MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL
(Formerly West Bengal University of Technology)
Syllabus of B. Sc Genetics
(Effective from 2023-24 Academic Sessions)

SECOND SEMESTER

Course Name: Principles of Transmission Genetics

Mode: Offline **Credits: 5(3T+2P)**
BMGN 2101
Aim of the Course: To acquaint students with Basic Concepts of genetics and pattern of inheritance

Course Objectives: The course is aimed to build knowledge in fundamentals of inheritance, Mendelian and Non Mendelian pattern of inheritance, linkage and crossing over, Allelic Variation, chromosome mapping mapping and pedigree analysis. Upon completion of this course, students should understand the pattern of mendelian inheritance and its deviations. It also helps to know the process of chromosome mapping and linkage analysis along with the clear view of allelic variation. They also know about the process of making pedigree and how to analyze a pedigree.

Sl	Graduate attributes	Mapped modules
CO1	To acquaint students with modern history of genetics, Mendelism& Chromosome Theory	**M1**
CO2	To acquaint students with Linkage & Crossing over and their types, mechanism significance and different scientific views.	M2
CO3	To acquaint students with Allelic Variation & Gene function, Epistasis, inter-allelic genetic interactions, Atavism, Penetrance, Expressivity, Pleiotropism,	**M3**
CO4	To acquaint students withNon-Mendelian inheritance like Cytoplasmic inheritance, extra-nuclear inheritance, uniparental inheritance and non-chromosomal inheritance.	**M4**
CO5	To acquaint students withChromosome Mapping, determination of linkage groups, map distance, gene order and cytological mapping.	**M5**
CO6	To acquaint students withPedigree and its symbols, patterns, types, analysis and significance.	**M6**

Learning Outcome/ Skills: To impart basic knowledge about the following

- Modern history of genetics, Mendelism and Chromosome Theory
- Linkage & Crossing over
- Allelic Variation & Gene function.
- Epistasis, inter-allelic genetic interactions, Atavism, Penetrance, Expressivity, Pleiotropism,
- Cytoplasmic inheritance, extra-nuclear inheritance, uniparental inheritance and non-chromosomal inheritance.
- Chromosome Mapping, determination of linkage groups, map distance, gene order and cytological mapping.
- Pedigree and its symbols, patterns, types, analysis and significance**.**

Module Number	Content	Total Hours	% of questions	Bloom Level (applicable)	Remarks, if any

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THEORY					
M1	History of genetics, Mendelism and Chromosome Theory	**8**	**15**	**1,2**	**NA**
M2	Linkage & Crossing over	**7**	**15**	**1,2,3,4**	**NA**
M3	Allelic Variation & Gene function	**8**	**20**	**1,2,3**	**NA**
M4	Non-Mendelian inheritance	**8**	**20**	**1,2,3,4**	**NA**
M5	Chromosome Mapping	**8**	**15**	**1,2,3**	**NA**
M6	Pedigree Analysis	**6**	**15**	**1,2,3,4**	**NA**
Total Theory		**45**	**100**		
Practical		**30**			
	TOTAL	**75**			

Detailed Syllabus

Module 1:
Science of Genetics – an overview of modern history of Genetics before 1860, 1860-1900, 1900-1944, 1944-Present.).
Mendelism& Chromosome Theory– Mendel's principles, applications of Mendel's principles, Chromosome Theory of Heredity (Sutton-Boveri), Inheritance patterns, phenomenon of Dominance, Incomplete dominance and co dominance.
Extension of Mendelism– Deviation from Mendel's Di-hybrid phenotype, Bateson &Punnet's Coupling & Repulsion hypothesis.
Total Hours: 8

Module 2:
Linkage & Crossing over- Chromosome theory of Linkage, kinds of linkage, linkage groups, Sutton's view on linkage, Morgan's view on linkage, types of Crossing over, mechanism of Meiotic Crossing over, theories about the mechanism of Crossing over, cytological detection of Crossing over, significance of Crossing over.
Total Hours: 7

Module 3:
Allelic Variation & Gene function– Multiple allele, Epistasis and Non-Epistasis inter-allelic genetic interactions, Atavism/Reversion, Penetrance (complete & incomplete), Expressivity, Pleiotropism, Modifier/Modifying genes.
Total Hours: 8

Module 4:
Non-Mendelian inheritance– Evidences for Cytoplasmic factors, cytoplasmic inheritance, extra-nuclear inheritance (mitochondrial, chloroplast), Kappa articles in Paramecium, Sigma factor in Drosophila, Cytoplasmic Male Sterility (CMS) in maize maternal inheritance, uniparental inheritance, non-chromosomal inheritance.
Total Hours: 8

Module 5:

Chromosome Mapping- Haploid mapping (2 point & 3point cross), Diploid mapping (Tetrad analysis), determination of linkage groups, determination of map distance, determination of gene order, cytological mapping.

Total Hours: 8

Module 6:

Pedigree analysis– Symbols of Pedigree, Pedigrees of Sex-linked & Autosomal (dominant & recessive), Inheritance patterns in Human (Unifactorial, Multifactorial); Mitochondrial

Total Hours: 6

PRACTICAL

BMGN 2191

Paper Name- Lab On Principles of Transmission Genetics

(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.)

Credit: 2

Total Hours: 30

1. Preparation of Mitotic Chromosome from human Leucocytes.
2. Study of salivary gland chromosomes in Drosophila.
3. Problems on Linkage and Crossing over in Eukaryotes
4. Barr body / drumstick identification

Suggested Readings:

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9th Ed. W.H.Freeman and Co., New York
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publishers
7. Russell PJ. (2009). i Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings

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Course Name: Population and Evolutionary Genetics

Mode: Offline **Credits: 5(3T+2P)**
BMGN 2102

Aim of the Course: To acquaint students with Basic Concepts of population and Evolutionary genetics

Course Objectives: To impart basic knowledge about Allele frequencies, polymorphism, Genetic Equilibrium, Application of Hardy –Weinberg theory and theories of evolution.

Sl	Graduate attributes	Mapped modules
CO1	To acquaint students with allelic frequency, changes in allele frequencies and different types of genetic polymorphism.	**M1**
CO2	To acquaint students with Random & Non-random mating and its role in population size & change in gene frequency.	**M2**
CO3	To acquaint students with Hardy-Weinberg method & its applications, assumption, proof and testing	**M3**
CO4	To acquaint students with the process of inbreeding and outbreeding process, its consequences and reason. Students also get knowledge about genetic drift, founder effect and bottle necking.	**M4**
CO5	To acquaint students with genetic equilibrium and it's condition and stability. Students also get knowledge about selection process and it's types and sub types.	**M5**
CO6	To acquaint students with different evolutionary theories and other important aspects of evolution including evolution and genetic diversity, molecular evolution, phylogenetics and neutral theory of molecular evolution.	**M6**
CO7	To acquaint students with Genetics of Speciation and its Patterns and process, isolating barriers and Genetics of reproductive isolation.	**M7**
CO8	To acquaint students with Our place in the Evolutionary tree, Evolution of Eukaryotic cells, Human sex chromosomes, Human DNA sequence families and evolution of modern humans	**M8**

Learning Outcome/ Skills: To impart basic knowledge about the following

- Allelic frequency, changes in allele frequencies and different types of genetic polymorphism.
- Random and Non-random mating and its role in population size.
- Hardy-Weinberg method and its applications.
- Process of inbreeding and outbreeding process, its consequences and reason.
- Genetic drift, founder effect and bottle necking.
- Genetic equilibrium and selection process and types
- Different evolutionary theories and other important aspects of evolution including evolution and genetic diversity, molecular evolution, phylogenetics and neutral theory of molecular evolution.
- Genetics of Speciation and barriers of isolation and Genetics of reproductive isolation.
- Our place in the Evolutionary tree, Evolution of Eukaryotic cells, Human sex chromosomes, Human DNA sequence families and evolution of modern humans

Module Number	Content	Total Hours	% of questions	Bloom Level (applicable)	Remarks, if any

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THEORY					
M1	Allelic frequency and genetic polymorphism.	**5**	**16**	**1,2,3**	**NA**
M2	Random & Non-random mating	**4**	**10**	**1,2**	**NA**
M3	Hardy-Weinberg method	**7**	**16**	**1,2,3,4**	**NA**
M4	Inbreeding and out breeding, genetic drift, founder effect and bottle necking.	**7**	**16**	**1,2,3,4**	**NA**
M5	Genetic equilibrium and Process of selection	**7**	**16**	**1,2,3**	**NA**
M6	Evolutionary theories and Molecular evolution	**7**	**16**	**1,2,3,4**	**NA**
M7	Genetics of Speciation	**4**	**5**	**1, 2, 3**	**NA**
M8	Our place in the Evolutionary tree	**4**	**5**	**1, 2**	**NA**
Total Theory		**45**	**100**		
Practical		**30**			
TOTAL		**75**			

Detailed Syllabus

Module 1:
Allele frequencies- deriving genotypic & allelic frequencies, introduction to quantitative genetics, deriving allelic frequencies from molecular data, changes in allele frequencies. Genetics & Polymorphism- phenotypic & genotypic polymorphisms, transient polymorphism, balanced polymorphisms.
Total Hours: 5

Module 2:
Random & Non-random mating– positive & negative assortative mating, role in population size & change in gene frequency.
Total Hours: 4

Module 3:
Hardy-Weinberg method & its applications– calculating allelic frequencies, assumptions of Hardy-Weinberg equilibrium, proof of Hardy-Weinberg equilibrium, Generation time, testing for fit to Hardy-Weinberg equilibrium
Total Hours: 7

Module 4:
Inbreeding & Out breeding- inbreeding co-efficient, genotype frequencies under inbreeding, uses & effects of inbreeding in farm animals, genetic consequences of inbreeding, reasons for inbreeding.
Random Genetic drift– definition, its effects in small & large populations, bottlenecking & founder effect, genetic drift simulation, genetic drift vs selection.
Total Hours: 7

Module 5:
Genetic equilibrium– definition, conditions for its stability, deviation of it (evolution). Selection– overview, types & subtypes, negative & positive selections, patterns and mechanism of selection (stabilizing, disruptive, directional, balancing, disassortative sexual selection, frequency dependent selection), overdominance, natural selection, artificial selection, ecological selection.

Total Hours: 7

Module 6:
Synthetic theory of Evolution– Lamarckian evolution theory, Darwin's theory of evolution, Neo-Darwinism, modern synthesis theory of evolution, Macroevolution & Microevolution.
Evolution of Genetic Diversity- natural variation, sources of genetic variation: chromosomes & crossing over, SNPs, mutation, deletion & rearrangements, recombination, gene flow. Molecular Evolution– general approaches, principles, rates of molecular evolution, , Evolution of eukaryotic genome structure, Gene family, evolution and phylogenetics, Gene genealogies, molecular study of phylogeny, neutral theory of molecular evolution, Gene function and molecular evolution.

Total Hours: 7

Module 7:
Genetics of Speciation- Patterns and processes of speciation: Reproductive isolating barriers, Species concepts, Genetics of reproductive isolation and species, Natural hybridization

Total Hours: 4

Module 8:
Our place in the Evolutionary tree– Evolution of Mitochondrial and nuclear genome & the origin of Eukaryotic cells, genome duplication & large-scale chromosomal alterations, Evolution of the Human sex chromosomes, Evolution of Human DNA sequence families, evolution of modern humans.

Total Hours: 4

PRACTICAL

BMGN 2192

Paper Name- Lab On Population and Evolutionary Genetics

(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.)

Credit: 2

Total Hours: 30

1. Maintenance and culturing of Drosophila stocks
2. Monohybrid segregation in Drosophila / Maize
3. Di-hybrid segregation in Drosophila / Maize
4. Use of Probability in genetic segregation.
5. Use of Chi square test in testing genetic ratios

Suggested Readings:

1. Genetics by Strickberger
2. Genetics by Gardener
3. Genetics by Tamarin and Robert
4. Theory and problems in Genetics by Stansfield
5. Introduction to Genetic Analysis by Suzuki, Griffith, Richard Lewontin