

# **CURRICULUM**

**OF**

**PLANT BREEDING & GENETICS**

**B.Sc (Hons)**

**M.Sc (Hons)**

(Revised 2005)



**HIGHER EDUCATION COMMISSION  
ISLAMABAD**

## **CURRICULUM DIVISION, HEC**

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## PREFACE

Curriculum of a subject is said to be the throbbing pulse of a nation. By looking at the curriculum one can judge the state of intellectual development and the state of progress of the nation. The world has turned into a global village; new ideas and information are pouring in like a stream. It is, therefore, imperative to update our curricula regularly by introducing the recent developments in the relevant fields of knowledge.

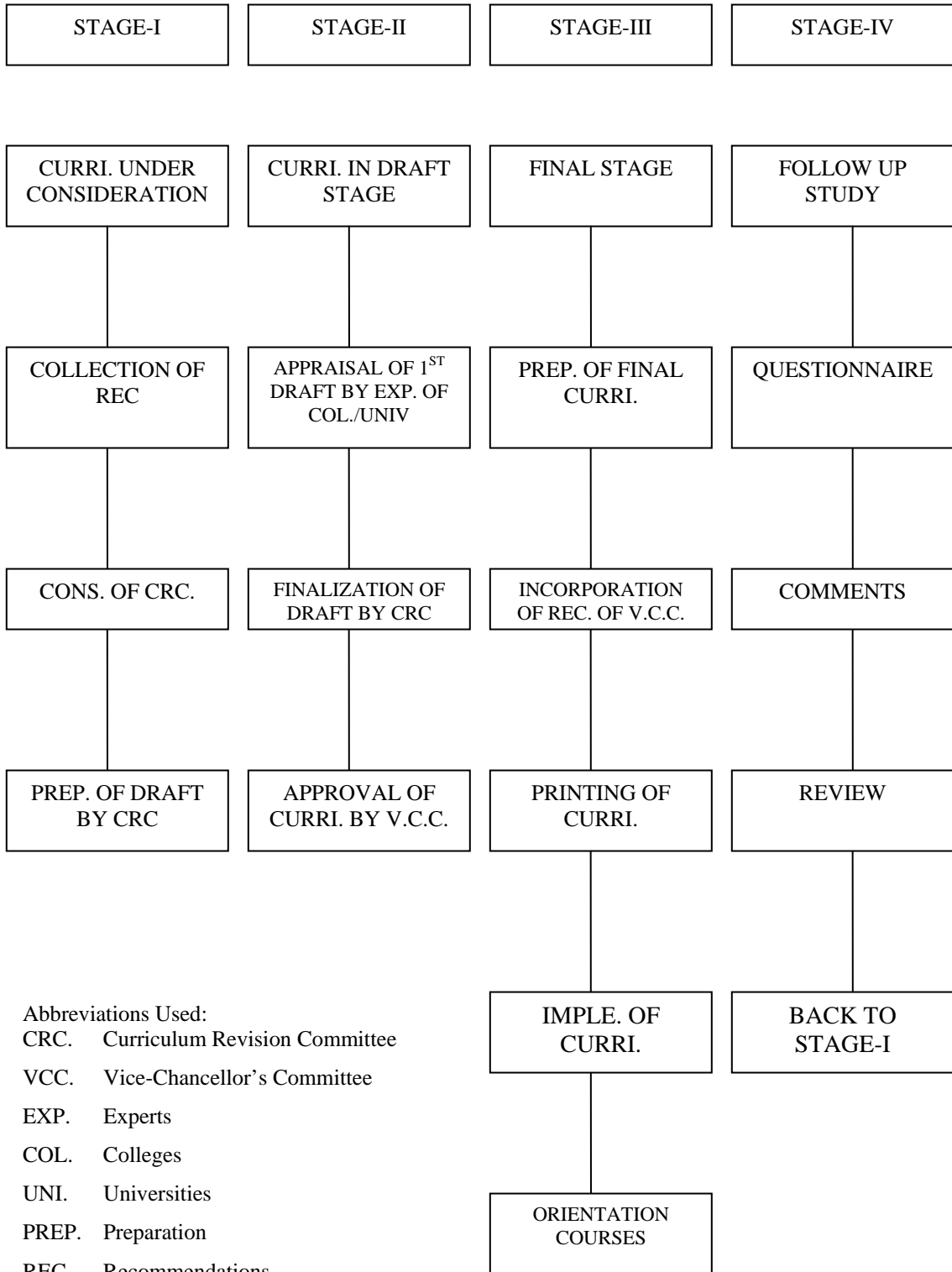
In exercise of the powers conferred by sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide notification no. D773/76-JEA (Cur.), dated December 4, 1976, appointed University Grants Commission as the competent authority to look after the curriculum revision work beyond class XII at bachelor level and onwards to all degrees, certificates and diplomas awarded by degree colleges, universities and other institutions of higher education.

In pursuance of the above decisions and directives, the Higher Education Commission (HEC) is continually performing curriculum revision in collaboration with universities. According to the decision of the special meeting of Vice-Chancellors' Committee, curriculum of a subject must be reviewed after every 3 years. For the purpose, various committees are constituted at the national level comprising senior teachers nominated by universities. Teachers from local degree colleges and experts from user organizations, where required, are also included in these committees. The National Curriculum Revision Committee for Plant Breeding & Genetics in its meeting held in **July 11-13, 2005** at the HEC Regional Centre, Peshawar revised the curriculum after due consideration of the comments and suggestions received from universities and colleges where the subject under consideration is taught. The final draft prepared by the National Curriculum Revision Committee duly approved by the Competent Authority is being circulated for implementation by architectural institutions.

**(PROF. DR. ALTAF ALI G. SHAIKH)**  
**Adviser (Acad/R&D)**

July 2005

# CURRICULUM DEVELOPMENT



- Abbreviations Used:
- CRC. Curriculum Revision Committee
  - VCC. Vice-Chancellor's Committee
  - EXP. Experts
  - COL. Colleges
  - UNI. Universities
  - PREP. Preparation
  - REC. Recommendations



## INTRODUCTION

Final Meeting of National Curriculum Revision Committee for Plant Breeding and Genetics was held on July 11-13, 2005 at Regional Center of Higher Education Commission (HEC), Peshawar. Following members were present:

1. Prof. Dr. Hidayat-ur-Rahman  
Chairman,  
Department of Plant Breeding & Genetics,  
NWFP, Agricultural University, Peshawar. **Convener**
2. Prof. Dr. Syed Sadaqat Mehdi,  
Registrar,  
Virtual University of Pakistan,  
M.A. Jinnah Campus,  
Defense Road, Off Raiwand Road, Lahore. **Member**
3. Prof. Dr. Muhammad Munir,  
Chairman,  
Department of Plant Breeding & Genetics,  
University of Arid Agriculture, Rawalpindi. **Member**
4. Prof. Dr. Ali Nawaz Channa,  
Department of Plant Breeding & Genetics,  
Faculty of Crop Production,  
Sindh Agriculture University, Tandojam. **Member**
5. Prof. Dr. Farzana Naqvi,  
Department of Genetics,  
University of Karachi, Karachi. **Member**
6. Prof. Dr. Iftikhar Ahmad Khan  
Chairman,  
Department of Plant Breeding & Genetics  
University of Agriculture, Faisalabad. **Member**
7. Mr. Rahim Din Khan,  
Chairman,  
Department of Plant Breeding & Genetics,  
Faculty of Agriculture,  
Gomal University, D.I. Khan. **Member**

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|-----|---|--------|
| 8.  | Dr. Muhammad Subhan,<br>Assistant Professor,<br>Department of Plant Breeding & Genetics,<br>Faculty of Agricultural,<br>Gomal University, D. I. Khan.             | Member |
| 9.  | Dr. Muhammad Yaqub Mujahid,<br>Senior Scientific Officer (Wheat Program),<br>National Agricultural Research Centre (NARC),<br>Park Road, Chak Shahzad, Islamabad. | Member |
| 10. | Dr. Syed Waseem Hassan,<br>Assistant Professor,<br>University College of Agriculture,<br>B.Z University, Multan.  | Member |
| 11. | Dr. Saif Ullah Ajmal,<br>Associate Professor,<br>University of Arid Agricultural, Rawalpandi.   | Member |
| 12. | Mr. Zahir Ali,<br>Lecturer,<br>Department of Biotechnology,<br>University of Malakand, Chakdara.  | Member |
| 13. | Mrs. Rashda Zafar,<br>Head,<br>Department of Botany,<br>Lahore College for Women University,<br>Jail Road, Lahore.  | Member |
| 14. | Mr. Asad Shabir<br>Assistant Professor,<br>Department of Mycology and Plant Pathology,<br>University of the Punjab, Lahore.                                       | Member |
| 15. | Dr. Iftikhar Hussain Khalil,<br>Associate Professor,<br>Plant Breeding & Genetics Department,<br>NWFP, Agricultural University, Peshawar.                         | Member |
| 16. | Mr. Sardar Ali Khan<br>Assistant Professor,<br>Plant Breeding and Molecular Genetics<br>Faculty of Agriculture. Rawalakot, AJK.                                   | Member |

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|-----|--|-----------|
| 17. | Prof. Dr. M. Fareed Khan<br>Chairman,<br>Department of Plant Breeding and Molecular Genetics<br>Faculty of Agriculture, Rawalakot, AJK.    | Member    |
| 18. | Prof. Dr. Raziuddin,<br>Department of Plant Breeding & Genetics<br>NWFP, Agricultural University, Peshawar.                                | Member    |
| 19. | Prof. Dr. Fida Muhammad,<br>Department of Plant Breeding & Genetics<br>NWFP, Agricultural University, Peshawar.                            | Member    |
| 20. | Dr. Muhammad Khan<br>Director<br>Cereal Crops Research Institute,<br>Pirsabak, Nowshera.   | Member    |
| 21. | Dr. Yusuf Zafar (T.I)<br>Chief Scientific Officer<br>National Institute for Biotechnology & Genetic Engineering<br>Jhang Road, Faisalabad. | Member    |
| 22. | Dr. Abdul Bari<br>Research Officer<br>Agricultural Research Station (North)<br>Mingora, Swat.  | Member    |
| 23. | Dr. Hafeez Ahmed Sadaqat,<br>Associate Professor,<br>Department of Plant Breeding & Genetics,<br>University of Agricultural, Faisalabad.   | Secretary |

Meeting started with the recitation from the Holy Quran. Mr. Sikandar Khan, Director HEC Regional Center, Peshawar welcomed the participants of the meeting.

Mr. Muhammad Tahir Shah, Assistant Director (Curriculum), HEC briefed the members that the HEC is striving hard to enhance quality of education in universities/institutions by making curriculum more compatible with international standard, job oriented and to match the needs of society. He

introduced the members of the committee of different Academic Programms of the commission aimed at facilitated the universities in execution of their programmes launched by HEC including Digital libraries, indigenous & overseas Ph. D. scholarships, In-service training of faculty, research grants, writing of monographs & textbooks etc.

Mr. Muhammad Tahir Ali Shah, circulated the minutes of Dean Committee meeting for restructuring of undergraduate (4 years degree programme) and requested the committee to follow the decisions to ensure uniformity at national level in all agriculture universities and degree awarding institutions

The committee discussed the scheme of studies and course contents both at under- and post-graduate levels in depth and unanimously improved the curricula by incorporating the latest advancements in the discipline of Plant Breeding and Genetics on national and international levels. In certain cases, the titles of the courses were also changed. The revised scheme of studies and course contents for both under- and post-graduate degree programs are attached herewith. The revisions in the curricula were made in the light of decisions taken by Joint Committee of Deans/Conveners of NCRC to **Restructure Curriculum of Under-graduate 4-Year Agriculture Degree Program** in a meeting held on April 19, 2005 at HEC Regional Center, Lahore.

The committee realized that complete uniformity in the syllabi could not be achieved due to site/regional specific agricultural issues. Therefore, different universities and colleges of agriculture were allowed for variation on minor level in the syllabi.

After thorough discussion, the committee decided that courses: PBG-302, PBG-401 and PBG-402 will remain as general courses to be taught to all undergraduate students before selection of the major discipline of studies.

## Scheme of Study for 4-Year B.Sc (Hons) Agriculture

Mathematics / Biology	6 Credits
Statistics 1 & 2	6
Computers / IT	3
Pak Studies	2
Islamiat	2
Communications Skills	3
English	3
Basic Agriculture	3
<b>Sub-Total</b>	<b>28</b>

One subject from each of the following disciplines

Agronomy	3
Plant Breeding & Genetics	3
Entomology	3
Plant Pathology	3
Food Technology	3
Horticulture	3
Soil Sciences	3
Agriculture Economics	3
<b>Sub-Total</b>	<b>24</b>

Additional Courses from disciplines mentioned below and above

Agriculture Extension	
Forestry & Range Management	
Animal Science	
Marketing & Agri Business	
Rural Development	
Human Nutrition	
Agriculture Chemistry	
Agriculture Engineering	
Water Management	
<b>Sub-Total</b>	<b>21-25</b>
<b>Sub-Total during the first four semesters</b>	<b>73 – 77</b>
<b>Semester 5, 6, 7 19 Credit Hours each</b>	<b>57</b>
<b>Final Semester</b>	<b>15</b>
<b>Grand Total</b>	<b>145 – 149</b>

**SCHEME OF STUDIES  
FOR  
UNDER-GRADUATE COURSES  
IN PLANT BREEDING AND GENETICS**

<b>Course No.</b>	<b>Title</b>	<b>Credit Hours</b>
PBG-302	Elementary Genetics	3(2-1)
PBG-401	Introductory Plant Breeding	3(2-1)
PBG-402	Introductory Molecular Genetics and Biotechnology	3(2-1)
PBG-501	Principles of Genetics	4(3-1)
PBG-502	Breeding Fibre Crops	4(3-1)
PBG-503	Breeding Field Crops	4(3-1)
PBG-504	Breeding Minor Crops	4(3-1)
PBG-505	Cytogenetics	4(3-1)
PBG-506	Breeding Oilseed Crops	4(3-1)
PBG-507	Methods in Genetics and Biometry	3(0-3)
PBG-508	Modern Techniques in Plant Breeding	3(2-1)
PBG-601	Breeding Sugar Crops	2(1-1)
PBG-603	Breeding Cereal Crops	3(2-1)
PBG-605	Breeding Pulse Crops	3(2-1)
PBG-607	Breeding Fodder and Forage Crops	3(2-1)
PBG-609	Germplasm Resources of Field Crops	2(2-0)
PBG-610	Internship and External Evaluation	15(0-15)
PBG-611	Preparation of Research Project and Scientific Writing	2(1-1)

**DETAIL OF COURSES**  
**FOR UNDER-GRADUATE STUDIES**  
**IN PLANT BREEDING & GENETICS**

**PBG-302    ELEMENTARY GENETICS**

**3(2-1)**

**OBJECTIVES**

To enable students to understand

1. The basic principles of genetics
2. The mechanism of heredity and effects of environment
3. How the traits are linked, expressed and transmitted from generation to generation

**THEORY**

Definition of genetics, concepts of heredity and variation. Chromosome theory of heredity; Sutton-Boveri law. Mendel's laws of segregation and independent assortment. Factors contributing to Mendel's success. Monohybrid and dihybrid phenotypic and genotypic ratios and their modifications. Illustration of epistasis by suitable examples; Pleiotropy and Multiple allelism. Multiple factor hypothesis and use of binomial theorem. Linkage and crossing over, discovery, definition, detection and calculation. Sex determination. Structure and replication of DNA.

**PRACTICAL**

Cell cycle and gametogenesis. Calculation of monohybrid and dihybrid ratios from suitable plant materials. Practice in solving numerical problems relating to multiple alleles, multiple factors and gene interaction. Calculation of linkage from test cross and F<sub>2</sub> data.

**BOOKS RECOMMENDED**

1. Gardner, E. J., M. J. Simmons and D. P. Snustad. 1991. Principles of Genetics. (8<sup>th</sup> ed.) John Wiley and Sons Inc., New York, USA
2. Griffiths, A. J. F., J. H. Miller, D. T. Suzuki, R. C. Lewontin and W. M. Gelbart. 2005. An Introduction to Genetic Analysis. W.H. Freeman and Company, New York, USA
3. Klug, W. S. and M. R. Cummings. 2003. Concepts of Genetics (7<sup>th</sup> Ed.), Pearson Education, Singapore
4. Singh, P. 2003. Elements of Genetics. (2<sup>nd</sup> Ed.) Kalyani Publishers, Delhi, India

## **OBJECTIVES**

To enable students to understand

- The reproductive mechanisms and mode of pollination in various crop plants
- The application of genetic principles in crop improvement.
- The basics of breeding methods in crop plants.
- 

## **THEORY**

Role of genetics in plant breeding, natural variation and its exploitation, creation of variation through induced mutation and heteroploidy. Genetic consequences of different reproductive systems. Breeding methods for self-pollinated crop plants viz., introduction, mass selection, pure line selection; hybridization, pedigree method, bulk method and backcross techniques. Breeding methods for cross-pollinated crop plants, introduction, mass selection, recurrent selection, development of inbred lines, hybrid and synthetic populations. Development of clones in asexually propagated crop plants.

## **PRACTICAL**

Descriptive study of floral structures and modifications in important field crops. Selfing and crossing techniques in self and cross-pollinated crops. Selection techniques and handling of filial generations, Phenomenon of heterosis.

## **BOOKS RECOMMENDED**

1. Khan, M. A (Editor). 1994. Plant Breeding. National Book Foundation, Islamabad.
2. Poehlman, J. H. and D. A. Sleper. 1995. Breeding Field Crops. 4th ed. Iowa State University Press/Ames, USA.
3. Singh, B. D. 2003. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.
4. Singh, P. 2003. Essentials of Plant Breeding. Kalyani Publishers, N Delhi, India

**OBJECTIVES**

To enable students to understand:

- The concept of genetic codes and gene function.
- The basics of genetic engineering and biotechnology.
- The scope of transgenics in plant breeding.
- 

**THEORY**

Concept of genetic code and protein synthesis. Basic control system in gene expression. Recombinant DNA, Transformation, identification of recombinants, various techniques of developing transgenic plants, gene cloning, PCR and its applications. DNA fingerprinting. Tissue culture, organogenesis, micro propagation, the scope of transgenic plants in plant breeding.

**PRACTICAL**

Preparation of nutrient media. Sterilization techniques. *In vitro* culturing. DNA Extraction. Working of PCR and gel electrophoresis.

**BOOKS RECOMMENDED**

1. Bilgrami, K. S. and A. K. Pandey. 1992. Introduction of biotechnology. CBS Publishers & Distributors, New Delhi, India
2. Maniatis, T., E. F. Fritsch and J. Sambrook, 1989. Molecular Cloning. A laboratory manual. Cold. Spring Harbour
3. Razdan, M. K. (Ed) 2003. Introduction to Plant Tissue Culture. 2nd Ed. Intercept, New York, USA

**PBG-501 PRINCIPLES OF GENETICS****4(3-1)****OBJECTIVES**

To enable students to understand:

- The principles of genetics
- Chemical nature of genetic material
- Genetic control of protein synthesis
- Molecular basis of gene
- Mutation and its types

## **THEORY**

Relative role of heredity and environment in the development of characters. Gene interaction: Multiple alleles; Multiple factor inheritance. Pleiotropism; Sex determination and sex-linkage inheritance. Sex and genic balance. Holandric genes, sex influenced and sex limited genes. Extra chromosomal inheritance. Linkage and crossing over. Three-point and multipoint linkage tests and chromosome mapping. Chemical nature of genetic material; Structure of DNA and RNA, genetic control of protein synthesis. Genetic coding, Molecular basis of gene. Mutation, various types of mutation and their implications.

## **PRACTICAL**

Solving problems on dihybrid and multihybrid segregation in F<sub>2</sub> and backcross. Interaction ratios. Sex inheritance problems on linkage and crossing over; Mapping of chromosomes. Solving problems including population genetics involving gene and genotypic frequencies. Construction of models for DNA structure and replication.

## **BOOKS RECOMMENDED**

1. Brooker, R. J. 2005. Genetics: Analysis and Principles. (2<sup>nd</sup> ed) McGraw-Hill
2. Jones, R. N. and G. K. Richards. 1991. Practical Genetics. Open University Press, Milton Keynes, Philadelphia, USA
3. Singh, B. D. 2003. Genetics. 1st Ed. Kalyani Publishers, New Delhi, India
4. Strickberger, M. W. 1990. Genetics. 3rd ed. McMillan Publishing Company, New York, USA

## **PBG-502 BREEDING FIBRE CROPS**

**4(2-2)**

### **OBJECTIVES**

To enable students to understand:

- The developmental history of various fibre crops
- Breeding fibre crops for yield and quality characteristics
- The breeding methods for incorporating resistance against biotic and abiotic stresses

### **THEORY**

Origin, history and a brief review of breeding of cotton, jute, hemp and other fibre crops. Taxonomy of cotton and other fibre crops. Species of cotton of economic importance. Objectives and methods of breeding cotton and other fibre crops. Host-plant genetic resistance mechanisms. Resistance to insect pests, diseases and abiotic

stresses. Transgenic cotton and the use of genetic engineering for breeding cotton.

## **PRACTICAL**

Selfing and crossing techniques in cotton and jute. Identification of various insect pests and diseases of cotton. Testing of fibre traits in cotton and jute. Visit to cotton research organizations and industrial units.

## **BOOKS RECOMMENDED**

1. Afzal, M. and M. Ali. 1983. Cotton Plant in Pakistan. Ismail Aiwan-e-Science, Lahore
2. Fehr, W. R. (Ed). 1987. Principles of Cultivar Development. Vol. 2, McMillan Publishing Company, New York, USA
3. Munro, J. M. 1987. Cotton. Longman Group Ltd., Essex, England
4. Poehlman, J. M. and D.A. Sleper. 1995. Breeding Field Crops. 4th Ed. Iowa State University Press/Ames, USA
5. Rafiq, M. 2004. Cotton: An Introduction. ICAC Washington DC, USA
6. Kohel, R.J. and C.E. Lewis (Eds). 1984. Cotton. Agronomy Series No.24. American Society of Agronomy. Crop Sci. Society of America, Soil Science Society of America Inc. Publishers, Madison, Wisconsin, USA

## **PBG 503 BREEDING FIELD CROPS**

**4(3-1)**

### **OBJECTIVES**

To enable students to understand

- The details of breeding methods in crop plants
- The application of genetic principles in crop improvement
- Different genetic and cytoplasmic systems in crop plants
- Idiotypes of various crops
- Variety development and release procedures
- 

### **THEORY**

Introduction to plant breeding and its history, breeding objectives and some important achievements, the strategy of plant breeding, genetic variability: the basis of plant breeding; scales of variability, Threshold characters: penetrance and expressivity. Breeding methods in self-, cross-pollinated and asexually propagated crops. Development of doubled haploids, mutation breeding, polyploidy in breeding, use of distant hybridization. Heterosis: genetic basis and exploitation, Male sterility and self-incompatibility: genetics, mechanism and exploitation. Breeding crops for biotic and abiotic stresses. Ideotype concept and

its various types, ideotype breeding and its limitations. Scope and importance of biotechnology in plant breeding. Release of new varieties, quality seed and its classes, maintenance of improved seed.

### **PRACTICAL**

Practice of selfing and crossing techniques in self- and cross-pollinated crops. Conduct of experiments for evaluating genotypic responses to biotic and abiotic stresses in field crops.

### **BOOKS RECOMMENDED**

1. Chahal, G. S. and S. S. Gosal. 2002. Principles and Procedures of Plant Breeding: Biotechnological and Conventional Approaches. Alpha Science International Ltd., UK
2. Khan, M. A (Ed). 1994. Plant Breeding. National Book Foundation, Islamabad
3. Poehlman, J. H. and D. A. Sleper. 1995. Breeding Field Crops. 4th ed. Iowa State University Press/Ames, USA
4. Simmonds, N.W. and J. Smartt. 1999. Principles of Crop Improvement. Blackwell Science. London, UK
5. Singh, P. 2004. Essentials of Plant Breeding. Kalyani Publishers, New Delhi, India

## **PBG-504 BREEDING MINOR CROPS**

**4(3-1)**

### **OBJECTIVES**

To enable students to understand

- The details of breeding methods in minor crops
- The application of genetic principles in minor crop improvement
- Different genetic and cytoplasmic systems in minor crop plants
- Ideotype of various minor crops
- Variety development and release procedures in minor crops
- 

### **THEORY**

Importance of minor crops: barley, guar, sesame, linseed, millets, sorghum, tobacco, etc. Breeding objectives, methodologies and selection procedures; recurrent selection, general and specific combining ability. Use of male sterility, commercial hybrid seed production. Breeding for biotic and abiotic stresses.

### **PRACTICAL**

Handling of inbred lines and hybrid materials. Development of various crosses, populations of minor crops, layout of experiments, recording and analysis of data on various plant parameters, visit to research Institutes and industry.

## **BOOKS RECOMMENDED**

1. Claudia, M. 1998. Specialty and Minor Crops Handbook. University of California USA
2. Douglas, C. A. 2005. Evaluation of Guar Cultivars in Central and Southern Queensland. RIRDC Publications, Australia
3. Jordan G. (Editor). 2004. Tobacco in History and Culture: An Encyclopedia. Charles Scribner's Sons
4. Khan, M. A (Editor). 1994. Plant Breeding. National Book Foundation, Islamabad
5. Poehlman, J. H. and D. A. Sleper. 1995. Breeding Field Crops. (4<sup>th</sup> ed.) Iowa State University Press/Ames, USA

## **PBG-505 CYTOGENETICS**

**4(3-1)**

### **OBJECTIVES**

To enable students to understand:

- Structure and functions of cell organelles
- Chromosomal structure, functions and their abnormalities

### **THEORY**

Description of plant cell organelles and their role in inheritance. Gross morphology and functions of chromosomes. Fine structure of chromosomes. Cytological differences in mitosis and meiosis. Karyotype studies of plant species; construction of ideograms; arm ratio and centromere index. Spontaneous and induced chromosomal aberrations. Structural changes and breakage of chromosomes by chemicals. Cytological basis and proofs of crossing over; Factors affecting crossing over. Chromosome mapping.

### **PRACTICAL**

Tools and techniques used in the laboratory, Preparation of different solutions, preservatives, fixatives and stains for cytological studies. Collection and identification of suitable material for cytogenetic studies. Observation of mitotic and meiotic chromosomes. Pollen viability test. Use of colchicine for chromosome duplication. Micrometry.

## **BOOKS RECOMMENDED**

1. Clark, M. S. and W. J. Wall. 1996. Chromosomes: The Complex Code. Chapman and Hall Ltd., London, UK
2. Dnyansagar, V. R. 1986. Cytology and Genetics. Tata McGraw Hill Publishing Co. Ltd. New Delhi, India

3. Jahier, J, A. M. Chevre, R. Delourme, F. Eber, and A. M. Tanguy. 1996. Techniques of Plant Cytogenetics. Science Publishers Inc, NY , USA
4. Larik, A. S. and M. A. Naz. 1999. Aneuploidy in Plant Breeding. Samara Printers, Karachi, Pakistan
5. Schulz-Schaeffer, J. 1980. Cytogenetics: Plants, Animals, Humans. Springe-Verlag, New York, USA
6. Singh, R. J. 2002. Plant Cytogenetics. 2nd Ed. CRC Press, USA

**PBG-506**

**BREEDING OILSEED CROPS**

**4(2-2)**

### **OBJECTIVES**

To enable students to understand:

- The details of breeding methods in oilseeds.
- The application of genetic principles in oilseeds improvement.
- Different genetic and cytoplasmic systems in oilseeds.
- Ideotype of various oilseed crops.
- Variety development and release procedures in oilseeds.

### **THEORY**

Origin and classification of oilseeds. Role of edible oilseeds in agriculture and economy. Introduction to conventional and non-conventional oilseeds, factors responsible for yield constraints and production. Breeding objectives and modified methodologies; Genetics of male sterility mechanisms and techniques for its induction for hybrid seed production. Exploitation of heterotic potential, development of inbreds, synthetics, hybrids and polycrosses. Character linkages. Development of double low varieties in rapeseed mustard crops.

### **PRACTICAL**

Identification of oilseeds, their reproductive biology, estimation of oil quality. Development of hybrid populations of oilseed crops, selection practices in segregating populations.

### **BOOKS RECOMMENDED**

1. Kimber, D. 1995. Brassica Oilseeds: Production and Utilization. Cambridge, UK and DI McGregor
2. Nagata, T. and S. Tabata (Ed).2003. Brassica and Legumes - From Genome Structure to Breeding. Springer Verlag, New York, USA
3. Ramanath. 2004. Applied Genetics of Oilseed Crops. Daya, New Delhi, India

4. Rehman, A., M. Munir, and M. A. Yousaf 1988. Rape and Mustard in Pakistan. PARC, Islamabad
5. Robbelem, G. and R. K. Downey. 1990. Oil Crops of the World, their Breeding and Utilization, HcGraw Hill Publishing Company, New York, USA
6. Verma, D. P. S. 1996. Soybean: Genetics, Molecular Biology and Biotechnology. Biotechnology in Agriculture Series, No 14. CABI Publishing

**PBG-507    METHODS IN GENETICS AND BIOMETRY    3(1-2)**

**OBJECTIVES**

To enable students to understand

- The application of biometrical techniques in genetics and breeding
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**THEORY**

Genetic analysis of quantitative and qualitative characters. Gene and genotype frequency in populations; Hardy-Weinberg law and its applications. Chi-square: definitions, assumptions, Yate's correction for continuity and interpretation. Test of independence or association. Methods related to one and two means, variance and covariance. Heritability and its uses.

**PRACTICAL**

Collection and tabulation of data on qualitative and quantitative traits. Estimation of gene and genotypic frequency from suitable examples. Chi-square: computation including test of independence or association. Methods related to one and two means, variance and covariance. Analysis of variance for one-way and two-way classifications. Methods of comparisons of means. Estimations of heritability. Correlation and regression analysis.

**BOOKS RECOMMENDED**

1. Backer, W. A. 1992. Manual of Quantitative Genetics. 5th Ed. Academic enterprises, Pullman, USA
2. Kang, M. S and M. Kang (Ed). 2003. Handbook of Formulas and Software for Plant Geneticists and Breeders. Harworth Press Inc, LA, USA
3. Singh, P. 2000. Biometrical Techniques in plant Breeding. 2nd Ed. Kalyani Publishers, New Delhi, India
4. Singh, R. K. and P. K. Singh. 1999. Biometrical Methods in Quantitative Genetics Analysis. Kalyani Publishers, New Delhi, India

**OBJECTIVES**

To enable students to understand

- Modern breeding methodologies, their principles and applications in crop improvement.

- 

**THEORY**

Introduction to genetic engineering and plant biotechnology. Basics of molecular biology; structure, organization, expression and regulation of gene. Transposons; bacterial transformation, conjugation and transduction. The concept of restriction, ligation, plasmids, vectors and transformation. DNA amplification, the polymerase Chain Reaction, DNA fingerprinting, transformation. Gene switches, and gene cloning. *In vitro* culture techniques; callus culture. Cell suspension culture, protoplast culture. The scope of transgenic plants in plant breeding. Introduction to bioinformatics.

**PRACTICAL**

Introduction to aseptic techniques, autoclaving, sterilization, Use of laminar flow and fume hoods for carrying out work. Handling chemicals, glassware and equipments. Storage and weighing of chemicals, Safety measures in the laboratories. Preparation of stock-solutions, adjusting the pH, making dilutions. Media preparation. Isolation, handling and quantification of DNA. Preparation of gels, Ladder markers. Restriction digestion, electrophoresis. Running, viewing and reading the gels.

**BOOKS RECOMMENDED**

1. Bilgrami, K. S. and A. K. Pandey. 1992. Introduction of Biotechnology. CBS Publishers & Distributers, New Delhi, India
2. Brown, T. A. 2000. Essential Molecular Biology: A Practical Approach Vol 1. Oxford University Press. New York, USA
3. Brown, T. A. 2000. Essential Molecular Biology: A Practical Approach Vol 2. Oxford University Press. New York, USA
4. Lodish, H. 2004. Molecular Cell Biology. (5<sup>th</sup> Ed.), John Wiley & Sons, NY, USA
5. Maniatis, T., E. F. Fritsch and J. Sambrook, 1989. Molecular Cloning. A Laboratory Manual. Cold. Spring Harbour, NY, USA
6. Paul, C and K. Harry. 2004. Handbook of Plant Biotechnology. John Willy & Sons, New York, USA
7. Razdan, M. K. (Ed) 2003. Introduction to Plant Tissue Culture. (2<sup>nd</sup> ed.) Intercept, New York, USA

**OBJECTIVES**

To enable students to understand

- The details of breeding methods in sugar crops
- The application of genetic principles in sugar crops
- Different genetic systems in sugar crops
- Ideotype of various sugar crops
- Variety development and release procedures in sugar crops.

**THEORY**

Sugar crops, origin, classification and botanical features; *Officinarum* canes, their evolution and present status; flowering: a breeding constraint; Artificial induction of flowering and hybridization techniques; Selection strategies and evolution of new varieties. Improvement through modern approaches, Co-products of sugarcane. Sugarbeet: botany, genetics, induction of flowering and breeding objectives. Seed production strategies.

**PRACTICAL**

Identification of sugarcane species and varieties using morphogenetic features; Study of sugarcane flowering mechanism, development of clones from seedling population, Study of morphogenetic features of sugar beet. Evaluation of sugarcane and sugar beet for quality parameters. Visit to sugar industries/research institutes.

**BOOKS RECOMMENDED**

1. Blackburn, F. 1984. Sugarcane. Longman Group Ltd. Essex England
2. Jaggard, K. W. (ed.) 1989. Sugar Beet; A Grower's Guide. Sugar Beet Research and Education Committee, London, UK
3. Mathur, R. B. L. 1992. Hand Book of Cane Sugar Technology. 2nd ed. Oxford and IBH, Publ. Co. (Pvt), Ltd, New Delhi, India
4. PARCB. 1984. Sugarcane. Punjab Agricultural Research Coordination Board, University of Agriculture, Faisalabad
5. Poehlman, J. M. and D.A, Sleper. 1995. Breeding Field Crops. (4<sup>th</sup> ed.) Iowa State University Press/Ames, USA
6. Razdan, M. K. (Ed) 2003. Introduction to Plant Tissue Culture. 2nd Ed. Intercept, New York, USA
7. Yadava, R. L. 1991. Sugarcane Production Technology; Constraints and Potentialities. Oxford and 1BH Publishing Co., Pvt. Ltd., New Delhi, India

**OBJECTIVES**

To enable students to understand

- The details of breeding methods in cereals.
- The application of genetic principles in cereals.
- Different genetic and cytoplasmic systems in cereals.
- Ideotype of cereals.
- Variety development and release procedures in cereals.

**THEORY**

Introduction, problems and prospects of cereals, wheat, maize and rice in Pakistan, Breeding objectives and methodologies, Development of isogenic lines, breeding for quality, development of cultivars for marginal lands. Use of non-conventional methods for improvement. Development of hybrids and exploitation of male sterility and other mechanisms. Resistance breeding.

**PRACTICAL**

Synthesis of hybrid population using appropriate parents and hybridization techniques; Layout of lab and field experiments. Use of selection strategies, recording of data on various growth parameters, statistical analysis and interpretation; analysis for quality. Visit to research institutes.

**BOOKS RECOMMENDED**

1. Chaudhry, A. R. 1983. Maize in Pakistan, Punjab Agric. Res. Coordination Board, Univ. of Agric., Faisalabad, Pakistan.
2. Heyne, E. G. (ed.), 1987. Wheat and Wheat Improvement. 2nd ed. ASA, CSSA and SSSA. Agronomy Monograph 13, Amer. Soc. Agron., Madison, Wisconsin, USA.
3. Morris, P. C. and J. H. Bryce. (Ed) 2000. Cereal Biotechnology. Woodhead, NY, USA.
4. Nanda, J. S. 2000. Rice Breeding and Genetics: Research Priorities and Challenges. Pak Book Corporation, Lahore.
5. Poehlman, J. M. and D. A. Sleper. 1995. Breeding Field Crops. (4<sup>th</sup> ed.) Iowa State University Press/Ames, USA.
6. Rehman, A, and K. Alam. 1994. Principles of Crop Breeding. University of Agriculture, Faisalabad, Pakistan.
7. Rehman, A. 1987. Manual of Wheat Breeding Procedures. Food and Agriculture Organization of United Nations, Rome, Italy.

**OBJECTIVES**

To enable students to understand:

- The details of breeding methods in pulses.
- The application of genetic principles in pulses.
- Different genetic and cytoplasmic systems in pulses.
- Ideotype of pulses.
- Variety development and release procedures in pulses.

**THEORY**

Introduction, classification, and evolution of pulse crops. Morphological Characteristics and breeding objectives of important pulse crops, their genetics and improvement. Breeding and hybridization constraints of pulses and possible improvement strategies. Breeding for quality, biotic and abiotic stresses. Nitrogen fixation in pulses.

**PRACTICAL**

Study of reproductive biology of important pulses- Crossing and hybridization techniques in major pulses. Study of Rhizobium nodulation and nitrogen fixation in various pulse crops. Layout of field experiments and data recording for various genetic parameters its statistical analysis and interpretation. Visit to research stations.

**BOOKS RECOMMENDED**

1. Nagata, T. and S. Tabata (Ed). 2003. Brassica and Legumes - From Genome Structure to Breeding. Springer Verlag, New York, USA
2. Persley, G. J. (ed.). 1984. Tropical Legume Improvement. Biblotech Anutech Pty Ltd., Canberra, Australia
3. Poehlman, J. M. and D. A. Sleper. 1995. Breeding Field Crops. (4<sup>th</sup> ed.) Iowa State University Press/Ames, USA
4. Sunnerfield, R. J. and E. H. Roberts, 1985. Grain Legume Crops. William Collins Sons and Co., Ltd., London, England

**PBG-607 BREEDING FODDER AND FORAGE CROPS****3(2-1)****OBJECTIVES**

To enable students to understand:

- The details of breeding methods in fodder and forages.
- The application of genetic principles in fodder and forages.
- Different genetic and cytoplasmic systems in fodder and forages.
- Idiotypes of fodder and forages.

- Variety development and release procedures in fodder and forages.

## **THEORY**

Introduction to fodder and forage crops, breeding problems and their possible genetic solutions. Vegetative propagation of fodder and forages. Genetic and cytogenetic studies in fodder and forage crops. Breeding self-, cross- pollinated and apomictic species. Seed production. Pasture forages. Mechanical seed mixtures. Breeding for nutritive quality. Application of biotechnology in fodder and forage breeding.

## **PRACTICAL**

Pollination, fertilization and seed setting in fodder and forage crops. Handling of self-, cross- pollinated and apomictic fodder and forage species. Determination of nutritive quality; nutritive value, intake and digestibility, toxic substances. Visit to research organizations, livestock farms and feed industry.

## **BOOKS RECOMMENDED**

1. Chatterjee, B. N, 1989. Forage Crop Production: Principles and Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India
2. Rognli, O.A.; E.T. Solberg, I. Schjelderup, (Eds.). 1994. Breeding Fodder Crops for Marginal Conditions. Series: Developments in Plant Breeding, Vol. 2. Springer
3. Poehlman J. M. and D. A. Sleper. 1995. Breeding Field Crops. 4th ed. Iowa State University Press/Ames, Iowa, USA
4. Sleper, D. A., K. H. Asay and J.F. Pedersen, (ed.) 1989. Contributions from Breeding Forage and Turf Grasses. CSSA Special Publication 15, Amer. Soc. Agron., Madison, Wisconsin, USA

## **PBG-609 GERMLASM RESOURCES OF FIELD CROPS**

**2(2-0)**

### **OBJECTIVES**

To enable students to understand:

- The importance of biodiversity in plant breeding.
- Principles and strategies of germplasm collection, maintenance, evaluation and conservation.
- Role of molecular techniques in identification and preservation of genetic resources.



The papers, table of contents, list of tables, the use of scientific quotations, illustrations, appendices, statistics and tables, standard abbreviations, editing and evaluating the final draft.

## **PRACTICAL**

Exercise of writing research proposal, assigning different titles to the students, exercise of collecting material from different sources on assigned topics, oral presentation.

## **BOOKS RECOMMENDED**

1. Anderson, J., B. H. Durston and M. Poole. 1992. Thesis and Assignment Writing. Wiley Eastern Ltd. New Delhi, India
2. Andrew, C. O. 1993. Applied Agricultural Research: Foundations and Methodology. Westview Press
3. Awan, J. A. 2003. Scientific Presentation. Unitech Communication, Faisalabad, Pakistan.
4. Gatner, E. S. M. and F. Cordasco. 1959. Research and Report Writing. Barnes and Noble, Inc., New York, USA
5. William R. L. 2001. Fine-Tuning Your Writing. Wise Owl Publishing Co., Madison, USA

**SCHEME OF STUDIES  
FOR  
POST-GRADUATE COURSES  
IN PLANT BREEDING AND GENETICS**

<b>Course No.</b>	<b>Title of the course</b>	<b>Credit hours</b>
PBG-701	Principles of Plant Breeding	3(2-1)
PBG-702	Hybrid Seed Production of Field Crops	3(2-1)
PBG-703	Breeding of Forage and Fodder Crops	3(2-1)
PBG-704	Advanced Methods in Plant Breeding	4(2-2)
PBG-705	Evolution of Field Crops	3(3-0)
PBG-706	Biotechnology in Crop Improvement	3(2-1)
PBG-707	Cytogenetics of Crop Plants	3(2-1)
PBG-708	Population Genetics	3(3-0)
PBG-709	Genetics of Plant Disease and Insect Resistance	3(2-1)
PBG-710	Advanced Cytogenetics	4(3-1)
PBG-711	Quality Evaluation in Field Crops	3(2-1)
PBG-712	Advanced Genetics	3(3-0)
PBG-713	Biometrical Techniques in Plant Breeding	4(2-2)
PBG-714	Genesis of Genetic Concepts	3(2-1)
PBG-715	Mutation Breeding	3(2-1)
PBG-716	Genetics of Cereals	4(3-1)
PBG-717	Breeding of Crop Plants for Stress Environments	3(2-1)
PBG-718	Genetics of Fibre Crops	3(2-1)
PBG-719	Special Problems	1(1-0)
PBG-720	Seminar	1(1-0)
PBG-721	Genetics of Oilseed Crops	3(2-1)
PBG-722	Genetic Engineering in Plants	3(2-1)
PBG-723	Genetics of Sugar and Vegetable Crops	3(2-1)
PBG-724	Advances in Molecular and Microbial Genetics	4(3-1)

**DETAIL OF COURSES**  
**POST-GRADUATE COURSES**  
**IN PLANT BREEDING & GENETICS**

**PBG-701    PRINCIPLES OF PLANT BREEDING                    4(3-1)**

**THEORY**

Role of plant breeding in crop improvement. Variability in natural population; its genetic basis and exploitation in crop improvement. Creation of genetic variability using various conventional and non-conventional techniques. Principles and breeding methods of field crops. Heterosis and its exploitation in crop improvement.

**PRACTICAL**

Handling of the breeding material in various segregating generations. Estimating effective population and sample sizes. Development and maintenance of pure line/inbred lines.

**BOOKS RECOMMENDED**

1. Allard, R. W. 1999. Principles of Plant Breeding. John Wiley and Sons, New York, USA.
2. Fehr, W. R. 1987. Principles of Cultivar Development. Vol 1. Theory and Technique. Macmillan Publishing Co. New York.
3. Khan, M. A. (Ed). 1994. Plant Breeding. National Book Foundation, Islamabad.
4. Poehlman, J. M. and D. A. Sleper. 1994. Breeding Field Crops. 4<sup>th</sup> ed. Iowa State University Press, Ames, USA.
5. Richards, A. J. 1997. Plant Breeding Systems. Chapman & Hall London, U.K.
6. Simmonds, N. W. and J. Smartt. 1999. Principles of Crop Improvement. Blackwell Science, London, UK.
7. Watson, J. A. 2005. Crops: Varieties and Plant Breeding. Vardhaman New Delhi, India

**PBG-702    HYBRID SEED PRODUCTION OF FIELD CROPS                    3(2-1)**

**THEORY**

Background and basic requisites for hybrid seed production. Selection, development and maintenance of parental lines (A, B and R lines). Production technology for hybrid seed of field crops and vegetables. Certification requirements for hybrid seed production. Production of hybrids for seedless fruit and vegetables. Isolation, planting ratios and

synchronization of male and female parents. Field standards, genetic purity, harvesting and handling of hybrid seed. Problems of hybrids. Economic aspects of hybrid seed production.

### **PRACTICAL**

Selection and maintenance of A, B and R lines, under field conditions. Induction of male sterility through chemicals. Seed testing.

### **BOOKS RECOMMENDED**

1. Agrawal, R.C. 1998. Fundamentals of Plant Breeding and Hybrid Seed Production. Sci. Pub., Inc. New York.
2. Feistritzer, W.P. and A.F. Kelly (eds.) 1987. Hybrid Seed Production of Selected Cereal, Oil and Vegetable Crops. FAO Plant Production and Protection Paper 82, Food & Agri. Organization of the United Nations, Rome, Italy.
3. IRRI. 1988. Hybrid Rice. Proceedings of the International Symposium on Hybrid Rice. Oct, 6-10, 1986. Changsha, Hunan, China. International Rice Res. Inst. Manila, Philippines.
4. Singal, W.C. 2004. Hybrid Seed Production. Kalyani Publishers, NEW Delhi, India.

## **PBG-703 GENETIC IMPROVEMENT OF FODDER AND FORAGE CROPS 3(2-1)**

### **THEORY**

Reproductive mechanisms in various forage legumes and grasses. Sterility and incompatibility mechanisms. Procedures for breeding self-, cross-pollinated apomictic and polyploid fodder and forage species. Breeding for high productivity, and quality. Interspecific and intergeneric crosses in fodder and forage species. Modern breeding techniques in fodder and forage crops.

### **PRACTICAL**

Floral structure in different fodder and forage crops. Identification and classification of various rabi and kharif fodders. Selfing and crossing techniques. Handling of the breeding material.

### **BOOKS RECOMMENDED**

1. Bhatti, M. B. and S. Khan (eds.). 1996. Fodder Production in Pakistan. Pakistan Agricultural Research Council, Islamabad.
2. Humphreys, L. R. 1987. Tropical Pasture and Fodder Crops. 2<sup>nd</sup> ed. Longman Scientific and Technical, Longman Group, Essex,, U.K.
3. Khan, M. A. (Eds). 1994. Plant Breeding. National Book Foundation, Islamabad.

4. Mandal, A. K., P. K. Ganguli and S. P. Banerjee. 1991. Advances in Plant Breeding. Vol. 1-2, CBS Publishers and Distributors, New Delhi., India.
5. Poehlman, J. M. and D. A. Sleper. 1994. Breeding Field Crops. 4<sup>th</sup> ed. Iowa State University Press, Ames, USA.

## **PBG-704    ADVANCED METHODS IN PLANT BREEDING    4(2-2)**

### **THEORY**

Components of variation and estimation of the relative magnitude of genetic and environmental components. Description of additive and non additive variances and their estimation. Mating designs including diallel, Biparental progenies, Design I, II and III. Uses of mating design in plant breeding. Selection indices and their uses. Selection for two traits and selection for multiple traits. Visual selection and its characteristics; influence and efficiency of visual selection. Marker assisted selection and its application in plant breeding. Participatory plant breeding.

### **PRACTICAL**

Expected mean squares and their use in plant breeding. Covariance between relatives and theoretical basis of co-variance. Response to selection, selection differential, selection intensity, selection differential estimation, factors affecting efficiency of selection. Estimation of variance components and heritability from the mating designs.

### **BOOKS RECOMMENDED**

1. Bos, I. And P. Caligari. 1995. Selection Methods in Plant Breeding. Chapman & Hall, London, U.K.
2. Falconer, D.S. and T.F.C. Mackay. 1996. Introduction to Quantitative Genetics. Longman Group Ltd. London, U.K.
3. Jensen, N.F. 1988. Plant Breeding Methodology, John Wiley & Sons, Inc., New York.
4. Kang, M.S and M. Kang (Ed). 2003. Handbook of Formulas and Software for Plant Geneticists and Breeders. Harworth Press Inc, LA, USA.
5. Kang, M.S. (Ed) 2002. Quantitative Genetics, Genomics and Plant Breeding. CABI, Sussex, UK.
6. Kang, M.S. and H.G. Gauch. 1996. Genotype by Environment Interaction. CRC Press, NY, USA.
7. Kearsey, M.J. and H.S. Pooni. 1996. The Genetical Analysis of Quantitative Traits. Chapman and Hall, Ltd. London, U.K.

**THEORY**

Evolution and its theories. Process of evolution in crop plants. Hybridization: role of natural hybridization in evolution, hybridization as a source of variation for adaptation to new environments. Introgression in crop plants. Plant Breeding and evolutionary concepts. Role of various factors in evolution of crop plants, Isolating mechanisms; Species and speciation: the species concept; gradual and abrupt speciation. Significance of polyploidy in the evolution of crop plants. Patterns of evolution. Evolution and species relationship in important crop plants. Role of wide crosses in the evolution of different crop plants and their up-to-date progress. Genetic polymorphism.

**BOOKS RECOMMENDED**

1. Hancock, J. 2004. Plant Evolution and the Origin of Crop Species. (2<sup>nd</sup> Ed) Oxford University Press, USA
2. Ladizinsky, G. 1998. Plant evolution under domestication. Kluwer Academic Publishers New York, USA.
3. Sinha, U. and S. Sinha. 1991. Cytogenetics, Plant Breeding and Evolution. Vikas Publ. House (Pvt.) Ltd., New Delhi, India.
4. Smartt, J. and N.W. Simmonds (eds.) 1995. Evolution of Crop Plants. (2<sup>nd</sup> ed.) Longman Scientific and Technical, Longman Group U.K. Ltd., Essex, England.
5. Stickberger, M.W. 2000. Evolution. Jones & Bartlett, NY, USA.
6. Willis, K.J. and J.C. McElwain. 2002. Evolution of Plants. Oxford University Press, Oxford, UK.

**PBG-706 BIOTECHNOLOGY IN CROP IMPROVEMENT 3(2-1)****THEORY**

General introduction, Vegetative propagation; Micropropagation, callus induction, callus culture, regeneration of organs and embryos, regeneration of plants from single cells. Production of bacteria, virus and fungal free plants. Genetics of cultured plant cells. Somaclonal variation and its use in plant improvement. Production of haploids; genetic manipulation and its use, somatic hybridization, selection procedures after somatic hybridization. Production and handling of transgenic plants.

**PRACTICAL**

Introduction to laboratory equipments, preparation and composition of nutrient media, sterilization of plant material, isolation, inoculation and subculturing. Selection of mutants and handling of regenerated plants.



**THEORY**

Introduction to population genetics. Allele frequency and polymorphism. Organization of genetic diversity, random mating, population models; Hardy-Weinberg law and factors affecting the population structure. Systems of mating; causes of evolution, consequences of random genetic drift, genetic differentiation of populations. The neutrality hypothesis, evolution of amino acid sequences. Inbreeding in small populations, effective population size. Wahlund's principle, patterns of migration; natural selection; over-dominance, heterozygote inferiority. Mutation, selection balance; shifting balance. Molecular population genetics.

**BOOKS RECOMMENDED**

1. Brown, A. G. D., M. T. Clegg, A. L. Kahler and B. S. Weir. 1990. Population Genetics, Breeding and Genetic Resources. Sinauer Associates, Sunderland, Massachusetts, USA.
2. Falconer, D. S. and T. E. C. Mackay. 1996. Introduction to Quantitative Genetics. Longman, London.
3. Harri, D. L. 1980. Principles of Population Genetics. Sinauer Associates, Sunderland, Massachusetts, USA.
4. Neal, D. 2003. Introduction to Population Biology. Cambridge University Press, Cambridge, UK.
5. Tomer, S. K. 1998. Textbook of Population Genetics. Kalyani Publishers, New Delhi, India.
6. Wright, S. 1978. Evolution and the Genetics of Populations. University of Chicago Press, Chicago, Illinois, USA

**PBG-709 GENETICS OF PLANT DISEASE AND INSECT RESISTANCE****3(2-1)****THEORY**

Nature of parasitism, pathogenicity and expression of disease resistance. Mendelian, quantitative and cytoplasmic resistance in the host. Genetics of the pathogens. Genetics of host-pathogen interactions; Comparison of horizontal and vertical resistance. Evolution of host-pathogen systems, locating sources of disease resistance, selection and breeding methods. Plant resistance for insect pests and diseases. Nature and mechanism of resistance. Transfer of genetic resistance. Pyramiding genes for resistance. Evaluation of plant resistance to insect pest and diseases. Molecular approaches for insect pest and disease resistance.

## **PRACTICAL**

Inoculation techniques for various plant diseases. Remnants of resistance, disease tolerance. Experimental layout for evaluation of plant disease and insect pests resistance. Measurement of resistance by using different scoring scales and their statistical analysis.

## **BOOKS RECOMMENDED**

1. Gunasekaran, M. and D. J. Web (Ed). 1995. Molecular Biology of the Biological Control of Pests and Diseases of Plants. Department of Botany and Range Science, Brigham Young University, Provo, Utah
2. Johnson, R. 1992. Breeding for Disease Resistance. Kluwer Academic Publishers Group, Dordrecht, The Netherlands.
3. Kranz, J. (Ed) 2002. Comparative Epidemiology of Plant Diseases. Springer, NY, USA
4. Russell, G.E. 1981. Plant Breeding for Pest and Disease Resistance. Butterworths, London, U.K.
5. Sadasivam, S., and B. Thayumanavan (Ed). 2003. Molecular Host Plant Resistance to Pests. Marcel Dekker, NY, USA.
6. Vanderplank, J. E. 1984. Disease Resistance in Plants. 2nd ed. Academic Press, Inc., Orlando, Florida, USA.

**PBG-710**

## **ADVANCED CYTOGENETICS**

**4(3-1)**

### **THEORY**

Heteroploidy; trisomics, monosomics, nullisomics, their transmission and factors influencing transmission. Breeding and genetic behaviour, genetic ratios and uses of trisomics and monosomics. Autopolyploidy: occurrence and general characteristics. Haploids vs monoploids, artificial production of haploids and dihaploids. Theoretical genetic ratios for single gene locus, genetic data, linkages in autopolyploids. Allopolyploidy: origin, evidences of homology between chromosomes. Identification of parents of polyploids through use of conventional and molecular techniques including RFLPs, AFLPs, RAPDs, SSRs etc., behaviour of univalents, genetic and breeding behaviour. Aneuploids in allopolyploids like wheat, cotton and tobacco. Chromosomal identification in different genomes. Chromosome mapping, chromosome banding. *In situ* hybridization. Special methods of locating genes; polyploidy and evolution, polyploidy in speciation.

### **PRACTICAL**

Calculation of segregating ratios in polyploids and aneuploids. Orientation with different molecular techniques including RFLPs, AFLPs, RAPDs, GISH, FISH and SSRs.

## **BOOKS RECOMMEND**

1. Burnham, C. R. 1962. Discussions in Cytogenetics. Burgess Publishing Co., Minnea Pub. Minn., USA.
2. Ladish, H., A. Berk, P. Matsudaira, C. A. Kaiser and M. Kriger. 2005. Molecular Cell Biology. W.H. Freeman, NY USA.
3. Lorz, H. and G. Wenzel. 2004. Molecular Marker Systems in plant Breeding and Crop Improvement. Springer, NY, USA.
4. Puertas, M. J. and T. Naranjo. 2005. Plant Cytogenetics: Cytogenetic and Genome Research. S. Karger Pub.
5. Schulz-Schaeffer, J. 1981. Cytogenetics. Plants, animal, humans. Springer-Verlag, New York. USA.
6. Singh, R. J. 2005. Plant Cytogenetics. Muze Inc.
7. Swanson, C. P., T. Merz and W. J. Young. 1981. Cytogenetics. 2<sup>nd</sup> ed. Prentice Hall international Inc., Englewood Cliff, NJ, USA.

## **PBG-711 QUALITY EVALUATION IN FIELD CROPS 3(2-1)**

### **THEORY**

Definition and elements of quality in field crops. Categorization of quality parameters and quality standards in relation to WTO. Association of quality characters with yield and yield components and its significance in crop improvement. Use of refined and modern laboratory techniques for the evaluation of quality characteristics in crops.

### **PRACTICAL**

Use of various techniques and instruments for measuring the fibre quality traits. Estimation of brix value and sucrose content in sugarcane. Estimation of oil and protein content, fatty acids and amino acids in different field crops.

### **BOOKS RECOMMENDED**

1. A.O.C.S. 1999. Official and Tentative Methods of the American Oil Chemists Society. A.O.C.S. Chicago, Illinois, USA.
2. A.S.T.M. 1999. Standards on Textile Materials. Amer. Soc. for Testing and Materials, Philadelphia, USA.
3. Gupta, U. S. 2000. Crop Improvement: Quality Characters. Vol 3. Science Publishers Incorporated.
4. Hevne, E. G. (ed). 1987. Wheat and Wheat Improvement. 2<sup>nd</sup> (ed) Agronomy Series No.13. American Society of Agronomy, Crop Sci. Society of America, Soil Science Society of America Inc. Publishers, Madison, Wisconsin, USA.
5. Jullano, B. O. 1993. Grain Quality Evaluation of World Rices, IRRI, Manila, Philippines.
6. Kohel, R. J. and C. E. Lewis (eds). 1984. Cotton. Agronomy Series No.24. American Society of Agronomy. Crop Sci. Society of

America, Soil Science Society of America Inc. Publishers, Madison, Wisconsin, USA.

7. Mathur, R. B. L. 1992. Hand Book of Cane Sugar Technology. 2<sup>nd</sup> ed. Oxford and IBH, Publ. Co. (Pvt), Ltd, New Delhi, India.

## **PBG-712    ADVANCED GENETICS**

**3(3-0)**

### **THEORY**

Development of gene concept, various types of genes; classical versus modern concepts of gene. Genetic material: a brief review of identification, structure, function, organization, replication and properties of genetic material. Gene interaction: control, basis and importance. Gene expression and regulation in prokaryotes and eukaryotes. Gene, genetic code, one gene-one polypeptide concept, protein synthesis. Mutation: Classification, Biochemical basis, factors affecting the rate of mutation. Transposable genetic elements. Genetic recombination: mechanisms of recombination. Allelism. Genetics of behaviour. Cytoplasmic genetic systems, their origin and Biological, implications, genetics of killer traits. Introduction to non-conventional gene manipulation techniques.

### **Books Recommended:**

1. Hartl, D. L. 2005. Genetic Analysis of Genes and genomes. 6<sup>th</sup> Ed. John and Bartlett Publishers, NY, USA.
2. Lewin, B. 2004. Genes VIII. John Wiley and Sons, NY, USA.
3. Reece, R. J. 2004. Analysis of Genes and Genomes. John Wiley & Sons, NY, USA.
4. Rothwell, N. V. 1988. Understanding Genetics (4<sup>th</sup> ed), Oxford University Press, Oxford, U.K.
5. Tamarin, R. H. 1999. Principles of Genetics. 6<sup>th</sup>. Ed. WCB/McGraw Hill, New York. USA.

## **PBG-713    BIOMETRICAL TECHNIQUES IN PLANT BREEDING**

**4(2-2)**

### **THEORY**

Objectives and scope: law of probability, binomial and normal distributions. Regression and correlation, reliability of path analysis, regression and correlation coefficients and their use in selections. Genotype x environment interaction and adaptation; the biological complexity of genotype x environment interaction, line x tester analysis, generation mean analysis and their application in plant breeding.

### **PRACTICAL**

Assumptions of analysis. Normality, homogeneity, additivity, transformation of data for theoretical reasons. Genotypic and

phenotypic correlations, their estimation with test of significance. Correlated response to selection, analytical methods to assess stability. Estimation of genetic components from line x tester analysis and generation mean analysis.

### **BOOKS RECOMMENDED**

1. Becker, W.L. 1993. Manual of Quantitative Genetics. Washington State University Press, Pullman, Washington, USA.
2. Comstock, R.E. 1996. Quantitative Genetics with special reference to Plants and animal breeding. 1st ed. Iowa State University Press, Ames, Iowa, USA.
3. Mead, R., R.N. Curnow and A.M. Hasted. 2003. Statistical Methods in Agriculture and Experimental Biology. Chapman & Hall, London, UK.
4. Singh, R.K. and B.D. Chaudhary. 1997. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi, India.
5. Townend, J. 2002. Practical Statistics for Environmental and Biological Statistics. John Wiley, NY USA

## **PBG-714 GENESIS OF GENETIC CONCEPTS 3(2-1)**

### **THEORY**

Brief review of development of classical genetics; role of evolution, cytology and hybridization in the understanding of genetic principles. Advent of Mendelian genetics, its growth and development. Lysenkonian genetics; its rise and fall. Eugenics. Development of molecular and microbial genetics. Recent developments and the present status of the subject.

### **PRACTICAL**

Writing and presentation of comprehensive reviews on assigned topics of classical genetics, modern genetics, genetic engineering and gene cloning.

### **BOOKS RECOMMENDED**

1. Aylas. F. J. and A.J. Kiger. Jr. 1984. Modern Genetics. 2<sup>nd</sup> ed. The Benjamin/Cummings Publishing Company, Inc. California, USA.
2. Chertas, J. 1982. Man Made Life. A History of the Early Years of Genetic Engineering, Blackwell Scientific Publications, Oxford. England
3. Jain, H. K. and M. C. Kharkwal. 2004. Plant Breeding: Mendelian to Molecular Approach Kluwer Academic, Dordrecht, Netherlands
4. Sturtevent, A.H. 1965. A History of Genetics. Harper and Row Publishers, New York, USA.

5. Suzuki, D.T., A.J.F. Griffiths and R.C. Lewontin. 1993. An Introduction to Genetic Analysis. W.H. Freeman and Company, San Francisco, California, USA.

## **PBG-715 MUTATION BREEDING**

**3(2-1)**

### **THEORY**

Mutation and its importance in plant breeding. Induction of mutation, detection, evaluation and utilization of induced mutants. Somatic and germinal mutations. Classes of mutagens. Observations in  $M_1$ , procedure for selection in later generations, use of mutants in hybridization programme. Factors modifying the effectiveness of irradiation in seed treatment. Determination of  $LD_{50}$ . Effectiveness and efficiency for inducing cytogenetical changes. Gamma garden, cytological studies of mutants. Improvement of specific characters through induced mutation. Mutation breeding research in some vegetatively propagated plants.

### **PRACTICAL**

Radiation treatment techniques of seeds and other parts of plants; Radio sensitivity of field crops; Cytological analysis of mutants; Field observations and selection procedure of irradiated material.

### **BOOKS RECOMMENDED**

1. Datta, S.K. 2005. Role of Classical Mutation Breeding in Crop Improvement. Daya, New Delhi, India
2. FAO/IAEA. 1970. Manual of Mutation Breeding, FAO/IAEA Publications, Rome, Italy.
3. Khan, M.A. (Ed). 1994. Plant Breeding. National Book Foundation, Islamabad.
4. Van Harten, A.M. 1998. Mutation breeding. Theory and Practical Applications. Cambridge University Press, Cambridge, U.K.

## **PBG-716 GENETICS OF CEREALS**

**3(2-1)**

### **THEORY**

Origin and importance of cereals; Description of various species in cereals. Genetic analysis and inheritance of important plants and grain traits in cereals. Heterosis. Genetics and its utilization in cereals. Genetics of biotic and abiotic stress tolerance.

## **PRACTICAL**

Problems relating to genetics of cereal. Identification of cereal diseases, screening of cereal cultivars for drought resistance and salt tolerance within lab and field conditions.

## **BOOKS RECOMMENDED**

1. Hallauer, A.R. and J.B. Miranda. 1988. Quantitative Genetics in Maize Breeding. The Iowa State Univ. Press, Ames, Iowa, USA.
2. Heyne, E.G. (ed.) 1987 Wheat and Wheat Improvement 2<sup>nd</sup> ed. Agronomy Series No.13. American Society of Agronomy, Crop Sci. Society of America, Soil Science Society of America Inc. Publishers, Madison, Wisconsin, USA
3. IRRI. 1989. Progress in Irrigated Rice Research. Selected paper and abstracts from the International Rice Research Conference, 21-25 Sept., 1987 Hangzhou, China IRRI, Manila, Philippines.
4. Maiti, U, and P. Wesche-Ebeling. 1998. Maize Science. Oxford and IBH publishing Co. Pvt. Ltd. New Delhi, India.
5. Walden, D.B. 1978. Maize Breeding and Genetics. John Wiley and Sons, New York, USA.

## **PBG-717 BREEDING FOR STRESS ENVIRONMENT 3(2-1)**

### **THEORY**

Definition; types of stress, environmental, soil and physiological stresses. Stress related plant parameters; Induction of stress tolerance, adaptive mechanisms. Genetic mechanisms of stress tolerance, genetic variability for stress tolerance. Transference of tolerance genes from related and alien sources; screening for stress tolerance under field and simulated conditions. Micro-screening techniques; breeding and selection strategies for stress tolerance. Molecular basis of stress tolerance.

### **PRACTICAL**

Field and laboratory study of stress parameters; screening under simulated conditions; genetic analysis of tolerance related traits.

### **BOOKS RECOMMENDED**

1. Blum, A. 1988. Plant Breeding for Stress Enviroments. CRC Press, Inc., Florida, USA.
2. Goyal, S. S., S. K. Sherma and D. W. Rains (Ed) 2003. Crop Production in Saline Environments: Global and Integrative Perspectives. Haworth Press, London UK.
3. Gupta, U. S. 1997. Crop Improvement Vol. 2 Stress Tolerance. Oxford and IBH Publishing Co. (Pvt) Ltd., New Delhi, India.

4. Hall, A. E. 2001. Crop Responses to Environment. CRC Press LLC, Boca Raton, Florida, UK.
5. Mooney, H. A., W. E. Winner, and E. J. Pell. 1991. Response of plants to multiple stresses. Academic Press, San Diego, California, USA.
6. Pessaraki, M. (ed.) 1994. Handbook of Plant and Crop Stress. Marcel Dekker Inc., New York. USA.
7. Saxena, N. P. 2003. Management of Agricultural Drought: Agronomic and Genetic Approaches. Science Publishers, USA

**PBG-718                      GENETICS OF FIBRE CROPS                      3(2-1)**

**THEORY**

Fibre crops and their economic importance. Description of various species in fibre crops. Genetic analysis of various plant and fibre traits. Heterosis and its exploitation in cotton. Genetic basis of insect pests and disease resistance/tolerance in fibre crops. Genetics of biotic and abiotic stress tolerance of fibre crops. Genetics and genetic manipulations for coloured cotton. Genetically modified cottons.

**PRACTICAL**

Collection of data on different plant and fibre characters and their genetic analysis.

**BOOKS RECOMMENDED**

1. Afzal, M. and M. Ali. 1983. Cotton Plant in Pakistan. Ismail Aiwan-e-Science, Karachi.
2. Kohel, R.J. and C.E. Lewis (Eds). 1984. Cotton. Agronomy Series No.24. American Society of Agronomy. Crop Sci. Society of America, Soil Science Society of America Inc. Publishers, Madison, Wisconsin, USA.
3. Maiti, R. 1997. World Fibre Crops. Oxford & IBH Publishing Co., (Pvt.) Ltd. New Delhi, India.
4. Munro, J.M. 1987. Cotton. Longman Group Ltd., Essex, England.
5. Rafiq, M. 2004. Cotton: An Introduction. ICAC Washington DC, USA

**PBG-719      SPECIAL PROBLEM                      1(1-0)**

**PBG-720      SEMINAR    1(1-0)**

**THEORY**

Adaptation and physiological characteristics of oilseed crops. Genetic diversity and its exploitation in oilseed crops. Genetics of quantitative traits. Incompatibility, sterility and its use in hybrid seed production. Strategies for genetic improvement of oil seeds.

**PRACTICAL**

Methods and equipments used for oil analysis. Specification and characteristics of edible oil, oil content, fatty acid, iodine number. Comparative evaluation of quality in oil seeds.

**BOOKS RECOMMENDED**

1. Carter, J.F. (ed). 1978 Sunflower. Science and Technology. Amer. Soc. Agron. Inc., Madison, Wisconsin, USA.
2. Nagata, T. and S. Tabata (Ed).2003. Brassica and Legumes - From Genome Structure to Breeding. Springer Verlag, New York, USA.
3. Ramanath, T. 2004. Applied Genetics of Oilseed Crops. Daya, New Delhi, India
4. Robbelem, G. and R.K. Downey. 1990. Oil Crops of the World, their Breeding and Utilization. McGraw Hill Publishing Company, New York. USA.
5. Scarisbrick, D.H. and R.W. Daniels (eds.). 1986. Oilseed Rape. Collins, London, U.K.
6. Veiss, E.A. 1971. Castor, Sesame and Safflower. Leonard Hill, London, U.K.
7. Verma, D.P.S. 1996. Soybean: Genetics, Molecular Biology and Biotechnology. Iowa State University, USA, CABI

**THEORY**

Molecular approaches in gene manipulation. Techniques for locating gene. Gene cloning, importance of gene cloning in Research and Industry. Cloning vehicle. Plasmids and bacteriophages, extraction and purification of DNA. Restriction endonucleases and ligases. DNA Probing, Southern & Northern blotting, PCR-amplification of DNA; cDNA- synthesis. Introduction of DNA into living cells. Selection for Recombinants; Cloning Vectors for *E. coli* and higher plants. Identification and selection of cloned gene. Formation of transgenic plants. Benefits and problems related with transgenic plants. Genetically modified plants and bioethical concerns. Bioinformatics.

## **PRACTICAL**

Extraction of genomic DNA, purification of DNA, restriction mapping. Genetic transformation of bacteria and plants. Electrophoresis. Visit to National Research Institute involved in molecular genetics and gene manipulation.

## **BOOKS RECOMMENDED**

1. Brown. T.A. 1990. Gene Cloning and Introduction. 4<sup>th</sup> ed. Chapman Hall, London, U.K.
2. Butler, L.O., C. Hardwood and B.E.B. Moseley. 1989. Genetic Transformation and Expression. Intercept Ltd. Hunts, England.
3. Desmand, S.T.N. 1994. An Introduction to Genetic Engineering. Cambridge University Press, Cambridge, U.K.
4. Jackson, J,F, and Linskens. 2002 (Ed) Testing for Genetics Manipulation in plants (Molcular Methods of plant analysis Vol 22) Springer-Verlag, Berlin, Germany.
5. Liang, G. H. and D. Z. Skinner. 2005. Transgenic Crops. Haworth Press. Inc., NY, USA.
6. Old, R. W. and S. B. P. Primose. 2000. Principles of Gene Manipulation: an introduction to genetic engineering. Blackwell, London, UK.
7. Prokop, A., R. K. Bajpai and C. S. Ho. 1991. Recombinant DNA Technology and Applications. McGraw-Hill, Inc., New York, USA.
8. Watson, J, D., T. A. Baker, S. P. Bell, A. Gann, M. Levine and R. Losick. 2004. Molecular Biology of the Gene. Pearson Education, London, UK.

## **PBG-723 GENETICS OF SUGAR AND VEGETABLE CROPS 3(2-1)**

### **THEORY**

Philosophy of sugarcane breeding. Constraints of flowering, fuzz growing in sugarcane. Agro. Ecological and industrial problems being faced for adaptation of sugarbeet in Punjab. Role of somaclonal variations in sugarcane improvement. Possible genetic improvement of sorghum and carrot as an alternate sugar crop. Natural evolution and genetic variability, domestication and differentiation of vegetable species. Systems of reproduction in vegetable species. Inheritance of important plant traits and methods of genetic improvement.

### **PRACTICAL**

Estimation of brix value of sugar plant. Growing of fuzz and evaluation of nursery. Estimations of losses due to retoo crop of sucrose content and cane yield. Sexual expression and classification of

vegetable species. Identification of problems relating to genetics of vegetable crops. Genetic problems in creation of hybrid varieties.

### **BOOKS RECOMMENDED**

1. Bassett, M. J. (ed.) 1986. Breeding Vegetable Crops. Avi Publishing Co., Inc. Westport, Connecticut, U.S.A.
2. Blackburn, F. 1984. Sugarcane. Longman, Green & Co. Ltd., London.
3. Jaggard, K. W. (ed.). 1989. Sugarbeet. A Grower's Guide. Sugarbeet Research and Education Committee, London, U.K.
4. Kalloo, G. and B. O. Bergh. (Eds) 1999. Genetic improvement of vegetable crops. Pergoman Press, New York. USA.
5. Poehlman, J. M. and D. A. Sleper. 1995. Breeding Field Crops. 4<sup>th</sup> ed. Iowa State University Press, Ames, Iowa, USA.
6. Stevenson, G. G. 1965. Genetics and Breeding of Sugarcane. Longman, Green & Co. Ltd., London.
7. Swiader, J. M., G. W. Ware and J. M. McCollum. 1992. Producing Vegetable Crops. 4<sup>th</sup> ed. Interstate. Publisher, Inc, Danville, Illinois, U.S.A.
8. Yadava, H. L. 1991. Sugarcane Production Technology Constraints & Potentialities. Oxford & IBH. Publ. Co., Pvt. Ltd., New Delhi, India.

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## **ADVANCES IN MOLECULAR AND MICROBIAL GENETICS**

4(3-1)

### **THEORY**

Enkaryotic viruses, basic structure of Nucleic acid and life cycle. Some DNA and RNA viruses of animals and plants and their importance in Molecular biology researches. Tumor viruses, retroviruses, Transformation, Integration of viral DNA, consequences of Integration. Viral oncogenes, carcinogens and oncogenes, oncogenes and cancer, Activation of oncogenes. Transposable elements, Transposition, Detection of Transposition in Bacteria, Types of Bactrial Transposons, Modes of Transposition in Bacteria. Genetic phenomena mediated by Transposons in Bacteria Transposable Elements in Eukaryotes. Plant and Bacterial Gene expression in Nitrogen Fixing legume root nodules Infection, nodules, Location of Genetic determinants in nodule formation, Rhizobium genes and plant genes involved in nodulation. Genetic colonization of plants by agro-bacterium infection and Tumor growth, Tumor inducing Ti Plasmid, its structure, organization of integrated T-DNA Function encoded in Ti plasmid DNA, Transcription. Examples of DNA cloning and Genetic Engineering from latest Publications.

## **PRACTICAL**

Isolation of nucleic acid, measurement of concentration, Digestion with specific restriction Enzymes and gel electrophoresis. Plasmid isolation and characterization.

## **BOOK RECOMMENDED**

1. Albert, B., D. Bray J. Lewise, M. Raff, K. Roberts and J. D. Watson. 1989. Molecular Biology of the Cell. NCBI Publishers
2. Ausubel, F. M. 1997. Current Protocols in Molecular Biology. John Wiley and Sons, NY, USA.
3. Gaudilliere, J. P. 2004. From Molecular Genetics to Genomics. Taylor & Francis Routledge.
4. Ladish, H, A. Berk, P. Matsudaira, C. A. Kaiser and M. Kriger. 2005. Molecular Cell Biology. W.H. Freeman, NY, USA.
5. Watson, J, D., T. A. Baker, S. P. Bell, A. Gann, M. Levine and R. Losick. 2004. Molecular Biology of the Gene. Pearson Education, London, UK.

## **RECOMMENDATIONS**

1. In under-graduate scheme of studies, PBG-501, PBG-503, PBG-505, PBG-507, PBG-508, and PBG-609 were declared as core courses for students majoring in Plant Breeding and Genetics which will be taught at all agricultural universities and colleges. However, other courses on different crops may be changed according to regional specific agricultural requirements.
2. All agricultural universities and colleges have adopted semester system except the Faculty of Agriculture, Gomal University, D.I Khan and Balochistan Agricultural College, Quetta. The Committee again recommended them for the adoption of semester system as was recommended during the meeting of the NCRC held on October 17-19, 2000 at HEC/UGC Regional Center, Lahore.
3. Representatives of Gomal University, University College of Agriculture, Baha-ud-Din Zakaryaia University, Multan and Balochistan Agriculture College, Quetta proclaimed about the deficiency of course related books, laboratory and faculty. They were advised to take the advantage of the projects launched by HEC. The information and details of these projects are available on HEC website ([www.hec.gov.pk](http://www.hec.gov.pk)).
4. At post-graduate level, all the universities and colleges have been following the scheme of studies approved by the HEC with minor differences due to site/regional requirements. The committee discussed the course contents in detail and made improvements wherever necessary.
5. The courses PBG-704, PBG-705, PBG-707 and PBG-712 were decided as core courses in the scheme of studies of Plant Breeding and Genetics at post-graduate level and these courses will be taught in every agricultural university/college of the country.
6. Members of the committee showed concern about the change in the nomenclature of the degree being offered by Faculty of Agriculture-Rawalakot, University of AJK. Muzaffarabad. The members after thorough discussion recommended that uniformity in nomenclature of the degree must be maintained.