

**Dr. M.G.R. EDUCATIONAL AND RESEARCH INSTITUTE**

**Deemed to be University**

Maduravoyal, Chennai – 600 095, Tamilnadu, India

(An ISO 2001:2018 Certified Institution)

**University with Graded Autonomy Status**



**SYLLABUS & CURRICULUM**

**for**

**M.D. BIOCHEMISTRY**

**2020 onwards**

**Sponsored by**

**Dr. M.G.R. EDUCATIONAL AND RESEARCH INSTITUTE TRUST**

# **M.D. BIOCHEMISTRY**

## **GOAL**

Training during the course shall equip the students with skills

1. To manage a diagnostic laboratory, able to generate and interpret the laboratory data
2. Contribute in effective patient care by interacting with the clinicians
3. Carry out a research projects and publishing the results in indexed journals
4. Train the student with skills to become an efficient teacher

**OBJECTIVES** : The main objective of the post graduate education in Biochemistry is to understand the molecular events of the life processes and apply this knowledge and skills in solving clinical problems and in scientific research.

## **KNOWLEDGE**

Demonstrate his understanding of the

1. Concepts and principles of general biochemistry:  
This includes molecular motif of a living cell, structural and functional hierarchy of biomolecules and their structure-function relationships. Biochemistry of human nutrition, metabolism, metabolic inter relationships, metabolic homeostasis, molecular and cell biology, body defense against xenobiotics and pathogens, principles of various laboratory estimations, instrumentations and rationale underlying biochemical laboratory investigations.
2. Fundamentals of biostatistics

## **SKILLS**

1. Conduct biochemical laboratory investigations and experimentations relevant to clinical management and biomedical research. Analyze,

interpret and evaluate the data. Rationalize their application in clinical management and experimental research.

2. Plan & conduct theory classes, practical demonstrations, tutorial classes and small group discussions on clinical problems for undergraduate students of medical and allied disciplines.
3. Analyze and solve clinical and experimental problems.
4. Develop literature survey/computer skills.
5. Critical review and comment on research papers
6. Give oral presentations and poster presentation
7. Prepare research protocols, conduct experimental studies

## **METHODOLOGY**

Following methods are used to facilitate learning and training of MD students.

1. **Lectures and tutorials:** Facilitate to acquire knowledge in basic, molecular biology, clinical biochemistry & advances in medicines.
2. Participation in UG laboratory theory and practical teaching and in UG problem based tutorials as a team with faculty in-charge of the department to gain in depth learning, teaching and tutoring experience.
3. **PG Practicals :** Once in a week, under the supervision of in-charge faculty to acquire practical skills
4. Should enroll and certify in Biomedical Research online course conducted by ICMR
5. **Dissertation:** Each PG student shall carry out research work under the supervision of a faculty member of the Department of Biochemistry, recognized by the University as a Guide. The thesis plan shall be submitted to the Dr. M.G.R University within 9 months from the date of admission. Completed thesis shall be submitted to the Dr. M.G.R University six months before the commencement of theory examination
6. **Seminar and Journal club:** Seminar shall be conducted by each PG student once in 15 days to acquire knowledge in basic and clinical

biochemistry and teaching skills. Journal clubs shall be conducted by each PG once in 15 days to acquire familiarity with methodologies, develop skills of presentation, analysis and evaluation of research papers and to update on emerging trends in biochemistry. Record of the same shall be maintained. Seminar and Journal clubs shall be evaluated by the staff using a checklist.

7. Clinical case presentation shall be routinely conducted one in a month from 2<sup>nd</sup> year onwards.
8. **Clinical Update:** To participate in clinical update organized by the Institution, which shall be conducted weekly once on rotation basis by all the Departments of the Medical College and to present a clinical update during the Biochemistry Department turn.
9. **Specialized training in Clinical Biochemistry:** 6 months posting in the Clinical Biochemistry Laboratory to learn sample collection, interpretation of laboratory results, quality control methods, setting up of a clinical biochemistry laboratory, specialized assays, and statistical analysis of data.
10. Special postings to related fraternities for four months during the first year for a period of 15 days to each Department a. Medicine b. Pediatrics c. Cardiology d. Nephrology e. Endocrinology Departments f. Clinical Pathology g. Clinical Microbiology and h. Central Research Laboratory
11. Shall present one poster, one paper in Biochemistry conference and publish one paper in indexed journal, any time during three years tenure.
12. Student shall maintain a logbook and record all the activities done during the course, which shall be submitted to the University after duly signed by the Head of the Department at the time of University Examination.
13. Formative assessment of all the activities shall be done periodically and documented. Final report shall be sent to the University at the end of each term.

**ATTENDANCE** : All the candidates joining the Post Graduate training programme shall work as 'Full Time Residents' during the period of training and shall attend not less than 80%

(Eighty percent) of the imparted training during each academic year including assignments, assessed full time responsibilities and participation in all facets of the educational process.

Following criteria shall be fulfilled by the PG student to be allowed to appear in the final University Examination.

1. Acceptance of the Dissertation
2. One Poster presentation in Biochemistry conference
3. One Paper presentation in Biochemistry conference
4. One paper publication in Indexed journal
5. Candidate shall have minimum 50% marks in Internal Assessment at the end of each term and aggregate of 50% at the end of the course.

## **SYLLABUS (Course Contents)**

### **THEORY**

#### **Paper I**

##### **1. Bio physical chemistry:**

- i. Water, pH, buffers, surface tension, osmosis, diffusion, viscosity, covalent and non-covalent interactions, atomic & molecular weight, Principles of thermodynamics, Donnan membrane equilibrium.
- ii. Henderson – Hasselbalch equation. Principles and procedures of determination of pH, pO<sub>2</sub>, pCO<sub>2</sub>, (blood gas analysis)
- iii. Isotopes – detection and measurement of stable and radioactive isotopes; their application in biochemistry.

- iv. Bioenergetics- free energy change, high energy linkages, redox potentials.

## 2. **Bio-organic Chemistry**

- i. Structure and function of cell, cell membrane and subcellular organelles, cytoskeleton, Cell fractionation: isolation and purification of sub cellular particles, biochemical markers of different subcellular organelle. Different mechanisms of Transport across the cell membrane.
- ii. **Carbohydrates:** Biological importance of carbohydrates. Chemistry, structure, functions and properties of monosaccharides, disaccharides and polysaccharides. Significance of heteropolysaccharides.
- iii. **Proteins:** Properties, functions, and different types of classification of amino acids. Functions, properties, structural organization of Proteins. Determination of Amino acid sequence of proteins and other structural organization of proteins. Structure of insulin, collagen, hemoglobin and myoglobin. Biologically important peptides. Different types of classification of proteins. Plasma proteins – Albumin (functions, clinical significance), globulins (alpha, beta, gamma), structure and functions of immunoglobulins. Separation of serum proteins by electrophoresis, acute phase proteins.
- iv. **Lipids:** Biological importance of lipids. Classification of lipids, chemistry, structure, properties and functions of simple, compound and derived lipids. Chemistry and functions of steroids and lipoproteins.
- v. **Nucleic acids:** Biological importance of nucleic acids. Structure of nucleic acids (RNA, DNA and biologically important nucleotides).

Methods of study of base sequence of DNA. Structure and functions of gene with respect to mammalian genome.

### **3. Biochemical techniques:**

- i. Ultracentrifugation techniques: their applications in the study of lipoproteins.
- ii. Principles and applications of Photometry and spectrophotometry, atomic absorption spectrophotometry, Flame photometry, Turbidometry and Nephelometry. Semi Auto Analyzer, Auto Analyzers
- iii. Chromatography: principles and applications of different types of chromatography techniques
- iv. Electrophoresis: principles, procedures, and applications different types of electrophoresis
- v. Principle and applications of Ion selective electrodes
- vi. Principles, procedures, types and applications Radio immune assay, ELISA, Chemiluminescence.
- vii. Techniques in Molecular Biology and their clinical applications: Principle and Procedure of Recombinant DNA technology, blotting techniques, PCR, DNA and protein sequencing, microarrays, DNA chip technology, cloning techniques, genomics, proteomics and metabolomics. Basics and applications of Nanotechnology and Nanoparticles - in medicine and research.
- viii. Recent advances in Instrumentation: Mass spectrometry, NMR, SPECT, PET scans
- ix. Bioinformatics and Computational biology – Basics, application in medicine and research

- x. Cytogenetics – Karyotyping, FISH, centromeric probes, chromosome painting probes etc.
- xi. Cell culture techniques
- xii. Microscopy – light, electron, fluorescent
- xiii. Flow cytometry

#### **4. Biostatistics and research methodology**

- i. Basic concepts of biostatistics as applied to health science
- ii. Statistical tests: t-test, analysis of variance, chi-square test, non-parametric tests, correlation and regression , Statistical methods of validation of diagnostic tests • Basics of epidemiological study designs and sampling methodologies, Meta-analysis and systematic reviews  
Basics of medical education in teaching and assessment of biochemistry  
Principles of adult learning, taxonomy of learning, educational objectives, principles of assessment and question paper setting, methods of assessing knowledge, appropriate use of media, microteaching, small group teaching. Environmental Biochemistry: Health and pollution.

### **Paper II**

#### **Enzymes, Vitamins, Metabolism, Biological oxidation**

##### **1. Enzymes**

- i. Classification, kinetics, specificity of enzymes. Active site of enzyme. Methods to identify the functional groups of active sites. Coenzymes. Mechanism of enzyme action in detail. Factors affecting enzyme catalyzed reactions, Michaelis - Menten constant, Line weaver- Burk plot. Enzyme inhibitions- competitive, non-competitive, uncompetitive, and allosteric; mechanism and application. Enzyme poisons. Regulation of enzyme action.



- ii. Isoenzymes
- iii. Immobilized enzymes- application.

## **2. Vitamins**

Fat soluble vitamins: chemistry, sources, RDA, biochemical functions, deficiency manifestations and toxicity.

Water soluble vitamins and Vitamin C: chemistry, sources, RDA, biochemical functions, deficiency manifestations, Antivitamins .

## **3. Metabolism**

- i. Introduction to intermediary metabolism, various methods of study of intermediary metabolism with examples, their advantages and disadvantages.
- ii. Digestion and absorption of carbohydrate, lipids and proteins
- ii. Carbohydrate Metabolism: A detailed account of metabolic pathways, their significance and regulation: Glycolysis, TCA cycle, Glycogenesis, Glycogenolysis, Gluconeogenesis, HMP shunt pathway, Uronic acid pathway, polyol pathway, Metabolism of fructose and galactose.

### **Metabolism of ethanol**

- iii. Lipid metabolism: Biosynthesis and different types of oxidation of Fatty acids biosynthesis of triacylglycerol. Biosynthesis and degradation of phospholipids. Metabolism of cholesterol. Formation and functions of Bile salts. Metabolism of Plasma lipoproteins, role of adipose tissue and liver in fat metabolism. Role of lipids in atherogenesis, Metabolism of eicosanoids.
- iv. Amino acid metabolism: Catabolism of amino acids, Urea cycle and its disorders, Hepatic coma, Blood urea, One carbon compound. Metabolism of all the individual amino acids.

- vi. Integration of metabolic pathways of carbohydrate, protein, and lipid.
  - v. Biosynthesis and catabolism of purine and pyrimidine nucleotides.
4. **Biological Oxidation** : Electron transport chain, mechanisms of electron transport and oxidative Phosphorylation. Regulation of oxidative Phosphorylation.
  5. Metabolism in fed and fasting states in Liver, adipose tissue, brain, RBCs

**Paper III: Molecular biology, molecular and genetic aspects of cancer, immunology and effects of environmental pollutants on the body**

**Structure and organization of chromosomes and chromatin re-modelling**

Molecular Biology, Molecular and genetic aspects of cancer, immunology and effects of environmental pollutants on the body Structure and organization of chromosomes and chromatin re-modelling DNA replication

• **DNA replication**

• DNA replication in prokaryotes and eukaryotes (including important differences between the two): • Roles of DNA polymerase, helicase, primase, topoisomerase and DNA ligase • Replication fork • Okazaki fragments and its importance in replication. • Overview of role of major DNA repair mechanisms – mismatch repair, base excision repair, nucleotide excision repair and double strand break repair. • Diseases associated with abnormalities of DNA repair systems • DNA recombination

**Transcription-** Structure of a gene - exons and introns, promoter, enhancers/repressors and response elements.

Process of transcription in prokaryotes and eukaryotes – initiation, elongation, and termination (including important differences). • Post-transcriptional processing – capping, tailing and splicing.

**Genetic code and mutations** • Characteristics of the genetic code • Molecular basis of degeneracy of the genetic code (Wobble hypothesis) • Mutagens – examples of physical, chemical and biological mutagens. • Types of mutations – point mutations and chromosomal mutations • Relationship of mutations with specific diseases

**Translation** – Basic structure of prokaryotic and eukaryotic ribosomes. • Structure of tRNA (diagram of clover leaf model of tRNA structure) and its function in protein synthesis. • Function of aminoacyl tRNA synthase. • Process of protein synthesis (translation) – initiation, elongation and termination (including important differences between prokaryotic and eukaryotic translation). • Inhibition of prokaryotic translation by antibiotics. • Post-translational modifications Regulation of gene expression in prokaryotes and eukaryotes • The operon concept in prokaryotes • Role of general and gene specific transcription factors • Small interference RNA (siRNA) and micro RNA (miRNA). • Other modes of regulation of gene expression: alternative splicing, alternative promoter usage, DNA methylation, Histone acetylation / deacetylation, RNA editing, alterations of RNA stability Recombinant DNA technology and its applications in modern medicine • Concepts of recombinant DNA, genetic engineering, biotechnology and cloning. • Restriction endonucleases. • Vectors for cloning – plasmids and phages. • Genomic and cDNA libraries. • Applications of recombinant DNA technology in medicine. • Gene therapy • Diagnosis of genetic diseases and genetic counseling • DNA fingerprinting • DNA sequencing • Microarrays • Fluorescent in situ hybridization (FISH) • DNA vaccines • Transgenic animals • Application of molecular techniques in forensic investigation and medicolegal cases.

Overview of Human Genome Project Basics of bioinformatics Principles of human genetics • Alleles, genotypes and phenotypes • Patterns of inheritance: monogenic and polygenic inheritance • Population genetics • Genetic factors in causation of diseases • Types of genetic diseases: Chromosomal, monogenic and

polygenic disorders, mitochondrial disorders, nucleotide repeat expansion disorders, imprinting disorders • Screening for genetic diseases and prenatal testing • Ethical and legal issues related to medical genetics Stem cells in clinical medicine • Basic concepts regarding stem cells • Types of stem cells: embryonic and induced pluripotent stem cells (iPSC) • Potential applications in the clinical medicine • Ethical and legal issues related to use of stem cells in medicine Cancer • Carcinogens: physical, chemical and biological • Clonal origin of cancers 15 • Genetic basis of carcinogenesis • Role of oncogenes and tumour suppressor genes • Familial cancer syndromes • Cancer stem cells • Epigenetic regulation in cancer • Gene expression profiling in cancer • Cancer cell biology: cell cycle abnormalities, telomerase activity, proliferative capacity and decreased apoptosis • Metastasis • Tumor markers • **Biochemical basis of cancer chemotherapy and drug resistance**

• New methods of anti-cancer therapy: targeted cancer therapy, cancer immunotherapy. Immunology • Innate and acquired immunity • Humoral and cell-mediated immunity • Cells and organs of the immune system - T and B cells, macrophages, dendritic cells, NK cells, granulocytes • Antigens, epitopes and haptens • Immunoglobulin classes, isotypes, allotypes, idiotypes, monoclonal antibodies, organization and expression of immunoglobulin genes, immunoglobulin gene rearrangement, class switching • Antigen-antibody interaction - immunochemical techniques • Major histocompatibility complex, antigen processing and presentation, • T cell and B cell receptor, toll like receptors • T cell maturation/activation/differentiation • B cell generation/activation/differentiation • Cytokines • Complement system, cell • Immune response to infections • Hypersensitivity reactions • Vaccines • Immuno-deficiency syndromes 16 • Autoimmunity • Transplantation immunology • Cancer and immune system, • Immunodiagnostics • Immunotherapy

## **Paper 4 - Clinical Biochemistry**

### **1. Clinical laboratory management**

- i. Specimen collection and processing
  - ii. Preanalytical variables and biological variables
  - iii. Reference range
  - iv. Clinical utility of all lab tests and
  - v. Setting up of clinical chemistry lab
  - vi. Evidence based laboratory medicine
  - vii. Total quality management
  - viii. Instrumentation, Automation, POCT, Quality control
  - ix. Biomedical waste management
- 2) Detailed account of Clinical Enzymology
  - 3) Inborn errors of metabolism involving carbohydrate, lipid, amino acid, purine, pyrimidine and porphyrin metabolism, mucopolysaccharidoses.
  - 4) Plasma lipoproteins in health and disease.
  - 5) Liver and Kidney function tests.
  - 6) **Endocrines** - A detailed account of the mechanism of action, chemistry and regulatory role of hormones secreted by pituitary, pancreas, adrenal, thyroid, parathyroid and gonads. Endocrine disorders, Methods of assay and clinical interpretations.
  - 7) **Immunology**-Basic immunology, Immune system, T&B Lymphocytes, antigen presenting cells, humoral immunity, cell mediated immunity, cytokines, lymphokines. Immune regulation. Monoclonal antibodies, application of immunological techniques, Complement system, Molecular mechanisms of antibody production, Transposition of genes, Somatic recombination, and molecular structure of antigens, HLA antigens, Immunodeficiency states, monoclonal and polyclonal gammopathy.

- 8) Disorders of calcium and phosphorus metabolism.
- 9) Water and electrolyte balance, acid base balance- their disturbances.
- 10) Composition of CSF, alterations in disease.
- 11) Cancer Biology: Biochemical aspects of cancer. Tumor markers, Oncogenes, tumor suppressor genes, biochemical tests for cancer.

**12) Systemic biochemistry:**

Biochemical basis of normal physiological functions, pathophysiology, complications, laboratory evaluation, biomarkers of various systemic disorders:

- a. Regulation of blood glucose level, Diabetes mellitus (types, pathogenesis, clinical manifestations, complications and their pathogenesis, diagnosis – laboratory tests) Hypoglycemia
- b. Obesity – Risk factors, metabolic derangements, genetics, hormonal regulation of adipose tissue metabolism, hormonal regulation of eating behavior, adipokines
- c. Metabolic syndrome
- d. Cardiovascular system – Atherosclerosis, Acute coronary syndrome, Myocardial infarction, Dyslipidemia and cardiovascular risk assessment, shock, Hypertension, congestive heart failure
- e. Nervous system – Parkinsons disease, Schizophrenia, Myasthenia gravis, Huntington disease, Alzheimers disease, Stroke, Epilepsy
- f. Renal system - Acute and chronic kidney disease, Glomerulonephritis, Nephrotic syndrome, Renal tubular acidosis, Renal stones, Renal transplantation
- g. Hepatobiliary system – Jaundice, Hepatitis, fatty liver, cirrhosis, hepatic coma, Gall stones and Cholestasis.

- h. Pregnancy and reproductive endocrinology – Prenatal diagnosis, Screening tests, Pregnancy induced hypertension, anemia, gestational diabetes, Infertility
  - a. Biochemical processes in pediatric and geriatric population
  - b. Newborn screening and Inborn errors of metabolism

13) Therapeutic drug monitoring

14) Clinical Toxicology

## **PRACTICALS**

### **Part 1 - General Biochemistry**

1. Estimation of amino acids by ninhydrin method.
2. Estimation of protein by Biuret method.
3. Estimation of protein by dye-binding method.
4. Color reactions of proteins
5. Amino acid-paper chromatography, TLC. Two-Dimensional paper chromatography.
6. Gross separation of proteins- precipitation by salts.
7. Paper electrophoresis.
8. Separation of mono and disaccharides by paper chromatography.
9. Cholesterol estimation.
10. Estimation of triglycerides and phospholipids.
11. Isolation of DNA.
12. HbA1c by HPLC method
13. Estimation of vitamin D.
14. Estimation of vitamin B12.
15. Estimation of Folic acid.
16. Assay of serum Lipase.

17. Enzyme inhibitions.
18. Effect of pH, temperature on enzyme activity: Determination of  $K_m$ ,  $V_{max}$ .
19. PCR
20. Immunofluorescence.
21. ELISA.

## **Part – II: Clinical Biochemistry**

1. Estimation of Plasma Glucose – Glucose oxidase method
2. Plasma Urea method – Urease method
3. Plasma Uric acid – Uricase method
4. Serum Creatinine – Jaffe's Kinetic and end point methods
5. Cholesterol/ HDL Cholesterol by enzymatic method
6. Albumin/ Globulin ratio
7. Serum Calcium
8. ISE: Na, K, Cl \_ determination
9. Serum Bilirubin – direct and indirect
10. Alkaline and Acid phosphatases
11. AST, ALT; UV kinetic methods and Colorimetric assay of Gamma GT
12. Estimation of LDH, CPK isoenzymes
13. Serum Amylase – Somoyogi Amylolytic method
14. Iron and Iron binding capacity
15. Estimation of serum Ferritin by CLIA
16. Agar gel electrophoresis of serum proteins, Hb
17. Pleural fluid analysis
18. Creatinine clearance
19. Plasma Cl,  $HCO_3$ , pH,  $PO_2$ ,  $PCO_2$ . Blood gas analysis



20. CSF analysis
21. Urine analysis
22. Stone analysis
23. Thyroid profile by chemiluminescence/ELISA
24. Fertility profile by chemiluminescence/ELISA
25. Tumor markers – PSA,  $\beta$ -hCG by chemiluminescence
26. Cardiac troponin by chemiluminescence

## **TEACHING AND LEARNING METHODS**

Active and interactive learning should be the mainstay of the program.

The following methods are to be used to facilitate learning by and training of MD students.

1. Interactive lectures, tutorials, problem-based learning, case discussions, seminars, guest lectures, E-learning.  
The above teaching learning methods should be employed for the post graduate students to acquire updated knowledge on various aspects of basic and clinical biochemistry, immunology and molecular biology, and their application in modern medicine and also to learn to communicate effectively.
2. Journal club Journal club sessions should be used by post graduate students to learn to search medical literature, to learn how scientific data is to be disseminated, to develop skills in presentation of research papers, to critically analyse and evaluate data, to become familiar with research methodologies, to keep oneself updated on new developments/emerging trends in biochemistry and to learn to communicate effectively
3. Practical exercises These exercises should be used by post graduate students to equip themselves with knowledge and hand-on skills in various techniques used for laboratory bench-work in 21 biochemistry and

molecular biology and in a diagnostic laboratory, and to learn to analyze and interpret data obtained.

4. Thesis Under the supervision of a professor or Associate Professor in the Department of Biochemistry, each PG student is expected to generate a hypothesis/research question and design a research protocol to test/answer 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.
5. Presentation of work done on thesis to peers A post graduate student of a postgraduate degree course in broad specialities/super specialities would be required to present one poster presentation, to read one paper at a national/state conference and to present one research paper which should be published/accepted for publication/sent for publication during the period of his postgraduate studies so as to make him eligible to appear at the postgraduate degree examination.
6. Teaching of undergraduates  
Postgraduate students in Biochemistry shall be required to 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.
7. Horizontal and vertical integration of teaching of Biochemistry with other preclinical, para-clinical and clinical departments The post graduate students should take part in integrated teaching of undergraduates by participation in joint teaching sessions and seminars with different

- departments, participation in clinical rounds for discussing cases of interest and by small group discussions of case-based problems.
8. Training in the basics of medical education and technology The post graduate students may be provided with training in the basics of medical education and technology through workshops at the departmental and/or institutional level.
  9. Development of communication skills The post graduate students should develop effective communication skills by making presentations at seminars and journal club sessions and by teaching undergraduates.
  10. Training in clinical Biochemistry: The post graduate students should receive hands-on training in a diagnostic laboratory in Biochemistry; such training should be extensive and rigorous enough for each post graduate student to acquire adequate skills and expertise to manage and supervise such a laboratory. The post graduate students should be posted in all sections of the laboratory in the institution, starting from sample collection and processing. They should become proficient in working with the autoanalysers in the laboratory, in quality control methods, setting up of a clinical biochemistry laboratory, specialized assays and statistical analysis of data. It would also be desirable for them to acquire experience in running a 24-hours diagnostic laboratory; towards this end, it would help if they are posted in the laboratory out of regular hours as well.
  11. Rotation in clinical departments It would be desirable for the post graduate students to be posted in clinical departments after their training period in the diagnostic laboratory, for up to 3 months of the course. Suggested departments and durations of postings are as follows: General medicine (1 month which includes endocrinology and intensive care units), Hematology (1 month), Routine Microbiology (1 month), Pediatrics (10 days). These postings will help post graduate students get a

better perspective on diagnostic tests in clinical practice and will enable them to contribute more effectively to patient care.

12. Logbook: All post graduate students should maintain a log book that documents all the work that they have done during their years of training. This logbook should be checked and assessed periodically by the faculty members involved in the training programme.
13. Department should encourage e-learning activities. During the training programme, patient safety is of paramount importance, therefore skills are to be learnt initially on the models, later to be performed under supervision followed by performing independently; for this purpose, provision of skills laboratories in medical colleges is mandatory.

### **FORMATIVE ASSESSMENT**

During the training General Principles Internal Assessment should be frequent, cover all domains of learning and used to provide feedback to improve learning; it should also cover professionalism and communication skills. The Internal Assessment should be conducted in theory and practical/clinical examination. Quarterly assessment during the MD training should be based on:

1. Journal based / recent advances learning
2. Patient based /Laboratory or Skill based learning
3. Self directed learning and teaching
4. Departmental and interdepartmental learning activity
5. External and Outreach Activities / CMEs

<b>Sl.No.</b>	<b>Contents</b>	<b>Marks</b>
1.	Personal Attributes	20
2.	Practical Work	20
3.	Academic activities	20
4.	End of term theory examination (conducted for 100 marks)	20
5.	End of term practical examination (conducted for 100 marks)	20
	<b>Total Marks</b>	<b>100 marks</b>

**SUMMATIVE ASSESSMENT**  
**UNIVERSITY EXAMINATION**

**A. THEORY EXAMINATION: (400 Marks)**

There shall be four question papers, each of three hours duration. Each paper shall consist of 10 short essay questions carrying 10 marks each. Total marks for each paper will be 100.

Paper I	- 100 Marks
Paper II	- 100 Marks
Paper III	- 100 Marks
Paper IV	- 100 Marks
<b>Total</b>	<b>400 Marks</b>

The distribution of topics/chapters for the papers shall be as under:

**Paper-I-** Biomolecules, cell biology, biochemical techniques, biostatistics and research methodology, basics of medical education in teaching and assessment of biochemistry

**Paper-II** – Enzymes, bioenergetics, biological oxidation, metabolism of biomolecules, intermediary metabolism and regulation, inborn errors of metabolism and nutrition

**Paper-III** – : Molecular biology, molecular and genetic aspects of cancer, immunology and effects of environmental pollutants on the body

**Paper- IV** – Clinical biochemistry and molecular diagnostics related to different body systems/organs, endocrinology, and recent advances in biochemistry

**Note:** The topics assigned to the different papers are given as general guidelines. A strict division of subjects may not be possible. Some overlapping of topics is inevitable. Students should be prepared to answer the overlapping topics.

## B. PRACTICAL EXAMINATION AND VIVA VOCE EXAMINATION

200 marks + 100 marks = 300 marks

The practical examinations will be held over 2 days; one day will be mainly for the practical exercises and the second day for the oral/ viva voce.

Part	Topics	Marks
<b>Part I: Laboratory procedures in General Biochemistry</b>		
	1. Qualitative Identification of any Biological fluid (urine, CSF, Pleural fluid) –interpretation and discussion.	20 Marks
	2. Interpretation of clinical data from cases on liver function, renal function, thyroid function, cardiac diseases, endocrine diseases, electrolyte and acid base disorders, analysis of body fluids, lipid profile, vitamin deficiencies, mineral metabolism, nutritional disorders etc.	(10 cases X 4marks) 40 Marks
	3. Experiments involving chromatography or electrophoresis. Separation and identification of amino acids or carbohydrates by chromatography or separation and interpretation of serum proteins, lipoproteins, isoenzymes of (LDH & CPK) by electrophoresis	40 marks
<b>Total Marks of Part I</b>		100 marks
<b>Part II</b>		
<b>Clinical Examination of a patient and relevant investigations in clinical Biochemistry.</b>		
Each candidate is expected to perform clinical examination and list the laboratory investigations he/she deems appropriate for the case. The candidate presents the case to the examiners would select two or three laboratory investigations, which the candidate will conduct.		

	1. Clinical examination and Discussion (Thirty minutes)	25 Marks
	2. Clinical Biochemistry (Three Relevant Biochemical Investigations : Standardization of one parameter and estimation of two parameters)	(3 X 25 marks) 75 marks
<b>Part II Total Marks</b>		100 Marks
<b>Part III.</b>		
<b>a. Viva –Voce:</b>		
Viva- Voce examination shall be conducted conjointly by all the examiners to test comprehension, analytical approach, expression and interpretation of facts. Student shall also be given case reports, charts for interpretation. It includes discussion on dissertation.		
	<b>Viva-Voce Examination:</b>	<b>80 Marks</b>
<b>b. Pedagogy:</b>		
A topic shall be given to each candidate along with the Practical Examination question paper on the first day. Student is asked to make a presentation on the topic on the second day for 20 minutes.		
	<b>Pedagogy Exercise</b>	<b>20 Marks</b>
<b>Part III Total Marks</b>		100 marks
<b>Grand Total (Part I, II and III)</b>		<b>300 Marks</b>

Maximum marks for M.D. Biochemistry	Theory	Practical & Viva	Grand Total
	400	300 (Practical – 200 & Viva – 100)	700

### MARKS QUALIFYING FOR A PASS

Obtaining a minimum of 40% marks in each theory paper and not less than 50% cumulatively in all the four papers for degree examination. Obtaining of 50% marks in Practical examination shall be mandatory for passing the examination as a whole in the degree examination.

## RECOMMENDED BOOKS FOR REFERENCE

1. Principles of Biochemistry. Ed Lehninger, Nelson and Cox. CBS publishers and distributors.
2. Harper's Biochemistry. Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell. Appleton
3. Tietz Textbook of Clinical Chemistry. Ed Burtis and Ashwood. W.B. Saunders Company.
4. Principles and techniques of practical biochemistry. Ed Keith Wilson and John Walker. Cambridge
5. Clinical Biochemistry by Varley
6. Text Book of Biochemistry by Vasudevan
7. Text Book of Biochemistry by Stryer
8. Text book of Biochemistry by Lippincott
9. Textbook of Biochemistry with Clinical Correlations. Ed. Thomas M. Devlin. Wiley-Liss Publishers.
10. Biochemistry Ed Lubert Stryer. W.H. Freeman and Company, New York. University Press
11. Genes VI. Ed Benjamin Lewin. Oxford University Press.
12. Biochemistry. Ed Donald Voet and Judith G. Voet. John Wiley & sons, Inc.
13. Molecular Cloning - A Laboratory Manual. J. Sambrook, E.F. Fritsch and T. Maniatis. Cold
14. Spring Harbor Laboratory Press.
15. Molecular Cell Biology, H. Lodish, A. Berk, S.L. Zipursky, P. Matsudaira, D. Baltimore, J. Darnell