Paper No-15
Concepts in Genetics

THEORY

1. **Introduction to model organisms and Mendelism (4 lectures)**
   Model organisms: *Escherichia coli*, *Saccharomyces cerevisiae*, *Drosophila melanogaster*, *Caenorhabditis elegans, Danio rerio* and *Arabidopsis thaliana*, Basic principles of heredity.
   [*Genetics (2012) Snustad & Simmons, p32-36, p41-45]*

2. **Applications of Mendel's principles & chromosomal basis of heredity (3 lectures)**
   Laws of probability & binomial expansion, formulating and testing genetic hypothesis, chromosomal basis of Mendelism -Sutton and Boveri hypothesis with experimental evidences.
   [*Genetics (2012) Snustad & Simmons, p46-52, p687-68, p92-97]*

3. **Extensions of Mendelism (4 lectures)**
   Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropy gene interaction - epistatic and non epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy.
   [*Genetics (2012) Snustad & Simmons, p63-76*]

4. **Genetic definition of a gene (2 lectures)**
   Complementation test, limitations of *cis-trans* test, intragenic complementation, rII locus of phage T_4 and concept of cistron
   [Genetics (2012) Snustad & Simmons, p342-346; *Genetics- A Conceptual Approach (2012) Pierce, p246–249]*

5. **Genetics of bacteria and viruses (6 lectures)**
   Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria.
   [Genetics (2012) Snustad & Simmons, p169-186]

6. **Linkage, crossing over and mapping techniques (6 lectures)**
   Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications in *Drosophila*, detection of linked loci by pedigree analysis in humans and somatic cell hybridization for positioning genes on chromosomes.
   [Genetics- A Conceptual Approach (2012) Pierce, p185 -215]

7. **Human pedigree analysis (3 lectures)**
   Pedigree conventions, characteristics of dominant and recessive inheritance. Applications of pedigree analysis.
   [Genetics- A Conceptual Approach (2012) Pierce, p128-135, p138-144]

8. The genetic control of development and sex determination (6 lectures)
Model organism for genetic analysis, *Drosophila* development, maternal effect genes, morphogens and zygotic gene activity in development, sex chromosomes and sex determination, dosage compensation of X-linked genes.
[Genetics (2012) Snustad & Simmons, p100-105; Genetics- A Conceptual Approach (2012) Pierce, p622-631]

9. Organelle heredity and epigenetics (3 lectures)
Extra nuclear inheritance, tests for organelle heredity and maternal effect, epigenetic mechanisms of transcriptional regulation & genomic imprinting.
[Genetics- A Conceptual Approach (2012) Pierce, p111-116, p315-316, p479-81]

10. Chromosomal aberrations (4 lectures)
Variations in chromosome number- monosomy and trisomy of sex and autosomes. Variations in chromosome structure - inversions, deletions, duplications and translocations.
[Genetics (2012) Snustad & Simmons, p110-129]

11. Inheritance of complex traits & population genetics (4 lectures)
Inheritance of complex trait, analysis of quantitative traits, narrow and broad sense heritability, quantitative trait loci (QTL) and their identification. Hardy-Weinberg law, predicting allele and genotype frequencies and exceptions to Hardy-Weinberg principle.
[Genetics (2012) Snustad & Simmons, p608-623, p635-641]

12. Evolutionary genetics (3 lectures)
Molecular evolution - analysis of nucleotide and amino acid sequences, molecular phylogenies, homologous sequences, phenotypic evolution and speciation.
[Genetics (2012); Snustad & Simmons, p662- 675]

Essential Readings

1. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.
2. Genetics - A Conceptual Approach (2012), 4th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.
3. An Introduction to Genetic Analysis (2010), 10th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN:10: 1-4292-2943-8.

PRACTICALS
1. Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes.
2. Induction of polyploidy in onion roots.
3. Smear technique to demonstrate sex chromatin in buccal epithelial cells.
4. Monohybrid crosses in *Drosophila* for studying autosomal and sex linked inheritance.
5. PTC testing in a population and calculation of allele and genotype frequencies.
6. Study of abnormal human karyotype and pedigrees (dry lab)
7. Conjugation in bacteria