MATA GUJRI COLLEGE

FATEHGARH SAHIB

(AN AUTONOMOUS COLLEGE)

RE-ACCEREDITED BY NAAC WITH "A" GRADE

"COLLEGE WITH POTENTIAL FOR EXCELLENCE" STATUS BY UGC

SYLLABI

SESSION: (2018-19, 2019-20)

FACULTY OF LIFE SCIENCE

DEPPARTMENT OF AGRICULTURE

COURSE: MASTER OF SCIENCE AGRICULTURE

Genetics and Plant Breeding

Outline of the Syllabus for Semester-I

M.Sc. Agriculture **GENETICS AND PLANT BREEDING**

Semester-I

Paper Code	Subject	Credit hrs.		Marks		External Assessment		Internal Assessment		Grand Total
		Theory	Practical	Theory	Practical	Theory	Practical	Theory	Practical	
GPB-501	PRINCIPLES OF GENETICS	3	1	75	25	45	25	30	00	100
GPB-502	PRINCIPLES OF PLANT BREEDING	3	1	75	25	45	25	30	00	100
GPB- 503	PRINCIPLES OF CYTOGENETICS	3	1	75	25	45	25	30	00	100
ENG-501	TECHNICAL WRITING AND COMMUNICATION SKILLS	3	0	100	00	60	00	40	00	100
STAT – 501	STATISTICAL METHODS	3	1	75	25	45	25	30	00	100
TOTAL		15	4	400	100	240	100	160	00	500

*One credit hour of Practical= 2 hours
*One credit hour of Theory= 1 hour
*One credit hour of Master Research= 1 hour

M.Sc. Agriculture First Year (1st and 2nd Semester) Session 2018-19, 2019-20

Course Structure
GPB 501 PRINCIPLES OF GENETICS

Time: 3 Hours **Max. Marks: 100**
Periods per Week 3+2 **Theory: 75**
Theory Internal assessment: 30
Theory external assessment: 45
Practical: 25

INSTRUCTIONS FOR THE PAPER SETTERS /CANDIDATES

The question paper will consist of three sections A, B and C. Section-A will have four questions from unit-I of the syllabus and section-B will have four questions from unit-II of the syllabus carrying 9 marks each. Student will have to attempt two questions from each section. Section - C will consist of 9 short answer type questions which will cover the entire syllabus uniformly and will carry 1 mark for each question. All questions of section-C are compulsory.

Objective

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.

Theory

UNIT-I

1. Genetics; definition and history, Early concepts of Inheritance; Mendel's laws; Chromosomal theory of inheritance; Cell division.
2. Multiple alleles; Gene interactions; Sex determination, differentiation and sex-linkage; Sex-influenced and sex limited traits; Linkage and Crossing over.
3. Multiple factor hypothesis, Extra chromosomal inheritance; Structural and numerical changes in chromosomes.
4. Nature, structure and chemical composition of genetic material (DNA and RNA). Gene structure analysis; Split genes; Overlapping genes, Pseudogenes.

UNIT-II

5. Regulation of gene activity in prokaryotes and eukaryotes; Mutation, transposable (Tn) elements; gene expression and regulation in eukaryotes.
6. Concepts of Eugenics, Epigenics; Genetic disorders; Overview of recent discoveries in the field of genetics.

7. Recombination in bacteria, fungi, viruses; Organization of DNA in chromosomes, Genetic code.
8. DNA replication in eukaryotes and prokaryotes.

List of Practical's

1. Demonstration of genetic principles.
2. Chromosome mapping using three point test cross.
3. Induction and detection of mutations through genetic tests;
4. DNA extraction and isolation.
5. PCR running
6. Electrophoresis– basic principles and running of amplified DNA -Extraction of proteins and isozymes.
7. Visit to experimental farm, glasshouse and learning some practical considerations.

Suggested Readings:

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*. Jones & Bartlett Publ.
4. 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. 3rd Ed. Prentice Hall.
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*
9. *Applied Genetics*. Dept. of Genetics, CCS HAU, Hisar.

M.Sc. Agriculture First Year (1st and 2nd Semester) Session 2018-19, 2019-20

GPB 502 PRINCIPLES OF PLANT BREEDING

Time: 3 Hours **Max. Marks: 100**
Periods per Week 3+2 **Theory: 75**
Theory Internal assessment: 30
Theory external assessment: 45
Practical: 25

INSTRUCTIONS FOR THE PAPER SETTERS /CANDIDATES

The question paper will consist of three sections A, B and C. Section-A will have four questions from unit-I of the syllabus and section-B will have four questions from unit-II of the syllabus carrying 9 marks each. Student will have to attempt two questions from each section. Section- C will consist of 9 short answer type questions which will cover the entire syllabus uniformly and will carry 1 mark for each question. All questions of section-C are compulsory.

Objective

To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.

Theory

UNIT-I

1. History of Plant Breeding, Principles and objectives of plant breeding.
2. Centres of Origin and biodiversity, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.
3. Genetic basis of breeding self and cross pollinated crops. Mating systems and response to selection, modes of reproduction.
4. Components of variation, Plant introduction, Domestication and germplasm conservation. Pure line theory; pure line selection and mass selection methods, pedigree, bulk, backcross, single seed descent and multiline method; population breeding in self-pollinated crops.

UNIT-II

5. Breeding methods in cross pollinated crops, population breeding-mass selection and ear-to-row methods; S_1 and S_2 progeny testing.
6. hybrid breeding- Genetical and Physiological basis of heterosis and inbreeding depression, production of inbreds, breeding approaches for improvement of inbreds, predicting hybrid performance.
7. Breeding methods in asexually/clonally propagated crops. Self-incompatibility and male sterility and its utilizations in hybrid seed production.

8. Concept of plant ideotype and its role in crop improvement.

List of Practical's

1. Floral biology in self and cross pollinated species,
2. Selfing and crossing techniques in field crop.
3. Selection methods in segregating populations and evaluation of breeding material.
4. Analysis of variance (ANOVA).
5. Learning techniques in hybrid seed production using male-sterility in field crops.

Suggested Readings

1. Allard RW. 1981. *Principles of Plant Breeding*. John Wiley & Sons.
2. Chopra VL. 2001. *Breeding Field Crops*. Oxford & IBH.
3. Chopra VL. 2004. *Plant Breeding*. Oxford & IBH.
4. Gupta SK. 2005. *Practical Plant Breeding*. Agribios.
5. Pohlman JM & Bothakur DN. 1972. *Breeding Asian Field Crops*. Oxford & IBH.
6. Roy D. 2003. *Plant Breeding, Analysis and Exploitation of Variation*. Narosa Publ. House.
7. Sharma JR. 2001. *Principles and Practice of Plant Breeding*. Tata McGraw-Hill.
8. Simmonds NW. 1990. *Principles of Crop Improvement*. English Language Book Society.
9. Singh BD. 2006. *Plant Breeding*. Kalyani.
10. Singh P. 2002. *Objective Genetics and Plant Breeding*. Kalyani.
11. Singh P. 2006. *Essentials of Plant Breeding*. Kalyani.
12. Singh S & Pawar IS. 2006. *Genetic Bases and Methods of Plant Breeding*. CBS.

M.Sc. Agriculture First Year (1st and 2nd Semester) Session 2018-19, 2019-20

GPB 503 PRINCIPLES OF CYTOGENETICS

Time: 3 Hours **Max. Marks: 100**
Periods per Week 3+2 **Theory: 75**
Theory Internal assessment: 30
Theory external assessment: 45
Practical: 25

INSTRUCTIONS FOR THE PAPER SETTERS /CANDIDATES

The question paper will consist of three sections A, B and C. Section-A will have four questions from unit-I of the syllabus and section-B will have four questions from unit-II of the syllabus carrying 9 marks each. Student will have to attempt two questions from each section. Section - C will consist of 9 short answer type questions which will cover the entire syllabus uniformly and will carry 1 mark for each question. All questions of section-C are compulsory.

Objective

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

Theory

UNIT-I

1. Architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere.
2. Artificial chromosome construction and its uses; Special types of chromosomes; Chromosomal theory of inheritance.
3. Variation in chromosome structure: evolutionary significance- Introduction to techniques for karyotyping; Chromosome banding and painting- *in situ* hybridization and various applications.
4. Structural and Numerical variations of chromosomes and their implications- Symbols and terminologies for chromosome numbers- euploidy- haploids, diploids and polyploids. Balanced lethals and chromosome complexes.

UNIT-II

5. Polyploidy and role of polyploids in crop plants; Role of aneuploids in basic and applied aspects of crop plants.
6. Evolutionary and genetics problems in crops with apomixes.

7. Chromosome manipulations in wide hybridization. Production and use of haploids, dihaploids and double haploids in genetics and breeding. Genome mapping in polyploids-Interspecific hybridization and allopolyploids.
8. Synthesis of new crops (wheat, triticale and brassica) Hybrids between species with same chromosome number, alien translocations, Hybrids between species with different chromosome number

List of Practical's

1. Learning the cytogenetics laboratory, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning etc.
2. Microscopy: various types of microscopes.
3. Studies on the course of mitosis in wheat, pearl millet.
4. Studies on the course of mitosis in onion.
5. Studies on the course of meiosis in cereals, millets and pulses
6. Studies on the course of meiosis in oilseeds and forage crops
7. Pollen germination *in vivo* and *in vitro*
8. Induction and identification of haploids:
9. Studies on another culture and ovule culture.

Suggested Readings

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.
4. Darlington CD & La Cour LF. 1969. *The Handling of Chromosomes*. Georger Allen &Unwin Ltd.
5. Elgin SCR. 1995. *Chromatin Structure and Gene Expression*. IRL Press.
6. Gray P. 1954. *The Mirotomist's Formulatory Guide*. The Blakiston Co.
7. Gupta PK & Tsuchiya T. 1991. *Chromosome Engineering in Plants: Genetics, Breeding*
8. *and Evolution*. Part A. Elsevier.
9. Gupta PK. 2000. *Cytogenetics*. Rastogi Publ.
10. Johannson DA. 1975. *Plant Microtechnique*. McGraw Hill.
11. Karp G. 1996. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons.
12. Khush GS, 1973 *Cytogenetics of Aneuploids*. Academic Press.
13. Sharma AK & Sharma A. 1988. *Chromosome Techniques: Theory and Practice*. Butterworth.
14. Sumner AT. 1982. *Chromosome Banding*. Unwin Hyman Publ.
15. Swanson CP. 1960. *Cytology and Cytogenetics. Macmillan & Co.*

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Outline of the Syllabus for Semester-II

M.Sc. Agriculture (Genetics and Plant Breeding)

Semester-II

Paper Code	Subject	Credit hrs.		Marks		External Assessment		Internal Assessment		Grand Total
		Theory	Practical	Theory	Practical	Theory	Practical	Theory	Practical	
GPB-504	PRINCIPLES OF QUANTITATIVE GENETICS	3	1	75	25	45	25	30	00	100
GPB- 505	MUTAGENESIS AND MUTATION BREEDING	3	1	75	25	45	25	30	00	100
GPB 506	CELL BIOLOGY AND MOLECULAR GENETICS	3	1	75	25	45	25	30	00	100
STAT-502	EXPERIMENTAL DESIGN	2	1	75	25	45	25	30	00	100
COMP- 501	INTRODUCTION TO INFORMATION TECHNOLOGY	2	1	75	25	45	25	30	00	100
Total		13	5	375	125	225	125	150	00	500

*One credit hour of Practical= 2 hours
*One credit hour of Theory= 1 hour
*One credit hour of Master Research= 1 hour

M.Sc. Agriculture First Year (1st and 2nd Semester) Session 2018-19, 2019-20

GPB 504 PRINCIPLES OF QUANTITATIVE GENETICS

Time: 3 Hours **Max. Marks: 100**
Periods per Week 3+2 **Theory: 75**
Theory Internal assessment: 30
Theory external assessment: 45
Practical: 25

INSTRUCTIONS FOR THE PAPER SETTERS /CANDIDATES

The question paper will consist of three sections A, B and C. Section-A will have four questions from unit-I of the syllabus and section-B will have four questions from unit-II of the syllabus carrying 9 marks each. Student will have to attempt two questions from each section. Section- C will consist of 9 short answer type questions which will cover the entire syllabus uniformly and will carry 1 mark for each question. All questions of section-C are compulsory.

Objective

To impart theoretical knowledge and computation skills regarding component of variation and variances, scales, mating designs and gene effects

Theory

UNIT-I

1. Mendelian traits *vs* polygenic traits; nature of quantitative traits and its inheritance.
2. Analysis of continuous variation, Variation associated with polygenic traits, phenotypic, genotypic and environmental- non-allelic interactions.
3. Nature of gene action- additive, dominance, epistatic and linkage effects. Principles of Analysis of Variance (ANOVA).
4. Expected Variance Components, Random and fixed models, MANOVA, Biplot Analysis, Comparison of Means and variances for significance. Metroglyph, cluster and D_2 analyses, Association analysis, correlations, Path analysis.

UNIT- II

5. Discriminant function and principal component analyses- selection indices -selection of parents, Concepts of selection- heritability and genetic advance.
6. Generation mean analysis, mating designs- Diallel, Partial Diallel, Line x tester analysis, NCDs and TTC., Concepts of combining ability and gene action.
7. Analysis of genotype x environment interaction- adaptability and stability, Models for G x E analysis and stability parameters- AMMI analysis– principle and interpretation.
8. QTL mapping in Genetic analysis and Hardy- Weinberg law.

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List of Practical's

1. Estimation of heritability and genetic advance.
2. Grouping of clusters and interpretation - Cluster analysis - Construction of cluster diagrams.
3. Diallel analysis: Griffing's method
4. Diallel analysis: Hayman's graphical approach, Diallel analysis:interpretation of results.
5. Line x tester analysis.
6. Estimation of heterosis: standard, mid-parental and better-parental heterosis.
7. Estimation of Generation mean analysis.
8. Estimation of different types of gene actions.
9. Environment and genotype x environment interactions.
10. Estimation of genetic variability.

Suggested Readings

1. Bos I & Caligari P. 1995. *Selection Methods in Plant Breeding*. Chapman & Hall.
2. Falconer DS. 1983. *Problems on Quantitative Genetics*. Longman.
3. Falconer DS. 1998. *Introduction to Quantitative Genetics*. Longman.
4. Mather K & Jinks JL. 1971. *Biometrical Genetics*. Chapman & Hall.
5. Mather K & Jinks J L. 1983. *Introduction to Biometrical Genetics*. Chapman & Hall.
6. Nadarajan N & Gunasekaran M. 2005. *Quantitative Genetics and Biometrical Techniques in Plant Breeding*. Kalyani.
7. Naryanan SS and Singh P . 2007. *Biometrical Techniques in Plant* Breeding. Kalyani.
8. Singh P & Narayanan SS. 1993. *Biometrical Techniques in Plant Breeding*. Kalyani.
9. Singh RK & Choudhary BD. 1987. *Biometrical Methods in Quantitative Genetics*. Kalyani.
10. Weir DS. 1990. *Genetic Data Analysis. Methods for Discrete Population Genetic Data*. Sinauer Associates.
11. Wricke G & Weber WE. 1986. *Quantitative Genetics and Selection in Plant Breeding*. Walter de Gruyter.

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GPB 505: MUTAGENESIS AND MUTATION BREEDING

Time: 3 Hours **Max. Marks: 100**

Periods per Week 3+2 **Theory: 75**

Theory Internal assessment: 30

Theory external assessment: 45

Practical: 25

INSTRUCTIONS FOR THE PAPER SETTERS /CANDIDATES

The question paper will consist of three sections A, B and C. Section-A will have four questions from unit-I of the syllabus and section-B will have four questions from unit-II of the syllabus carrying 9 marks each. Student will have to attempt two questions from each section. Section- C will consist of 9 short answer type questions which will cover the entire syllabus uniformly and will carry 1 mark for each question. All questions of section-C are compulsory.

Objective

To impart the knowledge about general principles of radiation and various tests/methods for detection of radiation effects on the living cells, genetic risks involved and perspectives of advances made .

Theory

UNIT-I

1. Mutation and its history- Nature and classification of mutations: spontaneous and induced mutations, micro and macro mutations.
2. Detection of mutations in lower and higher organisms– paramutations. Mutagenic agents: physical- Radiation types and sources: Ionising and nonionizing radiations *viz*., X rays, γ rays and β particles, protons, neutrons and UV rays.
3. Dosimetry- Objects and methods of treatment- Factors influencing mutation: dose rate, acute *vs*chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects.
4. Radiation sensitivity and modifying factors: external and internal sources- oxygen, water content, temperature and nuclear volume.

UNIT-II

5. Chemical mutagens- Classification- base analogues, antibiotics, alkylating agents, acridine dyes and other mutagens: their properties and mode of action.
6. Dose determination and factors influencing chemical mutagenesis- Treatment methods using physical and chemical mutagens- combination treatments.
7. Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage *etc*.

8. Mutation breeding for various traits (disease resistance, insect resistance, quality improvement, etc) in different crops.

List of Practical's

1. Learning the precautions on handling of mutagens
2. Studies of different mutagenic agents: Physical mutagens.
3. Studies of different mutagenic agents: Chemical mutagens.
4. Treating the plant propagules at different doses of physical and chemical mutagens
5. Study of M_1generation– parameters to be observed.
6. Study of M_2 generation– parameters to be observed.
7. Mutation breeding in cereals and pulses– achievements made and an analysis.
8. Mutation breeding in oilseeds and cotton– achievements and opportunities.
9. Mutation breeding in vegetative propagated crops.
10. Procedure for detection of mutations for polygenic traits in M_2 and M_3 generations.

Suggested Readings

1. Alper T. 1979. *Cellular Radiobiology*. Cambridge Univ. Press, London.
2. Chadwick KH & Leenhouts HP. 1981. *The Molecular Theory of Radiation Biology*. Springer-Verlag.
3. Cotton RGH, Edkin E & Forrest S. 2000. *Mutation Detection: A Practical Approach*, Oxford Univ. Press, USA.
4. International Atomic Energey Agency. 1970. *Manual on Mutation Breeding*. International Atomic Energey Agency, Vienna, Italy.

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GPB 506 CELL BIOLOGY AND MOLECULAR GENETICS

Time: 3 Hours **Max. Marks: 100**

Periods per Week 3+2 **Theory: 75**

Theory Internal assessment: 30

Theory external assessment: 45

Practical: 25

INSTRUCTIONS FOR THE PAPER SETTERS /CANDIDATES

The question paper will consist of three sections A, B and C. Section- A will have four questions from unit-I of the syllabus and section-B will have four questions from unit-II of the syllabus carrying 9 marks each. Student will have to attempt two questions from each section. Section- C will consist of 9 short answer type questions which will cover the entire syllabus uniformly and will carry 1 mark for each question. All questions of section-C are compulsory.

Objective

To impart knowledge in theory and practice about cell structure, organelles and their functions, molecules like proteins and nucleic acids.

Theory

UNIT-I

1. History and scope: Theory of cell differentiation- Genome constancy– indirect and direct evidences for differential gene expressions.
2. Genome control in embryogenesis; Maternal control in early development, Gene amplification; Localization and molecular mechanisms of morphogenetic determinants cytoplasms; Determination, trans determination.
3. Ultrastructure of the cell; Differences between eukaryotic and prokaryotic cells, macromolecules;
4. Structure and function of cell wall, nuclear membrane and plasma membrane; Cellular Organelles, nucleus, plastids: chloro/chromoplast, mitochondria endoplasmic reticulum, golgi complex, lysosomes, peroxisomes.

UNIT-II

5. Bioenergetics; Ultra structure and function of mitochondria and biological membranes; Chloroplast and other photosynthetic organelles; Interphase nucleus: Structure and chemical composition; Mechanisms of recombination in prokaryote;
6. DNA organization in eukaryotic chromosomes; types of DNA sequences: unique and repetitive sequences; Organelle genomes;
7. Gene amplification and its significance; gene regulation and gene expression.

8. DNA repair, Transcription and translation in eukaryotes and prokaryotes.

List of Practical's

1. Determination of soluble protein content in a bacterial culture.
2. Isolation, purification and raising clonal population of a bacterium; Biological assay of bacteriophage and determination of phage population in lysate;
3. Study of lytic cycle of bacteriophage by one step growth experiment;
4. Determination of latent period and burst size of phages per cell.
5. Quantitative estimation of DNA, RNA and protein in an organism; Numericals: problems and assignments.
6. Study of the bloating techniques.

Suggested Readings

1. Bruce A.2004. *Essential Cell Biology*. Garland.
2. Darell J, Harvey L& Baltimore D. 2004. *Molecular Cell Biology*. WH Freeman.
3. Karp G.2004. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley.
4. Klug WS & Cummings MR 2003. *Concepts of Genetics*. Scot, Foreman & Co.
5. Lewin B. 2008. *Genes IX*. Jones & Bartlett Publ.
6. Lodish H, Berk A & Zipursky SL. 2004. *Molecular Cell Biology*. 5th Ed. WH Freeman.
7. Nelson DL & Cox MM. 2005. *Lehninger's Principles of Biochemistry*. WH Freeman.
8. Russell PJ. 1996. *Essential Genetics*. Blackwell Scientific Publ.
9. Schleif R.1986. *Genetics and Molecular Biology*. Addison-Wesley Publ. Co.