MAHATMA GANDHI UNIVERSITY
of
MEDICAL SCIENCES & TECHNOLOGY
JAIPUR

Syllabus

MD – BIOCHEMISTRY

(3 Years Post Graduate Degree Course)

Notice

1. Amendment made by the Medical Council of India in Rules/Regulations of Post Graduate Medical Courses shall automatically apply to the Rules/Regulations of the Mahatma Gandhi University of Medical Sciences & Technology (MGUMST), Jaipur.

2. The University reserves the right to make changes in the syllabus/books/guidelines, fees-structure or any other information at any time without prior notice. The decision of the University shall be binding on all.

3. The Jurisdiction of all court cases shall be Jaipur Bench of Hon'ble Rajasthan High Court only.

RULES & REGULATIONS
MD BIOCHEMISTRY (9100)
(3 Years Post Graduate degree course)

TITLE OF THE COURSE:
It shall be called Doctor of Medicine.

ELIGIBILITY FOR ADMISSION:
No candidate of any category (including NRI quota) shall be eligible for admission to MD/MS courses, if he or she has not qualified NEET PG (MD/MS) conducted by National Board of Examinations or any other Authority appointed by the Government of India for the purpose.

(1) **General Seats**

(a) Every student, selected for admission to postgraduate medical course shall possess recognized MBBS degree or equivalent qualification and should have obtained permanent Registration with the Medical Council of India, or any of the State Medical Councils or should obtain the same within one month from the date of his/her admission, failing which the admission of the candidate shall be cancelled;

(b) Completed satisfactorily one year's rotatory internship or would be completing the same before the date announced by the University for that specific year as per MCI rules after passing 3rd professional MBBS Part II Examination satisfactorily.

(c) In the case of a foreign national, the Medical Council of India may, on payment of the prescribed fee for registration, grant temporary registration for the duration of the postgraduate training restricted to the medical college/institution to which he/she is admitted for the time being exclusively for postgraduate studies; however temporary registration to such foreign national shall be subject to the condition that such person is duly registered as medical practitioner in his/her own country from which he has obtained his basic medical qualification and that his degree is recognized by the corresponding Medical Council or concerned authority.

(2) **NRI Seats**

(a) Students from other countries should possess passport, visa and exchange permits valid for the period of their course of study in this Institution and should also observe the regulations of both central and state governments regarding residential permits and obtain no-objection certificate from the same.

(b) The candidate should have a provisional "Student Visa". If he comes on any other visa and is selected for admission, he will have to first obtain a student visa from his country and then only he will be allowed to join the course. Therefore it is imperative to obtain provisional student visa before coming for Counseling.

(c) This clause is applicable to NRI/Foreign Students only.

CRITERIA FOR SELECTION FOR ADMISSION:

(1) **NRI Quota**

15% of the total seats are earmarked for Foreign National / PIO / OCI/ NRI / Ward of NRI/NRI sponsored candidates who would be admitted on the basis of merit obtained in NEET PG or any other criteria laid down by Central Government/MCI.

(2) Remaining Seats (Other than NRI Quota Seats)

(a) Admissions to the remaining 85% of the seats shall be made on the basis of the merit obtained at the NEET conducted by the National Board of Examinations or any other Authority appointed by the Government of India for the purpose.
(b) The admission policy may be changed according to the law prevailing at the time of admission.

COUNSELING/INTERVIEW:

(1) Candidates in order of merit will be called for Counseling/Interview and for verification of original documents and identity by personal appearance.
(2) Counseling will be performed and the placement will be done on merit-cum-choice basis by the Admission Board appointed by the Government of Rajasthan.

RESERVATION:

Reservation shall be applicable as per policy of the State Government in terms of scheduled caste, scheduled tribe, back ward class, special back ward class, women and handicapped persons.

ELIGIBILITY AND ENROLMENT:

Every candidate who is admitted to MD/MS course in Mahatma Gandhi Medical College & Hospital shall be required to get himself/herself enrolled and registered with the Mahatma Gandhi University of Medical Sciences & Technology after paying the prescribed eligibility and enrolment fees.

The candidate shall have to submit an application to the MGUMST for the enrolment/eligibility along with the following original documents with the prescribed fees (upto November 30 of the year of admission without late fees and upto December 31 of the year of admission with late fees) –

(a) MBBS pass Marks sheet/Degree certificate issued by the University (Ist MBBS to Final MBBS)
(b) Certificate regarding the recognition of medical college by the Medical Council of India.
(c) Completion of the Rotatory Internship certificate from a recognized college.
(d) Migration certificate issued by the concerned University.
(e) Date of Birth Certificate
(f) Certificate regarding registration with Rajasthan Medical Council / Medical Council of India / Other State Medical Council.

REGISTRATION

Every candidate who is admitted to MD/MS course in Mahatma Gandhi Medical College & Hospital shall be required to get himself/herself registered with the Mahatma Gandhi University of Medical Sciences & Technology after paying the prescribed registration fees.

The candidate shall have to submit an application to the MGUMST for registration with the prescribed fees (upto November 30 of the year of admission without late fees upto December 31 of the year of admission with late fees).

DURATION OF COURSE:

The course shall be of 3 years duration from the date of commencement of academic session.

PERIOD OF TRAINING:

The period of training for obtaining Post graduate degrees (MD/MS) shall be three completed years including the period of examination.

MIGRATION:
No application for migration to other Medical Colleges will be entertained from the students already admitted to the MD/MS course at this Institute.

METHODS OF TRAINING FOR MD/MS:
Method of training for MD/MS courses shall be as laid down by the Medical Council of India.

ONLINE COURSE IN RESEARCH METHODS

i. All postgraduate students shall complete an online course in Research Methods to be conducted by an Institute(s) that may be designated by the Medical Council of India by way of public notice, including on its website and by Circular to all Medical Colleges. The students shall have to register on the portal of the designated institution or any other institute as indicated in the public notice.
ii. The students have to complete the course by the end of their 2nd semester.
iii. The online certificate generated on successful completion of the course and examination thereafter, will be taken as proof of completion of this course
iv. The successful completion of the online research methods course with proof of its completion shall be essential before the candidate is allowed to appear for the final examination of the respective postgraduate course.
v. This requirement will be applicable for all postgraduate students admitted from the academic year 2019-20 onwards

ATTENDANCE, PROGRESS AND CONDUCT:

(1) **Attendance:**

(a) 80% attendance in each course is compulsory. Any one failing to achieve this, shall not be allowed to appear in the University examination.
(b) A candidate pursuing MD/MS course shall reside in the campus and work in the respective department of the institution for the full period as a full time student. No candidate is permitted to run a clinic/work in clinic/laboratory/ nursing home while studying postgraduate course. No candidate shall join any other course of study or appear for any other examination conducted by this university or any other university in India or abroad during the period of registration. Each year shall be taken as a unit for the purpose of calculating attendance.
(c) Every candidate shall attend symposia, seminars, conferences, journal review meetings, grand rounds, CPC, CCR, case presentation, clinics and lectures during each year as prescribed by the department and not absent himself / herself from work without valid reasons. Candidates should not be absent continuously as the course is a full time one.

(2) **Monitoring Progress of Studies- Work diary/Log Book:**

(a) Every candidate shall maintain a work diary in which his/her participation in the entire training program conducted by the department such as reviews, seminars, etc. has to be chronologically entered.
(b) The work scrutinized and certified by the Head of the Department and Head of the Institution is to be presented in the University practical/clinical examination.

(3) **Periodic tests:**

There shall be periodic tests as prescribed by the Medical Council of India and/ or the Board of Management of the University, tests shall include written papers, practical/clinical and viva voce.

(4) **Records:**
Records and marks obtained in tests will be maintained by the Head of the Department and will be made available to the University when called for.

THESIS:

(1) Every candidate pursuing MD/MS degree course is required to carry out work on research project under the guidance of a recognized post graduate teacher. Then such a work shall be submitted in the form of a Thesis.
(2) The Thesis is aimed to train a postgraduate student in research methods & techniques.
(3) It includes identification of a problem, formulation of a hypothesis, designing of a study, getting acquainted with recent advances, review of literature, collection of data, critical analysis, comparison of results and drawing conclusions.
(4) Every candidate shall submit to the Registrar of the University in the prescribed format a Plan of Thesis containing particulars of proposed Thesis work within six months of the date of commencement of the course on or before the dates notified by the University.
(5) The Plan of Thesis shall be sent through proper channel.
(6) Thesis topic and plan shall be approved by the Institutional Ethics Committee before sending the same to the University for registration.
(7) Synopsis will be reviewed and the Thesis topic will be registered by the University.
(8) No change in the thesis topic or guide shall be made without prior notice and permission from the University.
(9) The Guide, Head of the Department and head of the institution shall certify the thesis. Three printed copies and one soft copy of the thesis thus prepared shall be submitted by the candidate to the Principal. While retaining the soft copy in his office, the Principal shall send the three printed copies of the thesis to the Registrar six months before MD/MS University Examinations. Examiners appointed by the University shall evaluate the thesis. Approval of Thesis at least by two examiners is an essential pre-condition for a candidate to appear in the University Examination.
(10) Guide: The academic qualification and teaching experience required for recognition by this University as a guide for thesis work is as laid down by Medical Council of India/Mahatma Gandhi University of Medical Sciences & Technology, Jaipur.
(11) Co-guide: A co-guide may be included provided the work requires substantial contribution from a sister department or from another institution recognized for teaching/training by Mahatma Gandhi University of Medical Sciences & Technology, Jaipur/Medical Council of India. The co-guide shall be a recognized postgraduate teacher.
(12) Change of guide: In the event of a registered guide leaving the college for any reason or in the event of death of guide, guide may be changed with prior permission from the University.

ELIGIBILITY TO APPEAR FOR UNIVERSITY EXAMINATION:

The following requirements shall be fulfilled by every candidate to become eligible to appear for the final examination:

(1) Attendance: Every candidate shall have fulfilled the requirement of 80% attendance prescribed by the University during each academic year of the postgraduate course. (as per MCI rules)
(2) Progress and Conduct: Every candidate shall have participated in seminars, journal review meetings, symposia, conferences, case presentations, clinics and didactic lectures during each year as designed by the department.
(3) Work diary and Logbook: Every candidate shall maintain a work diary for recording his/her participation in the training program conducted in the department. The work diary

and logbook shall be verified and certified by the Department Head and Head of the Institution.

(4) Every student would be required to present one poster presentation, to read one paper at a National/State Conference and to have one research paper which should be published/accepted for publication/ sent for publication to an indexed journal during the period of his/her post graduate studies so as to make him/her eligible to appear at the Post Graduate Degree Examination.

(5) Every student would be required to appear in and qualify the Pre-University Post graduate degree Mock examination. Post graduate students who fail to appear in or do not qualify the Pre-University Post graduate degree Mock examination shall not be permitted to appear in the final examination of the University.

The certification of satisfactory progress by the Head of the Department/ Institution shall be based on (1), (2), (3), (4) and (5) criteria mentioned above.

ASSESSMENT:

(1) The progress of work of the candidates shall be assessed periodically by the respective guides and report submitted to the Head of the Institution through the Head of the Department at the end of every six months. The assessment report may also be conveyed in writing to the candidate who may also be advised of his/her shortcomings, if any.

(2) In case the report indicate that a candidate is incapable of continuing to do the work of the desired standard and complete it within the prescribed period, the Head of the Institution may recommend cancellation of his/her registration at any time to the University.

(3) Formative Assessment:

(a) General Principles

i. The assessment is valid, objective, constructive and reliable.
ii. It covers cognitive, psychomotor and affective domains.
iii. Formative, continuing and summative (final) assessment is also conducted.
iv. Thesis is also assessed separately.

(b) Internal Assessment

i. The internal assessment is continuous as well as periodical. The former is based on the feedback from the senior residents and the consultants concerned. Assessment is held periodically.
ii. Internal assessment will not count towards pass/fail at the end of the program, but will provide feedback to the candidate.
iii. The performance of the Postgraduate student during the training period should be monitored throughout the course and duly recorded in the log books as evidence of the ability and daily work of the student.
iv. Marks should be allotted out of 100 as under

1) Personal Attributes - 20 marks

a. Behavior and Emotional Stability: Dependable, disciplined, dedicated, stable in emergency situations, shows positive approach.
b. Motivation and Initiative: Takes on responsibility, innovative, enterprising, does not shirk duties or leave any work pending.
c. Honesty and Integrity: Truthful, admits mistakes, does not cook up information, has ethical conduct, exhibits good moral values, loyal to the institution.

2) Clinical Work - 20 marks

a Availability: Punctual, available continuously on duty, responds promptly on calls and takes proper permission for leave.

b Diligence: Dedicated, hardworking, does not shirk duties, leaves no work pending, does not sit idle, competent in clinical case work up and management.

c Academic Ability: Intelligent, shows sound knowledge and skills, participates adequately in academic activities and performs well in oral presentation and departmental tests.

d Clinical Performance: Proficient in clinical presentations and case discussion during rounds and OPD work up. Preparing Documents of the case history/examination and progress notes in the file (daily notes, round discussion, investigations and management) Skill of performing bed side procedures and handling emergencies.

3) Academic Activities - 20 marks
Performance during presentation at Journal club/ Seminar/Case discussion/Stat meeting and other academic sessions. Proficiency in skills as mentioned in job responsibilities.

4) End of term theory examination - 20 marks
End of term theory examination conducted at end of 1st, 2nd year and after 2 years 9 months.

5) End of term practical examination - 20 marks
   a. End of term practical/oral examinations after 2 years 9 months.
   b. Marks for personal attributes and clinical work should be given annually by all the consultants under whom the resident was posted during the year. Average of the three years should be put as the final marks out of 20.
   c. Marks for academic activity should be given by the all consultants who have attended the session presented by the resident.
   d. The Internal assessment should be presented to the Board of examiners for due consideration at the time of Final Examinations.
   e. Yearly (end of 1st, 2nd & 3rd year) theory and practical examination will be conducted by internal examiners and each candidate will enter details of theory paper, cases allotted (2 long & 2 short) and viva.
   f. Log book to be brought at the time of final practical examination.

APPOINTMENT OF EXAMINERS:

Appointment of paper setters, thesis evaluators, answer books evaluators and practical & viva voce examiners shall be made as per regulations of the Medical Council of India.

SCHEME OF EXAMINATION:

Scheme of examination in respect of all the subjects of MD/MS shall be as under :

(1) The examination for MD/MS shall be held at the end of three Academic Years.
(2) Examinations shall be organized on the basis of marking system.
(3) The period of training for obtaining MD/MS degrees shall be three completed years including the period of examination.
(4) The University shall conduct not more than two examinations in a year for any subject with an interval of not less than 4 months and not more than 6 months between the two examinations.
(5) The examinations shall consist of:
   (a) Thesis :
      i. Thesis shall be submitted at least six months before the main Theory examinations.

ii. The thesis shall be examined by a minimum of three examiners – one Internal and two External examiners who shall not be the examiners for Theory and Clinical/Practical.
iii. In departments where besides the two earmarked practical/clinical examiners no one else is a qualified P.G. teacher, in that case the Thesis shall be sent to the third external examiner who shall actually be in place of the internal examiner.
iv. Only on the acceptance of the thesis by any two examiners, the candidate shall be eligible to appear for the final examination.
v. A candidate whose thesis has been once approved by the examiners will not be required to submit the Thesis afresh, even if he/she fails in theory and/or practical of the examination of the same branch.
vi. In case the Thesis submitted by a candidate is rejected, he/she should be required to submit a fresh Thesis.

(b) Theory papers:

i. There shall be four theory papers, as below :
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
ii. Each theory paper examination shall be of three hours duration.
iii. Each theory paper shall carry maximum 100 marks.
iv. The question papers shall be set by the External Examiners.
v. There will be a set pattern of question papers.
Every question paper shall contain three questions. All the questions shall be compulsory, having no choice.
Question No. 1 shall be of long answer type carrying 20 marks.
Question No. 2 shall have two parts of 15 marks each. Each part will be required to be answered in detail.
Question No. 3 shall be of five short notes carrying 10 marks each.
vi. The answer books of theory paper examination shall be evaluated by two External and two internal examiners. Out of the four paper setters, the two paper setters will be given answer books pertaining to their papers and the answer books of the remaining two papers will be evaluated by two Internal Examiners. It will be decided by the President as to which paper is to be assigned to which Internal Examiner for evaluation.
vii. A candidate will be required to pass theory and practical examinations separately in terms of the governing provisions pertaining to the scheme of examination in the post graduate regulations. The examinee should obtain minimum 40% marks in each theory paper and not less than 50% marks cumulatively in all the four papers for degree examination to be cleared as “passed” at the said Degree examination.

(c) Clinical/ Practical & Oral examinations:

i. Clinical/Practical and Oral Examination of 400 marks will be conducted by at least four examiners, out of which two (50%) shall be External Examiners.
ii. A candidate will be required to secure at least 50% (viz. 200/400) marks in the Practical including clinical and viva voce examinations.

(6) If a candidate fails in one or more theory paper(s) or practical, he/she shall have to reappear in the whole examination i.e. in all theory papers as well as practical.

GRACE MARKS

No grace marks will be provided in MD/MS examinations.

REVALUATION / SCRUTINY:

No Revaluation shall be permitted in the MD/MS examinations. However, the student can apply for scrutiny of the answer books as per University Rules.

GUIDELINES FOR COMPETENCY BASED POSTGRADUATE TRAINING FOR MD IN BIOCHEMISTRY (9100)

Preamble

The purpose of PG education is to create specialists who would provide high quality health care and advance the cause of science through research & training.

The student who has obtained MD degree in Biochemistry should be well-versed in basic concepts and recent advances in the subject and should have acquired skills and expertise in various laboratory techniques applicable to metabolic and molecular aspects of medicine and in research methodology. Training during the course should equip the student with skills to become an effective teacher, able to plan and implement teaching programmes for students in medical and allied health science courses, set up/manage a diagnostic laboratory, generate, evaluate and interpret diagnostic laboratory data, interact with clinicians to contribute to more effective patient care and carry out a research project and publish its results.

The purpose of this document is to provide teachers and learners illustrative guidelines to achieve defined outcomes through learning and assessment. This document was prepared by various subject-content specialists. The Reconciliation Board of the Academic Committee has attempted to render uniformity without compromise to purpose and content of the document. Compromise in purity of syntax has been made in order to preserve the purpose and content. This has necessitated retention of "domains of learning" under the heading "competencies".

SPECIFIC LEARNING OBJECTIVES

At the end of the MD training programme in Biochemistry, the post graduate student should have acquired competencies in the following areas, as detailed below.

1. **Acquisition of knowledge**
   The student should be able to explain clearly concepts and principles of biochemistry and cell biology, including correlations of these with cellular and molecular processes involved in health and disease.

2. **Teaching and training**
   The student should be able to effectively teach undergraduate students in medicine and allied health science courses so they become competent health care professionals and able to contribute to training of postgraduate post graduate students.

3. **Diagnostic services**
   The student should be able to set up/supervise/manage a diagnostic laboratory in Biochemistry in a hospital, ensuring quality control, and providing a reliable support service. The student should be able to provide clinicians with consultation services for diagnostic tests in biochemistry and in interpretation of laboratory results.
4. **Research**
   The student should be able to carry out a research project from planning to publication and be able to pursue academic interests and continue life-long learning to become more experienced in all the above areas and to eventually be able to guide postgraduates in their thesis work.

SUBJECT SPECIFIC COMPETENCIES

The student during the training programme should acquire the following competencies:

A. **Cognitive domain**

1. 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.
2. Explain energy transactions in a living system, and describe importance of biomolecules in sustaining the life process.
3. Describe pathways of the intermediary metabolism along with their individual and integrated regulation and apply that in understanding the functioning of the body.
4. Describe and apply the concept of nutrition in health and disease, micro- and macro-nutrition and essential nutrients, and interlinks of nutrients with metabolism and functions of a living system.
5. Apply and integrate knowledge of molecular and metabolic conditions in normal and disease states for clinical problem solving and research
6. Acquire knowledge on application of various aspects of genetic engineering in medicine
7. Acquire knowledge and apply the principle of statistics, biostatistics and epidemiology to the evaluation and interpretation of molecular and metabolic disease states.
8. Evaluate, analyze and monitor disease states by applying relevant biochemical investigations and interpreting the clinical and laboratory data.
9. Able to integrate principles of immunology in biochemistry.
10. Demonstrate 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 and eventually be competent to guide students.
11. Describe the principles of teaching - learning technology towards application and take interactive classroom lectures, prepare modules for PBL, organize and conduct PBLs, case discussions, small group discussions, Seminars, Journal club and research presentations
12. Demonstrate knowledge of principles of Instrumentation.
13. Demonstrate knowledge about recent advances and trends in research in the field of clinical biochemistry.

B. **Affective domain**

1. Effectively explain to patients from a variety of backgrounds, the molecular and metabolic basis of disease states and lifestyle modifications.
2. Communicate biochemical reasoning effectively with peers, staff and faculty, and other members of the health care team.
3. Demonstrate empathy and respect towards patients regardless of the biochemical nature of their disease.
4. Demonstrate respect in interactions with patients, families, peers, and other healthcare professionals.
5. Demonstrate ethical behavior and integrity in one's work.
6. Demonstrate effective use of nutrition, lifestyle and genetic counseling.
7. Be aware of the cost of diagnostic tests and economic status of patients.
8. Acquire skills for self-directed learning to keep up with developments in the field and to continuously build to improve on skills and expertise

C. **Psychomotor domain**

1. Able to select, justify, and interpret the results of clinical tests in biochemistry.
2. Develop differential diagnoses for molecular and metabolic causes of diseases.

3. Suggest preventive, curative, and/or palliative strategies for the management of disease.
4. Predict effectiveness and adverse effects associated with disease intervention.
5. Demonstrate skills for clinical diagnosis, testing, understanding of biochemical conditions and diagnostic service.
6. Perform important biochemical, immunological and molecular biology techniques.
7. Observe working of important advanced techniques.
8. Demonstrate standard operating procedures of various methods and techniques used in clinical biochemistry.
9. Determination of enzyme activity and study of enzyme kinetics. Ideally it should be accompanied by purification (partial) of the enzyme from a crude homogenate to emphasise the concepts of specific activity, yield and fold purification
10. Demonstrate and report routine investigations in hematology and microbiology
11. Demonstrate presentation skills at academic meetings and publications.

By the end of the course, the post graduate student should have acquired practical skills in the following:

- Performance of reactions of carbohydrates, amino acids and proteins, and lipids
- Experiments to demonstrate constituents of milk
- Experiments to demonstrate normal and abnormal constituents of urine
- Determination of iodine number and saponification number of fats
- Estimation of ammonia and amino acids by Sorenson formal titration
- Estimation of nitrogen estimation in a given amino acid solution by micro Kjeldahl method
- Estimation of phosphorus by Fiske Subbarao method
- Estimation of ascorbic acid in lime
- Estimation of calcium content in milk
- Estimation of proteins by Folin's method and dye binding method.
- Two-dimensional paper chromatography for separation of amino acids
- Preparation and estimation of starch, glycogen, cholesterol, casein (phosphorus in casein) and hemoglobin from biological samples Determination of enzyme activity and study of enzyme kinetics, using any 2 suitable enzymes (eg, catalase from rat liver and acid phosphatase from potatoes).
- Estimation of clinical analytes as detailed below:
  - Blood glucose, glycated haemoglobin; performance of glucose tolerance test
  - Electrolytes, arterial blood gas analysis
  - Cholesterol, triglycerides, free fatty acids, phospholipids, Lipoprotein A, urea, creatinine, uric acid, ammonia, microalbuminuria
  - Parameters of liver function tests (bilirubin, hepato-biliary enzymes such as AST, ALT, ALP, GGT, Serum Proteins/Albumin and Prothrombin time)
  - Calcium, magnesium, copper (and ceruloplasmin), Serum Iron, TIBC and Ferritin
  - Markers of myocardial damage (CK, CK MB, Troponins, LDH)
  - Other enzymes of diagnostic relevance (eg. Phosphatases, amylase etc)
  - Vitamins D and B_{12} and folate
- Electrophoresis of serum proteins
- Electrophoresis of lipoprotein (Optional)
- Electrophoretic separation of LDH isozymes or any other isoenzymes
- Clearance tests
- CSF analysis

- Thyroid function tests and other hormone assays by ELISA/RIA
- Preparation of buffers.

Clinical Laboratory

- Taking any one parameter, students should prepare a Levy Jennings chart and plot inter-assay and intra-assay variation for the laboratory.
- Implementation of Westgard rules.

Optional:

- Determination of reference values for any one parameter for the clinical laboratory

In addition, all efforts should be made to ensure that students at least see a demonstration of the following techniques.

- Separation of peripheral blood lymphocytes using Ficoll Hypaque
- Subcellular fractionation/marker enzymes for organelles to demonstrate fractionation
- Ultracentrifugation
- Isolation of high molecular weight DNA from tissues/blood
- Isolation of RNA; synthesis of cDNA by reverse transcription; PCR (both conventional and real-time)
- Isolation of plasmids and agarose gel electrophoresis for proteins and nucleic acids
- Basic techniques in cell culture
- High performance liquid chromatography (HPLC)

SYLLABUS

The course contents are outlined below:

Paper I : Biomolecules, Cell Biology, Biochemical Techniques, Biostatistics and Research Methodology, Basics of Medical Education in Teaching and Assessment of Biochemistry.

Biomolecules:

- Properties of water
- Concept of acid, base, pH, pK, buffer and buffering capacity
- Classification, structure and functions of amino acids and peptides
- Structural organization of proteins and relationship with their functions
  - primary, secondary, tertiary and quarternary structure of proteins
  - protein folding and denaturation
- Structure-function relationship of proteins
  - Structure and functions of hemoglobin and myoglobin
  - Structure and function of collagen
  - Structure and function of immunoglobulins
- Classification, functions, properties and reactions of carbohydrates
- Classification, properties and importance of lipids
  - Fatty acids - nomenclature, classification, properties, reactions
  - Mono, di- and triacylglycerols
  - Trans fats
  - Cholesterol - structure, properties and functions
  - Phospholipids - definition, types, properties and importance
  - Glycolipids - definition, types, functions, examples.

- Lipoproteins - definition, structure, types, functions, role of apoproteins, importance in health and disease.
- Biological membranes - structure, function, properties and importance.
- Micelles and liposomes

- Nucleotides and nucleic acids
  - Purine and pyrimidine bases in DNA and RNA
  - Nucleosides and nucleotides
  - Physiologically important nucleotides
  - Synthetic analogues of purine/pyrimidine bases and nucleosides used as therapeutic agents (anti-cancer drugs, anti-viral drugs)
  - Watson and Crick model of DNA structure
  - Structure and functions of different types of RNA.

Cell biology

- Structure of the cell and different subcellular organelles
- Structure and functions of cell membrane, solute transport across biological membranes
- Intracellular traffic and sorting of proteins
- Intracellular signaling pathways, membrane receptors and second messengers Extracellular matrix: composition, importance and biomedical importance, cellular adhesion molecules and intercellular communication
- Cytoskeleton, muscle contraction and cell motility
- Cell cycle, mitosis, meiosis and mechanisms of cell death
- Red and white blood cells

Analytical techniques in biochemistry

- Spectrophotometry (UV and visible spectrophotometry),
- atomic absorption spectrophotometry
- Flame photometry
- Fluorometry
- Turbidimetry and nephelometry
- Gravimetry
- Electrochemistry (pH electrodes, ion-selective electrodes, gas-sensing electrodes)
- Chemiluminescence
- Water testing
- Electrophoresis (principle, types, applications; isoelectric focusing capillary electrophoresis; 2-D electrophoresis)
- Chromatography (principle, types [including high performance liquid chromatography and gas chromatography])
- Techniques in molecular biology: Blotting techniques, polymerase chain reaction (PCR), DNA and protein sequencing, microarrays and DNA chip technology, cloning techniques, genomics, proteomics and metabolomics
- Nanotechnology and microfabrication
- Techniques to study in vivo metabolism - NMR, SPECT, PET scans, etc
- Radioisotope-based techniques and its applications

Biostatistics and research methodology

- Basic concepts of biostatistics as applied to health science
- 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, Bioenergetics, Biological Oxidation, Metabolism of Biomolecules, Intermediary Metabolism and Regulation, Inborn Errors of Metabolism and Nutrition

Enzymes:
Properties, classification, mechanism of action, coenzymes and cofactors, kinetics of enzyme activity, regulation of enzyme activity, isoenzymes, diagnostic and therapeutic enzymes, principles of assays of enzymes, enzymes as therapeutic targets of drugs.

Biological oxidation
Basic concepts of thermodynamics and its law, as applied to living systems, Exergonic and endergonic reactions and coupled reactions, redox potential, High energy compounds Classification and role of oxidoreductases, Cytochromes; cytochrome P450 system

Respiratory chain and oxidative phosphorylation
- Components, complexes and functioning of the respiratory chain
- Process of oxidative phosphorylation
- Mechanisms of ATP synthesis and regulation
- Mitochondrial transport systems and shuttles
- Inhibitors, uncouplers and ionophores
- OXPHOS diseases

Overview of metabolism and intermediary metabolism
- Metabolism of carbohydrates
  - Digestion and absorption
  - Glycolysis and TCA cycle, including regulation
  - Glycogen metabolism and its regulation
  - Cori cycle, gluconeogenesis and control of blood glucose
  - Metabolism of fructose and galactose
  - Pentose phosphate and uronic acid pathways and their significance
  - Polyol pathway
  - Regulation of blood glucose levels
  - Diabetes mellitus (including gestational diabetes mellitus) – classification, pathogenesis, metabolic abnormalities, diagnostic criteria, principles of treatment, pathogenesis of complications, laboratory tests
  - Metabolism of ethanol
- Metabolism of lipids
  - Digestion and absorption, including role of bile salts

- Biosynthesis and oxidation of fatty acids
- Ketone bodies – formation, utilisation and regulation
- Metabolism of unsaturated fatty acids and eicosanoids
- Metabolism of triacylglycerol; storage and mobilisation of fats
- Metabolism of cholesterol
- Metabolism of lipoproteins
- Metabolism in adipose tissue
- Role of liver in lipid metabolism
- Role of lipids in atherogenesis
- Metabolism of phospholipids and associated disorders

- **Metabolism of amino acids and proteins**
  - Digestion and absorption
  - Pathways of amino acid degradation - transamination, oxidative deamination
  - Transport and metabolism of ammonia
  - Metabolism of individual amino acids.
  - Plasma proteins
- **Metabolism of nucleotides**
  - De novo synthesis of purine nucleotides
  - Salvage pathway for purines
  - Degradation of purines
  - De novo synthesis of pyrimidine nucleotides
  - Degradation of pyrimidine
  - Synthetic analogues of purine/pyrimidine bases and nucleosides used as therapeutic agents
- **Metabolism of haem**
  - Biosynthesis of heme and associated disorders
  - Degradation of heme and associated disorders
- **Metabolism in individual tissues and in the fed and fasting states**
  - Liver, adipose tissue, brain, RBCs
- **Nutrition**
  - Principal food components
  - General nutritional requirements
  - Energy requirements
  - Biological value of proteins
  - Thermogenic effect of food
  - Balanced diet, diet formulations in health and disease, mixed diet
  - Nutritional supplements
  - Food toxins and additives
  - Parenteral nutrition
  - Disorders of nutrition, obesity, protein and protein energy malnutrition, dietary fibers, under-nutrition, laboratory diagnosis of nutritional disorders
  - National Nutrition Programme.
- **Vitamins**
  - Classification, biochemical role, sources, RDA and deficiency state of each vitamin (including diagnostic tests for deficiency and treatment)
- **Minerals**
  - Classification, biochemical role, sources, requirement and deficiency state of each mineral (including diagnostic tests for deficiency and treatment)
- **Metabolism of xenobiotics**

Free radicals and anti-oxidant defence systems in the body and associations with disease processes

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-modeling

- **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 medico-legal 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 pleuripotent 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
  - 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
- Autoimmunity
- Transplantation immunology
- Cancer and immune system,
- Immunodiagnostics
- Immunotherapy

Paper IV: **Clinical Biochemistry and Molecular Diagnostics Related to Different Body Systems/Organs, Endocrinology, and Recent Advances in Biochemistry**

Basic principles and practice of clinical biochemistry
Units of measure, reagents, clinical laboratory supplies, basic separation techniques, laboratory calculations, specimen collection and processing, safety in the laboratory, clinical utility of laboratory tests (including sensitivity, specificity, ROC curves, etc), analysis in the laboratory, selection and evaluation of methods (including statistical techniques), evidence-based laboratory medicine, establishment and use of reference values, pre-analytical variables and biological variations, quality management, c1inical laboratory informatics

Analytical techniques and instrumentation
Principles of basic techniques used in a clinical biochemistry laboratory (spectrophotometry, electrochemistry, electrophoresis, osmometry, chromatography, mass spectrometry, immunochemical techniques, molecular techniques, automation, point of care testing,

- **Clinical correlates and analytical procedures**
  - Amino acids, peptides and proteins; non-protein nitrogenous compounds
  - Enzymes
  - Carbohydrates
  - Lipids, lipoproteins and apolipoproteins and other cardiovascular risk factors
  - Electrolytes
  - Blood gases and pH
  - Hormones and associated disorders
  - Catecholamines and serotonin
  - Vitamins; trace and toxic elements
  - Hemoglobin, and bilirubin
  - Porphyrins and associated disorders
  - Bone and mineral metabolism
  - Tumour markers

- Assessment of organ functions (hypothalamus and pituitary, adrenal glands, gonads, thyroid, parathyroid, liver, kidney, heart, stomach, pancreas, intestine, etc) and associated disorders
- Pregnancy and maternal and fetal health
- Reproduction related disorders – infertility
- Newborn screening
- Inborn errors of metabolism
- Hemostasis
- Therapeutic drug monitoring
- Clinical toxicology
- Molecular diagnostics
- Body fluid analyses

- **Regulation of fluid and electrolyte balance and associated disorders**
- **Regulation of acid-base balance and associated disorders**
- **Biochemistry of the endocrine system**
  - Classification and general mechanism of action of hormones
  - Biosynthesis, secretion, regulation, transport and mode of action of hypothalamic peptides, adenohypophyseal and neurohypophyseal hormones, thyroid and parathyroid hormones, calcitonin, pancreatic hormones, adrenocortical and medullary hormones, gonadal hormones, gastrointestinal hormones, opioid peptides, parahormones.
  - Biochemistry of conception, reproduction and contraception
  - Endocrine interrelationship and their involvement in metabolic regulation
  - Neuro-modulators and their mechanism of action and physiological significance
  - Biochemical aspects of diagnosis and treatment of endocrinal disorders:
- **Hematopoietic disorders**
  - Iron deficiency and other hypoproliferative anaemias - iron metabolism, laboratory tests of iron status, iron therapy
  - Anaemia of chronic disease, anaemia of renal disease
  - Hemoglobinopathies - sickle cell anaemia, methaemoglobinemias, thalassemia syndromes, Megaloblastic anaemia
  - RBC membrane and metabolism
  - Hemolytic anaemia - 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.
- **Hemostasis and thrombosis**
  - Biochemical mechanisms, related laboratory tests, antiplatelet/anticoagulant/ fibrinolytic therapy
- **Cardiovascular system**
  - Atherosclerosis - pathogenesis, risk factors, prevention and treatment Cardiac failure, acute coronary syndrome, cardiac biomarkers
- **Respiratory system**
  - Gaseous exchange in lungs - physiological features and disturbances, arterial blood gases, Pathogenesis of cystic emphysema, alpha-1 anti-trypsin deficiency
- **Kidney**
  - Kidney function tests : Pathophysiology, biochemistry, laboratory findings and management in acute kidney injury and chronic kidney disease; estimation of GFR; glomerular diseases - pathogenesis and mechanisms of glomerular injury, nephrotic

syndrome, diabetic nephropathy; tubular disorders - renal tubular acidosis, proteinuria, nephrolithiasis, kidney transplant; biochemical aspects of renal stones.

- **Gastrointestinal system**
  - Gastric physiology
  - Pathophysiology of peptic ulcer disease, including role of H. pylori; gastric function tests; Zollinger-Ellison syndrome
  - Digestion and absorption of nutrients; evaluation of malabsorption (steatorrhea, lactose intolerance)
  - Celiac disease
  - Inflammatory bowel disease
  - Protein losing enteropathy
  - Regulatory peptides in the gut
  - Neuroendocrine tumours
- **Liver**
  - Liver function tests
  - Hyperbilirubinemias
  - Viral hepatitis
  - Serologic/virologic markers
  - Alcoholic liver disease, fatty liver protein, 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.
- **Bone and mineral metabolism**
  - Bone structure and metabolism;metabolism of calcium, phosphate and magnesium; regulation and abnormalities of bone metabolism; vitamin D; parathyroid hormone; calcitonin; parathyroid hormone-related (PTHrP); osteoporosis – pathophysiology; markers of bone turnover
- **Nervous system**
  - Neurotransmitters and their receptors
  - Ion channels and channelopathies
  - Neurotrophic factors
  - Protein aggregation and neurodegeneration
  - Alzheimer’s disease, Parkinson's disease, Huntington’s disease, multiple sclerosis
  - Prions and prion diseases
  - Guillain-Barre syndrome – immunopathogenesis
  - Myasthenia gravis – pathophysiology
  - Hereditary myopathies - Duchenne muscular dystrophy
  - Inherited disorders of muscle energy metabolism
  - Mitochondrial myopathies
  - Pathophysiology of psychiatric disorders such as anxiety, depression and schizophrenia

TEACHING AND LEARNING METHODS

Teaching methodology

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 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 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 pre-clinical, 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 ofcase-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. **Log Book:**
    All post graduate students should maintain a log book that documents all the work that they have done during their years of training. This log book 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.

ASSESSMENT

Formative assessment during the training

FORMATIVE ASSESSMENT, ie., 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

The student to be assessed periodically as per categories listed in postgraduate student appraisal form **(Annexure I).**

SUMMATIVE ASSESSMENT at the end of training,

The summative examination will be carried out as per the Rules given in **POSTGRADUATE MEDICAL EDUCATION REGULATIONS, 2000.**

The postgraduate examination shall be in three parts.

1 . **Thesis**

Every post graduate student shall carry out work on an assigned research project under the guidance of a recognized post-graduate teacher. The results of the work done shall be written up and submitted in the form of a thesis. The aim of doing a thesis is to contribute to development of a spirit of enquiry, to familiarize the post graduate students with research methodology, literature searches, laboratory techniques, analysis of data, interpretation of results and skills in scientific writing.

2. **Theory examination**

The examinations shall be organized on the basis of a 'Grading'or 'Marking' system to evaluate and certify a post graduate student's level of knowledge, skills and competence at the end of the training. The examination for MD/MS shall be held at the end of the 3rd academic year.

There shall be 4 theory papers each of three hours duration:

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

3. **Practical and oral/viva voce examination:**

This should be held over two days.

Practical examination

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. The practical examinations will have the following components:-

A. A clinical case for which an actual patient or a paper-based case may be used, as per the facilities available in each institution running the course. The clinical features of the patient and relevant laboratory investigation of biochemical abnormalities present will be discussed
B. Identification the carbohydrate/amino acid provided and confirm of its identity by paper chromatography, Urine analysis.
C. Performance of an electrophoresis for serum proteins and discussion of electrophoretic pattern.
D. Quality Control, its interpretation and Method validation

Viva-voce Examination

E. Thesis presentation (of about 15 mins duration)
F. Pedagogy (20 mins duration plus 10 mins for questions)

Suggested reading material:

Books (latest edition)

- Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox. W H Freeman & Co (Sd).
- Biochemistry (Stryer), Jeremy M. Berg , John L. Tymoczko , Lubert Stryer, W. H. Freeman.
- Biochemistry (Voet & Voet), Donald Voet , Judith G. Voet, John Wiley & Sons Inc.
- Textbook of Biochemistry with Clinical Correlations, Thomas M. Devlin, John Wiley & Sons.
- Kuby Immunology, Judy Owen, Jenni Punt , Sharon Stranford, W. H. Freeman.
- Clinical Chemistry: Principles, Techniques, and Correlations, Michael L Bishop, Edward P Fody, Larry E Schoeff, Lippincott Williams and Wilkins.
- Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, Carl A. Burtis, Edward R. Ashwood , Saunders.
- Harpers Illustrated Biochemistry, Victor W. Rodwell , David Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil , McGraw-Hill Education / Medical.
- Biochemistry (Lippincott's Illustrated Reviews), Denise R Ferrier , Lippincott Williams and Wilkins.
- Harrison's Principles of Internal Medicine, Dennis L. Kasper, Anthony S. Fauci, Stephen L. Hauser, Dan L. Longo, J. Larry Jameson, Joseph Loscalzo, McGraw-Hill Education / Medical.
- Davidson's Principles and Practice of Medicine, Walker, Elsevier Health Sciences – UK.
- Clinical Biochemistry: Metabolic and Clinical Aspects, William J. Marshall & Márta Lapsley & Andrew Day & Ruth Ayling, Imprint - Churchill Livingstone.
- Biochemistry: A Case-oriented Approach, Rex Montgomery, Thomas W. Conway, Arthur A. Spector, David Chappell, Mosby.
- Interpretation of Diagnostic tests, Jacques Wallach, Lippincott Williams & Wilkins.

Journals

03-05 international Journals and 02 national (all indexed) journals

Annexure - I

Postgraduate Students Appraisal Form

Pre / Para /Clinical Disciplines

Name of the Department/Unit :

Name of the PG Student :

Period of Training: **FROM.....TO.....**

Sr. No.	Particulars	Not satisfactory	Satisfactory	More Than Satisfactory	Remarks
		1 2 3	4 5 6	7 8 9	
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				
6.	Thesis/Research work				
7.	Log Book Maintenance				

Publications Yes/ No

Remarks*_____
_____
_____

*REMARKS: Any significant positive or negative attributes of a postgraduate student to be mentioned. For score less than 4 in any category, remediation must be suggested. Individual feedback to postgraduate student is strongly recommended.

SIGNATURE OF ASSESSEE | SIGNATURE OF CONSULTANT | SIGNATURE OF HOD

MODEL PAPER

MD-9101 **Biochem.-I**

MD Examination Month, Year
BIOCHEMISTRY

Paper – I

Biomolecules, Cell Biology, Biochemical Techniques, Biostatistics and Research Methodology, Basics of Medical Education in Teaching and Assessment of Biochemistry

Time : Three Hours
Maximum Marks : 100

Attempt all questions
All the parts of one question should be answered at one place in sequential order.
Draw diagrams wherever necessary

Q.1 Discuss principle & procedure of Electrophoresis. Mention different types of Electrophoresis & their application in Clinical Biochemistry. 20

Q.2 a) Describe the different types of Lipoproteins and their functions. Write a note on importance of apoproteins. 15

b) Describe the structural organization of proteins and their structure function relationship giving suitable examples. 15

Q.3 Write short notes on 5 x 10=50

a) Blotting techniques

b) Abnormal Hemoglobins

c) Synthetic analogues of Nucleosides & Nitrogen basis

d) e-Learning modalities in Medical education

e) Signal transduction

MODEL PAPER

MD-9102 **Biochem.-II**

MD Examination Month, Year
BIOCHEMISTRY

Paper – II

Enzymes, Bioenergetics, Biological Oxidation, Metabolism of Biomolecules, Intermediary Metabolism and Regulation, Inborn Errors of Metabolism and Nutrition

Time : Three Hours
Maximum Marks : 100

Attempt all questions
All the parts of one question should be answered at one place in sequential order.
Draw diagrams wherever necessary

Q.1 Describe the metabolic pathway for gluconeogenesis. How is it regulated? 20

Q.2 Write in detail : 2 x 15=30

a) Inborn errors of amino acid metabolism

b) Role of Calcium as second messenger.

Q.3 Write short notes on: 5 x 10=50

a) Phospholipids

b) Application of redox potential in electron transport chain

c) Obesity & adipokines

d) Galactose metabolism

e) Lipid storage diseases

MODEL PAPER

MD-9103 **Biochem.-III**

MD Examination Month, Year
BIOCHEMISTRY

Paper – III

Molecular Biology, Molecular and Genetic Aspects of Cancer, Immunology and Effects of Environmental Pollutants on the Body

Time : Three Hours
Maximum Marks : 100

Attempt all questions
All the parts of one question should be answered at one place in sequential order.
Draw diagrams wherever necessary

Q.1 Describe the process of protein synthesis in prokaryotes. How does it differ from protein synthesis in eukaryotes. 20

Q.2 a) Discuss the role of Genomics and proteomics in modern day medicine. 15

b) Describe different causes of DNA damage. Write in brief various DNA repair mechanism. 15

Q.3 Write short notes on: 5 x 10=50

a) RFLP

b) Gene therapy

c) Hybridoma technology and its applications

d) Molecular basis of AIDS

e) Southern blotting.

MODEL PAPER

MD-9104 **Biochem.-IV**

MD Examination Month, Year
BIOCHEMISTRY

Paper – IV

Clinical Biochemistry and Molecular Diagnostics Related to Different Body Systems/Organs, Endocrinology, and Recent Advances in Biochemistry

Time : Three Hours
Maximum Marks : 100

Attempt all questions
All the parts of one question should be answered at one place in sequential order.
Draw diagrams wherever necessary

Q.1 Write an essay on principle and application of Spectroscopy. 20

Q.2 Write in detail : 2 x 15=30

a) Bone mineral metabolism

b) Therapeutic drug monitoring

Q.3 Write short notes on 5 x 10=50

a) Cardiac markers

b) Blood gas analysis

c) Liver function test

d) Point of care testing

e) Isoelectric Focusing