SYLLABUS, ToS & OSPE

M.B.B.S.

FIRST PROFESSIONAL

PART-I

BIOCHEMISTRY

SYLLABUS MBBS FIRST PROF. PART-I
BIOCHEMISTRY

Course Duration

- 35 weeks per academic year
- Five hours lecture per week for 35 weeks (175 hours)
- Two hours practicals per week for 35 week (70 hours)
- Two hours tutorial/interactive group discussion classes per week (70 hours)
- Seminar / clinically-oriented presentation / case discussion one hour per week (35 hours)
- Total teaching hours for the subject of biochemistry (350 hours)

Teaching objectives (Biochemistry Part-I):

The general objectives and overall aims of the teaching course include:

1. To teach sufficient biochemistry to give the student a basic understanding of life processes at the molecular level.
2. To provide an understanding of the normal biochemical processes in the human body in which the function of the various organs and tissues are integrated.
3. To undertake practical classes that would familiarize the student with the various chemical methods which are used in the qualitative analysis of carbohydrates, lipids, amino acids/proteins, and biological fluids (urine, etc)
4. To familiarize the students with laboratory instruments / equipment used in biochemistry laboratory.
5. To undertake practical classes that would familiarize the student with the various chemical methods by which normal and abnormal constituents of urine are detected along with the interpretation of presence of these constituents in urine.

Learning objectives (Part-I)

At the end of the Part-I course, the student should be able to demonstrate his knowledge and understanding on the subject with following learning objectives:

1. Molecular and functional organization of a cell, and sub-cellular components.
2. In-depth knowledge of structure, function and interrelationship of biomolecules and consequences of deviation from normal.
3. Delineating, learning and understanding the chemistry of biomolecules of biologic significance. In order to accomplish this, the student will learn the basic chemical aspects of the biomolecules (carbohydrates, lipids, amino acids, polypeptides, nucleic acids).
4. Description of mechanisms involved in maintenance of body fluid & pH and the related homeostatic processes.
5. Recognizing homeostatic dynamics through the concepts of human nutrition and be familiar with the biochemical role of micro- and macro-nutrients like vitamins, minerals, and electrolytes along with their clinical implications of their dietary use.

6. Having a clear understanding of the fundamental aspects of enzymology & clinical applications along with regulation of enzyme activity.
7. Developing skills as a self-directed learner, recognize continuing educational needs; use appropriate learning resources and critically analyze relevant literature in order to have a comprehensive understanding and knowledge of biochemistry.

1- Cell Biochemistry

a) Introduction to biochemistry: An overview of biochemistry and its significance in medicine.

b) Biochemical composition and functions of cell: Organization and composition of eukaryotic and prokaryotic cells (only biochemical aspects)

c) Cell membranes (biochemical composition)

d) Membrane phenomena: Transport of substances across the cell membrane via active (primary and secondary active) transport; diffusion (simple and facilitated), and vesicle-mediated transport (phagocytosis, endocytosis, and exocytosis); Gibbs-Donnan equilibrium, osmosis and osmotic pressure

e) Membrane receptors and other biologically important regulatory and catalytic membrane-bound proteins like G-proteins, adenlylyl cyclase, phospholipase.

f) Basic methods to study cell biochemistry: Centrifugation, ultracentrifugation, radioimmunoassay, ELISA (enzyme-linked imnunosorbent assay); chromatography; electrophoresis, spectrophotometry, and pH metry.

2- Water, pH and buffers

a) Ionization of water; weak acids and bases

b) pH and pH scale: Concept of pH and related topics (determination of pH), and concept of pI (isoelectric pH)

c) pKa value, dissociation constant (Ka), and titration curve of weak acids

d) Determination of pH of buffer: Henderson-Hasselbalch equation and its applications (derivation not required).

e) Body buffer systems (bicarbonate, ammonia, phosphate, and proteins) and their mechanism of action.

3- Carbohydrates

a) Definition, biochemical functions and classification of carbohydrates.

b) Structure and function of biologically important monosaccharides and their important derivatives (sugar acids, sugar alcohols, sugar amines, and glycosides)

c) Isomerism in carbohydrates (types and description)

d) Biologically important disaccharides, their properties and their biomedical importance

e) Oligosaccharides, their combination with other macromolecules and their biomedical importance

f) Homopolysaccharides of biologic significance and their structural and functional characteristics

g) Structural and functional characteristics of heteropolysaccharides including details of glycosaminoglycans; proteoglycans, peptidoglycans; and mucopolysaccharidoses.

4- Amino acids and Proteins

a) Biomedical importance and classification (biologic functions; nutritional value; and overall shape of molecule) of proteins.

b) Structure, functions and properties of amino acids

c) Classification of standard (proteinogenic) amino acids (based upon side chain structure, polarity of side chain, nutritional, and metabolic end-products), biologically important non-standard (non-proteinogenic) amino acids and their principal functions.

d) Dissociation and titration of amino acids; determination of pI of amino acids with two and three dissociable groups; importance of amino acids in the maintenance of pH; and mechanism of buffering action of proteins.

e) Structural organization of proteins: Details of four orders of protein structure (primary, secondary, tertiary, and quaternary); denaturation of proteins; and protein misfolding (amyloidoses and prion disease)

f) Important techniques for separation of proteins (electrophoresis, isoelectric focusing, chromatography, filtration, centrifugation, and dialysis).

g) Immunoglobulins; their types; structure, and biomedical significance.

h) Plasma proteins (viz, prealbumin, albumin, haptoglobin, ceruloplasmin, alpha1-anti-trypsin; alpha 2-macroglobulin and transferrin) and their principal biologic functions along with their clinical significance. Alpha fetoprotein and clinically important acute phase proteins (alpha 1-acid glycoprotein, C-reactive protein).

i) Glycoproteins: components of glycoproteins (overview of linkages between proteins and carbohydrates, N- and O-linked oligosaccharides).

5- Nucleotides and nucleic acids

a) Chemistry of purines and pyrimidines; their types and structure

b) Structure and functions of nucleotides and nucleosides (EXCLUDING metabolism of nucleotides).

c) Natural and synthetic derivatives of purines and pyrimidines and their biomedical role.

d) Structure, functions and types of nucleic acids (EXCLUDING metabolism)

6- Lipids and fatty acids

a) Classification of lipids and their general biological functions.

b) Fatty acids: Definition; nomenclature; classification; chemical and physical properties; isomerism in fatty acids; role of saturated and unsaturated fatty acids in health and disease; role of trans fatty acids (*trans*-fats) in coronary heart disease; omega-3 and omega-6 fatty acids and the importance of their dietary use.

c) Nutritionally essential fatty acids and their functions

d) Eicosanoids and their biologic functions along with their significance in health and disease.

e) Physical and chemical properties of fats and oils (triacylglycerols); saponification, iodine number, and acid number of fats; rancidity of fats

f) Structure and biologic functions & significance of phospholipids, glycolipids, sulfolipids and gangliosides

g) Cholesterol and its related compounds such as bile acids: Structure (constituent structural components), properties and biologic role

h) Lipid peroxidation and its significance

7- Enzymes

a) Introduction, classification and nomenclature of enzymes: Definitions of enzymes and IU of enzyme activity; Enzyme Commission Classification of enzymes along with main subclasses.

b) Properties of enzymes: Chemical nature, active site, catalytic efficiency, specificity, proenzymes, and kinetic properties

c) Coenzymes and cofactors: Coenzymes derived from various vitamins along with the examples of enzymes requiring these coenzymes; and metal cofactors

d) Isozymes and their clinical significance

e) Allosteric enzymes and their biological significance

f) Factors affecting enzyme activity

g) Types of enzyme inhibitors and their biomedical importance: Effects of competitive, non-competitive and uncompetitive inhibitors on enzyme activity, effects of competitive and non-competitive inhibition on Lineweaver-Burke plot.

h) Mechanism of enzyme action and kinetics of enzyme activity (Michaelis-Menten and Lineweaver-Burke equations WITHOUT derivation)

i) Regulation of enzyme activity (covalent modification, allosteric regulation and regulation by gene induction, repression & de-repression of enzyme synthesis)

j) Therapeutic use of enzymes and diagnostic application of determination of enzyme activities of certain enzymes in plasma in hepatic, muscle, prostatic, pancreatic,bone and cardiac diseases.

8- Porphyrins and hemoproteins

a) Chemistry and biosynthesis of heme and other porphyrins including disorders of heme bionsynthesis (porphyrias)

b) Important hemoproteins found in body along with their principal biologic functions; structure and function of hemoglobin and myoglobin, and types of hemoglobin. Hemoglobin A_{1c}

c) Oxygen binding capacity of hemoglobin, factors affecting and regulating the oxygen-binding capacity of hemoglobin. Methaemoglobin (metHb) and methaemoglobinemia.

d) Bilirubin Metabolism: Degradation of heme, synthesis, hepatic uptake, conjugation, and excretion of bilirubin and fate of bilirubin in intestine.

e) Hyperbilirubinemias: Causes of hyperbilirubinemias along with the acquired and congenital disorders leading to hyperbilirubinemias; jaundice and kernicterus.

f) Hemoglobinopathies: Sickle cell anemia (biochemical cause and its clinical manifestations), haemoglobin C disease, haemoglobin SC disease and thalassemias.

9- Vitamins and Minerals

a) General features of vitamins as essential nutrients

b) Classification of vitamins according to their physico-chemical nature and biochemical functions

c) Important dietary sources and recommended dietary allowances of vitamins.

d) Intestinal absorption, transport and storage of vitamins.

e) Mechanism of action of vitamins and their biochemical functions in body.

f) Disorders associated with vitamin deficiency and hypervitaminoses.

g) Minerals (sodium, potassium, chloride, calcium, phosphorus, magnesium, and sulfur) and trace elements (iron, zinc, selenium, iodine, copper, chromium, manganese, cadmium and fluoride) in human nutrition and their sources, absorption, transport, storage, and biochemical functions along with their recommended dietary allowances (RDA).

10- Nutrition

a) Energy metabolism: Caloric value of food, Specific dynamic action (SDA) of food, respiratory quotient, metabolic rate (determination and factors affecting metabolic rate), basal metabolic rate (BMR) (measurement, calculation, and factors affecting BMR)

b) Balanced diet

c) Proteins in nutrition: Obligatory nitrogen loss, nitrogen balance, nutritionally essential amino acids and their role in body growth and nitrogen equilibrium, determination of comparative nutritional efficiency and quality of dietary protein, recommended dietary allowance of protein, protein energy malnutrition (kwashiorkor and marasmus).

d) Fats and lipids in nutrition: Fats as a source of energy, role of saturated and unsaturated fats in health and disease, effect of dietary intake of transfats on health, and nutritionally essential fatty acids.

e) Carbohydrates in human nutrition: Protein sparing effect of carbohydrates, dietary carbohydrates and blood glucose along with the details of glycemic index, dietary fibers (types and biomedical importance).

f) Calculation of caloric requirement of a person and nutritional requirements in pregnancy, lactation, infancy, and old age.

g) Obesity and food additives (artificial sweeteners and flavor enhancers)

11- The Extracellular Matrix

a) Collagen: Types and structure of collagen; biosynthesis & degradation of collagen; collagenopathies (Ehlers-Danlos syndrome (EDS) and Osteogenesis imperfecta (OI))

b) Elastin: Structural characteristics of elastins; role of alpha1-antitrypsin in elastin degradation; major biochemical differences between collagen and elastin; genetic disorders associated with elastin like Williams-Beuren syndrome, supravalvular aortic stenosis, pulmonary emphysema, and aging of the skin.

c) Fibrillin-1 as a protein of microfibrills; Marfan syndrome; fibronectin and its role in cell adhesion and migration; laminin as a protein component of renal glomerular and other basal laminas.

d) Glycosaminoglycans (GAGs): Structure, classification, functions and distribution of GAGs; diseases associated with enzyme deficiencies of degradation of GAGs (mucopolysaccharidoses – Hunter syndrome & Hurler syndrome)

e) Structure and functions of proteoglycans

Laboratory Experiments

- Introduction to use of laboratory facilities / equipment including safety measures
- Preparation of solutions:
  - Preparation of solutions (molar and normal) from various kinds of laboratory chemicals (solid and liquids);
  - Preparation of various kinds of buffer solutions;
  - Basic methods of laboratory calculations;
- Introduction and conversion of conventional and SI measuring units.
- Demonstration of buffer action, and determination of pH (by using indicators and pH meter).
- Qualitative analysis of carbohydrates and proteins.

- Tests to detect monosaccharides of biomedical significance ----- glucose, fructose and Galactose (Benedict's test, Selivanoff's test, and Osazone test)
- Tests to detect proteins / peptides / amino acids (Heat coagulation test, sulphosalicylic acid test, Heller's Ring test and Ninhydrin test)

- Collection and storage of urine samples for laboratory analysis, and physical and chemical analysis of urine to detect normal and abnormal constituents.
- Writing a urine report and interpretation of results of urine analysis.

RECOMMENDED BOOKS

- Harper's Illustrated Biochemistry by Murrary RK, Granner DK and Rodwell VW, latest edition, McGraw Hill
- Lippincott's Illustrated Reviews: Biochemistry by Harvey R and Ferrier D, Latest edition, published by Lippincott Williams & Wilkins
- Marks' Basic Medical Biochemistry – A Clinical Approach, by Smith C, Marks AD, and Lieberman M. Latest edition, published by Lippincott Williams & Wilkins
- Practicals and Viva in Medical Biochemistry by Dandekar SP and Rane SA, latest edition, published by Elsevier.

REFERENCE BOOKS

- Textbook of Biochemistry with Clinical Correlations by Devlin TM, latest edition, published by Wiley-Liss
- Biochemistry by Berg JM, Tymoczko JL, and Stryer L, latest edition, published by W.H. Freeman and Company
- Clinical Chemistry and Metabolic Medicine by Martin A. Crook, latest edition, Edward Arnold (Publishers) Ltd
- Lehninger Principles of Biochemistry by David L Nelson and Michael M. Cox
- Tietz Textbook of Clinical Chemistry by Burtis CA and Ashwood ER published by Saunders.
- Fundamentals of Biochemistry Life at Molecular Level by Donald Voet, Judith G Voet and Charlotte W. Pratt

Table of Specifications for Biochemistry Oral & Practical Examination
MBBS First Professional Examination (Part-I)

Oral and Practical Examination carries 100 marks

Examination Component	Marks
A- Internal Assessment	**10**
B- Practical Notebook/Manual (Internal Examiner)	**05**
C- Viva voce a. External examiner: 25 Marks b. Internal Examiner: 25 Marks	**50**
D- OSPE a. ***Observed stations (6 Marks):*** There are two observed stations; 3 marks for each station – time allowed is 3 minutes for each observed station) b. ***Non-observed stations (16 Marks):*** There are eight non-observed stations; 2 marks for each station – time allowed is 2 minutes for each non-observed station.	**22**
E- Practical a. Principle, supposed calculation, etc: 4 Marks (External Examiner) b. Performance of the experiment: 4 Marks (Internal Examiner) c. Structured table viva: 5 Marks (External Examiner)	**13**

Format (Practical Examination / OSPE)
MBBS First Professional Examination (Part-l)
BIOCHEMISTRY *(PART-I)*

Total Marks: 100

Total marks allocated to Oral and Practical Examination are 100

Internal Assessment: 10 Marks

General Viva (Theory Viva): 50 Marks

25 Marks are allocated to internal examiner and 25 marks to external examiner.

Practical Examination: 40 Marks

Practical examination comprises three components i.e. Yearly Workbook, OSPE and Experiment.

A- Yearly Workbook: 5 Marks (Internal Examiner)

B- OSPE: 22 Marks

OSPE comprises10 stations (two observed stations carrying 3 marks each and 8 non-observed stations 2 marks each)

Observed Stations (3 minutes for each station)

i. Tests for carbohydrates and proteins/ peptides / amino acids of clinical importance: 1 station
ii. Test for normal constituents and abnormal constituents of urine: 1 station

List of Tests for Observed Stations:

i. Benedict's Test.
ii. Selivanoffs Test.
iii. Identification of osazones of monosaccharides.
iv. Biuret Test.
v. Ninhydrin test.
vi. Heller's ring test.
vii. Sulphosalicylic acid test.
viii. Heat Coagulation Test.
ix. RothrasTest.
x. Hays Test.

Non-Observed Stations (2 minutes for each station)

i. Carbohydrate chemistry, biologic significance of carbohydrates and clinical implications of carbohydrates.
ii. Chemistry of proteins & amino acids, plasma proteins, and clinical implications of proteins.
iii. Chemistry of lipids, biologic significance of lipids, and clinical implications of lipids and lipoproteins.
iv. Interpretation of normal and abnormal constituents of urine.
v. Laboratory equipment/techniques (pH meter and laboratory glassware).
vi. Preparation of solutions.

C- Experiment: 13 marks

- Principle/supposed calculations of the experiment: 4 Marks (External Examiner)
- Performance of experiment. 4 Marks (Internal Examiner)
- Table Viva: 5 Marks (External Examiner)