

Course of Study
M. Sc. in Molecular & Human Genetics
DISTRIBUTION OF DIFFERENT COURSES AND CREDITS IN VARIOUS SEMESTERS

Semester-I		
Course Code	Title	Credits
MGM101	Transmission Genetics & Model Genetic Systems	4
MGM102	Basic Human Genetics	3
MGM103	Molecular Genetics	3
MGM104	Biochemistry & Biochemical Techniques	3
MGM105	Lab work based on courses MGM101 & MGM102	3
MGM106	Lab work based on courses MGM103 & MGM104	3
MGM107M	<i>Minor Elective: Reproductive Genetics & Genetics of Pathogens</i>	3
#	<i>Minor Elective: (for students of other PG programmes and MHG students as well)</i>	
	Total	22
Semester-II		
Course Code	Title	Credits
MGM201	Cell Biology & Microscopy	3
MGM202	Cytogenetics	3
MGM203	DNA Technology & Genetic Engineering	3
MGM204	Genomic Instability and Cancer & Bioinformatics	3
MGM205	Biochemistry & Metabolic Disorders	3
MGM206	Lab work based on courses MGM201 & MGM202	2
MGM207	Lab work based on courses MGM203 & MGM204	2
MGM208	Lab work based on course MGM205	2
MGM209M	<i>Minor Elective: Fundamentals of Molecular Biology (for students of other PG programmes)</i>	3
#	<i>Minor Elective: (for Molecular & Human Genetics students)</i>	
	Total	24
Semester-III		
Course Code	Title	Credits
MGM301	Human Molecular Genetics	3
MGM302	Clinical Genetics & Genetic Counseling	3
MGM303	Developmental Genetics	3
MGM304	Immunogenetics	3
MGM305	Lab work based on courses MGM301 & MGM302	2
MGM306	Lab work based on courses MGM303 & MGM304	2
MGM307	Clinical Assignments	2
MGM308M	<i>Minor Elective: Basic Genetics and Genetic Disorders (for students of other PG programmes)</i>	3
#	<i>Minor Elective: (for Molecular & Human Genetics students)</i>	
	Total	21
Semester-IV		
Course Code	Title	Credits
MGM T 401	Human Genome	3
MGM T 402	Population & Evolutionary Genetics	3
MGM T 403	Neurogenetics	3
MGM L 404	Lab work based on course MGM401	2
MGM L 405	Lab work based on courses MGM402 & MGM403	2
MGM L 406	Dissertation	6
MGM L 407	Comprehensive Viva-voce	2
MGM L 408	Seminar & Formulation of Research Project	2
	Total	23
	Grand Total	90

M.Sc. Molecular & Human Genetics students will opt 3 Minor Electives (3 credit each in semester I, II & III) offered by other PG Programmes of Faculty including Department of Molecular & Human Genetics.

SEMESTER - I

M. Sc. in Molecular & Human Genetics

MGM101: Transmission Genetics & Model Genetic Systems

Credits: 4

Section A: Transmission Genetics

Lecture hours

1	Introduction to Genetics	1
2	Mendelism	9
	2.1 Mendel and his experiments	
	2.2 Law of segregation	
	2.3 Law of independent assortment	
	2.4 Application of laws of probability (product rule, sum rule)	
	2.5 Chromosomal basis of segregation and independent assortment	
3	Chi-square test and its application in analysis of genetic data	1
4	Extensions of Mendelism	9
	4.1 Allelic variation and gene function- Dominance relationships, basis of dominant and recessive mutations	
	4.2 Multiple allelism, allelic series	
	4.3 Testing gene mutations for allelism: complementation test, intragenic complementation	
	4.4 Visible, sterile and lethal mutations	
	4.5 Genotype to phenotype: effect of the environment on phenotype development- Penetrance and expressivity, phenocopy	
	4.6 Gene interactions and modifying genes	
	4.7 Pleiotropy	
5	Sex-linked inheritance, Linkage and crossing over	10
	5.1 Genetic recombination and construction of genetic maps in Drosophila	
	5.2 Interference and coincidence	
	5.3 Cytological demonstration of crossing over in Drosophila	
	5.4 Mitotic recombination	
	5.5 Intragenic recombination	
6	Inheritance of quantitative traits	6
	6.1 Continuous and discontinuous variation	
	6.2 Polygenic inheritance	
	6.3 Genetic variance, heritability (narrow sense and broad sense)	
7	Cytoplasmic inheritance, maternal effects, inheritance due to parasites and symbionts	3

Recommended Books:

- 1 Atherly et al (1999). The Science of Genetics. Saunders
- 2 Brooker (1999). Genetics – Analysis and Principles. Benjamin/Cummings
- 3 Fairbanks et al (1999). Genetics. Wadsworth
- 4 Gardner et al (1991). Principles of Genetics. John Wiley
- 5 Griffiths et al (2002). Modern genetic Analysis. Freeman
- 6 Griffiths et al (2004). An Introduction to Genetic Analysis. Freeman
- 7 Hartl and Jones (1998). Genetics – Principles and Analysis. Jones & Bartlett
- 8 Snustad et al (1998). Principles of Genetics. Wiley and sons
- 9 Strickberger (1985). Genetics. Mcmillan
- 10 Tamarin (1996). Principles of Genetics. WCB

Section B: Model Genetic System

1	Life cycles and advantages of the following organisms commonly used in genetic studies	8
	1.1 T4 and I phages	
	1.2 <i>Neurospora</i>	
	1.3 <i>E.coli</i>	
	1.4 <i>Saccharomyces cerevisea</i> and <i>Schizosaccharomyces pombe</i>	
	1.5 <i>Caenorhabditis</i>	
	1.6 <i>Drosophila</i>	
	1.7 Zebra fish	
	1.8 Mouse	
2	Conventions of nomenclature of genes and gene products in different model systems	5

Recommended Books

- 1 Ashburner (1989). *Drosophila - A Laboratory Handbook*. CSHL Press
- 2 Demerec & Kaufmann(1965). *Drosophila Guide*. Carnegie
- 3 Hood(1998). *The Nematode: C. elegans*. CSHL
- 4 Trends in Genetics(1998). *Genetic Nomenclature Guide*. Elsevier

MGM102: Basic Human Genetics

Credits: 3

1	History of Human Genetics	1
2	Pedigrees- gathering family history, pedigree symbols, construction of pedigrees, presentation of molecular genetic data in pedigrees	1
3	Monogenic traits	12
	3.1 Autosomal inheritance-dominant, recessive	
	3.2 Sex-linked inheritance	
	3.3 Sex-limited and sex-influenced traits	
	3.4 Mitochondrial inheritance	
	3.5 MIM number	
	3.6 Complications to the basic pedigree patterns- nonpenetrance, variable expressivity, pleiotropy, late onset, dominance problems, anticipation, genetic heterogeneity, genomic imprinting and uniparental disomy, spontaneous mutations, mosaicism and chimerism, male lethality, X-inactivation	
	3.7 Risk assessment; application of Bayes' theorem	
	3.8 Allele frequency in population	
	3.9 Consanguinity and its effects	
4	Complex traits	10
	4.1 Approaches to analysis of complex traits- 'Nature -nurture' concept, role of Family and shared environment, monozygotic and dizygotic twins and adoption studies	
	4.2 Polygenic inheritance of continuous (quantitative) traits, normal growth charts, Dysmorphology	
	4.3 Polygenic inheritance of discontinuous (dichotomous) traits- threshold model, liability and recurrence risk	
	4.4 Genetic susceptibility in multifactorial disorders (alcoholism, diabetes mellitus, obesity)	
	4.5 Estimation of genetic components of multifactorial traits: empiric risk, heritability, coefficient of relationship	

5	Human cytogenetics	10
	5.1 Techniques in human chromosome analysis	
	5.2 Human karyotype: banding, nomenclature of banding	
	5.3 Pathology of human chromosomes	
	5.4 Nomenclature of aberrant karyotypes	
	5.5 Common syndromes due to numerical chromosome changes	
	5.6 Common syndromes due to structural alterations (translocations, duplications, deletions, microdeletion, fragile sites)	
	5.7 Common chromosome abnormalities in cancer	
	5.8 Genetics of fetal wastage	
6	Pharmacogenetics and ecogenetics	5

Recommended Books

- 1 Connor & Smith (1997). Essentials of Medical Genetics. Blackwell
- 2 Davies (1993). Human Genetic Disease Analysis. IRL
- 3 Emery and Mueller (1992). Elements of Medical Genetics. ELBS
- 4 Gersen & Keagle (2005). The Principles of Clinical Cytogenetics. Humana
- 5 Jorde et al (2005). Medical Genetics. Elsevier
- 6 Korf (2006). Human Genetics. Blackwell
- 7 Lewis (2006). Human Genetics. WCB
- 8 Mange and Mange (2005). Basic Human Genetics. Sinauer Assoc
- 9 Maroni (2001). Molecular and Genetic Analysis of Human Traits. Blackwell
- 10 Nussbaum et al (2004). Genetics in Medicine. Saunders
- 11 Pasternak (2005). An Introduction to Molecular Human Genetics. Fritzgarald
- 12 Prichard & Korf (2004). Medical Genetics at a glance. Blackwell
- 13 Strachan and Read (2003). Human Molecular Genetics. Wiley
- 14 Vogel and Motulsky (1997). Human Genetics. Springer

MGM103: Molecular Genetics

Credits: 3

1	Properties and evolution of genetic material, flow of genetic information	2
2	Organization of viral and bacterial genomes	2
3	Eukaryotic genome	5
	3.1 C-value paradox	
	3.2 Repetitive DNA	
	3.3 General concept of a gene	
	3.4 Gene families	
	3.5 Non-coding genes	
4	Replication in bacterial and eukaryotic chromosomes	5
	4.1 DNA polymerases	
	4.2 Replicons, origin and termination	
	4.3 Replisome	
	4.4 Genes controlling replication	
5	Transcription	5
	5.1 Prokaryotic RNA polymerase, sigma factors, initiation and termination	
	5.2 Eukaryotic RNA polymerases and their promoters	
	5.3 Processing of transcripts	
6	Translation	2
	6.1 General mechanism	
	6.2 Role of rRNA in translation	

7	Regulation of gene expression	8
	7.1. Regulation of transcription initiation	
	7.1.1. Operon and regulon	
	7.1.2. Positive and negative regulation	
	7.1.3. Enhancers and promoters	
	7.1.4. Transcription factors: types, DNA binding motifs	
	7.2. Regulation by attenuation and anti-termination	
	7.3. Post transcriptional regulation	
	7.3.1. Alternative splicing	
	7.3.2. Transport and targeting of RNA	
	7.3.3. Post-transcriptional gene silencing	
	7.4. Translational control and targeting of proteins	
	7.5. Mechanism of steroid hormone and stress induced gene expressions	
8	Mutation: Types and detection	3
9	Gene mapping in bacteria	4
	9.1. Transformation	
	9.2. Conjugation	
	9.3. Transduction	
	9.4. Sexduction	
10	Recombination, deletion and complementation mapping in T4 phage (rII locus)	3

Recommended Books

- 1 Alberts et al (1999). The Science of Genetics. Saunders
- 2 Benjamin (2003). Genetics: A Conceptual Approach. Freeman
- 3 Berg and Singer (1998). Genes and Genome.
- 4 Black (2002). Microbiology: Principles and Explorations. Wiley
- 5 Dale & Scharzt (2003). From genes to Genome. Wiley & Sons
- 6 Griffiths et al (2002). Modern Genetic Analysis. Freeman
- 7 Griffiths et al (2004). An Introduction to Genetic Analysis. Freeman
- 8 Hartl et al (2002). Essential Genetics. Wiley & Sons
- 9 Klug & Cummings (2003). Essentials of Genetics. Prentice Hall
- 10 Latchman (1995). Gene Regulation. Chapman & Hall
- 11 Lewin (2007). Genes IX. Pearson
- 12 Maloy and Freifelder (1994). Microbial Genetics. Jones and Barlett
- 13 Meesfeld (1999). Applied Molecular Genetics. Wiley-Liss
- 14 Ptashne (1986). Genetic Switch. Blackwell
- 15 Russell (2002). Genetics. Benjamin
- 16 Streips & Yasbin (2002). Modern Microbial Genetics. Wiley
- 17 Trun & Trempey (2004). Fundamentals of Bacterial Genetics. Blackwell
- 18 Watson et al. (2004). Molecular Biology of the Gene. Pearson

MGM104: Biochemistry & Biochemical Techniques

Credits: 3

1	Nucleic Acids:	5
	1.1 structure and conformations	
	1.2 Nucleic acid chemistry: non enzymatic transformation and methylation	
2	Nucleotide Metabolism	4
	2.1. Synthesis and degradation of pyrimidine and purine nucleotides	
	2.2. Disorders of nucleotide metabolism	
	2.3. Functional diversity of nucleotides	
3	Amino acids and peptides	6
	3.1. Essential and non-essential amino acids	
	3.2. Amino acids related disorders	
	3.3. Small peptides and their biomedical importance	
4	Proteins	5
	4.1. Structure-conformation-function relationship (exemplified by Myoglobin, Hemoglobin, and Collagen)	
	4.2. Protein degradation	
5	Enzymes	9
	5.1. General properties	
	5.2. Kinetics: derivation of Michaelis-Menten equation, L-B plot	
	5.3. Enzyme inhibition	
	5.4. Mechanism of action	
	5.5. Regulation of enzyme activity	
6	Biochemical techniques	10
	6.1. Centrifugation: types of rotors, clinical, highspeed and ultracentrifuges	
	6.2. Colorimetry and spectrophotometry: Beer-Lambert law; absorption spectrum, fluorescence spectrum, introduction to mass spectrometry	
	6.3. Chromatography: Paper, Thin layer chromatography; Columns: ion-exchange, gel-filtration, HPLC and affinity columns, electrophoresis	
	6.4. Tracer techniques: Properties and units of radioactivity; half-life; measurement of radioactivity by GM counter, liquid scintillation counter; autoradiography; radio-immunoassay; safety rules in handling of radioisotopes and hazardous chemicals	

Recommended Books

- 1 Berg et al (2006). Biochemistry. Freeman
- 2 Bhagwan (2004). Medical Biochemistry. AP
- 3 Devlin (2002). Biochemistry for the Molecular Sciences. Wiley
- 4 Higgins et al (1994). Biochemistry for the Molecular Sciences Longman
- 5 Murray et al (2006). Harpers Illustrated Biochemistry. Prentice Hall
- 6 Nelson et at (2006). Lehninger's Principles of Biochemistry. McMillan
- 7 Voet & Voet (2006). Biochemistry Vol. 1 and 2. Wiley
- 8 Zubay et al (1995). Principles of Biochemistry. WCB
- 9 Boney (1982). Cell Biology Level II. Macdonald & Evans
- 10 Boyer (1993). Modern Experimental Biochemistry. Benjamin
- 11 Clark & Switzer (2000). Experimental Biochemistry. Freeman
- 12 Freifelder (1987). Physical Biochemistry. Freeman
- 13 Boyer 2007 (2007). Concept of Biochem. 3rd Ed

MGM105 Lab work based on courses MGM101 & MGM102

Credits: 3

MGM106 Lab work based on courses MGM103 & MGM104

Credits: 3

Section A: Reproductive Genetics

1	Male and female reproductive systems	10
	1.1. Gonads and differentiation of sexual characters	
	1.2. Hormonal regulation of sexual differentiation	
2	Reproductive disorders	11
	2.1. Disorders of gonads, genital tracts and genitalia	
	2.1.1. Pseudohermaphroditism	
	2.1.2. True hermaphroditism	
	2.1.3. Gonadal dysgenesis	
	2.1.4. Anomalies of genital ducts	
	2.2. Infertility	
	2.2.1. Genetic basis of male infertility	
	2.2.2. Genetic basis of female infertility	
	2.2.3. Recurrent pregnancy loss	
3	Technologies in reproductive assistance	3
4	Legal and ethical implications in reproductive assistance	2

Recommended Books

- 1 Besser & Thorner (2002). Comprehensive clinical endocrinology. Mosby
- 2 Rimoin et al (2002). Principles & Practice of Medical Genetics, Vol I-III. Churchill

Section B: Genetics of Pathogens

1	Host-pathogen interaction, evolution of pathogenicity and regulation of virulence	2
2	Mechanism of drug resistance in pathogens	2
3	Molecular biology of following pathogens: HIV, <i>Hepatitis</i> viruses, <i>Mycobacterium tuberculosis</i> , <i>Vibrio cholerae</i> , <i>Plasmodium</i> , <i>Leishmania</i> , <i>Trypanosoma</i> , <i>Entamoeba</i>	8
4	Molecular mechanisms for origin of new pathogens	1

Recommended Books

- 1 Heritage et al (1996). Introductory Microbiology. Cambridge Univ.
- 2 Madigen et al (1997). Biology of Microorganisms. Prentice Hall
- 3 Nesler et al (1995). Microbiology-A Human Perspective. WCB
- 4 Pelczar et al (1993). Microbiology. Tata
- 5 Prescott et al (1999). Microbiology. WCB
- 6 Reischel (1998). Molecular Diagnosis of Infectious Diseases. Humana
- 8 Streips & Yasbin (2002). Modern Microbial Genetics. Wiley
- 9 Trun & Trumpy (2004). Fundamentals of Bacterial Genetics. Blackwell
- 10 Volk et al (1991). Essentials of Medical Microbiology. Lippincott & Co

SEMESTER - II

MGM201: Cell Biology & Microscopy

Credits: 3

1	Plasma Membrane: organization and dynamics transport across membrane; mechanisms of endocytosis and exocytosis	4
2	Endomembrane system	5
	2.1. General organization of protein transport within and outside the cell	
	2.2. Protein sorting and secretion	
	2.3. Mechanism of intracellular digestion	
3	Cytoskeleton	4
	3.1. Microfilaments: Structural organization, cell motility and cell shape	
	3.2. Microtubule: Structural and functional organization, cilia, flagella, centriole	
	3.3. Intermediate filaments	
4	Mitochondria	2
	4.1 Ultrastructure	
	4.2 Chemiosmotic theory and respiratory chain complexes	
5	Structure and function of peroxisome	1
6	Nucleolus and biosynthesis of ribosome	2
7	Cell cycle and its regulation	3
8	Cell-Cell Interaction	5
	8.1. Cell adhesion molecules	
	8.2. Cellular junctions	
	8.3. Extracellular matrix	
9	Signal transduction	5
	9.1. Intracellular receptor and cell surface receptors	
	9.2. Signalling via G-protein linked receptors (PKA, PKC, CaM kinase)	
	9.3. Enzyme linked receptor signaling pathways	
	9.4. Network and cross-talk between different signal mechanisms	
10	Programmed cell death	1
11	Basic knowledge of principles and applications of the following microscopy techniques	7
	11.1. Light Microscopy	
	11.2. Dark-field Microscopy	
	11.3. Phase-contrast Microscopy	
	11.4. Fluorescence Microscopy	
	11.5. Confocal Microscopy	
	11.6. Electron Microscopy	
	11.7. Photography, Digital imaging and image Processing	

Recommended Books

- 1 Alberts et al (1998). Essential Cell Biology. Garland
- 2 Alberts et al (2007). Molecular Biology of the Cell. Garland
- 3 Cooper (2007). The Cell: A molecular Approach. ASM Press
- 4 Gilbert (2006). Developmental Biology. Sinauer
- 5 Jeremy et al (2002). Biochemistry. Freeman
- 6 Karp (2005). Cell and Molecular Biology. John Wiley
- 7 Lewin (2007). Genes IX. Pearson
- 8 Lodish et al (2004). Molecular Cell Biology. Freeman
- 9 Pollard & Earnshaw (2002). Cell Biology. Saunders
- 10 Tobin and Morcel (1997). Asking about Cells. Saunders
- 11 Wilson & Hunt (2002). The Cell: A Problems Approach. Garland
- 12 Locquin and Langeron (1983). Handbook of Microscopy. Butterwaths
- 13 Tobin and Morcel (1997). Asking about Cells. Saunders

MGM202: Cytogenetics

Credits: 3

1	Chromatin structure	4
	1.1. Histones, DNA	
	1.2. Nucleosome and higher level organisation	
2	Chromosome organization	8
	2.1. Metaphase chromosome: centromere and kinetochore, telomere and its maintenance; Holocentric chromosomes and supernumerary chromosomes	
	2.2. Chromosomal domains (matrix, loop domains) and their functional significance	
	2.3. Heterochromatin and euchromatin, position effect variegation, boundary elements	
	2.4. Chromosome bandings	
3	Functional states of chromatin and alterations in chromatin organization	3
4	Structural and functional organization of interphase nucleus	2
5	Giant chromosomes	4
	5.1 Polytene chromosomes	
	5.2 Lampbrush chromosomes	
6	Mitosis	3
	6.1. Mitotic spindle and arrangement of chromosomes on equator	
	6.2. Regulation of exit from metaphase	
	6.3. Chromosome movement at anaphase	
7	Meiosis	5
	7.1 Overview of the process	
	7.2 Meiosis specific cellular changes	
	7.3 Genetic control of meiosis (example: yeast)	
8	Chromosomal anomalies	5
	8.1 Numerical	
	8.2 Structural	
	8.3 Meiosis in inversion and translocation heterozygotes; breakage-fusion-bridge cycles	
	8.4 Induced chromosomal aberrations in somatic cells	
	8.5 Sister chromatid exchanges and somatic crossing over	
9	Dosage compensation in Caenorhabditis, Drosophila and mammals	5

Recommended Books

- 1 Alberts et al (1998). Essential Cell Biology. Garland
- 2 Alberts et al (2007). Molecular Biology of The Cell. Garland
- 3 Bostoc and Sumner (1980). The Eukaryotic Chromosome. Elsevier
- 4 Hamsew and Flavell (1993). The Chromosome. Bios
- 5 Hawley & Walker (2003). Advanced Genetic Analysis. Blackwell
- 6 Hennig (1987). Structure & Function of Eukaryotic Chromosomes. Springer
- 7 Lewin (2007). Genes IX. Pearson
- 8 Lodish et al (2004). Molecular Cell Biology. Freeman
- 9 Obe and Natarajan(1990). Chromosome aberrations - Basic and Applied Aspects. Springer
- 10 Risley (1985). Chromosome Structure and Function. Reinhold
- 11 Rooney & Czepulkowski (1987). Human Cytogenetics – A Practical Approach. IRL
- 12 Sumner. Chromosomes. Blackwell

MGM203: DNA Technology & Genetic Engineering

Credits: 3

1	Enzymes used in DNA technology	4
1.1	Restriction and modification enzymes	
1.2	Other nucleases	
1.3	Polymerases	
1.4	Ligase, kinases and phosphatases	
2	Cloning vectors	6
2.1	Plasmids	
2.2	Phages	
2.3	Cosmids	
2.4	Artificial chromosomes	
2.5	Shuttle vectors	
2.6	Expression vectors	
3	Construction of genomic and cDNA libraries	2
4	Screening and characterization of clones	5
4.1	Preparation of probes	
4.2	Principles of hybridizations and hybridization based techniques (colony, plaque, Southern, Northern and in situ hybridizations)	
4.3	Expression based screening	
4.4	Interaction based screening: yeast two-hybrid system	
5	Basic principles and applications of the following techniques	5
5.1.	DNA sequencing	
5.2.	Oligonucleotide synthesis	
5.3.	Polymerase Chain Reaction	
5.4.	Microarray	
5.5.	DNA fingerprinting	
6	Promoter characterization: promoter analysis through reporter genes, electrophoretic mobility shift assay, DNA foot-printing	3
7	Mutagenesis	3
7.1.	Site directed mutagenesis	
7.2.	Transposon mutagenesis	
7.3.	Construction of knock-out mutants	
8	Gene transfer techniques	5
8.1	Electroporation and microinjection	
8.2	Transfection of cells: Principles and methods	
8.3	Germ line transformation in <i>Drosophila</i> and transgenic mice: Strategies and methods	
9	Applications of Recombinant DNA Technology	6
9.1	Crop and live-stock improvement	
9.2	Gene therapy: somatic and germ line gene therapy	
9.3	DNA drugs and vaccines	
9.4	Bio safety and ethical considerations	

Recommended Books

- 1 Ausubel et al (2002). Short Protocols in Molecular Biology. Wiley
- 2 Brown (2000). Essential Molecular Biology VI. AP
- 3 Brown (2000). Essential Molecular Biology VII. AP
- 4 Brown (2006). Gene Cloning and DNA Analysis - An Introduction. Blackwell
- 5 Glick and Pasternak (2003). Molecular Biotechnology. ASM Press
- 6 Kracher. Molecular Biology - A Practical Approach.
- 7 Krenzer and Massey (2000). Recombinant DNA and Biotechnology. ASM
- 8 Micklos and Freyer (1990). DNA Science. CSHL
- 9 Primrose (2001). Molecular Biotechnology. Panima

- 10 Robertson et al (1997). Manipulation & Expression of Recombinant DNA. AP
- 11 Sambrook et al (2001). Molecular Cloning. CSHL
- 12 Twyman (1999). Advanced Molecular Biology. Viva
- 13 Watson et al (1992). Recombinant DNA. Freeman
- 14 Primrose and Twyman (2006). Principles of Gene Manipulation and Genomics. Blackwell

MGM204: Genomic instability and Cancer & Bioinformatics Credits: 3

Section A: Genomic instability & Cancer

1	DNA repair	5
	1.1. Origins and types of DNA damage	
	1.2. DNA repair pathways	
	1.3. Error-prone repair and mutagenesis	
	1.4. Damage signaling and checkpoint arrest	
2	Recombination	4
	2.1. Homologous recombination: models and molecular mechanisms	
	2.2. Gene conversion: molecular mechanisms	
	2.3. Site specific recombination	
	2.4. Transposons and transposition mechanisms	
3	Cell transformation and tumourigenesis	8
	3.1. Cell cycle check point and cancer	
	3.2. Oncogenes	
	3.3. Tumour suppressor genes	
	3.4. DNA repair genes and genetic instability	
	3.5. Epigenetic modifications, telomerase activity, centrosome malfunction	
	3.6. Genetic heterogeneity and clonal evolution	
4	Familial cancers: Retinoblastoma, Wilms' tumour, Li-Fraumeni syndrome, colorectal, cancer, breast cancer	4
5	Genetic predisposition to sporadic cancer	1
6	Tumour progression: angiogenesis and metastasis	2
7	Tumour specific markers	1
8	Cancer and environment: physical, chemical and biological carcinogens	1

Recommended Books

- 1 Alberts et al (1999). The Science of Genetics. Saunders
- 2 Alberts et al (2008). Molecular Biology of the Cell. Garland
- 3 Benjamin (2003). Genetics: A Conceptual Approach. Freeman
- 4 Berg and Singer (1998). Genes and Genome.
- 5 Black (2002). Microbiology: Principles and Explorations. Wiley
- 6 Cowell (2001). Molecular Genetics of Cancer. Bios
- 7 Dale & Scharz (2003). From genes to Genome. Wiley & Sons
- 8 Ehrlich (2000). DNA Alterations in Cancer. Eaton
- 9 Gersen & Keagle (1999). Principles of Clinical Cytogenetics. Humana
- 10 Griffiths et al (2002). Modern Genetic Analysis. Freeman
- 11 Griffiths et al (2004). An Introduction to Genetic Analysis. Freeman
- 12 Hartl et al (2002). Essential Genetics. Wiley & Sons
- 13 Klug & Cummings (2003). Essentials of Genetics. Prentice Hall
- 14 Latchman (1995). Gene Regulation. Chapman & Hall
- 15 Lewin (2004). Genes VIII. Pearson
- 16 Lewin (2007). GenesIX. Pearson

- 17 Lodish et al (2004). Molecular Cell Biology. Freeman
- 18 Maloy and Freifelder(1994). Microbial Genetics. Jones and Barlett
- 19 Meesfeld (1999). Applied Molecular Genetics. Wiley-Liss
- 20 Ptashne (1986). Genetic Switch. Blackwell
- 21 Russell (2002). Genetics. Benjamin
- 22 Stillman (1994). Molecular Genetics of Cancer. CSHL
- 23 Streips & Yasbin (2002). Modern Microbial Genetics. Wiley
- 24 Trun & Trempy (2004). Fundamentals of Bacterial Genetics. Blackwell

Section B: Bioinformatics

1. Definition and Scope of Computational Biology and Bioinformatics 1
 2. Major Bioinformatics Databases & Resources: NCBI, EBI, ExPASy 1
 3. Biological **Sequence Analysis** 5
 - 3.1 **Sequence Similarity, Homology and Alignment:**
 - 3.1.1. Pairwise sequence Alignment, Global & Local Alignment algorithms, Basic concept of Scoring matrices (PAM & BLOSSUM), Dynamic programming Algorithms, Dot Plots for comparing sequences, Statistical significance of alignments score, motifs and pattern analysis
 - 3.1.2. BLAST and FASTA algorithms BLAST theory, other BLAST options, PSI-BLAST and PSSM, Applications of BLAST.
 - 3.2 **Multiple sequence alignment:** 2
 - 3.2.1 Introduction to Multiple sequence alignment and progressive alignment algorithm, MSA based software tools ClustalW. Applications of Multiple Sequence alignment.
 - 3.2.2 **Phylogenetic analysis:** 2

Definition and description of phylogenetic trees and various types of trees, A primer on Computational phylogenetic analysis.
 4. Computational Gene Prediction Methods (basic concept) 2
 5. Lab Exercises 26
- 5.1 Basics of Computer, Internet and Operating system
- 5.2 **Major Sequence and Structure Databases:** Knowledge of the following databases with respect to: organization of data, contents and formats of database entries, retrieval of data using text-based search tools
- 5.2.1 Nucleic acid sequence databases: GenBank, EMBL
 - 5.2.2 Protein sequence databases: SWISS-PROT, TrEMBL, PIR
 - 5.2.3. Genome Databases at NCBI, EBI, TIGR, SANGER
 - 5.2.4. Repositories for high throughput genomic sequences: EST, STS and GSS
 - 5.2.5. **Derived Databases:** basic concept of derived databases, PROSITE, PRODOM, Pfam, CATH, SCOP, DSSP, FSSP, DALI databases
- 5.3 Protein Structure Visualization: **Schematic Representations of proteins using Chimera, and Pymol, Protein Data Bank (PDB) and PDB format.**

Recommended Books

- 1 Attwood & Parry-Smith (2002). Introduction to Bioinformatics. Pearson
- 2 Barnes & Gray (ed) (2003). Bioinformatics for Geneticists. Wiley
- 3 Lesk (2003). Introduction to Bioinformatics. Oxford
- 4 Mount (2003). Bioinformatics: Sequence and Genome Analysis. CBS
- 5 Rashidi & Buchler (2000). Bioinformatics Basics. CRC Press
- 6 Rastogi et al (2003). Bioinformatics: Concepts, Skills and Applications. CBS
- 7 Westhead et al (2003). Bioinformatics Instant Notes. Viva Books

MGM205: Biochemistry & Metabolic Disorders

Credits: 3

1	Carbohydrates	9
	1.1. Mucopolysaccharides and related disorders	
	1.2. Glycolysis	
	1.3. Krebs cycle	
	1.4. Gluconeogenesis	
	1.5. Glycogenesis and glycogenolysis,	
	1.6. Disorders of glycogen metabolism	
2	Lipids	8
	2.1. Fatty acids: synthesis and oxidation of fatty acids	
	2.2. Ketogenesis	
	2.3. Metabolism of cholesterol	
	2.4. Lipoproteins: role in lipid transport and storage	
	2.5. Prostaglandins: structure and function	
3	Bioenergetics	5
	3.1. Second law of thermodynamics	
	3.2. High energy compounds	
	3.3. Oxidative phosphorylation	
4	Hormones	8
	4.1 Characteristics	
	4.2. Mechanism of action of peptide hormones	
	4.3 Mechanism of action of steroid hormones and gene expression	
	4.4 Hormonal regulation of fuel metabolism	
	4.5. Hormone receptors and diseases	
5	Vitamins	4
	5.1 Structure	
	5.2 Function of water- and lipid-soluble vitamins	
6	Inborn errors of metabolism	5
	6.1 Phenylketonuria	
	6.2 Maple syrup urine syndrome	
	6.3 Mucopolysaccharidosis	
	6.4 Galactesemia	
	6.5 Tay-Sachs disease	

Recommended Books

- 1 Berg et al (2006). Biochemistry. Freeman
- 2 Bhagwan (2004). Medical Biochemistry. AP
- 3 Devlin (2002). Biochemistry: with clinical correlations. Wiley
- 4 Higgins et al (1994). Biochemistry for the Molecular Sciences. Longman
- 5 Murray et al (2006). Harpers Illustrated Biochemistry. Prentice Hall Int
- 6 Nelson et al (2006). Lehninger's Principles of Biochemistry. McMillan
- 7 Voet & Voet (2006). Biochemistry Vol. 1 and 2. Wiley
- 8 Zubay et al (1995). Principles of Biochemistry. WCB

MGM206	Lab work based on courses MGM201 & MGM202	Credits: 2
MGM207	Lab work based on courses MGM203 & MGM204	Credits: 2
MGM208	Lab work based on course MGM205	Credits: 2

1	Eukaryotic cell Organization	4
	1.1 Biomembrane	
	1.2 Organelles of Eukaryotic cell	
2	Nucleic Acids	6
	2.1 Base composition, structure and conformation	
	2.2 Different forms and unusual structures	
	2.3 Nucleic acid chemistry: Denaturation, hybrids, nonenzymatic transformation, methylation.	
	2.4 Nucleosome & higher level Organization	
3	DNA Replication	5
	3.1 DNA polymerases	
	3.2 Replicons, origin and termination	
	3.3 Replisome	
	3.4 Genes controlling replication	
4	Transcription	8
	4.1 Prokaryotic RNA polymerase, sigma factors, initiation and termination	
	4.2 Eukaryotic RNA polymerases and their promoters	
	4.3 Processing of transcripts	
	4.4 Post transcriptional regulation:	
	4.4.1 Alternative splicing	
	4.4.2 Transport and targeting of RNA	
	4.4.3 Post-transcriptional gene silencing	
5	Translation	3
	5.1 General mechanism	
	5.2 Translational control	
6	DNA Technology	13
	6.1 Enzyme used in DNA technology	
	6.2 Purification & separation of nucleic acid	
	6.3 Cloning	
	6.4 Polymerase chain reaction & application	
	6.5 DNA sequencing	
	6.6 DNA fingerprinting	
	6.7 Nucleic acid & protein hybridization techniques: southern, northern, western hybridization	

Recommended Books

- 1 Lodish et al (2004). Molecular Cell Biology. Freeman
- 2 Gerald Karp (2005). Cell & Molecular Biology. Wiley & Sons
- 3 Brown (2001). Essential Molecular Biology. AP
- 4 Alberts et al (1999). The Science of Genetics. Saunders
- 5 Benjamin (2003). Genetics: A Conceptual Approach. Freeman
- 6 Berg and Singer (1998). Genes and Genome
- 7 Dale & Scharz (2003). From genes to Genome. Wiley & Sons
- 8 Griffiths et al (2002). Modern Genetic Analysis. Freeman
- 9 Griffiths et al (2004). An Introduction to Genetic Analysis. Freeman
- 10 Hartl et al (2002). Essential Genetics. Wiley & Sons
- 11 Klug & Cummings (2003). Essentials of Genetics. Prentice Hall
- 12 Latchman (1995). Gene Regulation. Chapman & Hall
- 13 Lewin (2007). Genes IX. Pearson
- 14 Watson et al (2004). Molecular Biology of the Gene. Pearson

SEMESTER - III

MGM301: Human Molecular Genetics

Credits: 3

1	Genetic mapping of Mendelian traits	6
	1.1. Identifying recombinants and nonrecombinants in pedigrees	
	1.2. Genetic and physical map distances	
	1.3. Genetic markers	
	1.4. Two-point mapping- LOD score analysis	
	1.5. Multipoint mapping	
	1.6. Homozygosity mapping	
2	Genetic mapping of complex traits	6
	2.1. Difficulties in mapping complex traits	
	2.2. Allele sharing methods- Affected sib pair analysis	
	2.3. Allelic association, Linkage disequilibrium mapping, Transmission disequilibrium test	
3	Physical mapping methods	6
	3.1. Low resolution mapping- Cell hybrids, mini- and microcells, synteny of genes, Radiation hybrid mapping	
	3.2. Assembly of clone contigs	
	3.3. Identifying genes in cloned DNA	
	3.4. Integration of cytogenetic, genetic and physical maps	
4	Identifying human disease genes	6
	4.1. Principles and strategies	
	4.2. Position-independent and positional cloning. Candidate gene approaches	
	4.3. Confirming a candidate gene- mutation screening, testing in animal models	
5	Molecular pathology	7
	5.1. Nomenclature of mutations and their databases	
	5.2. Loss-of-function and gain-of-function mutations in diseases	
	5.3. Instability of the human genome: Pathogenicity associated with repeat sequences	
6	DNA testing	8
	6.1. Direct testing	
	6.1.1. Screening for unknown mutations	
	6.1.2. Detection of known mutations	
	6.2. Indirect testing – gene tracking	
	6.3. DNA profiling: establishing identity and relationships	
	6.4. Population screening - ethics, organization and advantages	

Recommended Books

- 1 Davies (1993). Human Genetic Disease Analysis. IRL
- 2 Haines & Pericak (2006). Approaches to Gene Mapping in Complex Human Diseases. Wiley
- 3 Nussbaum et al (2004). Genetics in Medicine. Saunders
- 4 Pasternak (2005). An Introduction to Molecular Human Genetics. Fritsgerald
- 5 Rimoin et al (2002). Principles & Practice of Medical Genetics, Vol I-III. Churchill
- 6 Strachan & Read (1999). Human Molecular Genetics. Wiley
- 7 Sudbery (2002). Human Molecular Genetics. Prentice-Hall

1	An overview of the genetic basis of syndromes and disorders	1
2	Monogenic diseases with well known molecular pathology	6
	2.1. Cystic fibrosis	
	2.2. Tay-Sachs syndrome	
	2.3. Marfan syndrome	
	2.4 Inborn errors of metabolism	
3	Genome imprinting Syndromes: Prader-Willi & Angelman syndromes, Beckwith-Wiedeman Syndrome	2
4	Neurofibromatosis I	1
5	Disorders of muscle	3
	5.1 Dystrophies (Duchenne Muscular dystrophy and Becker Muscular Dystrophy)	
	5.2 Myotonias	
	5.3 Myopathies	
6	Disorders of Haemopoietic systems	4
	6.1 Overview of Blood cell types and haemoglobin	
	6.2 Sickle cell anemia	
	6.3 Thalassemias	
	6.4 Hemophilias	
7	Disorders of eye	3
	7.1 Retinitis pigmentosa	
	7.2 Cataract	
	7.3 Glaucoma	
	7.4 Colour blindness	
8	Multifactorial diseases	3
	8.1 Hyperlipidemia	
	8.2 Atherosclerosis	
	8.3 Diabetes mellitus	
9	Mitochondrial syndromes	1
10	Management of genetic disorders	3
11	Historical overview of genetic counseling	2
	11.1 Models of Eugenic, Medical/Preventive, Decision making, Psychotherapeutic counseling; current definition and goals	
	11.2 Philosophy and ethos of genetic services and counseling	
12	Components of genetic counseling	2
	12.1 Indications and purpose	
	12.2 Information gathering and construction of pedigrees	
	12.3 Medical Genetic evaluation	
	12.3.1 Basic components of Medical History	
	12.3.2 Past medical history, social & family history	
	12.4 Physical examination	
	12.4.1 General and dysmorphology examination	
	12.4.2 Documentation	
13	Patterns of inheritance, risk assessment and counseling in common Mendelian and multifactorial disorders	3
14	Biochemical and molecular genetic tests	2
	14.1 In children	
	14.2 Presymptomatic testing for late onset diseases (predictive medicine)	
15	Prenatal and pre-implantation diagnosis	2
	15.1 Indications for prenatal diagnosis	
	15.2 Indications for chromosomal testing	
	15.3 Noninvasive methods	
	15.4 Invasive methods	
16	Legal and ethical considerations	1

Recommended Books

- 1 Cox and Sinclair (1997). Molecular Biology in Medicine. Blackwell
- 2 DeGrouchy and Turleau (1984). Clinical Atlas on Human Chromosomes. Wiley
- 3 Jankowski and Polak (1996). Clinical Gene Analysis and Manipulation. Cambridge
- 4 Korf (1996). Human Genetics – A Problem Based Approach. Blackwell
- 5 Pasternak (2000). An Introduction to Molecular Human Genetics. Fritsgarald
- 6 Rasko and Downes (1995). Genes in Medicine. Kluwer
- 7 Rimoin et al (2002). Principles & Practice of Medical Genetics, vol I-III. Churchill
- 8 Robinson and Linden (1994). Clinical Genetics Handbook. Blackwell
- 9 Strachan and Read (1999). Human Molecular Genetics. Wiley
- 10 Wilson (2000). Clinical Genetics: A Short Course. Wiley-Liss
- 11 Baker et al (1998). A Guide to Genetic Counseling. Wiley
- 12 Harper (2001). Practical Genetic Counseling. Arnold
- 13 Rose & Lucassen(1999). Practical genetics of primary care. Oxford
- 14 Young (1999). Introduction to Risk Calculation in Genetic Counseling. Oxford

MGM303: Developmental Genetics

Credits: 3

1	Early development	5
	1.1 Fertilization	
	1.2 Types of cleavage	
	1.3 Gastrulation: Cell movement and formation of germ layers in frog, chick and mouse	
	1.4 Concept of determination, competence and differentiation	
2	Development of vertebrate nervous system	5
	2.1 Formation of neural tube	
	2.2 Formation of brain regions	
	2.3 Tissue architecture of the central nervous system	
	3.1 <i>Caenorhabditis</i> : Vulva formation	
	3.2 <i>Drosophila</i>	
	3.2.1 Maternal genes and formation of body axes	
	3.2.2 Segmentation genes	
	3.2.3 Homeotic genes function	
	3.2.4 Imaginal disc development	
	3.3 Vertebrates	
	3.3.1 Axes formation and HOX genes	
	3.3.2 limb formation in chick	
4	Programmed rearrangements in genes	4
	4.1 Chromatin diminution	
	4.2 Endoreplication cycles	
	4.3 Gene amplification	
5	Genome imprinting	1
6	Genetic determination of sex in <i>Caenorhabditis</i> , <i>Drosophila</i> and mammals	3
7	Regeneration	1
8	Senescence	1
9	Embryonic stem cells and their applications	2

10	Clinical embryology	5
10.1	Differentiation of germ cells and gametogenesis	
10.2	Fertilization and implantation	
10.3	Stages of human embryonic development	
10.4	Congenital malformations and teratogenesis	
10.5	Reproductive failure and infertility and assisted reproduction	

Recommended Books

- 1 Alberts et al (2007). Molecular Biology of The Cell. Garland
- 2 Gilbert (2006). Developmental Biology. Sinauer
- 3 Kalthoff (1996). Analysis of Biological Development. McGraw Hill
- 4 Lewin (2007). GenesIX. Pearson
- 5 Monk (1987). Mammalian Development – A Practical Approach. IRL
- 6 O'Rahilly and Muller (1992). Human Embryology and Teratology. Wiley
- 7 Rana (1998). Human Embryology Made Easy. Harwood
- 8 Wolpert (2007). Principles of Development. Oxford

MGM304: Immunogenetics

Credits: 3

1	An introduction to immune system	
1.1	Innate and adaptive immunity	
1.2	Cells and organs of the immune system	7
1.3	Primary and secondary immune responses	
1.4	Antigens, antibodies and T cell receptors	
1.4.1	Antigens	
1.4.2	Structure and function of immunoglobulins	
1.4.3	Monoclonal antibodies	
1.4.4	B and T cell receptors and coreceptors	
1.4.5	Antigen-antibody interactions	
2	Immunoglobulin and T-cell receptor genes	8
2.1	Organization of Ig gene loci	
2.2	Molecular mechanisms of generation of antibody diversity	
2.3	Expression of Ig genes	
2.4	Regulation of Ig gene transcription	
2.5	Antibody engineering	
2.6	Organization of TCR gene loci	
2.7	Generation of TCR diversity	
3	The HLA complex	3
3.1	Organization of HLA complex	
3.2	Structure of class I and II HLA molecules	
3.3	Expression of HLA genes	
3.4	HLA polymorphism	
4	Generation and regulation of immune responses	12
4.1	Antigen processing and presentation	
4.2	MHC-restriction	
4.3	Cytokines	
4.4	T Cell Maturation, activation and differentiation	
4.5	B Cell Generation, Activation and differentiation	
4.6	Clonal selection and immunological memory	
4.7	Complement system	
4.8	Leukocyte, Activation and Migration	
4.9	Cell mediated cytotoxic responses	

4.10 Regulation of immune responses	
4.11 Immunological tolerance	
5 Disorders of Human Immune System	5
5.1 Primary and secondary immunodeficiencies	
5.2 Autoimmune disorders	
5.3 Hypersensitive reactions	
5.4 Cytokine-related diseases	
6 Immune system in human health	4
6.1 Immune response to infectious diseases and malignancy	
6.2 Concept of immunotherapy	
6.3 Vaccines	
6.4 Transplantation immunology	

Recommended Books

- 1 Abbas et al (2007). Cellular and Molecular Immunology. Saunders
- 2 Barrett (1988). Text Book of Immunology. Mosloy
- 3 Benjamin et al (2003). Immunology – A Short Course. Wiley-Liss
- 4 Kuby (2006). Immunology. Freeman
- 5 Roitt (2003). Essential Immunology. Blackwell
- 6 Roitt et al (2001). Immunology. Mosloy

MGM305	Lab work based on courses MGM301 & MGM302	Credits: 2
MGM306	Lab work based on courses MGM303 & MGM304	Credits: 2

MGM307: Clinical Assignments

Credits: 3

Each student will visit the BHU hospital as per the schedule drawn each year and undertake analysis of some of the inherited diseases presented during these visits. Each student will maintain a detailed record of the visits and the patients analyzed and submit a Report on the same.

MGM308M: Basic Genetics and Genetic Disorders

Credits: 3

1 Mendelism and its extensions	7
1.1 Law of segregation	
1.2 Law of independent assortment	
1.3 Chromosomal basis of segregation and independent assortment	
1.4 Linkage	
1.5 Crossing over	
1.6 Multiple allelism	
1.7 Pleiotropy	
1.8 Cytoplasmic inheritance	
2 Cytogenetics	6
2.1 Chromatin structure	
2.2 Heterochromatin and euchromatin	
2.3 Mitosis	
2.4 Meiosis	
2.5 Dosage compensation	
2.6 Chromosomal aberrations	
3 Molecular Genetics	10
3.1 Nature of genetic material and flow of genetic information	
3.2 DNA replication	

3.3	Transcription	
3.4	Translation	
3.5	Genetic code	
3.6	Regulation of gene expression	
3.6.1.	Transcriptional regulation (Operon, Enhancers and promoters)	
3.6.2.	Post transcriptional regulation (Alternative splicing, gene silencing)	
3.7	Transposable elements	
3.8	DNA damage and repair	
3.9	Mutation	
4	Human Molecular Genetics	6
4.1	Organization of human genome	
4.2	Pedigree analysis	
4.3	Monogenic and polygenic traits	
4.4	Gene mapping and linkage analysis	
4.5	Genetic counseling	
4.6	Prenatal diagnosis	
5.1	Molecular mechanisms of carcinogenesis	
5.2	Oncogenes and tumour suppressor genes	
5.3	Apoptosis and cancer	
6	Genetic disorders	7
6.1	Inborn errors of metabolism: Phenylketonuria	
6.2	Neurogenetic disorders: Alzheimer's disease	
6.3	Muscle genetic disorders: Duchenne Muscular Dystrophy	
6.4	Genetic disorders of Haematopoietic systems: Sickle cell anemia	
6.5	Multifactorial disorders: Diabetes mellitus	
6.6	Mitochondrial syndromes	
6.7	Management of genetic disorders	

Recommended Books

- 1 Strickberger (1985). Genetics. McMillan
- 2 Snustad & Simmons (2005). Principles of Genetics. Wiley
- 3 Griffiths et al (2002). Modern genetic analysis. Freeman
- 4 Hartl and Jones (1998). Genetics-Principles and Analysis. Jones & Bartlett
- 5 Nelson et al (2006). Lehninger's Principles of Biochemistry. McMillan
- 6 Alberts et al (2007). Molecular Biology of the Cell. Garland
- 7 Lewin (2007). Genes IX. Jones & Bartlett
- 8 Kasper et al (2005). Harrison's Principles of Internal Medicine. Vol. I & II. McGraw Hill
- 9 Strachan and Read (2003). Human Molecular Genetics. Wiley
- 10 Pritchard & Korf (2007). Medical Genetics at a glance. Wiley-Blackwell
- 11 Lodish et al (2004). Molecular Cell Biology. Freeman
- 12 Karp (2005). Cell and Molecular Biology. John Wiley
- 13 Rimoin et al (2002). Principles & Practice of Medical Genetics. Vol. I-III. Churchill
- 14 Weinberg (2006). Biology of Cancer. Garland

SEMESTER - IV

MGM401: Human Genome

Credits: 3

1	The Genome project 1.1. History, organization and goals of human genome project 1.2. Mapping strategies, current status of various maps; DNA segment nomenclature 1.3. Human genome diversity	8
2	Organization of human genome 2.1. Mitochondrial genome 2.2. Gross base composition of nuclear genome 2.3. Gene density 2.4. CpG islands 2.5. RNA-encoding genes 2.6. Functionally identical/similar genes 2.7. Diversity in size and organization of genes 2.8 Annotation	8
3	Gene families 3.1 Multigene families – Classical gene families, families with large conserved domains, families with small conserved domains 3.2 Gene superfamilies 3.3 Gene families in clusters 3.4 Pseudogenes 3.5 Repetitive DNA and transposable elements 3.6 Origin of gene families	
4	Comparative Genomics 4.1 Overview of prokaryotic and eukaryotic genomes 4.2 C-value, number of genes and complexity of genomes 4.3 Conservation and diversity of genomes 4.4 Comparative genomics as an aid to gene mapping and study of human disease genes	8
5	Functional genomics 5.1 Transcriptome and its analysis 5.2 Proteome and Proteomics 5.3 gene silencing	5
6.	Disease and genomics	2

Recommended Books

- 1 Brown (2007). Genomes. Bios
- 2 Coleman and Tsongalis (1997). Molecular Diagnosis. Humana
- 3 Dale & Scharz (2003). From Genes to Genomes. Wiley
- 4 Hawley and Mori (1999). The Human Genome. Academic
- 5 Lewis (1999). Human Genetics. WCB
- 6 Liebler (2002). Introduction to Proteomics. Humana
- 7 Pasternak (2000). An Introduction to Molecular Human Genetics. Fitzgerald
- 8 Primrose & Twyman (2003). Principles of Genome Analysis & Genomics. Blackwell
- 9 Strachan and Read (2005). Human Molecular Genetics 3. Wiley
- 10 Sudbery (2002). Human Molecular Genetics. Prentice Hall
- 11 Alberts et al (2007). Molecular Biology of the Cell. Garland
- 12 Cowell (2001). Molecular Genetics of Cancer. Bios
- 13 Ehrlich (2000). DNA Alterations in Cancer. Eaton
- 14 Gersen & Keagle (1999). Principles of Clinical Cytogenetics. Humana
- 15 Lewin (2007). Genes X. Pearson
- 16 Lodish et al (2004). Molecular Cell Biology. Freeman
- 17 Stillman (1994). Molecular Genetics of Cancer. CSHL

MGM402: Population & Evolutionary Genetics

Credits: 3

1	Concept and theories of evolution	3
2	Microevolution in Mendelian population	5
	2.1 Mendelian Population	
	2.2 Allele frequencies and genotype frequencies	
	2.3 Hardy-Weinberg equilibrium and conditions for its maintenance	
3	Elemental forces of evolution	6
	3.1 Mutation	
	3.2 Selection (Types of selection, selection coefficient, selection in natural populations)	
	3.3 Genetic drift	
	3.4 Migration	
4	Chromosomal, DNA and allozyme polymorphism in natural population	5
	4.1 Adaptive genetic polymorphism	
	4.2 Balanced polymorphism and heterosis	
	4.3 Genetic coadaptation and linkage disequilibrium	
5	Isolating mechanisms	3
6	Concept of species and modes of speciation: sympatric, allopatric, stasipatric	3
7	Molecular population genetics	4
	7.1 Molecular evolution (neutral theory, punctuated equilibrium)	
	7.2 DNA-based phylogenetic trees	
	7.3 Molecular clock	
8	Nonrandom breeding	3
	8.1 Inbreeding and assortative mating	
	8.2 Path diagram construction and inbreeding coefficient, allelic identities by descent	
9	Human phylogeny	4
	9.1 Hominid evolution: anatomical, Geographical, Cultural	
	9.2 Molecular phylogenetics of Homo sapiens	
	9.3 Peopling of continents (Europe, Africa, Asia)	
10	Population Substructure	3
	10.1 Hierarchical population structure	
	10.2 Isolate breaking: The Wahlund principle	

Recommended Books

- 1 Brown (2007). Genomes. Bios
- 2 Hartl & Clark (1997). Principles of Population Genetics. Sinaur
- 3 Hartl and Jones(1998). Genetics _ Principles and Analysis. Jones and Bartlet
- 4 Hoelzel (1998). Molecular Genetic Analysis of Populations. Oxford Univ
- 5 Jobling et al (2004). Human Evolutionary Genetics. Garland
- 6 Moody (1964). Evolution. Harper and Row
- 7 Roberts & DeStefano (1986). Genetic Variation and its Maintenance. Cambridge Univ
- 8 Smith (1998). Evolutionary Genetics. Oxford
- 9 Strickberger (2000). Evolution. Jones and Barlett

MGM403: Neurogenetics

Credits: 3

1	Nervous system	12
1.1	Major regions of human brain	
1.2	Cellular components of nervous tissue	
1.3	Sub cellular organization of the nervous system	
1.4	Membrane potential and action potential	
2	Learning and memory	3
3	Circadian rhythms	2
4	Neurogenetic disorders	10
4.1	Spinomuscular atrophy	
4.2	Syndromes due to triplet nucleotide expansion	
4.3	Alzheimers disease	
4.4	Parkinsons disease	
5	Nature-nurture and behaviour	6
5.1	Genetic experiments to investigate animal behaviour	
5.1.1	Selection studies	
5.1.2	Inbred strain studies	
5.2	Identifying genes for controlling behavior	
5.2.1	Induced mutations	
5.2.2	Quantitative trait loci	
5.2.3	Synteny/orthology	
5.3	Investigating the genetics of human behaviour	
5.3.1	Twin and adoption study designs, interpreting heritability	
5.3.2	Linkage and association studies	
5.4	Environmental influence- shared and non-shared environment	
6	Psychopathology	6
6.1	Schizophrenia	
6.2	Mood disorders	
6.3	Disorders of childhood	

Recommended Books

- 1 Kaplan and Sadock (2007). Synopsis of Psychiatry. Williams & Wilkins
- 2 Plomin et al (2001). Behavioral Genetics. Freeman
- 3 Zigmond, Bloom et al., (2002). Fundamentals Neuroscience. Academic Press
- 4 Kandel, Schwartz et al. (2000). Principles of Neuroscience. Prentice Hall
- 5 Pasternak (2005). An Introduction to Molecular Human Genetics. Fritzgarald
- 6 Cox and Sinclair (1997). Molecular Biology in Medicine. Blackwell
- 8 Rasko and Downes (1995). Genes in Medicine. Kluwer
- 9 Rimoin et al(2002). Principles & Practice of Medical Genetics, vol I-III. Churchill
- 10 Robinson and Linden (1994). Clinical Genetics Handbook. Blackwell
- 11 Strachan and Read (2003). Human Molecular Genetics. Wiley
- 12 Wilson (2000). Clinical Genetics: A Short Course. Wiley-Liss

MGM L 404 Lab work based on course MGM401

Credits: 2

MGM L 405 Lab work based on courses MGM402 & MGM403

Credits: 2

MGM406: Dissertation (Credits: 6)

Each student will undertake an experimental project under supervision of one of the teachers during Semester 4 and submit TWO copies of the dissertation which will include: a) Review of the relevant literature, b) Objectives of the study, c) Materials and Methods, d) Results/Observations (supported by figures/tables etc as required), e) Discussion of the Results/Observations, f) Summary and g) References

MGM407: Comprehensive Viva-voice (Credits: 2)

MGM408: Seminar & Formulation of a Research Proposal (Credits: 2)

The student will deliver a comprehensive seminar on a current topic of his/her choice in the field of Molecular & Human Genetics. The topic of Seminar must be different from the topics covered in any of the courses.