

**All India Institute of Medical Sciences (AIIMS), Nagpur,
Maharashtra
Department of Biochemistry**

Undergraduate Curriculum

PART-1: The course outcomes

At the end of the course, the student should be able to:

Demonstrate his knowledge and understanding on the:

1. Molecular and functional organization of a cell, and sub- cellular components;
2. Structure, function and interrelationship of biomolecules and consequences of deviation from normal;
3. Basic and clinical aspects of enzymology and regulation of enzymatic activity;
4. Digestion and assimilation of nutrients and consequences of malnutrition;
5. Integration of the various aspects of metabolism, and their regulatory pathways;
6. Biochemical basis of inherited disorders and their associated sequelae;
7. Mechanisms involved in maintenance of body fluid and pH homeostasis;
8. Molecular mechanisms of gene expression and regulation, the principles of genetic engineering and their application in medicine;
9. Molecular concepts of body defence and their application in medicine;
10. Biochemical basis of environmental health hazards; and biochemical basis of cancer and carcinogenesis, principles of metabolism, and detoxication of xenobiotics.
11. Principles of various conventional and specialized laboratory investigations and instrumentation, analysis and interpretation of a given data; the ability to suggest experiments to support theoretical concepts and clinical diagnosis.
12. Make use of conventional techniques/ instruments to perform biochemical analysis relevant to clinical screening and diagnosis
13. Analyze and interpret investigative data
14. Demonstrate the skills of solving clinical problems and decision making.

PART 2: Specific Learning Objectives: Annexure no:1

PART: 3 Teaching / Learning (T/L) Methods

TOTAL =250 HOURS		
THEORY (180 HOURS)		PRACTICALS (70 HOURS)
Lectures: 100	Tutorials/SGTs/ECE/SDL* 80 hours	35 sessions

(*include all hours spared for innovative T/L sessions)

B) PRACTICAL:

First term (18 sessions)	Second term (17 sessions)
<ol style="list-style-type: none">1. Introduction, Laboratory safety and biomedical waste management : 1 session2. Instrumentations, pH measurement and buffer preparation: 1 session3. Protein fractionation, denaturation, separation of proteins and amino acids: 2 sessions4. Colour reactions of carbohydrates, amino acids, proteins: 3 sessions5. Principle and application of colorimetry and Beer's-Lambert's law: 1 session6. Estimation of blood glucose-1 session7. OSPE : Instruction to subject undergoing OGTT-1 session8. HbA1c -1 session9. POCT (Glucometer, urine strip): 1 session10. Analysis of urine sample for normal constituents : 2 sessions11. Analysis of urine sample for abnormal constituents : 3 sessions12. OSPE on urinalysis : 1 session	<ol style="list-style-type: none">13. Estimation of total cholesterol & triacylglycerol with Lipid profile interpretation and case discussion : 2 sessions14. Estimation of total protein and albumin : 2 sessions15. Estimation of inorganic phosphate & calcium : 1 session16. Estimation of bilirubin : 1 session17. Enzymes assays: alkaline phosphatase, AST or ALT: 1 sessions18. Estimation of uric acid and case discussion of gout : 1 session19. Estimation of urea, creatinine; Calculation of clearance of urea & creatinine : 2 sessions20. OSPE: providing instructions to patients how to collect 24 hour urine sample -1 session21. Effect of factors affecting enzyme activity, calculation of Km : 2 sessions22. DNA isolation: 1 session23. Gel electrophoresis & Chromatography: 2 sessions24. ELISA and Immunodiffusion: 1 session

3.2 TOPIC WISE DISTRIBUTION OF TEACHING HOURS

1. Cell and organelles: 2 hours

1. Architecture, compartmentation, cell membrane structure and functions
2. Membrane dynamics and related disorders

2. Biomolecules: 10 hours

1. Function and classification of carbohydrates, lipids, protein and amino acids.
2. Stereoisomerism and chemistry of monosaccharides, amino acids, and fatty acids
3. Structural organization and structure-function relationships of proteins.
4. Haemoglobin and myoglobin, molecular mechanism of O₂ transport and storage.

Molecular basis of sickle cell anaemia and thalassemia

5. Plasma proteins, their functions and clinical significance

3. Enzymes: 5 hours

1. Nomenclature, classification
2. Kinetics, mechanism of enzymatic catalysis

3. Factors influencing enzymatic catalyses, enzyme activators and inhibitors.
4. Regulation of enzyme activity
5. Clinical enzymology, isoenzymes

4. Bioenergetics, TCA cycle & introduction to metabolic pathways: 2 hours

TCA cycle, Bioenergetics, Biological Oxidation and Electron Transport Chain

General concepts and characteristics of metabolic pathways

5. Food assimilation and Nutrition: 12 hours

1. Digestive enzymes, their actions on dietary carbohydrates, fats and proteins
2. Absorption of glucose, amino acids and lipids
3. Functions of dietary ingredients, the macro and micronutrients
4. Caloric values of foods, Basal metabolic rate, specific dynamic action, respiratory quotient, Balanced diet
5. Fat soluble vitamins, Water soluble vitamins
6. Malnutrition
7. Minerals and trace elements - Iron and related disorders Copper, Zinc, Molybdenum, Cobalt, Iodine, Magnesium, Chromium, Calcium and phosphorus homeostasis

6. Carbohydrate metabolism: 6 hours

1. Pathways of glucose metabolism: glycolysis
2. HMP shunt
3. Gluconeogenesis
4. Glycogenolysis, glycogenesis
5. Glycogen storage diseases
6. Galactose and fructose metabolism
7. Regulation of blood glucose
8. Diabetes Mellitus

7. Amino acid metabolism: 6 hours

1. General reactions, transamination, its metabolic and diagnostic significance
2. Disposal of amino acid nitrogen and detoxification of urea
3. Metabolic fate of amino acid carbon skeleton
4. Metabolism of aromatic amino acids, Sulphur containing amino acids and branched chain amino acids
5. In born errors of amino acid metabolism & screening tests
6. Important amino acid derivatives

8.Lipid metabolism: 7 hours

1. Biosynthesis and oxidation of fatty acids, phospholipids & triacylglycerols
2. Biosynthesis and degradation of cholesterol with Inborn errors
3. Chemistry and metabolism of lipoproteins
4. metabolism of lipoproteins, hyperlipoproteinemias, other Disorders associated with lipoprotein metabolism: atherosclerosis, fatty liver
6. Ketone bodies: their synthesis, utilization and conditions leading to ketoacidosis, Prostaglandin and prostanoids.
7. metabolism in adipose tissue

9.Heme metabolism: 3 hours

1. Heme Synthesis
2. Heme degradation
3. Disorders of Heme metabolism

10.Regulation of the metabolic pathways: 4 hours

1. Carbohydrate, lipid and amino acid metabolism
2. Interlinks between these pathways
3. Organ interrelationships in metabolism
4. Blood glucose regulation, and its impairment in diabetes mellitus
5. Metabolic adaptation in the fed state, fasting and prolonged starvation
6. Metabolic derangements and adaptations in diabetes mellitus

11. Endocrinology: 6 hours

1. Molecular basis of mechanism of hormonal action, signal transduction
2. Chemistry, functions and mechanism of action of hormones of the pituitary, thyroid, parathyroid, adrenals, pancreas, and gonads
3. Biosynthesis of steroid hormones, their functions and mechanism of action.
4. Endorphins and enkephalins.

12. Clinical chemistry: 8 hours

1. Gastric function test
2. Pancreatic function test
3. Intestinal function test
4. Liver function test
5. Renal function test
6. Cardiac function test

13. Molecular and cancer biology: 12 hours

1. Nucleotides- chemistry, metabolism and disorders
2. Nucleic acids: DNA and RNA structure
3. DNA Replication
4. DNA Transcription and Post-transcriptional processing
5. Translation, post translational modifications
6. Regulation of gene expression and inhibitors of protein synthesis
7. Mutation, DNA repair mechanisms and related disorders
8. Genetic Engineering: Recombinant DNA technology and other molecular techniques
9. DNA and diagnostics
10. Telomeres and telomerases
11. Human genome project
12. Cell cycle, cancer biochemical basis and apoptosis, tumour markers

14.pH, buffer, physiological buffer systems: 4 hours

1. Sodium and Potassium, Water and electrolytes
2. Regulation of blood pH, Acidosis and Alkalosis

15. Immunology: 08 hours

1. Components and functions of the innate and adaptive immunity
2. Role of T and B lymphocytes, antigen presentation
3. Induction of immune response
4. Cell mediated immune response
5. Immunoglobulin structure and functions, generation of antibody diversity
6. Humoral immune response
7. Complement system
8. Cytokines
9. Hypersensitivities
10. Immunoregulation, autoimmunity, immunotolerance
11. MHC, HLA, disease association & transplantation
12. Immunological techniques, application in medicine (vaccines, immunotherapy, immunoassays and Immunodiagnostics)

16. Environmental biochemistry: 2 hours

1. Xenobiotics and detoxification
2. Free radicals & antioxidants

17. Miscellaneous: 3 hours

1. Extracellular matrix, Structure & functional properties of collagen
2. Abnormalities associated with its metabolism

3.3 EARLY CLINICAL EXPOSURE

1. Visit to clinical laboratory
2. Pre-Analytical Error quality control demonstration
3. Case discussion on molecular biology (Nucleotide metabolism)
4. Case discussion on Lipid metabolism
5. ABG case discussion
6. Case discussion on Carbohydrate metabolism + OGTT demonstration
7. Urine report + 24hrs Urinary protein sample collection demonstration

3.4 SELF-DIRECTED LEARNING (SDL)

Department of Biochemistry also encourages Self Directed Learning (SDL) and Directed Self Learning (DSL). The topic, learning objectives, teaching / learning activity & assessment methods will be decided by the students themselves. They will be helped by a facilitator. All the SDLs will be entered in the logbook.

Reflection writing: Later you will be writing the reflection under 3 questions

1. What happened? (Information gathering)
2. So what? (Significance of learning)
3. What next? (Application of newly gained knowledge)

Topics planned

1. Water soluble Vitamins
2. Molecular biology
3. Immunology
4. Integrated metabolism
5. Biomolecules and bio-membranes

3.6 PRACTICAL- 70 hours (35 sessions)

1. Introduction, Laboratory safety and biomedical waste management: 2 session
2. Instrumentations, pH measurement and buffer preparation: 2 session
3. Protein fractionation, denaturation, separation of proteins and amino acids: 2 sessions
4. Colour reactions of carbohydrates, amino acids, proteins: 3 sessions
5. Principle and application of colorimetry and Beer's-Lambert's law: 1 session

6. Estimation of blood glucose-1 session
7. OSPE : Instruction to subject undergoing OGTT-1 session
8. HbA1c -1 session
9. POCT (Glucometer, urine strip): 1 session
10. Analysis of urine sample for normal constituents : 1 session
11. Analysis of urine sample for abnormal constituents : 1 session
12. OSPE on urinalysis : 1 session
13. Estimation of total cholesterol & triacylglycerol with Lipid profile interpretation and case discussion : 3 sessions
14. Estimation of total protein and albumin : 1 session
15. Estimation of inorganic phosphate & calcium : 1 session
16. Estimation of bilirubin : 1 session
17. Enzymes assays: alkaline phosphatase, AST or ALT: 1 sessions
18. Estimation of uric acid and case discussion of gout : 1 session
19. Estimation of urea, creatinine; Calculation of clearance of urea & creatinine : 2 sessions
20. OSPE: providing instructions to patients how to collect 24 hour urine sample -1 session
21. Effect of factors affecting enzyme activity, calculation of K_m : 1 session
22. DNA isolation: 1 session
23. Gel electrophoresis: 2 sessions
24. Chromatography: 2 sessions
25. ELISA and Immunodiffusion: 1 session

3.7 TEACHING AND LEARNING (T/L) METHODS

A) Theory

- Didactic / interactive lectures
- Flipped classes
- PBL sessions
- Open book exams
- Small group T/L activities: group discussion, demonstration, case discussions, learning by framing MCQs, rating the OSPE stations, cross over groups, Jig -saw methods :

ANNEXURE 2

- Poster presentation by students
- Mini-lecture by students

B) Practical

- Practical Demonstration
- Training with OSPE
- Small group discussion

PART 4: Assessment / Evaluation

Department of Biochemistry gives more importance to formative assessment and providing immediate feedback.

Formative Assessment: There are two internal assessments and one pre-professional exam. The pattern for each assessment includes MCQs, Structured long essay, short answers and very short answers.

4.1 MARKS DISTRIBUTION IN INTERNAL ASSESSMENT (IA)

A) Theory:

- MCQs 16 X 0.5=8 marks
- Structured LAQ= 8 marks
- Short Answer Questions (SAQs): 5 x 2 marks =10 marks
- Short Notes (SNs): 2 x7 marks = 14 marks

TOTAL: 40 MARKS (Plus 10 marks from Viva Voce)= 50 marks

B) Practical: 50 MARKS

1. Quantitative exercise:12 marks
2. Qualitative exercise: 08 marks
3. Combined interpretation (of Quantitative and Qualitative exercises): 3 marks
4. Practical viva: 5 marks
5. OSPE = 20 marks
6. Practical manual and log book: 2 marks
7. **Viva voce: 10 marks (To be added to theory)**

TOTAL = 50 marks

Note: Portions for first IA (1 paper): first term topics theory and practical

Portions for second IA (1 paper): second term topics theory and practical

4.2 Marks distribution in Pre-Professional and Professional

A) Theory: Paper-1 & 2.

Total marks : 40 for each papers

- MCQs 16 X 0.5=8 marks
- Structured LAQ= 8 marks
- Short Answer Questions (SAQs): 5 x 2 marks =10 marks

- Short Notes (SNs): 2 x7 marks = 14 marks

TOTAL: 40 X 2 = 80 MARKS (Plus 20 marks from Viva Voce)

(Total Theory : 100 marks)

B) Practicals: 100 marks

- Quantitative: 25 marks
- Qualitative: 20 marks
- Combined interpretation: 5 marks
- Practical viva: 10 marks
- OSPE: 40 marks

TOTAL : 100 marks

C) Viva Voce :20 marks (To be added to theory)

4.3 DISTRIBUTION OF THE MARKS

A) THEORY (80 marks + 20 marks from viva voce)

I) PAPER – 1: 40 marks

1. Membrane biology, membrane dynamics & related disorders, ETC (4 marks)
2. Chemistry and Physiological significance of carbohydrates, lipids, proteins & amino acids (3 marks)
3. Enzymology & Clinical enzymology (5 marks)
4. Metabolism of Carbohydrates & IBEM (7 marks)
5. Amino acid Metabolism & IBEM (6 Marks)
6. Heme metabolism (including hemoglobin and myoglobin) & porphyrias (4 marks)
7. Lipid Metabolism & IBEM (7 marks)
8. Regulation of the metabolic pathways and integrated metabolism (4 marks)

II) PAPER -2 : 40 marks

1. Chemistry and Physiological significance of nucleic acids, metabolism of purines & pyrimidines with IBEM (4 marks)
2. Cell biology, Molecular biology, molecular techniques (9 marks)
3. Cell cycle & its regulation, Cancer biology(4 marks)
4. Clinical Chemistry & Organ function tests (3 marks)
5. pH, buffer, physiological buffer systems, Acid-Base balance & disorders, electrolytes (2 marks)

6. Endocrinology (4 marks)
7. Immunology (7 marks)
10. Environmental Chemistry and Miscellaneous (2 marks)
11. Food assimilation and Nutrition, including vitamin and minerals (5 marks)

B) PRACTICAL

(TOTAL MARKS = 100)

- Clinical case based: Quantitative and qualitative assays with interpretation (combined interpretation)
- OSPE: Performance stations (observer with checklist for rating / unobserved), Response stations.
- Viva voce

In addition, we have introduced OSPE stations to check the attitude and communication skills of the learners. Eg: providing instructions to the subject undergoing OGTT, estimation of 24-hour urine proteins etc.

I) Quantitative: Estimate the concentration of the analytes from the sample provided to you – 25 marks

- a) Writing the principle & formula for calculation (4+1=5 marks)
- b) Practical Skills & observation (5 marks)
- c) Plotting the standard graph and finding concentration from the graph (7 marks)
- d) Reporting and Interpretation (6 marks)
- e) Clearing work place (2 marks)

For those Quantitative experiments without standard graph the marks will be distributed as follows:

- a) Writing the principle & formula for calculation (3+1=4 marks)
- b) Practical Skills & observation (4 marks)
- c) Calculation (6 marks)
- d) Reporting and Interpretations (4 marks)
- e) Clearing work place (2 marks)

II) Perform complete Biochemical analysis to identify the abnormal constituents in the urine sample provided and report – 20 marks

NOTE: Both urine and blood samples are from the same patients (synthetically prepared samples can be used)

a) Biochemical analysis of urine sample (16 marks)

b) Report writing (4 marks)

III) Interpretation & provisional diagnosis – 5 marks

a) Provide the list of provisional diagnosis (3 marks)

b) List further investigations you want to request to confirm your diagnosis (2 marks).

IV) Practical viva: 10 marks

V) OSPE – 40 marks (5 stations X 8 marks): 1 performance and 4 response stations. (Includes case - based questions)

VI) VIVA VOCE : 20 marks (to be added to theory marks)

Note: Part Completion Tests (PCTs) are taken at least once in a month, preferably including MCQs, short answers and very short answers (Variable combination). Practical assessments are also done twice a year

Note: Summative assessment: At the end of first year (theory & practical):

Theory:

- The type of assessment tools are MCQs to check memory (knows), analysing and interpreting skills, short clinical cases (knows how). We include, recall, reason and assertion type of MCQs (at least 4) & match the following type of MCQs too.
- Structured long essay, short answers and very short answers (mostly reasoning and concept oriented).
- The pattern is similar to that of the pre-professional examination

5. RECOMMENDED BOOKS

5.1 REGULAR BOOKS:

1. Harper's illustrated Biochemistry 31st edition
2. Lippincott illustrated Reviews – Biochemistry 7th edition 2017-by Ferrier
3. Textbook of Medical Biochemistry 4th edition – Dr. Dinesh Puri
4. Essentials of Immunology 2nd edition -Dr. S K Gupta
5. Textbook of Biochemistry for medical students, 9th edition, DM Vasudevan et al.,

5.2 BOOKS FOR REFERENCE:

1. Wilson and Walker's Principles and techniques of Biochemistry and molecular Biology, Andreas Hofmann et al.,
2. Harrison's Principles of Internal Medicine vol 1 & 2, 20th edn, Jameson et al.,

3. Lehninger Principles of Biochemistry 7th International Edition by David L Nelson,
Macmillan
4. Kuby Immunology, sixth edition, by Thomas J. Kindt et al.