SYLLABI AND SCHEME OF EXAMINATIONS FOR M.Sc. Genetics

(Based on Curriculum and Credit Framework for PG Programs under NEP)

MAHARSHI DAYANAND UNIVERSITY ROHTAK (HARYANA)

Structure for 2 year Post Graduate Programme in Genetics (GEN2)

	Semester	Discipline-Specific Courses (DSC)	Skill Enhancement Courses (SEC) / Vocational Courses (VOC)/ Internship	Research thesis/project	Total Credits
	First year of 2 Year PG program (NHEQF Level 6)				
	I	24GEN201DS01 Concepts of Genetics 24GEN201DS02 Microbial Genetics 24GEN201DS03 Human Genetics 24GEN201DS04 Molecular Cell Biology 24GEN201DS05 Developmental Genetics	SEC1/VOC 1 24GEN201SE01 Techniques in Genetics 6a)Internship 1 @ 4 credits	---	**24**
	II	24GEN202DS01 Population and Evolutionary Genetics 24GEN202DS02 Molecular Genetics 24GEN202DS03 Immuno Genetics 24GEN202DS04 Medical Genomics 24GEN202DS05 Conservation of Genetic Resources	SEC2/VOC2 / Internship 2 @ 4 credits 24GEN202SE01 Molecular Techniques in Genetics	---	**24**
Students who exit after first year on completion of 48 credits will be awarded PG Diploma in Genetics					
Second year of two year PG program (NHEQF Level 6.5) (Student should select any one option for the second year of 2 year PG program)					
Only Course Work					
Option 1	**III**	25GEN203DS01 Recombinant DNA Technology 25GEN203DS02 Somatic Cell Genetics 25GEN203DS03 Human Molecular Genetics 25GEN203DS04 Genetics and Plant Breeding 25GEN203DS05 Drosophila Genetics	SEC 3/Internship 3/ Project Work 1 @ 4 credits 25GEN203SE01 Advanced techniques in Genetics	---	**24**
	IV	25GEN204DS01 Social, Ethical Issues in Genetics 25GEN204DS02 Lab Design and Bio safety 25GEN204DS03 Biostatistics and Bioinformatics 25GEN204DS04	SEC4/Internship 4/ Project Work 2 @ 4 credits 25GEN204SE01 Recent Advancement in Genetics	---	**24**

		Plant Molecular Genetics 25GEN204DS05 Microbial Technology			
Course work and Research					
Option 2	**III**	25GEN203DS01 Recombinant DNA Technology 25GEN203DS02 Somatic Cell Genetics 25GEN203DS03 Human Molecular Genetics 25GEN203DS04 Genetics and Plant Breeding 25GEN203DS05 Drosophila Genetics	SEC3/Internship 3 @ 4 credits 25GEN203SE01 Advanced Techniques in Genetics	---	**24**
	IV	--	SEC4/Internship 4 @ 4 credits 25GEN204SE01 Recent Advancements in Genetics	Research thesis/project @20 credits 25GEN204PD 01 Dissertation/P roject work	**24**

Only Research (only for the students who have completed 3 Years Bachelor's Program in Genetics)					
	Semester	**Discipline-Specific Courses (DSC)**	**Skill Enhancement Courses (SEC) / Vocational Courses (VOC)/ Internship**	**Research thesis/project**	**Total Credits**
Option 3	**III**	--	**SEC3/Internship 3 @ 4 credits** 25GEN203SE01 Advanced techniques in Genetics	**20 credits***	**24**
	IV	--	**SEC4/Internship 4 @ 4 credits** 25GEN204SE01 Recent Advancements in Genetics	**20 credits****	**24**

Note:

***The students who opted Option 3 should submit a project report/synopsis of at least 50 pages comprising of Literature survey, identification of Research Problem, Plan of work, methodology as well as practical work (if any) at the end of 3rd semester and the same will be evaluated by internal and external examiners.

**The students should continue the research work in 4th semester based on the project work/synopsis submitted at the end of 3rd semester. The final thesis/project report will be evaluated by the internal and external examiners.

Structure for 1 year Post Graduate Programme in Genetics (GEN2)
(Second year of 2-Year PG Program in Genetics) (GEN2)

	Semester	Discipline-Specific Courses (DSC)	Skill Enhancement Courses (SEC) / Vocational Courses (VOC)/Internship	Dissertation/ Project work	Total Credits
(STUDENT SHOULD SELECT ANY ONE OPTION)					
Only Course Work					
Option 1	**I (Semester III of 2 year PG Program)**	25GEN203DS01 Recombinant DNA Technology 25GEN203DS02 Somatic Cell Genetics 25GEN203DS03 Human Molecular Genetics 25GEN203DS04 Genetics and Plant Breeding 25GEN203DS05 Drosophila Genetics	SEC 3/Internship 3/ Project Work 1 @ 4 credits 25GEN203SE01 Advanced techniques in Genetics	---	**24**
	II (Semester IV of 2 year PG Program)	25GEN204DS01 Social, Ethical Issues in Genetics 25GEN204DS02 Lab Design and Bio safety 25GEN204DS03 Biostatistics and Bioinformatics 25GEN204DS04 Plant Molecular Genetics 25GEN204DS05 Microbial Technology	SEC4/Internship 4/ Project Work 2 @ 4 credits 25GEN204SE01 Recent Advancement in Genetics	---	**24**
Course work and Research					
Option 2	**I (Semester III of 2 year PG Program)**	25GEN203DS01 Recombinant DNA Technology 25GEN203DS02 Somatic Cell Genetics 25GEN203DS03 Human Molecular Genetics 25GEN203DS04 Genetics and Plant Breeding 25GEN203DS05 Drosophila Genetics	SEC 3/Internship 3 @ 4 credits 25GEN203SE01 Advanced techniques in Genetics	---	**24**
	II (Semester IV of 2 year PG Program)	--	SEC4/Internship 4 @ 4 credits 25GEN204SE01 Recent Advancement in Genetics	Dissertation/ Project work @ 20 credits 25GEN204PD01 Dissertation/Project work	**24**

Only Research (only for the students who have completed 4 Years Bachelor's Program in Genetics)					
	Semester	**Discipline-Specific Courses (DSC)**	**Skill Enhancement Courses (SEC) / Vocational Courses (VOC)/ Internship**	**Research thesis/project**	**Total Credits**
Option 3	**III**	--	SEC3/Internship 3 @ 4 credits 25GEN203SE01 Advanced techniques in Genetics	Dissertation/ Project work @ 20 credits* 25GEN203PD01 Dissertation/Project work	**24**
	IV	--	SEC4/Internship 4 @ 4 credits 25GEN204SE01 Recent Advancement in Genetics	Dissertation/ Project work @ 20 credits** 25GEN204PD01 Dissertation/Project work	**24**

Note:

*****The students who opted Option 3 should submit a project report/synopsis of atleast 50 pages comprising of Literature survey, identification of Research Problem, Plan of work, methodology as well as practical work (if any) at the end of 3rd semester and the same will be evaluated by internal and external examiners.

**The students should continue the research work in 4th semester based on the project work/synopsis submitted at the end of 3rd semester. The final thesis/project report will be evaluated by the internal and external examiners.

Note : -

1. The skill enhancement courses should contain maximum of component and w.e.f. the Academic session 2026 – 2027, the pattern of Skill Enhancement Courses be revised as follows by the UTDS/Centres/Institutes in Scheme and Syllabi of UG/PG programs under NEP - 2020:

For Four Credit SEC	**For Three Credit SEC**	**For Two Credit SEC**
L – T – P	L – T – P	L – T – P
0 – 0 – 4	0 – 0 – 3	0 – 0 – 2
1 – 0 – 3	1 – 0 – 2	----
2 – 0 – 2	---	----

Type of Course	M.Sc. Genetics 2 Year Program (GEN2)		Credits Distribution			Total Credits	Workload			Total Workload	Marks			
	Nomenclature of Course	Course Code	L	T	P		L	T	P		Theory		Practical	Total Marks
											Internal	External		
Semester I (Session 2024-25)														
DSC 1 @ 4 credits	Concepts of Genetics	24GEN201DS01	4	0	0	4	4	0	0	4	30	70	-	100
DSC 2 @ 4 credits	Microbial Genetics	24GEN201DS02	4	0	0	4	4	0	0	4	30	70	-	100
DSC 3 @ 4 credits	Human Genetics	24GEN201DS03	4	0	0	4	4	0	0	4	30	70	-	100
DSC 4 @ 4 credits	Molecular Cell Biology	24GEN201DS04	4	0	0	4	4	0	0	4	30	70	-	100
DSC 5 @ 4 credits	Developmental Genetics	24GEN201DS05	4	0	0	4	4	0	0	4	30	70	-	100
SEC1/VOC 1/ Internship 1 @ 4 credits	Techniques in Genetics	24GEN201SE01	0	0	4	4	0	0	8	8	0	0	100	100
Semester II (Session 2024-25)														
DSC 6 @ 4 credits	Population & Evolutionary Genetics	24GEN202DS01	4	0	0	4	4	0	0	4	30	70	-	100
DSC 7 @ 4 credits	Molecular Genetics	24GEN202DS02	4	0	0	4	4	0	0	4	30	70	-	100
DSC 8 @ 4 credits	Immuno Genetics	24GEN202DS03	4	0	0	4	4	0	0	4	30	70	-	100
DSC 9 @ 4 credits	Medical Genomics	24GEN202DS04	4	0	0	4	4	0	0	4	30	70	-	100
DSC 10 @ 4 credits	Conservation of Genetic Resources	24GEN202DS05	4	0	0	4	4	0	0	4	30	70	-	100
SEC2/VOC2/ Internship 2 @ 4 credits	Molecular Techniques in Genetics	24GEN202SE01	0	0	4	4	0	0	8	8	0	0	100	100

Type of Course			Credits Distribution			Total Credits	Workload			Total Workload	Marks			
	Nomenclature of Course	Course Code	L	T	P		L	T	P		Theory		Practical	Total Marks
											Internal	External		
Option - 1 Semester III (Session 2025-26)														
DSC 11 @ 4 credits	Recombinant DNA Technology	25GEN203DS01	4	0	0	4	4	0	0	4	30	70	-	100
DSC 12 @ 4 credits	Somatic Cell Genetics	25GEN203DS02	4	0	0	4	4	0	0	4	30	70	-	100
DSC 13 @ 4 credits	Human Molecular Genetics	25GEN203DS03	4	0	0	4	4	0	0	4	30	70	-	100
DSC 14 @ 4 credits	Genetics and Plant Breeding	25GEN203DS04	4	0	0	4	4	0	0	4	30	70	-	100
DSC 15 @ 4 credits	Drosophila Genetics	25GEN203DS05	4	0	0	4	4	0	0	4	30	70	-	100
SEC 3/Internship 3/ Project Work 1 @ 4 credits	Advanced techniques in Genetics	25GEN203SE01	0	0	4	4	0	0	8	8	-	-	100	100
Semester IV (Session 2025-26)														
DSC 16 @ 4 credits	Social, Ethical Issues in Genetics	25GEN204DS01	4	0	0	4	4	0	0	4	30	70	-	100
DSC 17 @ 4 credits	Lab Design and Bio safety	25GEN204DS02	4	0	0	4	4	0	0	4	30	70	-	100
DSC18 @ 4 credits	Biostatistics and Bioinformatics	25GEN204DS03	4	0	0	4	4	0	0	4	30	70	-	100
DSC19 @ 4 credits	Plant Molecular Genetics	25GEN204DS04	4	0	0	4	4	0	0	4	30	70	-	100
DSC20 @ 4 credits	Microbial Technology	25GEN204DS05	4	0	0	4	4	0	0	4	30	70	-	100
SEC4/Internship 4/ Project Work 2 @ 4 credits	Recent Advancement in Genetics	25GEN204SE01	0	0	4	4	0	0	8	8	-	-	100	100

Type of Course			Credits Distribution			Total Credits	Workload			Total Workload	Marks				
	Nomenclature of Course	Course Code	L	T	P		L	T	P		Theory		Practical		Total Marks
											Internal	External			
Option - 2 Semester III (Session 2025-26)															
DSC 11 @ 4 credits	Recombinant DNA Technology	25GEN203DS01	4	0	0	4	4	0	0	4	30	70	-		100
DSC 12 @ 4 credits	Somatic Cell Genetics	25GEN203DS02	4	0	0	4	4	0	0	4	30	70	-		100
DSC 13 @ 4 credits	Human Molecular Genetics	25GEN203DS03	4	0	0	4	4	0	0	4	30	70	-		100
DSC 14 @ 4 credits	Genetics and Plant Breeding	25GEN203DS04	4	0	0	4	4	0	0	4	30	70	-		100
DSC 15 @ 4 credits	Drosophila Genetics	25GEN203DS05	4	0	0	4	4	0	0	4	30	70	-		100
SEC 3/Internship 3/ Project Work 1 @ 4 credits	Advanced techniques in Genetics	25GEN203SE01	0	0	4	4	0	0	8	8	-	-	100		100
Semester IV (Session 2025-26)															
SEC4/ Internship 4 @ 4 credits	Recent Advancement in Genetics	25GEN204SE01	0	0	4	4	0	0	8	8	-	-	100 **External**		100
Research thesis/ project @20 credits	Dissertation/Project work	25GEN204PD01	-	-	-	20	-	-	-	-	-	-	150 **Internal**	350 **External**	500

Type of Course			Credits Distribution			Total Credits	Workload			Total Workload	Marks				
	Nomenclature of Course	Course Code	L	T	P		L	T	P		Theory		Practical		Total Marks
											Internal	External			
Option - 3 Semester III (Session 2025-26)															
SEC 3/Internship 3/ Project Work 1 @ 4 credits	Advanced techniques in Genetics	25GEN203SE01	0	0	4	4	0	0	8	8	-	-	100		100
Research thesis/ project @20 credits	Dissertation/Project work	25GEN203PD01	-	-	-	20	-	-	-	-	-	-	150 **Internal**	350 **External**	500
Semester IV (Session 2025-26)															
SEC4/ Internship 4 @ 4 credits	Recent Advancement in Genetics	25GEN204SE01	0	0	4	4	0	0	8	8	-	-	100		100
Research thesis/ project @20 credits	Dissertation/Project work	25GEN204PD01	-	-	-	20	-	-	-	-	-	-	150 **Internal**	350 **External**	500

L: Lecture; T: Tutorial; P: Practical

2 Year Program M.Sc. Genetics (GEN2) Total Credits; 96 Total Marks; 2400

Syllabi for Post Graduate Program in Genetics

Semester I

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Concepts of Genetics	**Course Code**	24GEN201DS01
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:
Examiner will set nine questions, and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit, and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: Students will be having knowledge about the basic concepts that form the building block for understanding Genetics i.e life cycles of Model Organisms, basic genetic experiments, mutations, polyploidy,.QTL Blood groups

CLO 2: Acquaintance of students with organization of genome and specialized chromosomes, Chromosomal theory of Inheritance, linkage, crossing over and recombination, inheritance modes in nature, maternal inheritance

CLO 3: Students will learn navigation in DNA databases (Introductory Bioinformatics)

Unit 1: Brief introduction: Life cycles of Genetically important experimental organisms: *Neurospora crassa*, *Saccharomyces cerevisiae*: Baker's Yeast, *Arabidopsis thaliana*: A Fast-Growing Plant, *Drosophilamelanogaster*: The fruit fly.

Mendelism: Mendel's experimental organism: the garden pea. Basic Principles of Inheritance: Monohybrid crosses (the principle of Segregation); Dihybrid crosses (the principle of independent Assortment); Applications of Mendel's Principles: The Punnett square method, Forked-line method, Probability method, Chisquare test.

Extensions of Mendelism: Incomplete Dominance and Co-dominance, Multiple Alleles, Testing gene mutations for allelism, Gene interactions: Complementation, Epistasis, Pleiotropy, Penetrance and Expressivity.

Unit 2: Chromosome Theory of Inheritance: Experimental evidence linking the inheritance of genes to chromosomes, Molecular organization of prokaryotic and eukaryotic chromosomes, chromomere, kinetochores, centromeres, telomeres, heterochromatin/ euchromatin; Linkage, Recombination and crossing over: Early evidence for linkage and genetic recombination, crossing over as the physical basis of recombination, cytological demonstration of crossing over, genetic recombination and construction of genetic maps, interference and coincidence.

Unit 3: Polyploidy and Aneuploidy in nature, tissue-specific polyploidy and polyteny (polytene and lampbrush chromosomes), Qualitative traits and Quantitative Traits and their inheritance, Polygenic inheritance, continuous discontinuous variation, Genetic variance, heritability & QTL mapping; Extra-nuclear Inheritance in nature: Mitochondrial and Chloroplast genes, maternal inheritance, Transposable elements/jumping genes. Mutation: definition, types, induction, detection, molecular basis and significance ofmutations in nature, mutagenic agents (exogenous & endogenous).

Unit 4: Genetic Material: Prediction of DNA structure & chemistry, Alternative forms of DNA, negative and positive supercoiling; One DNA molecule per chromosome, DNA packaging, Nucleosome structure, DNA scaffolds & loops; Fine structure of gene, split genes, pseudogenes, overlapping genes & multigene families; c value paradox and central dogma; Introduction to Bioinformatics: Biological Databases: Primary, secondary & specialized databases. Types of

databases- Nucleotide sequence database, EMBL, Genebank, Unigene, Genome biology, Protein dBase, 3D structure databases, Alignments using BLAST and FASTA.

References:

1. Principles of Genetics by D. Peter Snustad and Michael J Simmons
2. Genetics: A Conceptual Approach by Benjamin A. Pierce
3.The Science of Genetics by Alan G. Atherly, Jack R. Girton, John F. McDonald
4.http://highered.mcgrawhill.com/sites/007352526x/student_view0/genetic_portrait_chapters_

Syllabi for Post Graduate Program in Genetics

Semester I

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Microbial Genetics	**Course Code**	24GEN201DS02
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3 Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:
Examiner will set nine questions, and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):
CLO 1: Students would be able to understand the basic principles of Genetics using simpler organisms.
CLO 2: Understanding concept & principles of genetic recombination in bacteria and bacteriophages
CLO 3: Students will be familiar with transformation, transduction, bacteriophage and plasmids
CLO 4: Understanding basic principles, working and applications of microscopy;

Unit 1: Bacteria as model systems in genetic analysis: Mutation, recombination, test of allelism, gene mapping; Methods of gene transfer in bacteria; Conjugation: discovery, nature of donor strains and compatibility, interrupted mating and temporal mapping, Hfr, F', map of F plasmid, mechanism of chromosome transfer, molecular pathway of recombination; Chromosome transfer in other bacteria.

Unit 2: Transformation: Natural transformation systems, Biology and mechanism of transformation, transformation and gene mapping, Chemical-mediated and electro-transformation; Transduction: discovery, generalized and specialized or restricted transduction, Phage P1 and P22-mediated transduction, mechanism of generalized transduction, abortive transduction. Temperate phage lambda and mechanism of specialized transduction, gene mapping, fine structure mapping.

Unit 3: Structure and classification of bacteriophage: Virulent phage (T_4) and Temperate phage (lambda); Lytic and lysogenic cycles, phage-host relationship; immunity and repression, Site specific recombination (lambda and P1); Techniques for the study of bacteriophages. Transposable phage (phage Mu): Genetic organization, and transposition, Mu as a genetic tool; Plasmids: Types, detection, replication, incompatibility, partitioning, copy- number control and transfer; Properties of some known plasmids. Genetic rearrangements and their evolutionary significance: Phase variation in *Salmonella*

Unit 4: Microscopy: Light Microscopy-Introduction, Magnification and Resolution, Lens aberrations, Distortion of image and curvature of field; Types of microscopes- Compound, Comparison, Fluorescence, Polarized, Stereo, their basic principles, working and applications; Electron Microscopy- Introduction, Historical review, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Theory and basic principles, Instrumentation, applications

References:
1. Microbial Genetics - Maloy S., Cronan J., Freifelder D, Jones and Bertlett
2. Fundamental Bacterial Genetics - Trun N and Trempy J, Blackwell Publ.
3. Modern Microbial Genetics -Streips U. N. and Yasbin R.E., Wiley-Liss
4. Molecular Genetics of Bacteria -Sneider L. and Champness W. ASM Publishers
5. Genetics of Bacteria -Scaife J., Academic Press
6. Genetics of Bacteria and Viruses Birge E. A., Springer
7. Molecular Genetics of Bacteria -Dale J.W. and Park S, Wiley

Syllabi for Post Graduate Program in Genetics

Semester I

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Human Genetics	**Course Code**	24GEN201DS03
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):
CLO 1: Understanding of important hereditary diseases, their inheritance patterns, Pedigree analysis &Human karyotyping
CLO 2: Knowledge of Genetics & molecular basis of diseases, their clinical impact leading to plan treatment.
CLO 3: Insight into Cancer genetics, Human genome project, human cloning, Numerical, structural &multifactorial human genetic disorders.
CLO 4: This will be first step towards a professional carrier in disease diagnostics, allied bio-medical Sciences & Genetic counselling.

Unit 1: Overview of historical milestones in Human genetics, Study tools in Human Genetics: pedigree- gathering family history symbols, construction of pedigree, pedigree analysis in monogenetic traits; Autosomal dominantand recessive inheritance; Sex linked dominant and recessive inheritance; Consanguinity and its effects; Sex Chromosomes and autosomes, Different sex determination systems in nature; Sex linked anomalies: Haemophilia, Colour blindness; Sex limited and sex influenced traits; Sex determination in Man, TDF & SRY, Testicular feminization syndrome; Lyon hypothesis, Single active X hypothesis, Sex chromatin and drum sticks, Genetic mosaics**.**

Unit 2: Human Karyotypes: Harvesting of cells for chromosome analysis, conventional and specialized staining protocols, Banding patterns, Nomenclature of aberrant karyotypes; Human genome mapping methods: Physical mapping, Introduction to physical map markers; Radiation hybrids; Fluorescence in situ hybridization; SKY, Comparative genome hybridization, long range restriction mapping; High resolution mapping-STS/RFLP/EST/MS/SNP/sequencing**.**

Unit 3: Human Health and Disease: Chromosomal numerical and structural alteration: Mechanisms of Deletion,Duplication, Translocation, Aneuploidy and Nullisomy; Common syndrome according to numerical and structural alteration; Genetics and clinical features of Syndromes (Klinefilter, Down's, Turner, Achondroplasia, Edwards, Polydactyly); Single gene and diseases: Beadle and tatum experiment; Inherited enzyme defects in man (PKU, Alkaptonuria, Albinism, Galactosemia); Haemoglobinopathies: ABO blood group system, Rh blood group, Thalassemia syndromes; Multifactorial disorders: Genetics factors in Diabetes, Schizophrenia, Huntington's disease, Alzheimer's disease.

Unit 4: Cancer genetics: Cancer cells, Oncogenes, Tumour suppressor genes; Leukaemias, Lymphomes, myelomas; ; Human genome project: History and concepts, gateways, goals, role of sequencing, distribution of GC content, CPG islands, main conclusions, current activities; DNA finger printing ; Prenatal diagnosis; Human cloning and Eugenics; Ethical, legal and social issues in Human

Genetics

References:

1. Human Genetics: Problems and Approaches - T Vogel F. and. Motulsky A. GT, Springer Verlag
2. Human Molecular Genetics . - Strachan T & Read A, Garland Science
3. An Introduction to Human Molecular Genetics - Mechanism of Inherited Diseases Pasternak JFitzgerald, Science Press
4. Human Genetics - Cummings, M.R, Cehage Learning, USA.
5. Principles and branches of Medical Genetics, Emery and Rimoih, Churchill Livingstone, Newyork, Vol-1-3.
6. Human Cytogenetics-Constitutional analysis (Ed) D.E. Rooney, Oxford University Press.
7. Recombinant DNA - J.D. Watson Gillman, Scientific American books, W.H, freeman company N.Y.
8. Human Genetics - The molecular revolution McConkey, Edwin H, Jones & Bartlett publishers.

Syllabi for Post Graduate Program in Genetics

Semester I

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Molecular Cell Biology	**Course Code**	24GEN201DS04
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: Students will be able to understand structure, function of different cell organelles, biomolecules

CLO 2: Knowledge about the mechanism of cellular processes- cell cycle and regulation, cellular energetic, enzyme kinetics, transport across the cell membrane and cellular signal transduction

CLO 3: Students will be having knowledge of biophysical techniques (NMR, ESR, X ray diffraction etc)for the analysis of biomolecules

Unit 1: Diversity of cell size and shape; Cell Theory; Structural organization and function of intracellular organelles: Cell wall, Nucleus, Mitochondria, Golgi bodies, lysosomes, Ribosome, Endoplasmic reticulum, Peroxisomes, plastids, Vacuoles, Chloroplast, Structure & function of cytoskeleton and its role in motility; Cell adhesion, gap junction, Extra cellular matrix. Endosymbiotic origin of mitochondria and chloroplast.

Unit 2: Cell division and cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, chromosomal movements and control of cell cycle; Membrane transport processes, transport molecules, inhibitors, ion gradient, proton pumps (in oxidative phosphorylation, in photosynthesis & in bacteria); Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers and regulation of signaling pathways.

Unit 3: Composition, structure and function of biomolecules such as carbohydrates, lipids, proteins, nucleic acids (DNA and RNA: detail structure & types) and vitamins; Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds).

Unit 4: Bioenergetics, glycolysis, coupled reaction, group transfer, biological energy transducers; Enzyme kinetics: Factors affecting enzyme activity- pH, temperature, time of incubation, enzyme concentration and substrate concentration. Derivation of Michaelis-Menten equation, Kcat/Km and its significance, regulation of enzyme activity, allosteric enzymes ;Biophysical methods**:** Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy; Structure determination using X-ray diffraction and NMR analysis using light scattering; Different types of mass spectrometry and surface plasma resonance methods.

References:

1. Lodish et al., Molecular Cell Biology Freeman and Company

2. Smith and Wood. Cell Biology, Chapman and Halls
3. Watson et al. Molecular Biology of the gene. Pearson Prentice Hall, USA
4. Benjamin Lewin. Gene X, Jones and Barlett Publishers,
5. Lehninger Principles of Biochemistry 4th Ed By David L. Nelson and Michael M. Cox, WH Freeman andCompany.
6. Principles of Biochemistry (Hardcover) By Geoffrey Zubay. Publisher: McGraw Hill College.
7. Biochemistry By Lubert Stryer. WH Freeman and Co.

Syllabi for Post Graduate Program in Genetics

Semester I

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Developmental Genetics	**Course Code**	24GEN210DS05
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:
Examiner will set nine questions, and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: Students will be enabled to understand the process of development in various animals

CLO 2: It will be helpful in knowing different gene expression patterns in development and the role of maternal environment on fetal development

CLO 3: To understand the environmental influences on development, factors responsible for ageing & programmed cell death

CLO 4: Understanding of the basic concept of assisted reproduction

Unit 1: Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; Morphogenetic gradients, pattern formation, cell fate and cell lineages; Mosaic versus regulative development; Genomic imprinting.

Unit 2: Fertilization, Types of cleavage, Gastrulation; Cell movement and formation of germ layers in frog, Chick and mouse; Implantation and formation of the placenta in mammals; Gastrulation in mammals-formation of primitive streak, morphogenetic movements and induction; Organogenesis and foetal development; Formation of vulva in *C. elegans.*

Unit 3: Drosophila: Embryonic development, Maternal genes and formation of body axes, Segmentation genes, and Homeotic genes function, Imaginal disc development, P-element and insertional mutagenesis; Pattern forming genes and expression in mammalian embryos, Axes formation and Hox genes; Development of mammalian brain-cerebral cortex-cell lineages; Limb development and regeneration in vertebrates; Lens development-fibre differentiation; Programmed morphogenetic histogenetic cell death (apoptosis); erythropoiesis, myelopoiesis and ageing.

Unit 4: Embryonic stem cells and their applications; Clinical embryology: (Gametogenesis, Follicular development, egg release, fertilization implantation, Types of placenta), Brief account of hormonal control of reproduction; Gonadal malformation and their genetic basis; Reproductive failure and infertility; Assisted reproduction.

References:

1. Developmental Biology (2003) - Gilbert S. F, Sinauer Asso.
2. Principles of Development (2002) - Wolpert L et al., Oxford University Press
3. The Art of the Genes (1999) - How Organisms Make Themselves Coen E. Oxford University Press
4. Genetic Analysis of Animal Development (1993) 2nd ed. - Wilkins A. S., Wiley-Liss
5. Biological Physics of the Developing Embryo (2005) - Forgacs G. & Newman S. A., Cambridge UniversityPress.

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Semester I

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Techniques in Genetics	**Course Code**	24GEN201SE01
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3 Hrs

Course Learning Outcomes (CLO):

CLO1: Students will be able to learn about basic instruments used in the laboratories.
CLO2: Familiar with the model organisms such as *Drosophila melanogaster, C. elegans, E. coli* etc.
CLO3: Students will be skilled to isolate and analyse DNA from different biological samples.
CLO4: Able to understand the different stages of life cycle in frogs, chicks etc.

- To be familiar with the basic instrumentation of a genetics/molecular biology laboratory.
- To perform cleaning and sterilization of glassware and plasticwares.
- To prepare solutions for biological laboratories.
- To sterilize culture media and solutions.
- To study of life cycle of *Drosophila melanogaster*.
- To study life cycle of the *C. elegans*.
- To examine permanent slides of various stages of frog development.
- To examine permanent slides of various stages of chick development.
- To study the various stages of mitosis shown in permanent slides.
- To study various stages of meiosis shown in permanent slides.
- To study differential method in embryonic development.
- To examine permanent slides of various stages of mammalian development.
- To demonstrate germ layers (ectoderm, endoderm, mesoderm) in the human embryo.
- To demonstrate homeobox gene arrangement in *Drosophila*.
- To perform agarose gel electrophoresis.
- To isolate genomic DNA from human peripheral blood.
- To isolate the genomic DNA from mosquitoes
- To isolate the genomic DNA from *E. coli* cells.
- To isolate the plasmid DNA using alkaline lysis method
- To grow *E. coli* on LB agar and broth culture media.
- To perform Gram-staining of given bacterial culture.
- To study different types of plasmids e.g. pBR322 and F-plasmids.
- To study pedigree symbols and different inheritance patterns and their hallmarks.
- To study genetic variability in human population for behavioral, morphogenetic and serogenetic factors.
- To study genetic variability in human population through thumb impression.
- To calculate bleeding and clotting time of your own blood.
- To calculate the number of RBCs of your own blood via hemocytometer technique
- To perform nucleotide search by using BLAST.

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Semester II

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Population and Evolutionary Genetics	**Course Code**	24GEN202DS01
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3 Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Students will be having knowledge about natural selection, speciation, different theories of evolution and molecular evolution.

CLO2: They will be able to learn molecular evolution and quantitative genetics.

CLO3: Understanding of molecular tools in phylogeny, principle, procedure and applications of molecular biology techniques.

Unit 1: Population Genetics: Definition & Meaning; Microevolution in Mendelian population: Theory of Allele Frequencies; The Hardy-Weinberg Principle: Theory, exceptions and applications; Natural Selection: Concept of fitness, natural selection at the level of gene; factors affecting gene frequencies, genetic drift and mutation; Speciation: causes of reproductive isolation; Evidence for speciation; Mode of speciation: Allopatric, Parapatric, Sympatric; Co-speciation: sexual selection, Co-evolution and convergent evolution.

Unit 2: Populations in Genetic Equilibrium: Balancing Selection, Mutation–Selection Balance, Mutation–Drift Balance; Quantitative Genetics: Johannsen pure-line concept; Quantitative traits and their characteristics, threshold traits, multiple factor hypothesis, types of quantitative traits, determining gene number for a polygenic trait, components of phenotypic variation and genetic models for quantitative traits; Concept of heritability: Broad sense heritability and narrow sense heritability; Predicting phenotypes; Artificial selection.

Unit 3: Emergence of Evolutionary Theories: Lamarckism and Darwin's Theory of Evolution, Shortcomings of Lamarckism and Darwin's Theory; Origin of basic organic monomers and polymers, Spontaneous generation, Louis Pasteur's experiment, Oparin and Haldane's theory of origin of life, Miller-Urey Experiment; Origin of prokaryotes and eukaryotes; Evolutionary time scale: eras, periods and epoch; major events in evolutionary time scale.

Unit 4: Molecular evolution: Concept of neutral theory of molecular evolution; Molecular divergence and molecular clocks; Genetic variation in natural populations; Molecular tools in phylogeny, classification and identification; Construction of phylogenetic tree by distance-based methods and character-based methods; Protein and nucleotide sequence analysis; Electrophoresis: principle, procedure and application of agarose, SDS-PAGE, pulse-field electrophoresis and isoelectric focusing.

References:

1. http://evolution.berkeley.edu/evolibrary/article/0_0_0/evo_01.
2. http://evolution.berkeley.edu/evolibrary/article/evo_44.
3. Principles of Genetics by D. Peter Snustad and Michael J Simmons.
4. Genetics: A Conceptual Approach by Benjamin A. Pierce.
5. The Science of Genetics by Alan G.Atherly, Jack R. Girton, John F. McDonal.
6. Genes in the Environment-Rosie S. Hails, Wiley-Blackwell Publications.

Syllabi for Post Graduate Program in Genetics

Semester II

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Molecular Genetics	**Course Code**	24GEN202DS02
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):
CLO-1Knowledge about the molecular mechanisms of DNA, RNA.
CLO-2Understanding of DNA damage, repair, RNA transport, post and co transcriptional modifications, post translational modifications, RNA processing etc.
CLO-3Understanding about the mechanisms of gene expression regulation in prokaryotic and eukaryotic system.

Unit 1: DNA, RNA as genetic material; DNA replication, Repair and Recombination: Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication; DNA damage and repair mechanisms: nucleotide excision repair, base excision repair, SOS repair, recombination repair, Photo reactivation repair; Structure and function of different types of RNA, RNA transport; RNA synthesis and processing: Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation.

Unit 2: Protein synthesis and processing: Ribosomes, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA- identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post- translational modification of proteins.

Unit 3: Gene regulation and levels of regulation, evidences and experimental designs/methodologies, role of genetic analysis in understanding gene function and regulation; Gene regulation in prokaryotes- lac, trp operon. Yeast- Gene regulation in a single celled eukaryote using a model case of gal gene.

Unit 4: Genetic regulation in eukaryotes; DNA alteration (Gene amplification, programmed DNA rearrangement, DNA methylation); Spatial and temporal control, Tubul in gene in plant, glob in genes in animals); Molecular control of transcription in eukaryotes (Enhancer, Silencer, enhancer trap mutagenesis, transcription factors, alternate promoters, alternate splicing, molecular organization of transcriptionally active DNA, Translational control.

References:

1. BenjaminLewin.GeneX,10th Edition, Jones and Barlett Publishers 2010.
2. J DWatsonetal., Biology of Gene,6thEdition,BenjaminCummingspublishers Inc.2007
3. Albertsetal., Molecular Biology of the Cell, Garland, 2002
4. PrimoseSB, Molecular Biotechnology, Panima, 2001.
5. Watsonet al. Molecular Biology of the gene. Pearson Prentice Hall, USA 2003
6. Benjamin Lewin. GeneX, Jones and Barlett Publishers,2010.

Syllabi for Post Graduate Program in Genetics

Semester II

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Immunogenetics	**Course Code**	24GEN202DS03
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):
CLO-1 Understanding of the immune system, its components, properties, role of immunity in human health & disease.
CLO-2 Knowledge of the genetic basis of the immune response and antibody diversity.
CLO-3 Enable to make a research carrier in identification of new therapeutic targets for immune diseases & will help to develop new strategies to harness the power of immunity to defeat various diseases including cancer.
CLO-4 Insight in the genetics of transplantation and tissue rejection, Autoimmunity and immune suppression that can be applied to the estimates of transplant compatibility and the likelihood finding suitable donors

Unit 1: Overview of immunity; General properties of immune system, Immunological memory, Specificity; Innate and Adaptive immunity; Cells and organs of immune system; Haematopoiesis; Antigens (Haptens, epitopes, adjuvants) ; Antibodies; Immunoglobulin classes; Cytokines, Interferon, Colony stimulating factor, Transforming growth factor; Complement pathways.

Unit 2: Immune response: MHC complex, Class I, II, III molecules; Genetic map of H-2 complex & HLA Complex; T cell receptor complex; Subtractive hybridization; Ig gene super family; Humoral & cell mediated immune response (antigen recognition, processing and presentation),Hypersensitivity reactions (I, II, III & IV types).

Unit 3: Immunogenetics: Organization of immunoglobulin genes, Genetic control of light chains ((Lambda & Kappa), Genetic control of heavy chains; Genomic rearrangement during B lymphocyte differentiation, Somatic recombination events, Antibody class switching, Allelic exclusion, Somatic mutation; Genetic control of antibody diversity.

Unit 4: Immunity in health and disease: Disorders of immune system: Self tolerance & auto immunity, causative factors; Defects: Thyroiditis, IDDM, SLE, Rheumatoid arthritis; Immuno suppression: Severe combined immunodeficiency (SCID), AIDS; Tissue transplantation: Laws, types of grafts rejection, GVHR, alloantigens; Vaccines; Primary antigen, antibody reaction: Radio immunoassay, Enzyme linked immunosorbent assay; Secondary antigen antibody reaction: Precipitation, Agglutination & Immuno electrophoresis.

References:

1. Immunology - Kuby J. W. H., Freeman
2. Essentials of Immunology - Ivan M. Roitt, Wiley-Blackwell
3. Fundamentals of Immunology -William E. Paul Lippincott, Williams & Wilkins.
4. Immunology Understanding Immune system –Elgert K D, John Wiley and sons.

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Semester II

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Medical Genomics	**Course Code**	24GEN202DS04
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CO-1 Students will be able to explain the technical and medical aspects of diagnostic and screening methods and reproductive options including associated risks, benefits, and limitations.

CO-2 Understanding of basic principles of genetic manipulation and gene therapy.

CO-3 Understanding the role that genetic testing plays in pharmacogenetics& its applicability.

CO-4 Concept of genetic counselling.

Unit 1: Growth and development of medical genetics, Role of genetics in medicine; Diagnostic genetics: Cytogenetics/Molecular Cytogenetics /Biochemical/Molecular methods; Screening for mutation/ chromosomal anomaly -Adult/Prenatal/Newborn screening; Preimplantation screening (Assisted reproductive technology- in-vitro fertilization and Embryo transfer); Organ banking, transplantation, Forensic testing - DNA fingerprinting, paternity testing, individual identification.

Unit 2: Treatment of genetic disorders: Recombinant Proteins, Gene therapy: Types, Criteria & technical aspects, Viral vectors, delivery methods and microinjection, germline therapy, gene therapy of (Thalassemia, Cystic fibrosis, DMD), Mitochondrial inheritance and its disorders (Mitochondrial myopathy, Maternally inherited diabetes mellitus and deafness, (MIMD), Leber's hereditary optic neuropathy (LHON))

Unit 3: Pharmacogenetics: History, Genes involved in pharmacokinetics and pharmacodynamics of drugs, Pharmacogenetic diseases (Hereditary disorders with altered drug response, Malignant hyperthermia, G-6-PDdeficiency), Role of SNPs in drug discovery and development, Stages in drug development, Personalized medicine: testing for susceptibility of complex diseases, Clinical implications of Pharmacogenomics

Unit 4: Genetic counselling: Definition and process, Diagnostic problems, decision making, risk assessment and role of genetic counsellors, Prenatal/adult diagnosis of genetic disorders; Psychosocial aspects of genetic counselling. Medical ethics; Risks and benefits; Informed consent and confidentiality Right of choice universality of bioethics; Dilemmas faced by counsellors, Case studies; Genome ownership, Genetic insurance, Genetic privacy, genome Patenting.

References:

1. Human Molecular Genetics (2010) 4th ed. - Strachan T. & Read A., Garland Science
2. An introduction to Human Molecular Genetics (1999) - Mechanism of Inherited Diseases Pasternak J. Fitzgerald, Science Press
3. Thompson and Thompson Genetics in Medicine (2007) 7th ed. Robert et al., Saunders
4 Landmarks in Medical Genetics – (2002) Ed. Harper P. S., Oxford University Press
5.Chromosome Banding (1990) - Sumner A.T. Unwin, Hyman
6. Genes IX (2009) -Lewin B, Jones

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Semester II

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Conservation of Genetic Resources	**Course Code**	24GEN202DS05
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):
CLO-1: Students will be having knowledge about Ecosystems, Biomes and Bio-geographical zones, biodiversity and factors affecting biodiversity.
CLO-2: Appraisal of National and International organizations working for biodiversity, Conservation, IUCN Red Data book, different conservation Strategies, Project Tiger
CLO-3:Indian laws for Conservation, International agreements for conservation, Insight into Animals behaviour.

Unit 1: Structure and function of ecosystem; energy flow in a ecosystem, primary production and decomposition; Some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Major terrestrial biomes; Biogeographical zones of India; Mega-centres of biodiversity; Biodiversity hot spots- Global and Indian; Measurement of biodiversity- species diversity.

Unit 2: Environmental pollution: Soil, water, air; Global climate change and its effects; Role of IPCC; Biodiversity status: monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches; Factors affecting biodiversity: Environmental pollution, Global climatic change; Invasive species eroding diversity; Assessing the loss of biodiversity- Floristic surveys/inventory; IUCN Red data book.

Unit 3: *Conservation biology:* Strategies for conservation of biodiversity; *In situ* conservation- ecosystem approach; *In situ*-on farm conservation; *Ex situ* conservation- Whole plant conservation/maintenance, Conservation using cryobiology; Conservation using *in vitro* culture methods; Indian case study on conservation strategy (Project Tiger); International organization supporting conservation (PETA, WWF); Indian organizations supporting conservation (WPSI, Wildlife Trust of India); International agreement for conservation (CBD); *Indian laws for Conservation*: The Indian Wildlife Protection Act 1972; The National Forest Policy of 1988.

Unit 4: *Animal sexual behaviour:* Monogamy, Polygamy with examples*; Social Behaviour*: Living In Groups, Agonistic Behaviour, Territories and Dominance Hierarchies, Altruism, Reciprocal Altruism, Kin Selection, Parental Care in birds, animals (lion, elephant); Habitat Selection and Optimality in Foraging, Specialists and Generalists organism; Migration in animals, birds, fishes and insects; Orientation And Navigation.

References:

1. Sharma PD (2011). Ecology and Environment. Rastogi Publications
2. Odum EP & Barret GW (2004). Fundamentals of ecology. Brooks/Cole
3. Millet GT & Spoolman S (2019). Essentials of ecology. Cengage Learning
4. Alcock J (2013). Animal Behavior: An Evolutionary Approach. OUP USA
http://en.wikibooks.org/wiki/Animal_Behavior

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Semester II

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Molecular Techniques in Genetics	**Course Code**	24GEN202SE01
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3 Hrs

Course Learning Outcomes (CLO):

CLO1: Learn the techniques used for population genetics.
CLO2: Learn the advance technique for gene amplification from whole genome.
CLO3: Learn blood sample handling and determination of blood cell count.
CLO4: Understand the conservation and relevance of genetic resources.

- To study plant population density using quadrat method.
- To determine the frequency of a species in a population using quadrat method.
- To study abundance in a plant population using quadrat method.
- To derive the formula of Hardy Weinberg principal, p2 + 2pq + q2=1.
- To solve problem based on population genetics.
- To analyze phylogeny of an organism using a given sequence.
- To design primers and perform polymerase chain reaction.
- To separate and visualize the PCR product using agarose gel electrophoresis.
- To isolate RNA from mosquitoes.
- To determine concentration and purity of RNA extracted from mosquito using spectrophotometer
- To know titre value of antibody with help of Ouchterlony Double Immunodiffusion (ODD).
- To quantitatively estimate antigen (Ag) concentration using Rocket Immunoelectrophoresis (Laurell technique).
- To calculate Total Lymphocyte Count (TLC) and Differential Leukocyte Count (DLC) of your own blood.
- To estimate the amount of antibody (Ab) in antiserum using quantitative precipitin assay.
- Demonstration the Enzyme-Linked Immunosorbent Assay (ELISA).
- To perform Radial Immunodiffusion (RID).
- To demonstrate lymphocyte culture from peripheral blood.
- To study chromosomal abnormality associated with Down syndrome, Turner syndrome and Klinefelter syndrome.
- To prepare case Performa and discuss prenatal, neonatal, and postnatal aspects in genetic counselling.
- To prepare sulphate standard solutions (1-1000 ppm) from $CuSO_4 \cdot 5H_2O$.
- To determine the concentration of sulphate in a given water sample.
- To study biodiversity in a given field using quadrat method.
- To determine and compare the pH of the given soil and water samples.
- To determine the Total Dissolved Solids (TDS) level of different water samples.
- To visit a conservation site and demonstrate in-situ/ex-situ conservation techniques used.

Semester III

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Recombinant DNA Technology	**Course Code**	25GEN203DS01
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CO-1 Students will have knowledge of various components & techniques of genetic engineering & microarray.

CO-2 Students will be able use the recombinant technology in agriculture and human health; and know about the post translation modification of proteins.

CO-3 They will be able to understand the structure, behavior and activity of genes and how developments in gene manipulation have revolutionized medicine, agriculture and health

Unit 1: Principles of Genetic Engineering: Historical account, Components– Nucleic acids, DNA modifying enzymes, cloning vectors and Cloning hosts, Gene transfer and cloning methods, Gene Screening and isolation - Strategies, DNA libraries, Probe Selection and gene screening, Oligonucleotide synthesis.

Unit 2: PCR and DNA sequencing: PCR – Principle, Methodology, Types - RT-PCR, RAPD, AFLP, ISSR, inverse PCR and Real time PCR and their applications. Sequencing of nucleic acids, DNA sequencing methods - Maxam and Gilbert's method, Sanger's method, Automated DNA sequencing method, Capillary gel electrophoresis for DNA sequencing.

Unit 3: Molecular markers: Type of molecular markers; Application of molecular markers in discerning polymorphism, germplasm characterization, Gene tagging; Disease diagnostics; Marker aided selection in crop improvement. DNA Engineering techniques: Methods of labeling of DNA, Blotting of macromolecules: Southern, Northern and Western blotting techniques and hybridization, Promoter characterization, DNA fingerprinting, Microarray technology, *In vitro* translation.

Unit 4: Application r-DNA technology: (Production of recombinant protein, Vaccine and pharmaceutical compounds; application in agriculture, Fluorescence in situ hybridization (FISH), Proteomics: Tools techniques, study of protein- protein interaction, protein analysis for gene identification, post translation modification.

References:

1. Gene Cloning and Manipulation- Howe C., Cambridge University Press.
2. Principles of Gene Manipulation and Genomics (2001) - Primrose S. B. & Twyman R. M, Blackwell Publishing.
3. Molecular Cloning (2001) - A Laboratory Manual (3-Volume Set) Sambrook J. et al., CSHL Press
4. Calculations for Molecular Biology and Biotechnology (2003) -Stephenson F. H., Academic Press

Semester III

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Somatic Cell Genetics	**Course Code**	25GEN203DS02
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CO-1 They will be familiar with animal cell culture technology, equipments and various requirements of animal cell culture, different types of cell culture and its application.

CO-2 Students will understand the basics of processes and their application to cell culture and generate the products.

CO-3 Knowledge of techniques like hybridoma technology, transformation, transgenesis, Stem cell therapy and cloning

Unit 1: Structure and organization of animal cell; Equipments and materials for cell culture technology; Introduction to the balanced salt solution and simple growth medium, Role of carbon dioxide, Role of serum and supplements, Serum & protein free defined media and their application.

Unit 2: Primary culture, secondary culture, serum free culture and established cell line cultures; Measurement of viability and cytotoxicity; Biology and characterization of the cultured cells, measuring parameters of growth, Basic techniques of mammalian cell culture in vitro, disaggregation of tissue, maintenance of cell culture, cell separation, cell synchronization, Scaling-up of animal cell culture; Organ and histotypic cultures. - definition & characteristics of stem cell;

Unit 3: Biology and genetics of stem cells- definition & characteristics of stem cell; Sources and origin of stem cell, types of Stem cells, nature of pleuripotent cells, division; Hematopoitic stem cells, Neural stem cells, Adult & embryonic stem cell, Cancer stem cell; Cell based therapy, Therapeutic cloning, Bone marrow transplantation versus Stem cell transplantation and GVHD; Epidermis & its renewal by stem cell.

Unit 4: Somatic cell fusion and somatic cell genetics; Tissue and organ culture - advantages and limitations; medical/pharmaceutical products of animal cell culture; Monoclonal antibodies, Cell culture based vaccines, Hybridoma technology etc., Genetic engineering of animal cells and their applications; Artificial life.

References:

1. Freshney I. Culture of Animal Cells: A Manual of Basic Technique, 5th Edition Publisher: Wiley-Liss, 2005 ISBN: 0471453293.
2. Nigel Jen, Animal Cell Biotechnology:Methods and protocols, Humana Press.
3. R. Lanza, J. Gearhart et al (Eds), Essential of Stem Cell Biology. (2009), Elsevier Academic press.
4. Stein et al. Human Stem Cell Technology and Biology: A Research Guide and Laboratory Manual. Wiley-Blackwell; 1 edition (January 4, 2011).
5. Lanza et al. Handbook of Stem Cells, Two-Volume Set: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells (v. 1).Academic Press (September 28, 2004)

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Human Molecular Genetics	**Course Code**	25GEN203DS03
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:

Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CO-1 Describe the approaches used to identify the genetic basis of inherited diseases.

CO-2 Understand the role of copy number repeat and SNP in genetic susceptibility study.

CO-3 Understand the mechanisms of genotoxicity, DNA damage.

CO-4 Know about Functional genomics and understanding mechanisms together with in-silico approaches to unravel genome architecture.

Unit 1: Organization of genome in humans: General features of chromosomes, reiterated sequences and their detection: LINE, SINE, Alu family, transposable elements; Gene mapping: Gene mapping by somatic cell hybridization, top down approach to molecular mapping, restriction maps and contig construction (the bottom up approach);Engineering chromosomes : Yeast artificial chromosome, making YACs, MACs (mammalian artificial chromosomes) and satellite DNA's, artificial chromosomes (SAT ACS).

Unit 2: Molecular explanation of dominance & recessiveness, incomplete penetrance & expressivity; Identification of genetic basis of disease: Positional analysis, structural and functional cloning; Bioinformatic analysis; Characterization, Mutation detection, diagnosis and therapy (with examples from autosomal Dominant, autosomal recessive, X-linked dominant, X-linked recessive and complex disease Conditions); Identification of specific disease gene in Huntington's disease, DMD (Duchenne muscular dystrophy) and Cystic fibrosis.

Unit 3: Genetic susceptibility to common diseases: Types and mechanisms of susceptibility; Genetic approaches to common diseases (Diabetes mellitus, Hypertension, Coronary artery diseases, Schizophrenia, Alzheimer's disease); Whole genome association (Single nucleotide polymorphism, CNVs).

Unit 4: Genetic toxicology: Genotoxicity- classification of genotoxic agents, genotoxic test systems, mutagenicity, teratogenecity; DNA damage & genome instability: endogenous metabolism & DNA damage, exogenous factors (irradiation & carcinogens); Functional genomics: cDNA/gene, cloning; site-directed mutagenesis; Mammalian tissue culture, Methods for generation of transgenic animals/ knock-in, knockout models (microinjection, ES cell transformation); E Numutagenesis; PFGE, Automated DNA sequencing.

References:

1. Human Molecular Genetics 4thed - Strachan T. & Read A., Garland Science
2. An introduction to Human Molecular Genetics-Mechanism of Inherited Diseases Pasternak J. Fitzgerald, Science Press
3. Genetics in Medicine 7th Ed - Thompson and Thompson, Saunders
4. Landmarks in Medical Genetics (Ed.) Harper P. S. Oxford University Press
5. Chromosome Banding -Sumner A.T., Unwin Hyman
6. Human Genetics: Problems and Approaches - Vogel F. and Motulsky A. G, Springer Verlag

Semester III

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Genetics and Plant Breeding	**Course Code**	25GEN203DS04
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3 Hrs

Theory 4+0+0 **Marks Internal =30** **External = 70**

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Students will be able to understand the basic principles of plant inheritance.
CLO2: The course will provide insight into plant breeding and its role in improvement of different plant varieties.
CLO3: The course will provide skill-based learning on cytogenetic tools, different chromatography and centrifugation techniques.

Unit 1: Introduction of Plant Genetics: polyploidy inheritance, self incompatibility, cytoplasmic inheritance, mutable alleles; complex loci, genome analysis, recombination and mutagenesis; cytological aspects of hybridity and apomixes; chromosomes as they affect breeding behaviour.

Unit 2: History of plant breeding; Principles of plant breeding; Breeding methods for self- and cross-pollinated crops; Heterosis breeding; Polyploidy and haploids in plant breeding; Cytogenetic tools in plant breeding; Limitations of conventional breeding.

Unit 3: History of plant cell and tissue culture; Culture media; Various types of culture; callus, suspension, nurse, root, meristem, etc.; In vitro differentiation: organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, Molecular basis of plant organ differentiation.

Unit 4: Concept of genetic linkage, development and choice of mapping populations, linkage map construction – relational, integrated and comparative maps; Principles and methods of QTL mapping; Principle and applications of gel filtration and ion exchange chromatography; Thin layer chromatography; Gas chromatography; High pressure liquid chromatography (HPLC), Fast protein liquid chromatography (FPLC); Ultracentrifugation.

Suggested Readings

1. Principles of Plant Breeding, Allard R. W. Wiley & Sons
2. Genome Mapping in Plants, Paterson A. H. Academic Press

3. Molecular Markers in Plant Genetics and Biotechnology, Vienne D. INRA
4. Quantitative Genetics, Genomics and Plant Breeding, Kang M. S. CABI Publishing
5. Plant Molecular Breeding , Newbury H. J. CRC press
6. Bhojwani SS. Plant Tissue Culture: Theory and Practice . Elsevier.
7. Dixon RA. Plant Cell Culture. IRL Press.

Semester III

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Drosophilla Genetics	**Course Code**	25GEN203DS05
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3 Hrs

Theory 4+0+0 **Marks Internal =30** **External = 70**

Note: There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice, and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Course Learning Outcomes (CLO):

CLO1: Drosophila genetics its importance as model for human genetic disorders

CLO2: Mutagenesis & isolation of new variants

CLO3: Drosophila Genome Project

Unit 1: *Drosophila* as a model organism; Life cycle of *Drosophila* with characteristic features of each stage; Contribution of *Drosophila* in genetics; methods for *Drosophila* collection from natural sites, Basic requirements for setting up Drosophila laboratory: Basic Instrumentation, food and vial preparation; Basics of setting up *Drosophila* crosses; mating behavior in Drosophila; Mechanism of sex determination in *Drosophila,* sex lethal in *Drosophila.*

Unit 2: *Drosophila development*: Embryonic development, Maternal effect genes and formation of body axis, Segmentation genes, Homeotic genes and their functions; Imaginal discs and their types; Chromosomes of Drosophila; Polytene chromosome: Maps, puffing and utility; Balancer chromosomes; *Mutagenesis:* X-ray mutagenesis/ClB method, P-element and insertional mutagenesis.

Unit 3: Induction and development of compound eye of *Drosophila*, Ectopic expression, Stem cells in *Drosophila,* Oogenesis and spermatogenesis in Drosophila; Generation of transgenic *Drosophila flies;* GAL4/UAS expression system in drosophila, brief overview of RNAi based gene screening in *Drosophila*; Mitotic recombination in *Drosophila.*

Unit 4: *Drosophila* flies as a model for Alzheimer's disease, Parkinson's disease and Huntington's disease; Brief overview of *Drosophila* genome project: Online Drosophila databases in brief: Fly-Base, The Drosophila Interactions Database (DroID), Drosophila Genomics Resource Centre (DGRC), Fly Express and The Interactive Fly.

Suggested Readings

- Snustad, P. D., & Simmons, M. J. (2015). *Principles of Genetics* (7th ed.). John Wiley and Sons.
- Pierce, B. A. (2019). *Genetics: A Conceptual Approach* (Seventh ed.). W. H. Freeman.
- Atherly, A. G., Girton, J. R., & McDonald, J. F. (1999). *The Science of Genetics*. Van Haren Publishing.
- Bate, M., & Arias, M. A. (1993). *The Development of Drosophila Melanogaster (2 Volume Set)*. Cold Spring Harbor Laboratory Pr.
- LaFave, M. C., & Sekelsky, J. (2009). Mitotic recombination: why? when? how? where?. *PLoS Genet*, *5*(3), e1000411.
- Elliott, D. A., & Brand, A. H. (2008). The GAL4 system. In *Drosophila* (pp. 79-95). Humana Press.

http://highered.mcgraw-hill.com/sites/007352526x/student_view0/genetic_portrait_chapters_a-e.html

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Semester III

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Advanced Techniques In Genetics	**Course Code**	24GEN203SE01
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	8 Hrs

Course Learning Outcomes (CLO):
CLO1: Learning of plant breeding and tissue culture techniques.
CLO2: Purification and analysis of proteins.
CLO3: Learning of sex-linked inheritance patterns.

- To study floral structures of self- and cross-pollinated crops.
- To prepare cotton plugs used in plant tissue culture.
- To prepare solid and liquid plant tissue culture media.
- In-vitro seed germination for production of aseptic seedling.
- To culture of explant on slant for whole plant regeneration.
- To purify proteins using gel filtration chromatography.
- To isolate genomic DNA from plant tissue.
- To perform the LIC cloning.
- To perform the bacterial transformation.
- To isolate the protein from plants/insect samples.
- To estimate the concentration of protein using Bradford assay.
- To perform SDS-PAGE for protein separation and visualization.
- To carry out the restriction digestion using restriction digestion teaching kit.
- To study autosomal dominant and autosomal recessive inheritance using numerical problems.
- To study X-linked dominant and X-linked recessive inheritance using numerical problems.
- To perform polymerase chain reaction and agarose gel electrophoresis.
- To perform Restriction Fragment Length Polymorphism (RFLP) analysis.
- To dissect out the salivary gland from 3rd instar larva stage of *Drosophila melanogaster*.
- To prepare polytene chromosomes from salivary gland of larvae of fruit fly.
- To dissect out the imaginal disc from the 3rd instar larvae.
- To dissect and study the structure of testis in male fruit fly.
- To dissect & study the structure of ovaries in female fruit fly.

Semester IV

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Social and Ethical Issues in Genetics	**Course Code**	25GEN204DS01
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3 Hrs

Theory 4+0+0 **Marks Internal =30** **External = 70**

Note: There will be a total of nine questions. Question No. 1 will be compulsory and shall contain eight to ten short answer type questions without any internal choice and it shall cover the entire syllabus. The remaining eight questions will include two questions from each unit. Candidates will be required to attempt one question from each of the four units. They will attempt five questions in all.

Course Learning Outcomes (CLO):

CLO1: Intellectual properties, cases regarding IP, Ethical and Religious considerations in stem cell research

CLO2: International ethical guidelines for biomedical research involving human subjects (CIOMSWHO).

CLO3: Reprogenetics, Consumer genetics, Personal genomics, Public health genetics, Community genetics & Various acts.

Unit 1: Concept of Intellectual property and Intellectual property rights; Copyright, Trademark, Geographical indications, trade secrets, Layout design of integrated circuits; The Patents Act, 1970; World organizations for the protection of intellectual property right (WIPO); Few recent case studies on IPR: G*leevec* case study, Apple Inc. v. Samsung Electronics Co.

Unit 2: *Patents*: Criteria and procedure of patenting, patentable and non-patentable inventions. Patent procedure in India; Revocation of turmeric and neem patent; Patenting of naturally occurring biological material like DNA (*Association for Molecular Pathology v. Myriad Genetics*); Patentability of life forms with special reference to microorganisms (*Pseudomonas* patent case). *The International Patent System:* Patent Cooperation Treaty; procedure for filing a PCT application for international patent.

Unit 3 Professional ethics in medical research; Gene therapy: Social and Ethical concerns; International ethical guidelines for biomedical research involving human subjects (CIOMS-WHO); Ethics committees and their functions; Social and ethical issues in human stem cell research. Religious consideration in stem cell therapy; Genetic discrimination in insurance and employment, Genetic Information non-discrimination Act (GINA).

Unit 4: Human Cloning: Biological, ethical, and social considerations; Overview of reprogenetics, Personal genomics, Community genetics; Direct-to-Consumer Genetic Testing; Drugs & Cosmetics Act, The Medical Termination of Pregnancy Act, The Preconception & Prenatal Diagnostic Techniques Act, Assisted Reproductive Technology Act, The Transplantation of Human Organs Act;

Suggested Readings

- https://www.wipo.int/edocs/pubdocs/en/intproperty/450/wipo_pub_450.pdf
- https://www.nap.edu/read/2054/chapter/26
- https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf
- https://ghr.nlm.nih.gov/primer/dtcgenetictesting/directtoconsumer
- http://www.ipindia.nic.in/writereaddata/Portal/IPOAct/1_31_1_patent-act-1970-11march2015.pdf
- https://cioms.ch/wp-content/uploads/2017/01/WEB-CIOMS-EthicalGuidelines.pdf
- https://www.supremecourt.gov/opinions/12pdf/12-398_1b7d.pdf
- https://tcw.nic.in/Acts/MTP-Act-1971.pdf
- http://www.childlineindia.org.in/CP-CR-Downloads/PNDT%20Act.pdf
- http://www.ginahelp.org/GINAhelp.pdf
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3498641/
- http://www.ijtonline.in/temp/IndianJTransplant12284-3244506_090045.pdf
- https://www.pnas.org/content/112/29/8879#:~:text=Human%20cloning%20would%20still%20face,the%20individual%20cannot%20be%20cloned.
- https://medium.com/lsf-magazine/mr-pseudomonas-198a5eddc47
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4192767/

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Lab Design and Biosafety	**Course Code**	25GEN204DS02
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:

Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CO-1 Understand laboratories of BSL-2 and BSL-3,4 facilities.

CO-2 Conversant wih Lab Equipments and Precautions.

CO-3 Outline a Medical surveillance program.

CO-4 Understand risk assessment and biological risk management for field research.

Unit 1: Introduction, trends, risk classification of laboratory, design & safety guidelines for biosafety level I, II, III and IV laboratories, Laboratory animal facility. Laboratory space planning; Engineering Considerations: Electrical (Emergency power, power requirements, lighting), Mechanical (Heating, Ventilating, and Air Conditioning); Plumbing, Energy Conservation in lab.; Concerns Specific To Research Facilities: Finishes, Doors and hardware, Furniture, Glassware washers and Dryers, Reagent Grade Water Systems; Preparation rooms and storage, The greenhouse and animal house; Security, Life management: Eye wash and related facilities, Fire prevention and control measures.

Unit 2: Handling & Storing of hazardous chemicals, Chemical incompatibility, Chemical Storage Locations , Material safety data sheet and its significance; Disposal of chemical waste: Restrictions, Waste containers, Labels, Storage of waste chemicals, Scheduling of waste collection, Segregation of incompatible chemical wastes; Disposal of biological waste: Sharps, culture stocks and labware, animal body parts, animal solid waste, animal liquid waste etc; Radioactive waste management.

Unit 3: A Historical perspective of bio-safety; Definition, requirement, biosafety containment facilities, biohazards colour coding; Biosafety Requirements: Registration for the Use of Biological Materials, Human pathogens, Human Blood, Body Fluids, Tissue and Other Potentially Infectious Materials. Lab Equipments and Precautions for using: HEPA filters, Biological Safety Cabinets (BSCs), Use & care of pipettes, pipetteguards, syringes and needles, Centrifuges, Oven, Incubators, Sonicators, and Cell Disruption Equipment, Microtome/cryostat, Microincinerators, Miscellaneous Equipment (Waterbaths, Cold Storage, Shakers); Lab animals; Decontamination and Disposal Procedures; Transportation of Infectious Substances.

Unit 4: Risk Assessment and Risk Management; Routes of Exposures, Exposure incidents and their types; Emergency Procedures for Exposure Incidents, Emergency procedure for fire & chemical exposure, safety check list. Medical Surveillance Program and their significance:

Tuberculosis (TB) Screening and Immunizations; Medical Restrictions: Pregnancy, Reproductive Biological Hazards, Other Restrictions; Objectives of Housekeeping in laboratory; Bio-safety levels for different infectious agents and infected food/animals, routes of transmission & protection measures; Laboratory Practices for different biosafety levels, Biosafety training programs.

References:

1. Biosafety in Microbiological and Biomedical Laboratories 5th edition by U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institutes of Health
2. Biological Safety Manual by Yale University
3. Research Laboratory Design Guide by Department of Veterans Affairs, United States of America
4. Laboratory Safety Manual – the University of North Carolina at Chapel Hill 5. WHO (2003)-Laboratory biosafety manual WHO, Geneva.

Semester IV

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Biostatistics and Bioinformatics	**Course Code**	25GEN204DS03
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):
CO-1 Students will be able to understand biostatistical methods to measure the central tendency by using different statistical tests.
CO-2 Students will be having knowledge of bioinformatics, biological databases & their application in biological system.
CO-3 Sequence retrieval, primer designing for PCR, sequence alignment, multiple sequence alignment and applications of alignment, phylogenetics and protein 3D structure prediction based upon different methods.

Unit 1: Methods of data collection, sampling and sampling methods, Sample size estimation and designing of experiments, case-control studies, randomization, replication local control, completely randomized and randomized block design.

Unit 2: Types of data, tabular and graphical presentation of data; Measurement of central tendency, mean, median, mode, standard deviation, standard error and variance. Analysis of variance (ANOVA), Correlation & regression analysis, tests of significance, t-test, z-test, chi-square test.

Unit 3: Introduction to Bioinformatics, Biological Databases: Primary, secondary & specialized databases. Types of databases- Nucleotide sequence database, EMBL, Genebank, Unigene, Genome biology, Protein dBase (Swissprot&Trembl and Motif) and 3D structure databases (PDB, SCOP, Cath, Genecards, SRS & Entrez) and various specialized databases like TIGR, Hovergen, TAIR, PlasmoDB, ECDC etc. Sequence retrieval, primer designing for PCR.

Unit 4: Basics of sequence analysis- Dot matrix method, Needleman–Wunsch Algorithm and Smith-Waterman algorithm, Alignments using BLAST and FASTA, Multiple Sequence Alignment (CLUSTAL-X and CLUSTAL-W), Application of multiple sequence alignment (PSSM and Markov/Hidden Markov models. Phylogenetic tree construction by distance-based methods, character-based methods. Protein Structure Prediction - *Ab initio* based methods, Homology based methods and comparative modelling, Phylogenetic analysis: Application of phylip.

References:

1. David W. Mount Bioinformatics: Sequence and Genome Analysis CSHL Press, 2004
2. A. Baxevanis and FBF Ouellette, Bioinformatics: A practical guid to the analysis of genes and proteins 2nd eds. John Wiley 2001
3. Jonathan Pevsner Bioinformatics and functional genomics Ist Ed. Wiley Liss 2003
4. P E Bourne and H. Weissig Structural Bioinformatics Wiley 2003. Statistical Analysis of Non normal data: J.V. Deshpande, A.P. Gore, A. Shanubhogue, New Age International Publishers Ltd.
5. Introduction to Bioinformatics; T K Attword and DJ Parrysmith (2002) Pearson education. Statistical methods in Animal Sciences, By: V.N. Amble, Indian Society Agricultural Statistics (NewDelhi)
6. Statistical Procedure for Agricultural Research: Kwanchai A Gomes Arturo A. Gomez, John Wiley and Sons.
7. A text book of Agricultural Statistics. By: R. Rangaswamy, New Age International Pvt. Ltd.
8. Statistics for Agricultural Sciences. By: G. Nageswar Rao, Oxford and IBH Publishing Co.
9. SP Gupta, Statistical Methods S Chand and Sons 2004.
10. B L Agarwal, Basic Statistics, New Age. 2003

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Plant Molecular Genetics	**Course Code**	25GEN204DS04
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3Hrs

Theory 4+0+0 Marks Internal =30 External = 70

Note:
Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):
CO-1 Students will be having knowledge about gene structure and function in plant system, mitochondrial and chloroplast genome and Arabidopsis genome and applications of GM plants.
CO-2 Students will be having knowledge about the mechanism of plant genetic transformation.
CO-3 Concern of bio safety, regulatory norms at national and international levels about genetically modified crops.

Unit 1: Gene expression in plants: Gene structure, expression and regulation in plants- an overview of nuclear & organelle gene structure, function and expression with emphasis on aspects that are unique to plants genes; Development of Arabidopsis as a model for molecular genetic studies in plant biology.

Unit 2: Use of in vitro culture technology: Micro-propagation for multiplicaion; Embryo rescue for production of hybrids; Production of haploid through anther or pollen culture; Culture and manipulation of protoplasts. Somatic Hybrids, Organelle transfer and cybrids; In vitro screening and selection of desirable cell lines; Creation of soma-clonal variation and selection of desirable genotypes in genetic improvement; In vitro mutagenesis; Callus and cell culture for production secondary metabolites; Production of synthetic seed; Germplasm conservation.

Unit 3: Genetic Transformation: Plant transformation vectors- T-DNA, viral vectors, transposon elements; Genetic transformation methods: Agro-bacterium system; Direct DNA transfer by ballistic gun method, electroporation, microinjection; Alternate in-plant methods, floral dip, silicon carbide, pollen tube pathway etc.; Marker-free and novel selection strategies; Gene silencing; RNA interference (RNAi) system; Gene knockdown.

Unit 4: Application of technology and bio-safety; Targeted transfer of genes conferring resistance to biotic and abiotic stresses, nutritional quality, and other desirable traits, like male sterility, flowering, fruiting, ripening etc. (case study); Concerns about bio-safety of genetically modified organism (GMO) (Allergen, toxicity, impact on biodiversity etc.); Indian regulatory system for testing of GMOs in laboratory, field trials and commercial release of transgenic; Bio-confinement strategies for cultivated crops; bio-safety and ethics in generating GMOs; potential benefits of GMOs.

References:

1. Plant Tissue Culture- Theory and Practice (1996) Bhojwani S. S. & Razdan M. K., Elsevier
2. Plant Biotechnology-The Genetic Manipulation of Plants (2003) Slater A. Scott N. & Fowler M., Oxford University Press Inc.
3. Plants, Genes and Crop Biotechnology (2003) - Chrispeels M. J. & Sadava D. E., Jones and Barlett Publishers
4 Principles of Gene Manipulation and Genomics (2001) -Primrose S. B. &Twyman R M, Blackwell Publishing.
5. Plant Cell, Tissue and Organ Culture- Fundamental Methods (1995) (Eds). Gamborg O. L & Phillips G. C. Springer-Verlag.
6. Plant Biotechnology (2006) - B. D. Singh, Kalyani Publishers.
7. Plant Cell Culture- A practical approach - (1985) Dixon RA (ed.) IRL Press, Oxford, Washington, DC

Semester IV

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Microbial Technology	**Course Code**	25GEN204DS05
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3 Hrs

Theory 4+0+0 **Marks Internal =30** **External = 70**

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO-1 Students would be able to understand the importance of microbial products for various industrial applications.

CLO-2 Students would be able to learn techniques such as different chromatography, electrophoresis, centrifugation etc.

CLO-3 Students would be able to correlate the genetic basis of production of proteins and other biomolecules.

Unit 1: Microbial innovations in health, agricultural and industrial sectors; Strategies for selection and improvement of industrial strains of microorganisms; Metagenomics for the isolation of genes for novel compounds; Genetic and Environmental Control of metabolic pathways.

Unit 2: Bioprocess development: Upstream process; Measurement and control of bioprocess parameters; Optimization of bio-process development; Classical and statistical methods of optimization; Different matrices; Whole cell and enzyme immobilization; Scale up of bioprocess, General concept of fermenter: batch, fed and continuous fermentation.

Unit 3: Downstream process: Extraction of purification of industrially important microbial products; Characterization of microbial products; Primary and secondary metabolites; Industrial production of antibiotics, biofuel, steroids and single cell proteins; Peptide antibiotics of bacteria and their role to combat antimicrobial resistance.

Unit 4: Microbial overproduction of recombinant molecules: Selection of suitable promoter sequences; Ribosome binding sites; Fusion protein tags; Purification tags, Protease cleavage sites and enzymes; Inducible expression system; Maintenance and containment of recombinant molecules.

Suggested readings:

1. Biotechnological Innovations in Chemical Synthesis: BIOTOL, Butterworth - Heinemann.
2. Industrial Microbiology, G. Reed (editor), CBS Publishers (A VI Publishing Company).
3. Genetics and Biotechnology of Industrial Microorganisms. C.L. I-le'-shnergev, S.W. Queener and Q Hegen. American Society of Microbiology.
4. Protein Expression. A Practical Approach: Edited by S.J. Higgins and B.D. Hames (OUP).

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Semester IV

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Recent Advancement in Genetics	**Course Code**	24GEN204SE01
Hours per Week	4	**Credits**	4
Maximum Marks	100	**Time of Examinations**	3 Hrs

Course Learning Outcome (CLO)
CLO1: Students will be able learn advance techniques in genetics and molecular biology.
CLO2: Learning of different bioinformatic tools for the analysis of gene and protein sequences.
CLO3: Learning purification and characterization of microbial proteins for industrial applications.

- To study sterilization techniques used in laboratory practice.
- To study safe handling, storage, and disposal practices for human blood, body fluids, tissues, and other potentially infectious materials.
- To understand the procedures for registration and approval of biological materials, human pathogens, and potentially infectious substances.
- To demonstrate the correct use of fire extinguishers and emergency equipment.
- To study the design, maintenance, and operational practices of greenhouse and animal house facilities.
- Observe and record the trademarks and service marks on the daily use items.
- Make a record of cases involved illegal foetal sex-identification published in local and national news-papers recently.
- Differentiate between trademarks and service marks on daily used electronic gadgets and make a record.
- To germinate the seed for the preparation of seedling for the explant inoculation.
- To inoculate explants on the prepared slant.
- To isolate DNA from germinated plant tissue using CTAB method.
- To perform multiple sequence alignment analysis using CLUSTAL-W.
- To isolate lactic acid bacteria from fermented food.
- To grow *Lactobacillus* in TGYE medium and collect fermented broth.
- To isolate proteins from fermented broth using salt-precipitation method.
- To determine protein concentration using Bradford assay.
- To determine antimicrobial activity of given sample using agar well diffusion assay.
- To purify protein using cation-exchange chromatography.

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Semester IV (OPTION - 2)

Name of Program	M.Sc. Genetics	**Program Code**	GEN2
Name of the Course	Dissertation / project work	**Course Code**	25GEN204PD01
Hours per Week		**Credits**	20
Maximum Marks	100	**Time of Examinations**	8 Hrs

EVALUATION OF PROJECT REPORT / DISSERTATION

In case of the Project reports/Dissertation/Research Project, the assessment shall be jointly carried out by the internal and external examiners. There shall be no Internal assessment component for Dissertation / Project Report. External examiners shall be invited from amongst the panel of examiners (ordinarily not below the rank of Associate Professor) recommended by the concerned Board of Studies.