

# BIOCHEMISTRY STUDY GUIDE

FIRST YEAR BDS

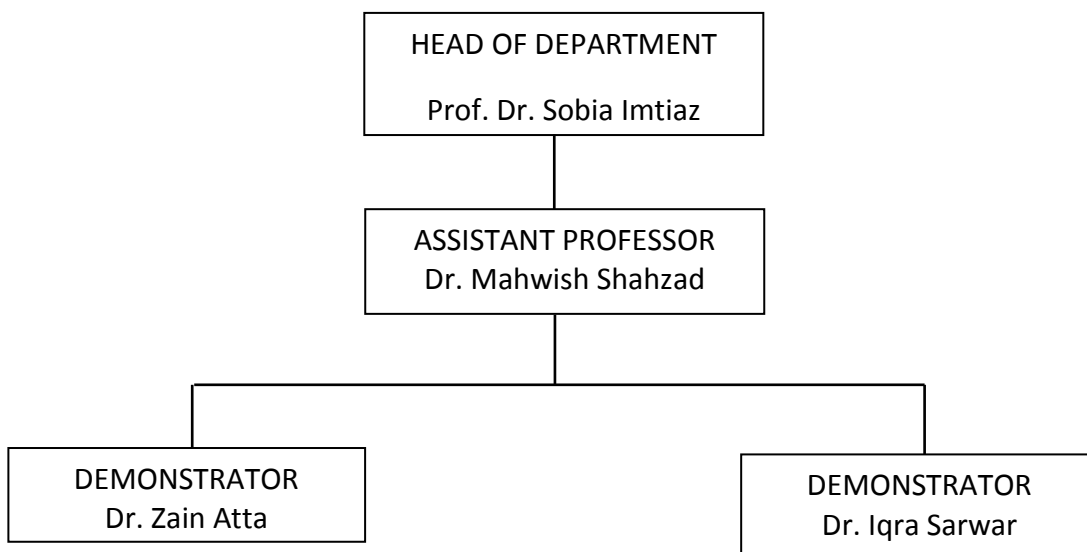
2024



DEPARTMENT OF BIOCHEMISTRY

LMDC, LHR

## DEPARTMENTAL ORGANOGRAM



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## **I. INTRODUCTION**

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

## **II. STUDY GUIDE OBJECTIVES**

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

## **III. UHS SYLLABUS AND ToS**

### **Syllabus**

#### **1. Introduction of biochemistry**

- Introduction to cell (biochemical aspects)
- Composition of cell
- Methods to study cell biochemistry

#### **2. Biochemistry of intra cellular and extra cellular communication**

- Structure, assembly and function of cell membrane
- Biochemistry of cell membrane, chemical composition
- Importance of lipids and proteins in membranes
- Chemistry of signals and receptors
- Biochemistry of membrane transport mechanisms

#### **3. Biochemistry of body fluids**

- Introduction of water and weak acids, bases
- Concept of pH and pH scale
- Dissociation constant and titration curve of weak acids, the concept of pKa values
- Henderson-Hasselbalch equation
- Buffers, their mechanism of action
- Regulation of pH of body fluids; the concepts of metabolic acidosis/alkalosis and respiratory acidosis/alkalosis
- Routes of transport across cell membrane including simple and facilitated diffusion, osmosis, osmotic pressure, surface tension, viscosity and their importance related to regulation of body fluids

#### **4. Amino Acids**

- Amino Acids, classification, properties, functions and significance
- Acid/base properties of amino acids
- Separation techniques

#### **Peptides**

- Introduction and biomedical significance
- Peptide structure and separation techniques
- Synthesis of peptides by automated techniques

#### **Proteins**

- Structure and classification of proteins

- Globular and fibrous proteins
- Plasma proteins and their clinical significance
- Heme proteins: Myoglobin and hemoglobin
- Structure, function and types of hemoglobin
- Oxygen binding capacity of hemoglobin and its regulation
- Degradation of Heme, formation of bile pigments, its types, transport and excretion
- Haemoglobinopathies (HbS, thalassemia etc.) and their biochemical basis

#### **5. Enzymes**

- Introduction, nomenclature, and properties of enzymes
- Enzyme kinetics; mechanism of action; factors affecting enzyme's activity, Michaelis-Menten equation
- Lineweaverburk equation and their application in enzyme kinetics
- Enzyme inhibitors and their classification and biomedical importance
- Application of enzymes in clinical diagnosis and therapeutic use

#### **6. Carbohydrates**

- Definition, classification, biochemical function and significance
- Structure and function of monosaccharides, disaccharides and polysaccharides, their important examples and biochemical role

#### **7. Lipids**

- Classification of lipids; classification, functions, biochemical significance
- Phospholipids, Glycolipids, sphingolipids and their biochemical significance
- Fatty acids: chemistry, classification and biochemical function
- Eicosanoids: their classification and functions in health and disease
- Cholesterol: chemistry, functions and clinical significance

#### **8. Biogenetics and metabolism of carbohydrates and lipids**

- Introduction to bioenergetics, biologic oxidation
- Oxidative phosphorylation and mitochondrial transport systems
- The citric acid cycle: the catabolism of Acetyl-CoA
- Glycolysis and the oxidation of pyruvate
- Metabolism of glycogen
- Gluconeogenesis and the pentose phosphate pathway
- Regulation of carbohydrate metabolism
- Oxidation and biosynthesis of fatty acids
- Metabolism of unsaturated fatty acids and Eicosanoids
- Metabolism of Acylglycerol and sphingolipids
- Lipids transport and storage
- Cholesterol synthesis, transport and excretion
- Regulation of lipid metabolism

#### **9. Metabolism of Proteins and Amino Acids**

- Biosynthesis of amino acids
- Catabolism of amino acids - urea cycle
- Porphyrins and bile pigments

#### **10. Vitamins**

- Introduction, classification

- Chemistry, biochemical functions, daily allowances and sources of water soluble and fat soluble vitamins
- Hypovitaminosis and hypervitaminosis

### **11. Mineral and trace elements**

- Classification, biochemical role and regulation of macro minerals (Na, K, Ca, Cl, PO<sub>4</sub>) and micro minerals (Fe, Zn, Mg, Se, I, Cu, Cr, Cd, Mn)

### **12. Nucleotides and Nucleic Acid**

- Chemistry and structure of nucleotides and their biochemical role
- Synthesis and degradation of purine and pyrimidine
- DNA structure and synthesis
- RNA structure and synthesis
- Recombinant DNA technology
- Protein synthesis and genetic code
- Regulation of gene expression and molecular basis of genetic disease

### **13. Biochemistry of Digestive Tract**

- Basic concepts of digestion of absorption
- Composition, function, daily secretions, stimulants and depressants of:
  - Saliva
  - Gastric juice and HCL
  - Pancreatic juice
  - Intestinal juice
  - Bile
- Digestion of absorption of carbohydrates, proteins and lipids
- Biochemical disorders of GIT, for example achlorhydria, peptic ulcer, lactose intolerance, cholelithiasis and related disorders

### **14. Integration of Metabolism**

- Metabolic effects of insulin and glucagon
- Glucose homeostasis
- Basic concepts of metabolism in fed-state, starvation and diabetes mellitus

### **15. An overview of nutrition, nutrient and energy requirements**

#### **Laboratory assignments**

- Introduction to use of laboratory facilities/equipments
- Basic techniques and fundamental information
- Preparation of solution - normal solution and normal saline
- Experiments on carbohydrates - qualitative Analysis
- Experiments on proteins - qualitative Analysis
- Experiments on fats - qualitative Analysis
- Chemical analysis of urine - normal and abnormal specimens

#### **Recommended Books**

- Lippincott illustrated Reviews, Biochemistry
- Basic and applied dental biochemistry by Williams and Elliott
- Harper's Biochemistry
- Textbook of biochemistry by West and Todd.
- Berg, Tymoczko & Stryer Biochemistry
- W H Freeman. Dow, Lindsay & Morrison Biochemistry
- Mosby. Cole and Eastoe Biochemistry and oral biology

### ToS for Biochemistry theory paper of first prof BDS

S. No.	Contents	SEQs	MCQs
1	Acid base balance	1	3
2	Proteins	1	2
3	Enzymes	1	4
4	Metabolism of proteins	1	1
5	Metabolism of carbohydrates	1	2
6	Metabolism of lipids	1	1
7	Biochemical techniques	1	1
8	Vitamins/human nutrition	1	3
9	Endocrines	-	2
10	Bilirubin	-	1
11	Genetics	-	1
	<b>Total</b>	<b>8</b>	<b>21</b>

### IV. UHS EXAMINATION PATTERN AND MARKS DISTRIBUTION (THEORY, PRACTICAL & VIVA)

Theory						Total	
SEQs			MCQs			Internal assessment	50
24 marks	8 SEQs	3 marks each	21 marks	21 MCQs	1 mark each	5	
Two hours		30 minutes					

Oral exam marks	Practical exam marks	Internal assessment	Total
25	20	5	50

### V. ACADEMIC CALENDAR

DATES	TOPICS
<b>INTRODUCTION TO BIOCHEMISTRY AND BIOMOLECULES</b> Assistant Prof. Dr. Mahwish Shahzad (07)	
26-02-24	Elementary knowledge of biochemical principles and methods: Biomolecules Elementary and biochemical composition of human body
26-02-24	Study of sub-cellular organelles Methods of study and separation of sub-cellular organelles
27-02-24 29-02-24	Structure, functions and organization of plasma membrane
29-02-24	Mechanism of transport across cell membrane
4-03-24 4-03-24	Chemistry of signals and receptors

Practical Classes	Osmosis and osmotic pressure with its related clinical and biochemical importance, concepts of surface tension and viscosity
<b>WATER, pH AND ACID BASE BALANCE</b> Prof. Dr. Sobia Imtiaz (06)	
5-03-24	A study of structure of H <sub>2</sub> O with its physical & chemical properties and ionization of H <sub>2</sub> O Body fluids
7-03-24	Definition and explanation of <i>pH</i> with its clinical significance
7-03-24	Definition of buffers with their mechanism of action
11-03-24	Concepts of <i>pK</i> with Henderson Hassel Balch Equation
11-03-24 12-03-24	An overview of the acid base balance/homeostasis in human body
<b>CHEMISTRY OF CARBOHYDRATES AND ECM</b> Prof. Dr. Sobia Imtiaz & Assistant Prof. Dr. Mahwish Shahzad (06)	
14-03-24	Definition, biochemical functions & classification of carbohydrates
14-03-24	Structure, functions, physical & chemical properties and biomedical importance of monosaccharides
18-03-24	Structure, functions, physical & chemical properties and biomedical importance of disaccharides and oligosaccharides
18-03-24 19-03-24	Structure, functions, physical & chemical properties and biomedical importance of polysaccharides
21-03-24	Derived carbohydrates, Extracellular matrix
<b>CHEMISTRY OF AMINO ACIDS, PROTEINS, PLASMA PROTEINS, IMMUNOGLOBULINS AND BLOOD COAGULATION</b> Prof. Dr. Sobia Imtiaz & Assistant Prof. Dr. Mahwish Shahzad (10)	
21-03-24	Structure, properties, functions, classification and nutritional significance of amino acids
25-03-24	Dissociation, titration and importance of amino acids in pH maintenance Structure and properties of peptide bonds
25-03-24	Definition, biomedical importance and classification of proteins based on: physicochemical properties, functions, nutritional value and structure
26-03-24	Structural organization of proteins
28-03-24	Fibrous and globular proteins
28-03-24	Structure and function of porphyrins
1-04-24	Hemoglobin and hemoglobinopathies
1-04-24	Immunoglobulins and their biomedical significance
2-04-24	Plasma proteins and their clinical significance
4-04-24	Biochemistry of blood clotting



**CHEMISTRY OF LIPIDS****Prof. Dr. Sobia Imtiaz & Assistant Prof. Dr. Mahwish Shahzad (07)**

4-04-24	Definition, biochemical functions and classification of lipids
8-04-24	Chemistry, classification and biochemical functions of fatty acids and TAG
8-04-24	Biochemistry of phospholipids, their biochemical and biomedical significance
9-04-24	Biochemistry of sphingolipids and glycolipids, their biochemical and biomedical significance
11-04-24*	Chemistry, functions and clinical significance of cholesterol
11-04-24*	Classification, functions and clinical significance of eicosanoids
15-04-24	Definition, classification, functions and clinical significance of lipoproteins

**BIOCHEMISTRY OF ENZYMES****Prof. Dr. Rubina Bashir & Prof. Dr. Sobia Imtiaz (09)**

15-04-24	Definition of enzymes , co- enzymes, co-factors and iso-enzymes
16-04-24	Classification of enzymes
18-04-24	Mechanism of catalysis
18-04-24	Factors affecting enzyme activity
22-04-24	Michaelis–Menten equation, Line weaver-burke plot and their application in enzyme kinetics
22-04-24 23-04-24	Enzyme Inhibitors and their clinical significance
25-04-24	Regulation of enzyme activity
25-04-24	Application of enzymes in clinical diagnosis and therapeutic uses
29-04-24	Application of enzymes in therapeutic uses

**METABOLISM OF CARBOHYDRATES****Prof. Dr. Sobia Imtiaz (09)**

29-04-24	Glycolysis: definition, reactions, bioenergetics, regulation and biomedical significance
30-04-24	Glycolysis: regulation and biomedical significance
2-05-24	Gluconeogenesis: definition, substrates, reactions, bioenergetics, regulation and significance
2-05-24	TCA Cycle: introduction, reactions , bioenergetics, regulation and biomedical significance
6-05-24	Glycogen Metabolism: introduction, reactions, and bioenergetics
6-05-24	Regulation and biomedical significance of glycogen metabolism and GSDs

7-05-24	HMP Shunt: reactions, regulation and biomedical significance
9-05-24	Metabolism of galactose, fructose, lactose and related disorders
9-05-24	Regulation of blood glucose level: hypoglycemia and hyperglycemia Biochemistry of diabetes mellitus: its lab. findings and diagnosis
<b>BIOCHEMISTRY OF VITAMINS</b> Prof. Dr. Sobia Imtiaz (14)	
13-05-24	Introduction and classification of vitamins
13-05-24	Chemistry, sources, daily allowances, functions and deficiency manifestations of vitamin A
14-05-24	Chemistry, sources, daily allowances, functions and deficiency manifestations of vitamin D
16-05-24	Chemistry, sources, daily allowances, functions and deficiency manifestations of vitamin K
16-05-24	Chemistry, sources, daily allowances, functions and deficiency manifestations of vitamins E
20-05-24	Chemistry, sources, daily allowances, functions and deficiency manifestations of vitamins B <sub>1</sub>
20-05-24	Chemistry, sources, daily allowances, functions & deficiency manifestations of vitamins B <sub>2</sub>
21-05-24	Chemistry, sources, daily allowances, functions & deficiency manifestations of vitamins B <sub>3</sub>
23-05-24	Chemistry, sources, RDA, functions and deficiency effects of B <sub>7</sub> and B <sub>5</sub>
23-05-24	Chemistry, sources, daily allowances, functions and deficiency manifestations of vitamins B <sub>6</sub>
27-05-24	Chemistry, sources, daily allowances, functions and deficiency manifestations of B <sub>12</sub>
27-05-24	Chemistry, sources, daily allowances, functions and deficiency manifestations of folic acid
28-05-24	Chemistry, sources, daily allowances, functions and deficiency manifestations of vitamin C
30-05-24	Chemistry, sources, daily allowances, functions and deficiency manifestations of vitamin C
<b>METABOLISM OF LIPIDS</b> Prof. Dr. Rubina Bashir & Prof. Dr. Sobia Imtiaz (10)	
30-05-24	Biosynthesis of fatty acids, triglycerides and their regulation
3-06-24	Mobilization and transport of fatty acids, triglycerides and sterols
3-06-24	Oxidation of fatty acids: activation and transport of fatty acids in the mitochondria beta oxidation and fate of acetyl CoA. Regulation of beta oxidation.
4-06-24	Other types of oxidation i.e., alpha oxidation, $\omega$ -oxidation, peroxisome oxidation, oxidation of odd No. carbon containing fatty acids and unsaturated fatty acids
6-06-24	Ketogenesis: mechanism and utilization of ketone bodies and its significance, ketosis and its mechanism
6-06-24	Cholesterol synthesis, regulation, function and fate of intermediates of cholesterol synthesis

10-06-24	Cholesterol degradation, hypercholesterolemia and atherosclerosis
10-06-24	Synthesis and degradation of phospholipids and related disorders
11-06-24	Metabolism of plasma lipoproteins Importance of plasma lipoproteins in health and disease
13-06-24	Biosynthesis of eicosanoids and their biochemical functions Glycolipids: Metabolism and related disorders
<b>METABOLISM OF PROTEINS</b> Prof. Dr. Sobia Imtiaz (08)	
13-06-24	Amino acid oxidation, metabolic fates of amino acids. Transamination & deamination
22-07-24	Decarboxylation, deamidation and trans-deamination reactions
22-07-24	Metabolism of ammonia (sources, transport and disposal of ammonia)
23-07-24	Nitrogen excretion and urea formation, urea cycle and its regulation. Related disorders Ammonia intoxication
25-07-24	Biosynthesis of non-essential amino acids
25-07-24	Degradation pathways of individual amino acids and related disorders
29-07-24 29-07-24	Conversion of amino acids to specialized products
<b>CHEMISTRY OF NUCLEOTIDES AND NUCLEIC ACIDS</b> Assistant Prof. Dr. Mahwish Shahzad (02)	
30-07-24	Biochemistry of nitrogenous bases and nucleotides
1-08-24	Biochemistry of nucleic acids
<b>STRUCTURE, FUNCTIONS AND REPLICATION OF INFORMATIONAL MOLECULES</b> Prof. Dr. Sobia Imtiaz (07)	
1-08-24 5-08-24	DNA organization and replication
5-08-24	RNA synthesis, processing and modifications
6-08-24 8-08-24	Protein synthesis and the genetic code
8-08-24	DNA mutations and repair
12-08-24	Recombinant DNA Technology, PCR
<b>BIOENERGETICS AND BIOLOGICAL OXIDATION</b> Prof. Dr. Sobia Imtiaz (03)	
12-08-24	Biological oxidation and reduction, electron transfer and redox potential
13-08-24	Respiratory chain and oxidative phosphorylation: components, ATP synthesis
15-08-24	Un-couplers and inhibitors

<b>METABOLISM OF PURINES AND PYRIMIDINES</b> Assistant Prof. Dr. Mahwish Shahzad (04)	
15-08-24 19-08-24	Metabolism of purine nucleotides and related disorders
19-08-24 20-08-24	Metabolism of pyrimidine nucleotides and related disorders
<b>BIOCHEMICAL TECHNIQUES</b> Assistant Prof. Dr. Mahwish Shahzad (04)	
22-08-24	GTT
22-08-24	Spectrophotometry
26-08-24 26-08-24	Protein separation techniques
<b>BIOCHEMISTRY OF GIT</b> Prof. Dr. Sobia Imtiaz (05)	
27-08-24	Introduction, composition and functions of saliva
29-08-24	Introduction, composition and functions of gastric juice and HCl
29-08-24	Introduction & composition of pancreatic juice
2-09-24	Introduction & composition of bile and succus entericus
2-09-24	Digestion and absorption of carbohydrates, proteins, nucleic acids & lipids
<b>BIOCHEMISTRY OF INTRACELLULAR AND EXTRACELLULAR COMMUNICATIONS</b> Assistant Prof. Dr. Mahwish Shahzad (06)	
3-09-24 5-09-24	Definition and classification of hormones and receptors. Mechanism of action of hormones
5-09-24	Hypothalamic hormones and hormones of anterior pituitary
9-09-24	Hormones of posterior pituitary
9-09-24	Hormones that regulate calcium metabolism and related disorders
10-09-24	Biochemistry of pancreatic hormones and related disorders
<b>MINERALS AND TRACE ELEMENTS</b> Assistant Prof. Dr. Mahwish Shahzad (05)	
12-09-24 12-09-24	Classification of minerals Biochemical role and metabolism of sodium and potassium and related disorders
16-09-24*	Biochemical role and metabolism of calcium and phosphate and related disorders
16-09-24*	Biochemical role and metabolism of chloride and magnesium and related disorders

17-09-24	Biochemical role and metabolism of micro-minerals and related disorders Biochemical role and metabolism of iron and related disorders
<b>NUTRITION</b> Assistant Prof. Dr. Mahwish Shahzad (07)	
19-09-24 19-09-24	Caloric requirements of the body, components of balanced diet and their importance
23-09-24 23-09-24	Nutritional requirements in pregnancy, lactation and newborn, Protein Energy Malnutrition
24-09-24 26-09-24	Basal Metabolic Rate
26-09-24 30-09-24 30-09-24	Nutritional disorders: Obesity and starvation

### VI. DEPARTMENTAL TIME TABLE

Monday	11:00 a.m. -11:45 a.m.		12:45 p.m. – 1:30 p.m.
	Biochemistry Lecture		Biochemistry Lecture
Tuesday		11:50 a.m. - 12:50 p.m.	
		Biochemistry hands on training	
Wednesday			
Thursday	10:45 a.m. – 12:15 p.m.	1:30 p.m. - 2:15 p.m.	2:15 p.m. - 3:00 p.m.
	Practical: Batch B	Biochemistry hands on training/ Dept. of DE once a month	Biochemistry Lecture
Friday	9:45 a.m. – 11:00 a.m.		
	Practical: Batch A		

### VII. TEACHING AND LEARNING METHODOLOGIES

- a. Large group teaching strategies
  - Lectures
  - Interactive sessions
- b. Small group teaching strategies: Employed during practicals and tutorials
  - Interactive sessions
  - Small group discussions (SGDs)
  - Directed self-learning (DSL)
  - Self-directed learning (SDL)

- Take home assignments
  - SEQ and MCQ exercises
  - Viva voce
  - Presentations by students
  - Laboratory demonstrations and practicals
- c. 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 hospital visits

### **VIII. LEARNING RESOURCES**

- a. Text books
- Harper's illustrated biochemistry
  - Lippincott's illustrated reviews
- b. Reference books
- Textbook of biochemistry with clinical correlations (Thomas M. Devlin)
  - Lehninger's principles of biochemistry (David L. Nelson, Michael M. Cox)
- c. Lectures hand-outs
- d. Practical note book

### **IX. 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.

a. Written tests

Written class tests include MCQs (one best type) and SEQs. Approximately 25% of questions are clinically oriented. University recommendations for marks distribution are strictly followed.

b. 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.

c. 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.).

d. OSPE

At least two OSPE tests are conducted during the session.

### **X. ROBUST FEEDBACK SYSTEMS**

a. Feedback on attendance

Attendance report is forwarded to students and parents on daily basis

b. 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 small group sessions. MCQ and SEQ papers are also discussed with students in small groups.

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

### **XI. SUMMER VACATIONS AND REMEDIAL CLASSES**

Summer vacations= 4 weeks

Remedial classes are mandatory for students who:

a. Join late

b. Have poor attendance/test performance or both in term I