DISCIPLINE SPECIFIC CORE COURSE -5 (DSC-5) – : PRINCIPLES OF GENETICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Principles of Genetics	4	3	0	1	Class XII pass	Nil

Learning Objectives

The Learning Objectives of this course are as follows:

- The course intends to introduce students to Mendelian principles of inheritance, deviations from Mendelian inheritance and extra-nuclear inheritance.
- Introduction to pedigree analysis for autosomal and X-linked traits
- Understanding of differences between prokaryotic and eukaryotic genome organization, transposons, and basic cytogenetics.
- Understanding of mechanisms of sex determination.

Learning outcomes

The Learning Outcomes of this course are as follows:

- The flavour of genomics as a progression from Mendelian genetics will be introduced to the students. They will learn about classical experiments that led to discovery of the genetic material. They will also learn the structure of DNA.
- Students will be able to explain Mendelian laws of inheritance, deviations from monohybrid ratio (incomplete dominance, codominance, multiple alleles and lethal genes) and deviations from dihybrid ratio (gene-gene interactions, linkage). They must be able to distinguish sex-linked, sex-limited and sex-influenced traits. Students must also be able to interpret patterns of inheritance for autosomal and X-linked traits from pedigrees.
- Students would learn the concept of extra-nuclear inheritance.

- Students would learn the differences in genomes of prokaryotes and eukaryotes. They would also learn about transposable genetic elements with examples from prokaryotes and eukaryotes.
- The lectures will cover details of the structure of the chromosomes, the abnormalities that commonly occur at chromosomal level. Discussion of various types of mutations at the DNA level (deletion, addition, substitution), their consequence on gene structure/product and the diseases associated with these abnormalities.
- Students wouldgain insights into genetic and environmental sex determination mechanisms.

SYLLABUS OF DSC- 5

UNIT – I (01 Weeks)

Overview of Changing Paradigms in Genetics

A brief overview of how genetic principles took shape, leading to the concept of a blueprint of life within the cell to the physical entity of DNA. Basic structure of DNA, salient features of the double helix, semi-conservative replication– Meselson and Stahl experiment. Also mention the surprises we have from genomics such as genetic variation between individuals. There are popular videos/presentations that can be used. The purpose is to ignite the curiosity of the students.

UNIT – II (03 Weeks)

Concept of Genetic Inheritance

Concept of alleles, haploid and diploid status, phenotype and genotype, Mendel's laws of inheritance, dominant and recessive inheritance, test, back and reciprocal crosses with two examples each. Chromosomal theory of inheritance. Concept of linkage and crossing over, cytological proof of crossing over, genetic mapping: two and three-point cross over. Distinguishing recombination and complementation. Allelic interactions- dominance relationships- complete, incomplete and co-dominance, gene-gene interactions. Sex linked, sex-limited and sex-influenced traits. Gathering family history, pedigree symbols and construction of pedigrees for autosomal and sex linked traits (dominant and recessive).

UNIT – III (01 Weeks)

Extra Nuclear Inheritance

Criteria for extra nuclear inheritance, plastid inheritance in *Mirabilis jalapa*, kappa particles in *Paramecium*, maternal effect- snail shell coiling, cytoplasmic inheritance (mitochondria and chloroplast).

UNIT – IV (1.5 Weeks)

Genome Organization

Organization of Genomes in prokaryotes and eukaryotes. Establishing the Central Dogma. Nucleosomes organization and assembly. Euchromatin, heterochromatin- constitutive and facultative heterochromatin. Structure and significance of polytene and lampbrush chromosomes. Transposable genetic elements: Prokaryotic transposable elements- IS elements, Composite transposons; Eukaryotic transposable elements- Ac-Ds system in maize; Uses of transposons.

UNIT – V (1.5 Weeks)

Cytogenetics and Mutations

Chromosome: Structure- centromere and telomere, types of chromosomes based on centromere. Karyotyping- banding pattern and nomenclature (G and Q banding). Structural abnormalities (Duplication, Insertion, Deletion, Translocation-Reciprocal and Non-Reciprocal) and associated syndromes. Numerical abnormalities (Aneuploidy and Euploidy) and associated syndromes. Spontaneous and induced mutations. Types of mutations: Point (Non-sense, miss-sense, silent, frameshift, insertion, deletion). Effects on the Gene products- loss of function and gain of function.

UNIT – VI (01 Weeks)

Chromosomal theory of sex determination, mechanisms of sex determination, environmental factors and sex determination in human and *Drosophila*. Barr bodies and dosage compensation.

Practical component (8-10)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)

1. Observation of wild type and mutant phenotypes in *Drosophila.*
2. Preparation of culture media for *Drosophila* and study different stages of the life cycle of *Drosophila.*
3. Verification of Mendelian laws through *Drosophila*/ seeds – dominant, recessive and sex- linked
4. Study of Barr bodies.
5. Karyotyping with the help of photographs (normal and abnormal karyotypes).
6. Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
7. Study of diploidy in onion root tip.
8. Study of polyploidy in onion root tip by colchicine treatment.
9. Study of polytene chromosomes.

Essential/recommended readings

- Klug, W. S., Cummings, M., Spencer, C. A., Palladino, M. A., Darrell K. (2019*).* 12th Edition. *Concepts of genetics.* San Francisco, NY:Pearson ISBN-13: 9780134604718.
- Snustad, D.P. and Simmons, M.J. (2019). 7th Asia Edition. *Principles of genetics.* New York, USA: John Wiley and Sons. ISBN-13: 9781119657552.
- Gardner E. J., Simmons M. J. and Snustad D. P. (2006). 8th edition *Principles of genetics.* USA. Wiley. ISBN-13: 978-8126510436.

Suggestive readings

- Cooper, G. M. and Hausman, R. E. (2019). 8th Edition. *The cell: A molecular approach.* Massachusetts, USA: Sinauer Associates. ISBN-13: 978-1605358635.
- Hardin, J., Bertoni, G. P., Becker, W.M. (2017). 9th Edition. *Becker's world of the cell.* NY:Pearso. ISBN-13: 978- 0805393934.
- Karp, G., Iwasa, J., Marshall W. (2018). 8th Edition. *Karp's Cell Biology.* New Jersey, USA: Wiley. ISBN-13: 978-1119456292.
- Kornberg, A. (2005). 2nd Edition. *DNA replication.* California, USA: University Science Books. ISBN-13: 978-1891389443.
- Griffith A. J. F., Wessler S. R., Carroll S. B. and Doebley J. (2011). 9th edition. *Introduction to Genetic Analysis.* W H Freeman & Co. ISBN-13 : 978-0716768876.
- Elrod, S and Stansfield, W. (2010). 5th edition. *Schaum's Outline of Genetics.* McGraw Hill. ISBN-13: 978-0071625036.