

M.Sc. BOTANY Course Structure

SEMESTER-I

PAPER-I: BIOLOGY AND DIVERSITY OF VIRUSES, BACTERIA, ALGAE AND FUNGI

PAPER-II: BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS AND PLANT FOSSILS

PAPER – III: TAXONOMY OF ANGIOSPERMS

PAPER – IV: PLANT RESOURCE UTILIZATION AND CONSERVATION

SEMESTER-II

PAPER - I: CYTOLOGY AND CELL BIOLOGY OF PLANT

PAPER – II: PLANT STRUCTURE AND DEVELOPMENT

PAPER – III: PLANT ECOLOGY

PAPER – IV: PLANT PHYSIOLOGY

SEMESTER-III

PAPER - I: GENETICS AND CYTOGENETICS

PAPER - II: MOLECULAR BIOLOGY OF PLANTS

PAPER – III: PLANT REPRODUCTION

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PAPER - I: PLANT CELL, TISSUE AND ORGAN CULTURE

PAPER - II: GENETIC ENGINEERING OF PLANTS AND MICROBES

PAPER - III: CYTOGENETICS OF CROP PLANTS AND PLANT BREEDING

PAPER - IV: PLANT PATHOLOGY

BOTANY SEMESTER-I
PAPER-I: BIOLOGY AND DIVERSITY OF VIRUSES, BACTERIA, ALGAE AND FUNGI

Unit-I: Viruses

Brief account of discovery of viruses; general properties, structure, cultivation, purification, replication and transition of viruses; brief account of bacteriophages and plant viruses; Economic importance

Unit-II: Bacteria

Morphology and ultra structure of bacteria; Nutritional types (autotrophs and heterotrophs); Growth of Bacteria; Recombination in bacteria (transformation, transduction and conjugation); General characters of Actinomycetes, Mycoplasmas and cyanobacteria; Economic importance.

Unit-III: Algae

Classification, thallus organization and economic importance of algae; General account on structure and reproduction of chlorophyta, charophyta, xanthophyta, bacillariophyta, phaeophyta, rhodophyta and cyanophyta.

Unit-IV: Fungi

General characters; Nutrition and reproduction of fungi; classification of Fungi (Ainsworth system); Ecto and endomycorrhizal associations; Mushroom cultivation; Importance of Fungi in Agriculture and industry.

Reference books

1. An Introduction to Fungi: by Webster, J. (1985). Cambridge Univ. Press.
2. Brock Biology of Microorganisms: by Madigan, Mordinko and Parker (2000). Prentice Hall.
3. Introduction to Plant Viruses: by Mandahar. C.I. (1978). Chand & Co., New Delhi.
4. Introductory Phycology by Kumar, H.D. (1988). Affiliated East-West Press. Ltd, New Delhi.
5. An Introduction to the Algae by Morris. J. (1986). Cambridge University' Press, U.K
6. Microbiology: by Prescott, L.M., Harley, J.P. and Klein, D.A. (1992), WCB Publishers.
7. Introductory Mycology: by Alexopoulos, C.J. Mims, C.W. and Blackwell, M. (1996). John Wiley & Sons.
8. The Biology of Algae by Round. F.E. (1986). Cambridge University Press. U.K.

BOTANY SEMESTER-I
PAPER-II: BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS AND PLANT FOSSILS

Unit-I: Bryophytes

Classification, general characters, range of thallus organization and reproduction in Hepaticopsida, Anthcerotopsida and Bryopsida. Evolutionary trends in gametophytes and sporophytes of Bryophytes

Unit-II: Pteridophytes

General characteristics and classification of pteridophytes; Study of morphology, anatomy and reproduction of Psilopsida, Psilotopsida, Lycopsida, Sphenopsida and Pteropsida. Origin and phylogeny of pteridophytes. Evolution of stele in Pteridophytes. Heterospory and seed habit in pteridophytes.

Unit-III: Gymnosperms

Classification, distribution and economic importance of Gymnosperms. Structure and reproduction in living (modern) Cycads, Coniferopsida and Gnetopsida. Wood of gymnosperms; Male and female gametophytes of gymnosperms.

Unit-IV: Plant Fossils

Principles of Palaeobotany; Geological time scale; determination of age of plant fossils; process of fossilization; types of fossils; a comprehensive account of fossil algae, fossil bryophytes, fossil pteridophytes and gymnosperms (Pteridospermales, Bennettitales, Cordaitales and Pentoxylales).

Reference Books

1. Agashe, S.N. 1995. Palaeobotany. Oxford & IBH, New Delhi
2. Arnold, C.A. 1947. An introduction to Palaeobotany, New York
3. Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms, New Age Int. Pvt. Ltd. New Delhi.
4. Parihar, N.S. 1991. Bryophytes. Central Book Depot, Allahabad.
5. Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
6. Puri, P. 1980. Bryophytes. Atma Ram & Sons, New Delhi.
7. Sporne, K.R. 1991. The Morphology of Pteridophytes. B.I. Publication. Pvt. Ltd.
8. Sporne, K.R. 1965. The Morphology of Gymnospermae. B.I. Publications, New Delhi.

BOTANY SEMESTER-I
PAPER – III: TAXONOMY OF ANGIOSPERMS

UNIT – I

Introduction: Taxonomy and Systematics; Basic components of taxonomy; Systems of Angiosperm classification – Natural, Artificial and Phylogenetic.

History: Pre-Darwinian and Post-Darwinian systems of classification.

Nomenclature: International Code of Botanical Nomenclature - Principles, Rules and Recommendations, Ranks of taxa, Principle of Priority, Typification, Author citation, Effective and Valid publication.

UNIT – II

Systems of classification: Salient features, systems of classification, merits and demerits of Bentham and Hooker, and Takhtajan; Classification of Angiosperm Phylogeny Group; Brief account of Paleoherbs, Magnoliids, Monocots, Commelinids, Eudicots, Rosids, Eurosids, Asterids and Euasterids; Hierarchical classifications – Taxonomic groups, categories, ranks and Species Concept;

Taxonomic evidence: Morphology, Anatomy, Embryology, Palynology, Cytology and Phytochemistry in relation to taxonomy.

UNIT – III

Plant Identification: Process of Plant Identification – Construction, types and use of Taxonomic keys; Herbarium methodology – Collection, processing and preservation of specimens.

Taxonomic tools: Herbaria- Important world and Indian Herbaria; Botanical gardens- Major Botanical Gardens of the world and India; Taxonomic literature – Floras, Monographs, Journals and computer data bases.

Plant Explorations and Plant Introductions.

UNIT – IV

Chemotaxonomy – Primary and secondary metabolites, Semantides and non-semantides in plants and their role in chemotaxonomy.

Numerical Taxonomy – Construction of numerical taxonomic groups and applications in taxonomy.

Cladistics – Operational evolutionary units, characters and coding, measure of distance and construction of cladograms.

Serotaxonomy– Methodology and its applications in taxonomy.

Basic concepts of **Molecular Systematics** – Gene sequences, restriction site analysis, allozymes etc.

Reference Books

1. Cole. A.J. 1969. **Numerical Taxonomy** Academic Press, London.
2. Davis, P.H. and Heywood, V.M. 1973. **Principles of Angiosperm Taxonomy**. Robert E.Kereiger Publishers, New York.
3. Gamble and Fisher. 1915-1935. **Flora of Presidency of Madras**. 3 Vols. BSMS, Dehradun.
4. Greuter *et al.* 1988. **International Code of Botanical Nomenclature**. Koeltz Scientific Books, Germany.
5. Gurcharan Singh. 1999. **Plant Systematics - Theory and Practice**. Oxford & IBH Publishing Company Pvt. Ltd., New Delhi.
6. Lawrence, G.H.M. 1951. **Taxonomy of Vascular Plants**. Mc Millan, New York.
7. Naik, V.N. 1984 **Taxonomy of Angiosperms**. Tata Mc Graw – Hill Publishing Company Ltd., New Delhi
8. Pandey, S.N. and Misra, S.P. 2008. **Taxonomy of Angiosperms**. Ane Books India, New Delhi.
9. Pullaiah, T. 2005. **Taxonomy of Angiosperms**. Regency Publications, New Delhi.
10. Radford, A.E. 1986. **Fudamentals of Plant systematics**. Harper & Row Publisher, New York.
11. Sambamurthy, A.V.S.S. 2005. **Taxonomy of Angiosperms**. I.K. International Private Limited, New Delhi.
12. Simpson, M.G. 2006. **Plant Systematics**. Elsevier Academic Press, Canada.
13. Verma, B. K. 2010. **Introduction to Taxonomy of Angiosperms**. PHI Learning Pvt. Ltd., New Delhi.

BOTANY SEMESTER-I
PAPER – IV: PLANT RESOURCE UTILIZATION AND CONSERVATION

UNIT – I

Biodiversity-Current concept, status in India, Biodiversity utilization concepts. Relationships between biodiversity and Biotechnology. Biodiversity of microbes. Role of Remote sensing in resource identification. Intellectual property rights. Biodiversity registers, Environmental impact assessment.

UNIT – II

Botany, cultivation and uses of:

- 1) Food crops: Rice, Sorghum.
- 2) Vegetable crops: Potato, Chillies
- 3) Oil crops: Groundnut, Sesamum

Distribution, description and uses of:

- 1) Timber yielding plants: *Tectona, Dalbergia*.
- 2) Medical plants: *Rawolfia, Withania*
- 3) Production and applications of biofuels- Biogas, hydrogen and methane.

UNIT – III

Current practice in conservation in India and abroad. Organizations involved in resource conservation IUCN, WWF, UNEP, and UNESCO.

Phytogeography- Hot spots of India and World.

General account on activities of DBT, BSI and NBPGR.

UNIT – IV

Strategies for *in situ* conservation-protected areas:-sanctuaries, national parks, biosphere reserves and mangroves.

Strategies, for *ex situ* conservation-Botanical Gardens, seed banks, field banks. Gene banks, *in vitro* preservation.

Reference Books

1. Swaminathan M.N. & Jam, R.S. Biodiversity: Implications for global security, Macmillan, 1982.
2. CSIR 1986. The Useful Plants in India.
3. Kothari, 1987. Understanding biodiversity, life sustainability and equity; Orient Longman.
4. Sharma, O.P. 1996. Hills Economic Botany.
5. Thakur. R.S. *et al.*, Major Medicinal Plants.
6. Kocchar, S.L. 1998. Economic Botany of Tropics.
7. Richard B. Primack. 1993. Essentials of Conservation Biology.
8. Heywood, V.H. & Watson, R.T. 1995. Global Biodiversity Assessment.
9. Peter B. Kaufman *et al.*, 1999. Natural Products from Plants.
10. Negi, S.S. 1993. Biodiversity and its Conservation in India.

BOTANY SEMESTER-II
PAPER - I: CYTOLOGY AND CELL BIOLOGY OF PLANT

Cytology

Unit-I

Prokaryotic and Eukaryotic Cells: Ultra structure of Prokaryotic and Eukaryotic cells. Ultra structure of prokaryotic and eukaryotic chromosome; chromosome banding; Chromosomes structure and organization of DNA; Euchromatin and heterochromatin. **Special types of Chromosomes:** Polytene, Lamp-brush, B-chromosomes, and Sex- chromosomes, Cell division; significance of meiosis; Karyo-type study in relation to taxonomy.

Unit-II

Structural alteration in chromosomes-Origin, meiosis and breeding behaviour of duplication deficiency, inversion and translocation heterozygotes.

Numerical alteration in chromosomes: Origin, occurrence and induction of haploids, polyploids and aneuploids.

Cell Biology

Unit-III

Biomembranes: Structure and functions of biomembranes; Cytoskeleton, organelles of eukaryotic cell; Nucleus, Chloroplast, Mitochondria, Ribosome, Endoplasmic reticulum, Microtubules, Peroxisomes, Golgi apparatus, Lysosomes and plant vacuoles.

Unit-IV

Cell cycle -- Phases of Cell cycle; Role of cyclins; Cyclin dependent kinases. regulation of cell cycle; Apoptosis; oncogenes; tumour suppressor genes. Genomes of mitochondria and chloroplasts. Endosymbiotic theory.

Reference Books

1. Brown and Berke: **Text Book of Cytology**, Blackstains Sons & Co.
2. Brachet and Mirsky (ed.): **The Cell**, Academic Press, Vols. 1-6.
3. Darlington, C.D : **Recent Advances in Cytology**, Blackstains Sons & Co.
4. Lewin, B. 2000. **Genes VII**, Oxford University Press, USA.
5. De Robertis, E.D.P. and De Robertis, E.M.F. 2001. **Cell and Molecular Biology**, Lippincott Williams & Wilkins, Bombay.
6. Sharma, A.K. and Sharma, A. 1980. Chromosome Techniques. Theory and Practice. Butterworth.
7. Stebbins, J.L. **Chromosomal Evolution in Higher Plants**, Edward Arnold Publ., London.
8. Roy, S.C. and Kumar, K.D.C. 1977. **Cell Biology**, New Central Book Agency, Calcutta.
9. Wolfe, S.L. 1993. **Molecular and Cellular Biology**. Wordsworth Publ. Co., California. USA.

BOTANY SEMESTER-II
PAPER – II: PLANT STRUCTURE AND DEVELOPMENT

Unit-I

Meristems, Shoot Apical Meristem (SAM) organization; Molecular analysis of SAM, cell to cell communication, control of cell differentiation. Vascular tissue differentiation and pattern formation. Principles and applications of light and electron microscopy (SEM and TEM)

Unit-II

Cambium - structure of Vascular cambium and its abnormal activity; Wood - types of wood, its development in relation to factors: Leaf – Leaf histology, development, Phyllotaxy; Stomata structure and types of stomata, development of stomata; Plant tissues – Parenchyma, Collenchyma, Sclerenchyma.

Unit-III

Root Apical Meristem (RAM) organization, Cell division, cell elongation and cell expansion in the root Meristem, Cell differentiation, types of roots; Seed germination and seedling growth, metabolism of carbohydrates, proteins, nucleic acids and lipids during - germination, mobilization of stored food reserves, hormonal control of seedling growth.

Unit-IV

Dormancy – Factors responsible for seed dormancy, methods of breaking the dormancy bud dormancy: Senescence – Senescence types, biochemical changes associated with leaf senescence; factors in relation to senescence; programmed cell death, Apoptosis.

Reference Books

1. Atwell, B.J. Kriederusann, P.E. and Jumbull, C.G.N. (Eds.), 1999. Plant in action: Adaptation in nature, Performance in cultivation, MacMillan Education. Sydney.
2. Bewley, J. D. and Black, M. 1994. Seeds: Physiology of Development and Germination, Plenum Press, New York.
3. Burgess, J. 1985. An Introduction to Plant Cell Development, Cambridge University Press, Oxford.
4. Fahn, A. 1982. Plant Anatomy (3Td Ed.), Pergamon Press, Oxford.
5. Fosket, D.E. 1994. Plant Growth and Development — A Molecular approach, Academic Press, Oxford.
6. Lyndon, R.F. 1990. Plant Development-The Cellular basis, Unnin Hyman, London.
7. Raghavan, V. 1999. Developmental Biology of Flowering Plants, Springer-Verlag, New York.
8. Steeve, T.A. and Sussex, I.M. Patterns in Plant Development (2r Ed.), Cambridge University Press, Cambridge.

BOTANY SEMESTER-II
PAPER – III: PLANT ECOLOGY

Unit-I

Structure and function of ecosystem: Biotic and abiotic components, Energy flow, Energy pyramids, Food chains and Food webs, Homeostasis

Population ecology: Population characteristics and dynamics, Ecological life cycle, Ecotypic differentiation

Community ecology: Analysis of communities (Qualitative and quantitative characteristics), Ecological succession (Types, mechanism, climax concept and pathways).

Unit-II

Soils: Soil properties, Soil profile and types of soils

Global biogeochemical cycles of Carbon, Nitrogen, Phosphorous and Sulphur

Dynamic phytogeography: Basic principles, Age and area theory, Centre of origin, Endemism, Plant migration and Continental drift

Biomes: Major biomes of the world.

Unit-III

Air pollution: Classification and properties of air pollutants and their effects on plants, Ozone layer and Ozone hole, climate change

Water pollution: Domestic and Industrial water pollution, Oil pollution

Soil pollution: Acidification, Agrochemical pollution, Contamination by metalliferous wastes.

Ecological Management: Concept of sustainable development, Forest conservation and Soil conservation.

Unit-IV

Biological diversity: Concept and levels, Role of biodiversity in ecosystem function and stability, Speciation and extinction, IUCN categories of threat; Causes of biodiversity loss; Conservation; Keystone species.

Conventional and Non-conventional energy sources; Bioremediation and environmental clean up; Phytoremediation of heavy metal pollutant sites.

Reference Books

1. Ambasht, R.S. and Ambasht, N.K. 1999. A text book of Ecology. CBS Pubi. & Distr. New Delhi.
2. Campman, J.L. and Reiss, M.J. 1988. **Ecology**. Principles and Applications, Cambridge University Press, U.K.
3. Heywood, V.M. and Watson, R.T. 1985. **Global Biodiversity Assessment**, Cambridge Univ. Press, Cambridge.
4. Kormondy, E.J. 1996. **Concepts of Ecology**. Prentice-Hall of India Pvt.Ltd. New Delhi.
5. Mitra, R. 1968. **Ecology Work Book**. Oxford and TBH, New Delhi.
6. Odum, E.P. 1983. **Basic Ecology**. Saunders, Philadelphia.

7. Purohit, S.S. and Ashok Agrawal. 2007. **Ecology and Environmental Biology**, Student Edition, Jodhpur.
8. Russell, P.J., Wolfe, S.L., Hertz, P.E., Starr, C. and McMillan B. 2008. **Ecology**, Cengage Learning India Pvt. Ltd., New Delhi.
9. Sharma, P.D. 2001. **Ecology and Environment**, Rastogi Publications, Meerut.

BOTANY SEMESTER-II
PAPER – IV: PLANT PHYSIOLOGY

Unit-I

Membrane transport and translocation of water and solutes: The structure and properties of water; water transport processes (diffusion, bulk flow, osmosis, water potential, components of water potential); Mechanism of water transport through xylem; Water loss by transpiration; Mechanism of stomatal movements, antitranspirants; Essential nutrients, deficiencies and plant disorders; Solute transport by passive and active mechanisms and membrane transport proteins.

Unit-II

Sensory Photobiology: History of discovery of phytochromes, structure and function of phytochrome, photochemical and biochemical properties of phytochrome, phytochrome induced plant responses, molecular mechanism of action of phytochrome in gene expression, Cryptochrome and its role in photomorphogenesis.

The flowering process: Photoperiodism and its significance, initiation of flower primordia, flowering stimulus, Vernalization, endogenous clock and its regulation.

Unit-III

Plant growth regulators: Physiological effects and mode of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroids, jasmonic acid and salicylic acid.

Signal transduction: Over view, receptors and G proteins, second messengers, two component sensor regulator system in bacteria and plants, signal transduction and gene expression.

Unit-IV

Stress Physiology: Water stress, salt stress, temperature stress (HSP), biotic stress (HR and SAR), heavy metal stress; Stress avoidance and tolerance mechanisms; Structural, physiological, biochemical and molecular responses of plants to environmental stress; Reclamation of saline and heavy metal contaminated soils.

Reference Books

1. Devline and Witham, 1986. Plant Physiology. CBS Pubis. and Distributors. New Delhi.
2. Hopkins, W.G. 1995. Introduction to Plant Physiology, John Wiley & Sons. Inc., New York, USA.
3. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones. Springer Verlag, New York, USA.
4. Singhal *et al.* 1999. Concepts in Photobiology. Photosynthesis and Photomorphogenesis, Narosa Pub. House. New Delhi.
5. Taiz and Zeiger, 1998. Plant Physiology. Sinauer Associates Inc., Publishers, Sunderland.
6. Salisbury F.B & C. W. Ross, 1992. Plant Physiology, 4th Edition. Wadsworth Publishing Co., Belmont, California.

SEMESTER-III
PAPER - I: GENETICS AND CYTOGENETICS

Unit-I

Mendelian principles, gene interactions, Multiple allelism, quantitative or polygenic inheritance, transgressive variation, linkage and recombination, gene mapping in diploids by three point crossover data, gene mapping in haploids, by tetrad analysis in Neurospora.

Unit-II

Sex determination mechanisms in Drosophila, plants and man. Sex-linked inheritance. sex limited and sex influenced genes, extra chromosome inheritance, genetic recombination in bacteria, gene mapping by transformation and conjugation. Life cycle of Bacteriophages, genetic recombination in T₄ phage, cis-trans test, gene fine structure and evolution of gene concept.

Unit-III

Cytogenetics of Polyploids and Aneuploids-Autopolyploidy, its phenotypic effects, genetics, chromosome pairing and breeding behaviour of autopolyploids. Allopolyploidy and genome analysis, aneuploids in plants- monosomics and trisomics their use in chromosome mapping.

Unit-IV

The basic structure of a gene- Multigene families, Repeat sequences of centromere and telomeres of chromosome Techniques involved in physical mapping of chromosomes in *situ* hybridization Fluorescence *in situ* hybridization.

Reference Books

1. Burnham. C.R. 1962. Discussion in Cytogenetics, Burgess Publishing: Comp, Minnesota.
2. Khush,G.S. 1973. Cytogenetics of aneuploids, Academic Press, New York.
3. Sybenga, J. 1975. Meiotic configurations. Springer Verlag, Berlin Heidel
4. Lewin, B. 2004. Gene VIII, Prentice Hall.
5. Russel, P.J. 1998. Genetics (5th edition), The Benjamin / Cummings Publishing Company, Inc., USA.
6. Sambamurthy, A.V.S.S. Genetics.
7. Gupta, P.K. Cytogenetics.
8. Strickberger, Genetics, Prentice Hall.

SEMESTER-III
PAPER - II: MOLECULAR BIOLOGY OF PLANTS

Unit-I

Chemistry of the gene: Evidence for DNA as genetic material, Physical and chemical structure of DNA, mechanism of DNA replication, DNA damage and DNA repair mechanisms.

Unit-II

Gene Expression: Transcription in prokaryotes and Eukaryotes, mRNA processing and other RNA processing events, mechanism of Translation, RNA splicing, genetic code, protein biosynthesis. Targeting of proteins to organelles.

Unit-III

Gene regulation: Principles of gene regulation, gene regulation in prokaryotes (lactose and tryptophan operons), strategies of gene regulation in Eukaryotes (e.g. DNA methylation only), Transposons, mechanism of transposition, IS elements, genetic consequences of transposition.

Unit-IV

Mapping and sequencing the genome: Linkage mapping and restriction mapping. C value and C value paradox. Cot curves, methods of DNA sequencing, microsatellites, Bioinformatics, microarray technology and its applications.

Reference Books

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D, Molecular Biology of the cell, Garland Publishing Inc., New York.
2. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology. W.H. Freeman and Co., New York, USA.
3. Richard, M., Twyman and Wisden, W. 1999. Advanced Molecular Biology, Viva Books Pvt. Ltd.
4. Turner, P.C., Mclennan, A.G., Bates, A.D. and White, M.R.H. 2001 Instant notes on molecular biology.
5. Snustad Peter, D. Michael J. Simmons. Principles of Genetics, John Wiley Sons.
6. Robert H. Tamarin. Principles of Genetics, Tata McGraw Hill Company.
7. Benjamin Lewin. Genes VIII, Prentice Hall.
8. West head, D.R. J.H. Parish & R.M. Twyman. Bioinformatics. Viva Books.

SEMESTER-III
PAPER – III: PLANT REPRODUCTION

Unit-I

Historical account of plant Reproduction; Microsporangium: Anther Wall, Endothecium Middle layers, Tapetum, Nuclear behaviour in tapetal cells, Sporogenous tissue; Male Gametophyte: Formation of vegetative and generative cells, Formation of Sperms, Pollen wall, Abnormal features. Megasporangium: Types of ovule, Integuments, Nucellus, Megasporogenesis, Special features; Female Gametophyte: Types of female gametophytes, ultra structure of mature Embryo sac, Haustorial behaviour of embryo sac, Nutrition of Embryo sac.

Unit-II

Pollination: Anther dehiscence, pollen transfer, self-pollination, cross-pollination, artificial pollination; Fertilization: Pollen germination and pollen-tube growth. Path of pollen-tube, pollen-tube discharge, Double fertilization, Syngamy; Endosperm: Types of endosperm, ruminant endosperm, cytology of endosperm. functions of endosperm.

Unit-III

Embryo: Embryogeny in dicotyledons, Embryogeny in monocotyledons. suspensor, under developed and reduced embryos, Nutrition of embryo. Polyembryony: Causes of polyembryony, experimental induction of polyembryony, classification of polyembryony practical value of polyembryony. Apomixis: Vegetative reproduction, apospory, causes of apomixis, significance of apomixis.

Unit-IV

Embryology in relation to Taxonomy: importance of Embryological characters in taxonomic considerations, families with special embryological features; Role of Palynology in taxonomy; Experimental Embryology: Embryo rescue and its culture, Parthenocarpy, parasexual hybridization.

Reference Books

1. Maheswari, P. A. Introduction to Embryology of Angiosperms, 1950
2. Shivanna, K.R. and John, B.M. The Angiosperm Pollen structure and Function, Wiley Eastern Ltd., Publications, 1989.
3. Johri, B.M., Ambegaokar, K.B. and Srivastava, P.S. Comparative Embryology of Angiosperms, Vol. I & II, Springer Verlag.
4. Bhojwani, S.S. and Bhatnagar, S.P. Embryology of Angiosperms (4th Revised and enlarged edition), 2000.

SEMESTER – III
PAPER – IV: PLANT METABOLISM

Unit-I

Energy and Enzymes: Energy flow through living systems, principles of the thermodynamics, free energy and chemical potential, free energy of Oxidation – reduction reactions, redox potential, types of Phosphorylations, structure and functions of ATP.

Enzymes: General aspects, nomenclature and classification of enzymes, mode of enzyme action, Michaelis – Menton equation and its significance, regulation of enzymes, enzymes inhibition and isoenzymes.

Unit-II

Photochemistry and Photosynthesis: General concepts of photosynthesis, photosynthetic pigments, structure of photosynthetic apparatus, photosynthetic electron transport (Non-cyclic, cyclic), proton transport and ATP synthesis.

Carbon assimilation: The carbon cycle, photorespiration and its significance, C₄ and CAM pathways and their physiological and ecological significance. Biosynthesis of starch and sucrose, translocation by phloem, phloem loading and unloading.

Unit-III

Respiration: Over view of plant respiration, glycolysis, pentose phosphate pathway, TCA cycle, electron transport, chemiosmotic hypothesis of ATP synthesis, alternative oxidase system, Alcohol and Lactic acid fermentations.

Unit-IV

Nitrogen metabolism: Sources of nitrogen to plants, biological nitrogen fixation, nodule formation and nod-factors, mechanism of nitrate uptake and reduction, ammonium assimilation (reductive amination, transamination and GS-GOGAT). **Sulfate metabolism:** Uptake, transport and assimilation. **Lipid metabolism:** Structure and function of lipids, classification of lipids, fatty acids and their biosynthesis. Synthesis of phospholipids and storage lipids; catabolism of lipids; glyoxylate cycle.

REFERENCE BOOKS

1. Dennis et al., 1997. **Plant Metabolism**(2nd ed.), Longman, Essex, England.
2. Hopkins, W.G. 1995. **Introduction to Plant Physiology**, John Wiley & Sons, Inc., New York, USA.
3. Nobel, P.S. 1999. **Physiochemical and Environmental Plant Physiology**, Academic Press, San Diego, USA.
4. Taiz and Zeiger, 1998. **Plant Physiology**(2nd ed.)
5. Voet and Voet, 1992. **Biochemistry**, John Wiley & Sons, Inc., New York, USA.
6. Raghavendra, S. 1988 Photosynthesis, A comprehensive Treatise, Cambridge University press, Cambridge, UK.

SEMESTER - IV
PAPER - I: PLANT CELL, TISSUE AND ORGAN CULTURE

Unit-I

General Introduction: History and scope; contributions of G.Haberlandt, F. Laibach, P.R. White, E.C. Cocking, I. K. Vasil, S. Guha and S.C. Maheswari.

Tissue culture media: Composition and preparation; Laboratory requirements and sterilization techniques.

Anther culture and androgenic haploids: Factors affecting the androgenesis; ontogeny of androgenic haploids; Isolated microspore and pollen culture; Diploidization of haploids; Bulbosum method; applications of androgenic haploids.

Unit-II

Meristem culture and production of Pathogen-free Plants: Methods for virus elimination; Virus Indexing; media composition and regeneration of Plantlets; Application and limitations.

Cell cultures: Isolation of single cells by enzymatic and non-enzymatic methods; Batch cultures and continuous cultures; synchronization of cell culture; viability of cell cultures; cultures of isolated single cells, plating efficiency; Production of secondary metabolites and other applications.

Embryo culture: Embryo-nurse endosperm transplant technique; Microscopic experiments with embryo; Kunslich Frugeburt; Applications.

Unit-III

Callus culture, Somatic embryogenesis and production of synthetic seeds. Endosperm **Culture:** Histology and Cytology of endosperm callus; Production of seedless fruits; applications.

Somatic hybridization: Protoplast isolation and purification; protoplast culture and fusion; selection of fused protoplast; regeneration of somatic hybrids; Cytoplasmic hybridization; practical applications.

Unit-IV

Clonal Propagation: Multiplication by axillary buds, apical shoots, adventitious shoots and callus cultures; culture media; acclimatization of plants transferred to soil conditions; practical applications.

Somaclonal and gametoclonal variation: Source material and culture conditions; isolation of variants; nature of gametoclonal variation; applications in Plant Breeding. Cryopreservation, germplasm storage and gene banks.

Reference Books

1. Bhojwani, S.S. and Razdan, M.K. 1996. Plant Tissue Culture: Theory and Practice (a revised edition). Elsevier Science Publishers, New York, USA.
2. Bhojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations, Elsevier Science Publisher, New York, USA.
3. Khasim, S.M. 2002. Botanical Microtechnique: Principles and Practice, Capital Publishing Company, New Delhi.
4. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture, Kluwer Academic Press, The Netherlands.
5. Razdan, M.K. 1994. An Introduction to Plant Tissue Culture: Oxford & IBH Publishing Company Private Limited, New Delhi.
6. Chawla, H.S. 2003. Introduction to Plant Biotechnology. Oxford & IBH, New Delhi.
7. Pierik, R.L.M. 1989. In Vitro Culture of Higher Plants. Martinus Nijhoff Publishers, Dordrecht, The Netherlands.

SEMESTER – IV
PAPER - II: GENETIC ENGINEERING OF PLANTS AND MICROBES

Unit-I

Recombinant DNA technology: Methods involved in generating r-DNA molecules, gene cloning-techniques, identification of clones by screening procedures, construction of genomic/c DNA libraries, PCR and its applications, Blotting techniques.

Unit-II

Genetic Engineering of plants: Plant transformation with Ti-plasmid of *Agrobacterium tumefaciens*, physical methods of transferring genes to plants, reporter genes, use of different promoters, transgenic plants. Genetically modified (GM) crops.

Unit-III

Nitrogen fixation: Mechanism and genetics of nitrogen fixation, nitrogen fixing bacteria, genetics of free living and symbiotic Diazotrophs, regulation of nif and nod gene expression, and Biofertilizers.

Unit-IV

Microbial Biotechnology: Microbes in the production of alcohol, beer, wine and vinegar. Commercial production of antibiotics, therapeutic vaccines, biopesticides. Microbes and bioremediation.

Reference Books

1. Lewin, B. 2000. **Gene VII**, Oxford University Press, New York, USA.
2. Sunstad, D.P. and Simmons, M.J. 2000. **Principles of Genetics**.
3. Purohit, S.S. 2000. **Biotechnology; Fundamentals and Applications**, Agrobios, New Delhi.
4. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Waston, J.D. 1989. **Molecular Biology of the Cell**, Garland Publishing Inc., New York.
5. Satyesh Chandra Roy and Kalyan Kumar, D.C. 1997. **Cell Biology**, New Central BookAgency, Calcutta.
6. Gupta, R.K. **Molecular Biology & Generic Engineering**, Rastogi Publication.
7. Adrian Slater, Nigel Scott, and Mark Fowler (2006). **Plant Biotechnology**

SEMESTER – IV
PAPER - III: CYTOGENETICS OF CROP PLANTS AND PLANTS BREEDING

Unit-I

Concept and scope of Plant Breeding: Principles and methods of plant breeding in self, cross and asexually propagated plants. Hardy-Weinberg law, Effect of selection in plant breeding.

Unit-II

Breeding objectives for crop improvement: Plant breeding for resistance to diseases and pests, genetics of male sterility and its applications, causes of Apomixis and breeding of apomictic crop, genetics of heterosis and its applications. Polyploidy breeding, mutation breeding and achievements.

Unit-III

Applications of Molecular markers in crop improvement: Construction of genetic maps in plants. Molecular markers – Restriction Fragment length polymorphisms (RFLPs), Random amplified polymorphic DNAs(RAPDs). Molecular maps and their utility in plant genomics.

Unit-IV

Applications of Plant Biotechnology in crop improvement: Transgenic crops- Genetic Engineering of crops for useful agronomic traits, viz., male sterility, food quality, improved crop productivity and molecular farming. Intellectual property rights, plant organizations and their role in crop improvement programmes.

Reference Books

1. Russel, P.J. 1998. **Genetics**. The Benjamin/Cummings Publishing Co., Inc., USA.
2. Khush, G.S. 1973. **Cytogenetics of Aneuploids**, Academic Press, London.
3. Gupta, P.K. 2005. **Molecular Biology and Genetics Engineering**
4. Snustad, D.P. and Simmons, M.J. 2000. **Principles of Genetics**.
5. Chahal, G.S. and Gosal, S.S. **Principles and Procedures of Plant Breeding – Biotechnological and Conventional Approaches**, Narosa Publishing House, New Delhi.
6. Darbeshwar Roy, 2000. **Plant Breeding: Analysis and Exploitation of variation**, Narosa Publishing House, New Delhi.
7. Singh, P. 2001. **Essentials of Plant Breeding**, Kalyani Publishers, Hyderabad.
8. Primrose, S.B. 1994. **Molecular Biotechnology** (2nd ed) Blackwell Sci. Publ. Oxford.
9. Balasubramanian, D. 2005. **Concepts of Biotechnology**
10. Old, A. and Primrose, S.B. 2002. **Principles gene manipulation**. Blackwell Publ. Oxford.

SEMESTER – IV
PAPER - IV: PLANT PATHOLOGY

Unit-I

1. Concept of disease in plants; Definitions of plant disease; Historical development of Plant Pathology.
2. Methods of studying Plant disease; collection, preservation, isolation of pathogens and proving Koch postulates.
3. Symptoms caused by plant pathogenic fungi, bacteria and viruses.
4. Classification of plant diseases.

Unit-II

5. Entry of pathogens into the host
6. Role of enzymes, toxins and phytoalexins in plant pathogenesis
7. Physiological changes in diseased plants
8. Plant disease forecasting
9. Genetics of disease resistance

Unit-III

Details study of symptoms, etiology, epidemiology and control of the following fungal diseases of plants; late blight of potato, Taphrina leaf spot of turmeric, powdery mildew of cucurbits, black stem rust of wheat, blast of rice, tikka disease of groundnut, red rot of sugarcane.

Unit-IV

Detailed study of the following bacterial and viral diseases: bacterial leaf blight of rice, angular leaf spot and black arm of cotton, citrus canker, tobacco mosaic disease. Principles of plant disease control: Plant quarantine, seed treatment, cultural practices chemical control, development of disease resistant varieties. Biological control of plant diseases. Integrated Pest Management.- concept, system, benefits and limitations.

Reference Books

1. Agrios, G.N. 1997. **Plant Pathology**, Academic Press, London.
2. Tar, S.A.J. 1972. **Principles of Plant Pathology**.
3. Singh, R.S. 1991. **Plant diseases**, 6th Edn., Oxford & IBH Co., New Delhi.
4. Singh, R.S. 1988. **Principles of Plant Pathology**, 3rd Edn., Oxford & IBH Co., New Delhi.
5. Mehrotra, R.S. 1980. **Plant Pathology**, Tata-McGraw Hill Publishing Company, New Delhi.
6. Rangaswami, G. and Mahadevan, A. 1999. **Diseases of Crop Plants in India**, 4th Edition, Printice Hall of India Publications.