

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	2
MGM102	Molecular Genetics	3
MGM103	Basic Human Genetics	3
MGM104	Cytogenetics	2
MGM105	Biochemistry	3
MGM106	Cell Biology	3
MGM107	Lab work based on courses MGM101 & MGM102	2
MGM108	Lab work based on courses MGM103 & MGM104	2
MGM109	Lab work based on courses MGM105 & MGM106	2
	Total	22
Semester-II		
Course Code	Title	Credits
MGM201	DNA Technology & Genetic Engineering	3
MGM202	Bioinformatics and Biotechniques	3
MGM203	Model Genetic Systems	2
MGM204	Genomic Instability and Cancer	3
MGM205	Human Genome	3
MGM206	Reproductive Genetics	2
MGM207	Lab work based on courses MGM201 & MGM202	2
MGM208	Lab work based on courses MGM203 & MGM204	2
MGM209	SWAYAM Course	2
	Total	22
Semester-III		
Course Code	Title	Credits
MGM301	Human Molecular Genetics	3
MGM302	Clinical Genetics	3
MGM303	Developmental Genetics	3
MGM304	Immunogenetics	3
MGM305	Population & Evolutionary Genetics	2
MGM306	Lab work based on courses MGM301 & MGM302	2
MGM307	Lab work based on courses MGM303 & MGM304	2
MGM308	SWAYAM Course	2
	Total	20
Semester-IV		
Course Code	Title	Credits
MGM401	Neurogenetics	3
MGM402	Genetic Counseling and Intellectual Property Rights	2
MGM403	Lab work based on course MGM401	1
MGM404	Seminar & Formulation of Research Project	2
MGM405	Comprehensive Viva-voce	2
MGM406	Dissertation	6
	Total	16
	Grand Total	80

SEMESTER - I

MGM101: Transmission Genetics

Credits: 2
Lecture hours

1. Introduction to Genetics	1
2. Mendelism	5
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	8
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	4
5.1. Genetic recombination and construction of genetic maps in <i>Drosophila</i>	
5.2. Interference and coincidence	
5.3. Cytological demonstration of crossing over in <i>Drosophila</i>	
6. Inheritance of quantitative traits	4
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. Hartl and Jones (1998). Genetics – Principles and Analysis. Jones & Bartlett
2. Snustad et al (1998). Principles of Genetics. Wiley and sons
3. Strickberger (1985). Genetics. Mcmillan
4. Brooker (2012). Genetics – Analysis and Principles, 4th edition. Benjamin/Cummings

Suggested Reading

1. Atherly et al (1999). The Science of Genetics. Saunders
2. Fairbanks et al (1999). Genetics. Wadsworth
3. Gardner et al (1991). Principles of Genetics. John Wiley
4. Griffiths et al (2002). Modern genetic Analysis. Freeman
5. Griffiths et al (2004). An Introduction to Genetic Analysis. Freeman
6. Tamarin (1996). Principles of Genetics. WCB

	Lecture hours
1.Properties and evolution of genetic material, flow of genetic information	2
2.Organization of viral,bacterial genomes and Eukaryotic genome	5
3.Replication:Prokaryotic and Eukaryotic	7
3.1. DNA polymerases	
3.2.Replicons, origin and termination	
3.3.Replisome	
3.4.Genes controlling replication	
4. Transcription	7
4.1. Prokaryotic RNA polymerase, sigma factors, initiation and termination	
4.2.Eukaryotic RNA polymerases and their promoters	
4.3. Processing of transcripts	
5. Translation	5
5.1. General mechanism	
5.2. Role of rRNA in translation	
6. Regulation of gene expression	10
6.1. Regulation of transcription initiation	
6.1.1. Operon and regulon	
6.1.2.Positive and negative regulation	
6.1.3.Enhancers and promoters	
6.1.4. Transcription factors: types, DNA binding motifs	
6.2. Regulation by attenuation and anti-termination	
6.3. Post transcriptional regulation	
6.3.1. Alternative splicing	
6.3.2.Transport and targeting of RNA	
6.3.3. Post-transcriptional gene silencing	
6.4. Translational control and targeting of proteins	
6.5. Mechanism of steroid hormone and stress induced gene expressions	
7. Mutation: Types and detection	3

Recommended Books

1. Watson et al. (2014). Molecular Biology of the Gene. 7th Edition
2. Krebs JE, Goldstein ES and Kilpatrick ST. Lewin's Gene XII, Jones and Bartlett
3. Weaver RF Molecular Biology(2012), 5th Edition, McGraw Hill Higher Education

Suggested Reading

- 1.Berg and Singer (1998). Genes and Genome.
- 2.Dale &Schartz (2003). From genes to Genome. Wiley & Sons
3. Griffiths et al (2015). An Introduction to Genetic Analysis. Freeman. 11th Edition
- 4.Latchman (1995). Gene Regulation. Chapman & Hall. 2nd Edition
- 5.Maloy and Freifelder (1994). Microbial Genetics. Jones and Barlett. 2nd Edition
- 6.Meesfeld (1999). Applied Molecular Genetics. Wiley-Liss
- 7.Streips&Yasbin (2002). Modern Microbial Genetics. Wiley. 2nd Edition
- 8.Trun&Trempey (2004). Fundamentals of Bacterial Genetics. Blackwell. 3rd Edition

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	12
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	3

Recommended Books

1. Mange and Mange (2005). Basic Human Genetics. Sinauer Assoc
2. Gersen & Keagle (2005). The Principles of Clinical Cytogenetics. Humana

Suggested Reading

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. Jorde et al (2005). Medical Genetics. Elsevier
5. Korf (2006). Human Genetics. Blackwell

6. Lewis (2006). Human Genetics. WCB
7. Maroni (2001). Molecular and Genetic Analysis of Human Traits. Blackwell
8. Nussbaum et al (2004). Genetics in Medicine. Saunders

MGM104: Cytogenetics

Credits: 2

Lecture hours

1. Chromatin structure	2
1.1. Histones, DNA	
1.2. Nucleosome and higher level organisation.	
2. Chromosome organization	5
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	
3. Functional states of chromatin and alterations in chromatin organization	2
4. Structural and functional organization of interphase nucleus	2
5. Giant chromosomes	4
5.1. Polytene chromosomes	
5.2. Lampbrush chromosomes.	
6. Mitosis	4
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	4
7.1. Overview of the process	
7.2. Meiosis specific cellular changes	
7.3. Genetic control of meiosis (example: yeast)	
8. Dosage compensation in <i>Caenorhabditis</i> , <i>Drosophila</i> and mammals	3

Recommended Books

1. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick. Lewin's Genes X.
2. Lodish et al (2004). Molecular Cell Biology. Freeman.
3. Bostoc and Sumner (1980). The Eukaryotic Chromosome. Elsevier.

Suggested Reading

1. Bostoc and Sumner (1980). The Eukaryotic Chromosome. Elsevier
2. Hamsew and Flavell (1993). The Chromosome. Bios
3. Hawley & Walker (2003). Advanced Genetic Analysis. Blackwell
4. Hennig (1987). Structure & Function of Eukaryotic Chromosomes. Springer
5. Lewin et al. (2009). Lewin's Genes X. Jones & Bartlett Learning, 2009
6. Lodish et al (2004). Molecular Cell Biology. Freeman
7. Obe and Natarajan (1990). Chromosome aberrations - Basic and Applied Aspects. Springer
8. Risley (1985). Chromosome Structure and Function. Reinhold
9. Rooney & Czepulkowski (1987). Human Cytogenetics – A Practical Approach. IRL
10. Sumner. Chromosomes. Blackwell

	Lecture hours
1 Nucleic Acids:	10
1.1 Nature of genetic material, evidences of DNA as the genetic material	
1.2 Structure & constitution of nucleic acids (purines, pyrimidines, nucleoside)	
1.3 Features of double helix DNA, structure and types and composition of RNA & DNA, unusual structures	
1.4 Nucleic acid chemistry: non enzymatic transformation and methylation	
1.5 Biological role of DNA & RNA, central dogma of molecular biology.	
2. Enzymes	10
2.1. General characteristics of enzymes, Activation energy, Coupled reactions, Active site and its importance	
2.2. Enzyme Classification and nomenclature of enzymes, and cofactors	
2.3. Kinetic studies: Significance; Rapid Equilibrium and Steady State approach, Michaelis-Menten's equations, derivation of Michaelis-Menten equation, Significance of K_m , Catalytic efficiency and turnover number, Effect of pH and temperature.	
2.4. Methods of plotting enzyme kinetics data: Lineweaver-Burk, Advantages and disadvantages; Integrated form of the Henry-Michaelis-Menten equation; Effect of pH and temperature.	
2.5 Enzyme Inhibition, Models and types of inhibition; Kinetics and diagnostic plots	
2.6 Regulatory enzymes; Multisite and allosteric enzymes; Models and examples	
2.7 Enzyme Regulation and control of enzyme activity: reversible covalent modification, irreversible covalent modification	
3. Hormones	7
3.1. Characteristics	
3.2. Mechanism of action of peptide hormones	
3.3. Mechanism of action of steroid hormones and gene expression	
3.4. Hormonal regulation of fuel metabolism	
4. Vitamins	3
4.1. Structure	
4.2. Dietary sources, biochemical functions, requirements of water- and lipid-soluble vitamins (vitamin B complex, C and A, D, E & K vitamins)	
4.3. Recommended dietary allowances, nutritive value, Requirement of vitamins under different physiological states- infancy, childhood, adolescence, pregnancy, lactation and ageing	
4.4. Deficiency diseases	
5. Bioenergetics	9
5.1. Second law of thermodynamics Gibbs free energy, Concept of free energy, standard free energy, determination of ΔG for a reaction, endergonic & exergonic reactions. Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions	
5.2. High energy compounds- introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG energy change	
5.3. Oxidative phosphorylation: Biological oxidation-reduction reactions	

Recommended Books

1. Nelson et al (2009). Lehninger's Principles of Biochemistry. McMillan
2. Devlin (2008). Biochemistry: with clinical correlations. Wiley

Suggested Reading

1. Berg et al (2006). Biochemistry. Freeman
2. Voet&Voet (2006). Biochemistry Vol. 1 and 2. Wiley
3. Zubay et al (1995). Principles of Biochemistry. WCB
4. Rodney Boyer (2006): Concepts in Biochemistry, Wiley

MGM106: Cell Biology

Credits: 3
Lecture hours

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	3
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	4
8. Cell-Cell Interaction	6
8.1. Cell adhesion molecules	
8.2. Cellular junctions	
8.3. Extracellular matrix	
9. Signal transduction	8
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	2

Recommended Books

1. Alberts et al (2008). Molecular Biology of the Cell. Garland
2. Cooper (2007). The Cell: A molecular Approach. ASM Press

Suggested Reading

1. Gilbert (2007). Developmental Biology. Sinauer
2. Jeremy et al (2002). Biochemistry. Freeman
3. Karp (2010). Cell and Molecular Biology. John Wiley
4. Lewin et al. (2009). Lewin's Genes X. Jones & Bartlett Learning, 2009
5. Lodish et al (2004). Molecular Cell Biology. Freeman
6. Pollard & Earnshaw (2002). Cell Biology. Saunders
7. Tobin and Morcel (1997). Asking about Cells. Saunders

8. Wilson & Hunt (2002). The Cell: A Problems Approach. Garland
 9. Locquin and Langeron (1983). Handbook of Microscopy. Butterworths
 10. Tobin and Morcel (1997). Asking about Cells. Saunders

MGM107	Lab work based on courses MGM101 & MGM102	Credits: 2
MGM108	Lab work based on courses MGM103 & MGM104	Credits: 2
MGM109	Lab work based on courses MGM105 & MGM106	Credits: 2

SEMESTER – II

MGM201: DNA Technology & Genetic Engineering

Credits: 3
Lecture hours

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. Genome editing using CRISPR/Cas9 system	2
10. Applications of Recombinant DNA Technology	4

- 10.1. Crop and live-stock improvement
- 10.2. Gene therapy: somatic and germ line gene therapy
- 10.3. DNA drugs and vaccines

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

MGM202: Bioinformatics and Biotechniques

Credits: 3

Section A: Bioinformatics

Lecture hours

- | | |
|---------------------------------------------------------------------------------------------------------------------------------------------|---|
| 1. Definition and Scope of Bioinformatics | 1 |
| 2. Major Bioinformatics Databases & Resources | 2 |
| 3. Biological Sequence Analysis | 5 |
| 3.1. Sequence Similarity, Homology and Alignment: Pairwise sequence Alignment, Global & Local Alignment, Basic concept of scoring matrices, | |
| 3.2. BLAST and PSI-BLAST tools | |
| 3.3. Multiple sequence alignment and its application | |
| 3.4A primer on computational phylogenetic analysis | |
| 4. Computational Gene Prediction (basic concept) | 1 |
| 5. Protein Structure Bioinformatics: | 4 |
| 5.1. Protein Data Bank (PDB) | |
| 5.2. Schematic representations of protein structure and analysis | |
| 5.3. Protein structure classification database | |
| 5.4. Computational protein structure prediction: Homology Modeling | |

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

Section B: Biotechniques

Lecture hours

1. Basic knowledge of principles and applications of the following microscopy techniques 4
 - 1.1. Light Microscopy
 - 1.2. Dark-field Microscopy
 - 1.3. Phase-contrast Microscopy
 - 1.4. Fluorescence Microscopy
 - 1.5. Confocal Microscopy
 - 1.6. Electron Microscopy
 - 1.7. Photography, Digital imaging and image Processing.
2. Biochemical techniques 8
 - 2.1. Centrifugation: types of rotors, clinical, highspeed and ultracentrifuges
 - 2.2. Colorimetry and spectrophotometry: Beer-Lambert law; absorption spectrum, fluorescence spectrum, introduction to mass spectrometry
 - 2.3. Chromatography: Paper, Thin layer chromatography; Columns: ion-exchange, gel-filtration, HPLC and affinity columns, electrophoresis
 - 2.4. 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.
3. Introduction to nanotechnology. 1
4. Omics 6
 - 4.1. Highthroughput Sequencing technologies: Genomic and transcriptome analysis by NGS
 - 4.2. Metabolomics: Introduction and overview of metabolites, applications of non-tracer and tracer based techniques, application of metabolomics
5. Biosafety 7
 - 5.1 Introduction of bio-safety,
 - 5.2 Biotechnology and bio-safety concerns at the level of individuals, institutions, society, region, country and world with special emphasis on Indian concerns.
 - 5.3 Primary Containment for Biohazards
 - 5.4 Biosafety practices in laboratory: laboratory associated infections and other hazards,
 - 5.4 Assessment of biological hazards and level of biosafety.
 - 5.5 Bio safety regulation: Special procedures for recombinant DNA based product production & handling of rDNA products and process in industry and in institutions (Indian context).
 - 5.6 Roles of Institutional Biosafety Committee

Recommended Books

1. Alberts et al (2008). Molecular Biology of the Cell. Garland
2. Cooper (2007). The Cell: A molecular Approach. ASM Press
3. Locquin and Langeron (1983). Handbook of Microscopy. Butterworths
3. Zubay et al (1995). Principles of Biochemistry. WCB
5. Boyer (1993). Modern Experimental Biochemistry. Benjamin
6. Clark & Switzer (2000). Experimental Biochemistry. Freeman
7. Freifelder (1987). Physical Biochemistry. Freeman
8. Boyer 2007 (2007). Concept of Biochem. 3rd Ed
9. Keith Wilson and John Walker. Principles and Techniques of Biochemistry and Molecular Biology
10. Laboratory Biorisk Management: Biosafety and Biosecurity - CRC Press, Reynolds M. Salerno, Jennifer Gaudio, 2015

11. Biological Safety: Principles And Practices (Biological Safety: Principles & Practices) 4th Edition, by Diane O. Fleming (Editor), Debra L. Hunt (Editor), 2006

MGM203: Model Genetic Systems

Credits: 2
Lecture hours

1. <i>Dictyostelium discoideum</i> :	2
1.1. An overview: life cycle	
1.2. Use of <i>Dictyostelium</i> as a model system	
2. Yeast:	3
2.1. Tetrad analysis, yeast mating type switch	
2.2. Use as a model system to study cell cycle, genetic recombination	
3. <i>Caenorhabditis elegans</i> :	3
3.1. Isolation & identification of mutants	
3.2. Study of cell lineage, apoptosis	
3.3. RNA interference	
4. <i>Drosophila</i> :	7
4.1. Advantages in genetic analysis	
4.2. Nomenclature of gene mutation, Balancer chromosomes	
4.3. Mutagenesis and isolation of new variants	
4.4. Generation of somatic and germline mosaics	
4.5. Targeted overexpression of genes	
4.6. <i>Drosophila</i> genome, online databases and other resources	
4.7. Use of <i>Drosophila</i> as a model organism to study human genetic disorders and for drug screening	
5. Zebrafish:	5
5.1. Isolation and identification of mutants, use of Morpholinos	
5.2. Zebrafish as a model system for the study of human diseases	
5.3. Zebrafish genome and online resources	
6. Mouse:	6
6.1. Relationship between human and mouse chromosomes	
6.7. Advantages to use as a model organism	
6.3. Understanding gene function by transgenic and knockout studies	
6.4. Mouse genome database	
6.5. Humanized mice	

Recommended Books

1. Ashburner (1989). *Drosophila* - A Laboratory Handbook. CSHL Press
2. Hood (1988) The Nematode: *C.elegans*. CSHL Press
3. Gilbert (2010). Developmental Biology. Sinauer
4. Monk (1987). Mammalian Development – A Practical Approach. IRL
5. Wolpert (2007). Principles of Development. Oxford

Suggested Reading

1. www.flybase.org
2. www.zfin.org
3. www.jax.org
4. Research papers

MGM204: Genomic instability and Cancer**Credits: 3****Lecture hours**

1. DNA repair	8
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	8
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 tumorigenesis	12
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.	5
5. Genetic predisposition to sporadic cancer	1
6. Tumour progression: angiogenesis and metastasis	3
7. Tumour specific markers	1
8. Cancer and environment: physical, chemical and biological carcinogens	1

Recommended Books

1. Cowell (2001). Molecular Genetics of Cancer. Bios
2. Ehrlich (2000). DNA Alterations in Cancer. Eaton
3. Gersen & Keagle (1999). Principles of Clinical Cytogenetics. Humana
4. Meesfeld (1999). Applied Molecular Genetics. Wiley-Liss
5. Ptashne (1986). Genetic Switch. Blackwell
6. Stillman (1994). Molecular Genetics of Cancer. CSHL
7. Research papers and Review articles

MGM205: Human Genome**Credits: 3****Lecture hours**

1. The Genome project	8
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	
2. Organization of human genome	8
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	
3. Gene families	8
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	8
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	
5. Functional genomics	5
5.1. Transcriptome and its analysis	
5.2. Proteome and Proteomics	
5.3. Gene silencing	
6. Disease and genomics	2

Recommended Books

1. Strachan and Read (2011). Human Molecular Genetics 4th Ed. Wiley
2. Pasternak (2000). An Introduction to Molecular Human Genetics. Fritzgerald

Suggested Reading

1. Sudbery (2002). Human Molecular Genetics. Prentice Hall
2. Lewin et al. (2009). Lewin's Genes X. Jones & Bartlett Learning, 2009
3. Brown (2007). Genomes. Bios
4. Coleman and Tsongalis (1997). Molecular Diagnosis. Humana
5. Dale & Scharz (2003). From Genes to Genomes. Wiley
6. Hawley and Mori (1999). The Human Genome. Academic

MGM206: Reproductive Genetics

Credits: 2
Lecture hours

1. Male and female reproductive systems	4
1.1 Gonads and differentiation of sexual characters	
1.2 Hormonal regulation of sexual differentiation	
2. Gametogenesis and Embryonic development	6
2.1 Differentiation of germ cells and gametogenesis	
2.2 Fertilization and implantation	
2.3 Stages of human embryonic development	
3. Reproductive disorders	10
3.1 Disorders of gonads, genital tracts and genitalia	
3.1.1 Pseudohermaphroditism	
3.1.2 True hermaphroditism	
3.1.3 Gonadal dysgenesis	
3.1.4 Anomalies of genital ducts	
3.2 Infertility	
3.2.1 Genetic basis of male infertility	
3.2.2 Genetic basis of female infertility	
3.3 Genetics of Pregnancy loss	
3.4 Congenital malformations and teratogenesis	
4. Technologies in reproductive assistance	3
5. Prenatal and pre-implantation diagnosis	2
5.1 Indications for prenatal diagnosis	

- 5.2 Indications for chromosomal testing
- 5.3 Noninvasive methods
- 5.4 Invasive methods
- 6. Legal and ethical considerations 1

Recommended Books

1. Rimon et al (2002) Principles and Practice of Medical Genetics, Vol I-III.
2. Martin H. Johnson & Barry Everitt. Essential reproduction.
3. Ramon Pinon. Biology of Human Reproduction.

Suggested Reading

1. Y.W. Loke and Ashley King. Human Implantation: Cell Biology and Immunology.
2. Jonathan S Berek .Berek and Novak's Gynecology.
3. FG Cunningham. Williams Obstetrics.

MGM207 Lab work based on courses MGM201 & MGM202	Credits: 2
MGM208 Lab work based on courses MGM203 & MGM204	Credits: 2
MGM209 SWAYAM Course	Credits: 2

SEMESTER – III

MGM301: Human Molecular Genetics

Credits: 3
Lecture hours

- | | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 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 | 7 |
| 4.1. Principles and strategies
4.2. Position-independent and positional cloning, Candidate gene approaches, Whole Genome and Exome Sequencing
4.3. Confirming a candidate gene: mutation screening, testing in animal models. | |

5. Molecular pathology	6
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. Strachan & Read (2011). Human Molecular Genetics. Garland Edition. 4th Edition.
2. Pasternak (2005). An Introduction to Molecular Human Genetics. Fritzgerald. 2nd Edition.
3. Mange and Mange (1999). Basic Human Genetics. Sinauer Assoc. 2nd Edition.
4. Lewis (2007). Human Genetics. WCB & McGraw. 7th Edition.
3. Sudbery (2010). Human Molecular Genetics. Prentice-Hall. 3rd Edition.

Suggested Reading

1. Davies (1993). Human Genetic Disease Analysis. 2nd Edition. IRL
2. Haines & Pericak (2006). Approaches to Gene Mapping in Complex Human Diseases. Wiley
3. Nussbaum et al (2015). Genetics in Medicine. Saunders. 8th Edition.
4. Rimoin et al (2013). Principles & Practice of Medical Genetics, Vol I-III. Churchill. 6th edition.

MGM302: Clinical Genetics

Credits: 3
Lecture hours

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	
3. Genome imprinting Syndromes: Prader-Willi & Angelman syndromes, Beckwith-Wiedeman Syndrome	3
4. Neurofibromatosis I	2
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	5
6.1. Overview of Blood cell types and haemoglobin	
6.2. Sickle cell anemia	
6.3. Thalassemias	
6.4. Hemophilias	
7. Disorders of eye	5
7.1. Retinitis pigmentosa	
7.2. Cataract	

7.3. Glaucoma	
7.4. Colour blindness	
8. Multifactorial diseases	4
8.1. Hyperlipidemia	
8.2. Atherosclerosis	
8.3. Diabetes mellitus	
9. Mitochondrial syndromes	
10. Inborn errors of Metabolism and their genetic basis	5
10.1. Phenylketonuria	
10.2. Maple Syrup urine syndrome	
10.3. Mucopolysaccharidosis	
10.4. Galactosemia	
11. Genetic disorders in skeleton and skin	3
12. Management of genetic disorders	2

Recommended Books:

1. Roderick R. McInnes and Huntington F. Willard (2007). Thompson & Thompson Genetics in Medicine.
2. Cox and Sinclair (1997). Molecular Biology in Medicine. Blackwell
3. DeGrouchy and Turleau (1984). Clinical Atlas on Human Chromosomes. Wiley
4. Jankowski and Polak (1996). Clinical Gene Analysis and Manipulation. Cambridge

MGM303: Developmental Genetics

Credits: 3
Lecture hours

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. Genetics of pattern formation	14
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. Genetic determination of sex in <i>Caenorhabditis</i> , <i>Drosophila</i> and mammals	3
6. Epigenetics in development	2

7. Regeneration	2
8. Senescence	2
9. Embryonic stem cells and their applications	2

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 et al. (2009). Lewin's Genes X. Jones & Bartlett Learning, 2009
5. Monk (1987). Mammalian Development – A Practical Approach. IRL
6. Wolpert (2007). Principles of Development. Oxford

MGM304: Immunogenetics		Credits: 3	Lecture hours
1	Biology of the immune system. 1.2 Biology of Immune cells: Dendritic cells monocytes and macrophages, Granulocytes, Natural killer cells, Lymphocytes 1.3 Organs of the immune system		2
2	Innate Immunity, 2.1 Characteristics, components and functions, 2.2 Toll like receptors and other immune receptors. 2.3 Newborn Immunology		3
3	Adaptive Immunity 3.1 Humoral and Cell mediated Immune responses 3.1.1 Antigens 3.1.2 Structure and function of immunoglobulins and T cell receptors 3.4 B and T cell receptors and coreceptors 3.5 Antigen-antibody interactions		3
4.	Basic and advanced Immunological Techniques Principles and modalities of Immunodiffusion techniques, Agglutination, ELISPOT, RIA, ELISA, Western blotting Immunoprecipitation, Immuno-histochemistry, and Flow-cytometry		2
5.	B cell receptor genes (Immunoglobulin) 5.1 Organization of Ig gene loci 5.2 Molecular mechanisms of generation of antibody diversity 5.3 Expression of Ig genes 5.4 Regulation of Ig gene transcription 5.5 Monoclonal Antibody and expression using recombinant DNA technologies		4
6.	T cell receptor genes 6.1 Organization of TCR gene loci 6.2 Generation of TCR diversity		2
7.	The HLA complex 7.1 Organization of HLA complex 7.2 Structure of class I and II HLA molecules		3

7.3 Expression of HLA genes	
7.4 HLA polymorphism	
8 Generation and regulation of immune responses	12
8.1 Antigen processing and presentation	
8.2 MHC-restriction	
8.3 Cytokines	
8.4 T Cell Maturation, activation and differentiation	
8.5 B Cell Generation, Activation and differentiation	
8.6 Clonal selection and immunological memory	
8.7 Complement system	
8.8 Cell mediated cytotoxic responses	
8.9 Regulation of immune responses	
8.10 Regulation of immune responses	
9 Disorders of Human Immune System	4
9.1 Immunological Tolerance and Autoimmune diseases	
9.2 Allergy and hypersensitivity	
9.3 Cytokine-related diseases	
9.4 Immunodeficiencies	
10 Dynamics of the immune response in health and disease	4
10.1 Experimental models,	
10.2 Immunotherapeutics and Drug targeting	
10.3 Vaccines	
10.4 Transplantation immunology	

Recommended Books

1. Janeway&Traver's Immunobiology (2016), Taylor & Francis
2. Abbas et al, Cellular and Molecular Immunology (2017), Saunders
3. Barrett, Text Book of Immunology (1988), Mosloy,
4. Benjamin et al, Immunology – A Short Course(2012), Wiley-Liss
5. Kuby, Immunology (2013), MacMillan,
6. Roitt, Essential Immunology (2017), Blackwell,

MGM305: Population & Evolutionary Genetics

Credits:2

	Lecture hours
1. Concept and theories of evolution	2
2. Microevolution in Mendelian population	4
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	4
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	3
4.1. Adaptive genetic polymorphism	

4.2. Balanced polymorphism and heterosis	
4.3. Genetic coadaptation and linkage disequilibrium	
5. Isolating mechanisms	2
6. Concept of species and modes of speciation: sympatric, allopatric, stasipatric	2
7. Molecular population genetics	2
7.1. Molecular evolution (neutral theory, punctuated equilibrium)	
7.2. DNA-based phylogenetic trees	
8. Nonrandom breeding	2
8.1. Inbreeding and assortative mating	
8.2. Path diagram construction and inbreeding coefficient, allelic identities by descent	
9. Human phylogeny	3
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	2
10.1. Hierarchical population structure	
10.2. Isolate breaking: The Wahlund principle	

Recommended Books

1. Hartl & Clark (1997). Principles of Population Genetics. Sinaur
2. Hartl and Jones (1998). Genetics. Principles and Analysis. Jones and Bartlett
3. Hoelzel (1998). Molecular Genetic Analysis of Populations. Oxford Univ

Suggested Reading

1. Brown (2007). Genomes. Bios
2. Jobling et al (2004). Human Evolutionary Genetics. Garland
3. Moody (1964). Evolution. Harper and Row
4. Roberts & DeStefano (1986). Genetic Variation and its Maintenance. Cambridge Univ
5. Smith (1998). Evolutionary Genetics. Oxford
6. Strickberger (2000). Evolution. Jones and Barlett

MGM306	Lab work based on courses MGM301 & MGM302	Credits: 2
MGM307	Lab work based on courses MGM303 & MGM304	Credits: 2
MGM308	SWAYAM Course	Credits: 2

SEMESTER – IV

MGM401: Neurogenetics

Credits: 3
Lecture hours

1. Nervous system	10
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.	
1.5 Neurotransmitters	
2.Genetic Aspect of Learning and memory	7
2.1. Classification of different types of memory	
2.2. Models for understanding learning and memory	
2.3. Molecular basis of short time and long time sensitization	
3.Circadian rhythms	6
3.1. Invertebrates (Drosophila)	
3.2. Mammals	
3.3. Clinical Implication	
4.Neurogenetic disorders	5
4.1. Syndromes due to triplet nucleotide expansion	
4.2.Alzheimers disease	
4.3.Parkinsons disease	
5.Nature-nurture and behaviour	5
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.Syntenly/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. Genetics of Psychiatric dieases	6
6.1. Schizophrenia	
6.2. Mood disorders	
6.3. Disorders of childhood.	

Recommended Books

- 1.Kaplan and Sadock (2014). Synopsis of Psychiatry.Williams & Wilkins. 11th Edition.
2. Plomin et al (2012). Behavioral Genetics. Worth. 6th Edition.
- 3.Zigmond, Bloom et al., (2012). Fundamentals Neuroscience. Academic Press. 4th Edition.
- 4.Kandel, Schwartz et al. (2012). Principles of Neuroscience.McGraw Hill. 5th Edition.
5. Anholt and Mackay (2010). Principles of Behavioural Genetics.Elsevier Press.

Suggested Reading

- 1.Pasternak (2005). An Introduction to Molecular Human Genetics.Fritzgarald. 2nd Edition.
2. Griffiths et al., (2015) Introduction to Genetic Analysis. Freeman. 11th Edition.

3. Cox and Sinclair (1997). Molecular Biology in Medicine. Blackwell. 1st Edition.
4. Rasko and Downes (1995). Genes in Medicine. Kluwer
5. Rimoin et al (2013). Principles & Practice of Medical Genetics, vol I-III. Churchill. 6th Edition.
6. Robinson and Linden (1994). Clinical Genetics Handbook. Blackwell
7. Strachan and Read (2011). Human Molecular Genetics. Wiley. 4th Edition.
8. Wilson (2000). Clinical Genetics: A Short Course. Wiley-Liss. 1st Edition.

MGM402: Genetic counseling & Intellectual Property Rights

Credits: 2

Section A: Genetic counseling

	Lecture hours
1. Historical overview of genetic counseling	2
1.1. Models of Eugenic, Medical/Preventive, Decision making, Psychotherapeutic counseling; current definition and goals	
1.2. Philosophy and ethos of genetic services and counseling	
2. Components of genetic counseling	4
2.1. Indications and purpose	
2.2. Information gathering and construction of pedigrees	
2.3. Medical Genetic evaluation	
2.3.1. Basic components of Medical History	
2.3.2. Past medical history, social & family history	
2.4. Physical examination.	
2.4.1. General and dysmorphology examination	
2.4.2. Documentation	
3. Patterns of inheritance, risk assessment and counseling in common Mendelian and multifactorial disorders	3
4. Biochemical and Molecular genetic tests	2
4.1. In Children	
4.2. Presymptomatic testing for late onset diseases (predictive medicine)	
5. Bioethics in research	2
5.1. Bioethics in cloning and stem cell research	
5.2. Bioethics in human and animal experimentation, animal rights/welfare	

Recommended Books

1. Baker et al (1998). A Guide to Genetic Counseling. Wiley
2. Harper (2001). Practical Genetic Counseling. Arnold
3. Rose & Lucassen (1999). Practical genetics of primary care. Oxford
4. Young (1999). Introduction to Risk Calculation in Genetic Counseling. Oxford

Section B: Intellectual Property Rights

	Lecture hours
1. Introduction	3
1.1 Meaning, Relevance, Business Impact, Protection of Intellectual Property	
1.2 Copyrights, Trademarks, Patents, Designs, Utility Models, Trade Secrets and Geographical Indications	
1.3 Bio-diversity and IPR	
1.4 Competing Rationales for Protection of Intellectual Property Rights	

- 1.5 Introduction to the leading International Instruments concerning Intellectual Property Rights: the Berne Convention, Universal Copyright Convention, The Paris Convention, Patent Co-operation Treaty, TRIPS, The World Intellectual Property Organization (WIPO) and the UNESCO
2. Patents 7
- 2.1 Concept of Patent
- 2.2 Product / Process Patents & Terminology
- 2.3 Duration of Patents- Law and Policy Consideration Elements of Patentability,- Novelty and Non Obviousness (Inventive Steps and Industrial Application, Non- Patentable Subject Matter
- 2.4 Procedure for Filing of Patent Application and types of Applications
- 2.5 Procedure for Opposition,
- 2.6 Revocation of Patents
- 2.7 Ownership and Maintenance of Patents
- 2.8 Assignment and licensing of Patents
- 2.9 Working of Patents- Compulsory Licensing
- 2.10 Patent Agent- Qualification and Registration Procedure
3. Patent Databases & Patent Information System 3
- 3.1 Patent Offices in India
- 3.2 Importance of Patent Information in Business Development
- 3.3 Patent search through Internet, Patent Databases

Recommended Books

1. IPR Biosafety & Bioethics by DeepaGoel and ShominiParashar, 2013
 2. Essentials of Licensing Intellectual Property by Alexander I. Poltorak and Paul J. Lerner, wiley publisher, 2002
 3. How to Invent and Protect Your Inventionby Joseph P. Kennedy Sr. and Wayne H. Watkins, Wiley publisher, 2012
- Patents for Chemicals, Pharmaceuticals and Biotechnology, by Phillip W Grubb, 2016

MGM 403: Lab work based on course MGM401

Credit: 1

MGM404: Seminar & Formulation of Research Project

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. Each student will formulate a research proposal and present the proposal before the panel of examiners.

MGM405: Comprehensive Viva-voce

Credits: 2

The understanding of the whole course content from semester-I through semester-IV will be assessed through a comprehensive viva-voce examination.

MGM406: Dissertation

Credits: 6

Each student will undertake an experimental project under supervision of one of the teachers during Semester-IV 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.