

BOT 406
Cytology and Genetics

Unit I. Chromatin organization:

- i. Chromosome structure and packaging of DNA.
- ii. Nucleosome organization, DNA Structure (A, B and Z forms)
- iii. Organization of centromere and telomere.
- iv. Karyotype analysis and the banding patterns.
- v. Special types of chromosomes- Polytene, Lampbrush, B-chromosome and sex chromosomes.
- vi. Molecular basis of chromosome pairing.

Unit II. Structural and Numerical alterations in chromosomes:

- i. The origin, meiosis and breeding behaviour of duplication, deficiency, inversion, translocation heterozygotes, haploids, aneuploids and autopolyploids.
- ii. The allopolyploids and evolution of major crop plants.

Unit III. Mutation:

- i. Spontaneous and induced mutations.
- ii. Physical and chemical mutagens.
- iii. Molecular basis of gene mutations.
- iv. Transposable elements and mutation induced by transposons.
- v. Site directed mutagenesis.

Unit IV. DNA damage and repair mechanism.

- i. DNA damage and repair mechanism.
- ii. Initiation of cancer at cellular level. Proto-oncogenes and oncogenes.

Unit V. Cytogenetics of aneuploids and structural heterozygotes:

- i. Effect of aneuploids on plant phenotypes.
- ii. The use of monosomics and trisomics in chromosome mapping of diploid and polyploid species.
- iii. The breeding behavior and genetics of structural heterozygotes.
- iv. The complex translocation heterozygotes.
- v. Robertsonian translocation.
- vi. B-A translocation.

Unit VI. Genetics of prokaryotic and eukaryotic organelles:

- i. **Phage and Bacterial Genetics** —mapping of the bacteriophage genome, genetic recombination in phage, transformation, transduction and conjugation in bacteria
- ii. Genetics of mitochondria and chloroplast, cytoplasmic male sterility.
- iii. Gene fine structure. Cis-trans test, introns and their significance, RNA splicing.
- iv. Regulation of gene expression in prokaryotes and eukaryotes.

Practical Based on 406

1. Induction of polyploidy in plants using colchicine. Different methods of application of colchicine.
2. Isolation of biochemical mutants following physical and chemical mutagenic

3. Isolation of chlorophyll mutants following physical and chemical mutagenic treatments.
4. Isolation of morphological mutants following physical and chemical mutagenic treatments.
5. Karyotype analysis in any two plant species.
6. Meiosis of complex translocation heterozygotes.
7. Meiotic behaviour of monosomy in plants & its effect.
8. Meiotic behaviour of trisomy in plants and its effect.
9. Mitotic/ meiotic chromosomal behaviour in mutagen treated materials.
10. Orcein and Feulgen staining of the polytene chromosomes of *Chironomus*.
11. Study of chromosome pairing and disjunction in translocation heterozygote.
12. Utilization of banding technique for identification of chromosomes in karyotype.

Suggested Readings :

1. Alberts, B. Bray, D. Lewis, J. Raff, M. Roberts, K. and Watson, J. D. 1989. Molecular Biology (Ed.) Garland Publishing Inc. New York.
2. Atherly, A. G., Girton, J. R. and McDonald, J. F. 1999. The Science of Genetics. Saunders College USA.
3. Burnham, C. R. 1962. Discussions in Cytogenetics, Burgess Publishing Co., Minnesota.
4. Busch. H. and Rothblum, L. 1982 Volume X. The cell nucleus: DNA part A, Academic Press.
5. Hartl, D. L. and Jones E. W. 1998. Genetics: Principles and Analysis (4th Ed.) Jones and Barew Publishers, Massachusetts, USA.
6. Khush, G. S. 1973. Cytogenetics of Aneuploids, Academic Press, New York, London.
7. Karp, G. 1999. Cell and Molecular Biology; Concepts and Experiments, John Wiley and Sons Inc. USA.
8. Lewin, B. 2000. Genes VII. Oxford University Press, New York, USA. Lewis, R. 1997. Human Genetics: Concepts and applications (2nd Ed), WCB, McGraw Hill, USA.
9. Malacinski, G. M. and Friefelder, D. 1998. Essentials of Molecular Biology (3rd Ed.), John and Bartlet Publishers Inc. London. Russel, P. J. 1998. Genetics (5th Ed) The Benjamin / Cummings Publishing Company, Inc. USA.
10. Snustad, D. P. and Simmons, M. J. 2000. Principles of Genetics (2nd Ed.), John Wiley and Sons Inc. USA.

BOT 407

Plant Development & Reproduction

Plant Development

- Unit I.** i. **Meristems:** Organization of shoot and root apical meristem, various theories, Cytological and Molecular analysis of SAM, control of tissue differentiation especially Xylem and Phloem.
- ii. **Tissue systems:** Differentiation and functions of different tissue systems such as epidermis, parenchyma, chlorenchyma, sclerenchyma, laticifers and glands.
- Unit II.** i. **Vascular tissues:** Origin, structure and functions Xylem and Phloem elements and their taxonomic significance, Wood development in relation to Environment.
- Unit III.** i. **Leaf:** Growth and differentiation, differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll.
- ii. **Root:** Initiation and development; lateral roots, root hair, root microbe Interaction.

Plant Reproduction

- Unit IV.** i. **Flower:** Structure and development
- ii. **Pollination:** Types of pollination, attractions and rewards of pollination, pollination mechanism and vectors, breeding systems, structure of pistil, pollen interaction and fertilization.
- Unit V.** i. **Male gametophyte:** Structure of anthers, micro-sporogenesis, role of tapetum, male sterility, pollen germination, pollen tube growth and development, pollen storage, pollen allergy, pollen embryos.
- ii. **Female gametophyte:** Ovule development, megasporogenesis, organization of the embryo sac. Structure of the embryo sac.
- Unit VI.** i. **Seed development and fruit growth:** Double fertilization, Endosperm development, Embryogenesis, Ultra-structure and nuclear cytology; Development of dicot and monocot embryos, poly-embryony, apomixes, embryo culture.

Practicals Based on BOT-407

1. **Dermatology** : trichomes and stomata and leaf anatomy of *Nerium*, *Terminalia* etc.
2. **Mechanical tissues:** (Collenchyma, Sclerenchyma, Stone cells and Xylem) , Secretary tissues (Mucilage Canals, Resin canals, Nectaries, and oil glands), laticifers (Latex cells and Vessels).
3. **Vascular tissues and its constituents:** Sections and maceration, wood anatomy, TS, TLS and RLS
4. **Abnormal secondary growth:** in *Dracaena*, *Bignonia*, *Aristolochia*, *Achyranthus*, *Nyctanthus*, *Salvadora*, *Beta*, *Mirabilis*, *Tinospora*.
5. Study of microsporogenesis and gametogenesis in sections of anthers.
6. Examination of modes of anther dehiscence and collection of pollen grains for
7. Microscopic examination (maize, grasses, *Crotolaria*, *Tradescantia*, *Brassica*, *Petunia*, *Solanum* etc.)
8. Test for pollen viability using stains and *in vitro* pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
9. Estimation of percentage and average pollen tube length *in vitro*
10. Pollen storage, pollen pistil interaction, *in vitro* pollination.
11. Study of ovules and embryo sacs.
12. Field study of types of flowers and pollination mechanism. .
13. Study of nuclear and cellular endosperms.

Suggested readings

- Burjes, J. (1985). "An Introduction to Plant cell development Cambridge University Press, Cambridge.
- Carlquist S (2001). Comparative Wood Anatomy, Springer-Verlag, Germany.
- Chopra, V.L. (2001), 'Plant Breeding, Field Crops', Oxford, BH Pvt. Ltd, New Delhi.
- Chopra, V.L. (2001), 'Plant Breeding; theory and practice', Oxford I BH Pvt. Ltd.
- Cutler DF (1978). Applied Plant Anatomy, Longman, United Kindom
- Cutter EG (1978) Plant Anatomy, Part I & II, Edward Arnold, United Kingdom.
- Cutter, E.G. 1978 Plant Anatomy - Experiments and interpretations' Part I and II, Edward Arnold
- Dickinson WC (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA.
- Esau, K, 1965. "Plant Anatomy" (Second edition; 7th reprint 1991), Wiley Eastern, New Delhi.
- Fahn A (1974) Plant Anatomy, Pergmon Press, USA & UK.

- Fahn, A. (1977). *Plant Anatomy*' (3rd edition, 1982). Pergamon Press, Oxford.
- Forster, A.S. 1960. *'Practical plant anatomy* D.van Nostrand company. Inc.
- Fosket D.E. 1994 *'Plant growth and development'* - A molecular approach Academic Press, Santiago.
- Fritsch FE (1935, 1945). *The Structure and Reproduction of Algae* Vols. I and II. Cambridge University Press, Cambridge, UK.
- Hopkins WG. (2006). *The Green World: Plant Development*, Chelsea House Publication
- Howell SH. (1998) *Molecular Genetics of Plant Development*, Cambridge University Press.
- Howell, S.H. 1998, *Molecular genetics of plant development*, Cambridge University Press, Cambridge.
- Hyndon, R.F. 1990, *Plant Development - The Cellular Basis* Univ. Hyman, London.
- improvement' Cambridge University Press. Cambridge.
- Leyser O and Day S (2003) *Mechanism of Plant Development*, Blackwell Press
- Mauseth JD (1988). *Plant Anatomy*, The Benjamin/ Cummings Publisher, USA
- Murphy, T.M. and Thompson, WF. 1988 *'Molecular plant development* Prentice Hall, New Jersey.
- Nair MNB (1998). *Wood Anatomy and Major Uses of Wood*, Faculty of Forestry, University of Putra Malaysia, Malaysia. 11
- Procton, M. and Yeo, P. (1973), *'The pollination of flowers'*, William Collins Sons, London.
- Raghavan V (1997). *Molecular Embryology of Flowering Plants*. Cambridge University Press.
- Raghavan V (2000) *Developmental Biology of Flowering Plants*, Springer, Netherlands
- Reven, P.H., Evert, R.F. and Eichhom, S.E. 1992 *'Biology of Plants'* (5th Edition), New York.
- Richards AJ (1986) *Plant Breeding System*, George Allen and Unwin.
- Roberts, L.W. 1976. *Cyto-differentiation in plants*, Cambridge University Press, Cambridge.
- Shivanna KR (2003) *Pollen Biology and Biotechnology*, Science Publishers.
- Shivanna, K.R. and John, B.M. (1985), *'The angiosperm pollen structure and function'*, Willey Eastern Ltd., New York.
- Shivanna, K.R. and Rangaswamy, N.S. (1992), *'Pollen Biology: A laboratory manual'*, Springer Verlag, Berlin.
- Shivanna, K.R. and V.K. Sarobney, (Ed) *'Pollen Biotechnology for crop production and*
- Sleeves, T.A. and Sussex, LM. 1989, *'Patterns in plant development* (7th edition) Cambridge Press, Cambridge.

BOT 408**Biotechnology**

- Unit I. Biotechnology:** Basic concept, Historical, principles of tissue culture, Cellular totipotency, Discoveries of Plant Growth hormones in brief review, Contribution of Sir Gottlieb Haberlandt, Development of Tissue culture as a technique, Scope and Importance.
- Unit II. Introduction to tissue culture:** Tissue culture laboratory, Equipment's in Tissue culture laboratory, Preparation of Media, Media composition, Plant Growth Regulators and their Role, selection of media for specified applications, Selection of explant, Sterilization, Sterilizing agents, initiation of tissue culture
- Unit III. Cellular totipotency:** Media for initiation of callus, dynamics of callus growth, measurement of growth, organogenesis and factors controlling it, genome instability in reaction to morphogenesis, somaclonal variation and its applications.
- Unit IV. Cell and organ culture:** Plant organ culture; shoot tip, shoot apical meristem, root, leaf, flower and ovary culture, embryo rescue, factors influencing embryogenesis, suspension culture in stationary and stirred tank reactors, isolation of single cells and their culture, measurement of growth,
- Unit V. Practical approaches of single cell culture:** Somatic embryogenesis, protoplast isolation, regeneration of protoplasts and protoplasts fusion, Synthetic seeds, generation of cybrid and hybrids, cryopreservation of plant cells.
- Unit VI. Applications of tissue culture:** Applications in agriculture and Horticulture, Application in Forestry, Application of Tissue culture in pharmaceutical industry. *In situ* and *ex-situ* conservation. *In vitro* mutagenesis and its application. Production of transgenic plants
- Unit VII. Recombinant DNA technology:** Gene cloning, Vectors, Role of *Agrobacterium*, Gene cloning techniques - Gene gun, Electroporation, Microinjection, Liposome mediated gene transfer, Ultra sonication and Pollen Mediated gene transfer.

Practicals based on 408

1. Equipment's required in Tissue culture Lab
2. Media preparation
3. Sterilization of media
4. Sterilization of explant.
5. Explant Culture.
6. Anther culture
7. Pollen culture,
8. Micropropagation.
9. Embryo rescue technique.
10. Somaclonal variation.
11. *In vitro* mutation.
12. Isolation of plant protoplasts and viability testing.
13. Protoplast fusion by PEG.
14. Tissue culture of Horticultural plant Banana.
15. Tissue culture of Medicinal plant.

Suggested readings:

1. Henry, R.J. Practical application of plant molecular Biology, Chapman and Hall
2. Kalyan kumar De. Introduction to Plant Tissue culture,
3. Bhojwani, Plant Tissue Culture.
4. Montell S.H. Mathews, J.A., Meker, R.A. Principles of Plant Biotechnology.
5. Glover, D.M. and Hanes, B.D. (eds.) 1995. DNA cloning 1: A practical approach, core techniques , 2nd edition, PAS, IRL press at Oxford University Press.
6. Plant cell culture protocols. Humana Press, Inc. New Jersey, USA.
7. Shaw, C.H. (ed.) 1998, Plant Molecular Biology. A practical approach IRI Press, Oxford.
8. Smith, R.H. 2000. Plant Tissue culture: Techniques and Experiments. Academic Press, New York.
10. Susan R. Barnum (1998). *Biotechnology: an introduction*. Thomson Brooks/cole.
11. George Acquaah (2005). *Understanding biotechnology*. Pearson.
12. Biotechnology; P.K. Gupta

BOT 409

Plant Physiology and Metabolism

- Unit I. Plant water relations:** Water Potential, Absorption and Transpiration, Stomatal Physiology, Active and passive transport of solutes, Phloem loading and unloading, source-sink relationship, Physiology of plants under water stress.
- Unit II. Enzyme:** Nomenclature, Properties and classification of enzymes, Mechanism of Enzyme action, regulation of enzyme action, isoenzymes.
- Unit III. Photosynthesis:** Light and dark reactions, pigments and mechanism of light absorption, Photosystem I and II, Emerson enhancement effect, C₃, C₄ and CAM pathways, significance of C₄ and CAM pathways, photorespiration, Photo synthetic productivity.
- Unit IV. Respiration:** Glycolysis, TCA cycle and its role in synthesis of bio-molecules Mitochondrial electron transport, oxidative phosphorylation, Pentose phosphate pathway, cyanide resistance, Bioenergetics principles.
- Unit V. Nitrogen Metabolism:** Nitrification and denitrification, Nitrate assimilation, Biological nitrogen fixation, Biosynthesis of amino acids - reductive amination and trans amination, Protein synthesis, classification of amino acids and proteins, amphoteric nature and zwitter ions, structure of proteins, protein denaturation, Isolation and purification of proteins.
- Unit VI. Lipid Metabolism:** Fatty acids, lipids, triglycerides, Saponification, oxidation of Fatty acids - alpha and beta oxidation.
- Unit VII. Plant Growth:** Growth curve, growth analysis, Plant Growth Regulating substance (PGRS), Gibberellins, Cytokines, Abscisic acid, Ethylene, role of PGRS in agriculture.
- Unit VIII. Plant Development:** Physiology of flowering, Phytochrome, flowers induction, Seed germination and dormancy, senescence and aging, stress physiology, vernalization and abscission.

Practicals Based On BOT- 409

1. Separation of chlorophyll pigments by paper and thin layer chromatography,
2. Spectrophotometry - Absorption spectrum for chlorophyll pigments extracted from green leaves.
3. Estimation of total chlorophyll, chlorophyll 'a' and chlorophyll b
4. Estimation of reducing sugars using Fehling's solution A and B.
5. Isolation of starch from potato.
6. Isolation of pectin from fruit rinds.
7. Hydrolysis of starch by acid and crude enzyme extract from germinating seeds.
7. Effect of temperature on permeability.
8. Difference between C3 and C4 plants- chlorophyll content and leaf anatomy.
9. Estimation of Ascorbic acid from fruit juice and germinating seeds.
10. Estimation of proline in normal plant and that under stress.
11. Separation of amino acids by paper and thin layer chromatography.
12. Chemical tests for protein.
13. Estimation of protein by Lawry's method.
14. Estimation of protein by Biuret method.
15. Isoelectric point of casein.
16. Immobilization of enzymes using sodium alginate.
17. Preparation of leaf protein concentrate (LPC) by heat coagulation method.
18. Iodine number of fat.
19. Saponification number of fat.
20. Growth analysis - RGR, NAR and LAI.
21. Biostatistics: mode, median, mean, range, mean deviation, standard deviation, coefficient of variation (C.V.) in simple or classified data (frequency distribution).

Suggested Readings :

1. Plant physiology: F.N. Salisbury and C.W. Ross, CBS Publishers and Distributors, New Delhi.
2. Principles of Biochemistry, A.L. Lehninger, CBS Publishers and Distributors, New Delhi.

3. Plant physiology: R.G.S. Bidwell, Mac Millan Publishers Co., New York.
4. Advanced plant physiology, M.B. Wilkins, English Language Book Society, London.
5. Principles of plant physiology, Borner, J. and Galston, A.W.
6. Introductory plant physiology, Noggle G.R. and Fritz, G.S., Prentice Hall, USA.
7. Plant Water Relationships, Slyter, R.O. Academic Press, New York.
8. Plant physiology, D. Hess, Narosa Publishing House, New Delhi.
9. Elementary Biochemistry, Mertz, E.T. Vakils, Fetter and Simsons Pvt Ltd. Mumbai.
10. Essentials of Biological Chemistry, Fairley, J.L. and Kilgon, G.L., Earr west Press Pvt. Ltd., Delhi.
11. Plant physiology, Devlin, R.M. and Hostan, F.H., CBS Publishers and Distributors, New Delhi.
12. Plant Physiology, S.C.Datta, Willey Eastern Limited, Calcutta.
13. Plant Physiology, S. Mukharji, A.K.Ghosh, New Central Book Agencies, Kolkatta.
14. An Introduction to Biometry, A.M.Mungikar, Sarswati Printing Press, Aurangbad.
15. Biostatistical Analysis, A.M.Mungikar, SarswatiPrinting Press, Aurangabad.
16. Laboratory Manual in Biochemistry, Jayraman, J., New Age International Publishers, Mumbai.
17. Experiment in Plant Physiology, D. Bajrachrys Narosa Publishing House, New Delhi.

BOT 410

Research Methodology - I

Unit I.: Microscopy: Light Microscopy, Phase contrast Microscopy, SEM & TEM, The flow cytometry and confocal microscopy in karyotype analysis.

Unit II.: Stains and Staining Procedures: Preparation and use of various stains used in Botany- Saffranine, Crystle Violet, Light Green, Erythrosine, Acetocarmine, Fuelgen, Basic Fuschin, Cotton Blue, Iodine, Sudan IV, Fluoroglucinol, Carboic acid etc. Sectioning and Maceration, Microtomy and its staining.

Unit III.: Ethical and Legal issues of Research: Authentication of specimens, Legal permissions for collection of biological material from Local Biodiversity committees, Forest Department, State Biodiversity Board and National Biodiversity Authority.

Unit IV.: Plant Collection and Preservation -- Plant collection, Voucher specimens, Herbarium techniques, Liquid preservation etc. **Sampling of Plant materials** for Phytochemistry, DNA finger printing, Tissue Culture, Cytological, pathological studies etc.

Unit IV.: Biostatistics: i) Biostatistics used in analysis of data - mean, variance, standard deviation, standard error, coefficient of variation and 't' test, lay out of field experiments.

Unit V.: Laboratory Techniques: Ultracentrifugation, TLC, fractionation, Biochemical analysis, Electrophoresis, PCR, GISH, FISH techniques. Tissue culture technique, Spectroscopy,

Suggested Readings :

1. An Introduction to Practical Biochemistry-Third Edition- David T. Plummer. Tata Macgrew Hill
2. Senger R. S. Gupta Shalini, Sharma A. K., 2011, Laboratory Manual On Bioechonology- Studium Press India PVT LTD, New Dehli-2000
3. Paterson, D. D. 2008, Statistical Techniques in Agricultural research, J.V. Publishing House Jodhpur.
4. Jensen William A. 2015, Botanical histochemistry- Principles and Practice-Agri-Horti Press New Dehli.
5. Mungikar, A. M. 2003. Biostatical Analysis. Saraswati Printing Press. Aurangabad.