

# Population Genomics

(Elective Course)

Course Code: 14B1WBT737

Credits: 3(L-3: T-0: P-0)

**Pre-requisites:** Genetics, Molecular Biology and Basic Mathematics

## Course Objectives (Learning Goal):

Population genomics is the study of the transmission of genetic variation through time and space.

1. This course explores how to quantify this variation, what the distribution of variation tells us about the structure of natural populations, and about the processes that lead to evolution. Topics include the diversity and measurement of genetic variation, mating and reproductive systems, selection and fitness, genetic drift, migration and population structure, mutation, multilocus models, the genetics of speciation, quantitative traits, and the maintenance of molecular variation.
2. To understand population genomics with emphasis on DNA sequence variation and the interplay between theory and the data from experiments and natural populations.
3. To understand specific case studies including the population genetic issues involved in DNA fingerprinting, personalized medicine, the genetic structure and evolution of natural and domesticated populations, and the study of adaptation at the molecular level. Examples are drawn from studies of animals, plants, and microbes.

## Course Assessment:

Mid Term Test	30
End Term Test	45
Teacher Assessment (Based on Assignments, quizzes, attendance, etc.)	25
Total	100

## Course Outcomes:

**CO I.** A focus on theoretical population genetics, using mathematical models to understand how different evolutionary forces drive allele frequency change. Students learn how to mathematically derive classic results in population genetics.

**CO II.** Use empirical methods and tools to describe levels and patterns of genetic diversity and differentiation in populations and to infer and assess population genetic structure;

**CO III.** Apply population genetic principles in DNA forensics, conservation genetics (including human impacts on genetics of natural populations), molecular ecology, genetic improvement programs, and evolutionary studies; critically engage with debates about the roles of genetics in human society.

## Topics Covered:

**Phenotypic & Genetic Variation in Natural Populations:** Single Locus (Mendelian) versus Multi-locus (quantitative) Inheritance; Sources of Data on Genetic Variation; Recent Advances in Molecular Methods The Idealized Random-mating Population and the Hardy Weinberg Principle, HW Complications and Extensions: Linkage and Linkage disequilibrium Genetic Drift: Stochastic Changes in Allele Frequencies, Effective Population Size, Gene Trees and the Coalescent Mutation; Mutation and Drift; **Darwinian Selection:** the Haploid Model, Selection in Diploid Organisms, Equilibria with Overdominance, Underdominance, Mutation , Special Cases: Sexual Selection, Kin Selection, Meiotic Drive, Epistasis, etc, Multiple Loci and Wright's Shifting Balance Theory Selection in a Finite Population: The Nearly Neutral Theory Inbreeding, Population Structure and F Statistics, Migration & Gene Flow; **Molecular evolution :** Rates of Molecular Evolution, Evolutionary Inferences based on Patterns of Synonymous and Non-synonymous Substitutions, Molecular Evolution: Selected Topics, Quantitative Traits & Heritability, Artificial Selection, The Neutral Theory of Molecular Evolution; Infinite Alleles Model Infinite Sites Model and DNA-sequence Based Tests of Neutrality Mutation, Recombination and Muller's Ratchet; **Evolutionary Quantitative Genetics:** Mapping Quantitative Trait Loci (QTLs), Components of Phenotypic Variance, Reaction Norms, Haldane's Rule, Transposable Elements, Human Population Genetics, Linkage Disequilibrium in the Human Genome, Human Population Structure and Demographic, History Population Genetics and Human Disease; **Phylogeography :** Analysis of molecular variance (AMOVA); Nested clade analysis, Statistical phylogeography , Fully coalescent-based approaches to phylogeography, Approximate Bayesian computation; **Basic techniques in Population Genomics:** Genome mapping , genome sequencing and next generation sequencing, Comparative mapping: Mapping Populations, Genetic Markers, Selfish DNA.

## Text books:

1. Population Genetics by Matthew B. Hamilton, Willey Blackwell publication
2. Principles of Genetics. E J Gardner, M J Simmons and D P Snustad, Willey Blackwell publication

## Reference books:

1. Principles of Population Genetics by Daniel L. Hartl and Andrew G. Clark, Sinauer Publication

2. Statistical Genomics, linkage, mapping and QTL analysis by Liu, CRC publication

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	<p>genetics (including human impacts on genetics of natural populations), molecular ecology, genetic improvement programs, and evolutionary studies; critically engage with debates about the roles of genetics in human society.</p>								
	<p><b>Assessment (%)</b></p>	<p><b>100</b></p>	<p><b>100</b></p>	<p><b>90</b></p>	<p><b>90</b></p>	<p><b>100</b></p>	<p><b>100</b></p>	<p><b>90</b></p>	