Program and Course Structure

School of Medical Science and Research

MD (Biochemistry)
Session:2020-23

1. Standard Structure of the Program at University Level

1.1 Vision, Mission and Core Values of the University

Vision of the University

To serve the society by being a global University of higher learning in pursuit of academic excellence, innovation and nurturing entrepreneurship.

Mission of the University

1. Transformative educational experience
2. Enrichment by educational initiatives that encourage global outlook
3. Develop research, support disruptive innovations and accelerate entrepreneurship
4. Seeking beyond boundaries

Core Values

- Integrity
- Leadership
- Diversity
- Community

Vision of the School

To serve the society by being a premier institute that promotes a comprehensive approach to human health through excellence inacademics, research and clinical care

Mission of the School

- Provide a transformative educational experience in Medical Science
- Develop skills and competencies to create global leaders in clinical care
- Promote innovative and collaborative research through intellectual and technological advancement
- Establish a center for excellence in preventive, promotive and curative health care

Core Values

- Integrity
- Leadership
- Ethics
- Community Health

1.3 Program Educational Objectives (PEO)

1.3.1 Writing Program Educational Objectives (PEO)

A post graduate student having qualified the MD (Biochemistry) examination should be able to:

PEO 1: explain clearly concepts and principles of biochemistry and cell biology, including correlations of these with cellular and molecular processes involved in health and disease.

PEO 2: effectively teach undergraduate students in medicine and allied health science courss so they become competent health care professionals and able to contribute to training of postgraduate post graduate students.

PEO 3: set up/supervise/manage a diagnostic laboratory in Biochemistry in a hospital, ensuring quality control, and providing a reliable support service.

PEO 4: provide clinicians with consultation services for diagnostic tests in biochemistry and in interpretation of laboratory results using an ethical and professional approach

PEO 5: 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.

1.3.2 Map PEOs with Mission Statements:

PEO Statements	School Mission 1	School Mission 2	School Mission 3	School Mission 4
PEO1	**3**	**3**	**3**	**3**
PEO2	**3**	**3**	**1**	**3**
PEO3	**3**	**1**	**3**	**3**
PEO4	**3**	**1**	**2**	**3**
PEO5	**3**	**2**	**3**	**3**

1.3.3 Program Outcomes (PO's)

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

A. Cognitive domain

PO1: Describe and apply biochemical principles ,molecular and metabolic conditions to explain the normal state, abnormal disease conditions and mechanism

PO2: Acquire knowledge on application of various aspects of genetic engineering in medicine

PO3: Acquire knowledge and apply the principle of statistics, biostatistics and epidemiology to the evaluation and interpretation of molecular and metabolic disease states.

PO4: Evaluate, analyze and monitor disease states by applying relevant biochemical investigations and interpreting the clinical and laboratory data.

PO5: Able to integrate principles of immunology in biochemistry.

PO6: 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.

B. Affective domain

PO: Effectively explain to patients from a variety of backgrounds, the molecular and metabolic basis of disease states and lifestyle modifications.

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

PO9: Demonstrate respect in interactions with patients, families, peers, and other healthcare professionals.

PO10: Demonstrate effective use of nutrition, lifestyle and genetic counseling.

PO11: Be aware of the cost of diagnostic tests and economic status of patients.

PO12: Acquire skills for self-directed learning

C. Psychomotor domain

PO13: Develop differential diagnoses for molecular and metabolic causes of diseases.

PO14: Predict effectiveness and adverse effects associated with disease intervention.

PO15: Perform routine investigations in hematology and microbiology and important biochemical, immunological and molecular biology techniques.

PO16: Observed working of important advanced techniques.

PO17: Demonstrate standard operating procedures of various methods and techniques used in clinical biochemistry.

PO18: Demonstrate presentation skills at academic meetings and publications.

1.3.4 Mapping of Program Outcome Vs Program Educational Objectives

	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	3	3	3	3
PO2	3	3	3	3	3
PO3	3	3	3	3	3
PO4	3	3	3	3	3
PO5	3	3	3	3	3
PO6	3	1	3	3	3
PO7	-	3	3	1	2
PO8	-	2	3	3	3
PO9	-	2	3	3	3
PO10	-	2	3	3	3
PO11	-	2	3	3	3
PO12	2	2	3	3	3
PO13	3	2	3	3	3
PO14	3	2	3	3	3
PO15	3	2	3	3	3
PO16	2	1	3	1	3
PO17	3	3	3	3	3
PO18	1	3	2	1	3

School: SMSR		Batch:
Program: MD Biochemistry		Current Academic Year: 2019-20
1	Programme Code	SMS0401

GUIDELINES FOR COMPETENCY BASED POSTGRADUATE TRAINING FOR MD IN BIOCHEMISTRY

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 macronutrition 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. 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.

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:
o blood glucose, glycated haemoglobin ; performance of glucose tolerance test
o electrolytes, arterial blood gas analysis
o cholesterol, triglycerides, free fatty acids, phospholipids, Lp (a), urea, creatinine, uric acid, ammonia, microalbuminuria
o parameters of liver function tests (bilirubin, hepato-biliary enzymes
such as AST, ALT, ALP, GGT, serum proteins/albumin and prothrombin time)
o Calcium, magnesium, copper (and ceruloplasmin), serum iron, TIBC and ferritin
o markers of myocardial damage (CK, CK MB, troponins, LDH)
o other enzymes of diagnostic relevance (eg. phosphatases, amylase etc)
o vitamins D and B12 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 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
o primary, secondary, tertiary and quarternary structure of proteins
o protein folding and denaturation
Structure-function relationship of proteins
o Structure and functions of hemoglobin and myoglobin
o Structure and function of collagen
o Structure and function of immunoglobulins
Classification, functions, properties and reactions of carbohydrates
Classification, properties and importance of lipids
o Fatty acids - nomenclature, classification, properties, reactions
o Mono, di- and triacylglycerols
o Trans fats
o Cholesterol - structure, properties and functions

o Phospholipids - definition, types, properties, s and importance
o Glycolipids - definition, types, functions, examples.
o Lipoproteins - definition, structure, types, functions, role of apoproteins, importance in health and disease.
o Biological membranes - structure, function, properties and importance.
o Micelles and liposomes Nucleotides and nucleic acids
o purine and pyrimidine bases in DNA and RNA
o nucleosides and nucleotides
o physiologically important nucleotides
o synthetic analogues of purine/pyrimidine bases and nucleosides used as therapeutic agents (anti-cancer drugs, anti-viral drugs)
o Watson and Crick model of DNA structure
o 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

o Spectrophotometry (UV and visible spectrophotometry),
o atomic absorption spectrophotometry
o Flame photometry
o Fluorometry
o Turbidimetry and nephelometry
o Gravimetry
o Electrochemistry (pH electrodes, ion-selective electrodes, gas-sensing electrodes)
o Chemiluminescence
o Water testing
o Electrophoresis (principle, types, applications; isoelectric focusing capillary electrophoresis; 2-D electrophoresis)

o Chromatography (principle, types [including high performance liquid chromatography and gas chromatography])
o 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, 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 laws, 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 heme

• 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 bodyand 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-modelling

DNA replication

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

Transcription

• Structure of a gene - exons and introns, promoter, enhancers/repressors and response elements.
• Process of transcription in prokaryotes and eukaryotes – initiation, elongation and termination (including important differences).
• Post-transcriptional processing – capping, tailing and splicing.

Genetic code and mutations

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

Translation

• Basic structure of prokaryotic and eukaryotic ribosomes.
• Structure of tRNA (diagram of clover leaf model of tRNA structure) and its function in protein synthesis.
• Function of aminoacyl tRNA synthase.
• Process of protein synthesis (translation) – initiation, elongation and termination (including important differences between prokaryotic and eukaryotic translation).

• Inhibition of prokaryotic translation by antibiotics.
• Post-translational modifications

Regulation of gene expression in prokaryotes and eukaryotes

• The operon concept in prokaryotes
• Role of general and gene specific transcription factors
• Small interference RNA (siRNA) and micro RNA (miRNA).
• Other modes of regulation of gene expression: alternative splicing, alternative promoter usage, DNA methylation, Histone acetylation / deacetylation, RNA editing, alterations of RNA stability

Recombinant DNA technology and its applications in modern medicine

• Concepts of recombinant DNA, genetic engineering, biotechnology and cloning.
• Restriction endonucleases.
• Vectors for cloning – plasmids and phages.
• Genomic and cDNA libraries.
• Applications of recombinant DNA technology in medicine.
• Gene therapy
• Diagnosis of genetic diseases and genetic counseling
• DNA fingerprinting
• DNA sequencing
• Microarrays
• Fluorescent in situ hybridization (FISH)
• DNA vaccines
• Transgenic animals
• Application of molecular techniques in forensic investigation and medicolegal cases

Overview of Human Genome Project

Basics of bioinformatics

Principles of human genetics

• Alleles, genotypes and phenotypes
• Patterns of inheritance: monogenic and polygenic inheritance
• Population genetics
• Genetic factors in causation of diseases
• Types of genetic diseases: Chromosomal, monogenic and polygenic disorders, mitochondrial disorders, nucleotide repeat expansion disorders, imprinting disorders
• Screening for genetic diseases and prenatal testing

• Ethical and legal issues related to medical genetics

Stem cells in clinical medicine

• Basic concepts regarding stem cells
• Types of stem cells: embryonic and induced 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 hypoproliferativeanaemias - 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, 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 athesis/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.

Horizontal and vertical integration of teaching of Biochemistry with other preclinical, para-clinical and clinical departments

The post graduate students should take part in integrated teaching of undergraduates by participation in joint teaching sessions and seminars with different departments, participation in clinical rounds for discussing cases of interest and by small group discussions 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.

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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 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. 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 examinations. A post graduate student shall be allowed to appear for the theory and practical/clinical examination only after the acceptance of the thesis by the examiners.

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. Obtaining a minimum of 50% marks in ‘Theory’ and ‘Practical’ examinations separately shall be mandatory for passing the examination as a whole. 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:

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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.

Journals

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

Annexure 1

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**