

## **BO 4.1: Cytogenetics and Plant Breeding**

**Credits: 4**

**Lectures: 60**

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### **Objectives:**

1. To understand the cell structure, function and different aspects of cytogenetical studies.
  2. To study importance of plants and inculcate the importance of farming based
  3. To reveal the different aspects of plant breeding.
  4. To provide platform to develop the investigation abilities by using biological tools.
  5. To provide training in scientific and transferable skills through modular lecture courses.
  6. To provide basic knowledge to be able to sustain in upcoming green revolution.
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### **Credit: I Cytogenetics-I (15L)**

1. Cell division: Mitosis and Meiosis.
2. Concept of Gene: Allele, Multiple allele, Pseudoallele, Complementation test.
3. Mendelian Principles: Dominance, Segregation and Independent assortment.
4. Extensions of Mendelian Principles: Codominance, Incomplete dominance, Gene interaction, Pleiotropy, Genomic imprinting, Penetrance, Expressivity and Phenocopy.
5. Extra chromosomal inheritance: Inheritance of mitochondria and chloroplast genes, Maternal inheritance and its effect.
6. Quantitative genetics- Introduction to complex traits, Polygenic inheritance. Heritability & its measurement, QTL Mapping.

### **Credit II: Cytogenetics-II (15L)**

1. Microbial genetics: Mapping of bacterial genome by interrupted mating.
2. Mutation: Types, causes and detection, Mutant types-lethal, Conditional, Biochemical, Gain of function, Loss of function, Germinal vs somatic mutant, Insertional mutagenesis.
3. Linkage and mapping in eukaryotes: Linkage and crossing over, Sex linkage, Sex limited and sex influenced characters. Recombination: homologous and non-homologous includ-

-ing transposition, Linkage maps, Lod score for linkage testing, Mapping by 3 point test cross, Mapping by tetrad analysis in Yeast and Neurospora, mapping with molecular markers, Mapping by using somatic cell hybrids, Development of mapping population in plants.

4. Karyotypes and genetic disorders.
5. Structural alterations of chromosomes: Deletion, Duplication, Inversion, Translocation, Complex translocation heterozygotes, Robertsonian translocations, BA translocations and their genetic implications.
6. Numerical alterations of chromosomes: Euploidy and aneuploidy and their genetic implications.

**Credit III: Plant Breeding-I (15L)**

1. Plant Breeding- Objectives, Plant Genetic resources and their conservation: Centers of origin and centers of diversity, Importance of genetic diversity in crop improvement and its erosion.
2. Breeding methods in self pollinated crops: Mass selection, Pure line selection, Pedigree selection, Bulk method, Backcross method.
3. Breeding methods in Cross pollinated crops: Mass selection, Progeny selection, Recurrent selection.
4. Breeding methods in clonally propagated crops: Clonal selection, hybridization.

**Credit IV: Plant Breeding-II (15L)**

1. Hybridization methods in plants.
- 2 Heterosis breeding.
3. Mutation breeding: Types, Mutagens: Physical and chemical mutagens, Mutant types, Role of mutation in breeding.
4. Role of polyploidy in plant breeding.
5. Breeding for biotic and abiotic stress resistance (fungal disease resistance and drought resistance).
6. Release of new variety, seed production and maintenance.

### **Selected Readings:**

1. Atherly, A.G., Girton, J.R. and McDonald, J. F. (1999) The science of genetics. Saunders College Pub. Fort Worth USA.
2. Burnham, C.R.(1962) Discussions in cytogenetics. Burgess Pub. Co., Minnesota.
3. Hartl, D.L., Jones E.W.(2001). Genetics: Principle and analysis (4th edn) Jones and Barlett Pub., USA.
4. Khush, G S (1973) Cytogenetics of Aneuploids. Academic press New York, London.
5. Lewin, B. Genes VIII. Oxford, University press. New York, USA.
6. Russel, P.J. 1998. Genetics (5th edn).The Benjamin/ Cummins Pub. Co., Inc. USA.
7. Snustad, D.P. and Simmons, M.J. 2000. Principles of genetics (4th edn). John Wiley and Sons, Inc., USA.
8. Freifelder, D. (1987) Microbial Genetics.
9. Strickberger, M.W: Genetics (4th edn). Mcmillan Publishing company, New York.
10. Griffiths, A.J.F. and Gilbert, W.M (2nd edn). Modern genetic analysis. W.H. Freeman and Company, New york.
11. Singh, B.D.(2005). Plant breeding: principles and methods. 7th edn.
12. Allard, R.W.(1960). Principles of plant breeding.John Wiley and sons, Inc., New York.
13. Chopra, V.L. (2000) Plant breeding: Theory and practice 2nd edn. Oxford & IBH Pub., Co., Ltd. New Delhi.
14. Jain, H.K. and Kharwal, M.C.(2003) Plant breeding: Mendelian to molecular Approaches. Navrosa Publishing House Pvt. Ltd., New Delhi.
15. Mandal, A.K. Ganguli, P.K., Banerjee, S.P. (1991). Advances in Plant breeding.Vol 1 and 2, CBS Pub.& distributors.
16. Sharma, J.R. 1994. Principles and practices of plant breeding.Tata Mcgraw Hill.Pub. Co. Ltd. New Delhi.
17. Simmonds, N.W.1979 Principles of crop improvement. Longman, London and New York.

## **BO 4.2: Plant Biotechnology & Genetic Engineering**

**Credits: 4**

**Lectures: 60**

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### **Objectives**

1. To know the molecular aspect.
  2. To study Agrobacterium mediated gene transfer.
  3. To know the DNA sequencing.
  4. To know the tissue culture techniques.
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### **Credit I: Plant tissue culture: (15L)**

1. History of plant tissue culture.
2. Laboratory condition requirement.
3. Tools and techniques for tissue culture.
4. Culture media and their constituents
5. Types of culture ( Anther, callus, Micropropagation) and application of tissue culture.
6. Somaclonal variation and its significance.
7. Protoplast culture and somatic hybridization.
8. Cryopreservation.

### **Credit II: Recombinant DNA technology and gene cloning (15L)**

1. Introduction to recombinant DNA technology.
2. Enzymes used in recombinant DNA technology.
3. Recombinant technology and gene cloning.
4. Use of vectors in cloning- Plasmids, cosmids, BACs and YACs.

5. DNA Sequencing methods (Maxam Gillbert, Sangers, Pyrosequencing and Next generation sequencing).

**Credit III: Gene libraries and Screening of recombinants (15L)**

1. Genomic and cDNA libraries – choice of vectors and construction.
2. RNA Interference mechanism, synthesis and its application. Virus Induced Gene Silencing(VIGS).
3. Concept of genomics and proteomics.
4. Concept of Human genome Project ( HGP ).

**Credit IV: Genetic transformation of plant (15L)**

1. Agrobacterium: Ti and Ri plasmids, transfer of DNA into host by Agrobacterium, mechanism of integration of DNA into plant genomes, vectors for chloroplast transformation, vectors for marker-free selection.
2. Transformation techniques: Agrobacterium-mediated, Factors affecting transformation.
3. Molecular markers and their applications.

**References:**

1. Recombinant DNA – Principles and Methodologies. Greene JJ and Rao VS, Marcel Dekker, New York, 1998.
2. Principles of gene manipulation. Primrose SB, Twyman RM and Old RW, 6th Edition, Blackwell Science, Oxford, 2001
3. Differentially expressed gene in plants. Hansen and Harper, Taylor and Francis Ltd. London, 1997.
4. Engineering plants for commercial products and applications. Eds. Collins GB and

- Shepherd RJ, NY Acad. Of Science Publishers 1996.
5. DNA markers. Eds. Caetano-Anolles and Gresshoff, Wiley-VCH Publishers, NY, 1998
  6. Introduction to Bioinformatics. Attwood, T.K., Parry-Smith, DJ, Addison Wesley Longman, Harlow, Essex, 1999.
  7. Bioinformatics. Westhead, DR, Parish JH and Twyman, RM, BIOS Scientific Publishers Ltd., Oxford, 2003
  8. Bioinformatics – Sequence and genome analysis. D.W. Mount, CBS Publishers, NewDelhi, 2003
  9. Collins GB and Shepherd RJ Eds., 1996, Engineering plants for commercial products and application. , NY Acad. Of Science Publishers
  10. Senson CW Edt, 2002, Essentials of Genomics and Bioinformatics,. Wiley-VCH Publishers, NY,
  11. Charlwood B.V. and Rhodes MV Edt. 1999, Secondary products from plant tissue culture. Clarendon Press, Oxford.
  12. Dicosmo F and Misawa M, Edt 1996, Plant cell culture: Secondary metabolism towards industrial application, CRC press, Boca Raton ,N.Y.
  13. Ramawat K G and Merillon J M, Edt.,1999 Biotechnology: Secondary metabolites, Oxford IBH Publishing Co., New Delhi
  14. Buchanan BB, Grussem Wand Jones RL ,2000 , Biochemistry and molecular biology of plants , IK International Pvt Ltd. New Delhi
  15. Verapoorte R and Alferman HW Eds ,2002 Metabolic engineering of plant

secondary metabolites. Kluwar Academic Publ., Netherlands.

### **B.O.4.3: Plant Pathology-II**

**Credits: 4**

**Lectures: 60**

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#### **Objectives:**

1. To awaken the students about microbial world and the nature of diseases of plants.
  2. To understand the principles and concept in plant pathology.
  3. To understand the relationships between pathogens and plants.
  4. To become familiar with terms and references used to diagnose plant disease.
  5. To develop the awareness about the importance of plant disease in human life.
  6. To learn the basic biology of major groups of plant pathogens.
  7. To explain the concept of plant disease and disease pyramid.
  8. To describe main modes of plant disease transmission.
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#### **Credit I: Introduction to Plant Pathology ( 15L )**

1. History: Beginning of modern plant pathology; Contribution of Anton De Bray;

Benedict Prevost; J.C. Kuhn; Paul Neergaard, P.H. Geregory. History of the development of plant pathology in India; plant disease clinics.

2. Disease inciting agents:

i ) Biotic agents: Bacteria, viruses, fungi, Mycoplasma, nematodes.

ii) Abiotic agents: Air pollution; mineral elements, temperature, toxic effects of improperly used chemicals.

3. Symptoms of plant diseases: Symptoms caused by Fungi, Bacteria, Viruses, Mycoplasma

and Nematodes.

4. Dissemination of plant pathogen: Dissemination by Air, Water, Buds, Insects, Man and transmission of plant viruses.
5. Economic importance of plant diseases.

**Credit- II: Epidemiology and forecasting of plant diseases ( 15L )**

1. Epidemiology and forms of epidemics:
  - i) Compound interest diseases, simple interest, diseases slow and rapid epiphytotic.
  - ii) Essential conditions of epidemics, decline of epidemics.
  - iii) Disease measurement, disease severity, analysis of epidemics.
2. Disease forecasting methods.
3. Pathogenesis: Penetration and entry by plant pathogen; Pre-penetration; Entry through natural opening; Direct penetration; Entry through wounds, root hairs and buds.
4. Survival of plant pathogen.
5. Effects of infection on the host :
  - i) Tissue disintegration .
  - ii) Effect on growth of host .
  - iii) Effect on reproduction
  - iv ) Effect on uptake and translocation of water and nutrients
  - v ) Effect on respiration of host.

**Credit- III: Diseases of crop plants I ( 15L )**

Symptomology, causal organism, etiology and control measures of:-

- 1) Stem rust of Wheat.
- 2) Leaf blight of Wheat.
- 3) Head smut of Jowar.



- 4) Wilt of Arhar.
- 5) Leaf spot of Potato (Cercospora).
- 6) Tikka disease of Groundnut.
- 7) Leaf spot of Cotton.

**Credit IV: Diseases of crop plants II ( 15L )**

Symptomology, causal organism, etiology and control measures of:-

- 1) Leaf curl of Chilly.
- 2) Anthracnose of Mango.
- 3) Wilt of Sugarcane.
- 4) Black rot of Crucifers.
- 5) Fruit rot of Cucurbits.
- 6) Gummosis of sugarcane.
- 7) Downy mildew of Maize.
- 8) Rust of Pea.

**Suggested readings**

1. Agrios, G.N. (1969) Plant Pathology, Academic Press, New York.
2. Rangaswami, G. and A. Mahadevan (2001) Disease of crop plants in India, Printic Hall of India, Pvt. Ltd., New Delhi.
3. Gupta, V.K. and V.S. Paul (2001) Disease of vegetable crops. Kalyani Publ. Ludhiana,
4. Gupta, V.K. and S.K. Sharma (2000) Disease of fruit crops, Malyani Publ. Ludhiana.
5. Raychaudhari, S.P. and T.K. Nariani (1977), Virus and Mycoplasma disease of plants in India. Oxford and IBK Publ. Corp., New Delhi.
6. Bos L. (1999), Plant viruses, unique and intriguing pathogens. Backhugs Publ. Leiden.
7. Rangaswami, G. and S. Rajagopalan (1973), Bacterial plant pathology, T.N. Agri. Uni.Coimbatore.

### **B.O.4.4: Plant Pathology-III**

**Credits: 4**

**Lectures: 60**

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#### **Objectives:**

1. To awaken the students about microbial world and the nature of diseases of plants.
  2. To understand the principles and concept in plant pathology.
  3. To understand the relationships between pathogens and plants.
  4. To become familiar with terms and references used to diagnose plant disease.
  5. To develop the awareness about the importance of plant disease in human life.
  6. To learn the basic biology of major groups of plant pathogens.
  7. To explain the concept of plant disease and disease pyramid.
  8. To describe main modes of plant disease transmission.
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#### **Credit I: Effect of environment on pathogenesis: ( 15L )**

1. Effect of environment , temperature, moisture, humidity, shade, wind, light, pH, O<sub>2</sub> and CO<sub>2</sub> concentration.
2. Role of Toxins in Plant pathogenesis: Pathotoxins, Vivo toxins and Phyto toxins.
3. Effect of toxins on plant tissues: Selective and non-selective toxins.
4. Seed Pathology: Scope and importance; seed health testing; methods and procedures; detection of seed borne-fungi, Bacteria and viruses. Seed bio deterioration: Biochemical changes, Morphological abnormalities, loss in

germinability. Mycotoxins, fusarium toxin and aflatoxin. Control of Post-harvest spoilage of grains.

**Credit II: Genetic Variability: ( 15L )**

1. Genetic Variability in plant pathogen :

- i) Genetic Variability in viruses
- ii) Genetic Variability in Fungi
- iii) Level of variability in pathogen
- iv) Loss of virulence

2. Genetics and molecular basis of host parasite interaction:

- i) Evolution of parasitism.
- ii) Genetics of host parasite interaction.
- iii) Gene for gene relationship.
- iv) Criteria for gene for gene relationship.
- v) Molecular basis of host parasitic interaction.

3. Physiologic specialization: General accounts.

**Credit- III: Diseases of crop plants-I: ( 15L )**

Symptomology , causal organism and control measures of :

- 1) Long smut of Sorghum.
- 2) Die back of Chilly.
- 3) Charcoal rot of Soyabean.
- 4) Leaf curl of Papaya.

- 5) Black heart of Potato.
- 6) Stem canker of Potato.
- 7) Fusarium wilt of Tomato.

**Credit IV: Diseases of crop plants II: ( 15L )**

Symptomology , causal organism and control measures of :

- 1) Black spot of Crucifers.
- 2) Loose smut of Sorghum.
- 3) Rust of Bean.
- 4) Brown Rust of Wheat.
- 5) Powdery mildew of Cucurbits.
- 6) Downy mildew of Grapes.
- 7) Sandal spike Disease.
- 8) Ear cockles of Wheat

**Suggested readings**

1. Chandnivala, M. (1955). Recent advances in plant pathology, Amol Publication, Pvt. Ltd.,
2. Nurenburg, H.W. (1985) Pollution and their ecotoxicological significance, John Wiley and Sons, New York.
3. Mehrotra, R.S. Plant Pathology, Tata McGraw Hill Publication Co., Ltd., New Delhi.
4. Agrisos, G.N. Plant Pathology, Academic Press, New York and London.
5. Bilgrami, K.S. and H.C. Dubey, A text book of Modem plant pathology, Vikas Publishing House, New Delhi.
6. Nene, Y. and P.N. Thaphyal Fungicides in plant disease control II lidiv Oxford and IBH Publishing Co., New Delhi

7. Vyas, S.C. Systemic fungicides, Vol. 1 - 3, Tata Mc(Jrnw Hill Publishing Co., Ltd., New Delhi.
8. Dekker, J. and S.G. Georgopoulos (Ed), Fungicides Resistance in plnnl Protection, CARD Publications,
9. Gangawane, L.V. and JayashreeDeshpande. Pesticides and crop plnntn in India, Ajay Prakashan, Aurangabad.
10. Holton, C.S., Fischr, C.N. Fulton, R.W., Hart, H. and S.K.A.Macallan. Plant Pathology: Problems and prograss (1908 - 1958), The University of Wisconsin, USA.

**PRACTICALS:**

**Lab course -VII Based on theory paper BO 4.1 and BO 4.2.**

**PRACTICALS: Based on BO 4.1**

- 1.Preparation of stains, Fixatives, preservatives and pretreatments to plant material .
- 2.Problems on determination of blood grouping
- 3.Problems based on Multiple alleles.
- 4.Problems based on Gene mapping.
- 5.Problems based on linkage.
- 6.Study of meiotic configuration from suitable plant material.
- 7.Study of chromosomal aberrations in irradiated plant material .
- 8.Study of Polygenic inheritance.
- 9.Problems of Mendelian inheritance and estimation of gene frequencies and heterozygotic frequencies, population genetics and Linkage.
- 10.Neurospora tetrad analysis.
- 11.Linear differentiation of chromosomes through banding techniques such as C-Banding,G-Banding and Q-Banding.
- 12.Floral Biology, study of Pollen Viability, germination in vitro and staining of any two major crops.
- 13.Study of monohybrid and dihybrid crosses and interactions.
- 14.Study of quality traits in rice, cotton/wheat/soybean/Brassica.
- 15.Use of Colchicine for induction of polyploidy in appropriate plant material.
- 16.Demonstration of techniques of hybridization .
- 17.Effect of physical or chemical mutagens on crop plants of M1 and M2 population.
- 18.Visit to research institutes / Biotechnology/ Tissue culture laboratories / Agriculture Universities.

### **Based on BO 4.2 Plant Biotechnology & Genetic Engineering**

1. Sterilization Techniques.
2. Preparation of stock solutions.
3. Preparation of Media MS Medium.
4. Surface sterilization of explants.
5. Characterization of Callus.
6. Protoplast isolation.
7. Preparation of Synthetic seeds.
8. Growth characteristics of E.coli using plating & turbidimetric method.
9. To detect mutants variant of a given plating techniques.
10. Isolation of plasmid from E.Coli by enzymatic method.
11. Effect of temperature and alkali on absorption of DNA: hyperchromicity
12. Isolation of RNA and its quantification.
13. Visit to Plant tissue culture laboratory.

**(Based on theory paper BO 4.3 and BO 4.4)**

**Practicals Based on theory paper BO 4.3**

1. . Extraction and estimation of pigments in healthy and diseased plants.
2. Detection of sugars from healthy and infected leaves by paper chromatography.
3. Production and assay of macerating enzymes.
4. Production and assay of polygalacturonase, cellulolytic enzymes, amylase.
5. Estimation of plant pigment from diseased and healthy plants
6. Detection of sugars from healthy and diseased leaves by paper chromatography.
7. Estimation of total phenol from diseased plant part.
8. Extraction and separation of alpha toxins
- 9-20 Symptomology, histopathology of disease given in theory.

17. Visits to fields for study of diseases.

**Practicals: Based on theory paper BO 4.4**

1. Detection of seed borne-fungi and Bacteria.
2. Evaluation of fungicide against plant pathogenic fungi.
3. Evaluation of Bioagents against plant pathogenic fungi
4. Evaluation of antibiotics against pathogenic bacteria.
5. Extraction and estimation of pigments in healthy and diseased plants.
6. Isolation of plant pathogen from infected plant parts.
7. Preparation of nutrient agar medium and PDA.
8. Study of common effect of pollutants –SO<sub>2</sub>, NO and NH<sub>3</sub> on leaves of common crop plants.
9. Estimation of protein from infected seeds.
- 10-22 Symptomology, histopathology of disease given in theory.

Head



