PG CURRICULUM FOR MD BIOCHEMISTRY AT AIIMS NAGPUR

Program Name: MD Biochemistry

Duration of the program : 3 years

Educational Qualification: MBBS

Mode of selection: Entrance examination conducted by AIIMS

GOAL

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 students of MD Biochemistry should have the basic concepts in metabolic and molecular aspects of medicine. The students should develop skills and expertise in various laboratory techniques comprising of clinical laboratory and diagnostic techniques, molecular techniques and immunological techniques. The student should be well versed with recent advancements in the subjects. Training in research methodology shall be the basic integral component. A culture of discussions, interpretations, counter-interpretations and re- interpretations must be established to achieve the goal of quality translational research. The aim of MD Biochemistry training is to undertake innovation and creativity as epicenter for all research initiatives. The MD course should impart the skills to plan and carry out research projects and publish the results.The MD degree training shall endow the skills to plan and implement advanced teaching methodologies to become an effective teacher. The students shall be equipped to set up / manage a diagnostic laboratory, suggest, generate, evaluate and interpret diagnostic laboratory data in a given clinical scenario to contribute to patient care

GUIDELINES FOR COMPETENCY BASED POSTGRADUATE TRAINING FOR MD IN BIOCHEMISTRY

PROGRAMME OUTCOMES

At the end of the training programme for MD Biochemistry, the post graduate student should have achieved the following:

1. **Acquire knowledge**

The student should be able to understand and clearly explain concepts of biochemistry and correlate them with processes at cellular and molecular levels along with their role in health and disease.

2. **Teach students**

The student should be able to teach and train undergraduate students to become competent health care professionals and also be able to contribute to training of postgraduate students.

3. **Diagnostic services**

The student should be able to establish and manage a diagnostic Biochemistry laboratory, ensuring quality control. The student should be able to support clinicians with consultation services for diagnostic tests and to correlate and interpret laboratory results.

4. **Research**

The student should be able to carry out a research project independently along with publication of findings and also be able to guide postgraduates in their thesis work.

SUBJECT SPECIFIC COMPETENCIES

The student during the training program 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, 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. Observed 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.

SYLLABUS

THEORY

Paper I

Cell biology, Biomolecules, biochemical techniques, biostatistics and research methodology, basics of medical education in teaching and assessment of biochemistry.

Cell biology:

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

Biomolecules:

- Properties of water, Concept of an acid, a 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**.**

Analytical techniques in biochemistry:

- Photometry and 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

- 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,
- 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 techniques,
- 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, intermediary metabolism and regulation, inborn errors of metabolism and nutrition

Enzymes:

- Properties, classification of enzymes, mechanism of action, coenzymes and cofactors,
- kinetics of enzyme activity, factors affecting enzyme activity,
- isoenzymes, diagnostic enzymology
- principles of assays of enzymes,
- enzymes as therapeutic agents.

Biological oxidation :

- Basic concepts of laws of thermodynamics
- 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,
- Oxidative phosphorylation, Mechanisms of ATP synthesis and regulation,
- Mitochondrial shuttle systems,
- Inhibitors of oxidative phosphorylation, uncouplers and ionophores
- Mitochondrial diseases

Overview of metabolism and intermediary metabolism
Metabolism of carbohydrates :

- Digestion and absorption of carbohydrates,
- Glycolysis and TCA cycle and their 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, Metabolism of ethanol
- 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 lipids :

- Digestion and absorption of lipids,
- 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 of proteins,
- Amino acid pool, transamination, oxidative deamination, Transport and metabolism of ammonia, ammonia toxicity
- Metabolism of individual amino acids along with inborn errors of metabolism
- Plasma proteins

Metabolism of nucleotides :

- De novo synthesis and degradation of purines, purine salvage pathways,
- De novo synthesis and degradation of pyrimidines,

- Synthetic nucleotide analogues used as therapeutic agents

Metabolism of haem :

- Biosynthesis of heme and associated disorders,
- Degradation of heme and associated disorders

Integration of metabolism, metabolism in individual tissues and in the fed and fasting states: Liver, adipose tissue, brain, RBCs

Nutrition:

- Principles of nutrition, energy requirements, Biological value of proteins, Thermogenic effect of food,
- Balanced diet, planning a diet in health and disease, Food toxins and additives,
- Parenteral nutrition,
- Disorders of nutrition, protein energy malnutrition, dietary fibers, laboratory diagnosis of nutritional disorders, Obesity

Vitamins:

- **Fat and water soluble vitamins -** Classification, biochemical role, sources, RDA and deficiency state of each vitamin including diagnostic tests for deficiency and treatment,
- Hypervitaminoses, and antivitamins

Minerals:

- Classification, biochemical role, sources, requirement and deficiency state of each mineral including diagnostic tests for deficiency and treatment.
- Toxicity of minerals and macro and micro (trace) elements

Metabolism of xenobiotics

Free radicals and anti-oxidant systems in the body and role of free radicals in health and 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 remodelling

DNA replication:

- DNA replication in prokaryotes and eukaryotes.
- 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:

- Process of transcription in prokaryotes and eukaryotes
- Post-transcriptional processing – capping, tailing and splicing.

Genetic code and mutations:

- Features of the genetic code,
- Mutagens- examples of physical, chemical and biological mutagens.
- Types of mutations – point mutations and chromosomal mutations, Relationship of mutations with specific diseases

Translation:

- Function of aminoacyl tRNA synthase. Process of protein synthesis, 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.
- Genomic and cDNA libraries. Applications of recombinant DNA technology in medicine.
- Gene therapy, Diagnosis of genetic diseases and genetic counseling, DNA fingerprinting, DNA sequencing, RFLP, 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
Genetic diseases:

- Patterns of inheritance: monogenic and polygenic inheritance,
- 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.

Cancer:

- Carcinogens: physical, chemical and biological,

- 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, 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),
- Use of reference values, pre-analytical variables and biological variations, quality management, clinical 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,
- 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 anaemiam, 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:

- 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, 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

PRACTICAL

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 normal and abnormal constituents of urine
- Paper chromatography for separation of amino acids
- Seperation,and/or 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 suitable enzymes (e.g salivary amylase, ALP)

Clinical Biochemistry Laboratory:

- Estimation of clinical analytes:
    - Blood glucose, glycated haemoglobin;
    - Glucose tolerance test
    - Estimation of Proteins, albumin A:G ratio
    - Electrolytes, arterial blood gas analysis
    - cholesterol, triglycerides, HDL cholesterol, Direct LDL, Lp (a), urea, creatinine, uric acid, ammonia,
    - parameters of liver function tests (bilirubin, hepato-biliary enzymes such as AST, ALT, ALP, GGT, serum proteins/albumin and prothrombin time etc)
    - Calcium, phosphorus, 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

    - Urinary microalbumin
- Electrophoresis of serum proteins /lipoprotein/LDH isozymes or any other isoenzymes
- Clearance tests
- CSF analysis and other body fluid analysis
- Thyroid function tests and other hormone assays by ELISA/RIA/ chemilumniscence

Quality Control in 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/Determination of reference values for any one parameter for the clinical laboratory
- Troubleshooting in clinical laboratory

Molecular Biology Laboratory:

- Isolation of genomic DNA from tissues/blood
- Isolation of RNA; synthesis of cDNA by reverse transcription; PCR (both conventional and real-time)
- Agarose gel electrophoresis for proteins and nucleic acids
- RFLP
- Western blotting

Demonstration practicals:

- Separation of peripheral blood lymphocytes using Ficoll Hypaque
- Subcellular fractionation/marker enzymes for organelles to demonstrate fractionation
- Ultracentrifugation
- Isolation of plasmids and
- Basic techniques in cell culture
- High performance liquid chromatography (HPLC), GC/MS or LC/MS

TEACHING AND LEARNING METHODS

Teaching methodology

Active and interactive learning will be the mainstay of the program. The following methods will be used to facilitate training of MD students.

1. **Interactive lectures, tutorials, problem-based learning, case discussions, guest lectures, E-learning**

2. **Journal club:** Twice in a month

3. **Seminars:** Once a month

4. **Practical exercises:** Twice a week

5. **Thesis:** The Dissertation will be submitted to Academic Section at least six months prior to the scheduled examination

6. **Presentation of work done on thesis to peers**

7. **Teaching of undergraduates**

8. **Horizontal and vertical integration of teaching of Biochemistry with other pre-clinical, para-clinical and clinical departments**

9. **Training in the basics of medical education and technology**

10. **Development of communication skills**

11. **Training in clinical Biochemistry**: Monthly rotation in clinical Lab

12. **Rotation in emergency laboratory, clinical laboratory and clinical departments (like Medicine, Surgery, Paediatrics, Dermatology, Gynecology, Opthalmology).** The second year PG students will attend clinics in these departments on every Monday, Wednesday and Friday between 2-5 pm.

13. **Maintaining a Log Book:**

14. The Department of Biochemistry will encourage **e-learning activities**.

A. Timing of six monthly progress report submission to Academic Section:

Report	July Session		January session	
	Period	To be submitted	Period	To be submitted
First	July to December	7th January	January to June	7th July
Second	ıry to June	7th July	July to December	7th January
Third	July to December	7th January	January to June	7th July
Fourth	January to June	7th July	July to December	7th January
Fifth	July to December	7th January	January to June	7th July
Sixth	January to June	10th June	July to December	10th December

Note: The first five reports will be taken into consideration to decide the eligibility of the student to appear for the Professional Examination.

B. Dissertation

Synopsis submission and approval:

Process to be completed within six months of admission to MS / MD program:

Activity	July admission	January admission
Selection of topic in consultation with PG Guide	September / October	March / April
Approval by Department PG Committee		
Institute Scientific Committee approval	November /	May / June

Institute Ethics Committee approval	December	
Final approval letter by Academics Section	31st December	30th June

B2 Submission of Dissertation:

The Dissertation will be submitted to Academic Section at least six months prior to the scheduled examination, i.e. by 31st December for June examination and by 30th June for December examination.

अखिल भारतीयआयुर्विज्ञान संस्थान, नागपुर
All India Institute of Medical Sciences, Nagpur

Six monthly Progress Report for Postgraduate Students

SECTION I

Name of the PG student: _____

Department:_____

Admitted in (Month and Year):_____

Name of the PG Guide:_____

Report for the period:_____ to_____

Attendance: _____days out of days (_____%)

SECTION II

Grading as per performance

Grade	Percentage
A	80% and above
B	65% to 79%
C	50% to 64%
D	Below 50%

As applicable:

1. **OPD work:**
2. **Ward work:**
3. **Lab work:**
4. **OT work:**
5. **ICU work:**
7. **Emergency work:**
6. **Teaching assignments:**

Section III

Progress of Dissertation

_____

_____

_____

_____

_____

_____

Section IV

1. **Case Presentations:**

Sr. No.	Title of case	Date	Faculty I/C	Marks

2. **Microteaching:**

Sr. No.	Topic	Date	Faculty I/C	Marks

3. **Seminars:**

Sr. No.	Title of presentation	Date	Faculty I/C	Marks

4. **Journal Clubs:**

r. No.	Journal	Title of Paper	Date	Faculty I/C	Marks

5. **Marks obtained in tests:**

. No.	Date	Theory / Practical	Marks obtained

6. **Any other academic activity conducted:**

Section V

1. **Papers presented**

r. No.	Title of Paper	Authors	Event	Date

2. Posters presented

r. No.	Title of Poster	Authors	Event	Date

3. Publications

(Note: Mention only those publications that are published or are accepted for publication during the said period only)

. No.	Title of Paper	Authors	urnal	ar/Vol/ ue	ge s	lexed/ n- Indexed	atus

Section VI

Any other significant achievement:

_____

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Certificate by the PG Guide and Head of Unit

This is to certify that Dr._____, has an attendance of _____%, during the period _____to_____.

Overall Grading:_____

Date:_____

Name and Signature of PG Guide:

Name and Signature of Head of Unit:

Certificate by the Head of Department

This is to certify that the performance of Dr._____, during the period _____to_____, has been **satisfactory/ average / unsatisfactory.**

Overall Grading:_____

Date:_____

Name and Signature of HOD:

PG COURSE SCHEDULE

Ist year:

Protocol presentation within four month of joining (before end of September)
Posting in clinical chemistry lab for I year (June – May next year)
Attend all UG lectures
Seminars presentations on UG topics
UG teaching skill evaluation – microteaching/ OSPE
Clinical case discussions
PG lectures on quality control & organ function tests
PG practicals on organ function tests
Undergraduate teaching –practicals
Start with thesis in May of IInd year

II year:

Thesis work (May – April next year) – submission of thesis by 30th April (end of II year)
Seminars presentations on research related topics
UG teaching skill evaluation – microteaching/ OSPE
Clinical case discussions
PG lectures on research related topics
Undergraduate teaching – practicals
PG practicals on the topics that are the part of the thesis and those given in syllabus (DU)

IIIrd year:

Posting in clinical chemistry lab for three months (May-July)
Undergraduate teaching – tutorials and practicals
Seminars and journal club presentations on research related topics
UG teaching skill evaluation – microteaching/ OSPE
Clinical case discussions
PG lectures as per syllabus (DU)
PG practicals on the topics that are given in syllabus (DU) and those techniques that are not part of the thesis.
Examination (March & April at the end of third year)

ASSESSMENT

Assessment will comprise of Formative assessment and summative assessment

FORMATIVE ASSESSMENT DURING THE TRAINING

General Principles

Internal Assessment will cover all domains of learning and used to provide feedback to improve learning; it will also cover professionalism and communication skills.

Formative assessment will be in the form of quarterly assessment followed by annual assessment at the end of each year. The Internal assessment exams will comprise of a Theory exam followed by a

Practical exam. At the end of the final year of training there will be a preliminary or Pre-Professional Exam. The marks scored by the student will be taken as the Internal Assessment (IA) marks. The quarterly assessment shall contribute to 10 % of marks of each IA theory exam.

Quarterly assessment during the MD training will be based on:

1. Journal based / recent advances learning/Seminar
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

There will be practical examination at the end of each year the marks of which will contribute towards IA marks (100 marks) for practicals. There will be no separate marks for quarterly assessment in Practicals.

SCHEDULE OF ANNUAL INTERNAL ASSESSMENT EXAMINATIONS

Schedule	**Marks**	**Practicals (Marks)**
At end of First year	**100 (1 Paper)**	**100**
At end of Second year	**100 (1 Paper)**	**100**
Pre-professional	**400 (4 Papers of 100 marks each)**	**400 (Practical 300 + Viva 100)**
Final Total Marks*	**600**	**600**
Internal Assessment	**Out of 100 (100/600 X Total Marks obtained)**	**Out of 100 (100/600 X Total Marks obtained)**

Exam Pattern for MD (Biochemistry)

Formative

(A) Theory:

Schedule	Marks
At end of First year	100 (1 Paper)
At end of Second year	100 (1 Paper)
Pre-professional	400 (4 Papers of 100 marks each)
Total	**600 Marks**

(B) Practical:

Schedule	Marks
At end of First year	100
At end of Second year	100
Pre-professional	400 (Practical 300 + Viva 100)
Total	**600 Marks**

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Candidate should secure a minimum of 50% marks in Theory and Practical separately, in order to be eligible to appear for Professional Examination.

Summative

A	Theory	4 Papers each of 100 Marks = 400 Marks
B	Practical	Practical 300 + Viva 100 = 400 Marks

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Final Result

(A) Theory – 400 Marks (Minimum 40% marks in each paper and aggregate of 50% in order to be declared pass)

(B) Practical – 400 Marks

Minimum 50% marks required in Theory & Practical separately, in order to be declared successful at MD/MS Examination.

SUMMATIVE ASSESSMENT (at the end of training)

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 aspirit 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.

   The thesis shall be submitted at least six months before the theory and clinical / practical examination. A post graduate student shall be allowed to appear for the theory and practical examination only after the acceptance of the thesis by the examiners.

2. **Theory examination:**

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:**

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 include the following:

Long exercise: This will be a clinical case history (preferably involving general examination of a patient), to make a provisional diagnosis of the case and suggestion of relevant laboratory investigations to diagnose the disease and comment on the treatment that could be offered. The candidate will be asked to perform laboratory investigations and report the results. This will be followed by a discussion on the results, procedures and biochemical aspects of the disease, rationale of therapy, interpretation of values) etc.

Short exercise: The topics for this includes: Chromatography of sugar and amino acids, electrophoresis, DNA extraction and quantification, Polymerase Chain reaction, ELISA-based estimation , Immunodiffusion, HbA1C estimation, CSF analysis, Quality control in clinical lab.

OSPE Topics: Benedict test, Standard curve for estimation of various analytes, Standardization of Colorimeter, Charging of chromatography, DNA sample loading in Agarose gel electrophoresis, Gel spread and dye binding in electrophoresis, Immunodiffusion, Case report analysis., Interpretation of data, Quality control, POCT

Viva-voce shall comprise theoretical and practical knowledge of the candidate related to biochemistry, wherein in-depth knowledge can be assessed. This includes the discussion on case presentation as well as the dissertation work carried out by the candidate.

Pedagogy (included in Viva Voce): The candidate will be given a choice of at least two topics in Biochemistry on day one of the examinations of which one topic will have to be presented by the candidate to the examiners in the form of classroom teaching for a period of 10 minutes only.

Details of Marks for Summative/Final Examinations :

Theory:

Total Marks = 400

(4 Theory papers of 100 marks each in the final examination)

Practical examination:

Total marks: 400

(Practical 300 + Viva 100)

The format of the practical examination (400 marks)

1. Case discussion
2. One quantitative investigation with standardization graph
3. Two other quantitative estimations
4. One common technique performed (e.g., Serum protein electrophoresis to be assessed)
5. One minor investigative analysis (urine, body fluids)

There will be a thesis presentation (of about 15 mins duration followed by 10 mins for questions) and Pedagogy (10 mins duration)

Suggested reading material:

Books (latest edition)

1. Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox. W H Freeman & Co (Sd).
2. Biochemistry (Stryer), Jeremy M. Berg , John L. Tymoczko , Lubert Stryer, W. H. Freeman.
3. Biochemistry (Voet & Voet), Donald Voet , Judith G. Voet, John Wiley & Sons Inc.
4. Textbook of Biochemistry with Clinical Correlations, Thomas M. Devlin, John Wiley & Sons.
5. Kuby Immunology, Judy Owen, Jenni Punt , Sharon Stranford, W. H. Freeman.
6. Clinical Chemistry: Principles, Techniques, and Correlations, Michael L Bishop, Edward P Fody, Larry E Schoeff, Lippincott Williams and Wilkins.
7. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, Carl A. Burtis, Edward R. Ashwood , Saunders.
8. Harpers Illustrated Biochemistry, Victor W. Rodwell , David Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil , McGraw-Hill Education / Medical.
9. Biochemistry (Lippincott's Illustrated Reviews), Denise R Ferrier , Lippincott Williams and Wilkins.

10. 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.
11. Davidson's Principles and Practice of Medicine, Walker, Elsevier Health Sciences – UK.
12. Clinical Biochemistry: Metabolic and Clinical Aspects, William J. Marshall & Márta Lapsley & Andrew Day & Ruth Ayling, Imprint - Churchill Livingstone.
13. Biochemistry: A Case-oriented Approach, Rex Montgomery, Thomas W. Conway, Arthur A. Spector, David Chappell, Mosby.
14. Interpretation of Diagnostic tests, Jacques Wallach, Lippincott Williams & Wilkins.

List of Recommended Journals:

1. Clin Chim Acta
2. British Journal of Nutrition
3. American Journal Nutrition
4. New England Journal of Nutrition
5. Clinical Biochemistry
6. Clinical Chemistry
7. Science
8. Metabolism
9. Lancet
10. Annual reviews of Biochemistry.
11. Indian Journal of Clinical Biochemistry
12. Indian Journal of Medical Biochemistry
13. Indian Journal of Biophysics and Biochemistry
14. Biochemica Biophysica Acta