Department of Biochemistry
All India Institute of Medical Sciences, Guwahati

MD Biochemistry – Curriculum

1. Goal

(Adopted/ modified from (i) NMC Post Graduate Medical Education Board; (ii) AIIMS New Delhi MD Syllabus)

The goal of the post-graduate training program (MD in Biochemistry) is to enable the trainee to (i) understand, envisage, and explain life processes as molecular events, (ii) apply their knowledge and skills in clinical diagnostic problem solving, (iii) develop expertise in laboratory techniques applicable to metabolic and molecular aspects of medicine, to enable them plan and execute quality research.

2. Objectives

(Adopted/ modified from NMC Post Graduate Medical Education Board)

The student, after undergoing training in MD Biochemistry, should be able to:

i. Demonstrate their knowledge of the basic concepts and recent advances in the subject, and a defined set of skills including expertise in various laboratory techniques applicable to metabolic, molecular, immunological, genetic, and nutritional aspects of medicine; planning and executing research projects; and writing research papers/ articles demonstrating the acquired training in research methodology.

ii. Become a competent teacher who is also able to demonstrate their competence in planning teaching programs and apply those to facilitate the learning of the students in medical and allied health science courses in compliance with the curriculum while advancing the same with needful and feasible innovations.

iii. Demonstrate competence in integrating teaching-learning of Biochemistry with other relevant subjects/disciplines to facilitate the holistic application of the subject of Biochemistry in patient care.

iv. Demonstrate their training in good laboratory practices with the ability to set up/manage a quality-controlled and quality-assured diagnostic laboratory, generate, evaluate, interpret, and report the diagnostic laboratory data, with a good understanding of

evidence-based medicine and evidence-based laboratory medicine, the sources of laboratory errors, their corrective and preventive actions, hospital and laboratory information system network, and interact with clinicians as may be needed for effective patient care.

v. Explain, comprehend and analyze the basics of cellular and molecular biochemistry, functional mechanisms of the biomolecules, and their logistics in the human body in normal health and their deviations in the disease conditions.

3. Competencies

(Adopted/ modified from (i) NMC Post Graduate Medical Education Board; (ii) AIIMS Bibinagar MD Curriculum; (iii) AIIMS New Delhi MD Syllabus)

A. Knowledge

i. Describe and apply biochemical principles to explain the normal state, abnormal disease conditions and mechanism of action used in the perception, diagnosis, and treatment of diseases.

ii. Describe the molecular motif of a living cell, structural and functional hierarchy of biomolecules, and their structure-function relationships and the importance of biomolecules in sustaining the life processes.

iii. Explain the energy transactions in a living system.

iv. Explain the characteristics, components, and functional significance of different metabolic pathways, their specific intermediates, their inter-conversions, pathway-specific, organ-specific, and interrelated regulation of metabolic pathways, and apply them in explaining the biochemical logic in the functioning of the body in health and disease.

v. Describe and apply the concept of nutrition in health and disease, critically evaluate the role of essential micro- and macro-nutrients, and their interlinks with cellular metabolism.

vi. Apply and integrate knowledge of molecular pathways and metabolic conditions in normal and disease states for clinical problem solving and research.

vii. Acquire knowledge on application and interpretation of various molecular diagnostic techniques in metabolic and molecular medicine.

viii. Apply the knowledge on genetic engineering and its principles and utility in various fields of medicine.

ix. Acquire knowledge on principles of immunology and apply them in relation to fundamental research and clinical medicine.

x. Acquire knowledge about recent advances and trends in research in the field of clinical biochemistry, molecular medicine, and metabolic medicine.

xi. Evaluate, analyze and monitor disease states by applying relevant biochemical investigations and interpreting the clinical and laboratory data and to apply the knowledge to suggest and implement judicious use of clinical laboratory investigations.

xii. Acquire knowledge of principles of instrumentation and quality control.

xiii. Demonstrate knowledge on the preparation of solutions and reagents with necessary precautions as may be required for the estimations in experimental and diagnostic laboratories.

xiv. Display knowledge about recent advances and trends in the core subject area, research, and laboratory practice along with point-of-care testing (POCT) in the field of biochemistry.

xv. Acquire knowledge of basics of research methodology, develop a research protocol, analyse data using currently available statistical software, interpret results and disseminate these results and to have the potential ability to pursue further specializations.

xvi. Acquire knowledge and apply the principle of statistics, biostatistics and epidemiology to the evaluation and interpretation of molecular and metabolic disease states.

xvii. Describe the principles of teaching - learning technology towards application and conduct of interactive classroom lectures including flip classrooms, problem-based learning (PBL), case discussions, small group discussions, self-directed learning, seminars, journal clubs and research paper presentations.

xviii. Demonstrate familiarity with the advances in computational biology, -omics technologies, data mining, artificial intelligence, and computer-based modelling.

B. Skills

i. Select, justify, and conduct clinical chemistry and molecular biology (including genetics) laboratory investigations and experimentations relevant to clinical management and biomedical research, and to analyze, interpret and evaluate the data, and to rationalize their applications in clinical management and experimental research.

ii. Attain clinical reasoning and decision-making skills for diagnosis, testing, and understanding of genetic and metabolic diseases.

iii. Ability to perform standard operating procedures of various methods and techniques used in a clinical biochemistry laboratory.

iv. Develop a differential diagnosis, wherever applicable, based on the results obtained after performing the adequate biochemical/ molecular/ immunological investigations.

v. Perform enzymatic assays and conduct experiments to study enzyme kinetics affirming the ability to discuss, interpret and document the related data.

vi. Ability to critically review and comment on research papers.

vii. Suggest preventive, curative, and/or palliative strategies for the management of diseases.

viii. Plan and conduct lectures, practical demonstrations, tutorial classes, and case-based or problem-based small group discussions for undergraduate students of medical and allied disciplines.

ix. Prepare research protocol to conduct experimental studies, and to analytically solve experimental problems.

x. The list of procedures in which the trainee is expected to demonstrate their competency is provided subsequently in Section 6B.

C. Practice and Communication

i. Effectively communicate with patients and healthy subjects from a variety of backgrounds, the molecular and metabolic basis of disease states and lifestyle modifications, maintaining an awareness about the cost of diagnostic tests and the economic status of patients.

ii. Communicate biochemical reasoning effectively with peers, staff, and faculty, and other members of the health care team.

iii. Demonstrate empathy and respect towards patients regardless of the molecular nature of their disease.

iv. Explain effectively to the stakeholders the precautions and preparations needed for them to comply with for specific biochemical analysis/laboratory tests that they will be subjected to.

v. Display appropriate attitude, professionalism, and respectful interactions with patients, families, peers, and other health care professionals.

vi. Demonstrate the ability to maintain confidentiality in declaring the laboratory results to the concerned personnel wherever applicable.

vii. Demonstrate ethical behaviour and integrity in one's work.

viii. Demonstrate counseling skills, especially in the context of nutritional, lifestyle and genetic disease counseling.

4. Methods

(Adopted/ modified from (i) NMC Post Graduate Medical Education Board; (ii) AIIMS Bibinagar MD Curriculum; (iii) AIIMS New Delhi MD Syllabus, (iv) Faculty of Medical Sciences – Delhi University – MD Curriculum; (v) AIIMS Gorakhpur M.Sc. Syllabus – Biochemistry

A. Theory

Aim: To update on various aspects of basic and clinical biochemistry, immunology, molecular biology, genetics, biostatistics, and computational biology, and the impact of molecular biology on recent advances in medicine.

Modalities: Interactive lectures, tutorials, seminars, group discussions, journal clubs, critical analysis of research articles, case presentations, case discussions, clinical rounds, micro-teaching, guest lectures, and e-learning.

i. Interactive lectures/ Self-directed learning: Will be held for 1 hour duration twice a week.

ii. Tutorials: Will be held for 1 hour duration, at least once a week. The objective is to provide an opportunity to the students to interact with the faculty to gain maximum coordinated information on the subject.

iii. Seminars/ case discussions: Will be held every month. The topics will be chosen from the latest advances in the subject and from areas of general interest relevant to the subject. Seminars will be done in consultation with a faculty member and the aim is to make the trainee acquaint with the advanced developments in the field and to comprehend and explain the information they have obtained.

iv. Journal clubs: Will be held on alternate weeks. The objectives are to develop (i) skills of analysis, evaluation, and presentation of research papers, (ii) familiarity with approaches and methodologies of research, and (iii) to update on new development/ emerging trends in the subject areas.

v. Critical analysis of research articles: Will be held monthly, to encourage critical reading of the research material, with emphasis on the objectives of the study, the choice of appropriate methodology, and the consistency of the results and outcomes.

vi. Case presentations and clinical rounds: Will be held monthly, to enable acquisition of skills pertaining to clinical correlation of the laboratory investigations, and to facilitate a better comprehension of the molecular basis of pathological states.

vii. Microteaching: Will be conducted on alternate months with the aim to improve and practice the teaching skills and to acquaint the trainee with the process of preparation of teaching modules.

viii. Invited lectures: To gain access to recent works by experts in an area and to create opportunity for free interactions with scientists of eminence.

B. Practical

Practical exercises will be performed by the trainees with the aim to equip themselves with knowledge and hand-on skills in various techniques used for laboratory bench-work in biochemistry and molecular biology and in a diagnostic laboratory, and to learn to analyze and interpret data obtained. All the practical exercises will be preceded by a comprehensive briefing on the topic concerned and will be followed by an assessment on the same.

C. Specialized training

i. Rotation in clinical chemistry, immunology, and molecular diagnostics laboratories: The post graduate students will be posted in all sections of the laboratories in the institution, starting from sample collection and processing. They should become proficient in working with the auto-analysers in the laboratory, in quality control methods, setting up of a clinical biochemistry laboratory and molecular diagnostics laboratory, specialized assays and statistical analysis of data. It is also desirable for them to acquire experience in running a 24-hours diagnostic laboratory. This will be an ongoing process during the entire duration of the post-graduate course.

ii. Rotation in other laboratory departments and clinical departments: The trainees will also be posted in various other laboratories within the Institute, but outside the Department, namely, in the Departments of Pathology, Transfusion Medicine, and Microbiology. The total duration of these postings will be five weeks – two weeks in Pathology, one week in

Transfusion Medicine, and two weeks in Microbiology. They will also have short clinical postings for a total duration of four to five weeks (divided into two blocks of two to three weeks each) in the broad-specialty and super-specialty departments to enable clinical correlation of the knowledge on molecular basis of diseases that they have learned; this will be formulated in an elective manner.

iii. Peripheral postings: The students will have a posting for a duration of two to three weeks in one of the following Institutes, to provide advanced training in relevant key areas:

a. NIPER Guwahati
b. IIT Guwahati
c. IIIT Guwahati

D. Thesis

Under the supervision of an eligible faculty member in the Department of Biochemistry (with co-supervision from faculty members within and outside the Department and the Institute), each PG student is expected to generate a hypothesis/research question and design a research protocol to test/address it. The protocol should have clearly defined objectives and a work plan. The post graduate student will carry out the experimental research work proposed, analyze data, interpret results and write a thesis/dissertation based on the work done and results obtained.

The schedule for the protocol submission, thesis updates, and thesis submission will be as per the guidelines issued by the Academic Section of the Institute. The evaluation of the thesis will also be in accordance with the guidelines issued by the Academic Section.

E. Involvement in undergraduate teaching

The trainees will participate in teaching and training programmes of undergraduate students. They should learn how to organize, conduct and co-ordinate UG laboratory teaching in practical classes, to participate in clinical case-based teaching sessions and small group discussions (as part of a team that includes faculty members and senior residents of the department), to develop skills of self-directed learning, effective communication, and leadership. They should learn how to work as part of a team and to facilitate learning by students.

5. Assessment

(Adopted/ modified from AIIMS New Delhi MD Syllabus)

Formative assessment will be in the form of evaluation of seminars, group discussions, journal clubs, critical analysis of research articles, case presentations, etc. There will be semester-wise periodic summative assessment in both theory and practical. The aforementioned assessments will carry a weightage of 20 percentage (80 marks), separately for theory and practical, in the final calculation of the marks.

The format for the MD final examination is given below:

A. Theory Examination (Total 320 marks)

- Paper I: General and physical biochemistry, and techniques: 80 marks
- Paper II: Metabolism, physiology, and nutrition: 80 marks
- Paper III: Molecular biology, immunology, and cancer: 80 marks
- Paper IV: Clinical chemistry and recent advances: 80 marks

B. Practical Examination (Total 320 marks)

- The Practical examination will have the following components:
    i. OSPE/ OSCE
    ii. Spots
    iii. Clinical scenario based clinical chemistry/ immunology practical
    iv. Practical based on analytical techniques covered in post-graduate practical syllabus
    v. Bench viva
    vi. Thesis presentation and discussion
    vii. General viva voce

Note: Thesis presentation and discussion will carry 100 marks. The distribution of marks for the rest of the components will be formulated at time of individual examinations.

The duration of the examination for theory and practical examinations will be according to the guidelines provided by the Academic Section. The same will apply with respect to the minimum marks to be obtained for passing the examination.

6. Syllabus

(Adopted/ modified from (i) AIIMS New Delhi MD Syllabus, (ii) Faculty of Medical Sciences – Delhi University – MD Curriculum)

A. Theory

i. **Paper I: General and physical biochemistry, and techniques.**

- General Biochemistry: Cell structure, its biochemical make up and functions, membrane structure and functions, cytoskeleton, Interaction between cells and environment, glycoproteins and proteoglycans, extracellular matrix structure and functions of proteins, muscle and plasma proteins, hemoglobin, biochemistry of blood clotting, body fluids and their importance in clinical biochemistry
- Enzymes: Principles and mechanisms of enzymatic catalysis, enzyme kinetics and regulation of enzyme activity, isoenzymes.
- Chemistry of carbohydrates, lipids, proteins, amino acids, nucleotides, and nucleic acids.
- Bioenergetics and biological oxidation.
- General laboratory techniques and procedures, pH meter, balances.
- Centrifugation, sub-cellular fractionation
- Purification of an enzyme and study of its kinetics
- Chromatography
- Electrophoresis techniques, immune-diffusion, isoelectric focusing, HPLC
- Immunoassay techniques, Immuno-electrophoresis, immunoblotting and ELISA.
- Spectroscopy techniques, including NMR.
- Radioactive Isotopes, their application in biomedical research and clinical diagnosis, measurements of radioactivity, tracer techniques, ELISA, chemiluminescence, etc.
- Molecular diagnostics, recombinant DNA technology and its applications.
- Microscopy – light microscopy, electron microscopy, and confocal microscopy
- Cell Culture
- Omics techniques

ii. Paper II: Metabolism, physiology, and nutrition.

- Intermediary metabolism: Digestion and absorption of food and other nutrients, metabolism of carbohydrates, lipids, proteins, amino acids, porphyrins, purines, pyrimidines, their regulation/dysregulation, and inter-relationships. Inborn errors of metabolism, genetic disorders. Electron transport chain and oxidative phosphorylation.
- Mineral metabolism and trace elements, water and electrolyte balance.
- Vitamins: Fat- and water-soluble vitamins, their chemistry, mechanism of action, and deficiency. Role in free radical homeostasis.
- Human Nutrition: Principal food components, general nutritional requirements, energy requirements, biological value of proteins, specific dynamic action, balanced diet, diet formulation in health and disease, mixed diet, nutritional supplements, food toxins and additives, parental nutrition, disorders of nutrition, obesity, protein and protein energy, malnutrition, dietary fibers, under-nutrition, laboratory diagnosis of nutrition disorders, national nutritional programme.
- Biochemistry of free radicals.
- Environmental biochemistry and detoxification

iii. Paper III: Molecular Biology, immunology, and cancer.

- Nucleic acids – replication, transcription, protein biosynthesis and gene regulation. Genetic code, mutations and mutants, DNA repair. Purines and pyrimidines – biosynthesis and degradation, cell – cell interaction, adhesion molecule, signal transduction, receptor-structure and regulation, cloning, construction of genomic libraries, strategies for screening DNA libraries.
- Human genome project, functional genomics, proteomics, Bioinformatics.
- Principles of human genetics - Transmission of genetic disease-mutations and their functional consequences, alleles, genotypes, haplotypes, phenotypes, genetic linkage, identification of disease-causing gene, chromosomal disorders, monogenic Mendelian disorders, mitochondrial disorders, nucleotide repeat expansion disorders, polygenic disease and complex genetic traits, imprinting disorders, methods of mutation detection, gene therapy.
- Stem cells in clinical medicine.
- Immunology: Structure, functions, classifications and synthesis of immunoglobulins, antigen-antibody reaction, mechanisms and regulation of immune responses.

Complement system, hypersensitivity, immune-tolerance, immunity to infection, autoimmunity & auto immune diseases, tumor immunity, genetics of immune response, transplantation, experimental system used in immunology, vaccination and immunization strategies, hybridoma technology. Apoptosis, telomeres and telomerase, cytokine network, immunodiagnostics.

- Cancer: biochemistry and molecular biology of cancer, growth factors and oncogenes, cancer genetics, clonal origin and multistep nature, tumour suppressor genes, familial cancer syndromes, chromosomal instability in solid tumours, viruses in human cancer, epigenetic regulation in cancer, gene expression profiling in cancer, cancer cell biology, cell cycle abnormalities, telomerase, apoptosis, metastasis, molecular basis and therapeutic strategies, tumour angiogenesis-molecular events and antiangiogenic therapy, biological basis of cancer chemotherapy, multidrug resistance, molecularly targeted cancer therapy, cancer immunotherapy.

iv. Paper IV: Clinical chemistry and recent advances.

- Clinical chemistry:
    - Principles of laboratory analysis and safety, specimen collection and processing, automation, point of care testing, evidence-based laboratory medicine, selection and analytical evaluation of methods, clinical evaluation of methods-sensitivity and specificity, ROC curves, establishment and use of reference values, preanalytical variables, clinical laboratory informatics, Total quality management, biomedical waste disposal.
    - Quality Control in clinical biochemistry and instrumentation in clinical laboratory.
    - Analytes: Amino acids/peptides/proteins, plasma proteins, enzymes, clinical enzymology, tumour markers, carbohydrates, lipids/lipoproteins/apolipoproteins, cardiovascular risk factors, electrolytes, blood, gases, catecholamines/serotonin, vitamins, and trace elements, hemoglobin, iron and bilirubin, porphyrins, and their disorders.
    - Analysis and significance of clinically important analytes in urine, CSF, and other body fluids.
    - Hematopoietic disorders-Iron deficiency and other hypo-proliferative anaemias-iron metabolism, laboratory tests of iron status, iron therapy, anemia of chronic

disease, anemia of renal disease. Hemoglobinopathies- sickle cell anaemia, methemoglobinemia, thalassemia syndromes, megaloblastic anaemias

- RBC membrane and metabolism, hemolytic anaemias-inherited defects in RBC membrane and enzymes-G6PD deficiency, immunologic causes of hemolysis. ABO blood group system-biochemical basis, transfusion biology.
- Plasma cell disorders-multiple myeloma, MGUS.
- Hemostasis and thrombosis: Biochemical mechanisms, related laboratory tests, antiplatelet /anticoagulant / fibrinolytic therapy.
- Cardiovascular system: Atherosclerosis- pathogenesis, risk factors, its prevention and treatment, heart failure, acute coronary syndrome, cardiac biomarkers, cardiomyopathy, hypertension-essential and secondary.
- Respiratory system: Gaseous exchange in lungs-physiological features and disturbances, arterial blood gases. Pathogenesis of asthma, cystic fibrosis, emphysema, α1AT deficiency.
- Kidney: Kidney function tests, pathophysiology, biochemistry, laboratory findings and management in AKI and CKD. Estimation of GFR, glomerular diseases-pathogenesis and mechanisms of glomerular injury, nephrotic syndrome, diabetic nephropathy, tubular disorders, renal tubular acidosis, proteinuria, nephrolithiasis, renal replacement therapy, kidney transplant.
- Gastrointestinal system: Alimentary tract-gastric physiology, pathophysiology of peptic ulcer disease, role of *H. pylori*, gastric function tests, Zollinger Ellison syndrome, nutrient digestion and absorption, evaluation of malabsorption, celiac disease, inflammatory bowel disease, steatorrhea, lactose intolerance, protein losing enteropathy, investigation of maldigestion / malabsorption, GIT regulatory peptides, neuroendocrine tumors.
- Liver: liver tests, hyperbilirubinemias, viral hepatitis, serologic /virologic markers, alcoholic liver disease, fatty liver, chronic liver disease, cirrhosis and its complications, pathogenesis of ascites, hepatic encephalopathy, metabolic diseases affecting liver, Reye's syndrome, diseases of gall bladder/bile ducts-pathogenesis of gallstones.
- Pancreas: acute and chronic pancreatitis, cystic fibrosis, pancreatic function tests.

- Disorders of immune system and joints: SLE - etiology/ pathogenesis/ laboratory tests for autoantibodies, Rheumatoid arthritis – genetics/ pathogenesis/ lab findings, vasculitic syndromes – pathophysiology/lab findings, sarcoidosis, amyloidosis. Osteoarthritis, gout, pseudogout, rheumatic heart disease, scleroderma, synovial fluid analysis
- Bone and mineral metabolism: bone structure and metabolism, calcium, phosphate and magnesium metabolism, regulation and abnormalities, vitamin D, calcitonin, PTH, PTHrP, osteoporosis, markers of bone turnover.
- Nervous system and neurologic disorders: Neurotransmitters and their receptors, ion channels and channelopathies, memory and learning-signaling pathways, neurotrophic factors, excitotoxicity and apoptosis, protein aggregation and neurodegeneration, genetic disorders of CNS, pathophysiology of ischemic stroke, Alzheimer's disease, Parkinson's disease, Huntington's disease, inherited ataxias, amyotrophic lateral sclerosis and other motor neuron diseases, multiple sclerosis. prions and prion diseases, Guillain-Barre syndrome, myasthenia gravis, hereditary myopathies and Duchenne muscular dystrophy, inherited disorders of muscle energy metabolism, mitochondrial myopathies. Biochemistry of olfaction, taste, vision, and touch.
- Psychiatric disorders: anxiety, depression, schizophrenia, neuropsychiatric drugs-biochemical basis of mode of action, biochemical basis of drug, addiction and abuse, CSF analysis.
- Hormones: chemistry, mechanism of action and their role in regulation of metabolism and physiological functions, consequence of hormonal dysfunction, estimation in the laboratory, pituitary, adrenal, and thyroid function tests.
- Therapeutic drug monitoring
- Reproductive related disorders-infertility, pregnancy-maternal and fetal health
- Inborn errors of metabolism
- Clinical toxicology
- Molecular diagnostics
- Liver, kidney, and gastric function tests. pH, buffers and acid base balance, metabolic acidosis and alkalosis, respiratory acidosis and alkalosis.

- Biostatistics and research methodology, their application in research and clinical chemistry, types of study designs, data analysis, correlation & agreement analysis methods, risk analysis methods, calculation of adequate sample size for various study designs, students 't' test, paired 't' test, chi-square test and Fisher's exact test, Non-parametric tests of significance, Statistical aspects of diagnostic tests, Multivariate analysis methods, One way and two way analysis of variance and multiple range tests, Commonly used statistical software for the analysis of bio-medical data.
- Recent advances in all the core areas mentioned in the syllabus above.

B. Practical

i. List of PG practical exercises

- PCR
- DNA isolation and RFLP
- RNA isolation and quality assessment
- Real Time PCR
- Western blotting
- Thin layer chromatography
- HPLC
- Gas chromatography
- Mass spectrometry
- Preparation of competent cells & transformation
- Plasmid preparation & Restriction digestion
- Analysis of genomic data
- Analysis of transcriptomic data
- Serum protein electrophoresis and immunofixation
- Enzyme kinetics
- Basics of cell-culture
- Cell cytotoxicity assays
- Electrophoresis
- ELISA
- PBMC isolation
- Flow cytometry

- Immunofluorescence microscopy
- QC in Clinical Chemistry
- Salt fractionation
- Subcellular fractionation
- Karyotyping and FISH
- HLA-typing
- Therapeutic drug monitoring

ii. List of UG practical exercises (The trainee is expected to be well-versed in all the aspects related to these practical experiments including reagent preparation, standardisation, clinical applications, and problem-solving skills)

- Laboratory instrumentation
- Paper chromatography
- Principles of colorimetry
- Estimation of serum AG ratio
- Serum protein electrophoresis
- Estimation of serum amylase
- Estimation of serum LDH
- Estimation of plasma glucose
- Glucose tolerance test
- Estimation of serum cholesterol
- Urine analysis
- Estimation of serum urea
- Screening for inborn errors of metabolism
- Estimation of serum bilirubin
- Estimation of serum uric acid
- DNA extraction and electrophoresis
- Polymerase chain reaction
- RNA isolation and quality assessment
- Restriction digestion and mapping
- Prenatal Screening and Diagnosis
- RIA and ELISA

- CSF analysis
- ABG analysis
- Point of care testing (UPT/Glucometer/Dipsticks)
- Tumor markers
- Estimation of serum calcium and phosphate
- Estimation of serum ALP
- Estimation of serum electrolytes
- Estimation of serum creatinine
- Estimation of serum ALT
- Iron studies

7. Recommended Books

i. Harper's Illustrated Biochemistry by Victor Rodwell, David Bender, Kathleen Botham, Peter Kennelly and P. Anthony Weil (32nd Edition)
ii. Lippincott Illustrated Reviews Biochemistry by Denise R. Ferrier, Ritu Singh, Rajeev Goyal (South East Asian Edition)
iii. Lehninger Principles of Biochemistry by David L. Nelson, Michael M. Cox (8th Edition)
iv. Biochemistry by Lubert Stryer, Jeremy Berg, John Tymoczko, Gregory Gatto (10th Edition)
v. Biochemistry by Voet and Voet (4th edition)
vi. Textbook of Biochemistry with Clinical Correlations by Thomas M Devlin (7th ed)
vii. Interpretation of Diagnostic tests by Jacques Wallach (South Asian Edition)
viii. Textbook of Biochemistry for Medical students by DM Vasudevan, Sreekumari S, Kannan Vaidyanathan (9th Edition)
ix. Textbook of Medical Biochemistry by SK Gupta (2nd Edition)
x. Manual of Practical Biochemistry for MBBS by SK Gupta (4th Edition)
xi. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics (South east Asian edition)
xii. Clinical Chemistry by Bishop (January 2017)
xiii. Clinical Biochemistry and Metabolic Medicine by Crook (8th Edition)
xiv. Harrison's Principles of Internal Medicine (Vol 1 & Vol 2) (21st Edition)
xv. Varley's Practical Clinical Biochemistry (6th Edition)
xvi. Molecular Cell Biology by H. Lodish (9th edition)
xvii. Molecular Biology of the Gene by James Watson (7th edition)

xviii. The Condensed Protocols: From Molecular Cloning: A Laboratory Manual by Russel Sambrook (January 2006)

xix. Molecular Cloning: A Laboratory Manual (3 Vol Set: Vol I, Vol II, Vol III): 4th Edition

xx. Kuby Immunology by Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby (8th Edition)

xxi. Immunology by Roitt, Brostoff, Male, and Roth (8th edition)

xxii. Robbins & Cotran Pathologic Basis of Disease (South Asia Edition)

xxiii. Goodman and Gilman's The Pharmacological Basis of Therapeutics (13th Edition)

xxiv. Wilson And Walkers Principles and Techniques of Biochemistry and Molecular Biology (8th edition)

xxv. Emery's Elements of Medical Genetics and Genomic (16th Edition)

xxvi. Thompson & Thompson Genetics in Medicine (8th Edition)

xxvii. Understanding Bioinformatics by Marketa J Zvelebil and Jeremy O. Baum (1st Edition)

xxviii. Emery and Rimoin's Principles and Practice of Medical Genetics and Genomics: Perinatal and Reproductive Genetics (7th edition)

xxix. Emery and Rimoin's Principles and Practice of Medical Genetics and Genomics: Cardiovascular, Respiratory, and Gastrointestinal Disorders (7th edition)

xxx. Emery and Rimoin's Principles and Practice of Medical Genetics and Genomics: Hematologic, Renal, and Immunological disorders (7th edition)

xxxi. Emery and Rimoin's Principles and Practice of Medical Genetics and Genomics: Clinical Principles and Applications (7th edition)

xxxii. Emery and Rimoin's Principles and Practice of Medical Genetics and Genomics: Foundations (7th edition)

xxxiii. Emery and Rimoin's Principles and Practice of Medical Genetics and Genomics: Metabolic Disorders (7th edition)

xxxiv. Wintrobe's Clinical Hematology (14th edition)

xxxv. Williams Textbook of Endocrinology (14th edition)

xxxvi. Nelson Textbook of Pediatrics (21st edition)