DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY

CIRCULAR NO.SU/Sci./C.B.C. & G.S./P.G. Syll./39/2015

It is hereby inform to all concerned that, the revised Curriculum under **Choice Based Credit and Grading System** submitted by the various Ad-hoc Boards which are run at college level only and recommended by the Dean, Faculty of Science, the Hon'ble Vice-Chancellor has accepted the same on behalf of the Academic Council under Section-14[7] of the Maharashtra Universities Act, 1994 as under :-

[1]	M.Sc. Forensic Science Ist Year, Semester-I & II Progressively
[2]	M.Sc. Electronics Ist & IInd Year, Semester-I to IV Progressively
[3]	M.Sc. Industrial Automation Ist & IInd Year, Semester-I to IV Progressively [Under Innovative Programme of U.G.C.]
[4]	M.Sc. Industrial Chemistry Ist & IInd Year, Semester-I to IV Progressively
[5]	M.Sc. Herbal Technology Ist & IInd Year, Semester-I to IV Progressively [Under Innovative Programme of U.G.C.]
[6]	M.Sc. Biophysics Ist & IInd Year, Semester-I to IV Progressively
[7]	M.Sc. Bioinformatics Ist & IInd Year, Semester-I to IV Progressively
[8]	M.Sc. Plant Breeding & Molecular Genetics Ist & IInd Year, Semester-I to IV Progressively
[9]	M.Sc. Plant Biotechnology Ist & IInd Year, Semester-I to IV Progressively
[10]	M.Sc. Geology Ist & IInd Year, Semester-I to IV Progressively.

This is effective from the Academic Year 2015-16 & onwards as appended herewith.

All concerned are requested to note the contents of the circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SU/S.S./C.B.C. & G.S. /
P.G.Syll./2015/9893-10142
Date:- 20-07-2015.

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Director,
Board of College and
University Development.

Copy forwarded with compliments to:-

1] The Principals, affiliated concerned colleges,
Dr. Babasaheb Ambedkar Marathwada University

Copy to :-

1] The Controller of Examinations,
2] The Director, [E-Suvidha Kendra], in-front of Registrar's Quarter, Dr. Babasaheb Ambedkar Marathwada University,
3] The Superintendent, [M.Sc. Unit],
4] The Programmer [Computer Unit-1] Examinations,
5] The Programmer [Computer Unit-2] Examinations,
6] The Record Keeper.

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DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD.

Curriculum under Choice Based Credit & Grading System

M.Sc. Plant Breeding and Molecular Genetics

I & II Year

Semester–I to IV

run at college level from the

Academic Year 2015-16 & onwards progressively

7/8.15

Curriculum under Choice Based Credit & Grading System

M.Sc. Plant Breeding and Molecular Genetics

I to IV Semester

2-Year Course

SYLLABUS AT GLANCE

1st Year					1st Semester					
Subject code	Subject Name	Hrs/ Week		Exam Hrs	Theory Credits	Practical Credits	Total Credits	Marks		
		T	P					E	I	Total
PBMG 401	Principles of Genetics and Plant Breeding	4	0	3	4	0	4	80	20	100
PBMG 402	Principle of Cytogenetics	4	0	3	4	0	4	80	20	100
PBMG 403	Crop science & physiology	4	0	3	4	0	4	80	20	100
PBMG 404	Biostatistics	4	0	3	4	0	4	80	20	100
PBMG 451	Practical based on PBMG 401	0	4	3	0	2	2	50	00	50
PBMG 452	Practical based on PBMG 402	0	4	3	0	2	2	50	00	50
PBMG 453	Practical based on PBMG 403	0	4	3	0	2	2	50	00	50
PBMG 454	Practical based on PBMG 404	0	4	3	0	2	2	50	00	50
					16	8	24	520	80	600
T-Theory P-Practicals, E-External, I- Internal										
1st Year					2nd Semester					

PBMG 405	Plant Molecular Biology	4	0	0	4	0	**4**	**80**	**20**	**100**
PBMG 406	Plant Biochemistry	4	0	3	4	0	**4**	**80**	**20**	**100**
PBMG 407	Mutation, Heterosis & Polyploidy Breeding	4	0	3	4	0	4	**80**	**20**	**100**
PBMG 408	Plant Informatics	4	0	3	4	0	**4**	**80**	**20**	**100**
PBMG 455	Practical based on PBMG 405	0	4	3	0	2	2	50	00	50
PBMG 456	Practical based on PBMG 406	0	4	3	0	2	2	50	00	50
PBMG 457	Practical based on PBMG 407	0	4	3	0	2	2	50	00	50
PBMG 458	Practical based on PBMG 408	0	4	3	0	2	2	50	00	50
					16	8	24	520	80	600
2nd Year						**3rd Semester**				
PBMG 501	Principles of genetic engineering and recombinant DNA technology	4	0	3	4	0	4	80	20	100
PBMG 502	Principles of quantitative, Population and Developmental Genetics,	4	0	3	4	0	4	80	20	100
PBMG 503	Breeding Cereal, Sugarcane, Oilseed	4	0	3	4	0	4	80	20	100

	and Fiber crop									
PBMG 504	Research Methodology, Biosafety, IPR	4	0	3	4	0	4	80	20	100
PBMG 505	Breeding for Biotic and abiotic stress resistance	4	0	3	4	0	4	80	20	100
PBMG 552	Practicals based on PBMG 501	0	4	3	0	2	2	50	00	50
PBMG 553	Practicals based on PBMG 502	0	4	3	0	2	2	50	00	50
PBMG 554	Practicals based on PBMG 504	0	4	3	0	2	2	50	00	50
PBMG 555	Practicals based on PBMG 505	0	4	3	0	2	2	50	00	50
					20	8	28	600	100	700
2nd Year						4th Semester				
PBMG 506	Molecular Plant Breeding	4	4	3	4	0	4	80	20	100
PBMG 507	Molecular Markers and Breeding	4	6	3	4	0	4	80	20	100
PBMG 508	Maintenance Breeding, Concepts of Variety Release and Seed Production	4	6	3	4	0	4	80	20	100
PBMG 556	Practical based on PBMG 506	0	4	3	0	2	2	50	00	50
PBMG 557	Project and Research Paper writing	0	8	3	0	8	8	200	00	200
PBMG 558	Practical based on PBMG 507	0	4	3	0	2	2	50	00	50

PBMG 559	Practical based on PBMG 508	0	4	3	0	2	**2**	**50**	**00**	**50**
					12	**14**	**26**	590	60	650

1st Year 1st Semester

1st Year		1st Semester								
Subject code	Subject Name	Hrs/ Week		Exam Hrs	Theory Credits	Practical Credits	Total Credits	Marks		
		T	P					External	Internal	Total
PBMG 401	Principles of Genetics and Plant Breeding	4	0	3	4	0	4	80	20	100
PBMG 402	Principle of Cytogenetics	4	0	3	4	0	4	80	20	100
PBMG 403	Crop science & physiology	4	0	3	4	0	4	80	20	100
PBMG 404	Biostatistics	4	0	3	4	0	4	80	20	100
PBMG 451	Practical based on PBMG 401	0	4	3	0	2	2	50	00	50
PBMG 452	Practical based on PBMG 402	0	4	3	0	2	2	50	00	50
PBMG 453	Practical based on PBMG 403	0	4	3	0	2	2	50	00	50
PBMG 454	Practical based on PBMG 404	0	4	3	0	2	2	50	00	50
					16	8	24	520	80	600

Subject Title: Principles of Genetics and Plant Breeding

Subject Code: PBMG 401 4 Credits

Objective:

1. This course is aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problem solving skills from classical to molecular genetics.
2. To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

UNIT I

Beginning of genetics; Cell structure and cell division; Early concepts of inheritance, Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance. Multiple alleles, Gene interactions. Sex determination, differentiation and sex linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic cell genetics, extra chromosomal inheritance.

UNIT II

Genetic fine structure analysis, Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters.

UNIT III

History of Plant Breeding (Pre and post-Mendalian era); Objectives of plant breeding, characteristics improved by plant breeding; Patterns of Evolution in Crop Plants-Centres of Origin-biodiversity and its significance.Genetic basis of breeding self- and cross - pollinated crops including mating systems and response to selection - nature of

variability, components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding; Plant introduction and role of plant genetic resources in plant breeding.

UNIT VI

Pure line theory, pure line selection and mass selection methods; Line breeding, pedigree, bulk, backcross, single seed descent and multiline method; Population breeding in self- pollinated crops (diallel selective mating approach).Breeding methods in cross pollinated crops; Population breeding-mass selection and ear- to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and interpopulation improvement and development of synthetics and composites; Hybrid breeding - genetical and physiological basis of heterosis and inbreeding, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance; seed production of hybrid and their parent varieties/inbreds.

UNIT V

Breeding methods in asexually/clonally propagated crops, clonal selection apomixes, clonal selection.Cultivar development- testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Suggested Reading

1. Gardner EJ &Snustad DP. 1991. Principles of Genetics. John Wiley & Sons.
2. Klug WS & Cummings MR. 2003. Concepts of Genetics. Peterson Edu.
3. Lewin B. 2008. Genes IX.
4. Jones & Bartlett Publ.Russell PJ. 1998. Genetics. The Benzamin/Cummings Publ. Co.
5. Snustad DP & Simmons MJ. 2006. Genetics. 4th Ed. John Wiley & Sons.
6. Strickberger MW. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India
7. Tamarin RH. 1999. Principles of Genetics. Wm. C. Brown Publs.
8. Uppal S, Yadav R, Subhadra& Saharan RP. 2005. Practical Manual on Basic and Applied Genetics.
9. Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.
10. Chopra VL. 2001. Breeding Field Crops. Oxford & IBH.
11. Chopra VL. 2004. Plant Breeding. Oxford & IBH.
12. Gupta SK. 2005. Practical Plant Breeding. Agribios.
13. Pohlman JM &Bothakur DN. 1972. Breeding Asian Field Crops. Oxford & IBH.
14. Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation.
15. Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
16. Simmonds NW. 1990. Principles of Crop Improvement.
17. Singh BD. 2006. Plant Breeding.
18. Kalyani.Singh P. 2002. Objective Genetics and Plant Breeding.
19. Kalyani.Singh P. 2006. Essentials of Plant Breeding.
20. Kalyani.Singh S & Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding.

Subject Title: PRINCIPLES OF CYTOGENETICS

Subject Code: PBMG 402 4 Credits

Objective:

To provide insight into structure and functions of chromosomes, chromosome mapping, polyploidy and cytogenetic aspects of crop evolution.

To provide a working knowledge of Cytogenetics, the preparation of materials for study, and the importance of chromosomal variations in structure and number in such fields as plant and animal breeding, population genetics, evolutionary genetics, taxonomy, and the medical sciences.

UNIT I

Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; Artificial chromosome construction and its uses; Special types of chromosomes.

UNIT II

Chromosomal theory of inheritance – Cell Cycle and cell division – mitosis and meiosis; Differences, significance and deviations – Synapsis, structure and function of synaptonemal complex and spindle apparatus, anaphase movement of chromosomes and crossing over-mechanisms and theories of crossing over- recombination models, cytological basis, - Variation in chromosome structure: Evolutionary significance - Introduction to techniques for karyotyping; Chromosome banding and painting - in situ hybridization and various applications.

UNIT III

Structural and Numerical variations of chromosomes and their implications Symbols and terminologies for chromosome numbers - euploidy - haploids, diploids and polyploids; Evolutionary significance of chromosomal aberrations - balanced lethals and chromosome complexes.

UNIT IV

Inter-varietal chromosome substitutions; Polyploidy and role of polyploids in crop breeding; Evolutionary advantages of autopolyploidsvs allopolyploids—Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer – Alien addition and substitution lines – creation and utilization; Apomixis - Evolutionary and genetic problems in crops with apomixes.

UNIT V

Reversion of autopolyploid to diploids; Genome mapping in polyploids - Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, triticale and brassica) – Hybrids between species with same chromosome number, alien translocations - Hybrids between species with different chromosome number; Gene transfer using amphidiploids - Bridge species.Fertilization barriers in crop plants at pre-and post fertilization levels- In vitro techniques to overcome the fertilization barriers in crops; Chromosome manipulations in wide hybridization ; case studies – Production and use of haploids, diploids and doubled haploids in genetics and breeding.

Recommended Books

1. Becker K & Hardin. 2004. The World of Cell. 5th Ed. Pearson Edu.
2. Carroll M. 1989. Organelles. The Guilford Press.
3. Charles B. 1993. Discussions in Cytogenetics. Prentice Hall.14
4. Darlington CD & La Cour LF. 1969. The Handling of Chromosomes.
5. Elgin SCR. 1995. Chromatin Structure and Gene Expression. IRL Press.
6. Gray P. 1954. The Mirotomist'sFormulatory Guide. The Blakiston Co.
7. Gupta PK & Tsuchiya T. 1991. Chromosome Engineering in Plants: Genetics, Breeding and Evolution. Part A. Elsevier.
8. Gupta PK. 2000. Cytogenetics. Rastogi Publ.
9. Johannson DA. 1975. Plant Microtechnique.
10. Karp G. 1996. Cell and Molecular Biology: Concepts and Experiments..
11. Khush GS. 1973. Cytogenetics of Aneuploids. Academic Press.
12. Sharma AK & Sharma A. 1988. Chromosome Techniques: Theory and Practice.
13. Butterworth.Sumner AT. 1982. Chromosome Banding. Unwin Hyman Publ.
14. Swanson CP. 1960. Cytology and Cytogenetics. Macmillan & Co.

Subject Title: Crop science & physiology

Subject Code: PBMG 403 4 Credits

Unit 1

Origin and history, area and production, classification, improved varieties, adaptability, climate, soil, water and cultural requirements, nutrition, quality components, handling and processing of the produce for maximum production, value addition and agro-based industries of *Rabi and Kharif* cereals and Pulses, Oil seed and Fiber crop—cotton, Jute

Unit 2

Importance of medicinal and aromatic plants in human health, national economy and related industries, classification of medicinal and aromatic plants according to botanical characteristics and uses, conservation of medicinal plants, Climate and soil requirements; cultural practices; yield and important constituents of medicinal plants (*Aloe vera*, Kacholam, Stevia, , Black Musali,etc). and value addition and aromatic plants (Citronella, Palmarosa, Mentha, Basil, Lemon grass, Rose, Patchouli, Geranium, etc.)

Unit 3

Introduction: Why study plant physiology? Relationship of Plant Physiology to other sciences. Physiology of Plant/Crop Growth and Developmental Stages, Fruit Development, Maturation, and Ripening--Dormancy: Manifestations and Causes--Senescence in Plants and Crops—Abscission.

Cell organelles and their physiological functions, structure and physiological functions of cell wall, cell inclusions; cell membrane structure and functions.

Soil and plant water relations, water and its role in plants, properties and functions of water in the cell water relations-cell water terminology, water potential of plant cells. Mechanism of water uptake by roots-transport in roots, aquaporins, movement of water in plants. Transpiration: the mechanism of foliar Transpiration, methods of measuring transpiration, Factors affecting transpiration- Plant or Internal Factors, Environmental or External Factors, Antitranspirants, significance of Transpiration, Gutting and bleeding. Stomatal apparatus- distribution of stomata, Stomatal Movements- starch-sugar hypothesis, the role of K+ transport for Osmatic Regulation, Osmatica in Guard Cells, Factor affecting stomatal Movements, Diffusive Capacity of stomata.

Unit 4

The role of mineral nutrients in plant metabolism: Essential elements, classification based on function of elements in plants. Uptake of mineral elements in plants – Mechanisms of uptake-translocation of minerals in plants.Physiological and metabolic functions of mineral elements, critical levels, deficiency symptoms, nutrient deficiency and toxicity. Foliar nutrition. Nitrogen metabolism: Inorganic nitrogen species (N2, NO3 and NH3) and their reduction to aminoacids, protein synthesis and nucleic acids.

Unit 5

Photosynthesis-Demonstration of photosynthesis, measurement of CO2 uptake, wilmott bubbler, Photosynthetic pigments, chlorophyll synthesis, carotenoid pigments- Role of carotenoids, The chloroplast, Photochemical, Light or Hill Reaction, the dark reaction, Products of photosynthesis, factor influencing the rate of photosynthesis, photorespiration, metabolism of photorespiration, Glycolate oxidation and CO2 Evolution, Energetic of photorespiration. Respiration- Mechanism of Respiration, Glycolysis, Krebs or citric Acid Cycle, Anaerobic Oxidation of pyruvic Acid, Fate of Pyruvate under aerobic conditions, oxidative phosphorylation in the Hydrogen Transport system, ATP formation, Pathway in intermediary Metabolism of carbohydrates, Regeneration of Glucose-6-Phosphate from Ribulose-5-Phosphate, respiratory Quotient, Factor affecting respiration.

Physiological Responses of Plants/Crops under Stressful (Salt, Drought, and Other Environmental Stresses) Conditions, Induction of Proteins in Response to Biotic and Abiotic Stresses. Seed physiology: Seed development, Germination, Mobilization of reserves during seed germination, seed dormancy, methods to break dormancy. Fruit Development and ripening: Chemical changes during fruit development, phytohormones in fruit growth, fruit ripening, Controlled ripening, artificial fruit ripening.

Recommanded Books

1. Taiz, L. and Zeiger, E. 2010. Plant Physiology. 5th Edition. Sinauer Associates, Inc. Sunderland, Massachusetts. 782 pp.
2. Sala. Plant Physiology Laboratory Manual. Fac. Pac. The University of Montana.
3. *Introduction to Plant Physiology, Second Edition*, by William Hopkins, 1999, John Wiley and Sons, Inc. New York. (Required)
4. Das, N. R. 2007. *Introduction to Crops of India*. Scientific Publ.
5. Pal, M. ,Deka, J. and Rai RK. 1996. *Fundamentals of Cereal Crop Production*. Tata McGraw Hill.
6. Prasad, R. 2002(ed.). *Text Book of Field Crop Production*. ICAR.
7. Yadav, D. S. 1992. *Pulse Crops*. Kalyani.

8. Handa, S. S. 1984. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR,Jammu.
9. Hussain, A. 1984. *Essential Oil Plants and their Cultivation*. CIMAP, Lucknow.
10. Hussain A. 1993. *Medicinal Plants and their Cultivation.* CIMAP, Lucknow.
11. ICAR 2006. *Hand Book of Agriculture.* ICAR, New Delhi.
12. Kumar, N., Khader, Md. A., Rangaswami, J.B.M. Irulappan 1997. I*ntroduction toSpices, Plantation Crops, Medicinal and Aromatic Plants.* Oxford & IBH.
13. Prajapati, N.D., Purohit, S.S., Sharma, A.K. and Kumar, T. 2003. *A Hand Book ofMedicinal Plants: A Complete Source Book*. Agrobios.
14. Chatterjee, B.N. and Das, P.K. 1989. *Forage Crop Production - Principles and Practices*. Oxford & IBH, New Delhi.
15. Narayanan, T.R. and Dabadghao, P.M. 1972. *Forage Crops of India*, ICAR, New Delhi.
16. NAS [National Academy of Sciences]. 1979. *Tropical Legumes- Resources for theFuture.* National Academy of sciences, Washington DC.
17. Skerman P.J. and Riveros F. 1990. *Tropical Grasses*. FAO Plant Production andProtection Series Food and Agriculture Organization of the United Nations, Rome.
18. Thomas, C.G. 2008. *Forage Crop Production in the Tropics* (2nd Ed.) KalyaniPublishers, Ludhiana.

Subject Title: Biostatistics

Subject Code: PBMG 404 4 Credits

Objective:

1. To introduce the need for statistics and statistical analysis
2. To describe the types of data
3. To present descriptive statistics

4. To introduce the fundamental probability basis
5. To discuss random variables and their distributions
6. To utilize probability distributions to perform statistical inference
7. To provide experience in a quantitative research study

UNIT I

Statistical Methods in Agriculture Presentation of Data: Frequency distributions; graphical presentation of data by histogram, frequency polygon, frequency curve and cumulative frequency curves.

Measures of Locations and Dispersion: Mean, median, mode and their simple properties (with-out derivation) and calculation of median by graphs; range, mean deviation, standard deviation, standard error, coefficient of variation.

UNIT II

Probability and Distributions: Random distributions; events exhaustive, mutually exclusive and equally likely; definition of probability (with simple exercises); definitions of binomial, Poisson and normal distributions; and simple properties of the above distributions (without derivation).

UNIT III

Correlation and Regression: Bivariate data-simple correlation and regression coefficients and their relation; Spearman rank correlation; limits of correlation coefficient; effect of change of origin and scale on correlation coefficient; linear regression and equations of line of regression; association and independence of attributes.

UNIT IV

Sampling: Concept of population and sample; random samples; methods of taking a simple random sample. Tests of significance: Sampling distribution of mean and standard error; z and t-test (equality of means; paired and unpaired t-test); t-test for comparison of means when variances of two populations differ; Chi- square test for goodness of fit; independenceof attributes, and homogeneity of samples; interrelation between t-test and F-Test

UNIT V

Principles of Design of experiments: randomization, replication and local control. Choice of size and type of a plot using uniformity trials. CRD, Randomized block design. Concept and definition of efficiency of design.Comparison of efficiency between CRD and RBD. Latin square Design : Lay-out, ANOVA table. Comparison of efficiencies between LSD and RBD; LSD and CRD

Missing plot technique ; estimation of missing plots by minimizing error sum of squares in RBD and LSD with one or two missing observations. Factorial Experiments : general description of factorial experiments; 2^2, $2^3$and 2n factorial experiments arranged in RBD and LSD. Definition of main effects and interactions in 2^2 and 2^3 factorial experiments.Preparation of ANOVA by Yates procedure.Estimates and tests for main and interaction effects (Analysis without confounding).

Recommended Books

1. Goulden, C.H. (1952). Methods of Statistical Analysis, 2/e, John Wiley, New York.
2. Hoshmand A. Reza 1988. Statistical Methods for Agricultural Sciences. Timber Press, Portland, Oregan, USA.
3. Kempthorne, O. (1957). An Introduction to Genetic Statistics, John Willey, New York.
4. Kempton RA and Fox PN (1997). Statistical Methods for Plant Variety Evaluation. Chapman and Hall
5. Panse, V.C. and Sukhatme, P.V. (1967). Statistical Methods for Agricultural Workers, I.C.A.R., New Delhi.
6. Snedecor, G.W. and Cochran, W.G. (1980). Statistical Methods, 7/e. Iowa State Univ. Press, Ames, Iowa.
7. Steel, R.G.D. and Torrie , H.H. (1960). Principles and Procedures of Statistics. McGraw- Hill, New York.
8. Gomez, AG and Gomez, AA (1994). Statistical Procedures for Agricultural Research, 2/e. John Wiley & Sons, New York.

PBMG 451 Practical based on PBMG 401

Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; DNA extraction and PCR amplification - Electrophoresis – basic principles and running of amplified DNA - Extraction of proteins and isozymes – use of Agro-bacterium mediated method andBiolistic gun; practical demonstrations - Detection of transgenes in the exposed plant material; visit to transgenic glasshouse and learning the practical considerations.
Floral biology in self and cross pollinated species, selfing and crossing techniques. Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male-sterility in field crops.

PBMG 452 Practical based on PBMG 402

Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc. - Microscopy: various types of microscopes, - Observing sections of specimen using Electron microscope; Preparing specimen for observation – Fixative preparation and fixing specimen for light microscopy studies in cereals - Studies on the course of mitosis in wheat, pearl millet - Studies on the course of mitosis in onion and Aloe vera - Studies on the course of meiosis in cereals, millets and pulses - Studies on the course of meiosis in oilseeds and forage crops - Using micrometers and studying the pollen grain size in various crops - Various methods of staining and preparation of temporary and permanent slides - Pollen germination in vivo and in vitro; Microtomy and steps in microtomy; Agents employed for the induction of various ploidy levels; Solution preparation and application at seed, seedling level - Identification of polyploids in different crops - Induction and identification of haploids; Anther culture and Ovule culture - Morphological observations

on synthesized autopolyploids - Observations on C-mitosis, learning on the dynamics of spindle fibre assembly – Morphological observations on alloployploids - Morphological observations on aneuploids - Cytogenetic analysis of interspecific and intergeneric crosses - Maintenance of Cytogenetic stocks and their importance in crop breeding - Various ploidy levels due to somaclonal variation ; Polyploidy in ornamental crops. - Fluorescent in situ hybridization (FISH)- Genome in situ hybridization GISH.

PBMG 453 Practical based on PBMG 403

(Minimum 12 Practicals conduct)

Are leaves good predictors of climate?

Primer on Seed Germination

Idioblasts in *Dieffenbachia*

Pigment composition of RCBr

Awn Movement in *Stipa* sp. - A Primer on Time Lapse Movies *(includes Pre & Post labs)*

Independent Research Project

Measuring Water Potential In Potato Tissue

Measuring Stomatal Frequency in Broad Bean

Plant Root Culture

Measuring Photosynthesis with a Qubit CO_2 Gas Analyzer; Starch Prints

Ecophysiological Analysis of Leaf Shape

Surface-to-Volume Ratios in Biology

Gravitropism in Dandelion Scapes

Phytochrome Experiments

Measuring Chlorophyll (& Anthocyanin) Concentrations in plant tissues

Measuring Photosynthesis in Green and White Regions of a Variegated Leaf

Starch Prints

Quantification of Anthocyanin in Red Cabbage (*Brassica oleracea*)

Protoplasts; Protoplast Images

Idioblasts in *Dieffenbachia*

Fruit Development in Rapid Cycling *Brassica rapa* (RCBr)

Seed Germination (Brief Primer on Seed Germination; Germination Percentage & Rate; Testing Seed Viability; Light and Seed Germination; Seedling

Photomorphogenesis (Etiolation Lab - different version); Seed packet analysis; Test Yourself; Seedling Structure (eudicot vs. monocot; epi vs. hypogaeous0

Light (Photomorphogenesis , Light & Plants)

・・ Phonological studies at different growth stages of crop

・・ Estimation of crop yield on the basis of yield attributes

・・ Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities

・・ Working out growth indices (CGR, RGR, NAR, LAD), LER, aggressiveness, relative crowding coefficient, monetary yield advantage and ATER (Area Time Equivalent Ratio) of prominent intercropping systems of different crops

・・ Estimation of protein content in pulses

・・ Planning and layout of field experiments

・・ Judging of physiological maturity in different crops

・・ Intercultural operations in different crops

・・ Determination of cost of cultivation of different crops

・・ Working out harvest index of various crops

・・ Study of seed production techniques in various crops

・・ Visit of field experiments on cultural, fertilizer, weed control and water management aspects

・・ Identification of crops based on morphological and seed characteristics

・・ Cultivation techniques of medicinal and aromatic plants

・・ Raising of herbarium of medicinal, aromatic and under-utilized plants

・・ Quality characters in medicinal and aromatic plants and value addition.

・・ Methods of analysis of essential oil and other chemicals of importance in medicinal and aromatic plants

-Canopy measurement, yield and quality estimation, viz. crude protein, NDF,ADF, lignin, silica, cellulose etc. of various fodder and forage crops

・・ Anti-quality components like HCN in sorghum and such factors in other crops

・・ Cutting of sugarcane setts, its treatment and methods of sowing, tying and propping of sugarcane

・・ Determination of cane maturity and calculation on purity percentage, recovery percentage and sucrose content in cane juice

・・ Judging of physiological maturity in different crops and working out harvest index

・・ Working out cost of cultivation of different crops

・・ Estimation of crop yield on the basis of yield attributes

・・ Formulation of cropping schemes for various farm sizes and calculation of cropping and rotational intensities

・・ Determination of oil content in oilseeds and computation of oil yield

・・ Estimation of quality of fibre of different fibre crops

・・ Study of seed production techniques in various crops

・・ Visit of field experiments on cultural, fertilizer, weed control and watermanagement aspects

・・ Visit to nearby villages for identification of constraints in crop production

PBMG 454 Practicals based on PBMG 404

1. Analysis of variance
2. Partioning of total genetic variance in various models
3. Correlation and regression analysis
4. Path coefficient analysis
5. Discriminant function analysis
6. Practicals related to Unit I,II and III should conduct as per theory
7. Large sample tests.
8. Analysis of variance in one-way and two-way classification (with and without interaction terms).
9. Analysis of a Latin square design. Factorial Experiment Practical.
10 Analysis of variance in RBD and LS design with one or two missing observations.
11. Drawing a simple random sample with the help of table of random numbers.
12. Estimation of population means and variance in simple random sampling.
13. Stratified random sampling for population mean (proportional and optimum allocation).

14. Ratio and regression estimation of population mean and total.

1st Year					2nd Semester					
Subject code	Subject Title	Hrs/ week		Exam Hrs	Theory Credits	Practical Credits	Total Credits	Marks		
		T	P					External	Internal	Total
PBMG 405	Plant Molecular Biology	4	0	3	4	0	4	80	20	100
PBMG 406	Plant Biochemistry	4	0	3	4	0	4	80	20	100
PBMG 407	Mutation, Heterosis & Polyploidy Breeding	4	0	3	4	0	4	80	20	100
PBMG 408	Plant Informatics	4	0	3	4	0	4	80	20	100
PBMG 455	Practical based on PBMG 405	0	4	3	0	2	2	50	0	50
PBMG 456	Practical based on PBMG 406	0	4	3	0	2	2	50	0	50
PBMG 457	Practical based on PBMG 407	0	4	3	0	2	2	50	0	50
PBMG 458	Practical based on PBMG 408	0	4	3	0	2	2	50	0	50
					16	8	24	520	80	600

Subject Title: Plant Molecular Biology

Subject Code: PBMG 405 4 Credits

Objective :

1. Understand Basic Molecular Genetic Processes
2. Be able to interpret results from basic Molecular Genetic experiments
3. Be able to critically review the molecular genetic primary literature in their field of interest
4. Be able to develop hypothesis and develop experiments to test these hypothesis in the Molecular Genetic aspects of their chosen fields
5. Have "hands on" experience with Molecular Genetic Techniques in a multi-step research project

UNIT I

Genetic material: DNA and RNA as genetic material (experimental evidences); structure of DNA (including Z-DNA, and Shasisekharan's RL model); supercoiling of DNA; different types of RNAs and their roles; differences between DNA and RNA.

Organization of genetic material: Chromosome ultra-structure and nucleosome concept; packaging of DNA as nucleosomes in eukaryotes; techniques used for discovery of nucleosome; structure and assembly of nucleosomes, solenoid; phasing of nucleosomes; DNA content and C- value paradox, repetitive and unique sequences; overlapping, pseudo, cryptic and split genes; satellite DNA's; selfish DNA (including transposons and retroposons); Centromere and telomere.

UNIT II

DNA replication (in prokaryotes and eukaryotes): Unwinding proteins; role of RNA polymerases for synthesis of RNA primers, DNA polymerases in prokaryotic and eukaryotic DNA replication; semi- conservative, discontinuous and bi-directional

replication; RNA primers; role of a number of proteins in prokaryotic and eukaryotic DNA replication; models of replication. 4

UNIT III

Transcription of message: Central dogma (including reverse transcription), prokaryotic RNA polymerases and eukaryotic RNA polymerases (I to V); promoters for transcription initiation (pribnow box, TATA box, CAAT box, GC box, etc.); enhancers and silencers; transcription initiation complex (including scaffold complex); different transcription factors for different RNA polymerases in eukaryotes (including mediators); DNA binding and activation domains in transcription factors; elongation of RNA transcript; termination of transcription. 8

Processing of RNA transcript: Different mechanisms of RNA splicing; spliceosomes; alternative splicing (exosomes); ribozymes; snRNAs;; RNA editing (editosomes)

UNIT IV

Genetic code (including mitochondria genetic code): Deciphering of code *in vitro* and *in vivo* (use of mutations -base replacement, frame shift and suppressor mutations. 2

Protein synthesis apparatus: Transfer RNA and ribosomes (including Rosen Kornberg's work); transfer RNA synthetases and second genetic code. 2

Translation of message: Initiation in prokaryotes and eukaryotes; Kozak's hypothesis; role of initiation factors; initiation complex; elongation of polypeptide (EF – Tu, EF – Ts& EF-G; eEF1 and eEF2); termination of polypeptide.

Maturation and modification of released polypeptide: Transport and modification of polypeptide and signal peptidases; protein splicing of inteins; elementary idea of protein folding; protein degradation (ubiquitin and proteasome).

UNIT V

Regulation of gene expression in prokaryotes: The operon concept and its recent modifications, positive and negative controls; leader sequence and attenuation; feedback inhibition.

Regulation of gene expression in eukaryotes: Regulation of transcription, Britten–Davidson model, histone and non-histone proteins in regulation, signal transduction pathways, transcription factors (DNA-binding and activation domains), rearrangement of

DNA; post-transcriptional regulation-alternative splicing, mRNA stability and translational control, UTRs of mRNA, miRNA, siRNA, riboswitches, antiswitches.

Suggested Readings

1. Bruce A.2004. Essential Cell Biology. Garland.
2. Karp G.2004. Cell and Molecular Biology: Concepts and Experiments. John Wiley.
3. Klug WS & Cummings MR 2003. Concepts of Genetics. Scot, Foreman & Co.
4. Lewin B. 2008. IX Genes. John Wiley & Sons
5. Lodish H, Berk A &Zipursky SL. 2004. Molecular Cell Biology. 5TH Ed. WH Freeman.
6. Nelson DL & Cox MM. 2005. Lehninger's Principles of Biochemistry. WH Freeman & Co.
7. Russell PJ. 1996. Essential Genetics. Blackwell Scientific Publ.
8. Schleif R.1986. Genetics and Molecular Biology. Addison-Wesley Publ. Co.
9. Lewin B. 2008. Genes IX. John Wiley & Sons.
10. Schleif R.1986. Genetics and Molecular Biology. Addison-Wesley.
11. Russell PJ. 1996. Essential Genetics. Blackwell Scientific Publ.
12. Brown TA. 2002. Genomes. Bios Scientific Publ.
13. Tamarin RH. 1999. Principles of Genetics. Wm C Brown Publ.
14. Griffiths AJF. 2000. An Introduction to Genetic Analysis. WH Freeman.
15. Hexter W & Yost HT. 1976. The Science of Genetics. Prentice Hall.
16. Singer M & Berg P.1991. Genes and Genomes. John Wiley & Sons.
17. Hartl DL & Jones EW. 1998. Genetics Principles and Analysis. Jones &Barlett Publ.
18. Micklos DA &Freyer G. 2003. DNA Science - A First Course. CPL Scientific Publ.
19. Brooker RJ. 2004. Genetics Analysis and Principles. Addison-Wesley Longman.
20. Watson JD. 2004. Molecular Bilology of the Gene. Pearson Edu.

Subject Title: Plant Biochemistry

Subject Code: PBMG 406 4 Credits

Objective:

1. Students will learn the stucture, function and biosynthetic pathways of essential biochemical molecules including their key chemical and physical properties.
2. Students will understand plant cell structure and organization and apply specific biochemical functions to all components of plant cell structure.
3. Students will learn amino acid structures and relate their chemical properties to the synthesis and function of proteins and enzymes.
4. Students will understand how light energy is captured and used to provide chemical forms of energy to power the functions of cells and whole plants.
5. Students will learn about the rich diversity of secondary compounds and metabolism in plants and how such compounds contribute to human health.

UNIT I

Scope and importance of biochemistry in agriculture; Fundamental principles governing life; structure of water; acid base concept and buffers; pH; hydrogen bonding; hydrophobic, electrostatic and Van der Waals forces; General introduction to physical techniques for determination of structure of biopolymers.

UNIT II

Classification, structure and function of carbohydrates, lipids and biomembranes, amino acids, proteins, and nucleic acids.classification and biological functions of vitamins, enzymes classification and mechanism of action; regulation, factors affecting enzyme action. Fundamentals of thermodynamic principles applicable to biological processes, Bioenergetics.

UNIT III

Metabolism of carbohydrates (Glycolysis, TCA cycle, electron transport chain) photosynthesis and respiration, oxidative phosphorylation, lipids, proteins and nucleic acids. Nutritional aspects of carbohydrates, lipids, proteins and minerals.

Photosynthetic pigments in relation to their functions, photosynthesis, C3, C4 and CAM pathways, photorespiration. Sucrose-starch interconversion,

UNIT IV

Biochemistry of nitrogen fixation and nitrate assimilation, sulphate reduction and incorporation of sulphur in to amino acids.Biochemistry of seed germination and development, Biochemistry of fruit ripening, phytohormones and their mode of action, signal transduction.

UNIT V

Biochemistry and significance of secondary metabolites-cyanogenic glycosides, glucosinolates, phenolic compounds, terpenoids, alkaloids, plant defense system.

Recommended Books

1. Conn EE &Stumpf PK. 1987. *Outlines of Biochemistry*. John Wiley.
2. Metzler DE. *Biochemistry.* Vols. I, II. Wiley International.
3. Nelson DL & Cox MM. 2004. *Lehninger's Principles of Biochemistry*.MacMillan.
4. Voet D &Voet JG. *Biochemistry*. 3rd Ed. Wiley International.
5. Buchanan BB, Gruissem W & Jones RL. 2000. *Biochemistry andMolecular Biology of Plants.* 2nd Ed. John Wiley.
6. Dey PM &Harborne JB. 1997. *Plant Biochemistry*. Academic Press.
7. Goodwin TW & Mercer EI. 1983. *Introduction to Plant Biochemistry*.Pergamon Press.
8. Heldt HS. 1997. *Plant Biochemistry and Molecular Biology*. Oxford Univ.Press.

Subject Title: Mutation, Heterosis&PolyploidyBreeding

Subject Code: 407 4 Credits

Objective :

1. learn breeding procedures in self and cross pollinated crops
2. understand exploitation of heterosis utilizing male sterility and other methods
3. know about the various population improvement programme
4. study about the fundamentals of mutation, polyploidy and wide hybridization and their role in crop improvement

UNIT I

Heterosis and Inbreeding, Hybrids and synthetic varieties:

Historical aspect of heterosis - Nomenclature and definitions of heterosis - Heterosis in natural population and inbred population; Evolutionary aspects - Genetic consequences of selfing and crossing in self-and cross-pollinated and asexually propagated crops crops.

Pre Mendelian and Post-Mendelian ideas - Genetic theories of heterosis – Physiological,

Biochemical and molecular factors underlining heterosis; theories and their estimation; - Evolutionary concepts of heterosis.

Prediction of heterosis from various crosses- Inbreeding depression, frequency of inbreeding and residual heterosis in F2 and segregating populations, importance of inbreeding in exploitation of heterosis – case studies. - Relationship between genetic distance and expression of heterosis – case studies; Divergence and Genetic Distance analyses-morphological and molecular genetic distance in predicting heterosis, Development of heterotic pools in germplasm / genetic stocks and inbreds, their improvement for increasing heterosis.

Types of male sterility and use in heterosis breeding; Maintenance, transfer and restoration of different types of male sterility; Use of selfing compatibility in development

of hybrids; Hybrid seed production system: 3-line, 2-line and 1-line system; Development of inbreds and parental lines- A, B and R lines – functional male sterility; Commercial exploitation of heterosis- maintenance breeding of parental lines in hybrids. Fixation of heterosis in self, cross and often cross pollinated crops, asexually/clonally propagated crops; Male sterile line creation and diversification in self pollinated, cross pollinated and asexually propagated crops; problems and prospects; Apomixis in fixing heterosis-concept of single line hybrid.

Organellarheterosis and complementation - Creation of male sterility through genetic engineering and its exploitation in heterosis. Heterosis breeding in wheat, rice, cotton, maize, pearl millet, sorghum and oilseed crops.

Hybrids and synthetic varieties: Prcocedure – development of inbreds – evaluation of inbreds – phenotypic and top cross test, single cross evaluation, production of hybrid seeds- double cross and polycross hybrids. Role of cytoplasmic genetic male sterility and self incompatibility in hybrid seed production. Improvement of inbred lines- pedigree selection- backcross method – convergent improvement – gametic selection – merits and demerits – achievements

Unit II

Mutation Breeding and Ploypoidy Breeding: Mutation and its history - Nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations - Detection of mutations in lower and higher organisms – paramutations.

Mutagenic agents: physical -- Radiation types and sources: Ionizing and non-ionizing radiations viz., X rays, γ rays, , and ß particles, protons, neutrons and UV rays - Radiobiology: mechanism of action of various radiations (, photoelectric absorption, Compton scattering and pair production) and their biological effects –RBE and LET relationships.

Effect of mutations on DNA - Repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects - Dosimetry - Objects and methods of treatment - Factors influencing mutation: dose rate, acute vs chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects - Radiation sensitivity and modifying factors: External and internal sources- Oxygen, water content, temperature and nuclear volume.

Chemical mutagens- Classification - Base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action - Dose determination and factors influencing chemical mutagenesis - Treatment methods using physical and chemical mutagens - Combination treatments; other causes of mutation - direct and indirect action, Comparative evaluation of physical and chemical mutagens.

Observing mutagen effects in M2 generation: plant injury, lethality, sterility, chimeras etc., -

Observing mutagen effects in M1 generation - Estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations -– Mutations in traits with continuous variation.

Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropyand linkage etc. - Individual plant based mutation analysis and working out effectiveness and efficiency in M3 generation - Comparative evaluation of physical and chemical mutagens for creation of variability in the same species – Case studies.

Use of mutagens in creating oligogenic and polygenic variations – Case studies - In vitromutagenesis – callus and pollen irradiation; Handling of segregating generations and selection procedures; Validation of mutants; Mutation breeding for various traits (disease resistance, insect resistance, quality improvement, etc) in different crops- Procedures for micro-mutations breeding/polygenic mutations- Achievements of mutation breeding- varieties released across the world- Problems associated with mutation breeding.Use of mutagens in genomics, allele mining, TILLING.

Polyploidy breeding: Definitions, types of changes in chromosome number – euploids and aneuploids – auto and allopolyploids. Aneuploids- nullisomics, monosomics, double monosomics and trisomics.Autopolyploids, autotriploids, autotetraploids, autohexaploids and autooctoploids.Allopolyploids, allotetraploids, allohexaploids, allooctoploids, morphological and cytological features. Production of autopolyploids: materials and agents used- method of treatment-merits and demerits-achievements

UNIT III

Distant hybridization, quality breeding, Ideotype breeding, Resistance Breeding, Breeding for stress resistance:

Distant hybridization: History, barriers in production of distant hybrids-failure of zygote formation-failure of zygote development- lethal genes-phenotypic disharmony between two parental genomes- chromosome elimination- incompatible cytoplasm- endosperm abortion-failure of hybrid seedling development. Techniques of production of distant hybrids- sterility in distant hybrids- cytogenetic basis- genetic basis and cytoplasmic basis- application of distant hybridization in crop improvement- alien

chromosome addition and substitution lines–transfer of small chromosome segment–achievements and limitations

Quality breeding: Introduction. Quality traits – morphological- nutritional – geological – hulling and milling recovery- cooking quality- nutritional quality of rice, wheat, fiber colour, length and strength in cotton, elimination of toxic substances-lathyrism- protein and mineral content and quality. Laboratory evaluation for protein quality and quantity, problems and prospects of quality breeding.

UNIT IV

Ideotype breeding: Ideotype concepts, types, development of ideotypes, steps in development. Characters of a crop ideotype, selected crops' ideotype; Barley, Rice, Cotton, *Brassica* – ideotype breeding- limitations

Resistance breeding: Historical account, loss due to disease, variability in pathogen. Physiological races and pathotypes.Genetics of pathogenicity- disease development-disease escape- disease resistance, susceptible reaction- immune reaction, resistance-tolerance.V ertical and Horizontal resistance- Mechanism of disease resistance–mechanical, hypersensitivity and nutritional.Genetics of disease resistance – oligogenic inheritance, gene for gene relationship–molecular basis for gene for gene relationship – polygenic inheritance.

Methods of breeding for disease resistance: Testing for disease resistance – Disease epidemics, Insect resistance, mechanism of resistance, breeding methods, screening techniques, problems in insect , resistance breeding.

UNIT V

Breeding for stress resistance: Drought resistance; introduction – types of abiotic stresses – minimizing drought resistance – breeding methods – Genetics of drought resistance –Problems.

Mineral stresses: Salt affected soil- alkali soil, breeding for salinity resistance – effect of salinity stress, water stress, salt toxicity – salinity resistance, sources of salinity resistance breeding approach- Problems

Breeding of Crop plants:

Origin, taxonomy, cytogenetics and evolution of the following crops 1. Cereals (Rice and wheat) 2. Tuber Crops (Potato)3.Fibre yielding (cotton) 4. Sugar yielding (Sugarcane) 6. Narcotics (Tobacco)

Recommended Books

1. Allard, R.W.1960.Principles of Plant breeding. John Wiley & Sons. Inc., New York.
2. Backcock, E. B. 2001. Genetics and Plant breeding. Agrobios (India) Jodhpur.
3. Basra, A.S. 2000. Heterosis and Hybrid Seed Production in Agronomic
4. Crops. In Basra, A.S.(Ed.). M.S. Swaminathan Research Foundation, Taraman Industrial Area Chennai.
5. Bose,T.K., Mitra S.K. & Sadhu, M.K.1986.Propagation of Tropical and Subtropical Horticultural Crops. NayaPrakash, Calcutta.
6. Briggs, F.N & Knowles, P.F.1967. Introduction to Plant breeding. Reinhold Publ. Co. Ltd., New York.54
7. Chopra,V. L. 2000. Plant Breeding. Theory and Practicals (2nd edition) Oxford & IBH Publ. Co. Pvt. .Ltd. New Delhi.
8. Frankel, R &Galum, E.1977. Pollination Mechanisms, Reproduction and Plant Breeding. Springer Verlag, Berlin, Heidelberg &. New York.
9. Jain H.K. &Kharkwal, M.C. .(Eds.) 2004. Plant Breeding. Mendelian to Molecular Approaches, Narosa Publishing House, New Delhi.
10. Poehlman, J.M. &Borthakur, D. 1959. Breeding Asian field crops with special reference to Crops of India. Oxford & IBH Publ. Co. New Delhi.
11. Poehlman, J.M. & David, A.S.1995. Field Crops (4th edition), Panima Publ. Co. Ltd., NewDelhi.
12. Russel. G.E. 1985. Progress in Plant Breeding I In Russel G E (Ed.) Butter Worth & Co. Publ. Ltd. Calcutta.
13. Sharma, J. R. 1994. Principles and Practice of Plant Breeding, Tata- McGraw-Hill. Publ. Co. Ltd New York, NewDelhi.
14. Simmond, N.W.1976 Evolution of Crop Plants. In Simmond N.W (Ed.) Edinburgh School of Agriculture/ Longman Group Ltd., London.

Subject Title: Plant Informatics

Subject Code: PBMG 408 4 Credits

Objective :

Introduce students to the current bioinformatics algorithms/concepts and their implementations.

Teach students to cast a molecular biology problem as a bioinformatic problem, provide them with the skills necessary to independently select relevant tools, optimize their settings, and build pipelines to solve the set problem.

Prepare students for more advanced bioinformatics courses involving method development.

UNIT I

Basic of Bioinformatics

Introduction-- What is bioinformatics?--Basic concepts--Protein and amino acid --DNA & RNA -- Sequence, structure and function

Bioinformatics databases—Introduction -- Type of databases-- Nucleotide sequence databases -- Primary nucleotide sequence databases—EMBL – GeneBank – DDBJ-- Secondary nucleotide sequence databases – UniGene – SGD -- EMI Genomes – Genome Biology -- Protein sequence databases -- SwissProt/ TrEMBL – PIR -- Sequence motif databases – Pfam –PROSITE -- Protein structure databases -- Protein Data Bank – SCOP – CATH -- Other relevant databases – KEGG – PQS –DockGround

Sequence alignment and database searching

Single sequence alignments -- Biological motivation -- Pairwise alignments -- Scoring matrix PAM – BLOSUM -- Gap penalty -- Dynamics programming --Needleman-Wunsch -- Smith- Waterman -- Heuristic methods – FASTA – BLAST -- Statistics of sequence

alignment score -- E-Value -- P-Value -- Multiple sequence alignments – ClustalW – Profile -- Profile- sequence alignment -- Profile-profile alignment -- PSI-BLAST -- Hidden Markov Models -- Viterbi algorithm -- HHM based multiple-sequence alignment ---SAM

Phylogenetics -- Sequence-based taxonomy --- Why Phylogenetics? -- Models, assumptions, and interpretations -- From multiple alignment to phylogeny – Neighbor joining -- Maximum likelihood and parsimony -- Computer tools for phylogenetic analysis – DISTANCES – GROWTREE --- PAUP – PHYLIP

Protein structure alignments -- What is structure superposition? – RMSD -- TM-score -- What is structure alignment? -- Different structure alignment algorithms – DALI – CE – VAST -- TM-align -- Number of protein folds in PDB

UNIT II

PROTEIN STRUCTURE

Protein function -- Sequence to function --- Structure to function -- Protein function -- identification methods and databases

Protein secondary structure predictions-- What is protein secondary structure? -- Hydrogen bond -- How to define a secondary structure element? --- Methods for predicting secondary structure -- Chou and Fasman method – PHD – PSIPRED -- SAM

Protein tertiary structure modeling -- Basic concepts -- Protein folding and dynamic simulation -- Comparative modeling – Modeller -- Swiss-Modeller – Threading -- What is threading? -- Bowie-Luthy-Eisenberg -- Profile-profile alignment – GenThreader -- PROSPECTOR --FFAS03 -- Meta-threading -- 3D-jury – LOMETS -- Ab initio modeling -- Anfinsen thermodynamic hypothesis – UNRES – ROSETTA – TOUCHSTONE – Combined modeling approaches -- TASSER/I-TASSER -- CASP: A blind protein structure prediction competition

Experimental methods for protein structure determination -- X-ray crystallography -- Diffraction theory -- Phase determination -- Calculating and interpreting electron density maps -- Model building and refinement -- Structure assessment -- Crystallization of macromolecules -- Dynamic crystallography -- Nuclear magnetic resonance (NMR) -- Classical NMR spectroscopy -- Theoretical description of NMR spectroscopy -- Experimental aspects of NMR spectroscopy –

Relaxation and dynamic processes -- Heteronuclear NMR experiments -- Sequential assignment and structure calculations

UNIT III

PROTEIN-PROTEIN INTERACTIONS

Experimental identification of protein-protein interactions

Yeast two-hybrid assay -- High-throughput mass spectrometry -- Interaction networks and system biology

Protein quaternary structure modeling --Basic concepts -- Degrees of freedom -- Presentation of protein conformations -- Hydrophobicity factor -- Shape complementary -- Docking Scoring function -- Protein-protein docking algorithms -- Fast Fourier

Transformation (FFT) – GRAMM -- Semi-flexible docking: Side-chain refinement -- Clustering and refinement -- Protein-ligand docking algorithms -- Drug design -- Multiple-threading algorithms -- Homology modeling of protein-protein interactions -- Protein and ligand binding – CAPRI

UNIT IV

BIOMOLECULAR SIMULATIONS

Basic concepts -- Units and derivatives -- Force field and energy landscape -- Truncation of nonbonded interactions --

Conformational Sampling—Introduction -- Minimization and algorithms – Molecular dynamics -- Ensembles (statistical mechanics) -- Monte Carlo simulations

Solvation -- Introduction -- Periodic boundary condition --Ewald summation – Implicit solvent model and continuum electrostatics -- Monte Carlo simulation on parallel computers

Advanced Techniques – Introduction -- Replica-exchange simulations -- Restraint potentials -- Free energy calculations -- Membrane simulations

UNIT V

SELECTED TOPICS

Biological membranes – Introductions -- Biological roles -- Structural features – Membrane lipids -- General structures -- Aggregation states --- Polymorphism -- Thermal transitions Electrostatic effects -- Molecular dynamics --- Membrane proteins – Crystallization -- Overview of structure features -- Structure/function relations -- Selected topics in membrane proteins -- simulation of Membrane proteins

Recommended Books

1) *Fundamental Concepts of Bioinformatics*, Dan E. Krane and Michael L. Raymer, San Francisco: Benjamin Cummings, 2003. ISBN: 0-8053-4633-3

2) *Bioinformatics: A Practical Guide to the analysis of genes and proteins* edited by Andreas D. Baxevanis, B.F. Francis Ouellette, New York: Wiley-Interscience, 2001, second edition. ISBN: 0-471-38391-0

PBMG Practical based on PBMG 405

Morphological and Gram staining of natural bacteria; Cultivation of bacteria in synthetic medium; Determination of growth rate and doubling time of bacterial cells in culture; Demonstration of bacteriophage by plaque assay method; Determination of soluble protein content in a bacterial culture. Isolation, purification and raising clonal population of a bacterium; Biological assay of bacteriophage and determination of phage population in lysate; Study of lytic cycle of bacteriophage by one step growth experiment; determination of latent period and burst size of phages per cell; Quantitative estimation of DNA, RNA and protein in an organism; Numericals: problems and assignments.

DNA EXTRACTION Spectrophotometry &Fluorometry Restriction Enzyme Digestion Agarose Gel Electrophoresis PCR PRIMER DESIGN, PCR REACTIONS Agarose Gel Electrophoresis, CLONING Ligation, Transformation Incubation, Plating, CLONING, pick colonies CLONING/SEQUENCING PCR colony screen Agarose Gel Electrophoresis Plasmid purification Agarose Gel Electrophoresis, SOUTHERN Agarose Gel Electrophoresis Blotting, RNAExtraction& Quantification and qualitative test, RNA Denaturing Agarose Gel Electroph. RNA RT-PCR RT2 –PCR, TRANSFORMATION Transient Plant seeds, TRANSFORMATION
Harvest and Stain, TRANSFORMATION View Transient Transformants Screen Transformant seedlings

PBMG 456 Practicals based on PBMG 406

Preparation of standard and buffer solutions.

Extraction and estimation of sugars and amino acids.

Estimation of proteins by Lowry's method.

Estimation of DNA and RNA by Diphenylamine and orcinol methods.

Estimation of ascorbic acid.

Separation of biomolecules by TLC and paper chromatography

Analysis of plant samples

Estimation of proximate constituents Ca, Mg and trace elements

Estimation of carbohydrates – Proteins – oils and fats, crude fibres –

Analysis of sugars in cane juice –

Assessment of quality of feed and forage crops –

Estimation of sugars, vitamin in fruits and vegetables –

Estimation of alkaloids and tannin

Estimation of toxin in feeds and forage crops

Tissue test – Identification of deficiency and toxicity symptoms.

PBMG 457 Practicals based on PBMG 407

Learning the precautions on handling of mutagens; Dosimetry - Studies of different mutagenic agents: Physical mutagens - Studies of different mutagenic agents: Chemical mutagens - Learning on Radioactivity – Production of source and isotopes at BRIT, Trombay - Learning about gamma chamber; Radiation hazards - Monitoring – safety regulations and safe transportation of radioisotopes - Visit to radio isotope laboratory ; learning on safe disposal of radioisotopes - Hazards due to chemical mutagens - Treating the plant propagates at different doses of physical and chemical mutagens - Learning combined mutagenic treatments; Raising the crop for observation - Mutagenic effectiveness and efficiency; Calculating the same from earlier literature - Study of M1 generation – Parameters to be observed; Study of M2 generation – Parameters to be observed; Mutation breeding in cereals and pulses – Achievements made and an analysis - Mutation breeding in oilseeds and cotton – Achievements and opportunities -

Mutation breeding in forage crops and vegetative propagated crops; Procedure for detection of mutations for polygenic traits in M2 and M3 generations.

Selection indices and selection differential – Calculations and interpretations - Male sterile line characterization in millets; Using morphological descriptors; Restorer line identification and diversification of male sterile sources - Male sterile line creation in dicots comprising oilseeds, pulses and cotton ; problems in creation of CGMS system; Ways of overcoming them - Male sterile line creation, diversification and restoration in forage crops; Understanding the difficulties in breeding apomicts; Estimation of heterotic parameters in self, cross and asexually propagated crops - Estimation from the various models for heterosis parameters -Hybrid seed production in field crops – an account on the released hybrids; their potential; Problems and ways of overcoming it; hybrid breeding at National and International level; Opportunities ahead.

Polyploidy breeding Autopolyploids- colchicines treatment –i.Capsicum seed and seedling b. Polyploids – Evolutionary chart of the following;Wheat – *Triticumaestivum*and *Triticale* ii). Cotton, *Nicotiana, Brassica*

Ideotype: - Super rice 2000 , Resistance Breeding Crops: Description on taxonomy, cytogenetics& evolution of all the above mentioned crops

PBMG 458 Practical based on PBMG 408

2nd Year					3rd Semester					
Subject Code	Subject Title	Hrs/Week		Exam Hrs	Theory Credit	Practical Credits	Total Credits	Marks		
		T	P					External	Internal	Total
PBMG 501	Principles of genetic engineering and recombinant DNA technology	4	0	3	4	0	4	80	20	100
PBMG	Principles of	4	0	3	4	0	4	80	20	100

502	quantitative, Population and developmental Genetics									
PBMG 503	Breeding Cereaks, Legumes, Oilseeds, fiber crops, and Sugercane	4	0	3	4	0	4	80	20	100
PBMG 504	Research Methodology, Biosafety, IPR	4	0	3	4	0	4	80	20	100
PBMG 505	Breeding for Biotic and abiotic stress resistance	4	0	3	4	0	4	80	20	100
PBMG 552	Practicals based on PBMG 501	0	4	3	0	2	2	50	0	50
PBMG 553	Practicals based on PBMG 503	0	4	3	0	2	2	50	0	50
PBMG 554	Practicals based on PBMG 504	0	4	3	0	2	2	50	0	50
PBMG 555	Practicals based on PBMG 505	0	4	3	0	2	2	50	0	50
					20	8	28	520	80	600

Subject Title: Principles of Genetic Engineering and Recombinant DNA Technology

Subject Code: PBMG 501 4 Credits

Unit 1

Fundamental techniques of gene manipulation, cutting and joining DNA molecules-cutting DNA molecules-joining DNA molecules

Defining purview of genetic engineering: Tools and techniques Properties and applications of DNA Modifying Enzymes: Host controlled restriction modification system (Nomenclature, Type I-IV restriction endonucleases, Isoschizomers); DNA Methyltransferases; DNA polymerases; Special case of thermo-stable DNA polymerases in context to PCR (History, concept, enzymology, applications); Reverse transcriptases in context to semi-quantitative and quantitative RT-PCR

Basic biology of plasmid and phage vector-plasmid biology and simple plasmid-bacteriophage λ--DNA cloning with single stranded DNA vector

Cosmid, phasmids, and other advanced vectors-vector for cloning large fragments of DNA-specialist purpose vectors

Unit 2

Gene cloning strategies – Genomic DNA libraries are generated by fragmenting the genome and cloning overlapping fragments in vectors—The PCR can be used as an alternative to genomic DNA cloning-complementary DNA (cDNA) libraries are generated by the reverse transcription of mRNA- The PCR can be used as an alternative to cDNA cloning-Many different strategies are available for library screening-Difference cloning exploits difference in the abundance of particular DNA fragments, Sequencing genes and short stretches of DNA, Changing genes: site directed mutagenesis and protein engineering-protein engineering, protein engineering

Unit 3

Gene transfer to Planta—introduction –Plant tissue culture-major strategies for gene to plant cells –Agrobacterium-mediated transformation-Direct DNA transfer Plants—gene targeting in plants-Plant viruses can be used as episomal expression vector

Types of vectors: Plasmids; Lambda based vectors and derivatives (Insertion vectors, replacement vectors, cosmids, phasmids, phagemids, in-vitro packaging, selection schemes); high-cloning capacity vectors: single stranded DNA vectors (M13, fd, f1); YACs, BACs, PACs, BIBACs, Plant Transformation vectors Ti, Ri plasmids, Binary, Conjugate, selection schemes), Protein Expression Vectors (expression systems for high level protein expression in E.coli and yeast, transcriptional efficiency, inducible promoters, translational efficiency, translational initiation, elongation, codon usage), protein extraction and purification (protein purification tags, histidine and GST tags, IMAC).

Cloning vectors for higher plants:Ti plasmid, Ri Plasmid, Agrobacterium tumefaciens—nature's smallest geneticengineer,Cloning vectors for animals:Cloning vectors for insects-P elements as cloning vectors for Drosophila.

Unit 4

Genomic DNA libraries (Procedures for Partial, Representative, Enriched, Largeinsert DNA libraries in context to medium and high-capacity cloning vectors) cDNA libraries (Self-priming methods, replacement synthesis, Okayama and Berg 4 strategy, use of Adapters/Linkers and methylation for directional cloning).

Advance transgenic technology—Inducible expression system—recombinant inducible system—site-specific recombinant system—strategies for gene inactivation—gene inhibition

Genome analysis, genome and beyond: the organization and structure of genome-the organization of nuclear DNA in eukaryotic—mapping and sequencing genome-sequencing genome-comparative genomics—comparative genomics of bacteria-comparative genomics of organelles-comparative genomics of eukaryotes

Large scale mutagenesis and interference: introduction- genome wide gene targeting is the systematic approach to large scale mutagenesis—genome wide random mutagenesis-insertional mutagenesis in invertebrate- Libraries of knock-down phenocopies

Analysis of the transcriptome : introduction- transcriptome- DNA microarray- expression profiling with DNA array

Site Directed Mutagenesis: PCR based methods for site-directed mutagenesis (Single primer methods viz. Mis-incorporation of mismatched oligos, Over-lap extension), whole plasmid single round PCR), mis-repair of mutant oligonucleotides, selection of mutant (dut/ung E. coli strains for SDM through uracil replacement), Ligase chain reaction.

Unit 5

Proteome I- Expression analysis and characterization of proteins: Introduction-protein expression analysis – mRNA Profiling-technologies for protein separation-Mass spectrometry-protein microarrayProteome II-analysis pf protein structure-Introduction-structural analysis and bioinformatics-Proteome III-Protein interactions—introduction-genetic approaches and protein interaction-methods of protein interaction analysis—traditional methods-Library based screening method-systematic analysis of protein complex—Interaction screening and bioinformatics support. Metabolomics and global biochemical:

Application of gene manipulation and genomics: understanding the basis of polygenic disorders and identifying quantitative trait loci—investigating discrete traits in out breeding populations- Investigating quantitative trait loci (QTLs) in inbred populations-understanding responses to drugs (phamacogenomics)

Application of genetic engineering:

Sequencing Genes and Genomes,Studying Gene Expression and Function-Studying the RNA transcript of a gene,Studying the regulation of gene expression,Identifying control sequences by deletion analysis,Identifying and studying the translation product of a cloned gene, Analysis of proteins by in vitro mutagenesis, Production of Protein from Cloned Genes-Expression vectors, Production of recombinant protein by eukaryotic cells,FlavrSavrtomato, Golden Rice, Bt Cotton, Plantibodies,Plant as the vehicle for molecular farming

Application of recombinant DNA technology: introduction-theme 1-producing useful molecules-theme 2-improving agronomic traits by genetic modification-theme 3 –using genetic modification to study, prevent and cure disease.

Recommended Books

1. M. R. Green, J. Sambrook. Molecular Cloning: A Laboratory Manual (Cold Spring Harbor, ed. 4, 2012).
2. M. Wink. An Introduction to Molecular Biotechnology: Molecular Fundamentals, Methods and Applications in Modern Biotechnology (Wiley, ed. 2, 2011) .
3. K. Wilson, J. Walker. Principles and Techniques of Biochemistry and Molecular Biology (Cambridge University Press, ed. 7, 2010).
4. B. R. Glick., et al. Molecular Biotechnology: Principles & Applications of Recombinant DNA (ASM Press, ed. 4, 2009).
5. M. M. Burell. Enzymes of Molecular Biology (Humana Press, 1993).
6. H.M. Eun. Enzymology. Primer for Recombinant DNA Technology (Academic Press, 1996).
7. Primerose, S.B. and Twyman, R.M.Principles of Gene Manipulations and Genomics. Blackwell Publisher
8. Old, R.W. and Primrose, S. B. 2001. Principles of Gene Manipula-tion: An Introduction to Genetic Engineering 5th Edition. Blackwell Science Ltd., USA.
9. Brown,T. A. Gene Cloning & DNA Analysis. Wiley-Blackwell
10. Kathy Wilson Peacock.Biotechnology and Genetic Engineering. ISBN 978-0-8160-77847
11. Wennacker, Ernst L. 1987. From Genes to Clones: Introduction to Gene Technology. VCH Publishers, Weinheim (Federal Republic of Germany)
12. Watson et al., Molecular Biology of the gene.

Subject Title: Principles of quantitative, Population and developmental Genetics

Subject Code: PBMG 502 4 Credits

Theory:

UNIT-I Fundamentals of Quantitative Genetics:

Multifactorial Traits,QuantitativeInheritance,Quantitativetraits,Multiple gene hypothesis, Genetic variation,Continuous, Meristic, and Threshold Traits, Distributions, Continuous and discrete variations,Expected values and breeding values, Features of polygenic traits, Significance of polygenes, polygenic variation, types of polygenic variations:Phenotypic variation, Genotypic variation and environmental variation,Biometricaltechiniques, Role of biometrical techiniques in crop improvement: Assessment of polygenic variation, Selection of elite genotypes, Choice of parents and breeding procedures, Assessment of varietal adaptability,Eminent Biometricians, Merits and demerits of quantitative genetics.

Components of phenotypic variation:

Phenotypic variance is a function of: genetic variance(Additive genetic variance,Dominance

genetic variation and Epistatic genetic variation), environmental variance,variance due to GXE interaction and covariance due to Genotype-environment association.Types of epistaticvariances:additive X additive, additive X dominance, dominance X dominance

UNIT-II

Basic statistical tools for quantitative genetic analysis:Elementary statistics, Probability laws, Elements of matrix algebra, Analysis of variance,

Analysis of covariance,Measures of dispersion, Components of genetic variances,Metroglyphanalysis,Correlationanlysis, path coefficient analysis, discriminant function analysis,partialdiallel, line X tester, triallel and quadriallel analysis, Generation mean analysis, Biparental cross analysis, Triple test cross analysis, Stability analysis.

Analysis of Quantitative Traits:Genetic variances and gene action, Heritability (Broad-Sense & narrow sense Heritability),selection, response to selection, genetic advance, combining ability, Heterosis and inbreeding depression.

Resmblances Between Relatives:Heritability, Genetic Covariance between relatives,Parent-offspring covariances,Full-sibcovariance and Half-sib covariance.

Introduction to quantitative trait loci (QTL) analysis:QTL, QTL mapping, Principle of QTL mapping, Steps involved in QTL mapping, application of QTL mapping.

UNIT III

Introduction to Population Genetics:

Population Genetics, Practical application of population genetics,Genetic variation inpopulations and species,Identification of genetic variation in a population, Explaining theHigh Level of Genetic Variation in Populations.Tools used for study of population genetics.

The Hardy-Weinberg Law:Hardy-Weinberg Law, Allele frequencies and genotypic frequencies in populations,Testingfor Hardy-weinberg equilibrium in a population, Calculating frequencies for multiple allelesin Hardy-Weinberg populations,Calculating allele frequencies for X-linked traits,Calculating Heterozygote frequency.

Factors shaping the dynamics of allele and genotype frequencies in populations:

Role of natural selection, mutation, gene flow, selection, genetic drift.

UNIT-IV

Principles of development :Genes& Development

Developmental biology, The genetic core of development: Differential gene expression,Differential gene transcription,Selective nuclear RNA processing,Selective messenger RNA translation,Differential protein modification.

UNIT V

Genetic analysis of evolutionary conserved developmental mechanisms:

Overview of plant development, Development in bryophytes pteridophytes,angiosperms Genetic basis of plant developmental systems, Arabidopsis, Tobacco as a model organism for studying plant development,Genetics of embryonic development in Drosophila, Genetic analysis of cell-cell interactions in development

References:

1. Comstock, R.E. 1996, Quantitative Genetics with Special Emphasis on Plant and Animal
Breeding. Iowa State University Press, Iowa.
2. Falconer, D.S. and Mackay, J. 1996. Introduction to Quantitative Genetics, Longman Group
Ltd., London.
3. Mather, K. and Jinks, J.L. 1971. Biometrical Genetics. Chapman and Hall, London.
4. Sharma, J.R. 1998. Statistical and Biometrical Techniques in Plant Breeding. New Age
International Publishers, New Delhi
5. Singh, R.K. and Chaudhary, B.D. 1997. Biometrical Methods in Quantitative Genetic Analysis.Kalyani Publishers, New Delhi.
6. Khalid M., Guenter, K. The Handbook of Plant Genome Mapping: Genetic & physical mapping. WILEY-VCH
Karl W. Broman, Saunak Sen. A Guide to QTL Mapping with R/qtl. SPRINGER
1. Concepts of Genetics.(10th Editions).William S. Klug, Michael R. Cummings, Charlotte A.Spencer, Michael A. Palladino.
Developmental Biology. Scott F. Gilbert
Genetics. Monroe W. Strickberger

Subject Title: Breeding Cereals, Legumes, Oilseeds, Fiber crops and Sugarcane

Subject Code: PBMG 503 4 Credits

Objective : -To provide insight into recent advances in improvement of cereals and forage crops, sugarcane legumes, oilseeds and fibre crops using conventional and modern biotechnological approaches.

UNIT I

Rice: Evolution and distribution of species and forms - wild relatives and germplasm;Genetics – cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc.– Hybrid rice breeding- potential and outcome - Aerobic rice, its implications and drought resistance breeding.

Wheat: Evolution and distribution of species and forms - wild relatives and germplasm;cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance, exploitation of heterosisetc; Sorghum: Evolution and distribution of species and forms - wild relatives and germplasm - cytogenetics and genome relationship - Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc; Pearl millet: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc.

Maize: Evolution and distribution of species and forms - wild relatives and germplasm;Cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc - QPM and Bt maize – strategies and implications - Heterosis breeding attempts taken in Sorghum, Pearl Millet and Maize; Minor millets: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship - Minor millets: breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc.

UNIT II

Sugarcane: Evolution and distribution of species and forms - wild relatives and germplasm;Cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc - Forage grasses: Evolution and distribution of species and forms – Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters and palatability studies; Biotic and abiotic stress resistance etc., synthetics, composites and apomixes.

Forage legumes: Evolution and distribution of species and forms; Wild relatives andgermplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc - Tree fodders: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress resistance etc, palatability studies.

Distinguishing features of popular released varieties in Rice and Sorghum - Wheat, Pearlmillet, Maize and other millets - Sugarcane, forage grasses and legumes and theirapplication to DUS testing - Maintenance of seed purity - Nucleus and Breeder Seed Production.

UNIT III

Pigeon pea: Evolution and distribution of species and forms; Wild relatives and germplasm;Genetics, cytogenetics and genome relationship; Morphological and molecular descriptors used for differentiating the accessions; Breeding objectives- yield, quality characters, biotic and abiotic stress etc - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at ICRISAT and other Institutes.

Chickpea: Evolution and distribution of species and forms - Wild relatives and germplasm - cytogenetics and genome relationship; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Protein quality improvement; Conventional and modern plant breeding approaches, progress made - Breeding for anti nutritional factors.

Other pulses: Greengram, blackgram, fieldpea, lentil,,lathyrus, cowpea, lablab, mothbean:Evolution, cytogenetics and genome relationship; Learning the descriptors; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

UNIT IV

Groundnut: Evolution and distribution of species and forms; Wild relatives and germplasm;Cytogenetics and genome relationship; Pod and kernel characters; Breeding objectives- yield, quality characters, biotic and abiotic stress etc.

Rapeseed and Mustard: Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc; Oil quality – characteristics in different

oils; Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship.

Soybean: Breeding objectives, utilization of wild relatives for yield and quality improvement, biotic and abiotic stress etc. - Oil quality – characteristics; Evolution and distribution of species and forms; Wild relatives and germplasm; Genetics, cytogenetics and genome relationship.

Other oilseed crops: Sunflower, sesame, safflower, niger: Evolution and distribution ofspecies and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress; Sunflower: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship, hybrid sunflower, constraints and achievements.

UNIT V

Castor: Evolution and distribution of species and forms; Wild relatives and germplasm;Cytogenetics and genome relationship, breeding objectives- yield, quality characters, biotic and abiotic stress etc - Hybrid breeding in castor – opportunities, constraints and achievements.

Cotton: Evolution of cotton; Breeding objectives- yield, quality characters, biotic and abiotic stress etc; Development and maintenance of male sterilelines – Hybrid development and seed production – Scenario of Bt cottons, evaluation procedures for Bt cotton. Jute: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, bioticand abiotic stress etc; Mesta and minor fibre crops: Evolution and distribution of species and forms; Wild relatives and germplasm; Cytogenetics and genome relationship; breeding objectives- yield, quality characters, biotic and abiotic stress etc

Distinguishing features of the released varieties in pulses, oilseeds and cotton;Maintenance of seed purity and seed production.

Suggested Readings

1. Agarwal RL. 1996. Identifying Characteristics of Crop Varieties. Oxford & IBH.

2. Bahl PN &Salimath PM. 1996. Genetics, Cytogenetics and Breeding of Crop Plants. Vol. I. Pulses and Oilseeds. Oxford & IBH.
3. Chandraratna MF. 1964. Genetics and Breeding of Rice. Longmans.
4. Chopra VL &Prakash S. 2002. Evolution and Adaptation of Cereal Crops. Oxford & IBH.
5. Gill KS. 1991. Pearl Millet and its Improvement. ICAR.
6. IRRI. 1964. Rice Genetics and Cytogenetics. Elsevier.
7. IRRI. 1986. Rice Genetics. Proc. International Rice Genetics Symposium.
8. IRRI, Los Banos, Manila, Philippines.
9. IRRI. 1991. Rice Genetics II. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
10. IRRI. 1996. Rice Genetics III. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
11. IRRI. 2000. Rice Genetics IV. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
12. Jennings PR, Coffman WR & Kauffman HE. 1979. Rice Improvement. IRRI, Los Banos, Manila, Philippines.
13. Kannaiyan S, Uthamasamy S, Theodore RK &Palaniswamy S. 2002. New Dimensions and Approaches for Sustainable Agriculture.
14. Directorate of Extension Education, TNAU, Coimbatore. Murty DS, Tabo R &Ajayi O. 1994. Sorghum Hybrid Seed Production and Management. ICRISAT, Patancheru, India.
15. Nanda JS. 1997. Manual on Rice Breeding. Kalyani.
16. Ram HH & Singh HG. 1993. Crop Breeding and Genetics. Kalyani.
17. Singh HG, Mishra SN, Singh TB, Ram HH & Singh DP. (Eds.). 1994.
18. Crop Breeding in India. International Book Distributing Co. Slafer GA. (Ed.). 1994. Genetic Improvement of Field Crops. Marcel Dekker.
19. Smartt J. 1994. The Groundnut Crop - a Scientific Basis for Improvement. Chapman & Hall.

Subject Title: Research Methodology, Biosafety, IPR

Subject Code: PBMG 504 4 Credits

UNIT-I

Introduction to Research Methodology:

Definition of research, classification ofresearch: Fundamental research, Applied research, Descriptive research,Analytical research, Qualitative research, Quantitative research, Conceptualresearch and Empirical research.

Elements of Research:

Research Problem formulation, Problem selecttion,Rationale for defining a research problem, Role of review of literature in definingthe problem, Sources of literature: Primary & secondary sources, treaties,monographs, patents, internet, scientific journals, Critical analysis of existing

literature in the selected research arena, Identification of the research gap, Designing of working research hypothesis.Basic Principles of research design, Ideal attributes of a good design,Conceptsassociated with research design:

Reporting:

Reports, Anatomy & architecture of scientific reports, Classification of reports: techinical reports, thesis, scientific research article, review article.Steps involved in mancuscriptpreparation:Layout, structure and language ofreports: Illustrations, tables , bibliography, referencing and footnotes, Thesismanuscript preparation, Making a seminar presentation, Role of effectivecommunication.

Entrepreneurship Concept, definition, structure and theories of entrepreneurshipTypes of start-ups Types of entrepreneurship, environment, process of entrepreneurial development,Entrepreneurial culture, entrepreneurial leadership,Product planning and developmentProject managementSearch for business ideaConcept of projectsProject identification, formulation Design and network analysis Project report and project appraisal

UNIT II

Ethical Issues: Introduction – causes of unethical acts, ignorance of laws, 15L codes, policies and Procedures, recognition, friendship, personal gainsProfessional ethics – professional conductEthical decision making, ethical dilemmasTeaching ethical vaues to scientists, good laboratory practices, good manufacturing practices, laboratory

acModuleationBioethics & Society (Indian context): Ethical issues on New Genetics – HumanGenome Project – Gene therapy – Genetic screening – Experimentation with humansubjects -National Practice of health care – Public & Private medical practice – National resource allocations.

UNIT III

EXPERIMENTAL DESIGNS

Objective:-

Design of Experiments provides the statistical tools to get maximum information fromleast amount of resources. This unit is meant to expose the students to the basic principles ofdesign of experiments. The students would also be provided with mathematical background ofvarious basic designs involving one-way and two way elimination of heterogeneity and theircharacterization properties. This Unit would also prepare the students in deriving theexpressions for analysis of experimental data.

Principles of experimental design, precision and accuracy, advantage of replication, experimental

technique. Analysis of variance, fundamental principles of analysis of variance.Criticaldifference, Limitations of the analysis of variance.

Statistical analysis and advantage and disadvantage of basic design-Completely RandomizedDesign, Randomized Block Design, Latin Square Design.

Factorial concept: simple effects, main effects and interaction, Factorial experiments (withoutconfounding), Yates method. Confounding, principles of confounding in a 23 factorialexperiments. Split plot design.

Missing plot technique; Bartlett's techniques for missing plots, cross-overdesign or switch-over

trials, Rotational experiments, progeny selection, compact family block design, uniformity trial,

sire index, sampling in field experiments.

Unit IV

Biosafety

Introduction; Historical Backround; Introduction to Biological Safety Cabinets; Primary Containment forBiohazards;

Biosafety in the laboratory institution: Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety,prudent biosafety practices in the laboratory/ institution Biosafety regulations in the handling of recombinant DNA processes and products in institutions and industries, biosafety assessment procedures in India and abroadBiotechnology and food safety: The GM-food debate and biosafety assessmentprocedures for biotech foods & related products, including transgenic food crops,case studies of relevance.Ecological safety assessment of recombinant organisms and transgenic crops, case studies of relevance (Eg. Bt cotton). Biosafety assessment of biotech pharmaceutical products such as drugs/vaccines etc. International dimensions in biosafety: Catagena protocol on biosafety, bioterrorismand convention on biological weaponsfor Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs& LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food andagriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Plant Quarantine and Inspection – Quarantine Rules and Regulations. Biological Diversity Act 2002 and its importance, National biodiversity authority and state biodiversity boards.

UNIT-V

Basics of Intellectual Property Rights (IPRs):

Intellectual property rights (IPR), sovereignty rights, CBD, bioethics and patenting 15L General agreement on trade and tariffs Indian sui-generis system for animal varietyand farmer's rights protection act, PVFRA , WTO with reference to biotechnological affairs, TRIPs. General Introduction: Patent claims, the legal decision – making process, ownershipof tangible and intellectual property, Patent litigation.Basic Requirements of Patentability: Patentable subject matter, novelty and the public domain, non obviousness . Special issues in Biotechnology Patents: Disclosure requirements, Collaborative research, Competitive research. Plant biotechnology Indian patents and Foreign patents, Plant variety protection act,The strategy of protecting plants.Recent Developments in Patent System and Patentability of biotechnological inventions.IPR issues in Indian Context Role of patent in pharmaceutical industry, computer related innovations. Case studies Rice, Turmeric, Margo, etc. and challenges ahead.

Copyrights & Related Rights,Trademarks, Geographical indications, Licensing and the transfer technology,WIPO: World Intellectual Property Organization, Intellectual Property Rights in India.

References:

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
7. Satarkar, S.V., 2000. Intellectual property rights and Copy right. EssEss Publications.
8. WIPO Intellectual Property Handbook :WIPO PUBLICATION No. 489 (E) ISBN 978-92-805-1291-5

9. Chakrabarti MC. 1962. Mathematics of Design and Analysis of Experiments. Asia Publ. House.
10. Cochran WG & Cox DR. 1957. Experimental Designs. 2nd Ed. John Wiley.
11. Dean AM & Voss D. 1999. Design and Analysis of Experiments. Springer.
12. Dey A &Mukerjee R. 1999. Fractional Factorial Plans. John Wiley.
13. Dey A 1986. Theory of Block Designs. Wiley Eastern.
14. Hall M Jr. 1986. Combinatorial Theory. John Wiley.
15. John JA &Quenouille MH. 1977. Experiments: Design and Analysis. Charles & Griffin.
16. Kempthorne, O. 1976. Design and Analysis of Experiments. John Wiley.
17. Khuri AI & Cornell JA. 1996. Response Surface Designs and Analysis. 2nd Ed. Marcel Dekker.
18. Montgomery DC. 2005. Design and Analysis of Experiments. John Wiley.
19. Raghavarao D. 1971. Construction and Combinatorial Problems in Design of Experiments. John Wiley.
20. Chandel S.R.S. A Hand Book of Agricultural Statistics. Kalyani publ.

Subject Title: Breeding for Biotic and abiotic stress resistance

Subject Code: PBMG 505 4 Credits

Objective : -

To apprise about various abiotic and biotic stresses influencing crop yield, mechanisms and genetics of resistance and methods to breed stress resistant varieties.

UNIT I

Importance of plant breeding with special reference to biotic and abioticstress resistance;Classification of biotic stresses – major pests and diseases of economically important crops - Concepts in insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence responses to pathogen invasions- Biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions; Concept of signal transduction and other host-defense mechanisms against viruses and bacteria.

UNIT II

Types and genetic mechanisms of resistance to biotic stresses –Horizontal and verticalresistance in crop plants. Quantitative resistance/Adult planresistance and Slow rusting resistance - Classical and molecular breeding methods - Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies.

UNIT III

Phenotypic screening methods for major pests and diseases; Recording of observations;Correlating the observations using marker data – Gene pyramiding methods and their implications.

UNIT IV

Classification of abiotic stresses - Stress inducing factors –moisture stress/drought andwater logging & submergence; Acidity, salinity/alkalinity/sodicity; High/low temperature, wind, etc. Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.

UNIT V

Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable tolow water regimes and water logging & submergence, high and low/freezing temperatures; Utilizing MAS procedures fidentifying resistant types in important crops like rice, sorghum, wheat, cotton etc; Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/contaminants in soil, water and environment.Exploitation of wild relatives as a source of resistance to biotic and abiotic

factors in majorfield crops - Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitnases and Bt for diseases and insect pest management- Achievements.

Suggested Readings

Blum A. 1988. Plant Breeding for Stress Environments. CRC Press.
Christiansen MN & Lewis CF. 1982. Breeding Plants for Less Favourable Environments. Wiley International.
Fritz RS & Simms EL. (Eds.). 1992. Plant Resistance to Herbivores and Pathogens: Ecology, Evolution and Genetics. The University of Chicago Press.
Li PH & Sakai A. 1987.Plant Cold Hardiness.Liss, New York
Luginpill P. 1969. Developing Resistant Plants - The Ideal Method of Controlling Insects. USDA, ARS, Washington DC.
Maxwell FG & Jennings PR. (Eds.). 1980. Breeding Plants Resistant to Insects. John Wiley & Sons.
Painter RH. 1951. Insect Resistance in Crop Plants. MacMillan, New York.
Russel GE. 1978. Plant Breeding for Pest and Disease Resistance. Butterworths.
Sakai A &Larcher W. 1987.Frost Survival in Plants. Springer-Verlag.
Turener NC & Kramer PJ. 1980. Adaptation of Plants to Water and High Temperature Stress. John Wiley & Sons.
Van der Plank JE. 1982. Host-Pathogen Interactions in Plant Disease. Academic Press.

PBMG 552 Practicals based on PBMG 501

Introduction to a genetic engineering lab
Competente cell preparation of E. coli
DNA transformation
Agarose gel electrophoresis
Plasmid isolation
Performing a restriction digestion in the laboratory
Mapping the positions of different restriction sites in a DNA molecule
Polymerase chain reaction

Reverse transcription-PCR
Gene cloning
Genomic library preparation
CDNA library preparation
Isolation of genomic DNA from Bacillus subtilis* genome.
PCR amplification of scoC gene and analysis by agarose gel electrophoresis
Preparation of plasmid, pET-28a from E.coli DH5α and gel analysis.
Restriction digestion of vector (gel analysis) and insert with NcoI and XhoI
Vector and Insert ligation b. Transformation in E.coli DH5α.
Plasmid isolation and confirming recombinant by PCR and RE digestion.
Transformation of recombinant plasmid in E.coli BL21 (DE3) strain
Induction of ScoC protein with IPTG and analysis on SDS-PAGE
Purification of protein on Ni-NTA column and analysis of purification by SDS-PAGE
Random Primer labeling of scoC with Dig-11-dUTPb. Southern hybridization of B. subtilis genome with probe and non-radioactive detection.

PBMG 553 Practicals based on PBMG 503

Problems on multiple factors inheritance - Partitioning of variance - Estimation of heritability and genetic advance - Covariance analysis - Metroglyph analysis - D2 analysis - Grouping of clusters and interpretation - Cluster analysis - Construction of cluster diagrams and dendrograms - interpretation - Correlation analysis - Path analysis - Parent-progeny regression analysis - Diallel analysis: Griffing's methods I and II – Diallel analysis: Hayman's graphical approach - Diallel analysis: interpretation of results - NCD and their interpretations - Line x tester analysis and interpretation of results - Estimation of heterosis : standard, mid-parental and better-parental heterosis - Estimation of inbreeding depression - Generation mean analysis: Analytical part and Interpretation – Estimation of different types of gene actions. Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions - Construction of saturated linkage maps and QTL

mapping - Strategies for QTL mapping; statistical methods in QTL mapping; Phenotype and Marker linkage studies - Working out efficiency of selection methods in different populations and interpretation, Biparental mating, Triallel analysis, Quadrille analysis and Triple Test Cross (TTC) – use of software's in analysis and result interpretation, Advanced biometrical models for combining ability analysis, Models in stability analysis Additive Main Effect and Multiplicative Interaction (AMMI) model – Principal Component Analysis model - Additive and multiplicative model – Shifted multiplicative model - Analysis and selection of genotypes - Methods and steps to select the best model - Selection systems - Biplots and mapping genotypes.

PBMG 554 Practicals based on PBMG 504

Conduct 4 seminar on concerned Unit on real case studies

Final external presentation on 4TH semester Project (**PBMG 557**) as well as synopsis and viva on it

Determination of size and shape of plots and blocks from uniformity trials data; Analysis of data generated from completely randomized design, randomized complete block design; Latin square design, Youden square design; Analysis of data generated from a BIB design, lattice design, PBIB designs; 2n, 3n factorial experiments without and with confounding; Split and strip plot designs, repeated measurement design; Missing plot techniques, Analysis of covariance; Analysis of Groups of experiments, Analysis of clinical trial experiments. Sampling in field experiments.

PBMG 555 PRACTICAL BASED ON PBMG 505

Floral biology – emasculation - pollination techniques ; Study of range of variation for yield and yield components – Study of segregating populations and their evaluation - Trait based screening for stress resistance in crops of importance– Use of descriptors for cataloguing Germplasm maintenance; learning on the Standard Evaluation System (SES) and descriptors; Use of softwares for database management and retrieval.Practical learning on the cultivation of fodder crop species on sewage water; analysing them for yield components and palatability; Laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes; Visit to animal feed producing factories, learning the practice of value addition; visiting the animal husbandry unit and learning the animal experiments related with palatability and digestibility of fodder.

Use of descriptors for cataloguing – Floral biology - emasculation – pollination techniques; Study of range of variation for yield and yield components - Study of segregating populations in Redgram, Greengram, Blackgram and other pulse crops; Attempting crosses between blackgram and greengram. Use of descriptors for cataloguing – Floral biology, emasculation, pollination techniques of oilseed crops like Sesame, Groundnut, Sunflower and Castor, Cotton: Use of descriptors for cataloguing – Floral biology - Learning on the crosses between different species - Cotton: Study of range of variation for yield and yield components - Study of segregating populations - evaluation - Trait based screening for stress resistance - Cotton fiber quality evaluation – conventional and modern approaches; analyzing the lint samples of different species, inter-specific and interracial derivatives for fiber quality and interpretation –Development and maintenance of male sterile lines Evaluation of cotton cultures of different species for insect and disease resistance – Learning the mechanisms of resistance, quantifying the resistance using various parameters; Evaluating the germplasm of cotton for yield, quality and resistance parameters – learning the procedures on development of Bt cotton - Visit to Cotton Technology Laboratory and Spinning Mills – Learning on cotton yarn production, its quality evaluation and uses.

Phenotypic screening techniques for sucking pests and chewing pests – Traits to be observed at plant and insect level - Phenotypic screen techniques for nematodes and borers; Ways of combating them; Breeding strategies - Weeds – ecological, environmental impacts on the crops; Breeding for herbicide resistance - Evaluating the available populations like RIL, NIL etc. for pest resistance; Use of standard MAS procedures Phenotypic screening methods for diseases caused by fungi and bacteria; Symptoms and data recording; use of MAS procedures - Screening forage crops for resistance to sewage water and tannery effluents; Quality parameters evaluation - Screening crops for drought and flood resistance; factors to be considered and breeding strategies - Screening varieties of major crops for acidity and alkalinity- their effects and breeding strategy Understanding the climatological parameters and predisposal of biotic and abiotic stress factors- ways of combating them.

2nd Year										
								4th Semester		
Subject Code	Subject Title	Hrs/Week		Exam Hrs	Theory Credits	Practical Credits	Total Credits	Marks		
		T	P					External	Internal	Total
PBMG 506	Molecular Plant Breeding	4	4	3	4	0	4	80	20	100
PBMG 507	Molecular Markers and Breeding	4	6	3	4	0	4	80	20	100
PBMG 508	Maintenance Breeding, Concepts of Variety Release and Seed Production	4	6	3	4	0	4	80	20	100

PBMG 556	Practical based on PBMG 506	0	4	3	0	2	2	50	00	50
PBMG 557	Project and Research Paper writing	0	8	3	0	8	8	200	00	200
PBMG 558	Practical based on PBMG 507	0	4	3	0	2	2	50	00	50
PBMG 559	Practical based on PBMG 508	0	4	3	0	2	2	50	00	50
					12	**14**	**26**	520	80	600

Subject Title: Molecular Plant Breeding

Subject Code: PBGM 506 4 Credits

Unit 1

DNA structure, DNA topology, RNA structure, chromosome sequence and diversity, chromosome duplication and segregation, the nucleosome-nucleosome assembly, higher order chromatin structure, regulation of chromatin structure. The Replication of DNA-the chemistry of DNA synthesis, the mechanism of DNA polymerase, the replication fork, the specialization of DNA polymerases, DNA synthesis at the replication fork, initiation of DNA replication, Binding and Unwinding-origin selection and activation by the initiator protein, finishing replication. The mutability and repair of DNA-replication errors and their repair, DNA damage, repair of the DNA damage

Unit 2

Homologous recombination at the molecular level: Model for homologous recombination, Homologous recombination protein machines, homologous recombination in eukaryotes, mating type switching, Genetic consequences of the mechanism of homologous recombination

Site-Specific Recombination and transposition of RNA: conservative site-specific recombination, biological roles of site specific recombination, transposition, examples of transposable elements and their regulation

Unit 3

Mechanism of transcription: RNA polymerase and the transcription cycle, the transcription cycle in bacteria, Transcription in eukaryotes and transcription in Plant. RNA Splicing: the chemistry of RNA splicing, the spliceosome machinery, alternative splicing, exon shuffling, RNA editing, mRNA transport

Unit 4

Translation: messenger RNA, Transfer RNA, attachment of amino acids to tRNA, Ribosome, initiation of translation, translation elongation, termination of translation, translation dependent regulation of mRNA and protein stability

The Genetic Code: the code is degenerate, three rules govern the genetic code, suppressor mutation can reside in the same or a different gene, the code is nearly universal

Unit 5

Gene regulation in prokaryotes: principles of transcriptional regulation, regulation of transcription initiation—examples from bacteria, example of gene regulation at steps after transcriptional regulation initiation, the case of phages λ—layers of regulation. Gene regulation in eukaryotes: Conserved mechanisms of transcriptional regulation from yeast to mammals to plants, recruitment of protein complexes to genes by eukaryotic activator, signal integration and combinatorial control, transcriptional repressors signal transduction and the control of transcriptional regulators, gene “silencing” by modification of histones and DNA, eukaryotic gene regulation at steps after transcription initiation, RNA in gene regulation

Subject Title: Molecular Markers and Breeding

Subject Code: PBMG 507 4 Credits

Course objectives:

To introduce current status of research underpinning plant genome analysis .

To integrate the abstractions of genetics with molecular biology phenomenon .

To provide a comparative account of diverse genotyping tools applied in molecular breeding, taxonomy, conservation genetics, gene flow and quantitative genetics.

Unit I

Genome Organization:Organellar genome and Nuclear Genome: Unique sequences, Repeat DNA sequences, Classification of Repeat DNA (Tandem repeats, Interspersed repeats, Micro-satellites, Mini-satellites, midi-satellites, VNTRs)

The dynamic genome: Polymorphisms and Sources of Genetic variation

Unit II

Oveview of Genetic Markers: Phenotypic Markers, Biochemicalmarkers, DNA based markersMolecular marker and DNA fingerprinting techniques:Concepts, classification and methodologies: Hybridization based markers (viz. Restriction Fragment Length Polymorphism, Oligonucleotide fingerprinting), PCR based markers (viz. DNA Amplification Fingerprinting, Arbitrarily Primed PCR, Randomly Amplified Polymorphic DNA, SSRs, STMS, SCARs, Inter-SSRs, Multiple Arbitrary Amplicon Profiling, Amplified Fragment Length Polymorphism, Selectively Amplified Microsatellite Polymorphic Loci, Inter retrotransposon amplified polymorphism, retrotransposon-microsatellite amplified polymorphism, Diversity Array Technology (DArTs), SNPs and SNP based assays for high-throughput genotyping, EST based markers, Sequencing by Hybridization (SBH)

Unit III

Molecular Markers and Assessment of genetic diversity:

Principles of Numerical taxonomy, binary matrix to pheneticdendograms, Structure analysis, Case Studies and examples

Molecular Markers for genome mapping:

Principles of Genetics: Laws of inheritance, Linkage and crossing-over, Recombination analysisGenotyping Concepts for Genetic mappingConstruction of genetic linkage maps for gene and QTL mapping, positional cloning for gene identification, Introduction to linkage mapping software packages and interfaces

Breeding by design: Marker Assisted Selection (MAS), gene introgression and pyramiding, BSAGenotyping for Physical mapping:Fingerprinting for BAC assembly

Unit IV

Types of Mapping populations in Plants: F2 populations, RILs (recombinant inbred lines), Backcross lines, NILS (Near Isogenic Lines), HIF (Heterogenous Inbred Families), AILs (Advanced Intercross Lines)

Unit V

Other Application of Molecular Markers: Genotyping tools as plant variety protection, hybrid purity tests, diagnostics (transgenics, forensics)

Other Mapping tools and Methodologies: Introduction to Cytogenetic maps, Radiation Hybrid Maps, HAPPY mapping, Physical Maps, Comparative/Synteny mapping

Suggested Readings:

Weising K, Nybom H, Wolff K, Meyer W (1995) DNA fingerprinting in plants an fungi. CRC Press, Boca Raton, Florida

Kole C (2007) Genome mapping and molecular breeding in plants. Springer Verlag, Berlin

H John Newbury (2003) Plant Molecular Breeding. CRC Press, US

Kole C and Abott AG (2008) Molecular breeding: principles and practices of plant genomics. Science Publishers, US

Griffiths AF, Miller JH, Suzuki DT, Lewontin RC, Gelbart WM (2000) An introduction to genetic analysis. WH Freeman & Co, US

Vos P, Hogers R, Bleeker M, Reijans M, van de Lee T, Hornes M, Frijters A, Plot J, Peleman J, Kuiper M, Zabeau M (1995) AFLP: a new technique for DNA fingerprinting. Nucl Acids Res 23: 4407-4414

Peleman JD and van der Voort JR (2003) Breeding by design. Trends in Plant Science.8: 330-339.

Collard BCY, Jahufer MZZ, Brouwer JB and Pang ECK (2005) An introduction to markers, quantitative trait loci (QTL) mapping and marker assisted selection for crop improvement: The basic concepts. Euphytica 142: 169-196

Varshney RK, Hoisington DA, Nayak S, Graner A (2009) Molecular Plant Breeding: methodology and achievements, In: Methods in Molecular Biology, Plant Genomics, vol. 513 (eds. Daryl J. Somers et al.), Humana Press, a part of Springer Science + Business Media, New York, NY; Book doi: 10.1007/978-1-59745- 427-8_15

Varshney RK, Tuberosa R (2008) Genomics Assisted Crop Improvement, Vol I: Genomics Approaches and Platforms, Springer, The Netherlands

Varshney RK, Tuberosa R (2008) Genomics Assisted Crop Improvement, Vol II: Genomics Applications in Crops, Springer, The Netherlands

Subject Title: Maintenance Breeding, Concepts of Variety Release and Seed Production

Subject Code: PBMG 508 4 Credits

Objective : - To apprise the students about the variety deterioration and steps to maintain the purity of varieties & hybrids and principles of seed production in self & cross pollinated crops.

UNIT I

Variety Development and Maintenance; Definition- variety, cultivar, extant variety,essentially derived variety, independently derived variety, reference variety, farmers' variety, hybrid,and population; Variety testing, release and notification systems in India and abroad.

UNIT II

DUS testing- DUS Descriptors for major crops; Genetic purity concept and maintenance breeding.

UNIT III

Factors responsible for genetic deterioration of varieties - safeguards during seed production; Maintenance of varieties in self and cross-pollination crops- isolation distance; Principles of seed production; Methods of nucleus and breeder seed production.

UNIT IV& V

Generation system of seed multiplication -nucleus, breeders, foundation, certified, - Quality seed production technology of self and cross-pollinated crop varieties viz. cereals & millets (wheat, barley, paddy, pearlmillet, sorghum, maize and ragi etc.); Pulses (greengram, blackgram, cowpea, pigeonpea, chickpea, fieldpea, lentil); Oilseeds (groundnut, soybean, sesame, castor, sunflower, safflower, linseed, rapeseed and mustard); fibres (cotton, jute) and forages (guar, forage sorghum, teosinte, oats, berseem, lucerne).; Seed certification procedures; Seed laws and plant variety protection regulations in India and international systems.

Suggested Readings

Agarwal RL. 1997. Seed Technology. 2nd Ed. Oxford & IBH.

Chhabra AK. 2006. Practical Manual of Floral Biology of Crop Plants. Department of Plant Breeding. CCS HAU Hisar.

Kelly AF. 1988. Seed Production of Agricultural Crops. Longman.

McDonald MB Jr& Copeland LO. 1997. Seed Production: Principles andPractices. Chapman & Hall.

Musil AF. 1967. Identification of Crop and Weed Seeds. Handbook No.219, USDA, Washington, DC.

Poehlman JM &Borthakur D. 1969. Breeding Asian Field Crops. Oxford & IBH.

Singh BD. 2005. Plant Breeding: Principles and Methods. Kalyani.

Thompson JR. 1979. An Introduction to Seed Technology. Leonard Hill.

Tunwar NS & Singh SV. 1985. Handbook of Cultivars. ICAR.

Subject Title: Project and Research Paper writing

Subject Code: PBMG 557 8 Credits

Each candidate, in consultation with the supervisors, will choose a topic in plant breeding and biotechnology for their research. Before embarking on research, the students will be required to prepare a proposal, which will be approved by the department. The thesis will be equivalent to eight credits and will be undertaken in all the semesters. At the end of the research, the candidate will write and submit a thesis for examination according to the current University of regulations for a Master of Science thesis.

Suggested Broad Topics for Project Work

Studies on introgressions, gene transfers, gene identification, location and localization with the application of technologies such as, in situ hybridization, chromosome identification like FISH (Fluorescent In Situ Hybridization), GISH (Genomic In Situ Hybridization), Spectral Karyotyping (SKY) and Multiplex Fluorescence In Situ Hybridization (M-FISH) etc.

Studies on stay-green traits in relation to genes affecting efficiency of photosynthethesisbiotic/abiotic stress tolerance

Genetics of AGP system for better photosynthesis and translocation Identification of genes/QTLs for NUE and WUE

Molecular markers tagged to genes/QTLs identified for improvement of nutrient use efficiency, water use efficiency

MAS based mobilization of transgenes for tolerance to biotic and abiotic stresses into desirable agronomic backgrounds

Breedingmethologiestoenhanceselectionefficiency

Component approaches and development of selection criteria for quantitiative trait improvement

Stability analyses and methods to estimate the G X E components in breeding materials

Relative efficiency analyses of genetic component estimation for reliable use in developing selection criteria in crop plants

Distance and divergence statistics for identification of similarity assessment among genetic stocks and parental genetic material

Linear and quadratic distance measures to identify relative contribution of component traits for complex traits

Studies on genetic and molecular bases of stress tolerance to develop molecular diagnostics for screening/identification of stress tolerant genotypes

Use of aneuploids for gene location and source for transfer through wild species

Development and trisomic and monosomic series in diploids and polyploids

Dependable marker systems for detection of introgression in wide crosses with minimized linkage drag

Analysis of Resistance Gene analogues and their use in MAS with enhanced disease resistance

Analysis of Gene analogues and expression synteny and their use in MAS with enhanced quality and trait expression

Refinements in embryo rescue and consequent diplodization for production of double haploids

Use of molecular marker sinphylo genetic analysis

Breeding through distant hybridization route for New Plant Type for breaking yield barriers

Genetics of durable, quantitative resistance and adult plant resistance in major crops against known pathogens

Development of tools and methodologies for identification of genes responsible for resistance against polyphagus insects

Developmentofalienadditionlinesandtelocentriclinesincrops

Microarraytechniqueandroboticsforidentificationofusefulgenesincrops

Characterizationofgermplasmthroughmolecularandserologicaltechniques

Induction of novel variation through mutagenesis tools and identify novel genes for different traits

Development of heterotic pools for maximized heterosis in cross and self pollinated crops where hybrid seed production tools are available

Genetics and traits responsible for terminal and initial heat tolerance in wheat, maize and mustard

Geneticsofcoldtolerancerelatedtraitsinmaize,riceandpigeonpea

Widening the QPM base in maize and prebreeding to add value to the genetic stocks of QPM

Comparison of relative efficiency of different softwares in analysis of quantitative trait loci and linkages

Biochemical and molecular bases of signal transduction in host-pathogen interactions

Metalbindingproteinsforidentificationofphytoremediators

Cropimprovementforbiomassenergyandindustrialuse

Developmentofcytogeneticstocksthroughvarietal/alienchromosomesubstitutions

PBMG 556 Practical based on PBMG 506

As per the subject requirement conduct minimum 10 Practicals

PBMG 558 Practicals based on PBMG 507

Study and lab experiment on following classes of genetic markers

1. Morphological traits: such as seed or flower colour are seriously limited in number while dominance, late expression, deleterious effects, pleiotropy and epistasis frequently reduce the usefulness of such markers
2. Proteins: analysis of isozymes has had limited success due to the low number of available markers. However, new techniques which simultaneously assay more than 50 seed storage proteins and structural proteins etc. provide a very cost effective means of screening variation in expressed traits which may be particularly powerful for distinctness, uniformity and stability (DUS) testing.
3. Restriction fragment length polymorphism (RFLP)
4. Random amplified polymorphic DNA (RAPD)
5. Simple sequence. repeat length polymorphi~m (SSRLP)
6. Amplified fragment length polymorphism (AFLP)
7. Expressed sequence tag (EST)
8. Single nucleotide polymorphism (SNP)
9. And other marker study

PBMG 559 Practical based on PBMG 508

Identification of suitable areas/locations for seed production; Ear-to-row method and nucleus seed production - Main characteristics of released and notified varieties, hybrids and parental lines; Identification of important weeds/objectionable weeds; Determination of isolation distance and planting ratios in different crops; Seed production techniques of varieties in different crops; Hybrid seed production technology of important crops.

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