: Simple linear correlation, simple linear regression,

Design of experiments: Randomized Block design, split plot design.

Suggested Reading:**Paper - I**

1. Alberts, B.B. Lewis J.Raff M.Roberts, K and Watson, J.D. 1999. Molecular Biology of the cell. Garland. Wolfe S.L. 1993.
2. Molecular and cellular Biology. Word Worth Publishing Co. california, U.S.A.
3. Krishnamurty; K.V. 2000 Methods in cell wall cytochemistry. CRC Press. Boca Rat on, Florida.
4. Guchanan. B.B.Guisse, W. and Jones R.L.2000 Biochemistry and Molecular Biology of plants. American Society of Plant Physiologist, Maryland, U.S.A.

5. De, D.N. 2000 Plant Cell vacuole: An introduction. CSTRO Publication. Colling Wood. Australia.
6. Klein Smith, L.J and Kish, V.M. 1995, Principle of cell and molecular Biology (2nd Edition) Harper cdlins college Publisher, Newyork. U.S.A.
7. Loldish, H. Berk, A. Zipurskt S.L. Matsudaire, P.Baltimore, D. and Darnell, J. 2000. Molecular cell biology (4th Edition) W.H. Freeman and Co. New York U.S.A.
8. Karp, G. 1999 Genes and Molecular Biology: Concepts and Experiments; John Willey and Sons, U.S.A.
9. Lewin B. 2000; Gene VII; Oxford University Press, NewYork U.S.A.
10. Malacinsky, GDD and Freifelder, D. 1998. Essentials Molecular Biology (3rd Edition) Jones and Bartlet Publisher M.C. London.
11. Fu, T-J, Singh, G., and Cuntis, W.R. (Eds) (1999) Plant cell and tissue culture for the Production of food ingredients Kluwer Academic / Renum Press.
12. Henny, R.J. (1997) Practical Application of Plant Molecular Biology, Cuapmman and Hall.
13. Annual Review of Plant Physiology and Molecular Biology, Annual review of Biochemistry Academic Press.

14. Cluawal, H.S. (1998) Biotechnology in corp improvement International Book distributing Company.
15. Rastogic, S.C. (2001) Cell and Molecular Biology New Age international Publisher, New Delhi.

Suggested Reading:**Paper II**

1. Smith, G.M. (1965) Cryptogamic Botany. Vol I and II Mc Graw Hill Book Co.
2. Fritsch, F.G.(1968) The Algae Vol I and ii Cambridge University Press.
3. Presocct, G.W. (1968) The Algae, Areved. Mc Graw Hill Book Company.
4. Alexopoulos. C.J.Mims, C.W and Blackwel M. 1996. Introductory Mycology. John wiley and Sons inc.
5. Clifton, A 1958. Ontroduction to Bacteria, Mc Graw Hill Book Co. New York.
6. Kumar H.D, 1988. Introductory Phycology. Affiliated East-West Press Ltd. New Delhi.
7. Manadhar, C.L. 1978. Introduction to Plant Virusess. Chand & Co. Ltd Delhi.
8. Mohrotra, R.S. 1998. An introduction to Mycollogy. New Age Intermediate Press
9. Morris. I. 1986. An introduction to the Algae. Cambridge University Press U.K.

10. Rangaswamy, G and Mahadevan, A. 1999 Diseases of Crop Plants in India (4th. Edition) Prentice Hall of India Pvt. Ltd. New Delhi.
11. Round R.F. 1986. The Biology of Algae. Cambridge University Press. Cambridge.
12. Webster, G. 1985. Introduction to Fungi, Cambridge University Press.

Suggested Reading:**Paper III**

1. Buchanan, B.B. Gruissem. W and Jones, R.L.2000. Biochemistry and Molecular Biology of Plants. American society of Plant physiologists, Maryland U.S.A.
2. Dechis, D.T., Turpin, D.H., Lefebvere, 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. U.S.A
4. Singhal, G.S, Renge, G., Sopory, S.K. Irrgang, K.D. and Govindjee 1999. Concepts in Photobiology Photosynthesis and Photomorphogenesis. Narosa Publishing house New Delhi.
5. Hopkins. W.G. 1995. Introduction to plant Physiology. John Wiley & Sons. Inc., New York, U.S.A.

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, NewYork. U.S.A
7. Salisbury. F.B. and Ross C.W. 1992. Plant Physiology (4th Edition). Wadsworth Publishing Co. California, U.S.A.
8. Taiz, L and Zeiger, E. 1998. Plant Physiology (2nd Edition). Sinauer associate. Inc Publishers Massachusetts. U.S.A.
9. Noggle, C.R. and Fritz, G.J. (1976) Introductory plant physiology, Prentice Hall.
10. Goodwin T.W. & Mercer, E.I 1983, Introduction to Plant Biochemistry, Pergamer press, New York.
11. Wilkins, M.B. (1987) Advanced Plant Physiology, ELBS.

Suggested Reading:**Paper VI**

1. Atherly, A.G.,Giroton J.R. and Mc Donald, J.F 1999, The science of Genetics, Sounders college publishing U.S.A. fort worth U.S.A
2. Durnham, C.R. 1962 Discussion in Cytogenetics, Burgass Publishing Co., Minnosota.
3. Hartl D.L. and Jones E.W. 1998, Genetics Principles and Analysis (4th Edition) Jones and Bartett Publishers Massachusetts U.S.A.
4. Khush T.N. 1973. Cytogenetics of aneuploids. Academic Press New York London.

5. Lewis 1997 Human Genetics Concepts and application (2nd Edition) WCB Mc Graw Hill.
6. Russel P.J. 1998 Genetic (5th Edition) The Benjamin Cummings Publishing Company inc U.S.A
7. Sunsted D.P. and Sunpens M.J. 2000, Principles of Genetics (2nd Edition) John Willey and Sons inc. U.S.A.
8. Singh B.D. (2001) Fundamentals of Genetics, Kalyani Publishers, New Delhi.
9. Davies, J.A. and Reznikolf, W.S. (1992) Milestones in Biotechnology Classic Papers on Genetic Engineering, Butter Worth Heixeman, Boston.
10. Hammoxd, J.Mc. Gonevey, P. and Yusibov V.(Eds) (2000) Plant Biotechnology Springer Verlag.
11. Henny R,J (1997) Parctical / Application of Plant Molecular Bilogy, Cuapmman and Hall.
12. Annual Review of Plant Physiology and Molecular Biology, Academic Press.

Suggested Reading:**Paper VII**

1. Parihar, N.S. Bryophyta Central Book Depot, Allahabad.
2. Parihar. N.S. Biology & Morphology of Pteridophytes Central Book Depot, Allahabad.
3. Sporne K.K. The Morphology of Pteridophytes. B.I. Publishing Pvt. Ltd., Bombay

4. Stewart W.N. and Rathwell, G.W. 1993 Paleobotany and the Evolution of Plant, Cambridge University Press.
5. Andrews, H.N. Studies in Plaeobotany
6. Bhatnagars S.P. and Moitra, A. Gymnosperms. New Age International Pvt. Ltd New Delhi.
7. Cole, A.J. Numerical Taxonomy, Academic Press London
8. Devis, P.H. and Heywood, V.H. 1973 Principles of Angiosperm Taxonomy, Robet E. Kreinger Pub Co. New York.
9. Grant, V. 1971 Plant Speciation Columbia University Press New York.
10. Grant, W.F. 1984 Plant Biosystematins, Academic Press London.
11. Harrison, H.J. 1971 New Concepts in flowering Plant Taxonomy, Hieman Educational Book. Ltd., London.
12. Heslop-Harrison, J. Plant Taxonomy, English Language Book soe & Edward Arnold Pub. Ltd. UK
13. Heywood V.H. and Moore D.M. 1984 Current Concepts in Plant Taxonomy. Academic Press London.
14. Jones A.D. and Wilbins, A.D. 1971 Variations and Adaptatin in Plant Species Himan &Co. Educational Book Ltd. London.
15. Jones, S.B. Jr. and Lushsinger A.E. 1986 Plant Systematic (2nd Edition) Mc Graw-Hill Book Co., New York.

16. Nordenstam. B.El. Gazarly, G. and Kassas, M. Plant Systematic for 21st Century Porland Press Ltd. London.
17. Radford, A.E. Fundamentals of Plant Systematic Harper & Row Publications, USA

Suggested Reading:**Paper XVII**

1. Bhojwani S.S. Plant Tissue Culture. Applications)and Limitations. Elsevier Science Publishers, New York U.S.A.
2. Brown. T.A. Genomes. John Wiley & Sons (Asia)Pvt. Ltd., Singapore.
3. Callow J.A. Ford-Lloyd, B.V. and Newbury. H.J Biotechnology and Plant Genetic Resources: Conservation and Use CAB International, UK.
4. Chrispeels, M.J and Sadava. D.F. Plants Genes and Agriculture, Jones and Bartiett Publishers, Boston USA.
5. Collins. H.A and Edwards. S. Plant Cell Culture. Rios Scientific Publishers Oxford.UK.
6. Glazer, A.N. and Nikaido, H. Microbial Biotechnology. W.H. Freeman and Company, New York USA.
7. Gustafson, J.P. Genomes, Kluwer Academic Plenum Publishers, New York USA.
8. Jain, S.M., Sopory, S.K. and Veilleux, R.E. 1996. In Vitro Haploid Production In Higher Plants. Fundamental Aspects and Methods, Kluwer Academic Publishers, Dordrechi The Netherlands.

9. Jollers, O. and Jornvall, H. Proteomics in Functional Genomics. Birkhausor Verlag. Basel Switzerland.
10. Kartha. K.K. Cryopreservation of Plant Cells and Organs. CRC Press, Boca Raton, Florida, USA.
11. Old R.W. and Primrose, S.B. Principles of GeneManipulation. Blackwell Scientific Publications. Oxford. UK
12. Primrose. S.B. Principles of Genome Analysis. Blackwell science Ltd. Oxford. UK.
13. Raghavan. V. Embryogenesis in Angiosperms. A Developmental and Experimental Study. Cambridge University press, New York, USA.
14. Shantharam. S. and Montgomery. J.F 1999 Biotechnology, Biosafety and Biodiversity. Oxford & 11311 Publishing Co. Pvt. Ltd. New Delhi.

Suggested Reading:**Paper VIII**

1. HooyKaas, P.J.J, Hall M.A. and Libbenga K.R. (Eds) Biochemistry and Molecular Biology of Plant Hormones. Elsevier, Amsterdam, the Netherlands.
2. Hopkins, W.G. Introduction to Plant Physiology John Wiley & Son. Inc. New York, USA.
3. Lodish, H. Berk. A. Zipursky, S.L. Matsudaira, P. Baltimore, D. and Darnell. J. Molecular Cell Biology (4th Edition)

- W.H.Freeman and Company. New York USA.
5. Moore, T.C. Biochemistry and Physiology of Plant Hormones (2nd Edition) Springer-Verlag New York USA.
 6. Noble, P.S. Physiochemical and Environmental Plant Physiology (2nd Edition) Academic Press San Diego USA.
 7. Salisbury, F.B. and Ross C.W. Plant Physiology (4th Edition) Wadsworth Publishing Co. California, USA.
 8. Taiz L. and Zeiger, E. 1998 Plant Physiology (2nd Edition) Sinauer Associates, Inc Publishers. Massachusetts, USA.
 9. Thomas, B. and Vince-Prue, D. Photoperiodism in Plant (2nd Edition) Academic Press San Diego USA.
 10. Westhoff. P. Molecular Plant Development form Gene to Plant . Oxford University Press Oxford UK.
 11. Noggle C.R. and Fritz, G.J. Introductory Plant Physiology Prantice Hall.
 12. Goodwin T.W. & Mercer, El. Introduction to Plant Biochemistry Pergamer Press, New York.
 13. Wilkins M.B. Advanced Plant Physiology, ELBS
 14. Deniel, W.W. Biostatistics - A Foundation for analysis in the health science, john Wiley & Son.
 15. Sokal, R.R and Rowlf, F.J. Biometry W.H. Freeman & Co. San Francisco.
 16. Panes, V.G. and Sukhatmi Plg. Statistical Methods of Agricultural works, ICAR, New Delhi.

17. Singh, H. Embryology of Gymnosperms Encyclopedia of Plant Anatomy X. Gebruder Bortraeger, Berlin.
18. Solbrid, O.T. Principles and Methods of Plant Biosystematics. The Mac Millan Co. Collier Mac Millan Ltd. London.
19. Solbrig O.T. and Solbrig, D.J. Population Biology and Evolution Addison Wesley Publicating Co. Inc USA.
20. Stebbins, G.L.. Flowering Plant — Evolution above species Level Edwards Arnold Ltd. London.
21. Stace, C.A. Plant Taxonomy and Biosystematics (2nd Edition) Edward Arnorid Ltd. London.
22. Takhtajan A.L. Diversity and Classification of flowering Plants. Columbia University Press New York.
23. Woodland, D.W. Contemporary Plant Systematic. Prentice Hall New Jersey.
24. lawrenc G.H.M. Taxonomy of Vascular Plant Oxford & IBH Publishing Co. New Delhi.
25. Heny, A.N. and Chandar Bose, M. An aid to the international code of Botanical Nomenclature Today, and Tomorrow's Printers & Publishers, New Delhi.
26. Naik, V.N. Taxonomy of Angiosperms, Tata Mc Graw Hill Publishing, New Delhi.
27. Chamberlain, G.J. Gymnosperms (structure and evolution) Dove Publication.

28. Culter, J.M. Achamberlain, C.J. Morphology of Gymnosperm Central Book Depot, Allahabad.
29. Scott, D.N. Studies in Fossil Botany Vol.1 Hefner Publishing Company. New York.

Practical Paper —IX

1. Temporary and permanent preparation for microscopic observation of external and internal features of vegetative and reproductive structure of important genera of Bryophytes available in the locality.
2. Examination of whole plant materials and permanent slides of different important genera of Bryophytes for comparative study.
3. Making permanent slides for microscopic study of vegetative and reproductive structures of important genera of pteridophytes.
4. Collection and identification of locally available forms.
5. Examination of whole plant materials and permanent slides of different important genera of pteridophytes for comparative study.
6. Making permanent slides microscopic study of vegetative and reproductive structures of important genera of Gymnosperms.

7. Examination of whole plant materials and permanent slides of different important genera of gymnosperms for comparative study.
8. To measure the chiasma frequency from diplotene stage of meiosis in *Allium cepa*.
9. Induction of polyploidy and analysis of polyploids.
10. Induction of mutation.
11. Study of meiosis of complex translocation heterozygotes.
12. Study of mutation by Ame's test.
13. Study of bacterial transformation.
14. Study of drosophila : Morphology, life history and mutants.

Practical

Paper — X

1. Collection, description, identification and mounting of locally available wild angiosperm taxa pertinent to nomenclaturaly important category and economic importance.
2. Description of a species based on various specimens to study intraspecific variation; a collective exercise.
3. Description of various species of a genus, location of key characters and preparation of key at generic level.
4. Comparison of different species of a genus and different genera of a family to calculate similarity coefficient and preparation of dendrograms.

5. Field trips within and around the campus, compilation of field notes and preparation of herbaria of such plants, wild or cultivated as are abundant.
6. Submission of field note book and herbarium sheets arranged after Bentham & Hooke's system of classification.
7. Determination of succinate dehydrogenase activity, & its kinetics & sensitivity to inhibitors.
8. Extraction of seed proteins depending upon the solubility
9. Preparation of the standard curve of protein (BSA) and estimation of protein content in extracts of plant material by Lowry's method.
10. Fractionation of proteins using gel filtration of chromatography by Sephadex-G200.
11. 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.
12. Statistical analysis of biological data pertaining to t- test, χ^2 - test & F- Test, Simple linear correlation regression.

