

Department of Biochemistry



Study Guide for 1st Year MBBS

**Sharif Medical & Dental College,
Lahore**



Preface

This curriculum is designed for medical undergraduates by collaborated effort of all subject specialists across the year to provide medical students of SM&DC a resource material to share important aspects of the curriculum designed by the university of Health Sciences, Lahore.

The main aim is to promote self-regulated and academic learning among students by empowering them to achieve their aims and objectives of medical education. The overarching curricular aspects of undergraduate competencies, assessment policies and names of curriculum coordinators are all included in this guidebook.

By means of careful arrangement amongst the primary subjects taught to first year MBBS, a resourceful alignment has been formatted for a conceptual understanding of these subjects whilst the provision of relevant clinical details ensures the necessary understanding of patient presentation and management.

SMDC aims to improve health indicators of the community and society at a large scale by training their students and doctors in preventive healthcare services and best health education through community outreach programs.

This study guide gives an overview of learning outcomes and objectives in relation to the course contents described. The assessment methodology used for the calculation of students' internal assessment is also provided. It has been prioritized that the entirety of the MBBS curriculum is designed in accordance with guidelines provided by the University of Health Sciences (UHS) and Pakistan Medical Commission (PMC). This is achieved by means of a combined and concentrated effort by of the institutional faculty.

Since curriculum is a living and a dynamic document, therefore it is suggested that it is to be updated and to be improved on yearly basis, using evidence generated through program evaluation and feedback from both students and faculty members. We hope that this humble effort of the contributing faculty will prove to be a guiding light for our dear students.

Regards.



Vision & Mission of UHS

Qualitative and Quantitative Revolution in Medical Education and Research through Evolution and thereby improve Health Care delivery to Populace.

UHS shall be innovative global center of excellence in learning and research, supporting a community of scholars and professionals committed to serving society, promoting the development of students to reach their true potential in becoming competent, ethical, caring, and inquiring health professionals for the benefit of the country and the wider world.

Mission of SMDC

Sharif Medical & Dental College is dedicated to best serve the nation through preservation and dissemination of advanced knowledge and educating the students by latest trends in learning and research reaching levels pars excellence.

The Institution is committed to provide standardized quality medical education to its students by inculcating professional knowledge, skills and responsibilities in them with the aim of:

- Preparing them as modern physicians having initiative to act as future leaders in their respective fields and becoming lifelong learners.
- Encouraging the spirit of critical thinking through research and publication.
- Building up an understanding of the ethical values compatible with our religion, culture and social norms.
- Developing a sense of being responsible citizens of the society possessing professional competence and instilling in them the values of hard work and dedication thus preparing them to be accountable to the stakeholders and the state.

The Institution is devoted to keep abreast its faculty with the latest trends in Medical Education encompassing teaching/learning methodologies, assessment tools, research opportunities and professionalism to facilitate their professional development, competencies and commitment towards continues learning.

Our patient-centered mission is achieved by outstanding medical care & services in professional practice with due emphasis and focus on our local health needs.

Our mission further elaborate upon establishing academic and research facilities in areas of local demand under global gold standards and leading advancement in research, education & patient care.

Vision of SMDC

To be recognized for the provision of a safe and functional environment conducive to collaborative teaching & learning, comfortable working atmosphere, and conducting world class research through professionalism and excellence.



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PLANNED TEACHING ACTIVITIES FOR 1st YEAR MBBS

DEPARTMENT OF BIOCHEMISTRY

PMC has allocated 200 hours of teaching in the subject of Biochemistry for the MBBS course. In order to meet this requirement following teaching modules have been planned. The modules have been carefully designed to impart core knowledge of Biochemistry in a way that an undergraduate student can grasp the subject fully and is adequately prepared for examination in any university.

Lectures:

A total of 144 lectures are planned for the entire year in 36 weeks. The lectures will be conducted by the Professor, Associate and assistant professors. The lectures will be interactive and students should actively participate in them to clear their doubts. The students are required to take notes of the lectures and study the topic with the help of prescribed text books.

Practical classes:

The whole class of 100 students divided into 4 batches to conduct the practicals effectively and one batch perform practical per week. Practical will be conducted by demonstrators under an active supervision of senior instructors. Students are required to enter their work in their practical note books which comprises of the principle procedure observation and interpretations of the current practical and get them checked by the instructors regularly.

Tutorials:

The whole class of 100 students divided into 4 batches to conduct the tutorial effectively and one batch take tutorial in alternate week. Topics for the tutorial will be notified at least one week before the class. The instructors will be deputed for every batch on rotation basis. During this interactive session the students must clear their concepts regarding the topic by actively engaging with their respective teachers.

Small Group Discussion:

Case based learning classes will be conducted from time to time throughout the academic year. A clinical scenario will be discussed with students by dividing them in groups. A senior instructor will be facilitating the discussion in interactive session and students are required to generate the discussion amongst themselves in line with the learning objectives of the topic.

Presentations by the students:

Presentations of the ongoing topic will be conducted throughout the year periodically by the students so as to cover the topic of discussion precisely according to course work designed by UHS and emphasizing its clinical relevance and research relationship. Preferably topics will be allocated to the group of 3-4 students and they will present a very short presentation of 10-15 minutes related to the topic and discuss all the relevant important aspects followed by Q&A session after it.



Training Program for Lecturers Department of Biochemistry 1st Year MBBS

General

- Biochemistry is the dynamic, exciting science in which chemistry is applied to the study of the atoms and molecules which comprise living organisms. This includes organic molecules and their chemical reactions. It has revolutionized our understanding of and provides a backbone to modern medicine.
- Biochemistry Department at SM&DC has a unique approach to the biochemical sciences that cultivates critical thinking as well as depth of knowledge by exposing its students to the full spectrum of modern biochemistry. The comprehensive teaching and assessment plan is strategically designed according to the UHS and PMC syllabi and guidelines to achieve maximum results.
- The strength of Biochemistry Department is its conducive environment and committed staff.
- The vibrant teaching staff is highly qualified with post graduates degrees and certifications along with vast teaching experience. The department's aim is establishment of research culture and encouragement of student participation in it.
- Biochemistry department has a well equipped laboratory and is managed by qualified and experienced technical staff.

CARBOHYDRATE CHEMISTRY

Sr. No.	Title of Lecture	Instructor
1	Carbohydrates, their biochemical function and classification	Prof. Dr. Gul-e-Raana
2	Structure, functions and derivatives of monosaccharides	
3	Structure and function of oligosaccharides and disaccharides	
4	Polysaccharides and their biochemical role in normal and disease conditions	
5	Biomedical importance of carbohydrate	
6	Clinical importance of various carbohydrates in diseases like diabetes mellitus and BSL disturbances, Hereditary Fructosemia and Lactose intolerance	

Prophyrias and Heam Protiens

Sr. No.	Title of Lecture	Instructor
1	Porphyryns and metabolism of haem	Dr. Hassan Jamil
2	Synthesis and structure of haemoglobin	



3	Types and function of haemoglobin	
4	O ₂ binding capacity of haemoglobin and factors regulating & affecting it	
5	Breakdown of haemoglobin, formation of bile pigments their transport and excretion	
6	Biochemical causes of hyper-bilirubinaemia and differentiation between different types of jaundice	
7	Causes and types of haemoglobinopathies	
8	Porphyrias	

Cell Biochemistry

Sr. No.	Title of Lecture	Instructor
1	Biochemical composition and functions of the cell	Dr. Samra Hafeez
2	Cell membranes and their chemical composition	
3	Importance of lipids and proteins in cell membranes	
4	Chemistry and mechanism involved in signal transduction and various types of receptors responsible for transduction of signals	
5	Membrane transport including active transport, passive transport, simple and facilitated diffusion	
6	Methods to study cell biochemistry	
7	Biochemical mechanisms for control of water and electrolyte balance	
8	Types of particles in solution	
9	Importance of selectively permeable membranes, osmosis and osmotic pressure, surface tension, viscosity also in relation to body fluids	

PH and Body Buffer

Sr. No.	Title of Lecture	Instructor
1	Ionization of water, weak acids and bases	Dr. Hassan Jamil
2	pH and pH scale	
3	pK values, dissociation constant and titration curve of weak acids	
4	Body buffers and their mechanism of action	
5	Henderson – Hesselbach equation	
6	Acid base regulation in human body	
7	Acid base control in clinical setting	



Lipid Chemistry

Sr. No.	Title of Lecture	Instructor
1	Classification of lipids and their biochemical functions	Dr. Gul-e-Raana
2	Structure and biochemical function of phospholipids, glycolipids, and sphingolipids	
3	Classification of fatty acids and their biochemical functions	
4	Functions of essential fatty acids	
5	Eicosanoids and their function in health and disease	
6	Steroids and their biochemical role	
7	Cholesterol, its structure chemistry and function	
8	Lipid peroxidation and its biological importance	
9	Clinical significance of lipids	
10	Clinical importance of steroids	

Enzymology

Sr. No.	Title of Lecture	Instructor
1	IUMB Classification of enzymes and their nomenclature	Dr. Gul-e-Raana
2	Enzymes as catalysts	
3	Biological functions and mechanism of action of enzymes	
4	Co-enzymes and co-factors	
5	Iso-enzymes and their clinical importance	
6	Factors affecting enzyme activity (Michaelis – Menten and Lineweaver Bulk equations)	
7	Enzyme inhibition and Classification of enzyme inhibitors with their biochemical importance	
8	Therapeutic uses of enzymes	
9	Application of enzymes in clinical diagnosis and treatment	

Amino Acid and Protein Chemistry

Sr. No.	Title of Lecture	Instructor
1	Proteins and their biochemical importance with classification of simple , compound and conjugated proteins	Dr Samra Hafeez
2	Physicochemical, functional nutritional and structural properties of proteins	
3	Structure, functions and properties of amino acids	

4	Amino acids classification and their nutritional significance	
5	Importance of amino acids in pH maintenance	
6	Separation of proteins, salting out, electrophoresis, chromatography and centrifugation	
7	Immunoglobulin structure , types and their biochemical function and role of IgG, Ig M, IgA, IgE&IgD	
8	Plasma proteins and their clinical function	
9	Clinical importance of proteins and amino acids	
10	Clinical significance of immunoglobulins	
	Plasma proteins in clinical practice	

Vitamins

Sr. No.	Title of Lecture	Instructor
1	Classification of vitamins, their chemical structure & biochemical function	Dr. Hassan Jamil
2	Functions and clinical importance and deficiency symptoms Fat soluble (A,D K&E) and water soluble Vitamins (Thiamine , Riboflavin , Niacin , pyridoxine , pantothenic acid Folic acid , biotin)	
3	Absorption of vitamins and minerals	
4	Daily requirements, sources of water- and fat-soluble vitamins	
5	Effects of vitamin c deficiency	
6	Role of vitamins as co-enzymes	
7	Hypervitaminosis	

Nucleic Acid Chemistry

Sr. No.	Title of Lecture	Instructor
1	Structure function and difference between Nucleotide and Nucleoside	Dr. Samra Hafeez
2	Nucleotides and their biochemical role	
3	Structure, function and biochemical role of nucleotides	
4	Synthesis of purines and pyrimidines and their clinical role	
5	Structure, function and types of nucleic acids	
6	Clinical significance of nucleic acids and nucleotides	



Nutrition

Sr. No.	Title of Lecture	Instructor
1	Caloric requirements of the body	Dr. Anam
2	Balanced diet	
3	Protein energy malnutrition	
4	Marasmus, Kwashiorkor	
5	Nutritional requirements in: Pregnancy, Lactation, New born, Nutritional disorder	

Minerals

Sr. No.	Title of Lecture	Instructor
1	Classification and list of Essential minerals in human nutrition	Dr. Anam
2	Sources, biochemical actions and recommended daily allowance (RDA) of Sodium, potassium, chloride, calcium, phosphorus, magnesium, sulfur, iodine, fluoride etc.	
3	Trace elements as Fe, Zn, Se, I, Cu, Cr, Cd and Mn	



LIST OF LECTURES IN THE SUBJECT OF BIOCHEMISTRY AND THEIR LEARNING OBJECTIVES

At the end of the course, the students should be able to discuss and describe following topics

S. No.	Title of Lectures with Learning Objectives
1	BIOCHEMISTRY OF CARBOHYDRATES a) Define biochemical function and classification of carbohydrates. b) Explain structure, function of biologically important monosaccharides and their important derivatives (sugar acids, sugar alcohols, sugar amines and glycosides). c) Discuss isomerism in carbohydrates (types and description). d) Elaborate biologically important disaccharides, their properties and their biomedical importance. e) Outline oligosaccharides, their combination with other macromolecules and their biomedical importance. f) Enlist homopolysaccharides of biologic significance and their structural and functional characteristics. g) Identify structural and functional characteristics of heteropolysaccharides including details of glycosaminoglycans; proteoglycans, peptidoglycans and mucopolysaccharidoses. h) Perform tests to detect monosaccharides of biomedical significance glucose, fructose and galactose (Benedict's test Selivanoff's test and Osazone test).
2	BIOCHEMISTRY OF HEMOGLOBIN a) Describe chemistry and biosynthesis of heme and other porphyrins including disorders of heme biosynthesis (porphyria's). b) Enlist important hemoproteins found in body along with their principal biologic functions; structure and function of hemoglobin and myoglobin and types of hemoglobin. Hemoglobin AR 1c c) Explain oxygen binding capacity of hemoglobin, factors affecting and regulating the oxygen binding capacity if hemoglobin. Methaemoglobin (metHb) and methaemogloemia. d) Discuss bilirubin metabolism: Degradation of heme, synthesis, hepatic uptake, conjugation and excretion of bilirubin and fate of bilirubin in intestine. e) Enumerate hyperbilirubinemias: Causes of hyperbilirubinemias along with the acquired and congenital disorders leading to hyperbilirubinemias; jaundice and kernicterus. f) What are hemoglobinopathies: Sickle cell anemia (biochemical cause and its clinical manifastations), hemoglobin C disease, hemoglobin SC disease and thalassemias.
3	CELL BIOCHEMISTRY a) Describe introduction to biochemistry: An overview of biochemistry and its significance in medicine. b) Explain biochemical composition and functions of cell: Organization and composition of eukaryotic and prokaryotic cells (only biochemical aspects). SIGNAL TRANSDUCTION

	<p>Explain different types of membrane receptors and their biological importance, various regulatory and catalytic membrane-bound proteins like G-proteins, adenylyl cyclase and phospholipase</p> <p>CELL SEPARATION TECHNIQUES</p> <p>a) Discuss basic methods to study cell biochemistry: Centrifugation, ultracentrifugation, radioimmunoassay, ELISA (enzyme-linked immunosorbent assay); chromatography, electrophoresis, spectrophotometry and pHmetry.</p> <p>b) Demonstrate the use of laboratory facilities / equipment including safety measures.</p> <p>c) Prepare 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.</p> <p>d) Summarize the conversion of conventional and SI measuring units</p> <p>MEMBRANE PHENOMENA</p> <p>a) Discuss cell membrane structure, functions and its chemical composition</p> <p>b) Elaborate 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.</p>
4	<p>PHYSIOLOGICAL ASPECTS (WATER, PH AND BUFFERS)</p> <p>a) Illustrate ionization of water, weak acids and bases.</p> <p>b) Define pH and pH scale: Concept of pH and related topics (determination of pH) and concept of pI (isoelectric pH).</p> <p>c) Discuss pK values, dissociation constant and titration curve of weak acids.</p> <p>d) Describe Henderson – Hasselback equation and its applications (derivation not required).</p> <p>e) Demonstrate actions of various types of body buffers and determination of pH (by using indicators and pH meter).</p> <p>ACID BASE BALANCE</p> <p>a) Discuss body buffer systems (bicarbonate, ammonia, phosphate and proteins) and their mechanism of action.</p> <p>b) Explain respiratory acidosis and alkalosis.</p>
5	<p>BIOCHEMISTRY OF LIPIDS AND PROSTAGLANDINS (EICOSANOIDS)</p> <p>a) Classify of lipids and their general biological functions.</p> <p>b) Explain 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 in coronary heart disease; omega-3 and omega-6 fatty acids and the importance of their dietary use.</p> <p>c) Outline nutritionally essential fatty acids and their functions.</p> <p>d) Discuss eicosanoids and their biologic functions along with their significance in health and disease.</p> <p>e) Differentiate physical and chemical properties of fats and oils (triacylglycerols); saponification, iodine number and acid number of fats; rancidity of fats</p> <p>f) Explain structure and biologic functions and significance of phospholipids, glycolipids, sulfolipids and gangliosides.</p> <p>g) Summarize cholesterol and its related compounds such as bile acids: Structure (constituent structural components), properties and biologic role.</p>

	<p>h) Discuss lipid peroxidation and its significance.</p> <p>i) Perform tests of fats, lipids and cholesterol.</p>
6	<p>BIOCHEMISTRY OF ENZYMES</p> <p>a) Define classification and nomenclature of enzymes: Definitions of enzymes and IU of enzyme activity; enzyme commission classification of enzymes along with main subclasses.</p> <p>b) Explain properties of enzymes: Chemical nature, active site, catalytic efficiency, specificity, proenzymes and kinetic properties.</p> <p>c) Differentiate co-enzymes and co-factors: Co-enzymes derived various vitamins along with examples of enzymes requiring these co-enzymes; and metal co-factors.</p> <p>d) Classify isozymes and their clinical significance.</p> <p>e) Discuss allosteric enzymes and their biologic significance.</p> <p>f) Outline factors affecting enzyme activity.</p> <p>g) Review types of enzyme inhibitors and their biomedical importance; effects of competitive, non-competitive inhibitors on enzyme activity, effects of competitive, non-competitive inhibition on Lineweaver-Burke plot.</p> <p>h) Draw mechanism of enzyme action and kinetics of enzyme activity (Michaelis-Menten and Lineweaver-Burke equations without derivation).</p> <p>i) Interpret regulation of enzyme activity (covalent modification, allosteric regulation and regulation by gene induction, repression and de-repression of enzyme synthesis).</p> <p>j) Identify 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</p>
7	<p>BIOCHEMISTRY OF PROTEINS</p> <p>a) Draw dissociation and titration of amino acids; determination of pl 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.</p> <p>b) Explain immunoglobulins; their types, structure and biomedical significance.</p> <p>c) Discuss plasma proteins (viz, prealbumin, albumin, haptoglobin, ceruloplasmin, alpha1-anti-trypsin, alpha2-macroglobulin and transferrin) and their principal biologic functions along with their clinical significance. Alpha fetoprotein and clinically important acute phase proteins (alpha1-acid glycoprotein, C-reactive protein).</p> <p>d) What are glycoproteins, components of glycoproteins (overview of linkages between proteins and carbohydrates, N-and O-linked oligosaccharides).</p> <p>e) Illustrate important techniques for separation of proteins (electrophoresis, isoelectric focusing, chromatography, filtration, centrifugation and dialysis).</p> <p>f) Perform tests to detect proteins / peptides / amino acids (heat coagulation test, suphosalicylic acid test, Heller's Ring test and Ninhydrin test).</p> <p>BIOCHEMISTRY OF AMINO ACIDS</p> <p>a) Enlist biomedical importance and classification (biologic functions; nutritional value, and overall shape of molecule) of proteins.</p> <p>b) Discuss structure, function and properties of amino acids.</p> <p>c) Explain 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.</p>

	d) Interpret 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)
8	<p>VITAMINS</p> <p>a) Explain general features of vitamins as essential nutrients.</p> <p>b) Classify vitamins according to their physic-chemical nature and biochemical functions.</p> <p>c) What are Important dietary sources and recommended dietary allowances of vitamins.</p> <p>d) Discuss intestinal absorption, transport and storage of vitamins.</p> <p>e) Describe mechanism of action of vitamins and their biochemical functions in body.</p> <p>f) What are disorders associated with vitamin deficiency and hypervitaminoses.</p>
9	<p>BIOCHEMISTRY OF NUCLEIC ACID</p> <p>a) Differentiate chemistry of purines and pyrimidines; their types and structure.</p> <p>b) Discuss structure and functions of nucleotides and nucleosides (excluding metabolism of nucleotides).</p> <p>c) Categorize natural and synthetic derivatives of purines and pyrimidines and their biomedical role.</p> <p>d) Distinguish structure, function and types of nucleic acids nucleosides (excluding metabolism).</p>
10	<p>NUTRITION</p> <p>a) Discuss 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).</p> <p>b) What is balanced diet?</p> <p>c) Explain the role of 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).</p> <p>d) Correlate 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 trans fats on health and nutritionally essential fatty acids</p> <p>e) Outline 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).</p> <p>f) Calculate caloric requirement of a person and nutritional requirements in pregnancy, lactation, infancy and old age.</p> <p>g) Discuss obesity and food additives (artificial sweeteners and flavor enhancers).</p>
11	<p>MINERALS</p> <p>Explain the detail of 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 recommended dietary allowances (RDA)</p>



LIST OF PRACTICAL FOR 1ST YEAR MBBS

Sr. No.	Topic	Practical
1	Lab Instruction and Solution Preparation	<ul style="list-style-type: none">• Instructions and Code of Conduct in Medical Laboratory• Laboratory Hazards, Precautions and First Aid Measures• Solutions and Laboratory Calculations• Conversion of Units• Determination of pH
2	CHO	<ul style="list-style-type: none">• Introduction to Carbohydrates• Barfoed's Test• Molisch's Test• Iodine Test• Benedict's Test• Selivanoff's Test• Phenyl hydrazine Test (Osazone test)• Hydrolysis of Sucrose• Hydrolysis of Starch• Identification Scheme of Carbohydrates• Scheme For Identification Of Unknown Carbohydrate
3	Lipid	<ul style="list-style-type: none">• Properties Of Lipids• Solubility Of Lipid In Various Solvents• Emulsification• Saponification
4	Amino Acid and Protein	<ul style="list-style-type: none">• Amino Acids: An Introduction• Proteins: An Introduction• Biuret Test• Precipitation Tests• Precipitation of Casein at its Isoelectric Point (pI)• Heat Coagulation Test• Scheme For Identification Of Unknown Protein• Identification Scheme For Unknown Proteins By Precipitation Tests• Salt Saturation Tests• Ninhydrin Test• Xanthoproteic Test• Millon-Nasse's Test• Aldehyde Test• Lead Sulphide Test• Chromatography• Tests: Identify the protein in the given solution by precipitation tests• Color Reaction Tests For Identification Of Amino Acids
5	Urine Analysis	<ul style="list-style-type: none">• Analysis of Normal Urine• Analysis of Abnormal Urine



FORMATIVE ASSESSMENT (At the conclusion of each topic)

Topic	No. of Test/ Tests	Marks	Mode of Evaluation
Cell biochemistry	1	25	Written/viva
Water, pH and buffer	1	50	Written/viva
Chemistry of Carbohydrates	3	100	Written +viva+ OSPE
Amino acids & proteins	3	100	Written +viva+ OSPE
Nucleic Acid	1	50	Written/viva
Chemistry of lipids	3	100	Written +viva+ OSPE
Enzymes	2	75	Written/viva
Porphyrins & hemoprotein	1	50	Written (MCQs & SAQs)
Vitamins	2	100	Written/viva
Minerals	1	25	Written/viva
Nutrition	2	75	Written/viva
Extra cellular matrix	1	25	Written (MCQs &SAQ)



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RECOMMENDED BOOKS

- Lippincott's Illustrated Reviews : Biochemistry by Harvey R and Ferrier D, Latest Ed, published by Lippincott Williams & Wilkins
- Harper's Illustrated Biochemistry by Murrar RK, Granner DK and Rodwell VW, Latest Ed, McGraw Hill
- Marks' Basic Medical Biochemistry – A Clinical Approach, by Smith C, Marks AD, and Lieberman M. Latest Ed. Published by Lippincott Williams & Wilkins
- An introduction to practical Biochemistry by D.T. Plurnor.

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

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