MD BIOCHEMISTRY CURRICULUM

AIIMS KALYANI

JANUARY 8, 2024

ACADEMIC SECTION
AIIMS Kalyani

BIOCHEMISTRY

GOAL

The goal of post-graduate education in Biochemistry is to enable a student to conceptualize and explain biochemical events of life processes in health and disease and apply biochemical knowledge and skills for problem-solving in clinical situations and in scientific research to help further understanding of life processes at the molecular level.

OBJECTIVES

KNOWLEDGE:

At the end of three years of training in Biochemistry, the MD student should be able to describe and explain concepts and principles of biochemical processes related to the human system.

1. Apply the principles of Biochemistry to explain molecular processes in health and disease states in clinical situations.
2. Apply basic principles of Biostatistics for research work.

SKILLS

At the end of three years of training in Biochemistry, the MD student should be able to:

1. Perform biochemical laboratory investigations and experiments relevant to clinical management and biochemical research.
2. Analyze, interpret and evaluate laboratory data.
3. Rationalize the application in clinical management and experimental research.
4. Organize a laboratory set up to deliver optimum investigative support for patient care services.
5. Plan and conduct lectures, practical demonstrations, tutorial classes, and small group discussions on various biochemical topics for undergraduate students of medical and Para-medical courses.
6. Be familiar with literature search and computer skills.
7. Critically review and comment on research papers and make oral presentations.
8. Prepare research protocols, conduct experimental studies, analyze, and solve clinical and experimental problems.

COURSE CONTENT:

I. Physical and organic aspects of biochemistry, Biostatistics, and General Principles of biochemical techniques including molecular techniques.
II. Cell and Molecular biology, Endocrinology and Immunology.
III. Enzymology, Macro, and Micronutrients, Intermediary metabolism, Inborn errors of metabolism, Human nutrition.
IV. Clinical biochemistry, Laboratory management, and Recent advances in Biochemistry

3. I. (A) PHYSICAL AND ORGANIC ASPECTS OF BIOCHEMISTRY

1. Electrolytic dissociation, mass law, acids, bases, buffers, indicators, and pH and their applied aspects. Surface tension, osmosis, viscosity, diffusion colloidal system, membrane phenomena, adsorption, Donnan equilibrium, and their applications in a biological system.
2. Principles of isolation and purification of biomolecules.
3. Ribose, Xylose, glucose, mannose, galactose, fructose, Deoxy sugars, amino sugars, uronic acids, lactose, maltose, sucrose starch, insulin, glycogen, cellulose, glycosaminoglycans, Blood group Antigens – Basic chemistry, Structure-function relationships.
4. Saturated and unsaturated fatty acids, their derivatives, triacylglycerols, phospholipids, glycolipids, sterols, lipoproteins –Basic chemistry, structure-function relationships.
5. Amino acids, peptides, polypeptides, hemoglobins, immunoglobulins, collagen, and proteoglycans, levels of organization of proteins with reference to insulin, hemoglobin, and collagen – Basic chemistry, structure-function relationships.
6. Purines, pyrimidines, their derivatives, nucleic acids, nucleotides, and polynucleotides – Basic chemistry, structure-function relationships.

(NOTE: Only the description of accepted structures of common biomolecules is required. While structure, physical and chemical properties of the following are included structural elucidation is NOT required.)

I. (B) BIOSTATISTICS:

Basic principles and concepts of biostatistics as applied to health sciences - basics of epidemiological study designs and sampling methodologies, basic concepts of probability, mean, standard deviation, binomial expression, Analysis of variance, Coefficient of correlation, Chi-square test, Parametric data, Nonparametric data, Regression Analysis, ROC curve, evaluation of a new diagnostic procedure, etc.

I. (C) PRINCIPLES OF BIOCHEMICAL TECHNIQUES.

1. Principles, types, and applications of photometry- colorimetry, spectrophotometry, Reflectance, flame photometry, absorption spectroscopy, fluorimetry, mass spectrometry, fluorescence, Chemiluminescence, spectroscopy, etc.
2. Ion-selective electrodes.
3. Principles, types, and applications of Centrifugation.
4. Principles, types, and applications of electrophoresis (incl. isoelectric focusing, isotachophoresis, immunoelectrophoresis in detail also).
5. Radioactivity, isotopes, detection and measurement of radioactivity, tracer techniques, counters, Radioisotope-based techniques and their applications, radiation hazards and their prevention, radioimmunoassay, radiation in food preservation.
6. Principles and applications of chromatography (paper, column, affinity, ion exchange, adsorption and partition, GLC, TLC, HPLC) Gel filtration.
7. Nanotechnology and microfabrication
8. Techniques to study in vivo metabolism - NMR, SPECT, PET scans

9. Genetic engineering techniques, Blotting techniques, Recombinant DNA technology, PCR, DNA sequencing, Cloning, array techniques
10. Environmental Biochemistry: Regulation of gene expression by pollutants, Endocrine-disrupting chemicals

II. (A) CELL BIOLOGY:

Structure-function of the cell, cytoskeleton, nucleus, nucleolus, mitochondria, and plasmic reticulum, ribosome, Golgi complex, lysosomes, plasma membranes, gap junctions, cell division – mitosis and meiosis, cell cycle.

1. Cell fractionation and differentiation of cellular and subcellular organelles, Cell sorting.
2. Biomembranes, receptors, membrane-bound biomolecules, mechanisms of transport across the cell membranes.

1. Cell culture – Principles and applications.

II. (B) MOLECULAR BIOLOGY AND HUMAN GENETICS:

2. Structural organization of DNA and RNA, Replication of DNA, mutation, and mechanisms of DNA repair, Transcription, its regulation and post-transcriptional processing, Translation, it's regulation and posttranslational modifications; regulation and expression of genes, Genetic engineering- Various processes and techniques, Blotting techniques, Recombinant DNA technology, PCR, DNA sequencing, Cloning, proteomics and array techniques, Monoclonal antibodies, Concepts of genomics, proteomics, Basic concepts in bioinformatics. Role of reverse transcriptase, Gene therapy, Apoptosis, Basics of inheritance of Genetic disorders; Molecular basis of cancer, Tumour Markers.
3. Mechanism of action of cytotoxic drugs and antibiotics. Concept of genetic counseling, medical ethics.

II. (C) ENDOCRINOLOGY:

1. Classification and general mechanism of action of hormones.

Biogenesis, secretion, regulation, transport, mode of action, and disorders of the following – hypothalamic peptides, adenohypophyseal and neurohypophyseal hormones, thyroid hormones, parathyroid hormones, calcitonin, pancreatic hormones, adrenocortical and medullary hormones, gonadal hormones, gastrointestinal hormones, opioid peptides, Para hormones. Endorphins and encephalins.

2. Biochemistry of conception, reproduction, and contraception.

II. (D) IMMUNOLOGY

1. Concepts, mechanisms, and role of Innate and acquired immunity, humoral and cell-mediated immunity, antigen and antibodies, MHC.
2. Recognition of antigens: Primary interaction, antigen processing, and presentation Immune response: Lymphocyte maturation, activation of T and B lymphocytes,

cytokines, regulation of immune response, immunologic tolerance, hypersensitivity, autoimmunity and autoimmune diseases, immunodeficiency, tumor immunity, transplantation, immunosuppression and immunopotentiation including vaccination

3. Basic concepts regarding stem cells: Types of stem cells, Potential applications in clinical medicine, ethical and legal issues related to use of stem cells in medicine

III. (A) ENZYMOLOGY:

1. General properties, classification, and nomenclature, coenzymes; Mechanism of

   enzyme activity, Km value, Enzyme kinetics, Equilibrium, Thermodynamics of Enzyme catalyzed reactions; Factors influencing enzyme kinetics, Enzyme inhibition, Regulation of enzyme action, Isoenzymes, Clinical enzymology,

2. Biological oxidation, Electron transport chain, Oxidative phosphorylation, and Bioenergetics.
3. Metabolism of Xenobiotics, Free Radical Biology, Environmental biochemistry
4. III. (B) INTERMEDIARY METABOLISM:

1. Digestion and absorption of food and other nutrients.
2. Methods of studying intermediary metabolism.
3. Intermediary metabolism of carbohydrates, lipids, and amino acids,
4. Metabolism of nucleic acids and heme.
5. Muscular contraction, nerve conduction, coagulation of blood.
6. Metabolism in specialized tissues like erythrocytes, lens, nervous tissue, etc.
7. Metabolic interrelationships and metabolism in starvation and well-fed state, Role of

   hormones in the regulation of metabolism.

III. (C) MICRONUTRIENTS:
1. Vitamins - structure, sources, metabolism, biochemical role, RDA, deficiency

manifestations of vitamins, hyper vitaminoses, and antivitamins.
2. Mineral metabolism Sources, Metabolism, Functions, Daily requirement / RDA,

deficiency manifestation, the toxicity of minerals and trace elements.

III. (D) INBORN ERRORS OF METABOLISM

Inborn errors of carbohydrate, lipid, amino acid, nucleic acids, mineral metabolism, and Hemoglobin metabolism; Biochemical basis of Management of disorders.

III. (E) HUMAN NUTRITION

Principal food constituents, general nutritional requirements, energy requirements, the biological value of proteins, specific dynamic action, balanced diet, diet formulation 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,

laboratory diagnosis of nutritional disorders, Nutrition gene interaction - The interaction between nutrients and with the genome at the molecular level: Direct, Epigenetic and Genetic variations

IV. (A) CLINICAL BIOCHEMISTRY

Definition, types, clinical features, biochemical basis of disease, complications, and laboratory diagnosis of

1. a) Diabetes mellitus, Hypoglycemia, Ketosis, Glycogenoses, Galactosemia, Hyper lipoproteinemias, Fatty liver, Alcoholic liver disease, Hepatic failure, Malabsorption syndrome, Malnutrition, Aminoaciduria, Hemoglobinopathies, Immunoglobinopathies, Porphyrias,
2. b) Atherosclerosis, laboratory diagnosis of Myocardial Infarction.
3. c) Digestive systems and related organs; Gastric and pancreatic function tests, hepatobiliary function tests, Jaundice.
4. d) Endocrines; Thyroid function tests, Adrenal and Gonadal function tests.

1. Acid-base balance, fluid and electrolyte balance and related disorders, Renal function tests, principles of dialysis.
2. CSF in health and disease.
3. Pleural and peritoneal fluid analysis.
4. Diseases of the central nervous system, Alzheimer‘s disease.
5. Immunological disorders, diseases of clotting, Biochemistry of AIDS, Prion Diseases.
6. Laboratory workup of a patient with any organ disease.
7. Therapeutic drug monitoring for anticonvulsants (phenytoin, phenobarbitone), antitubercular drugs (rifampicin), antipsychotic drugs (lithium), immunosuppressants (cyclosporin, tacrolimus, methotrexate)

(B) LAB MANAGEMENT

1. METHOD EVALUATION: Analytical goals, precision and accuracy, bias, sensitivity and specificity, selection of method, and evaluation.
2. TOTAL QUALITY MANAGEMENT: Fundamental concepts, control of preanalytical, analytical, and post-analytical variables, internal and external quality control programs, Accreditation programs, Quality indicators in laboratory medicine, Lab audits to assess the lab performance, and Lean six sigma
3. AUTOMATION: Definition, instrumental concepts, types of analyzers, Trends in automation in Biochemistry laboratory Laboratory information systems.

(C) RECENT ADVANCES IN BIOCHEMISTRY.
Recent biochemical concepts in health and disease, newer analytical methods - As discussed in recent/current Medical/Biochemical journals and recent editions of textbooks of Biochemistry.

PRACTICALS Course content

1. General reactions of carbohydrates, lipids, proteins, amino acids, hemoglobin, and its derivatives.
2. Estimation of glucose, bilirubin, urea, creatinine, total cholesterol, total protein,
3. Chromatographic separation of sugars, amino acids, lipid, and proteins
4. Analysis of common foodstuffs for Carbohydrates, Proteins, Lipids, Vitamins and Minerals.
5. Blood Glucose estimation and GTT in autoanalyzer.
6. Estimation of cholesterol and triacylglycerol in plasma in autoanalyzer.
7. Estimation of Ca^{++}, inorganic phosphate, electrolytes in autoanalyzer
8. pH and blood gas analysis.
9. Estimation of urea, creatinine, uric acid, and clearance tests in autoanalyzer.
10. Estimation of bilirubins, total proteins, albumin, serum enzymes like AST, ALT, Alkaline phosphatase, and Prothrombin time determination as hepatobiliary function tests in autoanalyzer
11. Estimation of copper, ceruloplasmin activity, lithium, iron, iron-binding capacity, magnesium in plasma/serum in autoanalyzer.
12. Thyroid function tests like T3, T4, and TSH Assays in autoanalyzer.
13. Complete urinalysis for normal and abnormal constituents
14. Analyses of gastric juice.
15. Analysis of renal and biliary calculi.
16. Estimation of amylase, acid phosphatase, and CK activities in serum in autoanalyzer
17. Separation of isoenzymes by polyacrylamide gel electrophoresis.
18. Estimation of ethyl alcohol in urine and blood.
19. CSF analysis. Analyses of pleural and peritoneal fluids in autoanalyzer.. .
20. Electrophoretic separation of - plasma/serum total proteins and Lipoproteins and Hemoglobins.
21. Estimation of glycated hemoglobin
22. Use of techniques/instrumentation:- ELISA, immunodiffusion, Spectrophotometry, Spectrofluorometric analysis, Western blotting, Southern blotting, PCR, Automated Clinical Chemistry Analysers.
23. Interpretation of laboratory data on biochemical parameters and correlations with the clinical profile.
24. Planning and organization of biochemical experiments in the laboratory.
25. Isolation of DNA and RNA from blood.
26. Synthesis of cDNA by reverse transcription
27. Polymerase Chain Reaction
28. Agarose gel electrophoresis for DNA
29. SDS PAGE
30. Separation of peripheral blood lymphocytes using Ficoll Hypaque
31. Preparation and interpretation of quality charts
32. Basics of quality assurance according to (NABL, NABH, and ISO 15189) guidelines
33. Interpretation of IQC and proficiency testing results, implementation of corrective and preventive action based on IQC and proficiency testing results
34. Troubleshooting for error flags in the analytical system including calibration failure, reagent or QC or calibrator deterioration, temperature instability, water quality, and other issues related to the equipment
35. Method validation, Linearity estimation

TEACHING LEARNING METHODS

The following are the TL methods suggested for being adopted during the MD biochemistry course.

1. Postgraduate Interactive Lectures, Presentations, Seminars, Group discussions, Clinical Case discussions, Lecture by guest faculty or interdepartmental discussion with Guest faculty – three to four a week
2. Journal club meetings- Once a week.
3. Practical Exercises
4. Micro Teaching sessions.
5. Dissertation under the guidance of Guide (and Co-guide if any).
6. Specialized Training in various sections of Clinical Biochemistry laboratories under supervision - four months a year
7. Participation in UG laboratory exercises and Tutorials as a team member under supervision.
8. Assignments.

Assessment :

Theory:

1. Formative evaluation of the candidate in theoretical aspects of Biochemistry: Class tests, MCQs
2. Internal assessments [IA]:

a. Semester examinations theory: Six [Two per year] and
b. A send-up examination in the final year

3. Final theory internal assessment mark of 100 to be calculated from the scores of periodic IA tests [80%], Journal club and seminar presentations, [20%]

Practical:

1. Formative evaluation of the candidate in practical aspects of Biochemistry and certification of the laboratory skills
2. Affective domain to be assessed by OSPE : [Two per year]
3. Formative assessment of students on their professionalism [Grades to be given to assess].
4. Internal assessments practical:

a.Lab leaving examinations: Ten [Four per year for the first and second year and two per year in the final year]
b. Semester examinations: Six [Two per year]
c.One send-up examination in the final year
d. Periodic review and assessment of logbook or portfolio

Final practical internal assessment mark of 100 to be calculated from the scores of practical IA tests [75% from lab leaving, semester, send up], log book[15%] charts [10%].

Final Practical examination:

Practical examination will be held over two days and the total marks will be 500. A practical examination will be conducted to evaluate both major and minor practicals for 300 marks. Major practicals include case-oriented and clinical investigative approach, general biochemistry techniques and molecular techniques, Reagent preparation/ Method validation / Linearity estimation. Minor practicalities include screening for IEM in urine, Abnormal constituents of urine, and Clinical calculations.

Oral examination of 100 marks shall assess the general theoretical and practical knowledge of the candidate related to biochemistry, quality control charts used in the clinical laboratory, Charts on clinical chemistry/ ABG / endocrinology/immunology/ the dissertation work carried out by the candidate, and Pedagogy. The candidate will be given a choice of at least two topics in Biochemistry on day one of the examination 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 – 15 minutes only.

An internal assessment of 100 marks will be added to the final practical examination marks.

Final practical evaluation sheet

		Current Marks Allocation (Max)

I. Major Practical (200 Marks)		
1	**Case Discussion**	**60**
2	**One common technique to be performed (Electrophoresis / SDS PAGE / Chromatography)**	**50**
3	**Molecular technique: DNA isolation and PCR**	**60**
4	**Reagent preparation/ Method validation / Linearity estimation**	**30**
II. Minor Practical (100 Marks)		
5	**Screening for IEM in urine**	**25**
6	**Abnormal constituents of urine**	**25**
7	**Clinical chemistry calculations (Any 2)**	**50**
	Total (I + II)	**300**
III. Oral (100)		
	a) General Viva-Voce	**20**
	b) Quality control charts	**15**
	c) Charts on clinical chemistry/ ABG / endocrinology / immunology [any 2]	**30**
	d) Pedagogy	**20**
	e) Viva-voce on Thesis	**15**
	GRAND TOTAL (I+II+III)	**400**

JOURNALS RECOMMENDED FOR M.D BIOCHEMISTRY COURSE

1. Clinica Chimica Acta
2. British Journal of Nutrition

3. American Journal Nutrition
4. Journal of Lipid Research
5. Clinical Chemistry
6. Clinical Biochemistry
7. Journal of Laboratory Investigation
8. Biochemical Journal
9. Metabolism
10. Nature
11. Nature Medicine
12. 12. Science
13. Lancet
14. Journal of Endocrinology
15. Trends in Biochemical Sciences
16. Federation of American Societies for Experimental Biology (FASEB) 17. Annual reviews of Biochemistry.
18. Immunology
19. Indian Journal Clinical Chemistry
20. Indian Journal of Biophysics and Biochemistry

LIST OF BOOKS - RECOMMENDED FOR MD CURRICULUM (All the books are to be recent editions).

1. Tietz – Textbook of Clinical Chemistry and Molecular Diagnostics. Burtis, Ashwood, Bruns.
2. Harper‘s Illustrated Biochemistry. Robert K.Murray.
3. Lehninger‘s Principles of Biochemistry. David L. Nelson and Michael M. Cox.
4. Practical Biochemistry – Principles and Techniques. Keith Wilson and John Walker.
5. Biochemistry. Lubert Stryer and Jeremy.M.Berg.
6. Metabolic and Molecular Basis of Inherited Diseases. Scriver et al.
7. Devlin‘s Text Book of Biochemistry with Clinical Correlations. Parslow GP, Wood

   EJ.

8. Biochemistry. Donald Voet and Judith Voet.
9. Williams Textbook of Endocrinology. P. Reed Larsen, Henry M. Kronenberg,

   Shlomo Melmed, and Kenneth S. Polonsky

10. Harrison‘s Principles of Internal Medicine. Dennis L. Kasper, Eugene Braunwald,

    Stephen Hauser, Dan Longo, J. Larry Jameson, Anthony S.

11. Molecular Cell Biology – Lodish.H, Berk A, Baltimore D.
12. Kuby Immunology. Thomas J. Kindt, Barbara A.Osborne, Richard A. Goldsby
13. Principles and Techniques of Biochemistry and Molecular Biology. Keith Wilson,

John Walker.

14.Clinical Diagnosis and Management by Laboratory Methods. Todd, Stanford,

Davidson, John Berhard.

15. Modern Nutrition in Health and Disease. Maurice E.Shills, Moshe Shike.
16. Practical Physiological Chemistry. Hawk and Philip.B.
17. Enzymes, Biochemistry, Biotechnology, Clinical Chemistry. Trevor Palmer.
18. Methods in Enzymology. M. Dickson and EC Webb.
19. Modern Experimental Biochemistry. Rodney Boyer.
20. Human Nutrition and dietetics. Leybourne Stanley, Patrick Davidson, R. Passmore,

MA Eastwood.

21. Practical Biochemistry. Harold Varley.
22. Cell and Molecular biology. De Robertis.
23. Methods in Biostatistics. B.K. Mahajan.
24. Practical Immunology. Talvar.
25. Textbook of Biochemistry. West and Todd.
26. Comparative Biochemistry and Physiology. Reaven.
27. Essentials of Clinical Immunology. Chappel.