

## **M.Sc. Botany**

### **Semester - I**

#### **Theory**

Core Paper 101	:	Biology and Diversity of Algae and Bryophytes
Core Paper 102	:	Biology and Diversity of Viruses, Bacteria and Fungi
Core Paper 103	:	Cell Biology
Core Paper 104	:	Cytology and Cytogenetics

#### **Practicals**

Practical 101	:	Corresponding to papers 101 and 102
Practical 102	:	Corresponding to papers 103 and 104

### **Semester - II**

#### **Theory**

Core Paper 201	:	Genetics
Core Paper 202	:	Molecular Biology
Core Paper 203	:	Biology and Diversity of Pteridophytes and Gymnosperms
Core Paper 204	:	Plant Development and Plant Cell, Tissue Culture
*Non-core Paper 205	:	----- ( To be opted by the student from among the papers offered by other Departments)

#### **Practicals**

Practical 201	:	Corresponding to papers 201 and 202
Practical 202	:	Corresponding to papers 203 and 204

### **Semester - III**

#### **Theory**

Core Paper 301	:	Taxonomy of Angiosperms and Plant Resources Utilization and Conservation
Core Paper 302	:	Plant Reproduction
Core Paper 303	:	Plant Ecology
Core Paper 304	:	Plant Physiology
*Non-core Paper 305	:	----- ( To be opted by the student from among the papers offered by other Departments)

#### **Practicals**

Practical 301	:	Corresponding to papers 301 and 302
Practical 302	:	Corresponding to papers 303 and 304

### **Semester - IV**

#### **Theory**

Core Paper 401	:	Genetic Engineering of Plants and Microbes
Core Paper 402	:	Evolution and Plant Breeding
Core Paper 403	:	Elective I
Core Paper 404	:	Elective II

**Practicals**

Practical 401 : Corresponding to papers 401 and 402

Practical 402 : Corresponding to papers 403 and 404

**\*This Department will offer the following two Non-core Papers to other Departments :**

**Non-core Paper 205 – Medicinal Plants and Ethnobotany**

**Non-core Paper 305 – Principles of Genetic Analysis**

## **M.Sc. Botany – Semester I**

### **Core Paper 101: BIOLOGY AND DIVERSITY OF ALGAE AND BRYOPHYTES**

#### **Theory:**

##### **Algae**

Criteria employed in Classification. Classification given by Fritsch, Bold and Wynne. Thallus organization, reproduction and life cycles in algae.

Range of thallus structure, reproduction, life histories of Chlorophyceae with special reference to the genera, Chlamydomonas, Tetraspora, Volvox, Chlorella, Scenedesmus, Ulva, Enteromorpha, Cladophora, Fritschiella, Oedogonium, Spirogyra, Cosmarium, Caulerpa, Chara.

Salient features of Protochlorophyta, Xanthophyta (Vaucheria), Bacillariophyta (Cyclotella), Phaeophyta (Ectocarpus, Dictyota, Padina, Laminaria, Sargassum).

Salient features of Rhodophyta (Gelidium, Gracilaria, Polysiphonia), Cyanophyta (Nostoc, Lyngbya, Spirulina).

Economic importance of Algae, Single cell protein, Algal blooms and algal biofertilizers, Cultivation of economically important seaweeds—Porphyra, Gracilaria, Gelidium.

##### **Bryophytes**

Morphology, structure, reproduction and life history, distribution, classification, General account of Marchantiales, Jungermaniales, Anthocerotales.

Morphology, structure, reproduction and life history, distribution, classification, General account of Sphagnales, Funariales and Polytrichales.

Economic and ecological importance of Bryophytes.

#### **Suggested Laboratory Exercises (PRACTICALS)**

##### **Algae**

Examination of vegetative and reproductive morphology of Chlorophyceae members listed in theory part of the syllabus.

Examination of Thallus structure and reproductive bodies of Xanthophyceae, Bacillariophyceae and Phaeophyceae members listed in the theory syllabus.

Examination of external and internal structure and reproductive organs of Rhodophyceae and Cyanophyceae members listed in the theory syllabus.

Field work to get acquaintance with the algae of coast in and around Visakhapatnam.

### **Bryophytes**

An examination of the external features and internal structure and reproductive organs of the genera, Riccia, Targionia, Monoclea, Plagiochasma, Fimbriaria, Marchantia, Pellia, Porella, Anthoceras, Notothylus, Andreaea, Funaria, Polytrichum.

### **Suggested Readings:**

1. Fritsch, F.E. 1945. The structure and reproduction of Algae Vols. 1 & II. Cambridge University Press, London;
2. Smith, G.E. Ed., 1950. Fresh water algae
3. Chapman, V.J. 1962. The Algae
4. Lewin, R.A. 1962. Physiology and Biochemistry of Algae
5. Round, E.E. 1962. Ecology of algae
6. Morris, I 1967. An Introduction to the Algae.
7. Prescott, G.W. 1969. The Algae- a review.
8. Bold, H.C and Wynne, M.J. 1978. Introduction to the algae
9. Kumar, H.D. 1988. Introductory Phycology
10. Round, E.E. 1986. The Biology of Algae.
11. Parihar, N.S. 1991. Bryophyta.
12. Puri, P. 1980. Bryophytes.
13. Smith, G.M. 1955. Cryptogamic Botany Vol. II
14. Kashyap, S. 1929. Liverworts of the Western Himalayas and Punjab Plains Part I and Part II.

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## M.Sc. Botany - Semester I

### Core Paper 102: BIOLOGY AND DIVERSITY OF VIRUSES, BACTERIA AND FUNGI

#### Theory:

General account of archaeobacteria, eubacteria and cyanobacteria, Ultrastructure, nutrition, reproduction and economic importance of bacteria

Ultrastructure and chemistry of viruses, Isolation and purification of viruses, Replication and transmission of viruses

Mycoplasma like organisms and their role in carrying plant diseases, Fungal and bacterial diseases in plants and humans, Plant viral diseases

Recent trends in fungal classification, Ultrastructure of fungal cell and thallus organization in fungi

General account of mastigomycotina, zygomycotina, ascomycotina, basidiomycotina, deuteromycotina

Reproduction in fungi – vegetative, asexual and sexual, Heterothallism, heterokaryosis and parasexuality

Nutrition of fungi – saprobic, biotrophic, and symbiotic, Phylogeny of fungi

Fungi in industry, medicine and as food and as biocontrol agents, Mushroom cultivation, Mycorrhiza

#### Suggested Laboratory Exercises

Morphological study of *Stemonitis*, *Saprolegnia*, *Mucor*, *Morchella*, *Aspergillus*, *Agaricus*, *Cyathus*, *Synchytrium*, *Helminthosporium*

Symptomatology of some diseased specimens – White rust, Powdery mildew, Green ear of Bajra, Rust of Wheat, Rust of Linseed, Tikka disease of ground nut, Red rot of sugarcane, Blast of rice, Citrus canker, and Tobacco mosaic disease.

Gram staining of bacteria

Sterilization methods

Preparation of media and stains

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## M.Sc. Botany - Semester I

### Core Paper -103 : CELL BIOLOGY OF PLANTS

#### Theory:

1. Introduction: The cell theory, Origin and development of cell biology as a separate branch. Structure and organization of prokaryotic and eukaryotic cells. Specialized cell types; Plasma membrane: Structure, models and functions of plasma membrane, ATPases, Receptors, Carriers, Channels and Pumps; Vacuole structure and function, Vacuolar ATPases, Transporters.
2. Cytoskeleton: Microtubules and Microfilaments, their role in cell division and motility ; Intermediate filaments- role in providing strength.
3. Chemical foundation: Macromolecules-Structure, shape and information, Non-covalent interactions in relation to function of nucleic acids and proteins. Biochemical energetics: Types of energy- thermal, electrical and radiant energy Interconvertability of energy; Laws of thermodynamics as applicable to biological systems.
4. Chloroplast, Mitochondria—Structure and function, genome organization, Nucleo-cytoplasmic interactions, RNA editing.
5. Other organelles—Structure and functions of Endoplasmic reticulum, Golgi apparatus, lysosomes, functions of microbodies and peroxisomes.
6. Cell wall: Structure and functions, Cell wall architecture, Biogenesis and Growth ; Plasmodesmata structure and function, Plasmodesmata in comparison with gap junctions of animal cells.
7. Tools in cell Biology 1- Microscopy: Working principles of Light microscopy, Scanning electron microscopy, Transmission electron microscopy, STEM; Preparation of specimens for Microscopy: Freeze fracture and Freeze etching techniques.
8. Tools in Cell Biology II- Subcellular fractionation - Principles of centrifugation. Spectroscopic techniques: principles and applications of UV- visible, ESR, Nuclear magnetic resonance, spectrofluorimetry, circular dichroism(CD).

#### Suggested Laboratory Exercises:

1. Staining techniques – Study of mitosis using acetocarmine.
2. Isolation of mitochondria and the activity of its marker enzyme, Succinate dehydrogenase (SDM).
3. Isolation of chloroplasts and photographs SDS – PAGE technique and photographs - profile of proteins to demonstrate (2) the two sub-units of Rubisco.

4. Isolation of nuclei and identification of histones by SDS-PAGE technique.
5. Fluorescence staining with FDA for cell viability and wall staining with calcofluor.
6. Immunofluorescence technique –observation of cytoskeleton.
7. Demonstration of SEM and TEM: SEM is available in Geology and students can familiarize with SEM, Photographs of SEM, TEM.
8. Techniques in cell biology Immuno- techniques, in situ hybridizations to locate transcripts in cell types FISH, GISH, Confocal Microscopes – Photographs.

**Suggested Readings:**

1. Alberts, B. Bray D. Lewis J. Ralf, M.Roberts, K. and Watson, J.D. 1999: Molecular Biology of the Cell, Garland Publishing Inc., New York.
1. Lodish, Berk A, Zipursky, S.L. Matsdaira P, Baltimore D and Darnell, J. 2000; Molecular Cell Biology (4<sup>th</sup> Edition) W.H. Freeman and Co., New York, USA.
2. De, D.N. 2000: Plant Cell Vacuoles. An Introduction. CSIRO Publication. Collingwood, Australia.
3. Krishna Murthy, K.V. 2000: Methods in cell wall cytochemistry CPC Press, Boca Raton, Florida.
4. Kleinsmith, L.J. and Kish, V.M. 1995: Principles of Cell and Molecular Biology (2<sup>nd</sup> Edition) Harper Collins College Publishes, New York, USA.
6. C.J. Avers 1986: Molecular Cell Biology. Addison Wesley Publishing Company.

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## M.Sc. Botany – Semester I

### Core Paper 104: CYTOLOGY AND CYTOGENETICS

#### Theory:

- 1) Nucleus – Structure of nuclear membrane, Nuclear pore complex; Chromosome structure, molecular organization of chromatin, centromeres and telomeres; types of chromosomes (lampbrush, Polytene)
- 2) Chromosome identification - Karyotype analysis; Chromosome banding techniques; Flowcytometry and confocal microscopy in karyotype analysis; computer assisted karyotype analysis – chromosome microdissection and micro-cloning.
- 3) Chromosomal structural aberrations – Origin, meiosis and breeding behaviour of duplications, deficiencies and inversions and interchanges; types of inversions. Robertsonian translocations; Basic concept of Complex translocation heterozygotes.
- 4) Chromosomal numerical aberrations I – Classification of numerical aberrations; Aneuploids–Trisomics (Primary, Secondary, Tertiary), Monosomic and nullisomics – meiotic behaviour; use in chromosome mapping.
- 5) Chromosomal numerical aberration II – Polyploids – Origin and production of auto-and allopolyploids; Meiosis in autotetraploid ; Genome analysis in Tobacco and wheat.
- 6) Nuclear DNA content – C-value paradox, hyperchromicity, Cot curves and significance- Molecular organization of nuclear genome.
- 7) Cell Cycle and its regulation – check points, cyclins and cyclin-dependent kinases, experimental control of cell division.
- 8) Apoptosis- mechanism and significance; Initiation of cancer at cellular level – proto oncogenes and oncogenes.

#### Suggested Laboratory Exercises:

1. Observation and identification of stages of meiosis.
2. Preparation of karyotypes and construction of idograms.
3. Observation of slides / photographs showing structural and numerical aberrations and chromosome banding mentioned in the theory syllabus.



**Suggested Readings:**

1. Khush, G.S., 1973. Cytogenetics of Aneuploids, Academic Press, New York, London..
2. Burnham, C.R. 1962. Discussions in Cytogenetics, Burgess Publishing Co., Minnesota.
3. Swanson, Merz and Young. Cytogenetics. Prentice Hall . India.
4. Sybenga, J. 1973. General Cytogenetics. North Hall and American Elsevier.
5. Gupta, P.K. 1995. Cytogenetics. Rastogi & Company, Meerut.
6. David M. Prescott. Cells. 1988. Jones and Bartlett Publ. Boston.

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## M.Sc. Botany - Semester II

### Core Paper 201: GENETICS

#### Theory:

- 1) Concept of Genetic markers and their types – application of probability laws to Mendelian principles. Chi-square testing for goodness of fit.
- 2) Allelic and gene interactions; Multiple allelism – Penetrance and expressivity – Pleiotropism, pseudoalleles, phenocopies.
- 3) Gene mapping methods based on test-cross and F<sub>2</sub> progenies; LOD score analysis; Tetrad analysis and its significance; somatic cell genetics and its use in mapping; correlation of genetic and physical maps; Sex-linked inheritance, sex-influenced and sex- limited characters.
- 4) Recombination and its molecular mechanism; role of recA,B,C,D enzymes; Holliday's model
- 5) Mutations – types – molecular basis; site-directed mutagenesis – DNA damage and repair mechanisms; examples of inherited defects in DNA repair.
- 6) Multigene families and their organization and significance; Transposable elements in pro-and eukaryotes, Mechanism of transposition; significance of transposable elements.
- 7) Mapping in bacteria and phages – methods using conjugation; Transformation and transduction; Fine structure analysis of gene - Benzer's work; concept of gene; Nature and variant forms of eukaryotic genes.
- 8) Maternal inheritance – Distinction between nuclear and cytoplasmic types of inheritances-Distinction - Genetics of mitochondrial and chloroplast characters; Male sterility, types and significance

#### Suggested Laboratory Exercises:

1. Observation of types of chlorophyll mutants.
2. Assignments containing problems on topics mentioned in the theory syllabus

#### Suggested Readings:

1. Hartl, D.L. and Jones, E.W. 1998. Genetics: Principles and Analysis (4<sup>th</sup> edition) Jones and Bartlett Publishers, Massachusetts, USA.
2. Snustad, D.P. and Simons, M.J., 2000. Principles of Genetics (2<sup>nd</sup> Edition), John Wiley and Sons Inc., USA.

3. Karp, G. 1999. Cells and Molecular Biology: concepts and Experiments. Hohn Wiley & Sons Inc. USA.
4. Lewin, B. 2000. Gene VII. Oxford University Press, New York, USA.
5. Lewis, R. 1997. Human Genetics: Concepts and Applications (2<sup>nd</sup> edition). WCB Mc Graw Hill, USA.
6. Russel, P.J. 1998. Genetics (5<sup>th</sup> edition). The Benjamin/ Cummings Publishing Company Inc., USA.
7. Griffiths, A.J.F., Miller, H.T., Suzuki, Lewontin, Gelbart Intd. Genetic analysis, (6<sup>th</sup> edition), H.F. Freeman and Co.
8. Atherly, A.G., Girton, J.R. and McDonald, J.F. 1999. The Science of Genetics, Saunders College Publishing, Fort Worth, USA.
9. Malacinski, G.M. and Freifelder, D. 1998. Essentials of Molecular Biology(3<sup>rd</sup> edition). Jones and Bartlet Publishers Inc. London.

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## M.Sc Botany - Semester II

### Core Paper 202: MOLECULAR BIOLOGY OF PLANTS

#### Theory:

- 1) Composition and structure of biomolecules: carbohydrates, lipids and proteins (Ramachandran plot, domains, motifs and folds). Nucleic acids, DNA structure and duplex model. A, B and Z forms of DNA.. Types of small RNAs – Si RNA, micro RNA and catalytic RNA
- 2) DNA replication, Semi-conservative, semi-discontinuous and uni- and bi directional mode of replication. RNA Priming, enzymes for DNA replication helicases, SSBs, topoisomerases and polymerases. Mechanism of DNA replication. Rolling circle and theta mode of replication. Replication of ends of chromosomes.
- 3) Transcription promoters, activators and transcription factors of prokaryotes and eukaryotes. RNA processing, spliceosome and mRNA transport.
- 4) Translation – structure of t – RNA, Ribosome as a translation factory. Genetic code - codon assignment. Mechanism of translation.- Initiation ,elongation and termination . Post translational modifications.
- 5) Protein sorting and targeting of proteins into chloroplasts, mitochondria, vacuoles and peroxisomes. Protein trafficking.
- 6) Signal transduction- concept of signaling molecules, ligand and receptors. G-protein coupled receptors. Receptor tyrosine kinases. MAP kinases. Second messengers and role of C-AMPs . Ca- calmodulin pathway.
- 7) Regulation of gene expression in prokaryotes. Basic models : Lac ,arabinose and Tryp operons.. Positive and negative controls. Regulation in viruses ∴ Lytic and lysogenic cycle.
- 8) Regulation of gene expression in eukaryotes. Britten-Davidson model. Role of chromatin in gene expression . DNA methylation. Temporal and spatial regulation. Gene silencing.

#### Suggested Laboratory Exercises:

1. Isolation of DNA from onion bulbs.
2. Isolation of DNA using CTAB method.
3. Histochemical staining of carbohydrates, proteins and fats in the plant cells.
4. Assignments on problems related to DNA replication, transcription, translation and gene regulation.

5. Diagrams/photographic display related to all the units.
6. Electrophoresis of seed proteins.

**Suggested Readings:**

1. Buchaman B.B., Grussem, W and Jones R.I. 2000. Biochemistry and Molecular Biology of plants: American Societies of plant physiologists, Maryland, U.S.A.
2. Lewin B, 2000. Genes VII Oxford University Press, New York.
3. R F Weaver 1999, Molecular Biology, WCB McGraw-Hill.
4. Glick, B.R. and Thompson J.E. 1993. Methods in Plant Molecular Biology and Biotechnology, CRC Press, Boca Raton Florida.
5. Shaw, C.H. 1998. Plant Molecular Biology. A practical approach, IRL Press, Oxford.
6. Alberts, B. Bray D, Lewis J, Ralf M, Roberts K and Watson J.D. 1999. Molecular Biology of the Cell Garland publishing Inc., New York.
7. Lodish, B.A, Zipursky S.L, Matsdaira P, Baltimore D. and Darnell J. 2000. Molecular Cell Biology (4th edition). W.H. Freeman & co. New York, USA.

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## M.Sc. Botany – Semester II

### Core Paper 203: BIOLOGY AND DIVERSITY OF PTERIDOPHYTES AND GYMNOSPERMS

#### Theory:

##### Pteridophytes:

1. Classification of Pteridophyta
2. Morphology, Anatomy and reproduction of *Psilotum*, *Lycopodium*, *Selaginella*, *Isoetes*, *Equisetum*, *Ophioglossum*, *Osmunda*, *Gleichenia*, *Cyathea*, *Marselia*, *Adiantum*, *Salvinia* and *Azolla*
3. General account of fossil Pteridophytes - Psilopsida, Lycopsida, Sphenopsida and Pteridopsida
4. Evolution of Stele types in Pteridophytes; Heterospory and origin of seed habit; Economic importance

##### Gymnosperms:

5. General account of fossils: Geological periods, types of fossil formations.
6. Classification of Gymnosperms and their distribution in India
7. General account of the families of Pteridospermales (Lygino-pteridaceae, Medullosaceae, Caytoniaceae) Bennettitales (Cycadeodiaceae), Pentoxylales (pentoxylaceae) and Cordaitales (Cordaitaceae).
8. Structure and reproduction in living Gymnosperms : Cycadales, Ginkgoales, Coniferales, Ephedrales, Welwitschiales and Gnetales; their economic importance

#### Suggested Laboratory Exercises

##### Pteridophytes:

Examination of the external features, anatomy and reproductive structures of *Psilotum*, *Lycopodium*, *Selaginella*, *Isoetes*, *Equisetum*, *Ophioglossum*, *Osmunda*, *Gleichenia*, *Cyathea*, *Marselia*, *Adiantum*, *Salvinia* and *Azolla*.  
Observations of the slides of the following fossil plants : *Rhynia*, *Lepidodendron*, *Lepidocarpon*, *Miadesmia*, *Sphenophyllum*, *Calamites*, *Calamostachys*, *Zygoptera* and *Eptaeteris*.

##### Gymnosperms:

Examination of the external features, anatomy and reproductive structures of *Ginkgo*, *Pinus*, *Cupressus*, *Cryptomeria*, *Araucaria*, *Ephedra* & *Gnetum*  
Study of fossil gymnosperms from prepared slides. *Lyginopteris*, *Lagenostoma*, *Medullosa*, *Trigonocarpus*, *Conostoma*, *Heterangium*, *Cordaites*).

### **Suggested Readings:**

1. Parihar, N.S. 1996. Biology and Morphology of Pteridophytes, Central Book Depot, Allahabad;
2. Sporne, K.R. 1962. The Morphology of Pteridophytes, Hutchinson University Library, London;
3. Stewart, WN. and Rothwell, GW. 1993. Paleobotany and the Evolution of Plants, Cambridge University Press;
4. Smith, G.M. 1995. Cryptogamic Botany, Vol. II McGraw Hill Book Company, New York;
5. Evans, A.J. 1936. Morphology of Vascular Plants (Lower groups) McGraw Hill Book Company, New York;
6. Bhatnagar, S.P. and Moitra A. 1996. Gymnosperms. New Age International Private Limited, New Delhi;
7. Singh, H. 1978. Embryology of Gymnosperms. Encyclopedia of Plant Anatomy, Gebrudev Bortraeger, Berlin;
8. Arnold, C.A. 1974. An introduction to Paleobotany, New York;
9. Chamberlain, C.J. 1935. Gymnosperms structure and evolution, University of Chicago Press;
10. Coulter, J.M. and Chamberlain, C.J. Morphology of Gymnosperms, Central Book Depot, Allahabad;
11. Maheswari, P. and Vasil, V. Genetum CSIR ( Monographs)
12. Sporne, K.R. 1965. The Morphology of Gymnosperms'; Hutchinson Company Limited;
13. Greguss, P. 1955. Identification of Living Gymnosperms on the basis of the Xylotomy - Budapest;
14. Biswas, C and Johri, B.M. 1997. The Gymnosperms, Narosa Publishing House, New Delhi;
15. Sharma, O.P. 1996. Gymnosperms, Pragati Prakashan, Meerut.

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## M.Sc. Botany – Semester II

### Core Paper 204: PLANT DEVELOPMENT AND PLANT CELL, TISSUE CULTURE

#### Theory:

#### Plant Development:

1. The Cell and Tissues: The cell; the cell wall, its chemical and gross structure; Simple and complex tissues; Epidermis, stomata and trichomes; secretory cells and tissues.
2. Shoot Development: Organisation of the shoot Apical meristem [SAM]; cytological and molecular analysis of SAM.  
Leaf Growth and Differentiation: Differentiation of epidermis and mesophyll; Structure of foliage leaves; structure of modified leaves.
3. Root Development: Organisation of root apical meristem [RAM]; cell fates and lineages; tissue differentiation; Lateral roots; root hairs; root microbe interactions.  
Cambium: Structure, cell types and development of vascular cambium; Cork cambium, structure of its derivatives; bark.  
Anomalous secondary growth: In dicot and monocot stems.
4. Vascular Tissue Development: Development and structure of the primary xylem; primary phloem. Secondary xylem; secondary phloem.

#### Plant cell, Tissue Culture:

5. Basic concepts of Tissue culture: Totipotency, Types of culture. Culture media: Composition and effects of media components. Role of Phytohormones and Sterilization methods. Organogenesis, Somatic embryogenesis.
6. Cell culture: Establishment, plating efficiency, induction and isolation of mutants, production of secondary metabolites, Bioreactors.
7. Somatic hybridization: Protoplast isolation, fusion and culture, cybrids, hybrid selection and regeneration, achievements and limitations in protoplast culture.
8. Applications of plant tissue culture: Clonal propagation, artificial seed, embryo rescue, somaclonal variation. Cryopreservation and germplasm storage.

#### Suggested Laboratory / Field Exercises:



### **Plant Development:**

Microscopic examination of Transverse sections of leaves such as Nerium, Maize to understand the internal structure of leaf tissues and trichomes, glands etc. Study of the C<sub>3</sub> and C<sub>4</sub> anatomy of plants.

Study of epidermal peels of different kinds of leaves to study the development and nature stomata and prepare stomatal index.

Study of elements of wood from macerations and sections taken in three planes T.S., T.L.S. and R.L.S.

Study of the anomalous structure of the stems of Aristolochia, Achyranthes, Bignonia, Boerhaavia, heptadenia and Dracaena.

### **Plant Cell, Tissue Culture:**

General out lay of PTC laboratory

Preparation of media

Callus induction – Carrot

Embryo culture – Ground nut

Anther culture – Datura

Protoplast isolation, culture and fusion

Establishment of cell cultures and determination of growth pattern and plating efficiency

Observing stages in Somatic embryogenesis

Artificial seed preparation

### **Suggested Readings:**

#### **Plant Development:**

Bailey, J.D. and Black, M. 1994. Seeds: Physiology of development and Germination, Plenum Press, New York.

Fahn, A. 1982. Plant Anatomy. (3rd edition). Pergamon Press, Oxford.

Fosket, D.E. 1994. Plant Growth and Development. A Molecular approach. Academic Press, San Diego.

Howell, S.H. 1998. Molecular Genetics of Plant Development Cambridge University Press, Cambridge.

Lyndon, R.F. 1990. Plant Development. The Cellular Basis. Unwin Hyman, London.

Mauseth, J.D. 1988. Plant Anatomy. Benjamin Cummings. California.

Pullaiah, T., Naidu, K.C., Lakshminarayana, K., and Hanumantha Rao, B. 2007. Plant Development. Regency Publications, New Delhi.

Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4th edition) Wordsworth Publishing, Belmont, California.

Steeves, T.A. and Sussex, I.M. 1989. Patterns in Plant Development (2nd edition), Cambridge University Press, Cambridge.

Waisel, Y., Eshel, A. and Kafkaki, V. (eds) 1996. Plant Roots: the Hidden Hall (2nd edition). Marcel Dekker, New York.

**Plant Cell, Tissue Culture:**

Bhojwani, S.S. and Razdan, M.K. 1996. Plant tissue culture: Theory and Practice (a revised edition ) Elsevier Science Publishers, New York, USA.

Bhojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, USA.

Callow, J.A. Ford-Lloyd, B.V. and Newbury, H.J. 1997. Biotechnology and Plant Genetic Resources: Conservation and use. CAB International, UK, Oxon.

Collin, H.A. and Edwards, S. 1998. Plant Cell Culture, Bioscientific Publishers, Oxford, UK.

Jain, S.M. Sopory, S.K. and Velleux, R.E. 1996. In Vitro Haploid production in Higher Plants, Volumes 1-5. Fundamental aspects and Methods Kluwer Publishers, Dordrecht, the Netherlands.

Kartha, K.K. 1985. Cryopreservation of Plant Cells and Organs CRC Press, Boca Roton, Florida, USA.

Raghavan, V. 1986. Embryogenesis in Angiosperms: A Developmental and Experimental Study. Cambridge University Press, New York, USA.

Raghavan, V. 1997. Molecular Biology of Flowering plants, Cambridge University press, New York, USA.

Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers. The Netherlands.

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## M.Sc. - Semester II

### Non-core Paper Offered by the Department of Botany

#### Paper 205: MEDICINAL PLANTS AND ETHNOBOTANY

##### Theory:

Ethnobotany: Introduction, concept, scope and objectives.

Ethnic groups and Ethnobotany: Major and minor ethnic groups of Andhra Pradesh and their life styles. Forest Vs. Ethnic groups.

Methodology of Ethnobotanical studies:

- (a) Field work
- (b) Herbarium
- (c) Ancient Literature
- (d) Archaeological findings
- (e) Temples and sacred places.
- (f) Protocols.

Plants and Tribal medicine: Significance of the following plants in Ethno-medical practices (along with a brief note on their habitat and morphology):

- (a) *Curculigo orchioides*
- (b) *Costus speciosus*
- (c) *Gloriosa superba*
- (d) *Butea monosperma*
- (e) *Wrightia tinctoria*
- (f) *Pongamia pinnata*.

Medico-ethnobotanical research in Andhra Pradesh.

Different systems of indigenous medicine (Traditional medicine, Ayurveda, Siddha, Unani), Homeopathy and Allopathy. Role of Phytomedicine in modern systems of medicine.

Classification of drugs; analytical methods – drug adulteration, drug evaluation, anatomical and phytochemical analysis of crude drugs; preliminary screening, fractionation and separation of different groups of biodynamic compounds and biological evaluation.

Phytopharmaceuticals: Drugs of alkaloids, coumarins, volatile oils, tannins, resins and gums. Natural pesticides, antibiotics, allergens and poisonous plants. Economic potential of phytomedicine; potential drug yielding plants and their marketing avenues. IPR and patenting of active principles.

**Suggested Readings:**

1. Cotton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester.
2. Faulks, P.J. 1958. An introduction to Ethnobotany, Moredale Pub. Ltd., London.
3. Jain S.K., (ed.) 1981 Glimpses of Indian Ethnobotany, Oxford and I B.H., New Delhi.
4. Jain S.K., (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
5. Jain S.K., 1990. Contributions of Indian ethnobotany. Scientific publishers, Jodhpur.
6. Jain S.K., 1995 Manual of Ethnobotany, Scientific Publishers, Jodhpur.
7. Kokate, C.K., A.P. Purohit & S.P. Gokhale, 2000. Pharmacognosy, Nirali Prakasan.
8. Martin, G.J.. 1996, Ethnobotany, A methods manual, Chapman & Hall, London.
9. Ramachandran, S.P. 1991, Recent Advances in Medicinal aromatic and spice crops
10. Rama Rao, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India, Howrah.
11. Schultes, R.E. 1995, Ethnobotany, Chapman and Hall.
12. Trease, G.E. and W.C. Evans, 2002. Pharmacognosy, Saunders, New York.

## M.Sc. Botany – Semester III

### Core Paper 301: TAXONOMY OF ANGIOSPERMS AND PLANT RESOURCES

#### UTILIZATION AND CONSERVATION

##### Theory:

##### **Taxonomy of Angiosperms:**

The species concept: Taxonomic hierarchy, species, genus, family and other categories; Principles used in assessing relationship delimitation of taxa and attribution of rank. Salient features of the International code of Botanical nomenclature.

Brief analysis of the features and evolutionary tendencies noticed in the following groups:

Ranales, Rosales, Centrospermae, Tubiflorae,  
Amentiferae, Helobiales, Liliflorae, Glumiflorae.

Taxonomic evidence: Embryology, Cytology, Phytochemistry.

Taxonomic tools: Biochemical and molecular techniques; computers and GIS.

Systems of angiosperm classification: Phenetic versus phylogenetic system; Cladistics in taxonomy; relative merits and demerits of major systems of classification Takhtajan, Cronquist, Thorne.

##### **Plant Resources Utilization and Conservation:**

Plant Biodiversity: Concept, status in India, utilization and concerns

Origin of Agriculture: World Centres of primary diversity of domesticated plants. The Indo Burmese Centre, plant introduction and secondary centers.

Origin, Evolution, Botany, Cultivation and uses of

1. Food Crops : Wheat, Rice, Sugarcane
- 2 Forage Crops : Sorghum, Red gram

- 3 Fibre Crops : Cotton
  - 4. Medicinal and aromatic crops : Catheranthus, Withania, Cymbopogan
  - 5. Oil yielding crops : Groundnut, Coconut
- Green Revolution : Benefits and adverse consequences

#### Principles of Conservation

Strategies for conservation, *in situ* conservation, protected areas in India- Biosphere reserves, wetlands, mangroves, conservation of wild biodiversity, strategies for conservation – *ex situ* conservation. Principles and practices. Botanical gardens, BSI, ICAR and CSIR.

#### **Suggested Laboratory Exercises:**

##### **Taxonomy of Angiosperms:**

1. Description of a specimen from representative and locally available families.
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 character and preparation of keys at genetic level.
4. Location of key characters and use of keys at family level.
5. Field trips within and around the campus; compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated, as are abundant.
6. Training in using floras and herbaria for identification of specimens described in the class.
7. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.
8. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparations of denodrograms.

##### **Plant Resources Utilization and Conservation:**

1. Laboratory work
2. Scientific visits

**1. Laboratory work:**

1. Food crops : Wheat, Rice & Sugarcane
2. Forage/fodder crops : Sorghum
3. Fibre crops : Cotton
4. Oil yielding : Groundnut & Coconut
5. Medicinal & Aromatic Catheranthus

**2. Scientific visits:**

The students should be taken to one of the following:

- (i) A protected areas or Biosphere reserve or national park or sanctuary
- (ii) A wetland
- (iii) A mangrove
- (iv) NBPGR (National Bureau of Plant Genetic Resources – New Delhi)
- (v) BSI
- (vi) CSIR Laboratory
- (vii) FRI
- (viii) Tropical Botanical Gardens

**Suggested Readings:**

**Taxonomy of Angiosperms:**

1. Cole, A.J. 1969. Numerical Taxonomy, Academic Press, London;
2. Davis, P.H. and Heywood, V.H. 1973. Principles of Angiosperms Taxonomy. Robert E Kreiger Pub. Co., New York;
3. Grant, V. 1971. Plant Biosystematics, Academic Press, London;
4. Harrison, H.J. 1971. New concepts in Flowering Plant Taxonomy, Hieman Educational Books Ltd., London;
5. Heslop-Harrison, J. 1967. Plant Taxonomy, English Language Books Soc. & Edward Arnold Pub. Ltd., U.K;
6. Heywood, V.H. and Moore, D.M. 1984. Current concepts in Plant Taxonomy, Academic Press, London;
7. Jones, A.D. and Wilkins, A.D. 1971. Variations and Adaptations in Plant species, Hieman & Co., Educational Books Ltd., London;
8. Jones, S.B. Jr. and Luchsinger, A.E. 1986. Plant Systematics (2<sup>nd</sup> Edition) McGraw Hill Book Co., New York;
9. Nordenstam, B.E. Lazily, G. and Kassar, M. 2000. Plant systematics for 2<sup>nd</sup> Century. Portland Press Ltd., London;
10. Radford, A.E. 1986. Fundamentals of plant systematics. Harper & Row Publications, USA;
11. Solbrig, O.T. 1970. Principles and Methods of Plant Biosystematics. The Macmillan Co.,

Collier- Mac. Millian Ltd., London; 12. Stace, C.A. 1989. Plant Taxonomy and Biosystematics (2<sup>nd</sup> Edition) Edward Arnold Ltd., London; 13. Takhtajan, A.L. 1997. Diversity and classification of Flowering Plants. Columbia University Press, New York; 14. Woodland, D.W. 1991. Contemporary plant Systematics, Prentice Hall New Jersey.

**Plant Resources Utilization and Conservation:**

Baker, H.G. 1978. Plants and Civilization (3rd Edition) C.A. Wadsworth, Belmont

Chrispeels, M.J. and Sadava, D. 1977. Plants, Food and People. W.H. Freeman and Co., San Francisco.

Cinway, G. 1999. The Doubly Green Revolution. Food for All in the 21st Century, Penguin Books.

Council of Scientific & Industrial Research 1986. The useful plants of India. Publications and Information Directorate. CSIR, New Delhi.

Council of Scientific & Industrial Research (1948-1976). The Wealth of India. A Dictionary of Indian Raw materials and Industrial products, New Delhi, Raw materials I - XII Revised Vol. I-III (1985-1992) supplement (2000).

Frankel, OH. Brown, A.H.D. & Burdon, J.J. 1995. The conservation of Plant Diversity, Cambridge University Press, Cambridge, UK.

Kocchar, S.L. 1998. Economic Botany of the Tropics, 2nd Edition. Mac Millan India Ltd., Delhi.

Paroda, R.S. and Arora, R.K. 1991. Plant Genetic Resources Conservation and Management. IPGRI (Publication) South Asia Office, C/o. NBPGR Pusa Campus, New Delhi.

Pinstrup – Anderson, P. et al. 1999. World Food Prospects: Critical Issues for the Early 21st Century. International Food Policy Research Institute, Washington, D.C., USA.’

Plant Wealth of India 1997. Special Issue of Proceedings Indian National Science Academy B-63.

Sambamurthy, AVSS and Subramanyam, N.S. 2000. Economic Botany of Crop Plants. Asiotech Publishers, Inc., New Delhi.

Schery, R.W. 1972. Plants for Man. 2nd Edition. Englewood Cliffs, New Jersey, Prentice Hall.



Sharma, O.P. 1996. Hills Economic Botany (Late Dr. A.F. Hill, adapted by O.P. Sharma). Tata McGraw Hill Co., Ltd., New Delhi.

Swaminathan, M.S. and Kocchar, S.L. (Eds.) 1989. Plants and Society. Mac Millan Publication Ltd., London.

Thakur, R.S. Puri, H.S. and Hussain, A. 1989. Major Medicinal Plants of India. Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.

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## M.Sc. Botany – Semester III

### Core Paper 302: PLANT REPRODUCTION

#### Theory:

Male Gametophyte: Structure of anthers; microsporogenesis; role of tapetum; pollen development, sperm dimorphism; pollen embryo sacs and compound pollen grains.

Female Gametophyte: Ovule development; megasporogenesis, organisation of the embryo sac; ultra structure of the embryo sac cells.

Pollination, Pollen-pistil interaction: Structure of the pistil; pollen-stigma interactions; Sporophytic and Gametophytic self-incompatibility, different methods to overcome self-incompatibility.

Fertilization: Pollen germination; pollen tube growth and guidance; Entry of pollen tube into the embryo sac; pollen tube discharge, syngamy and triple fusion; polyspermy and hetero fertilization.

Post-fertilisation events: Endosperm development; Types of Endosperm; Functions; Endosperm and embryo relationships.

Embryo development: Johanson and Soueges systems; Types.

Polyembryony; apomixis; parthenocarpy - outlines only.

Seed Dormancy: Seed dormancy; overcoming seed dormancy.

Outlines of Experimental Embryology – Anther culture, ovary culture, ovule culture; embryo culture; Invitro fertilisation.

Applications of Angiosperm Embryology (Agricultural, Horticultural and Taxonomic Considerations).

#### Suggested Laboratory Exercises:

Study of microsporogenesis and gametogenesis in sections of anthers.

Tests for pollen viability using stains and invitro germination.

Embryo sac development through examination of permanent, stained serial sections.

Study of nuclear and cellular endosperm through dissections and staining.

Isolation of different stages of embryo development from suitable seeds.

### **Suggested readings:**

1. Bhojwani, S.S and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4<sup>th</sup> revised and enlarged edition) Vikas Publishing House, New Delhi;
2. Leins, P., Tucker, S.C. and Endress. P.K. 1988. Aspects of Floral Development. J. Cramer, Germany;
3. Procter, M. and Yeo, P. 1973. The Pollination of Flowers. William Collins Sons, London;
4. Pulliah, T., Lakshminarayana, K. and Hanumantha Rao, B., 2008. Plant Reproduction, Scientific Publishers, Jodhpur, India;
5. Raghavan, V. 1997. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge;
6. Raghavan, V. 1999. Developmental Biology of Flowering Plants. Springer – Verlag, New York;
7. Sedgely, M. and Griffin, A.R. 1989. Sexual Reproduction of Tree Crops, Academic Press, London;
8. Shivanna, K.R. and Swahney, V.K. (Eds.) 1997. Pollen Biotechnology for Crop Production and Improvement. Cambridge University Press, Cambridge;
9. Shivanna, K.R. and Rangaswamy, N.S. 1992. Pollen Biology, A Laboratory Manual. Springer-Verlag, Berlin;
10. Shivanna, K.R. and Johri, B.M.1985. The Angiosperm Pollen Structure and Function, Wiley Eastern Ltd., New Delhi;
11. The Plant Cell. Special Issue on Reproductive Biology of plants, Vol.5 (10) 1993. The American Society of Plant Physiologists, Rockville, Maryland, USA.

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**M.Sc. Botany – Semester III**  
**Core Paper 303: PLANT ECOLOGY**

**Theory:**  
**Ecological Principles**

- A. The Environment: Physical environment, biotic environment and abiotic environment.  
Ecology and human welfare.
- B. Habitat and niche: Concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement.
- C. Population Ecology; characteristic of a population; Population growth curves; Population regulation, life history strategies (r and k selection) concept of metro population, demes and dispersal, interdemic extinctions, age structured population.
- D. Species interactions: Types of interactions, interspecific competition, herbivory, carnivory
- E. Community ecology: Nature of communities, communities structure and attributes; levels of species diversity and its measurement, edges and ecotones, and community classification.
- F. Ecological succession: Types; mechanisms, changes involved in succession; Concept of climax.
- G. Ecosystem: Structure and function; Energy flow and mineral cycling (CNP), primary production and decomposition. Structure and function of some Indian ecosystems: Terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine)
- H. Biogeography: Major terrestrial biomes; theory of island, biogeography, biogeographical zones of India
- I. Applied ecology: Environmental pollution, global environmental change, biodiversity status, monitoring and documentation; major drivers of biodiversity change, biodiversity management approaches.
- J. Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation, management strategy (Biosphere reserves, Project tiger).

### **Suggested Laboratory Exercises:**

- To study the stratification of plants in botanical gardens.
- To prepare life forms of botanical gardens of A.U. compare the biological spectrum of A.U. Campus with normal biological spectrum.
- To estimate the frequency of plants of your botanical gardens.
- To estimate the relative frequency of plants of your botanical gardens.
- To estimate the density of a plant species in your botanical gardens.
- To estimate the relative density of a plant species of your botanical gardens.
- To determine the minimal size and number of quadrats required for reliable estimate of biomass in grass land.
- To determine the basal area of a plant species in botanical gardens.
- To determine the important value index (IVI) of plant species in your botanical gardens.
- To estimate IVI of the plant species in a woodland using point center quarter methods.
- To determine plant diversity indices (Shannon - Wiener) continuum of dominance, species richness, equitability and Bio-diversity of species in botany garden.
- To estimate rate of Carbon dioxide evolution from different soils using soda lime or alkali absorption method.
- To study environmental impact of a given developmental activity using check list as a EIA method.
- Enumeration of pond Ecosystems
- To study the Compositions of Woodland Ecosystem.
- Demonstration of chemical energy stored in leaves which was the transformed from Radiation energy.
- Estimation of biomass of cropland plots.
- Estimation of Chlorophyll estimation method.
- Determination of leaf area index methods with plain graph sheets.
- To determine the water holding capacity of soil collected from different locations.

### **Suggested readings:**

1. Krebs, C.J. 1989. Ecological Methodology. Harper and Row, New York, USA;
2. Ludwig, J.A. and Reynolds, J.F. 1988. Statistical Ecology. Wiley, New York;
3. Magurran, A.E. 1988. Ecological Diversity and its measurement. Chapman and Hall, London;
4. Pielou, E.C. 1984. The interpretation of Ecological Data;
5. Sokal, R.R. and Rohlf, F.J. 1995. Biometry. W.H. Freeman & Co., San Francisco;
6. Moore, P.W. and Chapman, S.B. 1986. Methods in Plant Ecology Blackwell Scientific Publication;
7. Misra, R. 1968. Ecology Work Book. Oxford & IBH, New Delhi;
8. APHA – Standard Methods for the Examination of Water and Waste Water. American Public Health Association, Washington, DC;
9. Smith, R.L. 1996. Ecology and field Biology, Harper Collins, New York;

10. Muller – Dombois, DD. And Ellenberg, R. 1974. Aims and Methods of Vegetation Ecology, Wiley, New York;
11. Ambasht, R.S. & N.K. Ambasht: A Text Book Plant Ecology, CBS Publishers & distributors, New Delhi;
12. E.P. Odum 1971. Fundamentals of Ecology (3<sup>rd</sup> Edition), Saunders & Co., Philadelphia;
13. Dansemire, R.F. 1968. Plant Communities – Horpes and Row, N.Y;
14. Batra, N.K. & Sharma, K.K. 1990. A Treatise on Plant Ecology. Pradeep Publications;
15. P.D. Sharma, 2001. Ecology and Environment;
16. P.D. Sharma, 2<sup>nd</sup> Edition, Environmental Ecology.

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## **M.Sc. Botany – Semester III**

### **Core Paper 304: PLANT PHYSIOLOGY**

#### **Theory:**

Plant water Relations: free energy and chemical potential, osmotic potential, water potential and its determination, active and passive absorption of water, stomatal physiology and mechanisms of stomatal opening and closing, Soil-plant-atmosphere-continuum concept (SPAC) and mechanism of water transport through xylem.

Mineral Nutrition: Passive and active uptake of ions, translocation of minerals in plants, essential elements, their functions and symptoms of mineral deficiency, importance of foliar nutrition and use of chelates in agriculture, root microbe interactions in facilitating nutrient uptake and mechanism of assimilate translocation.

The flowering Process: Phytochrome structure, photochemical and biochemical properties and role in photomorphogenesis, photoperiodism and its significance, mechanisms of floral induction, role of vernalization, morphological, biochemical and metabolic changes accompanying seed germination.

Plant growth regulators and Elicitors: Biosynthesis, physiological effects and mechanism of action auxines, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroids, polyamines, jasmonic acid and salicylic acid, role in agri-horticulture, and hormone receptors.

Stress Physiology: Plant responses to biotic and abiotic stress, mechanisms of biotic and abiotic stress tolerance, water deficit and drought resistance, salinity stress, metal toxicity, heat stress and oxidative stress.

Fundamental of Enzymology: General aspects, allosteric mechanism, regulatory and active sites, isozymes, kinetics of enzymatic catalysis, Michaelis-Menten Equation and its significance, Mechanism of enzyme action.

Photochemistry and Photosynthesis: General concepts and historical back ground, evolution of photosynthetic apparatus, Redox reactions, photosynthetic pigments and light harvesting complexes, photooxidation of water, mechanisms of electron and proton transport, structure, synthesis and function of ATP, carbon assimilation-the Calvin cycle, photorespiration and its significance, the C<sub>4</sub> cycle and CAM pathway, biosynthesis of starch and sucrose, physiological and ecological considerations.

Respiration and Lipid metabolism : Plant respiration, glycolysis, the TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, glyoxylate cycle, alternative oxidase system, structure and function of lipids, fatty acid biosynthesis of membrane lipids, structural lipids and storage lipids and their catabolism.

Nitrogen fixation and nitrogen metabolism: Biological nitrogen fixation, nodule formation and nod factors, biosynthesis of amino acids and proteins, mechanism of nitrate uptake and reduction.

### **Suggested Laboratory Exercises:**

1. Determination of osmotic potential.
2. Determination of water potential.
3. Demonstration of osmosis.
4. Determination of root pressure.
5. Effects of high and low temperatures upon the permeability of the cytoplasmic membranes.
6. Determination of suction force due to transpiration.
7. Stomatal frequency and Stomatal index of leaves.
8. Rate of transpiration in leaves by Cobalt chloride paper method.
9. Mechanism of opening and closing of stomata.
10. Use of water cultures of investigating the plants requirements for various minerals.
11. Effect of time and enzyme concentration on the rate of reaction of enzyme (eg. acid phosphate / nitrate reductase / amylase).
12. Effect of substrate concentration on activity of any enzyme and determination of its K<sub>m</sub> value.



13. Extraction and separation of chloroplast pigments from leaves.
14. To determine the chlorophyll a / chlorophyll b ratio in C<sub>3</sub> and C<sub>4</sub> plants.
15. Isolation of intact chloroplasts and determination of Hill reaction.
16. Determination of rate of respiration by continuous current method.
17. Determination of catalase activity.
18. Demonstration of Polyphenol oxidase.
19. Determination of reducing sugars.
20. Estimation of free acids in Bryophyllum.
21. Extraction and estimation of seed proteins depending upon the solubility.
22. 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.
23. Separation of isozymes of esterases, peroxidases by native polyacrylamide gel electrophoresis.

### **Suggested readings:**

1. Audus, L.J. 1972. Plant Growth Substances, Volume 1. Chemistry and Physiology. Leonard Hill, UK;
2. Bewley, J.D. and Black, M. 1982. Physiology and Biochemistry of seed in relation to germination and dormancy. Volume 1 & 2, Springer – Verlag, Berlin;
3. Devlin, R.M. and Witham, F.H. 1986. Plant Physiology;
4. Davies, P.J. (Ed) 1987. Plant hormones and their role in Plant Growth and Development. Mertinus Nijhoff Publishers, The Netherlands;
5. Hess, D. 1974. Plant Physiology;
6. Hevit, E.J. and T.A. Smith, 1975. Plant Mineral Nutrition.
7. Hillman, W.S. 1962 Physiology of Flowering.
8. Hooykaas, P.J.J., Hall, M.A. and Libbenga, K.R. (Eds.) 1999. Biochemistry and Molecular Biology of Plant Hormones, Elsevier, Amsterdam, The Netherlands;
9. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons Including New York, USA;
10. Khan, A.A. 1982. The Physiology and Biochemistry of Seed Development, Dormancy and Germination. Elsevier, Amsterdam, The Netherlands;
11. H.N. Krishna Murthy. 1981. Plant growth substances including applications in Agriculture. Tata McGraw – Hill Publishers Company Limited;
12. Meyer, A.M. and A. Poljakoff Mayber. 1975. The germination of Seeds;
13. Moore, T.C. 1989. Biochemistry & Physiology of Plant Hormones. Narose Publishers, New Delhi;
14. Noggle, G.R. and G.J. Fritz. 1991. Introductory plant physiology (2<sup>nd</sup> edition) Prentice hall of India Limited;
15. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4<sup>th</sup> edition). Wordsworth Publishing Company, California, USA;
16. Slayter, R.O. 1967. Plant Water Relationships. Academic Press, London;
17. Taiz, L. and Zeiger, E. 1998. Plant Physiology (2<sup>nd</sup> edition). Sinauer Associates including Publishers, Massachusetts, USA;

18. I.P. Ting, Plant Physiology;
19. Thomas and Vince – Prue, D. 1997. PhotoPeriodism in Plants (2<sup>nd</sup> edition). Academic Press, Sandeigo, USA;
20. Wilkins, M.D. 1987. Advanced Plant Physiology. English Language Book Society, Longman;
21. Wisthoff, P. 1998. Molecular Plant Development from Gene to Plant. Oxford University Press, Oxford, UK;
22. Buchanan, B.B., Gruiseem, W. and Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA;
23. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. (Eds) 1997. Plant metabolism (2<sup>nd</sup> edition) Longman, Essex. England;
24. Galston, A.W. 1989. Life Processes in Plants. Scientific American Library, Springer – Verlag, New York, USA;
25. Godwin, T.W. and E.I. Mercer. 1982. Introduction to Biochemistry. Pergamon Press. Oxford;
26. Lehninger, A.I.1984. Principles of Biochemistry. CBS Publishers and Distributors, New Delhi;
27. Lodish, H., Berk, A., Zipursky, S.L., Matsudaria, P. Baltimore, D. and Darnell, J. 2000. Molecular Biology (4<sup>th</sup> edition) W.H. Freeman and Company, New York, USA.

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## M.Sc. - Semester III

### Non-core Paper Offered by the Department of Botany

#### Paper 305: Principles of Genetic Analysis

##### Theory:

1. Introduction to genetic analysis : Importance of Genes – relationship between genes, characters and environment ; penetrance and expressivity of genes ; qualitative and quantitative characters ; modifiers; concept of genetic markers; relation between chromosomes, DNA, RNA and genes.
2. Mendelian ratios – application of probability and Binomial concepts; estimation of number of genes governing a qualitative character; basic methods of genetic analysis – test cross & pedigree analysis.
3. Interaction between alleles and genes; Multiple allelism and blood groups in humans; Genetic analysis of quantitative and quasi-quantitative characters.
4. Concept of Linkage and linkage groups ; linkage analysis in higher organisms and methods to construct linkage maps; LOD scores and their importance.
5. Genetic analysis in microorganisms – use of selection media - use of tetrad analysis, conjugation, transformation and transduction methods ; Fine structure analysis of the gene; nature and variant forms of eukaryotic genes.
6. Genetic analysis using molecular markers and concept of DNA fingerprinting – establishment of molecular markers RFLP, RAPD & AFLPs; QTL analysis.
7. Genetic analysis of sex linked, sex influenced and sex-limited characters. Genetic analysis in populations – Hardy-Weinberg Law and its applications;
8. Applications of genetic analysis in Agriculture, Animal Husbandry, Industry and medicine; overall concept of genetic engineering ; Eugenics.

##### Suggested Readings:

1. Hartl, D.L. and Jones, E.W. 1998. Genetics: Principles and Analysis (4<sup>th</sup> edition) Jones and Bartlett Publishers, Massachusetts, USA.
2. Snustad, D.P. and Simons, M.J., 2000. Principles of Genetics (2<sup>nd</sup> Edition), John Wiley and Sons Inc., USA.
3. Lewis, R. 1997. Human Genetics: Concepts and Applications (2<sup>nd</sup> edition). WCB Mc Graw Hill, USA.
4. Russel, P.J. 1998. Genetics (5<sup>th</sup> edition). The Benjamin/ Cummings Publishing Company Inc., USA.
5. Griffiths, A.J.F., Miller, H.T., Suzuki, Lewontin, Gelbart Intd. Genetic analysis, (6<sup>th</sup> edition), H.F. Freeman and Co.

6. Atherly, A.G., Girton, J.R. and McDonald, J.F. 1999. The Science of Genetics, Saunders College Publishing, Fort Worth, USA.
7. Hartl, D.L. and Jones, E.W. 1998. Genetics: Principles and Analysis (4<sup>th</sup> edition) Jones and Bartlett Publishers, Massachusetts, USA.

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## M.Sc. Botany - Semester IV

### Core Paper 401: GENETIC ENGINEERING OF PLANTS AND MICROBES

#### Theory:

1. Basics of rDNA technology: Restriction enzymes: Types, Nomenclature, Mechanism of action: Methodology of rDNA molecule synthesis: Joining overlapping ends, Blunt end joining, Polylinkers. Vectors: Features and types: Cloning vectors - Plasmids, Viral DNA, Cosmids, Artificial chromosomes - Bacterial and Yeast artificial chromosomes(BACs and YACs); Expression vectors.
2. Bacterial transformation, *In-vitro* packaging, Recognition of transformants: Antibiotic resistance, Lac Z gene based selection. Genomic library, cDNA library.
3. Blotting techniques: Southern, Northern and Western blotting, Radioactive and Non-radioactive labeling. Properties of radio isotopes. Carbon, Phosphorus and Sulphur: Methods and Detection. *In-situ* Hybridization: Technique, Radioactive and non-radioactive probes: Enzyme and fluorescence detection methods (FISH), Applications of the technique. PCR: Technique, Types, Applications. DNA sequencing: Basic principle of Sanger's method, Automated DNA sequencing, High throughput DNA sequencing; Sequencing genomes: Whole genome sequencing, Shot gun sequencing.
4. DNA fingerprinting: Hybridization based – RFLP; PCR based: RAPD, AFLP; Chromosome mapping, Restriction maps and Genetic markers, QTL mapping; Introgression of useful traits using DNA markers. Microarray technique and its applications.
5. Methods of gene transfer in plants: Physical and Biological methods. *Agrobacterium* mediated: Binary and co integrative vector based. Chloroplast transformation. Classical examples of successful cases of transgenic plants: Fungal, Bacterial, Viral and Insect tolerant (BT and proteinase inhibitors) transgenics. Herbicide tolerance. Abiotic stress tolerance. Male sterility: Barnase-Barstar. Quality improvement: Golden rice, Late ripening tomatoes (Flavr Savr).
6. Plant growth promoting bacteria – Nitrogen fixers, Siderophores, phytohormone production. Genetic improvement of industrially important microbes for production of useful products: Biopesticides, Biofertilizers, Antibiotics.
7. Intellectual Property Rights, Farmers Rights. Patents. Ethical and Environmental issues in Genetic Engineering.
8. Bioinformatics: Scope. Data bases: Types, Genbank, PIR, PDB, An account of NCBI. Genome projects: Arabidopsis, Rice. Genomics: Structural genomics: Genome annotation, Gene annotation, Functional genomics, Comparative

genomics: Molecular phylogeny and Phylogenetic trees.

**Suggested Laboratory Exercises:**

1. Isolation of plasmid DNA
2. Bacterial transformation and identification of transformation
3. Plant DNA isolation
4. Restriction enzyme digestion and gel electrophoresis
5. Assignments on the syllabus
6. Pictorial demonstration of the various techniques

**Suggested Readings**

1. Genes VIII By Benjamin Lewin 2004 Pearson Prentice Hall International Edition.
2. Molecular Biotechnology Principles and practices Channarayappa 2006 University
3. Introduction to Plant Biotechnology H S Chawla 2002 Oxford and I B H Publishers
4. Bioethics and Biosafety M K Sateesh 2008 I K International
5. Molecular Biotechnology Principles and applications of rDNA B R Glick J.J. Pasternak
6. Introduction to Bioinformatics T K Atwood D J Parry Smith Anana and sons
7. Principles of Genome Analysis and genomics S B Primrose and RM Twyman 2006 Blackwell publishers
8. Recombinant DNA A short course J.D.Watson, J. Tooze and D.T.Kurtz

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## M.Sc. Botany – Semester IV

### Core Paper 402: EVOLUTION AND PLANT BREEDING

#### Theory:

- 1) Origin of life and Unicellular evolution – Origin of basic biological molecules – abiotic synthesis of monomers and polymers – Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell – evolution of prokaryote; Origin of eukaryotic cells, evolution of Unicellular eukaryotes, anaerobic and aerobic metabolism.
- 2) Theories of organic evolution – Darwinism, Synthetic theory, Phyletic gradualism, Punctuated equilibrium; Molecular evolution – Concepts of neutral evolution, molecular divergence and molecular clocks – protein and nucleotide sequence analysis; gene duplication and divergence.
- 3) Natural Selection, evidences, types; Reproductive isolation – types and species concept; Hardy –Weinberg equilibrium; applications.
- 4) Polygenic inheritance, heritability and its measurements, QTL analysis.
- 5) Origin of cultivated plants; evolution of wheat and maize; Plant introduction, Germplasm banks.
- 6) Methods of breeding self and cross pollinated plants; breeding of vegetatively propagated crops; Heterosis – genetic basis, and significance ;Types of seeds and their production – Tests for viability of seeds.
- 7) Biostatistical Methods: Basic concept of Parametric and non-parametric methods; - Graphical representation, measures of central tendency and dispersion; Probability distributions (Binomial, Poisson and Normal distributions); Concepts of confidence intervals, types of error, levels of significance.
- 8) Regression and correlation; t-test,  $\chi^2$  – test, ANOVA, Basic introduction to Multivariate statistics.

#### Suggested Laboratory Exercises:

1. Assignment containing problems on topics mentioned in the theory syllabus.
2. Floral biology, Pollination mechanisms and breeding of rice, maize, sorghum, Bajra, Brassica, Chilli and Solanum.

### **Suggested Readings:**

1. Jones & Wilkins – Variation and adaptation in plant species. Heinemann Educational Books Ltd., London.
2. Stebbins, J.L. – Chromosomal evolution in Higher Plants. Edward Arnold Publishers Ltd., London.
3. Poehiman and Borthakur, 1981. Breeding Asian field crops.
4. Singh, B.D.: Plant Breeding.
5. Alalrd, R.W. 1961: Principles of Plant Breeding.
6. Introduction to Plant Breeding – Briggs and Knowles.
7. Genetics M.W. Stickberger, Macmillan Company, New York.
8. Agricultural Genetics James L Brew Baker, Foundation of Modern Genetics Series.
9. Breeding, Kenneth J Frey, Univ. Press, Ames, Iora.

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## M.Sc. Botany - Semester IV

### Elective Paper: ADVANCED CYTOGENETICS

#### Theory:

1. Cytogenetics of inversions – consequences of crossing over in different types of inversions, identification of chromosomes and location of inverted regions- breeding behaviour of peri and paracentric inversions, interchromosomal effects- cytogenetic uses and evolutionary significance of inversions.
2. Cytogenetics of interchanges – meiotic configurations and consequences of crossing over (spore quartet analysis in maize as an example), identification of chromosomes involved and location of break points, tester stock establishment; A-B translocations; Cytogenetic importance and evolutionary significance of interchanges.
3. Haploids : techniques for production of haploids, androgenic and gynogenic types, mono and poly haploids - uses of haploids.
4. Cytogenetics of B-chromosomes : Distinction from A-chromosomes, effects on exo and endophenotypes; mechanisms of maintenance and elimination in natural populations.
5. Polyploids : Meiosis in autotriploids and autotetraploids with special reference to pachytene configurations - reasons for sterility; gene segregations in autopolyploids;
6. Meiosis in allopolyploids with special reference to homologous and homeologous chromosome pairing - 5B system in wheat; Genome analysis in Tobacco, wheat, Brassica and Gossypium ; Production of Alien addition and substitutes lines – concept of chromosomal engineering and gene juggling - use in gene transfer.
7. Cytogenetics of sex-determination – chromosomal, genetic and environmental , organization of X- and Y- chromosomes; Apomixis – types, genetic basis and applications.
8. Molecular biological approaches in Cytogenetics : use of molecular markers in chromosome mapping – recombinant inbred lines (RIL) and artificial chromosomes; chromosome walking and jumping ; top – down and bottom – up methods; optical mapping of genome mapping; Organization and inter relationships of cereal genomes on the basis of molecular markers.

#### Suggested Laboratory Exercises

1. Determination of circadian rhythms in mitotic cycle. – *Allium*, *Aloe*
2. Computerized analysis of Karyotypes - *Allium* / *Aloe*/ *Scadoxus*/ *Ornithogalum*
3. Feulgen staining of chromosomes.

4. Linear differentiation of chromosomes through C, Q and Ag-NOR banding techniques – *Ornithogalum / Allium / maize*.
5. Meiosis in maize and *Rhoeo*
6. Meiosis in polyploids – *Pennisetum* species
7. Assignments related to topics mentioned in the theory syllabus.

**Suggested Readings:**

1. Burnham, C.R. 1962. Discussions in Cytogenetics, Burgess Publishing Co., Minnesota.
2. Lewin B, 2000. Genes VII Oxford University Press, New York.
3. R.F. Weaver 1999, Molecular Biology, WCB Mc Graw Hill.
4. Glick, B.R. and Thompson J.E. 1993. Methods in Plant Molecular Biology and Biotechnology, CRC Press, Boca Raton Florida.
5. John, B. and Lewis, K.R. Chromosome Hierarch. Clarendon press, Oxford.
6. Lewis, K.R. and John, B. Chromosome Marker. J&A. Churchill Co., London.
7. Swanson, Merz and Young. Cytogenetics. Prentice Hall . India.
8. Sybenga, J. 1973. General Cytogenetics. North Hall and American Elsevier.
9. Sybenga, J. 1975. Meiotic configurations. North Hall and American Elsevier.
10. Gupta, P.K. 1995. Cytogenetics. Rastogi & Company, Meerut.

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## M.Sc. Botany - Semester IV

### Elective Paper: APPLIED PHYCOLOGY

#### Theory:

Algae in diversified habitats (terrestrial, freshwater, and marine).

Structure, reproduction, and lifecycles of some algae like *Ulva*, *Enteromorpha*, *Codium*, *Caulerpa*, *Ectocarpus*, *Padina*, *Sargassum*, *Porphyra*, *Gelidium*, *Euclima*, *Hypnea*, *Gracilaria*, *Nostoc*, *Spirulina*.

Composition and distribution of phytoplankton of Indian waters, Sampling techniques of phytoplankton, primary production.

Structure and reproduction of some important micro alga like, *Chlorella*, *Scenedesmus*, *Tetraselmis*, *Dunaliella*, *Ceratium*, *Peridinium*, *Cyclotella* and *Skeletonema*, and their importance in aquaculture industry.

Algae as biofertilizers.

Economic uses of fresh water and marine algae and their products.

Mass culture and yield of micro alga (*Chlorella*, *Scenedesmus*, *Spirulina*).

Sea weed farming in India, with emphasis on the methods of seaweed cultivation of *Sargassum*, *Porphyra*, *Gelidium*, *Gracilaria*.

Methods of extraction of Agar-agar and Algin.

Algae and water pollution; Algae as indicators of pollution.

Biofouling, Sewage disposal, Toxicity: waste land reclamation.

#### Suggested Laboratory Exercises:

Study of the following algae. *Ulva*, *Enteromorpha*, *Codium*, *Caulerpa*, *Ectocarpus*, *Padina*, *Sargassum*, *Porphyra*, *Gelidium*, *Gracilaria*, *Hypnea*, *Nostoc*, *Spirulina*.

Identification of phytoplankton.

Estimation of Salinity, Oxygen, Primary production.

Spore counting and germination.

Plankton cell density.

Extraction of Agar-agar and Algin.

Acquaintance with the Marine algal flora and fresh water lakes and pools in and

around Visakhapatnam.

**Suggested readings:**

1. Dawson E.Y. 1966. Marine Botany, Holt, Reinhart & Winston including New York;
2. Round F.E.1970. The Biology of the Algae. Edward Arnold Limited;
3. Fritsch F.E.1935. The Structure and reproduction of Algae. Cambridge University Press;
4. Chapman V.J.1970. The Sea weeds and their uses. Methena & Company Limited;
5. Levin R. 1964. Physiology and Biochemistry of Algae. Academic Press. Oxford;
6. Aymount J.E.E.1963. Plankton and productivity in Oceans, Pergamon Press. Oxford;
7. Smith G.M. (Ed.) 1951. Manual of phycology. Cronica Botanica, Company U.S.A.;
8. Lewis J.R.1964. The ecology of rocky shores. The English University Press Limited. London;
9. Trait R.V.1968. Elements of Marine Ecology. Butterworths. London;
10. Fogg G.E. Stewart, W.D.P., Fay P., and Walsby A.E. 1973. The blue green algae. Academic Press. London;
11. Kumar H.D. 1985. Algal Cell Biology. Affiliated East-West Press, New Delhi;
12. Kumar H.D. 1990. Introductory Phycology. Affiliated East-West Press, New Delhi;
13. Venkata Raman G.S. 1972. Algal Biofertilizers and Rice cultivation. Today and Tomorrow printers and publishers, New Delhi;
14. Singh R.N. 1961. Role of Blue green algae in Nitrogen economy of Indian Agriculture, ICAR, New Delhi;
15. Subba Rao N.S. 1988. Biofertilizers in Agriculture. Oxford publishing Company Private Limited. New Delhi.

## M.Sc. Botany - Semester IV

### Elective Paper: PLANT PATHOLOGY

#### Theory:

Importance of plant diseases, classification of plant diseases, causes of plant diseases, symptoms of plant diseases, post harvest diseases.

Dispersal of plant pathogens- Active and passive.

Infection phenomena – pre penetration, penetration and post penetration. Factors affecting infection. Effect of environment on plant disease development – Temperature, humidity and light.

Role of toxins in plant diseases – pectic, macerating, cellulolytic, lignolytic, proteolytic, lypolytic enzymes & hemicellulases.

Role of toxins in plant diseases – host specific & non specific toxins, pathotoxins, vivo toxins & Phytotoxins.

Plant diseases management through host resistance:

- a. Vertical, horizontal, monogenic, polygenic, specific & general resistance.
- b. Development of resistant varieties.

Defense mechanisms in plants: Pre – infectional defence mechanisms, Post – infectional defense mechanisms, phytoalexins.

Control of plant diseases:

- a. Cultural practices : field & crop sanitation, crop rotation;
- b. Chemical control: systematic & non systematic fungicides;
- c. Biological control.

Symptoms, etiology, epidemiology & control measures with reference to the following:

Fungal disease – Club rot of crucifers, Damping off of seedlings.

Leaf spot of Turmeric, Ergot of Bajra, Powdery mildew of Cucurbits, Whip smut of sugarcane, Grain smut of Sorghum, Bean rust, Coffee rust, Blast disease of rice, Wilt of Cotton, Tikka disease of Ground nut.

Bacterial disease – Citrus Canker, Angular leaf spot of Cotton, Bacterial leaf Blight of rice, Brown rot of potatoes.

Viral & phytoplasma diseases – Grassy shoot diseases of Sugarcane, Little leaf of Brinjal, Rice tungro.

### **Suggested Laboratory Exercises:**

1. Study of symptoms, microscopic examination of diseased parts and identification of the pathogens involved in different plant diseases included in the theory part of syllabus.
2. Acquaintance with the general techniques used in routine phytopathological and microbiological work.
3. Isolation and Identification of plant pathogens.

### **Suggested readings:**

1. Agrios, L., 1969: Plant Pathology;
2. Butler, E.J. 1973: Fungi and diseases in plants;
3. Mundkar, B.B.1967: Fungi and Plant diseases;
4. Goodman et al.1957: Biochemistry and physiology of infections & Plant diseases;
5. Rangaswamy G., 1967: Disease of crop plants in India;
6. Rangaswamy G., 1967: Bacterial Plant disease;
7. Singh, R.S. 1974: Plant pathology;
8. Singh, R.S. 1975: Plant diseases;
9. Smith, K.M. 1968: Plant viruses;
10. Walker, J.C. 1969: Plant pathology;
11. Strobell, G.A. & Mathre, D.E. 1979: Outline of Plant pathology;
12. Wheeler, B.E.J.1969: An introduction of Plant diseases;
13. Roberts, R.R. and Booth Royd, L.R. 1972: Fundamentals of plant pathology;
14. Bilgrami, S. and Dubey, H.C. 1974. A text book of modern Plant pathology;
15. Wood, R.K.S.1967: Physiological Plant pathology;
16. Horsfall, J.C. Diamond, A.E.1960: Plant pathology – An advanced treatise – 3 volumes.
17. Mathews, R.E.F. 1970: Plant virology;
18. Vander plank, J.E.1953:Plant diseases – Epidemics and control;
19. Kelman, A. 1967: Source book of laboratory exercise in Plant pathology;
20. Annual review of Phytopathology;
21. Mehrotra, R.S.1994. Plant pathology.

## **M.Sc. Botany - Semester IV**

### **Elective Paper: PLANT BIOSYSTEMATICS**

#### **Theory:**

Definition, History, Scope, Importance and Objectives of Plant Biosystematics. Biosystematics in the frame of work of evolution. Emphasis on Orthodox and Experimental taxonomy. Biosystematics categories (Phenotype, Genotype, and Biotype, Ecotype, Subspecies, Ecospecies, Coenospecies, Comparium and Intraspecific variation.)

Population–concept: Size and density; variation in individuals, ecological differentiation of population, Plasticity of phenotype, geographical and regional variation, Transplant experiments of Claussen, Keck and Hiesy, Macmillan, Watson and Claussen.

Breeding Systems: Establishment of inbreeding and consequences, out breeding its problems and perspectives, self compatibility isolating mechanism.

Importance of the following disciplines in Biosystematic studies:

1. Cytology; 2. Phytochemistry; 3. Embryology; 4. Palynology, 5. Anatomy;
6. Taximetrics.

Species concept: Models of species for formation, dynamics and mechanism of speciation process; abrupt speciation. Polyploidy, catastrophic selection, Biological species concept, Leaky isolation barriers, Gene flow and selection, species definition and classification, types of species: (1) Taxonomic species; (2) Biological species; (3) Semi species; (4) Micro species; (5) Successional species; (6) Biosystematic species; (7) Evolutionary species.

#### **Suggested Laboratory Exercises:**

Investigation of variation and evolution through Experiments in Cytology, Anatomy, Palynology & Plant chemistry to set boundaries around species and genera in a family.

A systematic study of 2 or more morphological variants of a species or 2 or more species of a genus, using comparative morphological, cytological and phytochemical methods.

Exercise 1: To determine the variation (1) different populations of a species; (2) between different species of a genus; (3) between different genera of a complex, by construction of polygons or polygraphs, scatter diagrams, bar diagrams and histograms.

Exercise 2: Preparation of palynological slides – Study of pollen grain types in some angiosperms including the pollen grains of different populations of a species, of different species of a genus.

Exercise 3: Phenotypic variability studies – Sketches from live specimens or from herbarium sheets or from text books or research publications of different populations of a species, growing in different environmental conditions.

Exercise 4: Preparation and study of meiosis in 2 or more populations of a species as well as some classical cytological material.

Exercise 5: Sketches from text books or from published papers relating to protein band patterns of seed proteins, Flavonoids and chromatograms.

Each student has to submit a herbarium of 10 sheets consisting of different population samples of a species and 10 species of a family or a group of families from any part of India.

**Suggested readings:**

1. Maheshwari, P. 1963 Recent Advances in the Embryology of Angiosperms. International soc. of Plant Morphologists. Univ. of Delhi;
2. Otto, T. Selbrig, 1970, Principles and methods of Plant Biosystematics. Macmillan. Co. London;
3. G.I. Stebbins 1950. Variation and evolution in Plants;
4. Heywood, V.H. 1963. Principles Plant Taxonomy;
5. Dobzhansky, T.H. 1951. Genetics and foreign of species;
6. Heywood, V.H. 1963. Modern methods in Plant Taxonomy, Academic Press, London;
7. Albert E Radford, 1974. Vascular Plant systematics;
8. Dickison, G.H. Massey, J.H. Ritchie Bell, G. and Bridggs, F.W. 1967. Introduction to Plant Breeding;
9. Knowles, P.F. and Stebbins, G.I. 1971. Chromosome evolution in Higher Plants;
10. Alston, R.F. and Turner, B.E. 1963. Biochemical systematics.
11. Heslop Harrison, 1970. New concepts in Flowering Plant Taxonomy;
12. Davis, P. H. and Heywood, V.H. 1963. Principles Plant Taxonomy;
13. Cronquist, S. 1961. Comparative Plant Anatomy.



## M.Sc. Botany - Semester IV

### Elective Paper: AGRICULTURAL BIOTECHNOLOGY

#### Theory:

Micro propagation technology and its use in Agriculture. Embryo culture and its utility in hybridization programme. Anther culture, Cell and protoplast culture – achievements and limitations – artificial seeds.

Conventional plant breeding approaches for crop improvement. Exploiting natural variability.

Inbreeding depression and heterosis, Self incompatibility and Male sterility.

Plant genetic engineering – an over view.

The molecular basis of plant breeding and genetic engineering.

Organizations for crop improvement in India.

General principles of plant protection. Principles of pest management – specific integrated pest management practice for rice, sugarcane, and cotton. Biological control – history and development; Use of Biopesticides in pest management.

Mutation breeding for crop improvement (Mutagens – mode of action of chemical mutagens at the molecular level. Transitions, transversions and frame shifts. Biochemical basis of mutations). Chromosome and chromatid aberrations. Molecular theories of radiation induced chromosomal aberrations, Radiation sterilized food.

#### Suggested readings:

1. Experiments in plant tissue culture (1985). Dodds, J.H. & I.W. Roberts;
2. Y.P.S. Bajaj. Biotechnology in agriculture and forestry. Vol, 22 Springer – Verlag;
3. Biotechnology in agriculture. Macmillan India Ltd.,1992.Ed,M.S.Swami Nathan;
4. Trends in agriculture insect pest management, G.S. Dhaliwal & Ramesh Arora. Common wealth Publishers, (1994);
5. Biocontrol of Plant diseases, K.G. Mukherji & K.I. Garg. C.B.S. Publishers & Distributors (1993);
6. The scientific principles of crop protection. Martin & David Woodcock, 7<sup>th</sup> Edition.
7. Plant Breeding, B.D. Singh, Kalyani Publishers (1983);
8. Molecular genetics, Davis Freifelder, Jones & Berlet Publishers (1987);

9. Chromosomal aberration, G. Obe & A.T. Natarajan, Springer – Verlag (1990);
10. Mutation research, Charlotte Auerbach (1976);
11. The molecular theory of radiation Biology, K.H. Chadwick & H.P. Leenhouts;
12. Environmental biology and Toxicology, P.D. Sharma, Rastogi & Company, (1993);
13. Breeding Asian Field Crops. Poehlman & Borthakur.

## **M.Sc. Botany - Semester IV**

### **Elective Paper: CROP PHYSIOLOGY AND BIOTECHNOLOGY**

#### **Theory:**

Crop Physiology: Molecular biology of light reactions Photosynthetic pathways, Mechanism of Photorespiration, Biotechnological strategies to improve Photosynthesis, Yield components, Source – sink relationships.

Stress Physiology: Physiology and molecular biology of stress tolerance in response to water, salt and heavy metal stress.

Methods in Biotechnology: Tissue culture techniques in crop improvement, Protoplasts and cell fusion, Basic principles of recombinant DNA technique, Technique for transferring genes into plants.

Potentials of Biotechnology: Molecular mechanism to confer herbicide resistance in crop plants. Genetic engineering to improve plant disease resistance. Genetic manipulation of crops for insect resistance, Genetic engineering of seed proteins and oils.

Bioinformatics: Fundamentals of Genomics and Proteomics. PCR and its applications in crop improvement, Principles of microarray technology and its applications.

#### **Suggested Laboratory Exercises:**

Exercise-1: Chlorophyll absorption spectrum and quantitative determinations, assay of Hill reaction in isolated chloroplast. Crop growth analysis;

Exercise-2: Determination of CO<sub>2</sub> compensation points in some crop plants, Estimation of carbohydrate, protein and nucleic acid contents in plants;

Exercise-3: Determination of the activities of some enzymes associated with Carbohydrates and protein metabolism;

Exercise-4: Effect of nitrogen and potassium on the growth and yield of crop plants;

Exercise-5: Leaf anatomy in relation to diversity in photosynthetic pathways;

Exercise-6: Effect of water and salt stress on the accumulation of proteins;

Exercise-7: Estimation of nitrogen, phosphorus and potassium;

Exercise-8: Experiments to study the effect of water and salt stress on seed

germination and seedling development;

Exercise-9: Experiments to study the weed control using some common herbicides;

Exercise-10: Polyacrylamide gel electrophoresis of proteins;

Exercise-11: Isolation of DNA;

Exercise-12: Polymerase chain reaction;

Exercise-13: Isolation of explants, establishment and maintenance of callus;

Sub-culture of callus. Study of Somaclonal variation;

Exercise-14: Isolation and culture of single cells;

Exercise-15: Experiments on herbicide resistance and disease resistance in plants.

### **Suggested readings:**

1. Annual review of Plant Physiology, 1950. Vol. – Annual Reviews INC., Stanford;
2. Ashston and Alden Crafts 1973. Mode of action of herbicides;
3. Burris, R.H. and C.C. Black (Ed.) 1975. CO<sub>2</sub> metabolism and productivity of plants;
4. Davies, K.E. (Ed.) 1988. Genome analysis. IRI. Press Oxford;
5. Day, P.R. 1986. Biotechnology and Crop improvement and protection, BCPC Publications;
6. Epstein, E., 1972. Mineral nutrition of plants: Principles and perspectives;
7. Evans, I.T. 1975. Crop Physiology;
8. Fogg, G.K. 1972. Photosynthesis;
9. Gollek, B. (Ed.) 1970. Structure and function of plant cells in saline habitats;
10. Gregory, R.P.F. 1971. Biochemistry of photosynthesis;
11. Hatch, M.D., C.B. Osmond and R.O. Slatyer (Eds.) 1971. Photosynthesis and Photorespiration;
12. Hillman, W.S. 1972. The Physiology of Flowering;
13. Kozlowski, T.T. (Ed.) 1968. Water deficit and Plant growth;
14. Kozlowski, T.T. (Ed.) 1972. Seed Biology, 3 Vols.;
15. Lange, O.I., L. Kappen and D.D., Schule 1976. Water and Plant life;
16. Lebowitz, R.J, 1995. Plant Biotechnology, a laboratory manual. Wm. C. Brown Publishers, Qubuque;
17. Levitt, J. 1972. Response of plants to environmental stresses;
18. Major, A.M. and a Poljakoff Mayber. 1975. The germination of seeds. (2<sup>nd</sup> edition);
19. Mantell, S.H. and N. Smith (Eds.) 1983. Plant Biotechnology, Cambridge University Press, Cambridge;

20. Marshall, G. and O. Walters, (Eds.) 1994. Molecular Biology in crop protection. Chapman & Hall;
21. Murray Meo – young, 1995. Comprehensive Biotechnology. (Vol .– 1)Pergamon Press Oxford;
22. Noggle, G.R. and G.J. Fritz. 1977. Introductory plant physiology;
23. Old, R.W. and S.B. Primrose, 1994. Principles of gene manipulation. Blackwell Science;
24. Poljakoff Mayber, A. and J. Gele, (Eds.) 1975. Plants in saline environments;
25. Pierik, R.I.M. 1987. Invitro culture of higher plant. Martinus Nihoff Publishers, Dordrecht;
26. Primrose, S.B. 1987. Molecular Biotechnology, Blackwell Scientific Publications;
27. Reinert, J. and Y.P.S. Bajaj. 1977, Plant Cell, tissue and organ culture. Springer – verlag, Berlin;
28. Salunkhe, D.K., N.R. Bhatt and B.B. Desai, 1990. Post harvest biotechnology of flowers and ornamental plants. N. Bayopokash, Calcutta;
29. Zelitch, I. 1971. Photosynthesis, Photorespiration and Plant Productivity.

## **M.Sc. Botany - Semester IV**

### **Elective Paper: EXPERIMENTAL EMBRYOLOGY OF ANGIOSPERMS**

#### **Theory:**

Historical account and role of experimental Embryology: Techniques and apparatus involved in different types of cultures. Preparation of nutrient media; sterilization, aseptic manipulation and maintenance of cultures. Pollen contents and the various factors affecting the pollen germination and pollen tube growth.

Anther culture, isolated microspore and pollen culture, cytology of androgenesis and role of haploids in higher plants. Nucellus culture and its applications.

Pollen-Pistil interaction and control of fertilization. Intra-ovarian pollination and in vitro fertilization.

Nutritional aspects of embryo Sac.

Ovule culture, seed culture and ovary culture and their applications.

Experimental induction of parthenocarpy and its importance in Horticulture.

Physiological aspects of the development of endosperm; embryo and endosperm relationships.

Endosperm culture and its applications.

Embryo Culture and its practical applications.

Nutritional aspects of embryo.

Experimental induction of polyembryony and its applications.

Protoplast culture and somatic hybridization and its importance.

#### **Suggested Laboratory Exercises:**

Some basic techniques to study pollen; In vitro pollen germination studies through hanging drop techniques.

In vivo pollen germination and pollen tube growth. Pollen physiology-Simple experiments to demonstrate the effect of various nutrients. PH and temperature.

Estimation of pollen fertility through pollen stainability technique.

Examination of embryo sac, embryo and endosperm with the help of dissection of ovules and seeds.

Isolation of explants, establishments, maintenance and sub culture of callus – carrot (*Daucus carota*).

Embryogenesis in the culture cells of carrot.

Culture of anthers from *Nicotiana tabacum* and establishment of haploid.

Isolation and culture of mesophyll protoplasts from *Nicotiana* leaves.

**Books:**

1. Johri, B.M. 1982: Experimental Embryology of Vascular plants. Narosa Publishing House, New Delhi;
2. Johri, B.M. 1984: Embryology of Angiosperms, Springer-Verlag;
3. Bhojwani, S.S and S.P. Bhatnagar, 1983: The Embryology of Angiosperms. Vikas Publishing House, New Delhi;
4. Bilgrami, K.S and A.K. Pandey 1992: Introduction to Biotechnology, CBS Publishers, New Delhi;
5. Heslop-Harrison, J. 1971: Pollen Development and Physiology, Butterworth's, London;
6. Reinert, J. and Y.P.S. Bajaj, 1977: Plant Cell, Tissue and Organ culture, Springer-Verlag, Berlin;
7. Shivanna, K.R. and B.M. Johri, 1985: The Angiosperm Pollen structure and function, Wiley Eastern Ltd., New Delhi.