CURRICULUM

M.Sc. (MEDICAL BIOCHEMISTRY) Course

2023-24

ALL INDIA INSTITUTE OF MEDICAL SCIENCES, NAGPUR
(Institute of national importance)
Plot No. 2, Sector 20, MIHAN, Nagpur 441108

I. QUALIFICATION FOR ADMISSION

A candidate for admission to M.Sc. (Medical Biochemistry) Course should have passed B.Sc. in Medical Laboratory Technology (MLT), B.Sc in Biochemistry or B.Sc in Biotechnology.

II. METHOD OF SELECTION

- Successful candidates of BSc Biochemistry/MLT /Biotechnology having minimum of 50% marks will be eligible to complete for the course. Candidates should be well versed with Hindi and English languages. Candidates have to be the citizen of India. Selection will be done for the open seats and on the basis of merit following a written competitive test followed by an interview as is done for other courses.
- No. of seats: 2 per year
- Course duration: 2 years
- Course fee: As per rules of AIIMS, Nagpur
- Course Stipend: As per rules of AIIMS, Nagpur
- Registration**:** All candidates admitted to M.Sc. (Biochemistry) course shall register with AIIMS, Nagpur at the commencement of the course.

III. GOAL

To enable students of science stream to acquire clinically relevant knowledge of Biochemistry so as to make them competent to contribute effectively in research in field of health sciences.

IV. OBJECTIVES

To train students of Medical Biochemistry so as to be able to:

1. Demonstrate sound knowledge of general concepts and principles of Biochemistry
2. Acquire molecular perspectives of biomolecules, cell organelles and diversity provided at the molecular level
3. Understand various aspects of metabolism of biomolecules and their regulation
4. Interpret interrelationship of metabolic events
5. Identify the molecular/metabolic basis of a disease
6. Explain the concepts of body defence/immunology
7. Understand and apply knowledge of molecular and cell biology
8. Describe the principles of various biochemical techniques and instrumentations and analyseand interpret the data
9. Understand the principle, functioning and implementation of advanced techniques in proteomics, metabolomics, genetics, recombinant DNA technology, cell and tissue culture.
10. Plan and execute high quality research in biomedical sciences

V. METHODOLOGY

The teaching learning activity to achieve these goals will be spanned across but not limited to following measures

1. Didactic lectures
2. Hands on Practical
3. Tutorials
4. Demonstrations
5. Self-directed learning sessions
6. Group discussions
7. Seminars
8. Journal clubs
9. Project presentation
10. Invited guest lectures
11. Dissertation
12. Laboratory posting within and out of institute

VI. SYLLABUS OF MSc MEDICAL BIOCHEMISTRY*

Year	Course content	
	Theory	Practical
I (First semester)	1. Biophysical chemistry 2. Cell biology 3. Chemistry of carbohydrate, amino acid,lipids andnucleotides 4. Introduction to techniques related to Biochemistry 5. Enzymes and clinical enzymology 6. Bioenergetics 7. Biological oxidation 8. Intermediary metabolism of carbohydrate protein and lipids 9. Human Nutrition and dietetics 10. vitamins and mineral. 11. Research methodology with biostatistics	1. Laboratory safety 2. Instruments and glassware 3. Titration 4. Properties of carbohydrates 5. Properties of protein 6. Qualitative analysis of normal andabnormal constituents of urine. 7. Enzyme kinetics 8. Principles of centrifugation 9. Electrophoresis (Paper, Gel) 10. Chromatography (Paper, Gel) 11. Principles of colorimetry. 12. Estimation of plasma glucose, lipid profile, protein , albumin, creatinine and urea in blood. 13. Estimation of Calcium and phosphorus 14. Estimation of Bilirubin and liver enzymes 15. Estimation of Uric acid 16. Energy content and glycaemic index of foods

I (Second semester)	1. Endocrinology and Cell signalling 2. Signal transduction 3. Principles of Genetics and Molecular biology 4. Immunology 5. Basics of laboratory medicine 6. Detoxification and xenobiotics	1. pH and acid base balance 2. pH Meter 3. Arterial blood gases 4. DNA extraction and quantification 5. Polymerase chain reaction 6. RFLP 7. ELISA 8. Immunodiffusion 9. Quality control in laboratory 10. Autoanalyzers 11. Estimation of electrolytes by Ion selective electrodes
II (First semester)	1. Techniques in Biochemistry 2. Techniques in Proteomics, Genetics, Recombinant DNA technology, 7. Tissue culture and its application	1. SDS-PAGE 2. Immuno-electrophoresis 3. Plasmid DNA isolation 4. Restriction Digestion of Plasmid DNA 5. Genomic DNA extraction from tissue sources 6. Genomic DNA extraction from alternative sources 12. DNA methylation analysis
II (Second semester)	1. Medical Genetics: Basic Principles 2. Recent advances in molecular biology 3. Techniques in laboratory medicine 4. Cancer biology	1. Gene cloning/Recombinant DNA technology 2. Blotting and hybridization 3. RNA isolation 4. Microarray 5. Cell culture 6. Preparation of SOP for various equipment
*The scope of curriculum will be only indicative and not restricted to the stated topics. Any topics of relevance and advancement in the field can be included in curriculum with approval of competent authority.		

VII. ASSESSMENT:

Examination Pattern for M.Sc. Medical Biochemistry (2 Year Course)

Formative Assessment	**First examination: Internal Assessment examination** • An Internal Assessment examination will be held at the end of the first year. • The Examination shall consist of one theory paper of 100 marks (10 questions x 10 marks) and Practical examination of 100 marks. **Second Examination: Pre-Professional Examination** • The Pre-Professional Examination will be held at the end of the second year. • The Examination shall consist of a Theory Examination having four papers (Paper I to IV) of 100 marks each (10 questions x 10 marks) = Total 400 marks. • Practical examination shall be for 400 marks (Practicals 250 marks + 50 marks Grand Viva + 100 marks for Dissertation Viva). • The Syllabus shall cover all topics in the syllabus covered from first year to the final year. • 50% marks separately in theory and practical examinations is mandatory in order to be eligible to appear in the summative examination.
Summative Assessment	• The Professional examination shall consist of a Theory Examination having four papers (Paper I to IV) of 100 marks each (10 questions x 10 marks) = Total 400 marks. • Practical examination shall be for 400 marks (Practicals 250 marks + 50 marks Grand Viva + 100 marks for Dissertation Viva). • 50% marks separately in theory and practical examinations shall be mandatory for passing.
Dissertation Submission	• Submission of dissertation at least 6 months before commencement of Professional theory examination with successful evaluation as per guidelines by AIIMS Nagpur will be mandatory for appearing in the Professional examination. • Dissertation viva shall be out of 100 marks and 50% marks shall be required for passing the viva.

Eligibility for appearing in the final exam:

Sr. No.	Parameter	Pass
1	Research Methodology Examination Conducted at End of induction Programme	Pass
2	Internal Assessment marks	>50% marks separately in theory and practicals
3	Dissertation	Accepted
4	MSc Programme attendance	>80% in each year
5	Poster and Paper presentation in Conference	1 poster or 1 paper presentation
6	Peer reviewed Indexed Publication	One (Accepted/ published/sent for publication)
7	Six monthly progress report	At least 5 out of 6 satisfactory progress report

Process to be completed within six months of admission to MSc program:

Activity	Month
Admission to the course	July
Allotment of PG guide and Selection of topic in consultation with PG Guide and synopsis submission	September/ October
Approval of synopsis by Department PG Committee	November
Institute Scientific Committee approval	
Institute Ethics Committee approval	
Submission of synopsis to Academic Section	1st December
Final approval letter by Academic Section	31st December

VIII. CURRICULUM

Year I (First semester)

1. **Biophysical chemistry**

a. Water and its properties pertaining to life
b. pH, buffer, Handerson- hesselbach's equation
c. Biological buffers
d. Acid-base balance and regulation
e. Methods of pH determination
f. Colligative properties
g. Osmosis and Osmotic pressure, Osmolarity of body fluids, Distribution of fluids in body compartments
h. Surface tension and viscosity - their application in health and disease
i. Colloidal system, preparation, protective action emulsification biological importance - their application and role in human body
j. Principle of Dialysis, semipermeable membrane, Gibbs-Donnan equilibrium.
k. Diffusion and absorption mechanisms - their application to biological systems.

2. **Cell biology**
   a. Structure of the cell and different sub cellular organelles
   b. Structure of cell membrane Movement of substances across cell membranes
   c. Interaction between cells andenvironment
   d. Glycoprotein's and proteoglycans
   e. Extracellular matrix
   f. Integrins, Cell-cell interaction-selectins, Cadherins
   g. Tight junctions ,Gap junctions
   h. Intracellular traffic and sorting of proteins
   i. Cell organelle: Nucleus, Endoplasmic reticulum, Golgi complex, Lysosomes, Mitochondria, peroxisomes
   j. Cytoskeleton and cell motility

3. **Chemistry of carbohydrate, amino acid, lipids and nucleotides**
   a. Overview of the Chemistry of carbohydrates: classification, optical isomerism, Homopolysaccharides, heteropolysaccharide, carbohydrates of biomedical significance, glycoproteins, proteoglycans and their role in health and disease
   b. Overview of chemistry of lipids: Classification, biomedical significance, essential fatty acids.
   c. Overview of chemistry of amino acids and proteins: Classification of amino acids, essential amino acids, structural organisation of proteins, peptide bond, principles governing protein folding, Venkatraman-Ramakrishnan plot, denaturation, renaturation, coagulation, flocculation, precipitation, techniques to study proteins, nucleic acids and nucleo-proteins, special proteins viz. haemoglobins, cytochromes, collagen, immunoglobulins.
   d. Nucleic acids and Nucleoproteins: Structure, isolation and functions of nucleosides, nucleotides, nucleoproteins, nucleic acids, DNA, RNA, Denaturation and hybridisation,biologically important nucleotides.

4. **Introduction to techniques related to Biochemistry**
   a. Centrifugation techniques: Principles, differential centrifugation, Density gradient centrifugation, ultra-centrifuge and their application in biological systems.
   b. Chromatographic techniques: Principles types of chromatographic techniques like column, thin layer, paper, adsorption, partition, gas liquid, ion exchange, affinity, high performance and their applications.
   c. Principles and techniques of photometry and Colorimetry: Beer and Lamberts laws, visible and ultra-violate Spectrophotometry, Spectro-fluorometry, fluorometry, phosphorescence, chemiluminescence, turbidimetry nephelometry, Flame photometry atomic absorption spectrometry and their applications.
   d. Nuclear Magnetic resonance, Electron spin resonance Crystallography, Mass spectrometry, Tandem Mass spectrometry, Nanotechnology and microfabrication, Techniques to study in vivo metabolism, NMR, SPECT, PET scans: Principles, instrumentation, techniques and applications,
   e. Principles of radioactivity: nature and types, decay rate radioactive decay , units ofradioactivity , detection and measurement, of radio activity, radiation hazards and its prevention applications of radio activity and radio isotopes in biological systems.
   f. Electrophoresis, Principles, types and their applications in biological systems.

5. **Enzymes and clinical enzymology**
   a. Definition and General properties

b. classification and nomenclature
c. Mechanism of enzyme actions
d. Enzyme kinetics
e. Factors influencing enzymes action
f. Enzyme specificity
g. Regulation of enzyme action, enzyme inhibitors and applications
h. Enzyme Isolation and activity assessment
i. Isoenzymes,
j. Clinical enzymology: diagnostic, therapeutic and other applications of enzymes

6. Bioenergetics

a. Laws of thermodynamics and their application in biological systems
b. Free energy change, entropy and enthalpy
c. Thermodynamics of coupled reactions
d. High energy phosphates, their role in energy capture and transfer, redox potential

7. Biological oxidation

a. Enzymes involved in biological oxidation
b. Components of respiratory chain, phosphorylation at the substrate level and respiratory chain level, inhibitors of biological oxidation, mechanism of energy capture, chemiosmotic theory, uncouplers of oxidative phosphorylation.

8. Intermediary metabolism of carbohydrate protein and lipids

a. Introduction to methods of studying intermediary metabolism whole organism studies
   - whole animal, plant studies - perfusion of isolated organ-organ and tissue slice techniques isolated and cultured tissue and cell technique.
b. Intermediary metabolism of carbohydrates - glycolysis, glycogenolysis, glycogenesis, HMP shunt, uronic acid, glucoconeogenesis, common metabolic pathway, aminosugar, sialic acids, glycoproteins and proteoglycans, regulation of blood glucose, hormonal control of carbohydrate metabolism.
c. Lipid metabolism: Oxidation of fatty acids, degradation of complex lipids, biosynthesis of fatty acids, essential fatty acids, triacyl glycerds, steroids, phospholipids, prostaglandins, cholesterol, bile acids, lipoproteins, glycolipids - regulation of lipid metabolism.
d. Protein and amino acid metabolism: Degradation of amino acids oxidative and non- oxidative deamination, transamination, decarbooxydation, detoxication of ammonia, catabolism of carbon skeletons of amino acids - ketogenic and glucogenic amino acids- nitrogen balance conversion of amino acids to specialized products.

9. Human Nutrition and dietetics

a. Emergence, scope and methodology of nutrition as science: Energy metabolism, indices of calorific value of foods, direct and indirect colorimetry, respiratory quotient Energy needs of the body, basal metabolism Calculation of total caloric requirements.
b. Concepts of adequate and balanced diet, recommended dietary allowances (RDA), protein efficiency ratio, biological value etc.
c. Food energy (carbohydrate, protein, fat) and individual nutrients (Vitamins and minerals) with special reference to: distribution in body and biochemical rate, amount in ordinary foods, digestion, absorption, transport, storage, disposal, requirements and recommended allowances and their modifications under stress, effects of their deficiency and excesses, incidence, etiology and prevention of

diseases, interrelation with other nutrients

d. Assessment of nutritional status of an individual and community.
e. Nutritional and food requirements to meet the needs of infants, preschool, school children,adolescents, adults, geriatric group pregnancy, and lactation.
f. Formulation of balanced diets, nutritional adaptation.
g. Common disorders of nutrition: under-nutrition, over nutrition, protein malnutrition, obesity, food allergy.
h. Diet therapy or formulation of therapeutic diets: purpose and principles of therapeutic diets with special reference to different age, gender, race ethnicity, diabetes mellitus, renal disorders, diseases of liver, diseases of heart and circulatory system, obesity and leanness, atherosclerosis, hypertension etc.

10. Vitamins and mineral.

a. Sources, properties, structure, sources, daily requirements, biochemical role, deficiency manifestations and toxic effects of water soluble and lipid soluble vitamins.
b. Mineral metabolism: macro, micro nutrients, daily requirements, sources, biochemical functions, regulation of intake, turnover and metabolism disorders related to macro and micro mineral nutrients, calcium, phosphorus, iron, copper, zinc, magnesium, chromium, selenium, sodium and potassium

11. Research methodology with biostatistics

a. Basic concepts of biomedical research
b. Types of study
c. Goal, Objectives and research question
d. Types of Data
e. Calculation of adequate sample size
f. Tests of significance: Students 't' test, Paired 't' test, Chi square test, Fisher's exact test, Nonparametric tests of significance, One way and two way Analysis of variance, Multivariate analysis, Survival analysis-log rank test, Relative risk calculation-Odd's ratio, commonly used statistical software's.

Year I (Second semester)

1. Endocrinology and Cell signaling

a. Concept of endocrine, exocrine and paracrine hormones, Types of hormone receptors, hormonal inter-relationships. Mechanism of hormone action, classification of hormones.
b. Hormones of the pituitary and hypothalamus - POMC peptide family.
c. Hormones of the thyroid: iodine metabolism, biosynthesis of thyroid hormone structure,activity, metabolism, interaction with other endocrine systems, antithyroid drugs.
d. Hormones regulating calcium metabolism: parathyroid hormones, calcitriol, calcitonin, synthesis, secretion, regulation
e. Hormones of the adrenal cortex:glucocorticoids, mineralocorticoids and androgens their biosynthesis, secretion, transport and metabolism and their metaboliceffects.
f. Hormones of adrenal medulla: catecholamines and their derivatives, biosynthesis, storage, regulation and metabolic effects, functional similarity between catecholamine receptor and visual response system.
g. Hormones of the gonads: androgens, estrogens and progestins, structure, biosynthesissecretion, regulation, metabolic effects, transport, menstrual cycle and its regulation.
h. Hormones and endocrinology and pregnancy and lactation - fetoplacentalunit.

i. Hormones of pancreas - chemistry, biosynthesis, regulation, secretion of insulin, glucagon, somatostatin-effects of insulin and glucagon on carbohydrate, lipid and protein metabolism-synthetic hypoglycemic agents.
j. Miscellaneous hormones: Hormones of GI tract, kidneys, prostaglandins and their derivatives, hormones of central nervous system, thymus and pineal gland.
k. Endocrine disorders: Biochemical basis of the disorders related to all the above endocrine system.

2. Signal transduction

a. Hormones and their receptors
b. Cell surface receptor
c. Signaling through G-protein coupled receptors
d. Signal transduction pathways: Enzymatic Jak-stat and non-enzymatic, Tyrosine kinase, serine threonine kinase, tyrosine phosphatase G protein coupled receptors
e. Second messengers
f. Regulation of signaling pathways
g. Cell interactions in terms of developmental biology

3. Principles of Genetics and Molecular biology

a. Information biomolecules, DNA and RNA their types, structure and properties, related experiments, 5' - 3' direction, size range location, isolation, shear, base composition, base equivalent, gel electrophoresis, secondary structure, base pairing, base stacking, helix-coil transition, Tm and relationship to GC content, Tertiary structures.
b. Genetic code: Evidence for a triplet code, properties of the code, sequential, ubiquitous, degenerative, wobble hypothesis, nonsense codon, adapter role of tRNA, amino acyl tRNA synthases, anticodon loop, direction of protein synthesis.
c. Principles of replication, details of Meselson and Stahl experiment, semi-conservative replication. Replication in prokaryotic and eukaryotic organisms. DNA replication: properties of DNA dependent DNA polymerases I, II, III and their role in DNA replication, Discontinuous/continuous synthesis, okazaki fragments, RNA primers, repairs of DNS polymerase and DNA lipase, role of DNA glyrase, unwinding enzyme, HD protein, polymerase chain reaction.
d. Mechanism of transcription: sigma cycle, recognition, binding and initiation sites, TATA / Pribnow box, enhancer and other regulatory elements, Direction of chain growth, termination rho and palindromes, Regulation of transcription of promoters and repressors, concept of operon. Post transcriptional processing: maturation of rRNA and tRNA, RNA splicing introns and exons, consensus sequence of junction, mechanism of RNA splicing, Poly A tail, 5' capping, Non cooling sequences etc, Introns and Protein functional domains.
e. Mechanism of translation: A & P sites, initiator codon, Shine-Dalgarno consensus sequence (AGGA) Formation of 70S initiation complex, role of initiation factors and GTP, Peptidyl transferase, translocation, role of various complexes, Rates of eukaryotic and prokaryotic protein synthesis, multiple initiation sites, bi-directional replication, bubble, fidelity of replication excision, repair systems, recombinant repair system, chemical carcinogenesis. Post translational processing: signal hypothesis-Functions of pre and pro regions signals, zymogen activation.
f. DNA dependent RNA polymerase, in vitro assay, physical properties of the enzyme, Subunit structure, proof of template directed synthesis.
g. DNA sequencing techniques: details of methodologies eg. plus and minus di-

deoxynucleotide, partial ribose substitution, Maxam and Guilbert, use of thin gels, resolution etc. interpretation of DNA sequences.

h. Role of counterions, deep and grooves, SBS-DNA, A, B&Z DNA etc. chirality of the helix, syn/antiparallel complementary strands.
i. Physical properties of RNA-classes of RNA-structure, methods of isolation and fractionationof RNA-primary, secondary and tertiary structures - DNases, RNases, phosphodiesterase etc.
j. Rapid RNA sequencing techniques: plus and minus, di-deoxynucleotide, Zimmern andKaesberg, Paettie, Simonesites method, interpretation of RNA sequences.
k. Satellite DNA: possible functions, C value paradox-mechanical strength, gene library, suppressor mutation, centromeric DNA, split genes.
l. Nucleic acid metabolism - Biosynthesis and degradation of purines and pyrimidine ring nucleotides - regulation of biosynthesis and degradation conversion to doxynucleot ides.

4. Immunology

a. Innate and acquired immunity, cells and organs of the immune system T and B cells, macrophages, dendritic cells, NK cells, granulocytes
b. Antigens, epitopes and haptens
c. Immunoglobulins: structure, classes, isotypes, allotypes, idiotypes
d. Monoclonal antibodies
e. Organization and expression of immunoglobulin genes, immunoglobulin gene rearrangement, class switching, antigen-antibody interaction immunochemical techniques
f. MHC, antigen processing and presentation
g. T cell and B cell receptor, toll like receptors, cell maturation/activation/differentiation
h. B cell generation activation, differentiation,
i. Cytokines
j. Complement system
k. Cell mediated immunity, T regulatory cells
l. Hypersensitivity
m. Immune response to infections
n. vaccines: newer approaches
o. Immunodeficiency
p. Autoimmunity, transplantation immunology
q. Cancer and immune system
r. Immunodiagnostics and immunotherapy.

1. Basics of laboratory medicine

a. Investigative aspects: principles of laboratory analysis and safety
b. Specimen collection and processing, automation
c. Point of care testing
d. Evidence based laboratory medicine
e. Selection and analytical evaluation of methods
f. Clinical evaluation of methods: sensitivity and specificity, ROC curves
g. Establishment and use of reference intervals
h. Preanalytical, analytical and post analytical variables
i. Clinical laboratory informatics
j. Total quality management
k. Biomedical waste disposal.
l. Role of biochemistry in diagnosis of diseases.

m. Organ function tests: Gastric, pancreatic, hepatobiliary, renal etc
n. Disorders of carbohydrates metabolism , nitrogen metabolism, lipid metabolism, mineral metabolism, blood coagulation
o. Cerebrospinal fluid: Composition in normal and diseases, laboratory findings of CSF constituents in health and disease.
p. Inherited disorders of metabolism: Changes occurring in phenyl ketonuria, alkaptonuria, tyrosinosis, albinism, Hartnup's disease, galactosemia. Tay-Sach's disease, Niemann Pick's disease, Hunter's and Hunter's syndrome, Lesch-Nyhan syndrome, detection of these anomalies.
q. Endocrine system: Laboratory diagnosis and investigations related to disorders of thyroid, pituitary, adrenal cortex, adrenal medulla, testes, ovaries, plasma and urinary assays of hormones related to various endocrinal disorders.
r. Acid base balance - coagulation of blood pH within normal range disturbances in acid base balance - acidosis, alkalosis, mixed disturbances - laboratory parameters - blood gasanalysis.
s. Fluid and electrolyte balance - regulation - disturbances of fluid and electrolyte balance - laboratory parameters in the diagnosis and management of fluid and electrolyte disorders, oral rehydration therapy.

2. Detoxification and xenobiotics

a. detoxication mechanisms in the body biological implications of xenobiotic metabolism.

Year II (First semester)

1. Techniques in Biochemistry

a. Centrifugation techniques and their applications in different aspects of Biochemistry.
b. Chromatographic techniques and their applications with reference to use in research and diagnostics.
c. Photometry, spectrophotometry and Colorimetry, Spectro-fluorometry, fluorometry, phosphorescence, chemiluminescence, turbidimetry nephelometry, Flame photometry atomic absorption spectrometry: instrumentation and applications in diagnostics and research.
d. Nuclear Magnetic resonance, Electron spin resonance Crystallography, Mass spectrometry, Tandem Mass spectrometry, Nanotechnology and microfabrication, Techniques to study in vivo metabolism, NMR, SPECT, PET scans: Principles, instrumentation and applications,

2. Techniques in Proteomics, Genetics, Recombinant DNA technology

a. Electrophoresis, Principles, types and their applications in biological systems.
b. SDS-PAGE, 2D electrophoresis
c. Various types of chromatography and their applications in proteomics
d. High performance liquid chromatography
e. Mass spectrometry, Tandem-MS, LC-MS, GC-MS with specific applications
f. ELISA, types and applications in diagnostics and research
g. Extraction of genomic DNA, RNA from different sources, quantity and quality checking of DNA, DNA/RNA/Protein ratio in the isolates. Use of Nanospectrophotometer.
h. PCR: standardization and identification of PCR products.
i. RFLP
j. DNA methylation analysis
k. Gene cloning/Recombinant DNA technology

l. Blotting and hybridization
m. Mutation analysis

3. **Tissue culture and its application**
   a. Cell lines, Cell culture, Animal tissue culture, contact inhibition, cancer, growth inhibitors, cell movement, communication between and within cells
   b. Applications of tissue culture techniques in translational medicine

Year II (Second semester)

1. **Medical Genetics**
   a. Structure of gene and chromosomes
   b. karyotyping and banding patterns
   c. chromosomal aberrations, inheritance, molecular genetics, mutations, genome imprinting, cancer genetics,reproduction genetics.

2. **Recent advances in molecular biology**
   a. DNA sequencing
   b. RNA sequencing
   c. RT-PCR
   d. Expression analysis
   e. Microsatellite analysis
   f. Mitochondrial DNA isolation
   g. Protein sequencing
   h. Next generation sequencing

3. **Techniques in laboratory medicine – principles and techniques in clinical lab including quality control**

4. **Cancer biology**
   a. Cell cycle, cyclins, CDKs and other regulatory factors in CELL cycle
   b. Genetic rearrangements in progenitor cells
   c. oncogenes, tumor suppressor genes, cancer and the cell cycle
   d. virus-induced cancer, metastasis
   e. interaction of cancer cells with normal cells
   f. apoptosis
   g. therapeutic interventions of uncontrolled cell growth

IX. BOOKS RECOMMENDED:

1. Biochemistry Ed. Lubert Stryer. W.H. Free man and Company, New York.
2. Principles of Biochemistry. Ed. Lehninger, Nelson and Cox. CBS Publishers and Distributors.
3. Harper's Biochemistry. Ed. R. K. Murray, D. K. Granner,P.A. Mayes and V.W. Rodwell. Appleton and Lange, Stamford, Connecticut.
4. Textbook of Biochemistry with Clinical Correlations. Ed. Thomas M. Devlin,Wiley-Liss Publishers.
5. Practical Clinical Chemistry by Varley H. Latest.
6. Genes VIII Ed Benjamin Lewin. Oxford University Press.
7. Tietz Textbook of Clinical Chemistry and molecular diagnostics Ed Burtis and Ashwood. W.B Saunders Company.
8. Principles and techniques of Practical Biochemistry. Ed Keith Wilson and John Walker. Cambridge University Press.
9. Biochemistry. Ed. Donald Voet and Judith G. Voet. John Wiley & Sons, Inc.
10. Molecular Cell Biology, H. Lodish, A, Berk, S. L. Zipursky, P. Matsudaira, D. Baltimore, J. Darnell.
11. Practical manual for MBBS Department of Biochemistry, AIIMS, Nagpur