

# **SYLLABUS**

## **BOTANY**

**MPET Examination 2015**

**JAI NARAIN VYAS UNIVERSITY**

**JODHPUR**

## Paper – I

### B-401: Cell and Molecular Biology of Plants

**Unit 1:** Concept of cell and cell theory. The dynamic cell: Origin of cell and multicellularity; Structural organization of plant cell. Specialized plant cell types. Chemical foundation: Covalent and non-covalent bonds. Structure of proteins, lipids and carbohydrates. Biochemical energetics: Various forms of energy and their interrelationships in living systems. Cell Wall: biochemistry and molecular biology of cell wall biogenesis. Nature of cell wall. Growth and its function. Macromolecules, architecture-type I and type II.

**Unit 2:** Plant vacuole: Tonoplast membrane transporters and storage organelle. Ribosomes: structure, site of protein synthesis; mechanism of translation, initiation, elongation and termination; structure and role of tRNA. Structure and function of Endoplasmic Reticulum (ER), ER-associated SNARE proteins.

Plasmodesmata: Composition and structure; signaling and movement of molecules and macromolecules; other functions; comparison with gap junctions.

**Unit 3:** Endosymbiosis theory and ancestry of plastids. Division and development of plastids. Nature, organization and functioning of plastome.

Mitochondria – Structure, division, biogenesis and development to mitochondria. Genome organization. Hydrogenosome.

Regulation of expression of gene(s) in plastid and mitochondria, RNA editing. Interactions among organelles and nucleus. Cytoplasmic inheritance.

**Unit 4:** Nucleus: Ultra structure, nuclear pores, mechanism of export and import of macromolecules, molecular structure of DNA, DNA replication and DNA polymerases. Transcription factors, promoters and splicing. DNA damage and repair. Nucleolus, rRNA biosynthesis. Cell cycle, Control mechanisms, role of cyclins and cyclin dependent kinases, cytokinesis and cell plate formation; retinoblastoma and E2F proteins. Apoptosis, mechanism of programmed cell death in plants and its importance.

**Unit 5:** Plasma membrane: structure, models and functions; sites for ATPases, ion carriers, channels, pumps and receptors. Cell shape and motility: The cytoskeleton; organization and role of microtubules and microfilaments; motor movements; implications in flagellar and other movements. Protein sorting: Targeting of proteins to organelles. Techniques in cell biology: Immuno techniques; chromosome microdissection and microcloning. Flow Cytometry. Principles of microscopy and optics (light, fluorescence, electron, confocal and atomic force microscopy).

#### SUGGESTED READINGS

Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. 1999. *Molecular Biology of the Cell*. Garland Publishing, Inc., New York.

Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists, Maryland, USA

De, D. N. 2000. *Plant Cell Vacuoles: An Introduction*. CSIRO Publication, Collingwood, Australia.

Glick, B. R. and Thompson, J. E. 1993. *Methods in Plant Molecular Biology and Biotechnology*. CRC Press, Boca Raton, Florida.

Glover, D. M. and Hames, B. D. (eds) 1995. *DNA Cloning I: A Practical Approach-, Core Techniques*, 2<sup>nd</sup> edition, PAS, IRL Press at Oxford University Press, Oxford.

## Paper – II

### B-402: CYTOLOGY, GENETICS, CYTOGENETICS AND PLANT BREEDING

**Unit 1:** Genome organization: Chromosome structure and packaging of DNA, molecular organization of centromere and telomere; euchromatin and heterochromatin; Chromosomal banding patterns, karyotype analysis and evolution; specialized types of chromosomes; polytene, lampbrush, B-and sex chromosome. Molecular basis of chromosome pairing.

Structural and numerical alterations in chromosomes: origin, meiosis and breeding behaviour of duplications, deficiency, inversion and translocation heterozygotes. Origin and occurrence of haploids, meiosis in haploids. Polyploids (aneuploids, euploids, autopolyploids and allopolyploids). Trisomics and monosomics.

**Unit 2:** Genetics of prokaryotes and eukaryotes: Genetic recombination of phage genome; genetic transformation, conjugation and transduction in bacteria. Fine structure of prokaryotic and eukaryotic genes. Regulation of gene expression in prokaryote: initiation of transcription, RNA polymerases, *lac* operon, tryptophan operon, attenuation and RNA regulators.

Regulation of gene expression in eukaryotes: transcription; RNA polymerases, regulator binding sites, transcription activator factors, post transcription, translation and post translation modifications/regulations. Introns and their significance, RNA splicing.

**Unit 3:** Genetic recombination and genetic mapping: Independent assortment, crossing over, linkage groups and chromosome mapping. Correlation of genetic and physical maps; somatic cell genetics- an alternative approach to gene mapping. Molecular mechanism of recombination: ss DNA and ds DNA breakage models, role of RecA and RecBCD enzymes; site-specific recombination. Mutations: spontaneous and induced mutations, molecular mechanisms of physical and chemical mutagens; repair mechanisms, reverse genetics. Transposable elements in prokaryotes and eukaryotes; mutation induced by transposons, site directed mutagenesis.

**Unit 4:** Genetics, evolution and breeding of major crop plants– Wheat, Rice, Cotton, Sugarcane, Potato, Brassica and Groundnut; Transfer of whole genome (examples from wheat, Arachis and Brassica); transfer of individual chromosomes and chromosome segments methods for detecting alien chromatin, characterization and utility of alien addition and substitution lines, Genetic basis of inbreeding and heterosis, exploitation of hybrid vigor, Male sterility and its application on crop improvement.

**Unit 5:** Molecular cytogenetics: concept and technique of restriction mapping and *in situ* hybridization. Construction of genetic or molecular maps. Genetic analysis: complementation, dominance, codominance, variable expressivity and incomplete penetrance. Chromatin remodeling, epigenetic and genome imprinting. Population genetics: allele and genotype frequencies, enzyme and DNA polymorphism, DNA typing and population substructure.

## SUGGESTED READINGS

- Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. 1989. *Molecular Biology of the Cell* (2<sup>nd</sup> edition). Garland Publishing Inc., New York.
- Atherly, A. G., Girton, J. R. and McDonald, J. F. 1999. *The Science of Genetics*. Saunders College Publishing, Fort Worth, USA.
- Burnham, C. R. 1962. *Discussions in Cytogenetics*. Burgess Publishing Co., Minnesota.
- Busch, H. and Rothblum, L. 1982. Volume X. *The Cell Nucleus rDNA Part A*. Academic Press.
- Hartl, D. L. and Jones, E. W. 1988. *Genetics: Principles and Analysis* (4<sup>th</sup> edition). Jones & Bartlett Publishers, Massachusetts, USA.
- Hoshmand A. Reza, 1988. *Statistical methods for environmental & Agricultural Sciences*, CRC Press, Florida.
- Karp, G. 1999. *Cells and Molecular Biology: Concepts and Experiments*. John Wiley & Sons, Inc., U.S.A.
- Khush, G. S. 1973. *Cytogenetics of Aneuploids*. Academic Press, New York, London.
- Lewin, B. 2000. *Gene VIII*. Oxford University Press, New York, USA.
- Lewis, R. 1997. *Human Genetics: Concepts and Applications* (2<sup>nd</sup> edition). WCB McGraw Hill, USA.
- Malacinski, G. M. and Freifelder, D. 1998. *Essentials of Molecular Biology* (3<sup>rd</sup> edition). Jones and Bartlett Publishers, Inc., London.
- Panase, V. G. and Sukhatme, P. V. 1989. *Statistical methods for agricultural workers*, ICAR, New Delhi.
- Russel, P. J. 1998. *Genetics* (5<sup>th</sup> edition). The Benjamin/Cummings Publishing Company Inc., USA.
- Snustad, D. P. and Simmnns, M. J. 2000. *Principles of Genetics* (2<sup>nd</sup> edition). John Wiley & Sons Inc., USA.

## SUGGESTED READINGS (FOR LABORATORY EXERCISES)

- Fukui, K. and Nakayama, S, 1996. *Plant Chromosomes: Laboratory Methods*. CRC Press, Boca Raton, Florida.
- Sharma, A. K. and Sharma, A. 1999. *Plant Chromosomes: Analysis, Manipulation and Engineering*. Harwood Academic Publishers, Australia.

## PAPER – III

### B-403: BIOLOGY AND DIVERSITY OF LOWER PLANTS

**Unit 1:** Microbiology: General account of Archaeobacteria, Eubacteria, Actinomycetes, Cyanobacteria, Mycoplasma, Phytoplasma and yeast. Ultrastructure of Bacteria. Biofilms and quorum sensing.

Viruses: morphology, architecture, chemistry, isolation and purification, transmission and genetics of viruses. General account of AIDS and Prions.

**Unit 2:** Phycology: Algae in diversified habitats; thallus organization; cell ultrastructure; reproduction; criteria for classification of algae. Classification and salient features of Protochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta. Algal blooms, algal biofertilizers; algae as food, feed and uses in industry.

**Unit 3:** Mycology: General characters and classification of fungi. Phylogeny of fungi. General account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina. Fungi in industry; Mycorrhizae; General concepts of plant pathology.

**Unit 4:** Bryophyta: Morphology, structure, reproduction and life history; distributions; classifications; general account of Marchantiales, Junger-maniales, Anthocerotales, Sphagnales, Funariales and Polytrichales; economic and ecological importance.

**Unit 5:** Pteridophyta: Classification; evolution of stele; heterospory and origin of seed habit; general account of fossil pteridophyta; morphology, anatomy and reproduction: introduction to Psilopsida, Lycopsidea, Sphenopsida and Pteropsida.

#### SUGGESTED READINGS

Alexopoulos, C. J., Mims, C. W. and Blackwell, M. 1996. *Introductory Mycology*. John Wiley & Sons Inc.

Clifton, A. 1958. *Introduction to the Bacteria*. McGraw-Hill Book Co., New York.

Kumar, H. D. 1988. *Introductory Phycology*. Affiliated East-West Press Ltd., New Delhi.

Mandahar, C. L. 1978. *Introduction to Plant Viruses*. Chand & Co. Ltd., Delhi.

Mehrotra, R. S. and Aneja, R. S. 1998. *An Introduction to Mycology*. New Age Intermediate Press.

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

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

Parihar, N. S. 1996. *Biology & Morphology of Pteridophytes*. Central Book Depot, Allahabad.

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

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

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

Sporne, K. K. 1991. *The Morphology of Pteridophytes*. B.I. Publishing Pvt. Ltd., Bombay.

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

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

#### Paper – IV

## B-404: TAXONOMY AND DIVERSITY OF SEED PLANTS

**UNIT 1: GYMNOSPERMS:** General characters and classification of Gymnosperms. Structure and reproduction in Cycadales, Ginkgoales, Coniferales, Ephedrales, Welwitschiales and Gnetales. Diversity and evolution of male and female gametophytes of Gymnosperms. Diversity and distribution of Gymnosperms of India.

Geological Time Scale. Evolution of Gymnosperms- a general account. General characters, classification and evolutionary significance of Pteridospermales (Lyginopteridaceae, Medullosaceae, Caytoniaceae and Glossopteridaceae), Cycadeoidales and Cordaitales.

**UNIT 2: ANGIOSPERMS:** Plant Taxonomy-principles and significance. Nomenclature: International Code of Botanical Nomenclature (2012)-Taxonomic hierarchy-concept of species, genus, family and other categories; typification, rule of priority, effective and valid publication. Angiosperm classifications: Phenetic versus phylogenetic systems; cladistics in taxonomy. Classification, relative merits and demerits of major systems of classifications-Bentham and Hooker, Cronquist, Takhtajan, Angiosperm Phylogeny Group (III).

### UNIT 3: TAXONOMIC TOOLS

Plant explorations. Herbarium methodology-collection and preservation of plant specimens. World and Indian herbaria. Plant identification-taxonomic keys; floras and taxonomic journals.

Taxonomic evidence: Morphology, Anatomy, Palynology, Embryology, Cytology, Phytochemistry, Nucleic acid hybridization as a tool in taxonomy; DNA Barcoding. Computer databases and Geographical Information systems.

### UNIT 4: BIOSYSTEMATICS AND PHYTOGEOGRAPHY

Biosystematic categories-Ecotype: nature, origin and their significance, different types of ecotypes, ecospecies, coenospecies, comparium; phenotype, genotype, biotype; deme concept. Intra specific and Inter specific variations. Genecotypes and phenecotypes. Plasticity of phenotypes; factors affecting phenotype variations and their significance, role of biosystematics in evolution.

Principles of phytogeography: Static and dynamic concepts. Continental drift theory and Endemism. Biodiversity hotspots. Invasions and introductions; Local plant diversity and its socio-economic importance.

### UNIT 5: STUDY OF SELECTED ANGIOSPERM ORDERS

Salient features, floral diversity, diversity of families and phylogeny of the following orders: Ranales, Centrospermae, Amentiferae, Tubiflorae, Helobieae and Glumiflorae.

### SUGGESTED READINGS

Angiosperm Phylogeny Group website. 2012. consult [www.apgweb](http://www.apgweb).

Bhatnagar, S. P. and Moitra, A. 1996. *Gymnosperms*. New Age International Pvt. Ltd., New Delhi.

Cole, A. J. 1969. *Numerical Taxonomy*, Academic Press, London.

Davis, P. H. and Heywood, V. A. 1973. *Principles of Angiosperms Taxonomy*. Robert E. Kreiger Pub. Co., New York.

Grant, V. 1971. *Plant Speciation*. Columbia University Press, New York.

Grant, W. F. 1984. *Plant Biosystematics*. Academic Press, London.

- Harrison, H. J. 1971. *New Concepts in Flowering Plant Taxonomy*. Hieman Educational Books Ltd., London.
- Heslop-Harrison, J. 1967. *Plant Taxonomy*. English Language Book Soc. & Edward Arnold Pub. Ltd., UK.
- Heywood, V. H., Brummitt, R. K., Culham, A. and Seberg, O. 2007. *Flowering Plant Families of the World*. Firefly books Ltd. New York.
- Heywood, V. H. and Moore, D. M. 1984. *Current Concepts in Plant Taxonomy*. Academic Press, London.
- Jones, A. D. and Wilbins, A. D. 1971. *Variations and Adaptations in Plant Species*. Hieman & Co-Educational Books Ltd., London.
- Jones, S. B. and Luchsinger, A. E. 1986. *Plant Systematics* (1<sup>st</sup> edition). McGraw-Hill Book Co., New York.
- Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F. and Donoghue, M. J. 2007. *Plant Systematics: A Phylogenetic Approach*, 3<sup>rd</sup> ed. Sinauer.
- Lawrence, G. H. M. 1951. *Taxonomy of Vascular Plants*. McMillan, New York.
- Naik, V. N. 1992. *Taxonomy of Angiosperms*. 2<sup>nd</sup> Edn. Tata Mc.Graw Hill.
- Nordenstam, B., El Gazaly, G. and Kassas, M. 2000. *Plant Systematics for 21<sup>st</sup> Century*. Portlant Press Ltd., London.
- Pullaiah, T. 2005. *Taxonomy of Angiosperms*. Regency Publications, New Delhi.
- Radford, A. E. 1986. *Fundamentals of Plant Systematics*. Harper & Row Publications, USA.
- Radford, A. E. *et.al.*, 1974. *Vascular Plant Systematics*. Harper & Row, New York.
- Ravi Prasad Rao, B. 2009. *Plant Name Directory*. ABCD, Planographers, Hyderabad.
- Simpson, M. G. 2006. *Plant Systematics*. Elseiver & Academic Press.
- Singh, G. 2005. *Plant Systematics*. Oxford & IBH, New Delhi.
- Singh, H. 1978. *Embryology of Gymnosperms*. Gebruder Bortraeger, Berlin.
- Sivarajan, V. V. 1991. *Introduction to Principles of Plant Taxonomy*. Oxford & IBH.
- Solbrig, O. T. 1970. *Principles and Methods of Plant Biosystematics*. The MacMillan Co. Collier-Mac Millan Ltd., London.
- Solbrig, O. T. and Solbrig, D. J. 1979. *Population Biology and Evolution*. Addison-Wesley Publishing Co. Inc., USA.
- Stace, C. A. 1989. *Plant Taxonomy and Biosystematics*. Edward Arnold Ltd., London.
- Stebbin, G. L. 1974. *Flowering Plant- Evolution Above Species Level*. Edward Arnold Ltd., London,
- Takhtajan, A. L. 1997. *Diversity and Classification of Flowering Plants*. Columbia University Press, New York.
- Woodland, D. W. 1991. *Contemporary Plant Systematics*. Prentice Hall, New Jersey.

## Paper – V

### B-405: PLANT PHYSIOLOGY AND METABOLISM

**UNIT 1:** Fundamentals of enzymology: General aspects, allosteric mechanism, regulatory and active sites, isozymes. Membrane transport and translocation of water and solutes: Plant-water relations, mechanism of water transport through xylem, root-microbe interactions in facilitating nutrient uptake, comparison of xylem and phloem transport, phloem loading and unloading, passive and active solute transport, membrane transport proteins.

**UNIT 2:** Photochemistry and photosynthesis: General concepts and historical background, evolution of photosynthetic apparatus, photosynthetic pigments and light harvesting complexes, photooxidation of water, mechanisms of electron and proton transport, carbon assimilation- the Calvin cycle, photorespiration and its significance, the C<sub>4</sub> cycle, the CAM pathway. Regulation of C<sub>3</sub> cycle. Biosynthesis of starch and sucrose, physiological and ecological considerations.

Respiration and lipid metabolism: Overview of plant respiration, glycolysis, the TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, glyoxylate cycle, alternative oxidase system, fatty acids and their metabolism.

**UNIT 3:** Signal transduction: Overview, receptors, signaling molecules, G-proteins, phospholipids signaling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity in protein kinases and phosphatases, specific signaling mechanisms, e.g. two-component sensor-regulator system in bacteria and plants. Sensory photobiology: History of discovery of phytochromes, cryptochromes and phototropins, their photochemical and biochemical properties. Photophysiology of light-induced responses, cellular localization. Brief account of molecular mechanism of action of photomorphogenic receptors.

**UNIT 4:** Plant growth regulators: Physiological effects and general mechanism of action of plant hormones. Specific mode of actions of auxins (cell enlargement), gibberellins (*de novo* alpha amylase secretion), cytokinins (delaying senescence, cell division), ethylene (fruit ripening, vase life) and abscisic acid (environmental stress). Brief account on brassinosteroids, polyamines, Jasmonic acid, salicylic acid and nitric oxide (NO). Hormone mutants. The flowering process: Photoperiodism and its significance, endogenous clock and its regulation. Vernalization.

**UNIT 5:** Nitrogen fixation, nitrogen and sulphur metabolism: Overview, biological nitrogen fixation, nodule formation and Nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation, sulfate uptake, transport and assimilation. Stress physiology- Plant responses to biotic and abiotic stress, general mechanisms of abiotic stress tolerance, HR and SAR, water deficit and drought resistance, salinity stress, metal toxicity, freezing and heat stress, oxidative stress and antioxidants system in plants.

#### SUGGESTED READINGS

Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists. Maryland, USA.

Dennis, D. T., Turpin, D. H., Lefebvre, D. D. and Layzell, D. B. (eds) 1997. *Plant Metabolism* (2<sup>nd</sup> edition). Longman, Essex, England.

Galston, A. W. 1989. *Life Processes in Plants*. Scientific American Library, Springer-Verlag, New York, USA.



- Hooykaas, P. J. J., Hall, M. A. and Libbenga, K. R. (eds) 1999. *Biochemistry and Molecular Biology of Plant Hormones*. Elsevier, Amsterdam, The Netherlands.
- Hopkins, W. G. 1995. *Introduction to Plant Physiology*. John Wiley & Sons, Inc., New York, USA.
- Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. *Molecular Cell Biology* (4<sup>th</sup> edition). W.H. Freeman and Company, New York, USA.
- Moore, T. C. 1989. *Biochemistry and Physiology of Plant Hormones* (2<sup>nd</sup> edition). Springer-Verlag, New York, USA.
- Nobel, P. S. 1999. *Physiochemical and Environmental Plant Physiology* (2<sup>nd</sup> edition). Academic Press, San Diego, USA.
- Salisbury, F. B. and Ross, C. W. 1992. *Plant Physiology* (4<sup>th</sup> edition). Wadsworth Publishing Co., California, USA.
- Singhal, G. S., Renger, G., Sopory, S. K., Irrgang, K. D. and Govindjee. 1999. *Concepts in Photobiology: Photosynthesis and Photomorphogenesis*. Narosa Publishing House. New Delhi.
- Taiz, L. and Zeiger, E. 1998. *Plant Physiology* (2<sup>nd</sup> edition). Sinauer Associates, Inc., Publishers, Massachusetts, USA.
- Thomas, B. and Vince-Prue, D. 1997. *Photoperiodism in Plants* (2<sup>nd</sup> edition). Academic Press, San Diego, USA.
- Westhoff, P. 1998. *Molecular Plant Development: from Gene to Plant*. Oxford University Press, Oxford, UK.

## **B-501: PLANT DEVELOPMENT AND REPRODUCTION**

**Unit 1:** Introduction: Unique features of plant development, differences between animal and plant development. Seed germination and seedling development. Concept of stem cells in plants. Hormonal and environmental signaling and plant development. Shoot apical meristem (SAM) and development of shoot. Cell to cell communication. Cell fates and lineages. Regulation of tissue differentiation with special reference to xylem and phloem, secretory ducts and laticifers. Bud dormancy. Wood development in relation to environmental factors. Nodal anatomy of angiosperms.

**Unit 2:** Differentiation and development of Leaf. Phyllotaxy. Differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll. Metabolic changes associated with senescence and its regulation; influence of hormones and environmental factors on senescence. Root apical meristem (RAM) and development of root(s), lateral roots and root hairs. Hormonal control of root development.

**Unit 3:** Reproduction: Vegetative options and sexual reproduction; flower development; genetics of floral organ differentiation; homeotic mutants in *Arabidopsis* and *Antirrhinum*; sex determination in plants. Male gametophyte: Structure of anthers; microsporogenesis, role of tapetum; pollen development and gene expression; sperm dimorphism and hybrid seed production; pollen germination, pollen tube growth and guidance; pollen storage; pollen allergy; pollen embryos.

**Unit 4:** Female gametophyte: Ovule development; megasporogenesis; organization of the embryo sac, structure of the embryo sac cells. Pollination, pollen-pistil interaction and fertilization: Floral characteristics, pollination mechanisms and vectors; breeding systems; commercial considerations; structure of the pistil; pollen-stigma interactions, sporophytic and gametophytic self-incompatibility in plants. Double fertilization and *in vitro* fertilization in plants.

**Unit 5:** Endosperm development during early, maturation and desiccation stages; embryogenesis, ultrastructure and nuclear cytology; cell lineages during late embryo development; storage proteins of endosperm and embryo; polyembryony; apomixis; embryo culture. Seed development and fruit growth: dynamics of fruit growth; biochemistry and molecular biology of fruit maturation. Seed dormancy: Importance and types. Basics of seed technology.

## SUGGESTED READINGS

- Atwell, B. J., Kriedermann, P. E. and Jumbull, C. G. N. (eds) 1999. *Plants in Action: Adaptation in Nature, Performance in Cultivation*, MacMillan Education, Sydney, Australia.
- Bewley, J. D. and Black, M. 1994. *Seeds: Physiology of Development and Germination*, Plenum Press, New York.
- Bhojwani, S. S. and Bhatnagar, S. P. 2000. *The Embryology of Angiosperms* (4<sup>th</sup> revised and enlarged edition), Vikas Publishing House, New Delhi.
- Burgess, J. 1985. *An Introduction to Plant Cell Development*. Cambridge University Press, Cambridge.
- Fageri, K. and Van der Pil, L. 1979. *The Principles of Pollination Ecology*, Pergamon Press, Oxford.
- Fahn, A. 1982. *Plant Anatomy* (3<sup>rd</sup> edition), Pergamon Press, Oxford.
- Fosket, D. E. 1994. *Plant Growth and Development. A Molecular Approach*. Academic Press, San Diego.
- Howell, S. H. 1998. *Molecular Genetics of Plant Development*. Cambridge University Press, Cambridge.
- Leins, P., Tucker, S. C. and Endress, P. K. 1988. *Aspects of Floral Development*. J. Cramer, Germany.
- Lyndon, R. F. 1990. *Plant Development. The Cellular Basis*, Unwin Hyman, London.
- Murphy, T. M. and Thompson, W. F. 1988. *Molecular Plant Development*. Prentice Hall, New Jersey.
- Proctor, M. and Yeo, P. 1973. *The Pollination of Flowers*. William Collins Sons, London.
- Raghavan, V. 1997. *Molecular Embryology of Flowering Plants*. Cambridge University Press, Cambridge.
- Raghavan, V. 1999. *Developmental Biology of Flowering Plants*. Springer-Verlag, New York.
- Raven, P. H., Evert, R. F. and Eichhorn, S. E. 1992. *Biology of Plants* (5<sup>th</sup> edition), Worth, New York.
- Salisbury, F. B. and Ross, C. W. 1992. *Plant Physiology* (4<sup>th</sup> edition), Wadsworth Publishing, Belmont, California.
- Sedgely, M. and Griffin, A. R. 1989. *Sexual Reproduction of Tree Crops*. Academic Press, London.
- Shivanna, K. R. and Johri, B. M. 1985. *The Angiosperm Pollen: Structure and Function*. Wiley Eastern Ltd., New York.
- Shivanna, K. R. and Rangaswamy, N. S. 1992. *Pollen Biology: A Laboratory Manual*, Springer-Verlag, Berlin.
- Shivanna, K. R. and Sawhney, V. K. (eds) 1997. *Pollen Biotechnology for Crop Production and Improvement*. Cambridge University Press, Cambridge.

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

*The Plant Cell. Special Issue on Reproductive Biology of Plants*, Vol. 5(10), 1993. The American Society of Plant Physiologists, Rockville, Maryland, USA.

Waisel, Y., Eshel, A. and Kafkaki, U. (eds) 1997. *Plant Roots: The Hidden Hall* (2<sup>nd</sup> edition), Marcel Dekker, New York.

## **B-502: PLANT ECOLOGY**

**Unit 1: Climate, Vegetation and Population Biology:** Introduction to Concept, developments in ecology. Atmosphere, Hydrosphere and Biosphere- Life zones, major biomes, vegetation types of the world. Vegetation Organization: Concepts of community, analytical and synthetic characters, community coefficients, interspecific associations, ordination. Concept of habitat, coexistence and niche. Population Biology: Concepts and Growth models.

**Unit 2: Ecosystem:** Ecosystem: Structure and function. Energy dynamics- flow models and efficiencies. Mineral cycles: C, N, P and S mineral cycles, pathways, processes and budgets in terrestrial and aquatic systems. Global biogeochemical cycles of C, N, P and S. Productivity: Primary productivity- measurements, global pattern and controlling factors. Succession (Ecosystem development): Concept, mechanisms and models, changes in ecosystem properties during succession.

**Unit 3: Soils and Mineralization:** Soils: Characters, formation, classification and major soil types of the world. Soil quality assessment and factors affecting soil quality. Mineralization: Litter fall and decomposition- litter quality, climatic factors, soil microorganisms affecting mineralization. Nutrient synchronization and biological management of soil fertility.

**Unit 4: Pollution and Climatic Changes:** Air, water and soil pollution- kinds, sources, quality parameters, effects on plants and ecosystems. Bioremediation. Environment Impact Assessment. Climatic changes: Greenhouse gases; CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, CFCs – sources, trends and role; ozone layer and hole; consequences of climatic change – CO<sub>2</sub> fertilization; global warming, sea level rise and UV radiation. Concepts of Industrial Ecology.

**Unit 5: Biodiversity, Ecosystem stability and Management:** Biodiversity: concept and levels; biodiversity role in ecosystem functions and stability; speciation and extinction; IUCN categories of threat; distribution and global patterns; terrestrial biodiversity hot spots. Biodiversity status in India. Concept of ecosystem resistance and resilience; natural and anthropogenic ecological perturbations and their impact on plants and ecosystems. Ecosystem restoration. Ecology of plant invasion. Ecological management: Concepts of sustainable development; sustainability indicators.

### SUGGESTED READINGS

Barbour, M. G., Burk, J. H. and Pitts, W. D. 1987. *Terrestrial Plant Ecology*. Benjamin/Cummings Publication Company, California.

Begon, M., Harper, J. L. and Townsend, C. R. 1996. *Ecology*. Blackwell Science, Cambridge, U.S.A.

Brady, N. C. 1990. *The Nature and Properties of Soils*. Macmillan.

- Cadish, G. and Giller, K. E. 1997. *Driven by Nature, Plant Litter Quality and Decomposition*, CAB International Wallingford, U.K.
- Chapman, B. and Bilharz, S. 1997. *Sustainability Indicators*. John Wiley & Sons, New York.
- Heywood, V. H. and Watson, R. T. 1995. *Global Biodiversity Assessment*. Cambridge University Press.
- Hill, M. K. 1997. *Understanding Environmental Pollution*. Cambridge University Press.
- Koromondy, E. J. 1996. *Concepts of Ecology*. Prentice-Hall of India Pvt. Ltd., New Delhi.
- Ludwig, J. and Reynolds, J.F. 1988. *Statistical Ecology*. John Wiley & Sons.
- Mason, C. F. 1991. *Biology of Freshwater Pollution*. Longman.
- Muller-Dombois, D. and Ellenberg, H. 1974. *Aims and Methods of Vegetation Ecology*, Wiley, New York.
- Odum, E. P. 1971. *Fundamentals of Ecology*, Saunders, Philadelphia.
- Odum, E. P. 1983. *Basic Ecology*, Saunders, Philadelphia.
- Smith, R. L. 1996. *Ecology and Field Biology*. Harper Collins, New York.
- Treshow, M. 1985. *Air Pollution and Plant Life*. Wiley Interscience.

### **B-503: PLANT RESOURCE UTILIZATION AND CONSERVATION**

**Unit 1:**Origin of agriculture: World centres of primary diversity of domesticated plants: The Indo-Burmese centre; plant introductions and secondary centres.

Green revolution: History of agriculture revolution, Wheat revolution in India, Strategies for further increasing production; Impact of green revolution, green revolution phase II.

Innovations for meeting World food demands. New dimensions of agricultural policy, research and education.

Regimes of WTO and plant genetic resources of India.

**Unit 2:**Important fire-wood and timber yielding plants with special reference to Rajasthan desert. Non-wood forest products (NWFPs). Bamboos: distribution, cultivation and economic uses. Rattans. Raw materials for paper making. Gums, resins, dyes and tannins from natural plant resources.

**Unit 3:** Origin, botany, cultivation and uses of (i) Food, forage and fodder crops, (ii) Fiber crops, (iii) Medicinal and aromatic plants, and (iv) Vegetable and oil-yielding crops. Plants used as avenue tree for shade, pollution control and aesthetics.

**Unit 4:**Basic statistics: Central tendency, dispersion, standard error, coefficient of variation; Probability distributions (normal, binomial of Poission), Confidence limits, Test of statistical significance (t-test; Chi-square). Analysis of variance. RBD and its application in plant breeding and genetics; Correlation and Regression. Computer application in data analysis.

**Unit 5:**Strategies for conservation- *in situ* conservation: International efforts and Indian initiatives, protected areas in India- sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs for conservation of wild biodiversity. Strategies for conservation- *ex*

*situ* conservation: Principles and practices, botanical gardens, field gene banks, seed banks, *in vitro* repositories, cryobanks; General account of the activities of Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR), Council of Scientific & Industrial Research (CSIR), and the Department of Biotechnology (DBT).

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## Paper IV

### **B-504: BIOTECHNOLOGY AND GENETIC ENGINEERING OF PLANTS AND MICROBES**

**Unit 1:** Biotechnology: Basic concepts, principles and scope. Plant Cell and Tissue Culture: General introduction, history, scope, concept of cellular differentiation, totipotency. Fundamental of Plant Morphogenesis, plant regeneration, cultured cell/tissue through somatic embryogenesis and organogenesis. Production of hybrids in plants and somatic hybridization: Protoplast isolation, fusion and culture, hybrid selection and regeneration.

**Unit 2:** Recombinant DNA technology: Extraction, purification and quantification of genomic and plasmid DNA; enzymes for cutting and joining of DNA and their mode of action. Cloning vectors: based on plasmids, bacteriophages, yeast, and plants. c-DNA libraries. Oligonucleotide synthesis. Sequencing of DNA: Chain termination, capillary electrophoresis and pyrosequencing. PCR: History, designing of primers, optimization, and applications. DNA fingerprinting and their applications.

**Unit 3:** Genetic engineering of plants: Aims, strategies for development of transgenics. *Agrobacterium* – the natural genetic engineer, T-DNA and transposon mediated gene tagging. Production of transplastomic plants and their utilization. Cisgenesis. Microbial genetic manipulation: transformation, transfection and selection of recombinant bacteria and bacteriophages. Introduction of DNA in yeast, fungi and plant. Genetic improvement of industrial microbes and nitrogen fixers. Fermentation technology: fundamentals and industrial applications.

**Unit 4:** Genomics and proteomics: Genetic and physical mapping of genes. Molecular markers and their applications in characterization of genes/germplasm and for introgression of useful traits. Artificial chromosomes and their uses. High throughput and ultra-high throughput sequencing. Genome projects. Bioinformatics and its applications. Functional genomics and microarrays. Proteomics-Protein profiling and its significance.

**Unit 5:** Applications of plant tissue culture: Clonal propagation, artificial seed, production of hybrids and somaclones, production of secondary metabolites/natural products, cryopreservation and germplasm storage. Applications of recombinant DNA technology. Intellectual property rights, possible ecological risks and ethical concerns.

### LABORATORY EXERCISES

1. Growth characteristics of *E. coli* using plating and turbidimetric methods.
2. Isolation of plasmid from *E. coli* by alkaline lysis method and its quantification by spectrophotometry.
3. Restriction digestion of the plasmid and estimation of the size of various DNA fragments.

4. Cloning of a DNA fragment in a plasmid vector, transformation of the given bacterial population and selection of recombinants.
5. Demonstration of DNA sequencing by Sanger's dideoxy method.
6. Isolation of protoplasts from various plant tissues and testing their viability.
7. Effect of physical (e.g. temperature) and chemical (e.g. osmoticum) factors on protoplast yield.
8. Demonstration of protoplast fusion employing PEG.
9. Organogenesis and somatic embryogenesis using appropriate explants and preparation of artificial seed.
10. Demonstration of androgenesis in *Datura*.
11. Electroporation of protoplasts and checking of transient expression of the reporter gene.
12. Co-cultivation of the plant material (e.g. leaf discs) with *Agrobacterium* and study GUS activity histochemically.

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