



Study Guide
OF BIOCHEMISTRY
For BDS First year



MESSAGE FROM THE PRINCIPAL
AVICENNA DENTAL COLLEGE



Prof.Dr.Sohail Abbas Khan
{MDS, Dip Op (Hons) BDS}

It is a matter of immense honour and privilege as the first Principal of Avicenna Dental College to welcome you to prospectively one of the finest dental institutes in the private sector of Pakistan. Avicenna Dental College is a private dental college, which aims to provide the finest dental education to dental undergraduate student in accordance with the latest trends in Medical Education, and to develop them to practice dentistry in the 21st century.

While educating dental students to become licensed, empathetic and competent professionals, Avicenna Dental College endeavours to educate students in a supportive environment in which they provide dental care for a diverse populace. In the times to come, we wish to transform our graduates into unfeigned teachers, researchers and consultants by starting post-graduation programs as well.

Avicenna Dental College aims to achieve an enterprising curriculum integrating the basic sciences with clinical experience while utilizing modern technological modalities.

In addition to the production of outstanding oral health professionals, we at Avicenna Dental College recognize our responsibility as a private dental institution to the citizens of the country in making the provision of oral the provision of oral health care available to those who are deprived of ready access.

I feel proud to lead this dental establishment such an inspiring time and hope all of you at Avicenna Dental College will share this pride and play your respective roles in materializing the dream of making this institution the premier dental educator in Pakistan.

MESSAGE FROM HOD, BIO-CHEMISTRY

AVICENNA DENTAL COLLEGE



DR.ZUBAIR.AHMED

(M.B.B.S.,M.PHIL.,F.C.P.S.)

PROFESSOR/H.O.D.

Bio-Chemistry relates to the Chemistry of and relating to Biological Organisms. It acts as a bridge between Biology and Chemistry by demonstrating how chemical reactions and structures give rise to life and life processes. The spacious laboratory has spectrophotometer, colorimeters, photometer analytical, electrophoresis, pH meters, centrifuge machine, electronic balances, microscopes, incubators, water bath, distillation unit, automated pipettes and dispensers, to facilitate the practical demonstration of concepts. The Clinical biochemistry laboratory (clinical lab) at Avicenna Medical College & Avicenna Hospital is also equipped to facilitate the learning of students. It has

clinical chemistry analyser, haematology analyser and blood gas analyser to enhance effective student learning and understanding of blood samples and tests. A maximum of 60 students can occupy the huge biochemistry lab at one time. The highlighted equipment is sufficient for qualitative & quantitative analysis of samples for undergraduates.

CONTENTS

	List of contents	Page No.
1.	HOD Message	01
2.	Syllabus	02-05
3.	TOS	06
4.	Curriculum	07-13
5.	Learning Object	14
6.	Internal Assessment Policy	15
7.		16
8.	Innovative Learning	17
9.	Interactive learning	18

BIOCHEMISTRY

Introduction of Biochemistry

Introduction to cell (biochemical aspects)

Composition of cell

Methods to study cell biochemistry

(2) (2.3)

Biochemistry of Intracellular and Extra cellular Communication

Structure, assembly and function of cell membrane

Biochemistry of cell membrane, chemical composition

Importance of Lipid and proteins in membranes, chemistry of signals and receptors

Biochemistry of membrane transport mechanisms

(3) (4)

Biochemistry of Body Fluids

Introduction of water & weak acids, Bases

Concept of pH and pH scale

Dissociation constant & titration curve of weak acids, the concept of pK 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 & facilitated diffusion, osmosis; osmotic pressure, surface tension, viscosity & their importance related to regulation of body fluids.

(4)

(5)

Amino Acids

Amino acids, classification, properties, functions & 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 & 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

Hemoglobinopathies (Hb-S, Thalassaemia etc) and their biochemical basis

Enzymes

Introduction, nomenclature, properties of enzymes

Enzyme kinetics; mechanism of action; factors affecting enzymes activity, Michaelis-Menten

Equation

Lineweaverburk equation and their application in enzyme kinetics

Enzyme inhibitors and their classification and biomedical importance

(5)

Carbohydrates

Definition, classification, biochemical function and significance
Structure and functions of monosaccharides, disaccharides and polysaccharides, their important examples and biochemical role. (3-4)

Lipids

Classification of lipids; classification, functions, biochemical significance
Phospholipids, glycolipids, sphingolipids and their biochemical significance.

Fatty acids, chemistry, classification and biochemical function (5-6)
Eicosanoids, their classification and functions in health and disease
Cholesterol: chemistry, functions and clinical significance

Bioenergetics and Metabolism of Carbohydrates and Lipids

Introduction to bioenergetics, biologic oxidation
Oxidative phosphorylation and mitochondrial transport systems } Biosyn. acid & O.P. (3-4)

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 acylglycerols and sphingolipids

Lipids transport and storage

Cholesterol synthesis, transport and excretion

Regulation of lipid metabolism

Metabolism of Proteins and Amino Acids

Biosynthesis of amino acids

Catabolism of amino acids- the urea cycle

Porphyrias & bile pigments

Vitamins

Introduction, classification

Chemistry, Biochemical functions, daily allowances and source of water soluble and fat-soluble vitamins.

Hypovitaminosis and hypervitaminosis (8-9)

Mineral & Trace Elements:

Classification, biochemical role and regulation of macro minerals (Na, K Ca, Cl, PO4) and micro minerals (Fe, Zn, Mg, Se, I, Cu, Cr, Cd, Mn) (8)

Nucleotide and Nucleic Acid

Chemistry and structure of nucleotides and their biochemical role

Synthesis and degradation of purines and pyrimidines

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 - (12)

Biochemistry of Digestive Tract

Basic concepts of digestion and absorption

Composition, functions, daily secretion, stimulants and depressants of:
Saliva

Gastric juice & HCL

Pancreatic juice

Intestinal juice

Bile Juice

Digestion and absorption of carbohydrates, proteins, and lipids.

Biochemical disorders of GIT, e.g. achlorhydria, peptic ulcer, lactose intolerance, cholelithiasis and related disorders.

Integration of Metabolism

Metabolic effects of Insulin and glucagon

Glucose homeostasis

Basic concepts of metabolism in fed-state, starvation and diabetes mellitus

An overview of nutrition, nutrient and energy requirements

Laboratory Assignments

Introduction to use laboratory facilities / equipments

Basic techniques and fundamental information's

Preparations 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's Illustrated Reviews, Biochemistry

Basic and applied dental Biochemistry by Williams & Elliott

Harper's Biochemistry

Text Book of Biochemistry by West & Todd.

Berg, Tymoczko & Stryer, 5th edition (2002). *Biochemistry*

WH Freeman.Dow, Lindsay & Morrison (1995) *Biochemistry*.

Mosby.Cole and Eastoe, 2nd Edition (1988). *Biochemistry and Oral Biology*.

**BDS FIRST PROFESSIONAL EXAMINATION
BIOCHEMISTRY
TABLE OF SPECIFICATIONS**

Contents	MCQs	SEQs
Acid base balance	3	1
Proteins	2	1
Enzymes	4	1
Metabolism of Proteins	1	1
Metabolism of Carbohydrates	2	1
Metabolism of Lipids	1	1
Biochemical Techniques	1	1
Vitamins/Human Nutrition	3	1
Endocrines	2	-
Bilirubin	1	-
Genetics	1	-
Total	21	8

CURRICULUM:

TABLE OF SPECIFICATIONS/ BLUEPRINTS (1st YEAR BDS; Subject; BIOCHEMISTRY)						
Total marks= 45 Short Essay Questions (SEQ)= 8 =24 marks MCQ= 21= 21 marks						
TOPICS	LEARNING OUTCOMES	Knowledge	Skills	Attitude	Assesment	Mode of instruction
Biochemistry of Body Fluids;	At the end of the session, students will be able to: <ol style="list-style-type: none"> 1. Introduction of water & weak acid & bases 2. Concept of pH & pH scale. 3. Dissociation constant & titration curve of weak acids. 4. discuss the concept of pK values. 5. Buffers their mechanism of action. 6. Regulation of pH of body fluids, concept of Acidosis/Alkalosis. 7. Routes of transport across cell membrane 	C1	+	-	3 MCQs 1SEQ	Lectures, Tutorial, Small groups discussions, presentations
Chemistry & metabolism of Carbohydrates	At the end of the session, students will be able to: <ol style="list-style-type: none"> 1: Classification, biochemical functions & significance. 2: Structure & functions of Monosaccharides, diasaccharides& polysaccharides, their important examples & biochemical role.. 3: Citric acid cycle, 4: Oxidation of pyruvate, Glycolysis 5: Metabolism of Glycogen 6: Definne& elaborate gluconeogenesis, 7: Define Pentose phosphate pathway with reactions. 8. Reulation of carbohydrates metabolism 	C1 &C2	-	-	2 MCQs 1 SEQs	
Chemistry & metabolism Of Lipids	At the end of the session, students will be able to: <ol style="list-style-type: none"> 1: Define & Classify Lipids with their biological functions. 2: Define & Classify fatty acids along with their properties. 3: Define Nutritionally essential fatty acids and their functions. 4: Briefly discuss the eicosanoids & their biologic functions. 5. Explain the structure & biological role of Cholesterol. 6. Oxidation & biosynthesis of fatty acids. 7. Metabolism of Unsaturated fatty acid &Ecosanoids 8. Metabolism of acylglycerol&Sphingolipids. 9. Lipids transport & storage (Lipoproteins metabolism) 	C1	-	-	1MCQs 1SEQs	

	10. Cholesterol biosynthesis transport & excretion. 11. Regulation of lipids metabolism.					
Chemistry of Amino acids and Proteins	At the end of the session, students will be able to: 1: Define & classify the Amino acids along with examples. 2: Differentiate between standard and non-standard amino acids. 3: Briefly discussed the functions of Amino acids. 4. Importance of amino acids in maintenance of pH. 5. Peptides their biochemical significance & structure. 5. Define & Classify Proteins along with their biomedical functions, Properties and structure of proteins. 6. Globular & fibrous proteins. 7. Briefly discuss the denaturation of proteins 8. Define Immunoglobulin their types, structure & biological importance. 9. Define Plasma proteins their types & biomedical importance. 10. Briefly discuss the important Techniques for separation of proteins. 11. Explain the structure & functions of Hemoglobin & myoglobin & types of Hemoglobin. 12. Explain the oxygen binding capacity of hemoglobin. 13. Define Hemoglobinopathies; Sickle cell anemia & Thalassemia.	C1& C2	-	-	2MCQs 1SEQs	
Metabolism of Amino acids & Proteins:	At the end of the session, students will be able to: 1: Discuss the biosynthesis of amino acids. 2: Urea Cycle 3: Catabolism of Amino acids 4: Porphyrins& bile pigments.	C1	-	-	1 MCQs 1 SEQs	
Biochemical Techniques:	At the end of the session, students will be able to: To study biochemical Techniques; Includes principle, procedure, instrumentation & interpretations. <ul style="list-style-type: none"> • Centrifugation • Ultracentrifugation • Enzyme-linked immunosorbent assay (ELISA) • Radioimmunoassay • Chromatography • Electrophoresis • pH metery • Spectrophotometry 	C1 & C2	-	-	1 MCQs 1 SEQs	

Enzymes	<p>At the end of the session, students will be able to:</p> <ol style="list-style-type: none"> 1: Define, introduce & classify the enzymes along with their properties. 2: Define coenzymes & cofactors & classify them. 3. Briefly explain the mechanism if enzyme action and kinetics of enzymes. 4. Discuss the factors affecting the enzyme activity. 5. Define enzyme inhibition , classify them into their types with examples. 6. Line weaver burk equation & their applications in enzymes kinetics. 7. Define isoenzymes& their clinical significance. 8. Briefly explain the regulation of enzyme activity. 9. Briefly explain the diagnostic importance of enzymes in diseases. (Clinical enzymology). 10. Discuss the therapeutic uses of enzymes 	C1 & C2	-	-	4 MCQs 1 SEQs	
Vitamins/Human nutrition						

Endocrines:	<p>At the end of the session, students will be able to:</p> <ol style="list-style-type: none"> 1: Overview of endocrine system, classification of hormones . 2: Pituitary & Hypothalamic hormones;Structure, transport, synthesis secretion regulation catabolism & biological action.. 3. Briefly explain the Thyroid hormones; Structure, transport, synthesis secretion regulation catabolism & biological action. 5: Briefly explain the Calcium regulating hormones;Structure, transport, synthesis secretion regulation catabolism & biological action. 6. Briefly explain the Adrenal cortical hormones; Structure, transport, synthesis secretion regulation catabolism & biological action. 7. Briefly explain the Adrenal medullary; Structure, transport, synthesis secretion regulation catabolism & biological action of all adrenal medullary hormones. 8. Briefly explain the Male & female Gonadal hormones ;Structure, transport, synthesis secretion regulation catabolism & biological action. 	C1	-	-	2 MCQs 0 SEQs	
Bilirubin	<p>At the end of the session, students will be able to:</p> <ol style="list-style-type: none"> 1. Discuss the Chemistry & biosynthesis of heme& other porphyrins including disorders of hemebiosynthesis. (porphyrias) 2.Explain the bilirubin metabolism. 	C1	-	-	1 MCQs 0 SEQs	
Nucleotides& Nucleic acid/ Genetics:	<p>At the end of the session, students will be able to:</p> <ol style="list-style-type: none"> 1. Discuss the Chemistry & structure of nucleotides & their biochemical role. 2. Synthesis & degradation of purines &pyrimidines; <ul style="list-style-type: none"> • DNA structure & synthesis • RNA structure & synthesis. • Protein synthesis & genetic code. • Recombinant DNA technology • Regulation of gene expression & molecular basis of genetic diseases. 	C1	-	-	1 MCQs 0 SEQs	

--	--	--	--	--	--	--

TOS FOR WRITTEN EXAMINATION (Total marks=45):

BDS1nd Professional

CONTENTS	%of EXAM	SEQ(total marks=24) One SEQ= 3 marks			Total	MCQ(total marks=21) One MCQ=1 mark			Total
		C1	C2	C3		C1	C2	C3	
Biochemistry of Body fluids; Acid base balance	13%	1			1 (12.5%)	2	1		3(14%)
Chemistry &Metabolism of Carbohydrates	11%	1			1 (12.5%)	1	1		2(9.5%)
Chemistry & Metabolism of Lipids	9%	1			1 (12.5%)	1			1(5%)
Chemistry of Amino acids & Proteins	11%	1			1 (12.5%)	2			2(9.5%)
Metabolism of Amino acids & Proteins	9%	1			1 (12.5%)	1			1(5%)
Biochemical Techniques	9%		1		1 (12.5%)	1			1(5%)
Enzymes	16%	1			1 (12.5%)	4			4(19%)
Vitamins/Nutrition	13%	1			1 (12.5%)	3			3(14%)
Endocrines	5%	-			0(0%)	2			2(9%)

C1= Knowledge (simple recall)

C2=Understanding

C3=Application

Bilirubin	2%	-			0(0%)	1			1(5%)
Nucleotides & Nucleic acid/ Genetics	2%	-			0(0%)	1			1(5%)
Total	100%	7 (75%)	1 (25%)		8 (100%) Total marks 8×3=24	19(90%)	2(10%)		21(100%) Total marks 21×1=21

BDS 1st Prof

BIOCHEMISTRY

Teaching objectives (Biochemistry):

The general objectives and overall aim 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 comprehend the principles of metabolic integration that would contribute to the students' understanding of the biochemical basis of various disease processes.
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 which are used in the diagnosis of disease.
6. To familiarize the students with modern biochemical techniques and their uses in the diagnosis of diseases especially genetic diseases.

Learning objectives

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

1. To be familiar with the homeostatic mechanisms through the concepts of inter-regulation of carbohydrates, lipids and protein metabolism and its relation to hormone actions in the human body.
2. Once these basic concepts are understood, it will be straightforward to understand how alterations in the basic processes can lead to a disease state.
3. To have understanding and knowledge about many pathological situations where these can be related to biochemical defects, and to have some experience of biochemical techniques in order to understand the practical/clinical problems in biochemistry.
4. To develop 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.
5. To learn and understand the basic biochemical processes taking place in the body, since these underline an understanding of normal and abnormal human metabolism. In order to accomplish this, the student should learn how large molecules are synthesized and used (DNA, RNA, and proteins), and how energy is generated, stored, and retrieved (metabolism).
6. To describe digestion and assimilation of nutrients & consequences of malnutrition. Integrate the various aspects of metabolism & their regulatory pathways.
7. To explain biochemical basis of inherited disorders with their associated sequelae.
8. To outline the molecular mechanisms of gene expression, the principles of genetic engineering & their applications in medicine.
9. To outline the biochemical basis of cancer & carcinogenesis.
10. To make use of conventional techniques/instruments to perform biochemical analysis relevant to clinical screening & diagnosis. Familiarize with principles of various conventional & specialized lab investigations & instrumentation analysis & interpretation of a given data.
11. Applying basic knowledge of protein synthesis, post translational modification and targeting to its cellular destination.
12. 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

POLICY FOR FORMATION OF INTERNAL ASSESSMENT FOR First YEAR

BDS:

Internal assessment is formulated according to the rules of UHS. It is of 10 marks out of total 100 marks in the subject of biochemistry that is the 10% of total assessment.

It is calculated as;

1. Aggregate of all class Tests includes all relevant topics.
2. Aggregate of term test.
3. 10% of the average percentage results of all the above mentioned tests are taken as internal assessment out of 10marks.

Formula applied is given below;

$$= \frac{\text{Aggregate of all marks obtained in \%}}{\text{Total no.of tests}} \times 0.2$$

RECOMMENDED BOOKS FOR BDS 1ST PROF.

- Harper's Illustrated Biochemistry by Murrar 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.

- 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
- 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
- Biochemistry by Berg JM, Tymoczko JL, and Stryer L, latest edition, published by W.H. Freeman and Company
- Tietz Textbook of Clinical Chemistry by Burtis CA and Ashwood ER published by Saunders.
- Clinical Chemistry and Metabolic Medicine by Martin A. Crook, latest edition, Edward Arnold (Publishers) Ltd
- Practicals and Viva in Medical Biochemistry by Dandekar SP and Rane SA, latest edition, published by Elsevier.

INNOVATIVE LEARNING

- **Presentations**
- **Lectures (Multimedia, Projector)**
- **Assignments**
- **Web search**
(www.medstudies.com)

(www.biomedcentral.com)

INTERACTIVE LEARNING

- **Tutorials**
- **MCQs & SEQs discussion**
- **Quiz**