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 Cell, Tissue and Organ 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 Development and 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

S. No	Unit
	SECTION A
1.	Criteria employed in classification of algae. Classification given by Fritsch, Bold and Wynne, Lee. Thallus organization, reproduction and life cycles in algae.
2.	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.*
3.	Salient features of Protochlorophyta; Xanthophyta: *Vaucheria*. Bacillariophyta: *Cyclotella, Navicula;* Phaeophyta: *Ectocarpus, Dictyota, Padina, Laminaria, Sargassum*.
4.	Salient features of Rhodophyta: *Gelidium, Gracilaria, Polysiphonia*; Cyanophyta: *Nostoc, Lyngbya, Spirulina.*
	SECTION B
5.	Diversity of marine and fresh water algae in India. Economic importance of algae– single cell protein, pigments, lipids, and omega fatty acids. Algal blooms. Algal bio fertilizers. Cultivation of economically important seaweeds–*Porphyra, Gracilaria, Gelidium*. Mass culture of micro algae.
6.	Classification of Bryophytes given by Smith, Campbell. Ecological and economic importance of Bryophytes. Conduction in Bryophytes.
7.	Morphology, structure, reproduction and life history of Hepatocopsida: Marchantiales: *Marchantia*; Jungermaniales: *Pellia*, *Porella*; Anthocertopsida: *Anthoceros*.
8.	Morphology, structure, reproduction and life history of Bryopsida: Sphagnales: *Sphagnum*; Funariales: *Funaria*; Polytrichales: *Polytrichum.*

Practical

S. No	Exhibit/Experiment
1.	Examination of vegetative and reproductive morphology of Chlorophyceae: *Chlamydomonas, Tetraspora, Volvox, Chlorella, Scenedesmus, Ulva, Enteromorpha, Cladophora, Fritschiella, Oedogonium, Spirogyra, Cosmarium, Caulerpa, Chara.*
2.	Examination of vegetative and reproductive morphology of Bacillariophyceae:

	Cyclotella, Navicula; Phaeophyceae: *Ectocarpus, Dictyota, Padina, Laminaria, Sargassum.*
3.	Examination of vegetative and reproductive morphology of Rhodophyceae: *Gelidium, Gracilaria, Polysiphonia*.
4.	Examination vegetative and reproductive morphology of Xanthophyceae: *Vaucheria* Cyanophyceae: *Nostoc, Lyngbya, Spirulina*.
5.	Field work to get acquaintance with the algae of Visakhapatnam coast and fresh water algae in and around Visakhapatnam.
6.	An examination of the external features and internal structure and reproductive organs of: *Riccia, Targionia, Monoclea, Plagiochasma*.
7.	An examination of the external features and internal structure and reproductive organs of the genera: *Fimbriaria, Marchantia, Pellia, Porella.*
8.	An examination of the external features and internal structure and reproductive organs of: *Anthoceros, Notothylus, Andreaea, Funaria, Polytrichum*.

Reference Books

1.	Lee RW. 2007. **Classification of Algae.**
2.	Kumar HD. 1988. **Introductory Phycology.** Affiliated East West Press Pvt. Ltd., New Delhi.
3.	Round FE. 1986. **The Biology of Algae**. Cambridge University Press, New York.
4.	Bold HC and Wyne MJ. 1978. **Introduction to the Algae.** Prentice-Hall, New Jersey.
5.	Presscot GW. 1969. **The Algae- a Review**. Houghton Mifflin Company, Boston.
6.	Morris I. 1967. **An Introduction to the Algae.** Cambridge University Press, UK.
7.	Chapman VJ.1962**. The Algae.** Macmillan and Co Ltd., London.
8.	Lewin RA. 1962. **Physiology and Biochemistry of Algae.** Academic Press, New York.
9.	Round FE. 1962. **Ecology of Algae**. Cambridge University Press, New York
10.	Smith GE (ed) 1950. **Fresh Water Algae.** Elsevier Science, USA.
11.	Fritsch FE.1945. **The Structure and Reproduction of Algae Vols. 1& II**. Cambridge University Press, New York.
11.	Chopra RN and Kumra PK. 1988. **Biology of Bryophytes.** New Age International (P) Ltd. Publishers, New Delhi.
12.	Parihar NS. 1991. **Bryophyta**. Central Book Depot, Allahabad.

13.	Puri P. 1980. **Bryophytes**. Atmaram and Sons, Delhi.
14.	Smith GM. 1955. **Cryptogamic Botany Vol.II.** Tata McGraw Hill Publishing Co. Ltd., New Delhi.
15.	Kashyap S. 1929. **Liverworts of the Western Himalayas and Punjab Plains Part I and Part II.** University of Panjab, Lahore, Pakistan.

M.Sc. Botany - Semester I

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

Theory

S. No	Unit
	SECTION A
1.	General account of archaebacteria, eubacteria and cyanobacteria. Classification of eubacteria. Ultrastructure, nutrition, reproduction and economic importance of bacteria.
2.	Morphology and chemical composition of Actinomycetes, Spirocetes, Rickettsiae and Mycoplasmas.
3.	Classification of viruses. Ultrastructure and chemistry of viruses. Replication and transmission of viruses. History, origin and evolution of plant viruses. Plant viral diseases.
4.	Microbial Ecology: quorum sensing, gentrification, phosphorous solubilization, nitrogen fixation.
	SECTION B
5.	Classification and phylogeny of fungi. Molecular aspects in classification. Thallus organization in fungi. Ultrastructure of fungal cell. Unicellular and multicellular organization. Cell wall composition. Fungal diseases in plants and humans.
6.	General account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina.
7.	Reproduction in fungi: vegetative, asexual and sexual. Heterothallism, heterokaryosis and parasexuality. Nutrition in fungi: saprobic, biotrophic, and symbiotic.
8.	Fungi in industry: medicine, food, pest and weed management (biocontrol agents). Mushroom cultivation. Fermentation methods. Mycorrhiza.

Practical

S. No	Exhibits/ Experiments
1.	Tools of microbiology: Care and use of the microscope, Spectrophotometer, P^H meter, Micrometer, Hemocytometer, Autoclave, Centrifuge, Biological safety

	cabinets, Inoculation needle and loop, Incubator, Colony counter & Lyophilizer.
2.	Differential staining: Gram staining.
3.	Differential staining: Acid fast staining.
4.	Study of bacterial growth: To prepare the growth curve of bacteria.
5.	Study of cyanobacteria: Isolation and cultivation of cyanobacteria.
6.	Isolation of rhizobia from root nodules.
7.	Cultivation of viruses in embryonated eggs.
8.	Isolation of fungi by Petri plate exposure method.
9.	Morphological study of: *Stemonitis, Saprolegnia, Mucor, Morchella, Aspergillus, Agaricus, Cyathus, Synchitrium, Helminthosporium.*
10.	Symptomotology and anatomical study 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, tobacco mosaic disease.

References Books

1.	Kaursethi I and Surinder KW 2011. **Text Book of Fungi and their Allies.** Macmillan publishers, New Delhi, India.
2.	Ram Reddy S & Reddy SM 2007. **Essentials of Virology.** Scientific publishers, Jodhpur, India.
3.	Sharma K 2005. **Manual of Microbiology Tools and Techniques.** Ane Book, New Delhi, India.
4.	Matthew RH 2004. **Plant virology.** 4th edition. Academic press an imprint of Elsevier, California, USA.
5.	Prescott *et al.* 2003. **Microbiology**. McGraw Hill Education, New York.
6.	Aneja KR 2003. **Experiments in Microbiology, Plant pathology and Biotechnology**. New Age International publishers, New Delhi.
7.	Verma HN 2003. **Basics of plant Virology.** IBH publishing co. Pvt. Ltd., New Delhi.

8.	Mehrotra KS and Aneja KR 2003. **An Introduction to Mycology**. New Age International Publishers, New Delhi.
9.	Sullia SB and Shantharam S 2001. **General Microbiology**. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
10.	Reddy SM and Ram Reddy S 2000. **Microbiology a Laboratory Manual**. BSC Publishers and Distributors, Hyderabad.
11.	Flint SJ, Enquist LW, Krug RM, Racaniello VR, Skalka AM 2000. **Principles of Virology, Molecular Biology, Pathogenesis and Control.** ASM press, Washington DC.
12.	Rao AS 1999. **Introduction to Microbiology**. Prentice Hall of India Pvt. Ltd., Delhi.
13.	Alexopoulus CJ, Mims CW, Blackwell M 1996. **Introductory Mycology**. 4th edition. Replika press, North Delhi.
14.	Paul S 1995. **Bacteria in Biology, Biotechnology and Medicine**. 5th edition. John Wiley and son Ltd., UK.
15.	Pelczar, Chan and Krieg 1993. **Microbiology.** 5th edition. McGraw Hill Education, New York.
16.	*Stainer* RT, Ingraham JL, Wheelis ML and Painter PR 1987. ***General Microbiology***. 5th Edition. Macmillan, London.
17.	Smith KM 1968. **Plant viruses**. Elsevier, New York.
18.	Rangaswamy G 1962. **Bacterial Plant disease in India**. Asia Publishing House, Bombay.

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M.Sc. Botany - Semester I

Core Paper–103: CELL BIOLOGY OF PLANTS

Theory

S. No	Unit
	SECTION A
1.	The cell theory. Origin and development of cell biology as a separate branch. Dimensions of size and weight: micron to angstrom, microgram to pictogram. Ultra structure and organization of prokaryotic and eukaryotic cells. Specialized cell types.
2.	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.
3.	Cell wall:structure and functions, cell wall architecture, biogenesis and growth. Plasmodesmata: structure and function, plasmodesmata in comparison to gap junctions of animal cells. Plasma membrane: structure, models and functions. ATPases receptors, carriers, channels, pumps. Vacuole structure and function, vacuolar ATPases, transporters.
4.	Cytoskeleton: microtubules and microfilaments, their role in cell division and motility; intermediate filaments– role in providing strength. Labeled antibody technique for visualizing cytoskeleton.
	SECTION B
5.	Chloroplast and Mitochondria: structure and function, genome organization, nucleo-cytoplasmic interactions, RNA editing.
6.	Other organelles: structure and function– endoplasmic reticulum, Golgi apparatus lysosomes,, ribosomes, microbodies, peroxisomes.
7.	Tools in cell biology 1: microscopy–working principles of light microscopy, resolution power of microscope, different types of light microscopes, stains used. Image processing methods in microscopy. Scanning electron microscopy. Transmission electron microscopy– principle of working, preparation of specimens for electron microscopy –Fixing, sectioning, spreading molecules, negative staining, shadow casting, freeze fracture and freeze etching.
8.	Tools in cell biology II: subcellular fractionation– homogenization, principle of density gradient centrifugation. Spectroscopic techniques– principle and applications

	of UV- visible, ESR. Spectrofluorimetry. Circular dichroism (CD). Nuclear magnetic resonance (NMR). Whole cell autoradiography. Radiolabeling techniques: properties of different radioisotopes used in biology, their detection and measurement, incorporation of radioisotopes in biological tissues and cells.

Practical

S. No	Exhibit/Experiment
1.	Electron microscopic picture of prokaryotic and eukaryotic cells.
2.	Images of cytoskeleton.
3.	Electron microscope pictures of chloroplast and mitochondria.
4.	Electron microscope pictures of endoplasmic reticulum, Golgi apparatus.
5.	Study of mitosis using acetocarmine.
6.	Isolation of mitochondria and the activity of its marker enzyme, succinate dehydrogenase (SDM).
7.	Fluorescence staining with FDA for cell viability and cell wall staining with calcofluor.
8.	Pictures of images of shadow casting, negative staining, freeze fracturing and freeze etching.
9.	Images of cells in flourescence, phase contrast and confocal microscopy, whole cell autoradiography.
10.	Establishing sucrose density gradients.

Reference Books

1.	Alberts B, Breyer D, Hopkin K, Johnson AD, Lewis J, Raff M, Roberts K and Watter P 2014. **Essential Cell Biology.** 4th Edition. Garland publishers, New York.
2.	Sharp D, Ploppe G and Sikorski E 2014. **Lewin's Cells.** 3rd Edition. Viva Books, New Delhi.
3.	Cooper GM, Hausman RE 2013. **The Cell – A Molecular Approach**. 6th Edition. Sinauer Associates, Incorporated, USA.
4.	Karp G 2013. **Cell and Molecular Biology – Concepts and Experiments.** 7th Edition. Wiley Global Education, USA
5.	McLennan A, Bates A, Turner P, White M 2013. **Bios Instant Notes in Molecular Biology.** 4th Edition. Garland publishers, New York.
6.	Cowling G, Allen T 2011. **The Cell. A very Short Introduction**. Oxford University Press, USA.

7.	Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walker P 2007. **Molecular Biology of the Cell.** 5th Edition. Garland publishers, New York.
8.	Schaffer SW 2007. **Mitochondria: The Dynamic Organelle.** 1st Edition. Springer Verlag.
9.	Wilson J, Hunt T 2007. **Molecular Biology of the Cell** 5th edition**. The Problems Book.** 2nd Edition. Garland publishers, New York.
10.	Celis JE (ed) 2006. **Cell Biology–A Laboratory Hand Book.** 3rd Edition. Elsevier, USA.
11.	Lodish H, Berk A, Kaiser CA, Kreiger M, Scott P M, Bretcher A, Ploegh H, Matsudaira P. 2004. **Molecular Cell Biology.** 5th edition. W. H. Freemanand Company, New York.
12.	De DN 2000. **Plant Cell Vacuoles. An Introduction**. CSIRO Publication Collingwood, Australia.
13.	Krishna Murthy KV 2000. **Methods in Cell Wall Cytochemistry.** CPC Press, Boca Raton, Florida.
14.	Lodish, Berk A, Zipursky SL, Matsdaira P, Baltimore D and Darnell J 2000 **Molecular Ce11 Biology.** 4th Edition. W.H. Freeman and Co., New York.
15.	Alberts B, Bray D, Lewis J, Ralf M, Roberts K and Watson JD 1999. **Molecular Biology of the Cell**, Garland Publishing, New York.
16.	Kleinsmith LJ and Kish VM 1995. **Principles of Cell and Molecular Biology.** 2nd Edition. Harper Collins College Publishes, New York, USA.
17.	Avers CJ 1986. **Molecular Cell Biology**. Addison Wesley Publishing Company USA.

M.Sc. Botany – Semester I

Core Paper 104: CYTOLOGY AND CYTOGENETICS

Theory

S. No	Unit
	SECTION A
1.	Nucleus: structure of nuclear membrane and nuclear pore complex, nucleolus, ribosome biosynthesis.Chromatin: eu and heterochromatin, arrangement of chromatin. Molecular organization of chromatin: components, nucleosomes– composition and organization, 10 nm, 30 nm, solenoid, scaffolds. Chromosome structure: molecular organization of centromeres and telomeres. Types of chromosomes: lampbrush, polytene.
2.	Chromosome identification: karyotype analysis. Chromosome banding techniques–Q, C, G and R banding. Flowcytometry and confocal microscopy in karyotype analysis. Computer assisted karyotype analysis – chromosome microdissection and micro cloning. FISH and GISH techniques.
3.	Chromosomal structural aberrations: origin, meiosis and breeding behaviour of duplications, deficiencies, inversions and interchanges. Types of inversions. Robertsonian translocations– basic concept of complex translocation heterozygotes.
4.	Chromosomal numerical aberrations: classification of numerical aberrations. Aneuploids– trisomics (primary, secondary, tertiary), monsosomics and nullisomics – meiotic behavior. Eupolyploids – origin and production of auto -and allopolyploids, meiosis in autotetraploid. Genome of tobacco and wheat as examples of allopolyploids.
	SECTION B
5.	Nuclear DNA content: C-value paradox, hyperchromicity, cot curves and their significance. Molecular organization of eukaryotic nuclear genome: highly repeated, middle repeated and unique sequences.
6.	Cell cycle and its regulation: the G1, S, G2 and M phases. Synchronous and asynchronous cell divisions. The measurement of duration of different phases of cell cycle using a flow cytometer. Check points in cell cycle– role of cyclins and cyclin-dependent kinases in regulation of cell cycle.
7.	The different stages of mitosis and meiosis: description of the stages. Experimental control of cell division. Significance of meiosis.

8.	Apoptosis: mechanism and significance. Initiation of cancer at cellular level – proto oncogenes and oncogenes; retinoblastoma and E2F proteins.

Practical

S. No	Exhibit/ Experiment
1.	Photographs of interphase nucleus, 10 nm, 30nm and scaffolds. Electron microscope picture of metaphase chromosome, *in-situ* hybridization of chromosome spreads showing telomeres and centromeres. rRNA synthesis –christmas tree configuration.
2.	Pictures of lampbrush and polytene chromosomes.
3.	Photographs of chromosomes with different banding patterns. Identifying homologous chromosomes from the pictures.
4.	Preparation of karyotypes in *Allium*/ *Aloe* (with treated root tips).Construction of idograms from pictures of karyotypes.
5.	Photographs showing meiosis in structural and numerical aberrations.
6.	Meiosis in *Rheo discolor* showing complex translocation heterozygote.
7.	Preparation of slides from *Allium* floral buds for observation and identification of stages of meiosis.
8.	C value paradox chart and Britten and Kohne's Cot curves picture.

Reference Books

1.	Singh RJ. 2014. **Plant Cytogenetics.** 2nd Edition.CRC Press, India.
2.	Pierce BA. 2013. **Genetics: A Conceptual Approach.** 5th Edition. W. H. Freeman, California.
3.	William K, Cummings S, Spencer MR and Charlotte A. 2013. **Essentials of Genetics.** Pearson Books, Delhi.
4.	Hartwell L. 2011 **Genetics: From Genes to Genomes, Study Guide and Solution Manual.** 4th Edition**.** Nero, McGraw Hill Publishing company, New York.
5.	Bass H and Birchler J. 2011. **Plant cytogenetics: Genome structure and chromosome Function.** Springer, New York.
6.	Ram M. 2010. **Cytogenetics and Genetics.** PHI Learning Pvt. Ltd., Delhi.
7.	Anthony J, Griffiths F, Wessig SR, Carroll SB and Doebley J. 2010. **Introduction to genetic analysis.** 10th Edition**.** W. H. Freeman, California.
8.	Russel PJ. 2009. **Genetics–A Molecular Approach.** 3rd Edition**.** Pearson Benjamin Cummings, San Francisco, USA.
9.	Roy D. 2009. **Cytogenetics.** Alfa Science International Ltd., UK.

10.	Brooker R. 2008. **Genetics, Analysis and Principles.** 3rd edition**.** McGraw Hill Science.
11.	Gupta P.K .1995. **Cytogenetics.** Rastogi & Company, Meerut.
12.	Sybenga J. 1992. **Cytogenetics in Plant Breeding**. Springer London Ltd.
13.	David M. Prescott. 1988. **Cells.** Jones and Bartlett Publ. Boston.
14.	Swanson M and Young. 1982. **Cytogenetics**. Prentice Hall, India.
15.	Khush GS. 1973. **Cytogenetics of Aneuploids.** Academic Press, New York and London.
16.	Sybenga J. 1973. **General Cytogenetics**. North Holland and American Elsevier Publishing Co., New York.
17.	Burnham CR. 1962. **Discussions in Cytogenetics.** Burgess Publishing Co., Minnesota.

M.Sc. Botany - Semester II

Core Paper 201: GENETICS

Theory

S. No	Unit
	SECTION A
1.	Concept of genetic markers and their types. Mendel's experiments and theories, application of probability laws to Mendelian principles. Chi-square testing for goodness of fit. Penetrance and expressivity. Pleiotropism. Phenocopies. Codominance and incomplete dominance.
2.	Multiple allelism: interaction among multiple alleles, complementation test, pseudoalleles. Gene interaction and modified F_2 ratios in two gene interactions.
3.	Linkage and crossing over: identifying linkage from F_2 and test cross, recombination frequency and distance between genes. Linkage maps. Tetrad analysis–ordered and unordered tetrads.
4.	Recombination in prokaryotes: transformation, conjugation, transduction, sexduction. Mapping of genes in bacteria using transformation and conjugation (interrupted mating). Fine structure analysis of gene – Benzer's work.
	SECTION B
5.	Sex determination: chromosomal and genetic basis. Sex-linked inheritance. Sex influenced and sex limited characters. Polygenic inheritance: heritability and its measurement. QTL mapping.
6.	Extra chromosomal inheritance: inheritance of mitochondrial and chloroplast genes. Male sterility. Chloroplast mutations. Maternal inheritance.
7.	Nature of the eukaryotic gene: split gene with a promoter and terminator. Variant forms of eukaryotic gene – nested genes, overlapping genes, assembled genes, assorted genes. Multigene families– organization and significance. Transposable elements in pro- and eukaryotes: types, mechanism of transposition, significance of transposable elements.
8.	Mutations: types, causes and detection. Physical and chemical mutagens. Lethal, conditional, biochemical, loss of function, gain of function. Molecular basis of mutations. Spontaneity of mutations, site-directed mutagenesis. Recombination: molecular mechanism– role of rec A, B, C, D enzymes, Holliday model, site specific recombination.

Practical

S. No	Exhibit/Experiment/Assignment
1.	Assignment on Mendel's principles, chisquare test, proabability.
2.	Assignment on dominance relationships, multiple alleles and two gene interactions.
3.	Assignment on linkage and crossing over.

Reference Books

1.	Benajamin Pierce 2013. **Genetics: A Conceptual Approach.**5th Edition.W.H. Freeman and Company.
1.	Lewin B. 2000. **Gene VII**. Oxford University Press, New York, USA.
2.	Snustad DP. and Simons MJ 2000. **Principles of Genetics.** 2nd Edition. John Wiley and Sons Inc., USA.
3.	Atherly AG, Girton JR and McDonald JF. 1999.**The Science of Genetics**. Saunders College Publishing, Fort Worth, USA.
4.	Karp G. 1999. **Cells and Molecular Biology: concepts and Experiments**. Hohn Wiley and Sons Inc., USA.
5.	Hartl DL and Jones EW. 1998. **Genetics: Principles and Analysis.** 4th Edition**.** Jones and Bartlett Publishers, Massachusetts, USA.
6.	Malacinski GM and Freifelder D. 1998. **Essentials of Molecular Biology**. 3rd Edition. Jones and Bartlet Publishers Inc., London.
7.	Russel PJ. 1998.**Genetics**. 5th Edition. The Benjamin/ Cummings Publishing Company Inc., USA.
8.	Lewis R. 1997. **Human Genetics: Concepts and Applications**. 2nd Edition. WCB McGraw Hill, USA.
9.	Griffiths RCL, Anthony JF, Miller JH and Suzuki DT. 1996. **Genetic analysis**. 6th Edition. W. H. Freeman and Co., New York.

M.Sc. Botany - Semester II

Core Paper 202: MOLECULAR BIOLOGY OF PLANTS

Theory

S. No	Unit
	SECTION A
1.	Composition and structure of biomolecules: carbohydrates, lipids, proteins (Ramachandran plot) domains, motifs and folds. Nucleic acids– DNA structure, A, B and Z forms of DNA. Types of small RNAs: Si RNA, micro RNA, catalytic RNA.
2.	DNA replication: semi-conservative, semi-discontinuous- Okazaki fragments, uni and bi directional mode of replication. RNA priming, enzymes for DNA replication– gyrase, helicase, topoisomerases and polymerases, SSBs. Mechanism of DNA replication– in prokaryotes–rolling circle and theta mode of replication, in eukaryotes– multiple replicons. Fidelity of replication. Replication at ends of chromosomes. Extrachromosomal replicons. DNA damage and repair.
3.	RNA synthesis and processing: transcription process in prokaryotes and eukaryotes. Transcription factors. RNA processing– mRNA processing – spliceosome, capping and tailing, processing of tRNA and rRNA.
4.	Protein synthesis: structure of tRNA, aminoacylation of tRNA, aminoacyl tRNA synthetases. Ribosome as a translation factory. Genetic code– codon assignment, characteristics of genetic code. Mechanism of translation in prokaryotes and eukaryotes– initiation elongation and termination. Chemical proof reading during translation. Translation inhibitiors. Post translational modifications.
	SECTION B
5.	Protein sorting and targeting of proteins into nucleus, chloroplasts, mitochondria, vacuoles and peroxisomes. Protein trafficking through GERL system– signal peptide, signal recognition particle, vesicles.
6.	Signal transduction: signaling molecules, ligands and receptors. G protein coupled receptors. Receptor tyrosine kinases. MAP kinases. Second messengers, signal amplification, cAMPs. Ca-calmodulin pathway.
7.	Regulation of gene expression in prokaryotes: bacteria – Lac, arabinose ,Tryp operons, positive and negative control. Regulation in viruses–lytic and lysogenic cycles.
8.	Regulation of gene expression in eukaryotes: cis and trans factors. Motifs of DNA

	binding domains of trans factors–zinc fingers, leucine zippers, helix turn helix. Temporal and spatial regulation. Role of chromatin in gene expression. DNA methylation and gene imprinting. Gene silencing.

Practical

S. No	Exhibit/Experiment
1.	Isolation of DNA using CTAB method.
2.	Histochemical staining of carbohydrates, proteins and fats in the plant cells.
3.	Electrophoresis of seed proteins.
4.	Assignments on problems related to DNA structure, replication, transcription and translation
5.	Photographs depicting the content of theory

Reference Books

1.	Snustad P, Simmons MJ. 2003. **Principles of Genetics.** 3rd Edition**.** John Wiley and Sons, Inc, USA.
2.	Buchaman BB, Gruissem,W and Jones R. 2000. **Biochemistry and Molecular Biology of plants:** American Societies of plant physiologists, John Wiley and Sons Ltd., Maryland, U.S.A.
3.	Lewin B. 2000. **Genes IX,** Oxford University Press, New York.
5.	Lodish BA, Zipursky SL, Matsdaira P, Baltimore D and Darnell J. 2000. **Molecular Cell Biology.** 4th Edition. W.H. Freeman and Co., New York.
6.	Alberts B, Bray D, Lewis J, Ralf M, Roberts K and Watson JD.1999. **Molecular Biology of the Cell.** Garland publishing Inc., New York.
7.	Weaver RF. 1999**. Molecular Biology**. WCB /McGraw-Hill,.
8.	Shaw CH. 1998**. Plant Molecular Biology. A practical approach,** IRL Press, Oxford.
9.	Glick BR and Thompson JE. 1992. **Methods in Plant Molecular Biology and Biotechnology,** CRC Press, Boc Raton Florida.

M.Sc. Botany – Semester II

Core Paper 203: BIOLOGY AND DIVERSITY OF PTERIDOPHYTES AND GYMNOSPERMS

Theory

S. No	Unit
	SECTION A: Pteridophytes
1.	Classification of Pteridophyta. Origin of Pteridophytes. Pteridophytes in comparison to Bryophytes and Gymnosperms. Distinguishing features of Pteridophyta. Economic importance of Pteridophytes.
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 stelar types in Pteridophytes. Heterospory and origin of seed habit. Evolution of the sporophyte.
	SECTION B: Gymnosperms
5.	The evolutionary time scale: eras, periods and epochs. General account of fossils. Types of fossil formations.
6.	Gymnosperms in comparison to ferns and seed plants. Classification of Gymnosperms and their distribution in India. Economic importance of Gymnosperms.
7.	General account of the families of Pteridospermales–Lyginopteridaceae, Meduloisaceae, Caytoniaceae; Bennettitales–Cycadeodiaceae; Pentoxylales – Pentoxylaceae; Cordaitales–Cordaitaceae.
8.	Structure and reproduction in living Gymnospermsof Cycadopsida, Coniferopsida and Gnetopsida.

Practical

S. No	Exhibit/Experiment
1.	Examination of the external features, anatomy and reproductive structures of *Psilotum, Lycopodium, Selaginella, Isoetes* and *Equisetum.*
2.	Examination of the external features, anatomy and reproductive structures of *Ophioglosum, Osmunda, Gleichenla, Cyathea, Marselia, Adiantum, Salvinla* and

	Azolla.
3.	Observations of the slides of the following fossil plants–*Rhynia, Lepidodendron, Lepidocarpon, Miadesmia,* and *Sphenophyllum.*
4.	Observations of the slides fossil Pteridophytes: *Calamites, Calamostachys, Zygopters* and *Etapteris*.
5.	Examination of the external features, anatomy and reproductive structures of *Ginkgo, Pinus, Cupressus* and *Cryptomeria.*
6.	Examination of the external features, anatomy and reproductive structures of *Araucaria, Ephedra* and *Gnetum.*
7.	Study of fossil gymnosperms from prepared slides: *Lyginopteris*, *Lagenostoma* and *Medullosa*.
8.	Study of fossil gymnosperms from prepared slides: *Triganocarpus*, *Conostoma*, *Heterangium*, *Cordaites*.

Reference Books

1.	Saxena P and Pathak C. 2012. **A Text Book of Pteridophyta.**, Wisdom Press, New Delhi.
2.	Sharma OP.2006. **Pteridophyta**. MacMillan India Ltd., New Delhi.
3.	Parihar NS. 1996. **Biology and Morphology of Pteridophytes**. Central Book Depot, Allahabad.
4.	Smith GM. 1995. **Cryptogamic Botany. Vol. II**. McGraw Hill Book Company, New York.
5.	Sporne KR. 1962. **The Morphology of Pteridophytes**. Hutchinson University Library, London.
6.	Evans AJ. 1936. **Morphology of Vascular Plants (Lower groups)**. McGraw Hill Book Company, New York.
7.	Biswas C and Johri BM. 1997. **The Gymnosperms.** Narosa Publishing House, New Delhi.
8.	Bhatnagar SP and Moitra A. 1996. **Gymnosperms**. New Age International Private Limited, New Delhi.
9.	Sharma OP. 1996. **Gymnosperms**. Pragati Prakashan, Meerut.
11.	Stewart WN and Rothwell GW. 1993. **Paleobotany and the Evolution of Plants**. Cambridge University Press, USA.
12.	Singh H. 1978. **Embryology of Gymnosperms**. Gebrudev Bortraeger, Berlin.

13.	Arnold CA. 1974. **An introduction to Paleobotany**. McGraw Hill Book Co., Inc., New York.
14.	Sporne KR. 1967. **The Morphology of Gymnosperms**. Hutchinson University Library, London.
15.	Chamberlain CJ. 1935. **Gymnosperms structure and evolution**. University of Chicago Press, USA.

M.Sc. Botany - Semester II

Core Paper 204: PLANT CELL, TISSUE AND ORGAN CULTURE

Theory

S. No	Unit
	SECTION A
1.	Plant cell and tissue culture: introduction, history, scope. Basic concepts of tissue of culture: tissue culture cycle, types of cultures. Concept of cellular differentiation, totipotency.
2.	Culture media: composition and effects of media components, phytohormones – effects in tissue culture. Sterilization methods.
3.	Pathways of regeneration – biochemical and molecular aspects of tissue culture cycle.
4.	Technique and applications of cryopreservation and germplasm storage.
	SECTION B
5.	Organogenesis and adventitious embryogenesis. Fundamental aspects of morphogenesis, somatic embryogenesis. Methods of androgenic and gynogenic haploid production-dihaploids and application in agriculture. Embryo rescue.
6.	Cell culture: establishment, plating efficiency, induction and selection of mutants. Free cell cultures: production of secondary metabolites/natural products.
7.	Somatic hybridization: protoplast isolation, fusion and culture, hybrid selection and regeneration, possibilities, achievements, limitations, merits and demerits . Cybrids. Protoplasts in genetic transformation.
8.	Applications of plant tissue culture: clonal propagation, artificial seeds and its applications, somaclonal variation and its applications.

Practical

S. No	Exhibit/Experiment
1.	General out lay of plant tissue culture laboratory.
2.	Preparation of media.
3.	Callus induction – carrot.
4.	Clonal propagation through meristem cultures.
5.	Embryo culture – groundnut.
6.	Anther culture – *Datura*/tobacco.
7.	Establishment of cell cultures and determination of growth pattern.
8.	Determination of plating efficiency of cell cultures.

9.	Protoplast isolation and culture.
10.	Protoplast fusion.
11.	Observation of different developmental stages of somatic embryo in embryogenic callus.
12.	Preparation of artificial seeds.

Reference Books

1.	Collin HA and Edwards S. 1998. **Plant Cell Culture.** Bioscientific Publishers, Oxford, UK.
2.	Callow JA, Ford-Lloyd BV and Newbury HJ. 1997. **Biotechnology and Plant Genetic Resources: Conservation and Use.** CAB International, UK.
3.	Raghavan V. 1997. **Molecular Biology of Flowering plants.** Cambridge University press, New York, USA.
4.	Bhojwani SS and Razdan MK. 1996. **Plant tissue culture: Theory and Practice**. (A revised edition). Elsevier Science Publishers, New York, USA.
5.	Jain SM, Sopory SK and Velleux RE. 1996. **In Vitro Haploid production in Higher Plants. Volumes 1-5**. Fundamental aspects and Methods Kluwer Academic Publishers, Dordrecht, Netherlands.
6.	Vasil IK and Thorpe TA. 1994. **Plant Cell and Tissue Culture.** Kluwer Academic Publishers, Dordrecht, Netherlands.
7.	Bhojwani SS. 1990. **Plant Tissue Culture: Applications and Limitations**. Elsevier Science Publishers, New York, USA.
8.	Raghavan V. 1986. **Embryogenesis in Angiosperms: A Developmental and Experimental Study.** Cambridge University Press, New York, USA.
9.	Kartha KK. 1985. **Cryopreservation of Plant Cells and Organs**. CRC Press, Boca Raton, Florida, USA.

M.Sc. - Semester II

Non-core Paper Offered by the Department of Botany

Paper 205: MEDICINAL PLANTS AND ETHNOBOTANY

S.No	Unit
	SECTION A
1.	Ethnobotany: Introduction, concept, scope and objectives.
2.	Ethnic groups and Ethnobotany: Major and minor ethnic groups of Andhra Pradesh and their life styles. Forest Vs. Ethnic groups.
3.	Methodology of Ethnobotanical studies: (a) Field work (b) Herbarium (c) Ancient literature (d) Archaeological findings (e) Temples and sacred places. (f) Protocols.
4.	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.*
	SECTION B
5.	Medico-ethnobotanical research in Andhra Pradesh.
6.	Different systems of indigenous medicine (Traditional medicine, Ayurveda, Siddha, Unani), Homeopathy and Allopathy. Role of Phytomedicine in modern systems of medicine.
7.	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.

8.	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.

Reference Books

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

S. No	Unit
	SECTION A
1.	Origin and evolution of Angiosperms. Fossil Angiosperms. Taxonomy and Systematics. Concepts of species. Taxonomic hierarchy - species, genus, family and other categories. Principles used in assessing relationship and delimitation of taxa and attribution of rank. Plant identification. Plant nomenclature – Binomial nomnclature, ICBN. Plant collection and documentation.
2.	Brief analysis of the features and evolutionary tendencies noticed in the following groups: Ranales, Rosales, Centrospermae, Tubiflorae, Amentiferae, Helobiales, Liliflorae and Glumiflorae.
3.	Taxonomic evidences: embryology, cytology and phytochemistry. Taxonomic tools: herbaria, floras, botanical gardens, biochemicaland molecular techniques, computers and GIS (Geo Information Systems). Cladistics in taxonomy. Numerical taxonomy and sero taxonomy.
4.	Systems of Angiosperm classification: Phenetic versus Phylogenetic system. Relative merits and demerits of major systems of classification: Takhtajan, Cronquist and Thorne. Basic concepts of Molecular Systematics: Gene sequencing, Restriction site analysis, Allozymes etc., Angiosperm Phylogeny Group (APG III) classification system, Relevance of Taxonomy to conservation, sustainable utilization of bioresources and ecosystem research.
	SECTION B
5.	World centres of primary diversity of domesticated plants. The Indo-Burmese Centre, Plant Introductions and Secondary centers. Plant explorations. Origin of agriculture.
6.	Origin, evolution, Botany, cultivation and uses of :

	1. Food Crops : Wheat, Rice 2. Forage Crops : *Sorghum*, Red gram 3. Fibre Crops : Cotton, Jute 4. Oil yielding crops : Groundnut, Coconut 5. Medicinal and aromatic crops : *Catharanthus, Withania, Cymbopogan*
7.	Green Revolution: benefits and adverse consequences. Ethnobotany: Introduction, concept, objectives and scope. Plant biodiversity: Concept, status in India, utilization and concerns, conservation of wild biodiversity.
8.	Principles of conservation: Strategies for conservation, *In-situ* conservation: protected areas in India- reserves, wetlands, mangroves, *Ex-situ* conservation: principles and practices. Botanical gardens. BSI, ICAR and CSIR.

Practical

Exhibits/ Experiments/ Suggested Laboratory Exercises	
Taxonomy	
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:** 1. Food crops : Wheat, Rice 2. Forage/fodder crops : *Sorghum*, Red gram 3. Fiber crops : Cotton, Jute 4. Oil yielding : Groundnut, Coconut 5. Medicinal and Aromatic plants : *Catharanthus, Withania, Cymbopogan*
2.	**Scientific visits:** The students should be taken to one of the following: A protected areas or Biosphere reserve or national park or sanctuary. A wetland. A mangrove. NBPGR (National Bureau of Plant Genetic Resources – New Delhi). BSI. CSIR Laboratory. FRI. Tropical Botanical Gardens.

Reference Books

Taxonomy of Angiosperms	
1.	Mondal AK. 2011. **Advanced Plant Taxonomy**. New Central Book Agency Pvt. Ltd., Kolkata.
2.	Simpson MG. 2006. **Plant Systematics**. Elsevier Academic Press, California, USA.
3.	Nordenstam BEI, Lazily G and Kassas M. 2000. **Plant systematic for 2nd Century.** Portland Press Ltd., London.
4.	Takhtajan AL. 1997. **Diversity and classification of Flowering Plants**. Columbia University Press, New York.
5.	Zomlefer WB. 1994. **A Guide to flowering plant families**. University of California Press, USA.
6.	Woodland DW. 1991. **Contemporary Plant Systematics.** Prentice Hall, New Jersey.
7.	Stace CA. 1989. **Plant Taxonomy and Biosystematics** .2nd Edition. Edward Arnold Ltd., London.

8.	Jones SB Jr. and Luchsinger AE. 1986. **Plant Systematics.** 2nd Edition. McGraw Hill Book Co., New York.
9.	Radford AE. 1986. **Fundamentals of Plant Systamatics**. Harper and Row Publications, USA.
10.	Heywood VH and Moore DM. 1984. **Current concepts in Plant Taxonomy**. Academic Press, London.
11.	Davis PH and Heywoos VH. 1973. **Principles of Angiosperms Taxonomy**. Robert E Kreiger Pub. Co., New York.
12.	Harrison HJ. 1971. **New concepts in Flowering Plant Taxonomy**. Hieman Educational Books Ltd., London.
13.	Jones AD and Wilbins AD. 1971. **Variations and Adaptations in Plant species.** Hiemen and Co., Educational Books Ltd., London.
14.	Grant V. 1971. **Plant Biosystematics**. Academic press, London.
15.	Solbrig OT. 1970. **Principles and Methods of Plant Biosystamatics**. Macmillan, London.
16.	Heslop-Harrison J. 1967. **Plant Taxonomy**. English language Books Soc. and Edward Arnold Pub. Ltd., U.K.
Plant Resource Utilization And Conservation	
17.	Sambamurthy AVSS and Subramanyam NS. 2000. **Economic Botany of Crop Plants**. Asiatech Publishers, Inc., New Delhi.
18.	Conway G. 1999. **The Doubly Green Revolution: Food for All in the 21st Century**. Comstock Publishing Associates, New York.
19.	Pinstrup – Anderson P. et al. 1999. **World Food Prospects: Critical Issues for the Early 21st Century**. International Food Policy Research Institute, Washington DC, USA.
20.	Kocchar SL. 1998. **Economic Botany of the Tropics**. 2nd Edition. Mac Millan India Ltd., Delhi.
21.	Plant Wealth of India 1997. Special Issue of Proceedings Indian National Science Academy B-63.
22.	Sharma OP. 1996. **Hills Economic Botany**. (Late Dr. A.F. Hill, adapted by O.P. Sharms). Tata McGraw Hill Co., Ltd., New Delhi.
23.	Frankel OH, Brown AHD and Burdon JJ. 1995. **The conservation of Plant Diversity**. Cambridge University Press, Cambridge, UK.

24.	Paroda RS and Arora RK. 1991. **Plant Genetic Resources Conservation and Management.** IPGRI (Publication) South Asia Office, C/o. NBPGR Pusa Campus, New Delhi.
25.	Swaminathan MS and Kocchar SL (ed). 1989. **Plants and Society**. Mac Millan Publication Ltd., London.
26.	Thakur RS, Puri HS and Hussain A. 1989. **Major Medicinal Plants of India. Central Institute of Medicinal and Aromatic Plants**. CSIR, Lucknow.
27.	Council of Scientific & Industrial Research 1986. **The useful plants of India. Publications and Information Directorate**. CSIR, New Delhi.
28.	Baker HG. 1978. **Plants and Civilization**. 3rd Edition. C.A. Wadsworth, Belmont.
29.	Chrispeels MJ and Sadava D. 1977. **Plants, Food and People**. W.H. Freeman and Co., San Francisco, USA.
30.	Schery RW. 1972. **Plants for Man**. 2nd Edition. Englewood Cliffs, New Jersey.
31.	Raw materials I - XII Revised Vol. I-III (1985-1992) supplement (2000).

M.Sc. Botany – Semester III

Core Paper 302: PLANT DEVELOPMENT AND REPRODUCTION

Theory

S. No	Unit
	SECTION A
1.	Simple and complex tissues. Epidermis – stomata, trichomes. Secretory cells and tissues. Vascular tissue development: development and structure of the primary xylem, primary phloem, secondary xylem, secondary phloem. Root shoot transition.
2.	Shoot development: organization 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 and modified leaves. Phyllotaxy.
3.	Root development: organization of root apical meristem (RAM), cell fates and lineages, tissue differentiation. Lateral roots, root hairs, root microbe interactions. Cambium–structure, cell types, development of vascular cambium, cork cambium–structure of its derivatives, bark. Anomalous secondary growth in dicot and monocot stems.
4.	Floral development taking the examples of homeotic mutants in *Arabidopsis* and *Antirrhinum*.
	SECTION B
5.	Male gametophyte: structure of anther, microsporagenesis, types and role of tapetum, pollen development, sperm dimorphism, pollen embryo sacs and compound pollen grains. Pollen allergy.
6.	Female gametophyte: types of ovule, development of ovule, megasporogenesis, types of embryo sacs, organisation of the embryo sac – ultra structure of the embryo sac cells.
7.	Pollination: mechanisms and vectors. Pollen-pistil interaction–structure of the pistil, pollen-stigma interaction. Self-incompatibility: sporophytic, gametophytic, 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.
8.	Post-fertilization events: endosperm– development, types ,functions, endosperm - embryo relationship. Embryo development–Johanson and Soueges systems; Types. polyembryony; apomixis; parthenocarpy. Storage proteins of endosperm and embryo– LEA proteins. Seed dormancy, overcoming seed dormancy.

Practical

Exhibits/ Experiments/ Suggested Laboratory Exercises	
Plant Development	
1.	Microscopic examination of transverse sections of leaves such as *Nerium* and maize to understand the internal structure of leaf tissues and trichomes, glands etc. Study of the C_3 and C_4 anatomy of plants
2.	Study of epidermal peels of different kinds of leaves to study the development and nature stomata, computing stomatal index.
3.	Study of elements of wood from macerations and sections taken in three planes T.S., T.L.S. and R.L.S
4.	Study of the anomalous structure of the stems of Aristolochia, Achyranthes, Bignonia, Boerhaavia, Leptadenia and Dracaena.
Plant Reproduction	
1.	Study of microsporogenesis and gametogenesis in sections of anthers.
2.	Tests for pollen viability using stains and *in-vitro* germination.
3.	Embryo sac development through examination of permanent, stained serial sections.
4.	Study of nuclear and cellular endosperm through dissections and staining.
5.	Isolation of different stages of embryo development from suitable seeds.

Reference Books

Plant Development	
1.	Pullaiah T, Naidu KC, Lakshminarayana K and Hanumantha Rao B. 2007. **Plant Development**. Regency Publications, New Delhi.
2.	Fosket DE. 2004. **Plant Growth and Development. A Molecular approach.**

	Academic Press, San Diego.
3.	Howell SH. 1998. **Molecular Genetics of Plant Development**. Cambridge University Press,
4.	Waisel Y, Eshel A and Kafkaki V (ed) 1996. **Plant Roots: the Hidden Hall**. 2nd edition. Marcel Dekker, New York.
5.	Bailey JD and Black M. 1994. **Seeds: Physiology of development and Germination**. Plenum Press, New York.
6.	Salisbury FB and Ross CW. 1992. **Plant Physiology**. 4th Edition. Wordsworth Publishing, Belmont, California.
7.	Lyndon RF. 1990. **Plant Development. The Cellular Basis**. Unnin Hyman, London.
8.	Steeves TA and Susses IM. 1989. **Patterns in Plant Development**. 2nd Edition. Cambridge University Press, Cambridge.
9.	Mauseth JD. 1988. **Plant Anatomy**. Benjamin Cummings, California
10.	Fahn A. 1982. **Plant Anatomy**. 3rd edition. Pergamon Press, Oxford
Plant Reproduction	
1.	Pulliah T, Lakshminarayana K and Hanumantha Rao B. 2008. **Plant Reproduction**. Scientific Publishers, Jodhpur, India.
2.	Bhojwani SS and Bhatnagar SP. 2000. **The Embryology of Angiosperms**. 4th revised and enlarged edition. Vikas Publishing House, New Delhi.
3.	Raghavan V. 1999. **Developmental Biology of Flowering Plants**. Springer – Verlag, New York.
4.	Raghavan V. 1997. **Molecular Embryology of Flowering Plants**. Cambridge University Press, Cambridge.
5.	Shivanna KR and Swahney VK. (ed.) 1997. **Pollen Biotechnology for Crop Production and Improvement**. Cambridge University Press, Cambridge.
6.	The Plant Cell. Special Issue on Reproductive Biology of pants, Vol.5 (10) 1993. The American Society of Plant Physiologists, Rockville, Maryland, USA.
7.	Shivanna KR and Rangaswamy NS. 1992. **Pollen Biology, A Laboratory Manual**. Springer-Verlag, Berlin.
8.	Sedgely M and Griffin AR. 1989. **Sexual Reproduction of Tree Crops**. Academic Press, London
9.	Sedgely, M. and Griffin, A.R. 1989. Sexual Reproduction of Tree Crops, Academic

	Press, London.
10.	Leins P, Tucker SC and Endress PK. 1988. **Aspects of Floral Development**. J. Cramer, Germany.
11.	Shivanna KR and Johri BM.1985. **The Angiosperm Pollen Structure and Function**. Wiley Eastern Ltd., New Delhi.
12.	Procter M and Yeo P. 1973. **The Pollination of Flowers**. William Collins Sons, London.

M.Sc. Botany - Semester III

Core Paper 304: PLANT ECOLOGY

Theory

S. No	Unit
	SECTION A
1.	The environment: physical environment, biotic environment and abiotic environment. Ecology and human welfare. Climate, soil and vegetation patterns of the world: life zones, major biomes, vegetation and soil types of the world.
2.	Habitat and niche: concept of habitat and niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement.
3.	Population Ecology: characteristics of a population, population growth curves, population regulation, life history strategies (r and k selection), concept of meta population, demes and dispersal, interdemic extinctions, age structured population.
4.	Species interactions: types of interactions, interspecific competition, herbivory, carnivory. Ecological succession: types, mechanisms, changes involved in succession, concept of climax. Hydrosere and Xerosere
	SECTION B
5.	Community ecology: nature of communities, community structure and attributes, levels of species diversity and its measurement, edges and ecotones, community classification.
6.	Ecosystem: structure and function. Energy dynamics. Mineral cycling (carbon, nitrogen and phosphorus). Primary production and decomposition. Structure and function of some Indian ecosystems– Terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).
7.	Biogeography: Major terrestrial biomes. Theories of island biogeography. Biogeographical zones of India.
8.	Applied ecology: Environmental pollution – air, water and soil, kinds, sources, quality parameters. Effects on plant ecosystmems. Climate change – green house gases, ozone layer and ozone hole, consequences of climate change. Methods for mitigation of climate change: physical, chemical and biological. Biodiversity status, monitoring and documentation, major drivers of biodiversity change, biodiversity management approaches. Conservation biology: principles of conservation, major approaches to management. Indian case studies on

	conservation, management strategy (Biosphere reserves, Project tiger).

Practical

Exhibits/ Experiments/ Suggested Laboratory Exercises	
1.	To study the stratification of plants in botanical gardens.
2.	To prepare life forms of botanical gardens of college campus. Compare the biological spectrum of college campus with normal biological spectrum.
3.	To estimate the frequency of plants in the college campus.
4.	To estimate the relative frequency of plants in the college campus.
5.	To estimate the density of a plant species in the college campus.
6.	To estimate the relative density of a plant species in college campus.
7.	To determine the minimal size and number of quadrats required for reliable estimate of biomass in grass land.
8.	To determine the basal area of a plant species in the campus.
9.	To determine the important value index (IVI) of plant species in the campus.
10.	To estimate IVI of the plant species in a woodland using point center quarter methods.
11.	To determine plant diversity indices (Shamon - Wiener) continuum of dominance, species richness, equitability and biodiversity of species in the campus.
12.	To estimate rate of carbon dioxide evolution from different soils using soda lime or alkali absorption method.
13.	To study environmental impact of a given developmental activity using check list as a EIA method.
14.	Enumeraration in pond ecosystems.
15.	To study the composition of woodland ecosystem.
16.	Demonstration of chemical energy stored in leaves which was the transformed from radiation energy.
17.	Estimation of biomass of cropland plots.

18.	Estimation of chlorophyll.
19.	Determination of leaf area index methods with plain graph sheets.
20.	To determine the water holding capacity of soil collected from different locations

Reference Books

1.	American Public Health Association American Water Works Association. 2013. **Standard Methods for the Examination of Water and Waste Water.** General Books LLC, USA.
2.	Sharma PD. 2007. **Ecology and Environment.** Rastogi Publications, Meerut.
3.	Sharma PD. 2001. **Ecology and Environment.** Rastogi Publications, Meerut.
4.	Smith RL. 1996. **Ecology and field Biology.** Harper Collins, New York.
5.	Sokal RR and Rohit FJ. 1995. **Biometry.** W.H. Freeman and Co., New York.
6.	Batra NK. 1992. **Treatise on Plant Ecology.** Pradeep Publications, Delhi.
7.	CJ. 1989. **Ecological Methodology**. Harper and Row, New York, USA.
8.	Ludwig JA and Reynolds JF. 1988. **Statistical Ecology.** Wiley, New York.
9.	Magurran AE. 1988. **Ecological Diversity and its measurement.** Croom Helm, UK.
10.	Moore PD and Chapman SB. 1986. **Methods in Plant Ecology**. Blackwell Scientific, Oxford, UK.
11.	Pielow EC. 1984. **The interpretation of Ecological Data.** John and Wiley Sons, USA.
12.	Muller – Dombois D and Ellenberg H. 1974. **Aims and Methods of Vegetation Ecology.** Blackburn Press, New Jersey.
13.	Odum PE. 1971. **Fundamentals of Ecology.** 3rdEdition. W. B. Sounders, Philadelphia.
14.	Dansemmire RF. 1968. **Plant Communities**. Horpes and Row, New York.
15.	Misra R. 1968. **Ecology Work Book.** Oxford and IBH Publishing Co., New Delhi.
16.	Ambasht RS and Ambasht NK. **AText Book Plant Ecology.** CBS Publishers and distributors, New Delhi.

M.Sc. Botany – Semester III

Core Paper 304: PLANT PHSYSIOLOGY

Theory

S. No	Unit
	SECTION A
1.	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), mechanism of water transport.
2.	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, mechanism of assimilate translocation.
3.	The flowering process: phytochrome: structure, photochemical and biochemical properties, role in photomorphogenesis. Photoperiodism and its significance, mechanisms of floral induction. Vernalization. Morphological, biochemical and metabolic changes accompanying seed germination.
4.	Plant growth regulators and elicitors: biosynthesis, physiological effects and mechanism of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroids, polyamines, jasmonic acid and salicylic acid. Role of plant growth regulatiors in agri-horticulture. Hormone receptors.
	SECTION B
5.	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.
6.	Photochemistry and Photosynthesis: General concepts and historical back ground, evolution of photosynthetic apparatus, Redox reactions, photosynthetic pigments and light harvesting complexes, photo-oxidation of water, mechanisms of electron and proton transport, structure, synthesis and function of ATP, carbon assimilation-the Calvin's cycle, photorespiration and its significance, the C_4 cycle and CAM pathway, biosynthesis of starch and sucrose, physiological and ecological considerations.
7.	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.
8.	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.

Practical

Exhibits/ Experiments/ 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.	Determination of amylase activity
10.	Extraction and separation of chloroplast pigments by paper chromatographic method
11.	Determine chlorophyll a / chlorophyll b contents in C_3 and C_4 plants by spectrophotometric method
12.	Determination of Hill reaction
13.	Determination of rate of Aerobic respiration by continuous current method
14.	Determination of rate of Anaerobic respiration by continuous current method
15.	Determination of catalase activity
16.	Demonstration of Polyphenol oxidase
17.	Determination of reducing sugars

18.	Estimation of free acids in Bryophyllum in terms of milliequivalents of NaOH
19.	Extraction and estimation of seed proteins depending upon the solubility
20.	SDS – PAGE for soluble proteins extracted from the given plant materials
21.	Separation of isozymes esterase, peroxidase by native polyacrylamide gel electrophoresis
22.	Effect of Light quality on the rate of Photosynthesis
23.	Effect of CO_2 concentartion on the rate of Photosynthesis
24.	Estimation of Starch by gravimetric method
25.	Demonstration of Starch hydrolysis
26.	Separation of Chloroplast pigments by chemical method
27.	Separation of amino acids and carbohydrates through two dimensional chromatographic method

Reference books

1.	Sinha SK 2014.**A text book of Plant Physiology.** Centrum Press, New Delhi.
2.	Seema Yadav 2014. **Plant Physiology.** SBW publishers, New Delhi.
3.	Heribert H and Kazuo S (eds) 2010. **Plant responses to abiotic stress. Series Topics in Current Genetics, Vol 4.** Springer, Berlin.
4.	Philip Stewart and Schine Gobig 2011. Plant Physiology. CRC Press.
5.	Moore TC. 2011. **Biochemistry and Physiology of Plant Hormones**. Springer, New York.
6.	Hooykaas PJJ, Hall MA and Libbenga KR (ed) 1999. **Biochemistry and Molecular Biology of Plant Hormones**. Elsevier, Amsterdam, Netherlands.
7.	Taiz L and Zeiger E. 1998. **Plant Physiology**. 2nd Edition. Sinauer Associates including Publishers, Massachusetts, USA.
8.	Wisthoff P. 1998. **Molecular Plant Development from Gene to Plant**. Oxford University Press, Oxford, UK.
9.	Thomas and Vince – Prue D. 1997. **PhotoPeriodism in Plants**. 2nd Edition. Academic Press, Sandeigo, USA.
10.	Hopkins WG. 1995. **Introduction to Plant Physiology**. John Wiley & Sons Including New York, USA.
11.	Mohr H and Schopfer P. 1995. **Plant Physiology**. Springer-Verlag, New York.

12.	Salisbury FB and Ross CW. 1992. **Plant Physiology.** 4th Edition. Wordsworth Publishing Company, California, USA.
13.	Noggle GR and Fritz GJ. 1991. **Introductory plant physiology**. 2nd Edition. Prentice hall of India Limited, New Delhi.
14.	Davies PJ (ed) 1987. **Plant hormones and their role in Plant Growth and Development.** Mertinus Nijh off Publishers, Netherlands.
15.	Witham FH and Devlin RM. 1986. **Plant Physiology.** CBS Publishers and Distributors, Bangalore.
16.	Wilkins MD. 1987. **Advanced Plant Physiology**. English Language Book Society, Longman Scientific and Technical, Harlow, UK.
17.	Bewley JD and Black M. 1982. **Physiology and Biochemistry of seed in relation to germination and dormancy. Volume 1 and 2**. Springer – Verlag, Berlin.
18.	Khan AA. 1982. **The Physiology and Biochemistry of Seed Development, Dormancy and Germination**. Elsevier, Amsterdam, Netherlands.
19.	Ting IP. 1982. **Plant Physiology**. Addison-Wesley, Reading, MA.
20.	Murthy HNK. 1981. **Plant growth substances including applications in Agriculture**. Tata McGraw Hill Publishing Company Ltd., New Delhi.
21.	Kramer PM and Kozlowski TT. 1980. **Physiology of Woody Plants**. Academic Press, New York.
22.	Hewit EJ and Smith TA. 1975. **Plant Mineral Nutrition.** English University Press,
23.	Meyer AM and Poljakoff-Mayber A. 1975. **The germination of Seeds.** Pergamon Press, Canada.
24.	Hess D. 1974. **Plant Physiology.** Narosa Publishing House, New Delhi.
25.	Audus LJ. 1972. **Plant Growth Substances. Volume 1.** Chemistry and Physiology. Leonard Hill, UK.
26.	Slayter RO. 1967. **Plant Water Relationships**. Academic Press, London
27.	Hillman WS. 1963. **Physiology of Flowering.** Holt, Reinhart and Winston, New York.

M.Sc. - Semester III

Non-core Paper Offered by the Department of Botany

Paper 305: Principles of Genetic Analysis

S.No	Unit
	SECTION A
1.	Relationship between genes, characters and environment, penetrance and expressivity of genes, qualitative and quantitative characters, modifiers, relation between chromosomes, DNA, RNA and genes. Split nature of eukaryotic genes. Variant forms of eukaryotic genes
2.	Mendel's Experiments and principles. F_1, F_2, test cross and back cross analysis. Concept of allelism and dominance.Pedigree analysis.
3.	Multiple alleles: blood groups in humans. Semi and co dominance. Modified F_2 ratios due to interaction between two genes. Genetic analysis of quantitative and quasi-quantitative characters.
4.	Concept of Linkage and linkage groups ; linkage analysis in diploid organisms and methods to construct linkage maps. Tetrad analysis.
SECTION B	
5.	Genetic analysis in microorganisms: Auxotrophic mutants. Genetic recombination through conjugation, transformation and transduction methods . Fine structure analysis of the gene of Benzer.
6.	DNA markers: 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; Overview of genetic engineering. Eugenics.

Reference Books

13.	Hartl, D.L. and Jones, E.W. 1998. Genetics: Principles and Analysis (4th edition) Jones and Bartlett Publishers, Massachusetts, USA.
14.	Snustad, D.P. and Simons, M.J., 2000. Principles of Genetics (2nd Edition), John Wiley and Sons Inc., USA.
15.	Lewis, R. 1997. Human Genetics: Concepts and Applications (2nd edition). WCB

	Mc Graw Hill, USA.
16.	Russel, P.J. 1998. Genetics (5th edition). The Benjamin/ Cummings Publishing Company Inc., USA.
17.	Griffiths, A.J.F., Miller, H.T., Suzuki, Lewontin, Gelbart Intd. Genetic analysis, (6th edition), H.F. Freeman and Co.
18.	Atherly, A.G., Girton, J.R. and McDonald, J.F. 1999. The Science of Genetics, Saunders College Publishing, Fort Worth, USA.
19.	Hartl, D.L. and Jones, E.W. 1998. Genetics: Principles and Analysis (4th edition) Jones and Bartlett Publishers, Massachusetts, USA.

M.Sc. Botany - Semester IV

Core Paper 401: GENETIC ENGINEERING OF PLANTS AND MICROBES

Theory

S.No	Unit
	SECTION A
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. Cloning vectors– plasmids, viral DNA, cosmids, 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.	Methods of gene transfer in plants: electroporation, gene gun, *Agrobacterium* mediated– binary and co integrative vector based. Chloroplast transformation.
4.	Classical examples of successful cases of transgenic plants– fungal, bacterial, viral and insect tolerance (BT and proteinase inhibitors), herbicide tolerance, abiotic stress tolerance, male sterility– Barnase-Barstar. Quality improvement –golden rice, late ripening tomatoes (Flavr Savr).
	SECTION B
5.	Techniques in genetic engineering I: Blotting techniques– Southern, Northern and Western blotting, radioactive and non-radioactive labeling, detection of hybridization. *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.
6.	Techniques in genetic engineering II: DNA fingerprinting–hybridization based (RFLP), PCR based (RAPD, AFLP). Restriction mapping. Microarray technique and its applications. Sequencing genomes–whole genome sequencing, shot gun sequencing. Next generation sequencing– 454 sequencing.
7.	Plant growth promoting bacteria – nitrogen fixers, siderophores, phytoharmone production. Genetic improvement of industrially important microbes for production of useful products – biopesticides, biofertilizers, antibiotics. Intellectual Property Rights, farmer's rights. Patents. Ethical and environmental issues in genetic engineering.

8.	Bioinformatics: Scope. Data bases– types, Genbank, PIR, PDB. An account of NCBI. Web based tools for sequence searches –BLAST. Genome projects, genome annotation, gene annotation, features of the genome of *Arabidopsis*, rice. Genomics– structural genomics, comparative genomics, functional genomics. Molecular phylogeny and phylogenetic trees.Metagenomics.

Practicals

S. No	Exhibit/Experiment
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

Reference Books

1.	Glick BR, Pasternak JJ and Patten CL. 2010. **Molecular Biotechnology Principles and Applications of rDNA.** ASM Press, USA.
2.	Attwood TK, Smith DJP and Phukan S. 2009. **Introduction to Bioinformatics**. Pearson Education Ltd., UK.
3.	Sateesh MK. 2008. **Bioethics and Biosafety**. I K International Pvt. Ltd., Bangalore.
4.	Channarayappa. 2007. Molecular Biotechnology Principles and practices. Taylor and Francis, UK.
5.	Watson JD. 2007. **Recombinant DNA: Genes and Genomes: A short course**. W. H. Freeman, USA.
6.	Primrose SB and Twyman RM. 2006. **Principles of Genome Analysis and Genomics.** Blackwell publishers, USA.
7.	Lewin B. 2004. **Genes VIIII**. Pearson Prentice Hall, New Jersey.
8.	Chawla HS. 2002. **Introduction to Plant Biotechnology**. Oxford and I B H Publlishers, USA.

M.Sc. Botany – Semester IV
Core Paper 402: EVOLUTION AND PLANT BREEDING
Theory

S. No	Unit
	SECTION A
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, RNA world. Origin of eukaryotic cells– Endosymbiont theory, evolution of unicellular eukaryotes, anaerobic and aerobic metabolism.
2.	Theories of organic evolution: Lamarckism, Darwinism–concepts of variation, adaptation, struggle, fitness and natural selection, Synthetic theory, phyletic gradualism, punctuated equilibrium, concepts of neutral evolution.
3.	Molecular evolution: molecular divergence and molecular clocks–protein and nucleotide sequence analysis, gene duplication and divergence. Hardy-Weinberg equilibrium and its applications.
4.	Plant breeding: history, objectives, activities, important achievements and undesirable consequences. Organizations for crop improvement in India: ICAR, Agricultural universities, Central institutes for crop improvement, All India coordinated programmes. Plant Introduction, domestication and acclimatization.
	SECTION B
5.	Methods of breeding self pollinated crops: Mass selection, Pureline selection, Pedigree method, Bulk method, Backcross method, Multiline varieties.
6.	Methods of breeding cross pollinated plants: Bulk Selection, Recurrent selection, Synthetic varieties, Hydbridization. Inbreeding depression and Heterosis – genetic and molecular basis.
7.	Breeding of vegetatively propagated crops. Role of apomixis in plant breeding. Mutation breeding.
8.	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. Regression and correlation; t-test. ANOVA. Basic introduction to multivariate statistics.

Practical

1.	Problems based on Hardy Weinberg law
2.	Line diagrams showing the plan of different methods of breeding self pollinated crops- Mass selection, Pureline selection, Pedigree method,
3.	Line diagrams showing the plan of different methods of breeding cross pollinated crops- Bulk Selection, Recurrent selection.
4.	Methods of hybridization in rice, sorghum, bajra, cotton in standing crop in the field.
5.	Assignments with problems for computing measures of central tendency and dispersion- mean, median and mode, standard deviation and standard error.
6.	Assignment with problems for computing correlation and regression coefficients.
7.	Assignment with problems for implementing t test.
8.	Assignment with problems for computing ANOVA.

References

1.	Singh BD. 2012. **Plant Breeding: Principles and Methods.** Kalyani Publishers, Delhi.
2.	Stickberger MW. 1985. **Genetics**. McMillan, New York.
3.	Frey KJ. 1981. **Plant Breeding II**. Iowa State University Press, Oxford.
4.	Jones DA and Wilkins DA. 1971. **Variation and adaptation in plant species.** Heinemann Educational Books Ltd., London.
5.	Stebbins GL.1971. **Chromosomal evolution in Higher Plants**. Edward Arnold Publishers Ltd., London.
6.	Poehlman JM and Borthakur D. 1969. **Breeding Asian field crops: With Special Reference to Crops of India.** Oxford and IBH Pub. Co., Delhi.
7.	Briggs FN and Knowles PF. 1967.**Introduction to Plant Breeding.** Reinhold Pub. Corp., New York.
8.	Brewbaker JL. 1964. **Agricultural Genetics**. Prentice-Hall, New Jersey, USA.
9.	Allard RW. 1961. **Principles of Plant Breeding.** 2nd Edition. John Wiley and Sons Inc., New York.

M.Sc. Botany - Semester IV

Elective Paper: AGRICULTURAL BIOTECHNOLOGY

Theory

S. No	Unit
	SECTION A
1.	Definition and perspective of biotechnology. New technologies: scope, potential and achievements. Introduction to agriculture. Effects of biotechnology on agrobiodiversity. Biotechnology for agriculture. Genetic manipulation in plant breeding of crop plants. Dangers of genetic uniformity. Preservation and exchange of genetic resources. Use of transgenic plants in industry, agriculture and medicine.
2.	Origin of agriculture. Conventional plant breeding approaches (Introduction, selection, hybridization, mutation breeding and polyploidy breeding) for crop improvement. Exploiting natural variability. Inbreeding depression and heterosis. Self incompatibility and methods of its overcoming. Male sterility– types and its applications in agriculture.
3.	Mutation breeding for crop improvement: mutagens – mode of action of chemical mutagens at the molecular level–transitions, transversions and frame shifts. Chromosome aberrations. Molecular theories of radiation induced chromosomal aberrations. Radiation sterilized food.
4.	Organizations for crop improvement in India: ICAR, IARI, ICRISAT and CSIR. Biofertilizers, types (*Rhizobium Azotobacter*, *Azospirillum*, blue green algae and Vasicular arbuscular mycorhizal (VAM) fungus), production, utility and limitations.
	SECTION B
5.	The molecular basis of plant breeding and genetic engineering. Use of radioisotopes in agriculture. Biological waste treatment and reuse of wastes.
6.	Micro propagation technology and its use in agriculture. Embryo culture and its utility in hybridization programmes. Anther culture, methods and applications, Cell culture types and uses. Protoplast culture, achievements and limitations, Artificial seeds production, achievements and limitations.
7.	Methods of plant genetic engineering: vector mediated and vector less methods.

	Production and applications of transgenics with reference to disease and insect resistance.
8.	General principles of plant protection. Principles of pest management – specific integrated pest management (IPM) practices for rice, sugarcane, and cotton. Biological control of pests, pathogens and weeds, biopesticides, entamopathogen formulations for use in pest management.

Practical

Exhibits/ Experiments/ Suggested Laboratory Exercises	
1.	Callus cultures.
2.	Micropropagation
3.	Isolation of plant genomic DNA from leaf tissue
4.	Separation of seed proteins using SDS-PAGE
5.	Separation of Isozymes using PAGE
6.	Isolation of protoplast
7.	Culture of entamopathogens
8.	Formulation of biopesticides

Reference Books

1.	Chadwick K and Leenhouts HP. 2012. **The molecular theory of Radiation Biology**. Springer Berlin Heidelberg, Berlin.
2.	Dhaliwal GS and Arora R. 1994. **Trends in agriculture insect pest management**. Common wealth Publishers, New Delhi.
3.	Mukherji KG and Chincholkar SB. 2006. **Biological Control of Plant diseases**. Heaworth Food and Agricultural Products Press, New Delhi.
4.	Sharma PD. 1993. **Environmental biology and Toxicology**. Rastogi and Company Meerut.
5.	Sharma R. 1992. **Biotechnology in Agriculture**. Biotech Books, New Delhi.
6.	Obe G and Natarajan AT. 1994. **Chromosomal Alterations: Origin and Significance**. Springer–verlag, Berlin.
7.	Freifelder D. 1987. **Molecular genetics**. Jones & Berlet Publishers.
8.	Dodds JH and Roberts IW. 1985. **Experiments in plant tissue culture**. Cambridge

	University Press, New York.
9.	Singh BD. 1983. **Plant Breeding**. Kalyani Publishers,
10.	Auerbach C. 1976. **Mutation Research: Problems Research and Perspectives**. Chapman and Hall, London.
11.	Poehlman JM and Borthakur D. 1969. **Breeding Asian field crops: With Special Reference to Crops of India.** Oxford and IBH Pub. Co., Delhi.
12.	Martin H. 1928. **The Scientific Principles of Crop Protection**. 4th Edition. Edward Arnold, London.
13.	Bajaj YPS. **Biotechnology in Agriculture and Forestry. Vol. 22.** Springer – Verlag.

M.Sc. Botany - Semester IV

Elective Paper: APPLIED PHYCOLOGY

Theory

S. No	Unit
	SECTION A
1.	Algae in diversified habitants (terrestrial, freshwater, and marine).Structure, reproduction, and lifecycles of some algae such as *Ulva, Enteromorpha, Codium, Caulerpa, Ectocarpus, Padina, Sargassum, Porphyra, Gelidium, Eucheuma, Hypnea, Gracilaria, Nostoc, Spirulina.*
2.	Composition and distribution of phytoplankton of Indian waters. Sampling techniques of phytoplankton. Primary production.
3.	Structure and reproduction of some important micro algae such as *Chlorella, Scenedesmus, Tetrasilmis, Dunaliella, Ceratium, Peridinium, Cyclotella* and *Skeletonema*, and their importance in aqua culture industry
4.	Algae as biofertilizers. Economic uses of fresh water and marine algae and their products.Mass culture and biomass of microalgae (*Chlorella, Scenedesmus, Spirulina*).
	SECTION B
5.	Sea weed farming in India with emphasis on the methods of seaweed cultivation of *Euchema, Porphyra, Gelidiella, Gracilaria.*
6.	Algae and water pollution; Algae as indicators of pollution, Toxic algae, Phycotoxins and their effects on human beings.
7.	Bio-fouling, Sewage disposal, waste land reclamation. Methods of extraction of Agar-agar and Alginic acid.
8.	Industrial products from marine and fresh water algae, Carbon sequestration through micro algae.

Practical

S. No	Exhibit/Experiment
1.	Study of the following algae. *Ulva, Enteromorpha, Codium, Caulerpa, Ectocarpus, Padina, Sargassum, Porphyra, Gelidium, Gracilaria, Hypnea, Nostoc, Spirulina.*
2.	Collection, isolation and identification of phytoplankton.
3.	Estimation of salinity, oxygen, primary production.

4.	Spore counting and germination of different types of spores from marine algae.
5.	Study of plankton cell density.
6.	Extraction of Agar-agar from red algae, Extraction of Alginic acid from brown algae.
7.	Acquaintance with the marine algal flora of Visakhapatnam coast.
8.	Acquaintance with the fresh water algae in the lakes and pools of Visakhapatnam and nearby areas.

Reference Books

1.	Richard S. 2010. **Micro algae: A Potential for carbon capture**.
2.	Kumar HD. 1990. **Introductory Phycology**. Affiliated East-West Press, New Delhi.
3.	Subba Rao NS. 1988. **Biofertilizers in Agriculture**. Oxford publishing Company Private Ltd., New Delhi.
4.	Kumar HD. 1985. **Algal Cell Biology**. Affiliated East-West Press, New Delhi.
5.	Fogg GE, Stewart WDP, Fay P and Walsby AE. 1973. **The Blue Green Algae**. Academic Press, London.
6.	Venkata Raman G.S. 1972. **Algal Biofertilizers and Rice cultivation**. Today and Tomorrow printers and publishers, New Delhi.
7.	Chapman VJ.1970. **The Sea weeds and their uses**. Methena and Company Ltd.,
8.	Round FE.1970. **The Biology of the Algae.** Edward Arnold Ltd.,
9.	Trait RV.1968. **Elements of Marine Ecology**. Butterworths, London.
10.	Dawson EY. 1966. **Marine Botany**. Holt, Reinhart and Winston Inc., NewYork.
11.	Levin R. 1964. **Physiology and Biochemistry of Algae**. Academic Press, Oxford.
12.	Lewis JR.1964. **The Ecology of Rocky Shores.** The English University Press Ltd., London.
13.	Aymount JEE.1963. **Plankton and productivity in Oceans**. Pergamon Press, Oxford.
14.	Singh RN. 1961. **Role of Blue green algae in Nitrogen economy of Indian Agriculture**. ICAR, New Delhi.
15.	Smith GM. (ed.) 1951. **Manual of phycology**. Cronica Botanica Company, U.S.A.
16.	Fritsch FE.1935. **The Structure and Reproduction of Algae**. Cambridge University Press, Cambridge.

M.Sc. Botany - Semester IV

Elective Paper: PLANT PATHOLOGY

Theory

S. No	Unit
	SECTION A
1.	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.
2.	Infection phenomena – pre penetration, penetration and post penetration. Factors affecting infection. Effect of environment on plant disease development – temperature, humidity and light.
3.	Molecular basics of host pathogen interactions (fungi, bacteria & viruses) and genetic engineering for disease resistance. Defense mechanisms in plants: pre–and post–infectional defense mechanisms, phytoalexins.
4.	Role of enzymes in plant diseases – pectic, macerating, cellulolytic, lignolytic, proteolytic, lypolytic enzymes and hemicellulases, inactivation of enzymes.
	SECTION B
5.	Role of toxins in plant diseases – Phytotoxins, vivo toxins, host specific patho toxins & non specific patho toxins.
6.	Control of plant diseases: Cultural practices: field & crop sanitation, crop rotation; Chemical control: systematic & non systematic fungicides; Biological control. microbial pesticides. Plant diseases management through host resistance: vertical, horizontal, monogenic, polygenic, specific & general resistance. Development of resistant varieties.
7.	Symptoms, etiology, epidermology & control measures with reference to the following: Fungal diseases – Club root 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.
8.	Bacterial diseases – Citrus Canker, Angular leaf spot of cotton, Bacterial leaf Blight of rice, Brown rot of potatoes. Viral and phytoplasma diseases – Grassy shoot diseases of sugarcane, Little leaf of brinjal, Rice tungro.

Practical

. S. No	Exhibits/ Experiments
1.	Study of symptoms, microscopic examination of diseased parts and identification of the pathogens involved in different plant diseases Fungal diseases–Club root 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 diseases–Citrus Canker, Angular leaf spot of cotton, Bacterial leaf Blight of rice, Brown rot of potatoes. Viral and phytoplasma diseases – Grassy shoot disease of sugarcane, Little leaf of brinjal, rice tungro.
2.	Isolation of fungal pathogens from leaves.
3.	Isolation of fungal pathogens from soil.
4.	Extraction of pectolytic enzymes from a pathogen.
5.	Extraction of cellulase enzyme from a pathogen.
6.	Isolation of plant pathogen– bacteria.
7.	Isolation (purification) of plant viruses.

Reference Books

1.	Ravichandra NG. 2013. **Fundamentals of Plant Pathology**. PHI Learning Pvt. Ltd., Delhi.
2.	Ronald PC. 2007. **Plant-Pathogen Interactions: Methods in Molecular Biology.** Humana Press, New Jersey.

3.	Mehrotra RS.2006. **Plant pathology**. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
4.	Sharma PD. 2004. **Plant pathology**. Rastogi Publications, New Delhi.
	Bilgrami S and Dubey HC. 1998. **A text book of modern Plant pathology.** Sangam Books Ltd., Mumbai.
5.	Stacey G and Keen TN. (ed). 1996. **Plant Microbe Interactions. Vols. I-III**. Chapman and Hall, New York; **Vol. IV**. APS Press, St. Paul, Minnesota.
6.	Singh RS. 1990. **Plant diseases.** Oxford and IBH Publishing Co., New Delhi.
7.	Butler EJ. 1973. **Fungi and diseases in plants**. Periodical Expert Book Agency, Delhi.
8.	Roberts D and Boothroyd CW. 1973. **Fundamentals of Plant pathology**. W. H. Freeman and Co., Ltd., New York.
9.	Rangaswamy G. 1972. **Disease of crop plants in India.** Prentice Hall of India, New Delhi.
10.	Strobell GA and Mathre DE. 1970. **Outline of Plant pathology**. D. Van Nostrand-Reinhold Co., New York.
11.	Matthews REF. 1970. **Plant virology**. Academic Press, New York.
12.	Agrios GN. 1969. **Plant Pathology.** Academic Press, New York.
13.	Walker JC. 1969. **Plant pathology**. McGraw Hill Book Co., New York.
14.	Wheeler BEJ.1969. **An introduction of Plant diseases.** John Wiley and Sons Ltd., New York.
15.	Smith KM. 1968. **Plant viruses**. Methuen, London.
16.	Mundkar BB.1967. **Fungi and Plant diseases.** McMillan and Co. Ltd., Calcutta.
17.	Wood RKS.1967. **Physiological Plant Pathology**. Blackwell Scientific Publications, Oxford.
18.	Kelman A. 1967. **Source Book of Laboratory Exercise in Plant Pathology**. W. H. Freeman, New York.
19.	Rangaswamy G. 1962. **Bacterial Plant Diseases in India**. Asia Publishing House,

	Bombay.
20.	Horsfall JC and Diamond AE.1960. **Plant Pathology – An Advanced Treatise – 3 volumes.** Academic Press, New York.
21.	Goodman et al.1957. **Biochemistry and Physiology of Infections and Plant Diseases.** Princeton, Van Nostrand, Belgium.
22.	Plank JEV.1953. **Plant Diseases – Epidemics and Control**. Academic Press, New York.

M.Sc. Botany – Semester IV

ELECTIVE PAPER: PLANT BIOSYSTEMATICS

Theory

S. No	Unit
	SECTION A
1.	Definition, History, Scope, Importance and Objectives of Plant Biosystematics. Biosystematics in the frame of work of evolution. Emphasis on orthodox and experimental taxonomy.
2.	Biosystematics categories: Phenotype, Genotype, Biotype, Ecotype, Subspecies, Ecospecies, Coenospecies, Comparium and Infraspecific variation.
3.	Population concept: Size and density; variation in individuals, ecological differentiation of population, plasticity of phenotype, geographical and regional variation.
4.	Transplant experiments of Claussen, Keck and Hiesy, Macmillan, Watson and Claussen.
	SECTION B
5.	Breeding Systems: Establishment of inbreeding and consequences, out breeding– its problems and perspectives, self incompatibility, isolating mechanisms.
6.	Modern trends in Taxonomy: Cytology, Phytochemistry, Embryology, Palynology, Anatomy, Taximetrics.
7.	Species concept: Models of species formation, dynamics and mechanism of speciation process, abrupt speciation. Polyploidy, catastrophic selection, Biological species concept, Leaky isolation barriers, Gene flow and selection.
8.	Species definition and classification. Types of species: Taxonomic species, Biological species, Semi species, Micro species, Successional species, Biosystematic species, Evolutionary species.

Practical

1.	Investigation of variation and evolution through Experiments in Cytology, Anatomy, Palynology and Plant chemistry to set boundaries around species and genera in a family.
2.	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.
3.	Exercise 1: To determine the variation (1) between 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.
4.	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.
5.	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.
6.	Exercise 4: Preparation and study of meiosis in 2 or more populations of a species as well as some classical cytological material.
7.	Exercise 5: Sketches from text books or from published papers relating to protein band patterns of seed proteins, Flavonoids and chromatograms.
8.	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.

Reference books

1.	Gurcharan Singh, 2009. **Plant Biosystematics an integrated approach**. Science Publishers, USA.
2.	S. Venkat Ratnam, 2009. **Plant Biosystematics**. MD-Publications, New Delhi.
3.	Pullaiah T. 1998. **Taxonomy of Angiosprems, Regency Publications**, New Delhi.
4.	Singh V and Jain DK. 1993. **Taxonomy of Angiosprems**. Rastogi Publications, Meerut.
5.	Heywood VH and Davis PH. 1991. **Principles of Angiosperm Taxonomy.** Krieger Publishing Co., Malabar, FL, USA.
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7.	Clive A. Stace. 1984. **Plant Taxonomy and Biosystematics.** Edward Arnold Publishers Ltd. London.
8.	William F Grant. 1984. **Plant Biosytematics**. Academic Press, New York.
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12.	Radford AE, Dickison, WC, Massey JR and Bell CR. 1974. **Vascular plant systematic.** Harper and Row, New York.
13.	Harborne JB. 1973. **Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis.** Chapman and Hall, London.
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17.	Stebbins GL. 1971. **Chromosome evolution in Higher Plants.** Edward Arnold, Michigan, USA.
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19.	Lawrence GHM. 1965. **Taxonomy of Vascular Plants**. Oxford and IBH Publishing, Oxford.
20.	Swain T. 1963. **Chemical Plant Taxonomy.** Academic Press, London.
21.	Sokal RR and Sneath PHA. 1963. **Principles of Numerical Taxonomy.** W. H. Freeman, San Francisco.
22.	Benson LD. 1962. **Plant Taxonomy: Methods and Principles**. Ronold Press, New York.
23.	Heslop-Harrison J. 1953. **New concepts in Flowering Plant Taxonomy**. Heinemann, London.
24.	Solbrig OT. 1970. **Principles and methods of Plant Biosystematics**. Macmillan Co., London.
25.	Dickison GH, Massey JH, Bell RG and Bridggs FW. 1967. **Introduction to Plant Breeding.** Reinhold Pub. Corp.,
26.	Alston RE and Turner BL. 1963. **Biochemical systematics.** Literacy Licensing, USA.
27.	Heywood VH. 1963. **Modern methods in Plant Taxonomy**. Academic Press, London.

28.	Maheshwari P. 1963. **Recent Advances in the Embryology of Angiosperms.** International soc. of Plant Morphologists. University of Delhi.
29.	Cronquist S. 1961. **Comparative Plant Anatomy.** Holt, Renehart and Winston, New York.
30.	Stebbins GL. 1950. **Variation and Evolution in Plants**. Colombia University Press, New York.
31.	Dobzhansky TH. 1937. **Genetics and Origin of Species.** Columbia University Press, New York.

M.Sc. Botany - Semester IV
Elective Paper: ADVANCED CYTOGENETICS
Theory

S. No	Unit
	SECTION A
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.
	SECTION B
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.

Practical

S. No	Exhibit/Experiment
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.

Reference books

1.	Lewin B. 2000. **Genes VII**. Oxford University Press, New York.
2.	Weavor RF. 1999. **Molecular Biology**. WCB McGraw Hill, New York.
3.	Gupta PK. 1995. **Cytogenetics.** Rastogi and Company, Meerut.
4.	Glick BR and Thompson JE. 1993. **Methods in Plant Molecular Biology and Biotechnology**. CRC Press, Boc Raton, Florida.
5.	John B and Lewis KR. 1975. **Chromosome Hierarch**. Clarendon press, Oxford.
6.	Sybenga J. 1975. **Meiotic configurations**. Springer, Berlin.
7.	Sybenga J. 1973. **General Cytogenetics**. American Elsvier Pub Co., New York.
8.	Swanson, merz and Young. 1967. **Cytogenetics**. Prentice Hall, India.
9.	Lewis KR and John B. 1963. **Chromosome Marker**. J&A. Churchill Co., London.
10.	Burnham, C.R. 1962. Discussions in Cytogenetics, Burgess Publishing Co., Minnesota.

M.Sc. Botany - Semester IV
Elective Paper: CROP PHYSIOLOGY AND BIOTECHNOLGY
Theory

S. No	Unit
	SECTION A
1.	Crop Physiology: Molecular biology of light reactions. Photosynthetic pathways.
2.	Mechanism of Photorespiration. Biotechnological strategies to improve photosynthesis, yield components. Source – sink relationships.
3.	Stress Physiology: Physiology and molecular biology of stress tolerance in response to water, salt and heavy metal stress.
4.	Methods in biotechnology: Tissue culture techniques in crop improvement, Protoplasts and cell fusion.
	SECTION B
5.	Recombinant DNA technology: basic principles of recombinant DNA technique. Techniques of transferring genes into plants.
6.	Potentials of Biotechnology: Molecular mechanism to confer herbicide resistance in crop plants. Genetic engineering to improve plant disease resistance.
7.	Genetic manipulation of crops for insect resistance, Genetic engineering of seed proteins and oils.
8.	Bioinformatics: Fundamentals of Genomics and Proteomics. PCR and its application in crop improvement, Principles of microarray technology and its applications.

Practical

S. No	Exhibit/Experiment
1.	Exercise-1: Chlorophyll absorption spectrum and quantitative determinations, assay of Hill reaction in isolated chloroplast. Crop growth analysis.
2.	Exercise-2: Determination of CO2 compensation points in some crop plants, Estimation of carbohydrate, protein and nucleic acid contents in plants.
3.	Exercise-3: Determination of the activities of some enzymes associated with Carbohydrates and protein metabolism.
4.	Exercise-4: Effect of nitrogen and potassium on the growth and yield of crop plants.
5.	Exercise-5: Leaf anatomy in relation to diversity in photosynthetic pathways.
6.	Exercise-6: Effect of water and salt stress on the accumulation of proteins.
7.	Exercise-7: Estimation of nitrogen, phosphorus and potassium.

8.	Exercise-8: Experiments to study the effect of water and salt stress on seed germination and seedling development.
9.	Exercise-9: Experiments to study the weed control using some common herbicides.
10.	Exercise-10: Polyacrylamide gel electrophoresis of proteins.
11.	Exercise-11: Isolation of DNA.
12.	Exercise-12: Polymerase chain reaction.
13.	Exercise-13: Isolation of explants, establishment and maintenance of callus; Sub-culture of callus. Study of Somaclonal variation.
14.	Exercise-14: Isolation and culture of single cells.
15.	Exercise-15: Experiments on herbicide resistance and disease resistance in plants.

Reference Books

1.	Lebowitz RJ. 1995. **Plant Biotechnology, a laboratory manual**. Wm. C. Brown Publishers, Qubuque.
2.	Murray Meo – young. 1995. **Comprehensive Biotechnology. Vol . 1.** Pergamon Press Oxford.
3.	Marshall G and Walters O (ed) 1994. **Molecular Biology in Crop Protection.** Champman and Hall.
4.	Old RW and Primrose SB. 1994. **Principles of gene manipulation.** Blackwell Science.
5.	Salunkhe DK, Bhatt NR and Desai BB. 1990. **Post Harvest Biotechnology of Flowers and Ornamental Plants**. N. Bayoprokash, Calcutta
6.	Davies KE. (ed) 1988. **Genome Analysis**. IRI Press, Oxford.
7.	Pierik RIM. 1987. **Invitro Culture of Higher Plants**. Martinus Nihoff Publishers Dordrecht.
8.	Primrose SB. 1987. **Molecular Biotechnology**. Blackwell Scientific Publications,
9.	Day PR. 1986. **Biotechnology and Crop Improvement and Protection**. BCPC Publications.
10.	Mantell SH and Smith N (ed) 1983. **Plant Biotechnology**. Cambridge University Press, Cambridge.
11.	Noggle GR and Fritz GJ. 1977. **Introductory plant physiology.**
12.	Reinert J and Bajaj YPS. 1977. **Plant Cell, Tissue and Organ Culture**. Springer – verlag, Berlin.
13.	Lange OI, Kappen L and Schule DD. 1976. **Water and Plant Life.**

14.	Burris RH and Black CC (ed) 1975. **CO_2 Metabolism and Productivity of Plants**.
15.	Evans IT. 1975. **Crop Physiology.**
16.	Major AM and Mayber P. 1975. **The germination of seeds**. 2nd Edition.
17.	Mayber PA and Gele J. (ed) 1975. **Plants in Saline Environments.**
18.	Ashston and Crafts A. 1973. **Mode of Action of Herbicides.**
19.	Epstein E. 1972. **Mineral Nutrition of Plants: Principles and Perspectives.**
20.	Fogg GK. 1972. **Photosynthesis.**
21.	Hillman WS. 1972. **The Physiology of Flowering**
22.	Kozlowski TT. (ed) 1972. **Seed Biology. 3 Vols.**
23.	Levitt J. 1972. **Response of Plants to Environmental Stresses.**
24.	Hatch MD, Osmond CB and Slatyer RO (ed) 1971. **Photosynthesis and Photorespiration.**
25.	Gregory RPF. 1971. **Biochemistry of Photosynthesis.**
26.	Zelitch I. 1971. **Photosynthesis, Photorespiration and Plant Productivity.**
27.	Gollek B. (ed) 1970. **Structure and Function of Plant Cells in Saline Habitats.**
28.	Kozlowski TT. (ed) 1968. **Water Deficit and Plant Growth.**
29.	**Annual Review of Plant Physiology**. 1950. Vol. – Annual Reviews Inc., Stanford.