Semester: 3	
Course: Major 2	
Paper Title: GENETICS	
Paper Code: C2BT230322T/P	**Credits: 4 (3 Th + 1 Pr)**
Hours/week: 3 + 3	
Category: Core/MDC/SEC/VAC: Core	
Theory / Practical / Composite: Composite	
No of Modules: 2 (Theory)	

Course Overview:

1. **I**mpart a comprehensive understanding of the principles of genetics and the modes of inheritance.
2. Provide an overview of the basic structure of chromosomes, chromosome function and chromosome mutations.
3. Provide a comprehensive idea about genetic linkage, crossing over and extra chromosomal inheritance.
4. Introduce students to DNA damage and mutation.
5. Thereafter introduce students to various DNA damage repair pathways and their detailed mechanisms
6. Students will learn the basic techniques of chromosome preparation and analysis from plant and animal samples leading to elucidation of karyotype. (Practical)
7. Students will also learn basic statistical testing of genetic traits from relevant biological data/samples. (Practical)

Course Outcome:

Theory Module A

1. Outline concepts of genetics with reference to modes of inheritance, chromosome and genomic organization, chromosomes and chromosome mutations, genetic linkage, crossing over and extrachromosomal inheritance.
2. Explain modes of inheritance such as Mendelian genetics, allelic interactions, non-allelic interactions, mechanisms of sex determination and sex linkage and extrachromosomal inheritance and discuss chromosome and genomic organization with reference to eukaryotic chromosome morphology, variations in chromosome structure and number, linkage and recombination of genes in a chromosome and crossing over.
3. Solve genetic problems involving monohybrid, dihybrid and trihybrid crosses, test crosses, back crosses, sex-linked and sex-influenced inheritance patterns, incomplete dominance, codominance, multiple alleles, lethal genes, epistasis, complementary genes, duplicate genes, inhibitory genes, chromosomes, crossing over and genetic mapping.
4. Analyse various inheritance patterns and phenotypic ratios, structural and functional roles of chromatin types and various DNA sequence categories, types of chromosomal mutations such as deletions, duplications, inversions, translocations euploidy and aneuploidy and their phenotypic consequences and associate crossing-over patterns with gene order and map distances.
5. Critically evaluate modes of inheritance such as Mendelian inheritance, incomplete dominance codominance, multiple alleles, epistasis, complementary and duplicate

genes, mechanisms of sex determination and dosage compensation, how genome organization impacts gene regulation, impact of variation in chromosomal structure and number, modes of extrachromosomal inheritance and patterns of gene linkage and recombination.

6. Develop a comprehensive overview of the principles of genetics.

Theory Module B

1. Recognize the causes of DNA damage and mutations, and recall various DNA damage repair pathways and their mechanisms.
2. Describe the different types of DNA damage like base modifications, thymine dimers and the various DNA repair pathways involved in their repair.
3. Illustrate mechanisms of DNA repair, including photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, double-strand break repair and translesion synthesis and determine the types and causes of mutations and mechanism of Ames test.
4. Associate the DNA repair pathways such as mismatch repair, base excision repair, nucleotide excision repair and double-strand break repair, along with direct reversal with the type of mutations and the molecular effects of gene mutations.
5. Assess the impact of DNA damage and mutations and the role of DNA repair pathways based on the type of damage and the enzymes involved, the molecular effects of mutations and the role of Ames test to identify mutagenic agents
6. Develop a comprehensive overview of the principles of genetics with reference to gene mutations and DNA repair.

Practical

1. Visualization of meiosis by isolation of testicular cells from grasshoppers to prepare temporary mounts as a demonstration of animal-based cytogenetics.
2. Analyze provided photographs of human karyotypes to identify various chromosomal aberrations, explaining their potential phenotypic consequences.
3. Study the technique for Barr body localization in human buccal smears using staining methods and interpret the findings.
4. Solve practical problems of genetics involving human traits inventory and blood group.
5. Analyze and evaluate the different mitotic stages from root tip cells of *Allium cepa*.
6. Create and illustrate comprehensive karyograms from suitable mitotic stages.
7. Assess the goodness of fit of Mendelian ratios from supplied natural samples.

Prerequisites: Basic knowledge about biology

SYLLABUS

UNIT/Module	CONTENT	HOURS or NUMBER OF CLASSES	CO Mapping	COGNITIVE LEVEL
Module A	UNIT I: Modes of Inheritance: Mendelian genetics: Mendel's laws of segregation & independent assortment, monohybrid, dihybrid and trihybrid	2 classes per week	CO1-CO6	K1-K6

	crosses, test and back crosses. Allelic interactions: dominant & recessive genes, incomplete dominance, codominance, pleiotropy, multiple alleles, lethal genes, penetrance and expressivity. Non-allelic interactions: interactions producing new phenotype, epistasis, complementary genes, duplicate genes, inhibitory genes. Sex determination and sex linkage: Mechanisms of sex determination, Barr bodies and dosage compensation, sex linked inheritance, sex influenced dominance, sex limited traits. UNIT II: Chromosome and genomic organization: Unique & repetitive DNA, satellite DNA, centromeric and telomeric DNA, VNTRs, STRs. Eukaryotic chromosome morphology: euchromatin and heterochromatin, packaging of DNA molecules into chromosomes, chromosome banding patterns, one gene one polypeptide hypothesis, concepts of cistron, exons, introns. UNIT III: Chromosomes: Chromosome mutations: Variations in chromosome structure: deletion, duplication, inversion and translocation, position effects of gene expression. Variations in chromosome number: aneuploidy and euploidy. Chromosomal aberrations in human beings. UNIT IV: Genetic linkage, crossing over and			

	extrachromosomal inheritance: Linkage and recombination of genes in a chromosome, crossing over, cytological basis of crossing over, crossing over at four strand stage, crossing over and genetic mapping. Extra chromosomal inheritance: cytoplasmic organelle heredity, maternal effects.			
Module B	UNIT V: Gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents. DNA damage and repair: causes and types of DNA damage, mechanisms of DNA repair - Photoreactivation, Base excision repair, Nucleotide excision repair, Mismatch repair, Double strand break repair, Translesion synthesis.	1 class per week	CO1-CO6	K1-K6
Practical	1. Study of mitosis from root tip cells of *Allium cepa* L. 2. Study of meiosis from flower buds of *Allium cepa* L. 3. Study of meiosis from grasshopper testis 4. Study of symmetric and asymmetric karyotypes in plants 5. Identification of chromosomal aberrations in human with the help of photographs 6. Demonstration of Barr Body localization 7. Testing of the goodness of fit of Mendelian Ratios 8. Practical problems on genetics (Inventory of Human traits, blood group genetics, etc.)	3 classes per week		
Text Books				
Theory				
1. M.W. Strickberger. Genetics				
2. P. J. Russell. iGenetics- A Molecular Approach.				

3. A.J.F. Griffiths, S.R. Wessler, R.C. Lewontin, S.B. Carroll. An Introduction to Genetic Analysis.
4. E.J. Gardner, M.J. Simmons, D.P. Snustad. Principles of Genetics.
5. T.A. Brown. Genomes 3.
Practical
1. Sharma A and Sharma A. Chromosome Techniques (3rd Edition) Butterworth and Co (Ltd) Publishers.
2. D. J. Balding, M. Bishop, C. Cannings. Handbook of Statistical Genetics; John Wiley & Sons, Ltd.
Evaluation: Theory: CIA: 15 marks; Semester Exam: 45 marks Practical: 40 marks (30 marks Continuous Assessment; End Semester Viva: 8 Marks; Attendance: 2 marks)
Paper Structure for Theory Semester Exam Module: **Module A: 30 marks** Any three out of four questions: Each of 2 marks Any three out of four questions: Each of 8 marks with subparts [No sub-part will be less than 2 marks or more than 6 marks] Module B: 15 marks Compulsory objective questions: 5 x 1= 5 marks Any two out of three questions: 2 x 5 = 10 marks [No sub-part will be more than 4 marks]

Course outcomes (COs) and Cognitive Level Mapping

COs	CO Description	Cognitive levels
	Theory Module A	
CO1	Outline concepts of genetics with reference to modes of inheritance, chromosome and genomic organization, chromosomes and chromosome mutations, genetic linkage, crossing over and extrachromosomal inheritance.	K1
CO2	Explain modes of inheritance such as Mendelian genetics, allelic interactions, non-allelic interactions, mechanisms of sex determination and sex linkage and extrachromosomal inheritance and discuss chromosome and genomic organization with reference to eukaryotic chromosome morphology, variations in chromosome structure and number, linkage and recombination of genes in a chromosome and crossing over.	K2
CO3	Solve genetic problems involving monohybrid, dihybrid and trihybrid crosses, test crosses, back crosses, sex-linked and sex-influenced inheritance patterns, incomplete dominance, codominance, multiple alleles, lethal genes, epistasis, complementary genes, duplicate genes, inhibitory genes, chromosomes, crossing over and genetic mapping.	K3
CO4	Analyse various inheritance patterns and phenotypic ratios, structural and functional roles of chromatin types and various DNA sequence categories, types of chromosomal mutations	K4

	such as deletions, duplications, inversions, translocations euploidy and aneuploidy and their phenotypic consequences and associate crossing-over patterns with gene order and map distances.	
CO5	Critically evaluate modes of inheritance such as Mendelian inheritance, incomplete dominance codominance, multiple alleles, epistasis, complementary and duplicate genes, mechanisms of sex determination and dosage compensation, how genome organization impacts gene regulation, impact of variation in chromosomal structure and number, modes of extrachromosomal inheritance and patterns of gene linkage and recombination.	K5
CO6	Develop a comprehensive overview of the principles of genetics.	K6
	Theory Module B	
CO1	Recognize the causes of DNA damage and mutations, and recall various DNA damage repair pathways and their mechanisms.	K1
CO2	Describe the different types of DNA damage like base modifications, thymine dimers and the various DNA repair pathways involved in their repair.	K2
CO3	Illustrate mechanisms of DNA repair, including photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, double-strand break repair and translesion synthesis and determine the types and causes of mutations and mechanism of Ames test.	K3
CO4	Associate the DNA repair pathways such as mismatch repair, base excision repair, nucleotide excision repair and double-strand break repair, along with direct reversal with the type of mutations and the molecular effects of gene mutations.	K4
CO5	Assess the impact of DNA damage and mutations and the role of DNA repair pathways based on the type of damage and the enzymes involved, the molecular effects of mutations and the role of Ames test to identify mutagenic agents.	K5
CO6	Develop a comprehensive overview of the principles of genetics with reference to gene mutations and DNA repair.	K6