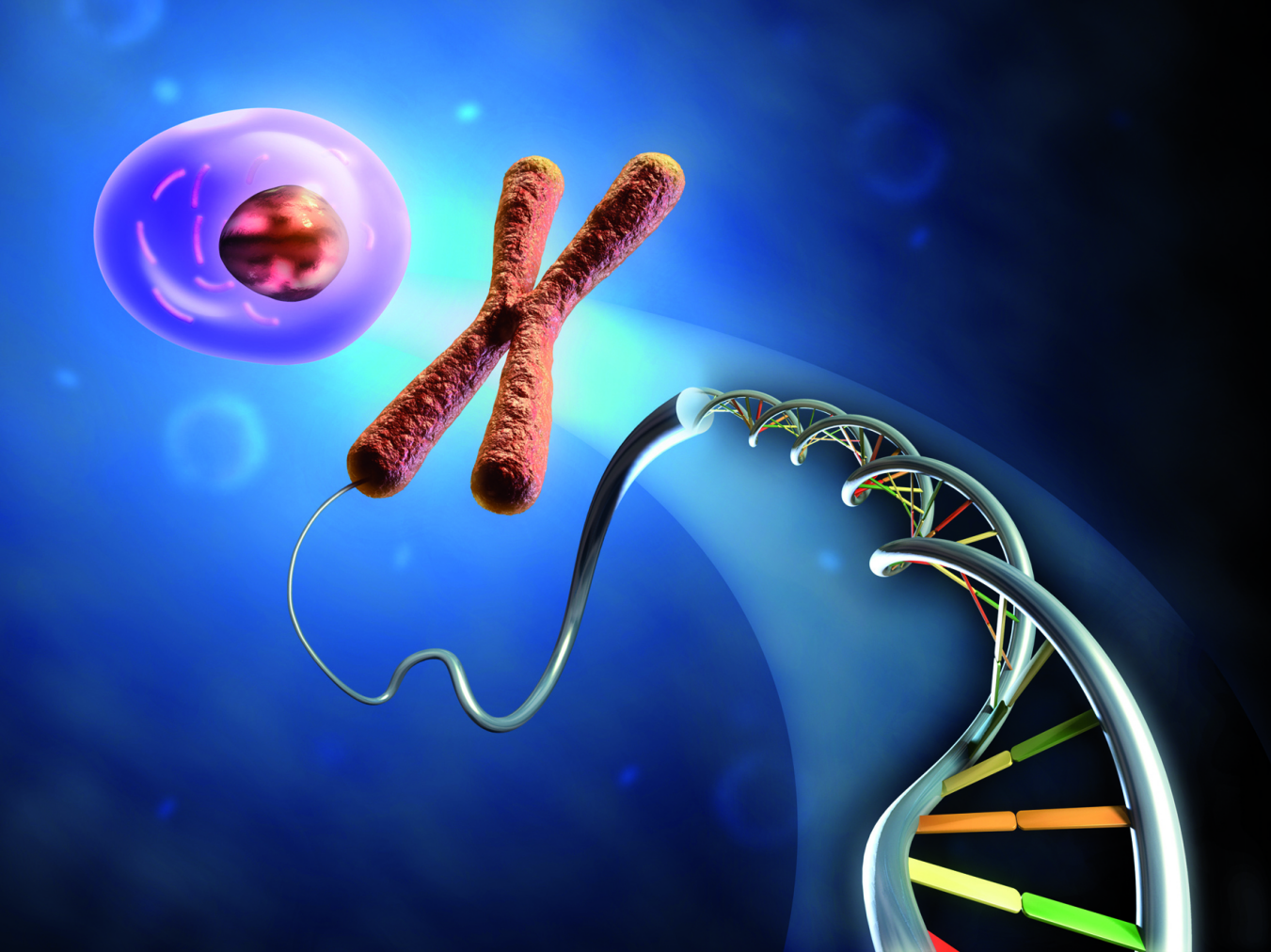
BIOCHEMISTRY STUDY GUIDE

FIRST YEAR MBBS

2022



DEPARTMENT OF BIOCHEMISTRY

LMDC, LHR

**DEPARTMENTAL ORGANOGRAM**

HEAD OF DEPARTMENT

Prof. Dr. Rubina Bashir

ASSOCIATE PROFESSOR

Dr. Naveed Shuja

DEMONSTRATOR

Dr. Hina Amjad

DEMONSTRATOR

Dr. Aadil Rehman

DEMONSTRATOR

Dr. Maham Zeba

ASSISTANT PROFESSOR

Dr. Mahwish Shahzad

PROFESSOR

Dr. Sobia Imtiaz

DEMONSTRATOR

Dr. Momina Sajjad

DEMONSTRATOR

Dr. Maryam Saeed

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**I. INTRODUCTION**

The study guide is prepared to facilitate learning of first year MBBS students by enlightening them about organization of the program.

**II. STUDY GUIDE OBJECTIVES**

To facilitate students of first year MBBS in managing their studies by prompt information and guidance pertaining to the various aspects of biochemistry course.

**III. UHS SYLLABUS, EXAMINATION RULES AND REGULATIONS**

**Course duration**

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

**Teaching objectives:**

*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 the 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:**

*At the end of the Part-1 course the student should be able to demonstrate his knowledge and understanding on the subject with the 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 biological significance. In order to accomplish this, the student will learn the basic chemical aspects of 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 the 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, recognizing continuing educational needs; use appropriate learning resources and critically analyze relevant literature in order to have a comprehensive understanding and knowledge of biochemistry.

**Course contents**

1. Biochemistry of the cell and biological membranes
2. Introduction: An overview of biochemistry and its significance in medicine
3. Biochemical composition and functions of cell: Organization and composition of eukaryotic and prokaryotic cells (biochemical aspects)
4. Cell membrane (biochemical composition)
5. Membrane phenomena: transport of substances across the cell membrane (primary and secondary active transport); diffusion (simple and facilitated), and vesicle-mediated transport (phagocytosis, endocytosis & exocytosis); Gibb’s-Donnan equilibrium, osmosis and osmotic pressure
6. Membrane receptors and other biologically important regulatory & catalytic membrane bound proteins like G- proteins, adenylyl cyclase, phospholipase C
7. Basic methods to study cell biochemistry: centrifugation, ultracentrifugation, radioimmunoassay, ELISA (enzyme-linked immunosorbent assay); chromatography, electrophoresis, spectrophotometry, and pH metry
8. Water, pH, and buffers
9. Ionization of water; weak acids & bases
10. pH and pH scale: concept of pH and related topics (determination of pH), and concept of pI (isoelectric pH)
11. pK value, dissociation constant (Ka) and titration curve of weak acids
12. Determination of pH of buffer: Henderson-Hasselbalch equation and its applications (derivation not required)
13. Body buffer systems (bicarbonate, ammonia, phosphate and proteins) and their mechanism of action

3. Carbohydrates

1. Definition, biochemical functions and classification of carbohydrates
2. Structure and function of biologically important monosaccharides and their important derivatives (sugar acids, sugar alcohols, sugar amines, and glycosides)
3. Isomerism in carbohydrates (types and description)
4. Physical and chemical properties of carbohydrates
5. Biologically important disaccharides and their biomedical importance
6. Oligosaccharides: their combination with other macromolecules & biomedical importance
7. Homopolysaccharides of biologic significance and their structural and functional characteristics
8. Structural and functional characteristics of heteropolysaccharides including details of glycosaminoglycans; proteoglycans, peptidoglycans, and mucopolysaccharidoses
9. Amino acids, proteins and plasma proteins
10. Biomedical importance & classifications (biological functions, nutritional value and overall shape of molecules) of proteins
11. Structure, functions and properties of amino acids
12. Classifications of standard (proteinogenic) amino acids (based upon side chain structure, polarity of side chain, nutritional importance, and metabolic end products), biologically important non-standard amino acids and their principal functions
13. 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
14. Structural organization of proteins: details of four orders of protein structure (primary, secondary, tertiary and quaternary); denaturation of proteins; and protein misfolding (amyloidosis and prion disease)
15. Important techniques for separation of proteins (electrophoresis, isoelectric focusing, chromatography, filtration, centrifugation, and dialysis)
16. Immunoglobulin: types, structure and biomedical significance
17. Plasma proteins: (prealbumin, albumin, haptoglobin, ceruloplasmin, alpha 1-antitrypsin, alpha 2-macroglobulin and transferrin) and their principal biologic functions along with their clinical significance. Alpha fetoproteins and clinically important acute phase proteins (alpha 1-acid glycoprotein, C-reactive protein)
18. Glycoproteins: components of glycoproteins (overview of linkages between proteins and carbohydrates, N- and O-linked oligosaccharides)
19. Nucleotides and nucleic acids
20. Chemistry of purines and pyrimidines; their types and structures
21. Structure and functions of nucleosides and nucleotides (excluding metabolism)
22. Natural and synthetic derivatives of purines and pyrimidines & their biomedical role
23. Structure, functions and types of nucleic acids (excluding metabolism)
24. Biochemistry of lipids and fatty acids
25. Classification of lipids and their general biologic functions
26. Fatty acids: definition and nomenclature, classification, chemical and Physical properties, isomerism; role of saturated & 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 importance of their dietary use
27. Nutritionally essential fatty acids and their functions
28. Eicosanoids and their biologic functions along with their significance in health and disease
29. Physical and chemical properties of fats and oils (triacylglycerols): saponification, iodine number, and acid number; Rancidity of fats
30. Structure and biologic functions & significance of phospholipids, glycolipids, sulfolipids and gangliosides
31. Cholesterol and its related compounds such as bile acids: structure, properties and biologic role
32. Lipid per-oxidation and its significance
33. Biochemistry of enzymes
34. Introduction, classification and nomenclature of enzymes: definitions of enzymes and IU of enzyme activity; Enzyme commission classification of enzymes along with main subclasses
35. Properties of enzymes: chemical nature, active site, catalytic efficiency, specificity, proenzymes, and kinetic properties
36. Co-enzyme and cofactors: coenzymes derived from various vitamins along with the examples of enzymes requiring these coenzymes; and metal co-factors
37. Isozymes and their clinical significance
38. Allosteric enzymes and their biological significance
39. Factors affecting enzyme activity
40. 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 inhibitors on Lineweaver Burke plot
41. Mechanism of enzymes action and kinetics of enzyme activity (Michaelis-Menten equation and Lineweaver Burke plot without derivation)
42. Regulation of enzyme activity (covalent modification, allosteric regulation, and regulation by gene induction, repression, and de-repression of enzyme synthesis)
43. Therapeutic use of enzymes and diagnostic applications of determination of enzyme activities of certain enzymes in plasma in hepatic, muscle, prostatic, pancreatic, bone, and cardiac diseases
44. Porphyrins and hemoproteins
45. Chemistry and biosynthesis of heme and other porphyrins including disorders of heme biosynthesis (porphyrias)
46. Important hemoproteins found in body along with their principal biologic functions: structure and function of hemoglobin and myoglobin, and types of hemoglobin. Hemoglobin A1c
47. Oxygen binding capacity of hemoglobin, factors affecting and regulating the oxygen-binding capacity of hemoglobin. Methemoglobin (metHb) and methemoglobinemia
48. Bilirubin metabolism: degradation of heme, synthesis, hepatic uptake**,** conjugation, excretion of bilirubin and fate of bilirubin in intestine
49. Hyperbilirubinemias: causes of hyperbilirubinemias along with the acquired and congenital disorders leading to hyperbilirubinemia, jaundice and kernicterus
50. Hemoglobinopathies: sickle cell anemia (biochemical cause and its clinical manifestations), hemoglobin C disease, hemoglobin SC disease & thalassemias
51. Vitamins and minerals
52. General features of vitamins as essential nutrients
53. Classification of vitamins according to their physic-chemical nature and biochemical functions
54. Important dietary sources and recommended dietary allowances of vitamins
55. Intestinal absorption, transport and storage of vitamins
56. Mechanism of action of vitamins and their biochemical functions in body
57. Disorders associated with vitamin deficiency and hypervitaminoses
58. Minerals (sodium, potassium, chloride, calcium, phosphorous, 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
59. Nutrition
60. 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)
61. Balanced diet
62. 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 proteins, RDA of proteins, protein energy malnutrition (kwashiorkor and marasmus)
63. Fats and lipids in nutrition: fats as a source of energy, role of saturated and unsaturated fatty acids in health and disease, effect of dietary intake of trans-fats on health, and nutritionally essential fatty acids
64. Carbohydrates in human nutrition: protein sparing effects of carbohydrates, dietary carbohydrates and blood glucose along with the details of glycemic index, dietary fibres (types and biomedical significance)
65. Calculation of the caloric requirement of a person and nutritional requirements in pregnancy, lactation, infancy and old age
66. Obesity and food additives (artificial sweeteners and flavor enhancers)
67. The extracellular matrix
68. Collagen: types and structure of collagen; biosynthesis and degradation of collagen; collagenopathies (Ehlers Danlos Syndrome and osteogenesis imperfacta)
69. Elastin: structural characteristics of elastin; role of alpha-1 antitrypsin in elastin degradation; major biochemical differences between collagen and elastin; genetic disorders associated with elastin like William Beuren syndrome, supra-valvular aortic stenosis, pulmonary emphysema and aging of the skin
70. Fibrillin-1 as a protein of microfibrils; Marfan Syndrome; fibronectin and its role in cell adhesion and migration; laminin as a protein component of renal glomerular and other basal laminas
71. Glycosaminoglycans (GAGs): structure, classifications, functions and distribution of GAGs; diseases associated with enzyme deficiencies of degradation og GAGs (mucopolysaccharidoses – Hunter syndrome & Hurler syndrome)
72. 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 (solids 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, Salivanoff’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**

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   1. Observed stations (6 Marks): There are two observed   stations; 3 marks for each station – time allowed is 3 minutes for each observed station)   1. 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   1. Principle, supposed calculation, etc: 4 Marks (External Examiner) 2. Performance of the experiment: 4 Marks (Internal Examiner) 3. Structured table viva: 5 Marks (External Examiner) | 13 |

Format (Practical examination/OSPE)

MBBS first professional examination

Total Marks: 100

Total marks allocated to oral and practical examination= 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 comprises 10 stations (two observed stations carrying 3 marks each and 8 non-observed stations 2 marks each)

Observed stations (3 minutes for each station)

1. Tests for carbohydrates and proteins/peptides/amino acids: 1 station
2. Test for normal constituents and abnormal constituents of urine: 1 station

List of tests for observed stations:

1. Benedict's test
2. Selivanoffs test
3. Identification of osazones of monosaccharides
4. Biuret test
5. Ninhydrin test
6. Heller’s ring test
7. Sulphosalicylic acid test
8. Heat Coagulation test
9. Rothra’s test
10. Hay’s test

Non-observed stations (2 minutes for each station)

1. Carbohydrate chemistry, biologic significance of carbohydrates and clinical implications of carbohydrates
2. Chemistry of proteins & amino acids, plasma proteins, and clinical implications of proteins
3. Chemistry of lipids, biologic significance of lipids, and clinical implications of lipids and lipoproteins
4. Interpretation of normal and abnormal constituents of urine
5. Laboratory equipment/techniques (pH meter and laboratory glassware)
6. 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)

**IV. ACADEMIC CALENDAR**

|  |  |
| --- | --- |
| **Biochemistry of the cell and biological membranes (16) Professor Dr. Rubina Bashir** | |
| **7-2-22** | Introduction: An overview of biochemistry and its significance in medicine |
| **7-2-22** | Biochemical composition and functions of cell |
| **8-2-22** | Organization and composition of eukaryotic and prokaryotic cells (biochemical aspects) |
| **8-2-22** | Scientific methods to study cell biochemistry |
| **9-2-22** | Biochemical composition of cell membrane |
| **11-2-22** | Biochemical composition of cell membrane (contd) |
| **14-2-22** | Membrane transport mechanisms and related clinical modules |
| **14-2-22** | Membrane transport mechanisms and related clinical modules (contd) |
| **15-2-22** | Membrane transport mechanisms and related clinical modules (contd) |
| **15-2-22** | Chemistry of signals and receptors |
| **16-2-22** | Chemistry of signals and receptors (contd) |
| **18-2-22** | Biologically important regulatory & catalytic membrane bound proteins (G- proteins) |
| **21-2-22** | Regulatory & catalytic membrane bound proteins (adenylyl cyclase) (contd) |
| **21-2-22** | Regulatory & catalytic membrane bound proteins (phospholipase C) (contd) |
| **22-2-22** | Clinical correlations |
| **22-2-22** | Gibb’s Donnan equilibrium, osmosis and osmotic pressure, Surface tension, Viscosity. |
| **Biochemistry of lipids and fatty acids (20) Professor Dr. Sobia Imtiaz** | |
| **23-2-22** | Definition, biochemical functions and classification of lipids |
| **25-2-22** | Definition, biochemical functions and classification of lipids (contd) |
| **28-2-22** | Chemistry of fatty acids: definition and nomenclature |
| **28-2-22** | Fatty acids: classification and biochemical functions |
| **1-3-22** | Fatty acids: chemical and physical properties, isomerism |
| **1-3-22** | Nutritionally EFAs, saturated & unsaturated fatty acids, their biomedical importance |
| **2-3-22** | Trans fatty acids, omega-3 and omega-6 fatty acids |
| **4-3-22** | Triacylglycerols: chemistry, classification and biomedical importance |
| **7-3-22** | Physical and chemical properties: saponification, iodine number, and acid number |
| **7-3-22** | Rancidity of fats & lipid per-oxidation and its significance |
| **8-3-22** | Phospholipids: structure, functions, and biomedical importance |
| **8-3-22** | Phospholipids: structure, functions, and biomedical importance (contd) |
| **9-3-22** | Phospholipids: structure, functions, and biomedical importance (contd) |
| **11-3-22** | Glycolipids: structure, functions, and biomedical importance |
| **14-3-22** | Cholesterol: structure, properties, functions, and clinical significance |
| **14-3-22** | Bile acids: structure, properties, functions, and clinical significance |
| **15-3-22** | Eicosanoids: classification, functions, and clinical significance |
| **15-3-22** | Eicosanoids: classification, functions, and clinical significance (contd) |
| **16-3-22** | Definition, classification, functions and clinical significance of lipoproteins |
| **18-3-22** | Definition, classification, functions and clinical significance of lipoproteins (contd) |
| **Water, pH, and buffers (09) Professor Dr. Sobia Imtiaz** | |
| **21-3-22** | Ionization of water, weak acids & bases |
| **21-3-22** | pH and pH scale: concept of pH and related topics (determination of pH) |
| **22-3-22** | Concept of pI (isoelectric pH) |
| **22-3-22** | pK value, dissociation constant (*Ka*) |
| **25-3-22** | Titration curve of weak acids |
| **28-3-22** | Determination of pH of buffer: Henderson-Hasselbalch equation and its applications |
| **28-3-22** | Body buffer systems and their mechanism of action |
| **29-3-22** | Body buffer systems and their mechanism of action (contd) |
| **29-3-22** | Body buffer systems and their mechanism of action (contd) |
| **Carbohydrates (14) Professor Dr. Rubina Bashir** | |
| **30-3-22** | Definition, biochemical functions and classification of carbohydrates |
| **1-4-22** | Physical and chemical properties of carbohydrates |
| **4-4-22** | Isomerism in carbohydrates |
| **4-4-22** | Isomerism in carbohydrates (contd) |
| **5-4-22** | Structure, functions and biomedical importance of monosaccharides |
| **5-4-22** | Important derivatives (sugar acids, sugar alcohols, sugar amines, and glycosides) |
| **6-4-22** | Structure, functions and biomedical importance of important disaccharides |
| **8-4-22** | Oligosaccharides: combination with other macromolecules & biomedical importance |
| **11-4-22** | Structure, functions and biomedical Importance of homopolysaccharides |
| **11-4-22** | Structure, functions and biomedical Importance of homopolysaccharides (contd) |
| **12-4-22** | Structure, functions and biomedical Importance of heteropolysaccharides |
| **12-4-22** | Structural and functional characteristics of GAGs |
| **13-4-22** | Structural and functional characteristics of proteoglycans and glycoproteins |
| **15-4-22** | Structural and functional characteristics of peptidoglycans, mucopolysaccharidoses |
| **Amino acids, proteins & plasma proteins (18) Prof. Dr. Rubina Bashir & Assistant Prof. Dr. Mahwish Shahzad** | |
| **18-4-22** | Classifications of standard amino acids |
| **18-4-22** | Classifications of standard amino acids (contd) |
| **19-4-22** | Structure and functions of amino acids |
| **19-4-22** | Structure and functions of amino acids (contd) |
| **20-4-22** | Properties of amino acids |
| **22-4-22** | Dissociation and titration of amino acids, & determination of pI |
| **25-4-22** | Role of amino acids in maintenance of pH & mechanism of buffering action of proteins |
| **25-4-22** | Structure & properties of peptide bond, biomedical importance of peptides |
| **26-4-22** | Biomedical importance & classifications of proteins |
| **26-4-22** | Biomedical importance & classifications of proteins (contd) |
| **27-4-22** | Structural organization of proteins: Four orders of protein structure |
| **29-4-22** | Denaturation of proteins and protein misfolding |
| **2-5-22** | Important plasma proteins: Functions and their clinical significance |
| **2-5-22** | Important plasma proteins: Functions and their clinical significance (contd) |
| **6-5-22** | Important plasma proteins: Functions and their clinical significance (contd) |
| **9-5-22** | Important plasma proteins: Functions and their clinical significance (contd) |
| **9-5-22** | Immunoglobulin: types, structure and biomedical significance |
| **10-5-22** | Immunoglobulin: types, structure and biomedical significance (contd) |
| **Practicals** | Biochemical techniques: centrifugation, ultracentrifugation, filtration, dialysis, IEF, RIA |
| **Practicals** | ELISA, chromatography, electrophoresis, spectrophotometry, and pH metry |
| **The extracellular matrix (04) Professor Dr. Rubina Bashir** | |
| **10-5-22** | Collagen: types and structure, biosynthesis and degradation |
| **11-5-22** | Collagenopathies (Ehlers Danlos Syndrome and osteogenesis imperfacta) |
| **13-5-22** | Elastin: characteristics of elastin, differences between collagen & elastin, & disorders |
| **16-5-22** | Fibrillin-1, fibronectin, laminin , & disorders |
| **Biochemistry of vitamins (22) Professor Dr. Sobia Imtiaz** | |
| **16-5-22** | Introduction and classification of vitamins |
| **17-5-22** | Vitamin A |
| **17-5-22** | Vitamin A (contd) |
| **18-5-22** | Vitamin-D |
| **20-5-22** | Vitamin-D (contd) |
| **23-5-22** | Vitamin E |
| **23-5-22** | Vitamin K |
| **24-5-22** | Vitamin K (contd) |
| **24-5-22** | Vitamin-C |
| **25-5-22** | Vitamin-C (contd) |
| **27-5-22** | Vitamin B1 |
| **30-5-22** | Vitamin B1(contd) |
| **30-5-22** | Vitamin B2 |
| **31-5-22** | Vitamin B3 |
| **31-5-22** | Vitamin B3 (contd) |
| **1-6-22** | Vitamin B5 |
| **3-6-22** | Biotin |
| **6-6-22** | Vitamin B6 |
| **6-6-22** | Vitamin B9 |
| **7-6-22** | Vitamin B9 (contd) |
| **7-6-22** | Vitamin B12 |
| **8-6-22** | Vitamin B12 (contd) |
| **Minerals and trace elements (08) Assistant Prof. Dr. Mahwish Shahzad** | |
| **10-6-22** | Introduction and classification of minerals. Sodium and potassium |
| **13-6-22** | Sodium and potassium (contd) |
| **13-6-22** | Calcium and phosphorous |
| **14-6-22** | Calcium and phosphorous (contd) |
| **14-6-22** | Chloride, magnesium and sulfur |
| **15-6-22** | Iron |
| **18-7-22** | Zinc, selenium, iodine, and copper |
| **18-7-22** | Chromium, manganese, fluoride and cadmium |
| **Biochemistry of enzymes (14) Professor Dr. Rubina Bashir** | |
| **19-7-22** | Introduction and nomenclature of enzymes |
| **19-7-22** | Enzyme commission classification of enzymes along with main subclasses |
| **20-7-22** | Enzyme commission classification of enzymes along with main subclasses (contd) |
| **22-7-22** | Properties of enzymes |
| **25-7-22** | Co-enzymes, examples of enzymes requiring these coenzymes; and metal co-factors |
| **25-7-22** | Mechanism of catalysis of enzymes (mechanism of action of enzymes) |
| **26-7-22** | Factors affecting enzyme activity |
| **26-7-22** | Michaelis-Menten equation & its applications in enzyme kinetics |
| **27-7-22** | Lineweaver Burke plot & its applications in enzyme kinetics |
| **29-7-22** | Classification (types) and biomedical significance of enzyme inhibitors |
| **1-8-22** | Classification (types) and biomedical significance of enzyme inhibitors (contd) |
| **1-8-22** | Regulation of enzyme activity |
| **2-8-22** | Therapeutic and diagnostic uses of enzymes |
| **2-8-22** | Isozymes: definition, examples and their clinical significance |
| **Nucleotides and nucleic acids (09) Professor Dr. Sobia Imtiaz** | |
| **3-8-22** | Chemistry of purines and pyrimidines |
| **5-8-22** | Chemistry of purines and pyrimidines (contd) |
| **9-8-22** | Structure and functions of nucleosides |
| **9-8-22** | Structure and functions of nucleotides |
| **10-8-22** | Structure and functions of nucleotides (contd) |
| **12-8-22** | Types of nucleic acids: Structure and functions of DNA |
| **15-8-22** | Structure and functions of RNA |
| **15-8-22** | Structure and functions of RNA (contd) |
| **16-8-22** | Natural and synthetic derivatives of purines and pyrimidines & their biomedical role |
| **Porphyrins and hemoproteins (13) Prof. Dr. Rubina Bashir & Prof. Dr. Sobia Imtiaz** | |
| **16-8-22** | Chemistry and biosynthesis of heme and other porphyrins |
| **17-8-22** | Chemistry and biosynthesis of heme (contd) |
| **19-8-22** | Disorders of heme biosynthesis (porphyrias) |
| **22-8-22** | Structure and function of hemoglobin and myoglobin |
| **22-8-22** | Types of hemoglobin, Hemoglobin A1c |
| **23-8-22** | O2 binding capacity of Hb, factors affecting the O2 binding capacity of Hb |
| **23-8-22** | Hemoglobinopathies: sickle cell anemia (cause and its clinical manifestations) |
| **24-8-22** | hemoglobin C disease, hemoglobin SC disease & thalassemias |
| **26-8-22** | Methemoglobin (metHb) and methemoglobinemia |
| **29-8-22** | Bilirubin metabolism |
| **29-8-22** | Bilirubin metabolism (contd) |
| **30-8-22** | Hyperbilirubinemias, jaundice and kernicterus |
| **30-8-22** | Hyperbilirubinemias, jaundice and kernicterus (contd) |
| **Nutrition (10) Assistant Prof. Dr. Mahwish Shahzad** | |
| **31-8-22** | Energy metabolism: caloric value of food, specific dynamic action of food, RQ |
| **2-9-22** | Metabolic rate (determination and factors affecting metabolic rate), BMR |
| **5-9-22** | Calculation of the caloric requirement of a person |
| **5-9-22** | Nutritional requirements in pregnancy, lactation, infancy and old age |
| **6-9-22** | Balanced diet: components of balanced diet and their importance |
| **6-9-22** | Proteins in nutrition, obligatory nitrogen loss & nitrogen balance |
| **7-9-22** | Protein Energy Malnutrition (PEM): Kwashiorkor and marasmus |
| **9-9-22** | Fats and lipids in nutrition |
| **12-9-22** | Carbohydrates in human nutrition & glycemic index |
| **12-9-22** | Obesity and food additives (artificial sweeteners and flavor enhancers) |
| **Interactive sessions (16)** | |
| **13-09-22 To**  **30-09-22** | Clinical correlations |

**V. DEPARTMENTAL TIME TABLE**

|  |  |  |  |
| --- | --- | --- | --- |
| Monday | 8:00 am - 9:30 am | 9:30 am - 10:15 am | 1:45 pm – 2:30 pm |
| Practical: Batch C (every week)  Tutorial: Batch E (every week) | Biochemistry Lecture | Biochemistry Lecture |
| Tuesday | 8:00 am - 9:30 am | 9:30 am - 10:15 am | 1:45 pm – 2:30 pm |
| Practical: Batch D (every week)  Tutorial: Batch A (every week) | Biochemistry Lecture | Biochemistry Lecture |
| Wednesday | 8:00 am - 9:30 am | 9:30 am - 10:15 am |  |
| Practical: Batch E (every week)  Tutorial: Batch B (every week) | Biochemistry Lecture | ------------------ |
| Thursday | 8:00 am - 9:30 am | 10:15 am -11:45 am |  |
| Practical: Batch A (every week)  Tutorial: Batch C (every week) | Long Tutorial  Physiology/Biochemistry  On alternate weeks | ------------------ |
| Friday | 8:00 am - 9:30 am | 10:15 am -11:00 am |  |
| Practical: Batch B (every week)  Tutorial: Batch D (every week) | Biochemistry Lecture | ------------------ |

**Course duration**

* 36 weeks per academic year
* Six lecture per week (45 min) for 36 weeks (162 hours)
* One practical (1.5 hours) per week for 36 week (54 hours)
* One tutorial/interactive group discussion classes (1.5 hours) per week (54 hours)
* One tutorial (Alternative week) (1.5 hours) per 18 weeks (27 hours)
* Total teaching hours for the subject of biochemistry (297 hours)

**VI. TEACHING AND LEARNING METHODOLOGIES**

1. Large group teaching strategies

* Lectures
* Interactive sessions

1. Small group teaching strategies:

* Employed during practicals (weekly) and tutorials (weekly)
* Interactive sessions
* Small group discussions (SGDs)
* Take home assignments
* SEQ and MCQ exercises
* Viva voce
* Presentations by students
* Laboratory demonstrations and practicals

1. Integrated teaching strategies

* Horizontal integration is being achieved by aligning teaching of biochemistry course with that of anatomy and physiology
* Vertical integration is being achieved by regular clinico-biochemical conferences (CBCs) and hospital visits

**VII. LEARNING RESOURCES**

1. Text books

* Harper’s illustrated biochemistry
* Lippincott’s illustrated reviews

1. Reference books

* Textbook of biochemistry with clinical correlations (Thomas M. Devlin)
* Lehninger principles of biochemistry (David L. Nelson, Michael M. Cox)

1. Hand-outs

* Practical demonstrations
* Lectures

**VIII. ASSESSMENT FORMATS**

All assessments are meticulously planned in collaboration with other concerned departments to avoid clustering/overlapping and schedule is placed on the departmental notice board specified for each class at the beginning of session. At least one biochemistry test is conducted each month. Topics included in each test are notified and resources are identified.

1. Written tests

Written class tests include MCQs (one best type) and SEQs. Approximately25% of questions are clinically oriented. University recommendations for marks distribution are strictly followed.

1. Oral examination

In order to prepare the students for oral component of university examination, viva voce examinations (by senior faculty members) are also conducted during the session.

1. Send up examination

Send up is a comprehensive examination including whole biochemistry course that is conducted at the end of academic session and final university examination pattern is followed in every respect (no. of questions, ToS, marks distribution, total time allowed etc.).

1. OSPE

At least two OSPE tests are conducted during the session.

1. Pre-test quizzes

Pre-test quizzes on clinically relevant topics are introduced during 2019.

**IX. ONLINE TEACHING DURING COVID-19 PANDEMIC**

During covid-19 pandemic, teaching was continued online for first year MBBS. Online time tables were formulated by consensus of all the concerned departments. Students, faculty and concerned staff was optimally trained and facilitated by IT and DME. Lectures and tutorials were held using google meet and Microsoft teams. Class tests were conducted in google class room. Assignments, hand-outs, and other necessary information were shared on web portal of LMDC, google class room and Microsoft teams. Online viva was conducted using zoom software program. Online attendance record was meticulously maintained and added to the total record.

In case of lockdown, similar strategies would be employed for both synchronous and asynchronous e-learning program.

**X. ROBUST FEEDBACK SYSTEMS**

1. Feedback on attendance

Attendance report is forwarded to students and parents on daily basis

1. Feedback on academic performance

Academic performance report is also regularly forwarded to students and parents. Moreover, individual students are given feedback on their academic performance during tutorials. MCQ and SEQ papers are also discussed with students in small groups.

1. Parents of weak students are regularly contacted (PTM sessions)

**XI. COUNSELING FACILITIES FOR STUDENTS**

1. Senior faculty members of biochemistry department are actively involved in resolving academic and non-academic issues of allocated students (PTS sessions)
2. Sessions on life skills are regularly conducted by qualified student counselor
3. Individual students are also referred to the student counselor, if needed

**XII. SUMMER VACATIONS AND REMEDIAL CLASSES**

Summer vacations= 4 weeks

Remedial classes are mandatory for students who:

1. Join late
2. Have poor attendance/test performance or both in term I