



MGM INSTITUTE OF HEALTH SCIENCES

(Deemed to be University u/s 3 of UGC Act, 1956)

Grade 'A' Accredited by NAAC

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Curriculum for M.Sc. Medical Genetics

Amended as per BOM-55/2018, Dated 27/11/2018

Amended History

1. Approved as per BOM- 23/2018, Item No 4, Dated 30/03/2012.
2. Approved as per BOM -45/2016 [Resolution No. 3.6(I)], Dated 11/08/2016.
3. As amended in BOM-55/2018, [Resolution No.4.13], Dated 27/11/2018.

Syllabus for Two-Year**MASTER OF SCIENCE (M. Sc.) MEDICAL GENETICS SYLLABUS**

DURATION: Four Semesters (Two Years)

Module/ Semester	Theory/ Practical	Theory/ Practical	Theory/ Practical	Theory/ Practical
I Semester	Molecular Cell Biology	Biochemical Genetics	Immunology, Immunotechnology & Immunogenetics	Biostatistics and Research Methodology & Scientific Writing
II Semester	Analytical Instrumentation	Bioinformatics	Molecular Biology	Recombinant DNA Technology
III Semester	Principles of Genetics and Population Genetics	Clinical Genetics, Genetic Counseling & Prenatal Diagnosis	Cancer Genetics & Pharmacogenomics	Developmental & Environmental Genetics
IV Semester	Biosafety, Introduction to quality assurance, accreditation & SOP writing	PROJECT		

INTRODUCTION TO THE CURRICULUM

This curriculum is developed for the course leading to the award of M.Sc degree in Medical Biotechnology. This manual is provided to assist you in integrating important elements of the content with the selection of effective teaching strategies.

The curriculum is presented in three main sections:

CORE CURRICULUM: These modules are defined as **essential base** information about Biotechnology that all post graduate professionals need to know

SEMESTER-1		Lecturers (Hrs)	Practicals (Hrs)
Module-1	Molecular Cell Biology (Theory & Practical)	30	50
Module-2	Biochemical Genetics(Theory and Practical)	40	60
Module-3	Immunology, Immunotechnology & Immunogenetics (Theory and Practical)	30	50
Module-4	Biostatistics & research methodology(Theory & Practical)	40	30
	Evaluation	30	30
	Seminars : LCD, tutorial, Group discussion	190	-
	Semester total hours	360	220*
SEMESTER II			
Module-5	Analytical Instrumentation (Theory & Practical)	30	35
Module-6	Bioinformatics, Research Methodology & Scientific Writing (Theory & Practical)	30	35
Module-7	Molecular Biology	45	80
Module-8	Recombinant DNA Technology (Theory & Practical)	40	80
	Evaluation	30	30
	Seminars : LCD, tutorial, Group discussion	190	
	Semester total hours	365	260

SEMESTER III			
Module-9	Principles of Genetics and Population Genetics (Theory & Practical)	50	80
Module-10	Clinical Genetics, Genetic Counseling and Prenatal Diagnosis (Theory & Practical)	50	80
Module-11	Cancer Genetics & Pharmacogenomics (Theory & Practical)	60	100
Module-12	Developmental Genetics & Environmental Genetics	50	40
	Evaluation	30	30
	Seminars : LCD, tutorial, Group discussion	100	
	Semester total hours	340	330
SEMESTER IV			
Module-13	Biosafety, Introduction to quality assurance, accreditation & SOP writing	40	
Module-14	DISSERTATION CURRICULUM: An interdisciplinary module has been developed for selection of relevant dissertation work.	400	
		440	

TABLE OF CONTENTS**MODULE 1: MOLECULAR CELL BIOLOGY: THEORY**

UNIT	TOPIC
1	<i>Cytology:</i> Development history of cytology. Cell – basic unit of life: Structure and function of cell, Prokaryotic & Eukaryotic cell, Structure and function of various cells such as Viruses, Bacteria, Animals, Pancreatic islets, Neurons, Muscle cells, Tissues & their composition
2	<i>Concept of Cyto-receptors:</i> Function of membrane receptors. Methods of introduction of substances to cells: endo and exocytosis, pinocytosis, phagocytosis. Mechanism of transport substances through membrane: diffusion, osmosis, ion channels, active and passive transport, ion pumps.
3	<i>Structural organization and mechanism of sorting and regulation</i> of intracellular transport, electrical properties of membranes: Cell wall, nucleus, Mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, structure & function of cytoskeleton and its role in motility.
4	<i>Cell signaling:</i> Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, and regulation of signaling pathways
5.	<i>Cellular communication:</i> General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, desmosomes, tight junction, extracellular matrix, integrins, neurotransmission and its regulation
6.	<i>Pathogenecity of cell :</i> Living cells Vs dead cell, Necrotic Vs pycnotic death, Prgrammed cell death, Regeneration of cell
7.	<i>Differentiating Cells :</i> Sperms, Oocytes, Blood cells
8.	<i>Stem cells (Basics):</i> Adult stem cell, Umbilical stem cell (UCB). Embryonic stem cell

CELL BIOLOGY PRACTICALS

SESSION	TOPIC
1	Sterilization techniques (Wet and Dry Sterilization, Chemical sterilization and Ultrafiltration.
2	Microscopy
3	Cell counting (using Haemocytometer) a) WBC- Differential Staining b) Total Count
4	RBC osmotic fragility
5	Cell Viability Assay- (using Typhan blue Stain)
6	Preparation of monolayer cell
7	Preparation of microbial, animal for microscopic observation (anucleated and nucleated cells)
8	Osmosis , exosmosis and endosmosis
9	Fixation of cells & different fixatives
10	Microtomy

Reference Books:

1. Cell and Molecular biology, Gerald Karp, John Wiley and sons Inc
2. Cell Biology by C.B. Powar.
3. Cell and Molecular Biology; DeRobertis; Lippincott Williams & Wilkins 8th Edition (2001)
4. Molecular Biology of the Cell and the Hypercell with CDROM; Alberts, Bray; Garland Publishing 1st Edition (1999)
5. Molecular Biology of the Cell with CDROM Alberts, Bruce; Johnson, Alexander; Lewis, Julian 4th Edition (2005).
6. Molecular Cell Biology, H. Lodish, A. Berk, S. L. Zipursky, W. H. Freeman and Company

MODULE 2: BIOCHEMICAL GENETICS

UNIT	TOPIC
1	<i>Error in enzyme synthesis: Genetic disorders</i> Phenylketoneurea, Diagnosis, Heterogeneity, Mutational basis, Maternal Phenylketoneurea, Treatment Alkaptonurea, Occulocutaneous albinism Homocystinurea, Disorders amino acid metabolism, Maple syrup urine disease, Urea cycle disorders.
2	<i>Carbohydrate metabolism disorders</i> Monosaccharide metabolism galctosemia and hereditary fructose intolerance, Glycogen storage disorders affecting primarily liver muscle, Disorders of steroid metabolism, Congenital adrenal hyperplasia, Androgen insensitivity syndrome.
3	<i>Lipid metabolism disorders</i> Familial hypercholesterolemia, Lysosomal storage disorders, Muvopolysaccharides, Hurler, Hunter, Lipid storage disease, Tay Sachs disease Gaucher, Niemann-Pick disease.
4	<i>Purine pyrimidine disorders</i> Lesch-Nyhan, Immunodeficiency diseases due to defect in purine metabolism, Adenosine deaminase deficiency, Hereditary orotic aciduria.
5	<i>Disorders of porphyrin metabolism</i> Hepatic, Erythropoietic, Organic acid disorders, Copper metabolism disorders, Menkes, Wilson disease, Peroxisomal disorders, Zellweger syndrome, Adrenoleukodystrophy.
6	<i>Disorders function affecting mitochondrial</i> Myoclonic epilepsy and ragged red fiber disease, Disorders of mitochondrial fatty acid oxidation, Glutaric acidurease, Prenatal diagnosis of inborn errors of metabolism.

BIOCHEMICAL GENETICS PRACTICALS

SESSION	TOPIC
1	Determination of serum total protein, albumin and A/G ratio
2	Estimation of total serum creatinine
3	Estimation of serum cholesterol
4	Estimation of S.G.P.T. (ALT)
5	Estimation of S.G.O.T. (AST)
6	Estimation of serum alkaline phosphatase

7	Estimation of serum acid phosphatase
8	Estimation of serum amylase
9	C.S.F. - sugar and protein.
10	Serum uric acid.

Reference Books:

1. Principles of Gene Manipulations; S. B. Primrose, R. M. Twyman, R. W. Old, Blackwell Science, 6th Edition (2003).
2. Gene VIII; Benjamin Lewin; Oxford Univ. Press, 8th edition (2004)
3. Thompson & Thompson
4. Emery's

MODULE 3: IMMUNOLOGY, IMMUNOTECHNOLOGY & IMMUNOGENETICS

UNIT	TOPIC
1	<i>Introduction to immune system:</i> Innate and adaptive immunity; Cells and organs of the immune system; Primary and secondary immune responses; Antigens; Antibodies and T cell receptors: Antigens, Structure and function of immunoglobulins, Monoclonal antibodies, B and T cell receptors and co-receptors
2	<i>Generation and regulation of immune responses:</i> Antigen processing and presentation; MHC-restriction; Cytokines; T Cell Maturation, activation and differentiation; B Cell Generation, activation and differentiation; Clonal selection and immunological memory; Complement system; Leukocyte activation and migration; Cell mediated cytotoxic responses; Regulation of immune responses; Immunological tolerance
3	<i>Antigen-antibody Reaction:</i> Strength of Antigen-Antibody Reactions (Antibody Affinity, Avidity and Cross Reactivity), In Vivo Antigen-Antibody Reactions, In Vitro Antigen-Antibody Reactions <ul style="list-style-type: none"> ➤ Precipitation (In Fluid and In Gel Immunoelectrophoresis), ➤ Agglutination (Heamagglutination, Bacterial agglutination, Passive agglutination and Agglutination Inhibition). ➤ Radioimmuno Assay (RIA) ➤ Enzyme Linked Immunosorbant Assay (ELISA), ➤ Western Blot ➤ Immuno Fluorescence
4	<i>Disorders of Human Immune System:</i> Primary and secondary immunodeficiencies; Autoimmune disorders; Hypersensitive reactions; Cytokine related diseases

IMMUNOLOGY & IMMUNOTECHNOLOGY PRACTICALS

SESSION	TOPIC
1	Blood film preparation and identification of cells
2	Lymphoid organs and their microscopic organization

3	Immunization, Collection of Serum
4	To test the pattern of antigen-antibody interaction through Ouchterlony double diffusion assay
5	Radio Immune diffusion
6	Purification of IgG from serum
7	Separation of mononuclear cells by Ficoll-Hypaque
8	Western-blotting
9	To detect the presence of antigen/antibody using Enzyme Linked ImmunoSorbent Assay (ELISA).
10	VDRL test
11	Immunodiagnosics (demonstration using commercial kits)
12	Blood group typing using haemagglutination tests.
13	Estimation of hemoglobin content in blood
14	Isolation, purification and identification of immunoglobulin from blood

Reference Books:

1. Essential Immunology: Ivan Roitt.
2. Kuby Immunology: Goldsby, Kindt and Osborne.
3. Immunology: Roitt, Brostoff, Mole.
4. Introductory Immunology : Huw Davies

MODULE 4: BIOSTATISTICS (THEORY)

UNIT	TOPIC
1	<i>Definitions and scope of Biostatistics</i> : Variable in biology, collection, classification and tabulation of data. Graphical and diagrammatic representation, histogram, frequency polygon, frequency curve.
2	<i>Descriptive statistics</i> : Measures of central tendency – Mean (arithmetic, harmonic and Geometric), Median and Mode. Measures of dispersion – Standard deviation and Standard errors
3.	<i>Basic idea of significance test</i> : Statistical hypotheses, types of errors, level of Significance, Student's t, chi-square, goodness of fit and F tests. Correlation and Regression Analysis- concepts and applications. Probability : Basic concepts, Basic theorems of probability- addition and multiplication theorems Conditional probability, Probability distribution-definition & applications
4.	Computational Techniques for understating above three units like Met Lab, SPSS and SAS
5	Research Methodology & Scientific Writing: Building the foundation of research, Choosing appropriate subject, Narrowing subject into topic, Writing thesis statements Managing the project; How to allow time efficiently, Creating a Schedule Researching the material (Making bibliography cards), Summarizing research material, Documentation style (DPA & MS), Preparing "Works Cited", "References" pages, Writing thesis Writing a research paper

BIOSTATISTICS & COMPUTER APPLICATIONS PRACTICALS

1	Use of INTERNET and WWW
2	Medline, Medline Search
3	Usage of statistics for data analysis
4	To develop and design case studies according to Medical Cases with the help of statistical methods. (Minimum 10)

Reference Books:

1. D. H. Sanders Computers Today. Mc. Graw-Hill. Book Company.
2. J. Peek, G. Todino & J. Straug Learning the unix operating system. O'Reilly Associates.
3. S. C. Gupta. Fundamentals of Statistics. Himalaya Pub. House.
4. J. Medhi. Statistical Methods An introductory text. New Age International (P) Ltd. Publishers.
5. P. S. S. Sudar Rao & J. Richard. An introduction to biostatistics. Prentice Hall of India. N. Delhi.
6. Fundamentals of mathematical Statistics.
7. Fundamentals of Applied I Statistics.
8. Statistical Method.
9. Probability and Random Proc

MODULE 5: ANALYTICAL TECHNIQUES: PRINCIPLES AND INSTRUMENTATION

UNIT	TOPIC
1	<i>Chromatography</i> : Basic Principles <i>Types</i> : Adsorption chromatography, Partition chromatography , Liquid chromatography, Gas-liquid chromatography, Ion-exchange chromatography, Affinity chromatography, HPLC <i>Applications of chromatographic techniques in biology</i>
2	<i>Spectroscopy</i> : Interaction of radiation with matter, absorption of radiation, emission of radiation Beer-Lambert relationship, Components of spectrophotometer, Types of detectors <i>Types</i> : UV-Vis Spectrophotometry, Fluorimetric methods, Atomic absorption spectroscopy Flame photometry, Magnetic resonance spectroscopy <i>Applications of different spectroscopic techniques</i>
3	<i>Electrophoresis</i> : Factors affecting electrophoresis <i>Types</i> : Vertical, submarine and gradient electrophoresis , Isoelectric focusing, Capillary electrophoresis, Immuno-electrophoresis <i>Applications of electrophoresis in biology</i> <i>Centrifugation</i> : Preparative and analytical centrifuges; RCF, zonal, equilibrium and density gradients
4	<i>Radioisotopes</i> : Nature of radioactivity, types of radioactive decay, unit of radioactivity. Detection and measurement of radioactivity. Geiger counter, scintillation counters, autoradiography Applications of isotopes in biology (tracers, radio immunoassay)
5	Flow cytometry, DNA sequencing; PCR, DNA microarray, Proteomics, Nanotechnology

INSTRUMENTATION PRACTICALS

1	Practical based on Centrifugation
2	Practical based on Spectrophotometer
3	Practical based on Chromatography
4	Practical based on Electrophoresis

Reference Books:

1. Instrumental methods of chemical analysis. B.K. Sharma, Goel Publishing House, 25th edition
2. Principles and techniques of biochemistry and molecular biology, Wilson and Walker, Cambridge University Press, 6th edition
3. Instrumental methods of chemical analysis, Chatwal and Anand, Himalaya Publishing House, 5th Edition
4. Tools and techniques of biotechnology, Mousumi Debnath, Pointer Publishers, 1st edition
5. Biophysical chemistry-Principles and techniques, Upadhyay; Upadhyay and Nath, H Himalaya Publishing House, 3rd Edition
6. Physical biochemistry- applications to biochemistry and molecular biology, David Freifelder, Freeman and Co., 2nd edition.

MODULE 6: BIOINFORMATICS, RESEARCH METHODOLOGY & SCIENTIFIC WRITING (THEORY)

UNIT	TOPIC
1	<p><i>Introduction to Genomic data and Data Organization:</i> <i>Sequence Data Banks</i> – Introduction to sequence data banks – <i>Protein sequence data bank</i>. NBRF-PIR, SWISSPROT, Signal peptide data bank, <i>Nucleic acid sequence data bank</i> – GenBank, EMBL nucleotide sequence data bank, AIDS virus sequence data bank, <i>Structural data banks</i> – protein Data Bank (PDB), The Cambridge Structural Database (CSD) : Genome data bank – Metabolic path way data : Microbial and Cellular Data Banks.</p>
2	<p><i>Sequence analysis:</i> Analysis Tools for Sequence Data Banks; Pair wise alignment - NEEDLEMAN and Wunsch algorithm, Smith Waterman, BLAST, FASTA algorithms to analyze sequence data: Sequence patterns motifs and profiles.</p>
3	<p><i>Secondary Structure predictions;</i> prediction algorithms; Chao-Fasman algorithm, Hidden-Markov model, Neural Networking. <i>Tertiary Structure predictions;</i> prediction algorithms; Chao-Fasman algorithm, Hidden-Markov model, Neural Networking</p>
4	<p>Applications in Biotechnology: Primer Designing, Phylogenetic Tree Analysis with Mammalian and Bacterial 9-10 specific genes, development of specific case studies of that.</p>
5	<p>Protein classifications, Fold libraries, Protein structure prediction: Fold recognition (threading), Protein structure predictions: Comparative modeling (Homology), Advanced topics: Protein folding, Protein ligand interactions, Molecular Modeling & Dynamics, Drug Designing</p>

BIOINFORMATICS PRACTICALS

SESSION	TOPIC
1	Searching protein sequences related to an unknown sequence
2	Finding the secondary structure of an unknown sequence
3	Using BLAST
4	Using Clustal W
5	Finding the tertiary structure of an unknown sequence
6	Programmes related to graphics and animation, RASMOL, MOLMOL, MX VRML etc
7.	Visualization, characterization and annotation of unknown gene and proteins.

Reference Books:

1. Introduction to Bioinformatics – Teresa Atwood and David J. Parry, Pearson smith publication (2003)
2. Introduction to Bioinformatics – lesk, Oxford press (2003)
3. Fundamental Concepts of Bioinformatics - Dan E. Krane, Michael L. Raymer, Pearson education (2004)
4. Sequence structure and Database – Des Higgins, Willice Taylor, oxford press (2003)
5. Bioinformatics: Sequence and Genome analysis by David W. Mount CBS Publishers & Distributors, 2004 reprint
6. Bioinformatics: Sequence, Structure and Databanks A Practical Approach, Higgins, ISBN: 0195667530, I.K. International Publishing House Pvt. Ltd
7. Bioinformatics: Theory and Practice, Chikhale NJ and Gomase VS,b ISBN:978-81-8318-831-9, Himalaya Publication House
8. Proteomics: Theory and Practice, Gomase VS and Chikhale NJ, Himalaya Publication House
9. Discovering Genomics, Proteomics and Bioinformatics, Campbell, ISBN: 9788131715598, Pearson Education
10. Bioinformatics: Databases, Tools, and Algorithms, Orpita Bosu, Simminder Kaur, Thukral , ISBN: 9780195676839, Oxford University Press

MODULE7: MOLECULAR BIOLOGY (THEORY)

UNIT	TOPIC
1	<i>Structure of Nucleic Acid:</i> DNA, RNA, mRNA, tRNA, rRNA, Denaturation and Renaturation of DNA, T _m ; GC content from T _m , Renaturation kinetics of DNA and complexity of DNA, Cot curves Satellite DNA: Repetitive DNA, SNP, STR,
2	<i>DNA Replication:</i> Prokaryotic and eukaryotic DNA replication, Mechanism of DNA replication, Enzymes and accessory proteins involved in DNA replication. DNA Damage & Repair.
3	<i>Transcription</i> Prokaryotic transcription, Eukaryotic transcription, RNA polymerases, General and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, 5'-Cap formation, Transcription termination, 3'-end processing and polyadenylation, Post-transcriptional gene silencing
4	<i>RNA splicing</i> Nuclear splicing, splice some and small nuclear RNAs, group I and group II introns, <i>Cis</i> - and <i>Trans</i> -splicing reactions, tRNA splicing, alternate splicing.
5	<i>Translation</i> Prokaryotic and eukaryotic translation: Synthesis of aminoacyl tRNA, aminoacyl synthetases, Mechanism of initiation, elongation and termination, Regulation of translation, co- and post-translational modifications of proteins
6	<i>Regulation of gene expression</i> Induction and repression, operon theory, lac operon, trp operon, ara operon, attenuation, positive and negative control, catabolite repression, regulation of transcription by cAMP and CRP

MOLECULAR BIOLOGY PRACTICALS

SESSION	TOPIC
1	DNA extraction from blood - Manual Method
2	Isolation of RNA

3	Purification and Concentration of the DNA/RNA- Spectrophotometer
4	Estimation of DNA by Chemical Means- Diphenyl amine method
5	Estimation of RNA by Chemical Means- Orcinol Method
6	Isolation of plasmid DNA- Kit Based Method
7	Isolation of nucleic acids from the given sample and determination of the DNA and RNA content.
8	PCR based diagnosis of diseases

Reference Books:

- 1) Molecular Biology; David Freifelder, Narosa Publishing House, 2nd edition (2004)
- 2) Microbial Genetics; David Freifelder, Narosa Publishing House, 2nd edition (2004)
- 3) Principles of Gene Manipulations; S. B. Primrose, R. M. Twyman, R. W. Old, Blackwell Science, 6th Edition (2003).
- 4) Gene VIII; Benjamin Lewin; Oxford Univ. Press, 8th edition (2004)
- 5) Advanced Molecular Biology; R. M. Twyman, 1st Edition, (2003)
- 6) Instant Notes on Molecular Biology; P.C. Turner, A. G. Mclellan, A. D. Bates & M. R. H. White, 2nd Edition (2002)

MODULE 8: RECOMBINANT DNA TECHNOLOGY (THEORY)

UNIT	TOPIC
1	<i>Enzymes used in DNA technology:</i> Restriction and modification enzymes, Other nucleases, Polymerases, ligases, kinases and phosphatases. Cloning vectors: plasmids, phages, cosmids, artificial chromosomes, shuttle vectors, expression vectors.
2	<i>DNA transactions in Microbes:</i> Transformation, transduction and conjugation. Construction of libraries; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries
3	<i>Screening and characterization of clones:</i> preparation of probes, Principles of hybridizations and hybridization based techniques (colony, plaque, Southern, Northern western and in situ hybridizations, chromosomal walk), Expression based screening, Interaction based screening: yeast two-hybrid system <i>Mutagenesis:</i> site directed mutagenesis, transposon mutagenesis, construction and knock out mutations
4	<i>PCR and Its Applications</i> Primer design; Fidelity of thermos table enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; PCR in gene recombination; Deletion; addition; Overlap extension; and Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)
5	<i>Sequencing methods; Enzymatic DNA sequencing;</i> Chemical sequencing of DNA; Automated DNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Gene transfer techniques; Electroporation and microinjection, Transfection of cells: Principles and methods <i>Gene silencing techniques;</i> Introduction to siRNA; siRNA technology; Micro RNA; Principle and application of gene silencing; <i>Gene knockouts and Gene Therapy;</i> Creation of knock out mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

RECOMBINANT DNA TECHNOLOGY PRACTICALS

SESSION	TOPIC
1	Making the bacterial cells competent
2	Transformation of <i>E. coli</i> .
3	<i>In vitro</i> DNA ligation
4	Bacterial conjugation
5	DNA blotting technique Northern blotting technique & Southern blotting
6	RFLP technique
7	PCR analysis of DNA fragments by agarose gel electrophoresis

Reference Books:

1. Recombinant DNA: Watson et. al.
2. Genetic engineering : Sandya Mitra
3. Principles of gene manipulation : Old & Primrose
4. Molecular Biology Lab fax I & II : T. A. Brown
5. Genetic Engineering and its applications. (2004) 2/e, Joshi. P: Agrobios, India
6. Gene Cloning and DNA analysis: An introduction, (2006) 5/e . T. A. Brown, Black Well Publishing Company.
7. Principles of Gene Manipulation; S. B. Primrose, R. M. Twyman & R. W. old; Blackwell Science, 6th Edition (2001).
8. Essential Molecular Biology (volume I) Practical Approach; Edited By T. A. Brown; Oxford University Press, 2nd Edition (2001).
9. Molecular Cloning lab manual; Joseph Sambrook, David W. Russell, cold Spring Harbor Laboratory Press, 3rd Edition (2001)

MODULE 9: PRINCIPLES OF GENETICS & POPULATION GENETICS

UNIT	TOPIC
1	<i>Introduction to Genetics Mendelism:</i> Mendel and his experiments, Law of segregate, Law of independent assortment, Application of laws of probability (product rule, sum rule), Chromosomal basis of segregation and independent assortment. Chi-square test and its application in analysis of genetic data
2	<i>Extensions of Mendelism:</i> Allelic variation and gene function-Dominance relationships, basis of dominant and recessive mutations, Multiple alleles, allelic series, <i>Testing gene mutations for alleles:</i> complementation test, intragenic complementation <i>Genotype to phenotype:</i> effect of the environment on phenotype development- Penetrance and expressivity, Visible, sterile and lethal mutations, Gene interactions and modifying genes, Pleiotropy, Pedigree analysis – Symbols of Pedigree, Pedigrees of Sex-linked & Autosomal (dominant & recessive),
3	<i>Microevolution in Mendelian population:</i> Hardy-Weinberg method & its applications – calculating allelic frequencies, assumptions of Hardy-Weinberg equilibrium, proof of Hardy-Weinberg equilibrium, Generation time, testing for fit to Hardy-Weinberg equilibrium <i>Elemental forces of evolution;</i> Mutation, Selection (Types of selection, selection coefficient, selection in natural populations), Genetic drift , Migration
	<i>Linkage & Crossing over</i> - Chromosome theory of Linkage, kinds of linkage, linkage groups, types of Crossing over, mechanism of Meiotic Crossing over, kinds of Crossing over, theories about the mechanism of Crossing over, cytological detection of Crossing over, significance of Crossing over.
4	<i>Genetic mapping of Mendelian traits:</i> Identifying recombinants and non recombinants in pedigrees. Genetic and physical map distances, Genetic markers, Two-point mapping- LOD score analysis, Multipoint mapping, Homozygosity map

PRINCIPLES OF GENETICS & POPULATION GENETICS PRATICALS

SESSION	TOPIC
1	Problems based on linkage
2	Problems based on multiple alleles
3	Problems based on epitasis
4	Problems based on sex-linked inheritance

MODULE 10: CLINICAL GENETICS & GENETIC COUNSELING

UNIT	TOPIC
1	<i>Chromosomal anomalies Numerical, Structural</i> , Meiosis in inversion and translocation heterozygotes; breakage-fusion-bridge cycles Induced chromosomal aberrations in somatic cells Sister chromatid exchanges and somatic crossing over
2	<i>Genetics in Medical Practice</i> : Genetic Principles and their application in medical practice; Case studies (Interacting with patients, learning family history and drawing pedigree chart); Syndromes and disorders: Definition and their genetic basis Molecular pathology of monogenic diseases: Cystic fibrosis, Tay Sach's Syndrome & Marfan Syndrome; Genetics of diseases due to Inborn errors of metabolism: Phenylketonuria, Galactosemia & Mucopolysaccharidosis
3	<i>Genetics of Neurogenetic disorders</i> : Charcot-Marie tooth syndrome, Spino-muscular atrophy, Alzheimer's disease & Syndromes due to triplet nucleotide expansion; Genetic basis of muscle disorders: Dystrophies (Duchenne Muscular dystrophy and Becker Muscular Dystrophy), Myotonias & Myopathies; Genetic disorders of Haemopoietic systems: Overview of hematopoiesis, Blood cell types and haemoglobin, Sickle cell anemia, Thalassemias & Hemophilia.
4	<i>Genetic basis of eye disorders</i> : Colour Blindness, Retinitis pigmentosa, Glaucoma & Cataracts; Genetics of skeleton & skin disorders; Genetics of Syndromes & Genomic Imprinting: Neurofibromatosis I, Prader-Willi & Angelman syndromes, Beckwith-Wiedeman syndrome
5	<i>Complex polygenic syndromes</i> : Hyperlipidemia, Atherosclerosis, Diabetes mellitus ; <i>Mitochondrial syndromes</i> ; Management of genetic disorders
6	<i>Genetic counseling</i> : Historical overview (philosophy & ethos) and Components of genetic counseling: Indications for and purpose; Information gathering and construction of pedigrees; Medical Genetic evaluation (Basic components of Medical History, Past medical history, social & family history). <i>Components of genetic counseling</i> : Physical examination (General and dys morphology examination, Documentation), Legal and ethical considerations; Patterns of inheritance, risk assessment and counseling in common Mendelian and multifactor syndromes;
7	<i>Prenatal and Preimplantation screening and diagnosis</i> : Indications for prenatal diagnosis, Indications for Prenatal Diagnosis Genetic testing: biochemical & molecular tests in children, Presymptomatic testing for late onset diseases (predictive medicine) Noninvasive methods (Ultrasound, Endoscopy, MRI, Maternal Serum Screening for Down's syndrome & Neural tube defect, Fetal Blood Sampling, etc.) Invasive methods; Amniocentesis, Chorionic Villi Sampling Ethical issues in pre-natal screening & diagnosis.

CLINICAL GENETICS & GENETIC COUNSELING PRATICALS

SESSION	TOPIC
1	Lymphocyte culture and chromosome analysis- <ul style="list-style-type: none"> • Culture set up • Harvesting • G-banding
2	Identification of chromosomal abnormalities using banding technique.
3	Preparation of pedigree on case based study
4	Case based genetic counseling
5	Case based genetic diagnosis(General laboratory organization of prenatal Diagnosis)
6	Determination of Sex based on barr body analysis.
7	PCR Diagnostics in relation to Chromosomal abnormalities
8	Real Time PCR Technique

References Books

1. Baker et al, A Guide to Genetic Counseling, Wiley-Liss. 1998.
2. Pastemak, an Introduction to Molecular Human Genetics: Mechanisms of Inherited Diseases, 2nd Edition, Fritsgarald, Wiley Liss, 2005.
3. Iankowski and Polak, Clinical Gene Analysis and Manipulation: Tools, Techniques and Troubleshooting, Cambridge University Press, 1996.
4. Wilson, Clinical Genetics, Wiley-Liss, 2000.
5. Robinson and Linden, Clinical Genetics Handbook, 2nd Edition Blackwell Science, 1994.
6. Rasko and Downes, Genes in Medicine, Chapman & Hall, 1996.
7. Young, Introduction to Risk Calculation in Genetic Counseling, 3rd Edition Oxford University Press, 2006.

MODULE 11: CANCER GENETICS AND PHARMACOGENOMICS (THEORY)

UNIT	TOPIC
1	<i>Introduction to Cancer:</i> An overview, Types of cancer, Cytology of cancer cells, Characteristics of cancer cells, Difference between normal and cancer cells, Contact inhibition, Malignancy as a loss of normal cellular affinities, Differential gene expression in normal vs transformed cells, The genetic basis of cancer, Cancer as hereditary change
2	<i>Cell transformation and tumourigenesis:</i> Cell cycle check point and cancer, Oncogenes Tumour suppressor genes, DNA repair genes and genetic instability, Epigenetic modifications, telomerase activity, centrosome malfunction, Genetic heterogeneity and clonal evolution
3	<i>Familial cancers:</i> Retinoblastoma, Wilms' tumour, Li-Fraumeni syndrome, colorectal, cancer, breast cancer, Epstein Barr virus and its relationship to Burkett's lymphoma, Papilloma virus and cervical carcinoma. <i>Genetic predisposition to sporadic cancer</i>
4	<i>Tumour progression: angiogenesis and metastasis</i> <i>Tumour specific markers</i>
5.	<i>Pharmacokinetics:</i> Variation of enzymes in drug metabolism, Pharmacodynamics: Definition, Drug metabolism, Biochemical modification, Kinetics of drug metabolism, detoxification system, Cytochrome P450, N Acetyltransferase, Succinylcholine sensitivity, G6PD, Debrisoquine metabolism, Alcohol metabolism, Hereditary disorders with altered drug response, <i>Historical aspects of pharmacogenomics</i> , Current status: Pharmacokinetics/ Drug metabolis, <i>Pharmacokinetics –receptors</i> <i>Pharmacokinetics of drug transporters</i> Interethnic difference in drug responses, Genomic variation and pharmacogenomics

CANCER GENETICS AND ENVIRONMENTAL GENETICS PRATICALS

SESSION	TOPIC
1	Bone Marrow culture and chromosome analysis- <ul style="list-style-type: none"> • Culture set up • Harvesting • G-banding •
2	Identification of chromosomal abnormalities in relation to cancers using banding technique.
3	Visit to a flow cytometry laboratory.
4	Identification of Polyploidy
5	Identification of Translocations

Reference 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 & Schartz (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

MODULE:-**12****MODULE 12: DEVELOPMENTAL GENETICS & ENVIRONMENTAL GENETICS
(THEORY)**

UNIT	TOPIC
1	<p><i>Spermatogenesis, Oogenesis</i> <i>Fertilization</i> <i>Human embryonic development:</i> Brief account of embryonic development: Blastulation, Gastrulation, formation of notochord and establishment of body axis; <i>Organogenesis:</i> Formation of embryonic germ layers and their derivatives; Fetal development and placentation (development, structure and function); Fetal membrane in twins.</p>
	<p><i>Central Nervous System in vertebrates:</i> Neural tube formation; Tissue architecture of CNS; <i>Limb development in vertebrates:</i> Formation of Limb Bud; Proximal Distal axis of the limb; Cell death and formation of digits and joints; Regeneration and Senescence: <i>Epimorphic, morphallactic and compensatory regeneration;</i> Ageing: causes and regulation; <i>Pleuropotency of Stem cells:</i> Embryonic and adult stem cells, organization, characteristics and therapeutic applications.</p>
2	<p><i>Understanding Human Birth defects through Model Organism</i> Developmental malformation caused by Teratogens <i>Induced Reproductive Problems;</i> Gene-Teratogen Interaction; Environmental Factors and Genetic <i>Susceptibility;</i> Genomic imprinting: Parent-of-origin effect; Gene silencing;</p>
3	<p><i>Cancer and environment: physical, chemical and biological carcinogens,</i> Mutagens and Teratogens, Carcinogenesis, Environmental modifications of Gene expression, Environmental Carcinogens, Radiation Biology: Basics Effects of Radiation on cells, Human beings Uses of Radiation in Medical Technology</p>

DEVELOPMENTAL GENETICS & ENVIRONMENTAL GENETICS PRACTICAL

1	<p>Introductory lecture on various assays</p> <ul style="list-style-type: none"> ○ Flow Cytometry ○ Micronuclei Technique. ○
2	Identification of Trisomy 13, 18, 21
3	<p>Models –</p> <ul style="list-style-type: none"> a.) Spermatogenesis, Oogenesis b.) Sites of implantation c.) Development of germ layers

Texts/References

1. SA Moody, Principles of Developmental Genetics, Academic Press. 2007.
2. S. P. Gilbert, Developmental Biology, 8th Edition, Sinauer Associates Inc., 2006.
3. Wolpert, Principles of Development, 2nd Edition, Oxford University press, 2002.
4. T. W. Sadler, Langman's Medical Embryology, 9th Edition, Lippincott Williams & Wilkins, 2004
5. K. L. Jones, Smith's recognizable Patterns of Human Malformation, 6th edition, Elsevier Saunders, 2006

MODULE 13: BIOSAFETY, INTRODUCTION TO QUALITY ASSURANCE, ACCREDITATION & SOP WRITING (THEORY)

UNIT	TOPIC
1	<i>Biosafety</i> Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs
2	<i>Introduction to quality assurance, accreditation & SOP writing</i> :Concept of ISO standards and certification , National regulatory body for accreditation, Quality parameters, GMP & GLP, Standard operating procedures, Application of QA in field of genetics, Data management of clonical and testing laboratory

MODULE 14: DISSERTATION: LIST OF TOPICS

The M.Sc. student is required to register for Research work that will be compiled into a thesis. The thesis must be supervised by the Supervisor appointed by the Faculty of Medicine upon the recommendation by Head of the Department or Course Director.

Progress in research and thesis work will be evaluated at the end of each semester by Head of the department /Course Director as satisfactory or unsatisfactory.

At the end of his/her study, the student must defend his/her thesis in an oral examination administered by the board of examiners, consists of at least four members, appointed by the examination committee of the MGM University of Health Sciences, Navi Mumbai.

M.Sc. Medical Genetics

Exam Pattern

The new suggested exam pattern which is common for all subjects is as follows.

- There will **one final university exam** at the end of every semester.
- **Internal exam** will be conducted at the college level for **1st and 2nd** semesters with a common time table and for **3rd, 4th, 5th and 6th** semesters at the departmental level. The marks scored will be used for calculating the internal assessment as described on page 4, 5..

Marks scheme for the University exam:

Final theory marks will be **80 marks (60marks University Theory exam + 20 Marks**

Internal assessment).

The existing University Theory exam pattern should be modified.as follows:

Existing Scheme:

Question	Mark distribution	Total marks (60)
Sec:A:MCQ	20X0.5M	10
Sec:B: SAQ	10/11 x 4M	40
Sec C: LAQ	1/ 2 x 10 M	10
		Total= 60 M

Modified scheme: (This gives equal weightage to sec B and Sec C)

Question		Mark distribution	Marks allotted per section	Marks
Sec:A	MCQ	10X 1 M =10	10	10
Sec:B	SAQ	3/ 4 x 5 M =15	15	25
	LAQ	1/ 2 x 10 M =10	10	
Sec : C	SAQ	3/ 4 x 5 M =15	15	25
	LAQ	1/ 2 x 10 M =10	10	
				Total= 60 M

Final practical marks will be **70M.(50 marks University practical exam + 20 Marks Internal assessment)**

Practical exam pattern : Total 50 marks with following break up.

Exercise	Description	Marks
Q No 1.	Practical exercise	15 M
Q No 2	Station exercise	5x 5M =25 M
Q No 3	VIVA	10 M
		Total= 50 M

Calculation of Internal assessment: there will be 20 marks each towards internal assessment in theory and practicals. This should be submitted by respective departments atleast 15 days before university exam to the university (exam section)

Break up of Theory IA calculation for 20marks

Internal exam(at department)	10 marks
Attendance	5 marks
Seminar	5marks
	Total= 20 M

Break up of Practicals IA calculation:

Internal exam(at department)	10 marks
Attendance	5 marks
Journal	5marks
	Total= 20 M

Exam pattern for Internal exam Theory: (30 marks) to be converted to 10 marks.

Question	Mark distribution	Total marks (30)
Sec:A:MCQ	10 x1M	10
Sec:B: SAQ	2 /3 x 5M	10
Sec C: LAQ	1/ 2 x 10 M	10
		Total= 30 M

Exam pattern for Internal exam Practicals (30 marks) to be converted to 10 marks.

Exercise	Description	Marks
Q No 1.	Practical exercise	10 M
Q No 2	Station exercise	10 M
Q No 3	VIVA	10 M
		Total= 30 M

5 marks allocated for Attendance in theory and 5 marks for attendance in practicals.

It was decided that weightage be given to attendance as per following scheme:

Attendance percentage	Marks
<75	Zero
75	2.5
76-80	3.0
81-85	3.5
86-90	4.0
91-95	4.5
96-100	5.0

5marks for Seminar presentations (to be added to theory internal assessment) and 5marks for Journal (to be added to Practical Internal assessment).

Regarding exam marks distribution in VI Semester (3 year courses)

It was proposed that for the final semester ie 6th Sem in 3 year courses, the same mark distribution should be kept for practical exams.

Out of 50 marks practicals, break up will be as follows:

Exercise	Description	Marks
Q No 1.	Practical exercise	15 M
Q No 2	Dissertation presentation	25
Q No 3	VIVA	10 M
		Total= 50 M

- However, Dr. Harke & Dr. Mansi opined that for 2 year courses, evaluation project including viva may be carried out, out of 100 marks.

Dissertation:-

M.Sc. (Biotechnology & Genetics Courses) student should submit a suitable dissertation topic forwarded by the guide to the School of Biomedical Sciences by 16th September in III Semester of the course. Following approval of ethics & scientific committee, work should be carried out.

Completed dissertation should be submitted by 31st march in IV Semester.

Resolution No. 3.6(l): It was resolved to accept Post Graduate Journal [Annexure - XXI of BOM-45/2016] & log book [Annexure - XXII of BOM-45/2016] for M.Sc. Medical Genetics to be implemented from 2016-17 new Batch onwards and as well as for Students who have taken admission in 2015-16 and will be entering into their 2nd year in 2016-17.

Resolution No. 3.6(m): It was resolved to accept Post Graduate Journal [Annexure - XXIII of BOM-45/2016] & log book [Annexure - XXIV of BOM-45/2016] for M.Sc. Clinical Embryology to be implemented from 2016-17 new Batch onwards and as well as for Students who have taken admission in 2015-16 and will be entering into their 2nd year in 2016-17.

Resolution No. 3.6(n): It was resolved to accept Academic Calendar for B.Sc. Paramedical Sciences (3 years courses) & M.Sc. Medical (2 & 3 year courses) for 2016-17. [Annexure V of BOM-45/2016]

Resolution No. 3.7(a): Resolved to approve the BPT Academic calendar 2016-17 [for both syllabi (new & old)] & MPT Academic calendar 2016-17. [Annexure - V of BOM-45/2016]

Resolution No. 3.7(d): It was resolved to schedule the MPT university theory examination (Regular batch) in the month of July every year with effect from year 2017 onwards. It was also resolved to make the necessary changes in the academic calendar [Annexure - XXVI of BOM-45/2016] so as the course can commence every year in August.

Resolution No. 3.7(e): It was resolved to change the MPT theory paper pattern as follows with effect from MPT exam scheduled in the year 2017 onwards:

Question No.	Question pattern	Marks per question	Total Marks
Q 1	Three LAQs	20	60
Q2	Four SAQs	10	40
		Total	100

Resolution No. 3.8(a): It is resolved to include following minor corrections in the existing B.Sc. Nursing curriculum with immediate effect (April 2016): [Annexure - XXVII of BOM-45/2016]

1. Traditional procedures needs to be continued as part of teaching and demonstration as traditional procedures are still practiced in community field.
2. Specifications in the biochemistry practical hours (*Enclosed*)
3. Home visit and bag technique to be included as an objective and 5 hours to be allotted for demonstration of bag technique in unit II of Community Health Nursing - I (*Enclosed*)
4. Process recording to include in Mental Health Nursing - Unit III (*Enclosed*)

(P.T.O)

Resolution No. 4.13 of BOM-55/2018: Resolved as follows:-

- (i) Slow learners must be re-designated as potential learners.
- (ii) Students scoring less than 35% marks in a particular subjects/course in the 1st formative exam are to be listed as potential learners. These learners must be constantly encouraged to perform better with the help of various remedial measures.
- (iii) Students scoring more than 75% marks in a particular subjects/course in the 1st formative exam are to be listed as advanced learners. These learners must be constantly encouraged to participate in various scholarly activities.



MGM INSTITUTE OF HEALTH SCIENCES

(Deemed to be University u/s 3 of UGC Act, 1956)

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