

## Course Content

(Based on Competency Table published by Medical Council of India. Students/Teachers are directed to refer competency table published on MCI Website for details)

**Subject: Biochemistry**

**Year: First MBBS**

Competency No.	Topics & Subtopics
<b>1</b>	<b>Basic Biochemistry</b>
<b>1.1</b> Describe the molecular and functional organization of a cell and its subcellular components.	Molecular and functional organization of cell and its subcellular components
<b>2</b>	<b>Enzymes</b>
<b>2.1</b> Explain fundamental concepts of enzyme, isoenzyme, alloenzyme, coenzyme & co-factors. Enumerate the main classes of IUBMB nomenclature.	Biochemical nature of enzyme, isoenzyme, alloenzyme, coenzyme & co-factors IUBMB enzyme classification
<b>2.2</b> Observe the estimation of SGOT & SGPT	Estimation of SGOT (AST) & SGPT (ALT) with its normal range and clinical significance.
<b>2.3</b> Describe and explain the basic principles of enzyme activity	Mechanism of enzyme action, factors affecting enzyme activity, brief concept of enzyme kinetics with special reference to $V_{max}$ & $K_m$ .
<b>2.4</b>	Enzyme inhibition. Various inhibitors as drugs and poisons

Competency No.	Topics & Subtopics
Describe and discuss enzyme inhibitors as poisons and drugs and as therapeutic enzymes	
<p style="text-align: center;"><b>2.5</b></p> Describe and discuss the clinical utility of various serum enzymes as markers of pathological conditions.	Diagnostic and therapeutic importance of various serum enzymes in various disorders
<p style="text-align: center;"><b>2.6</b></p> Discuss use of enzymes in laboratory investigations (Enzymebased assays)	Analytical uses of Enzymes in laboratory investigations (enzyme based assays)
<p style="text-align: center;"><b>2.7</b></p> Interpret laboratory results of enzyme activities & describe the clinical utility of various enzymes as markers of pathological conditions.	Interpret various serum enzymes of liver & biliary tract, Pancreas, cardiac & skeletal muscle in various disorders
<p style="text-align: center;"><b>3</b></p>	<b>Chemistry &amp; Metabolism of Carbohydrates</b>
<p style="text-align: center;"><b>3.1</b></p> Discuss and differentiate monosaccharides, di-saccharides and polysaccharides giving examples of main carbohydrates as energy fuel, structural element and storage in the human body	Classification of carbohydrates with examples and functions of monosaccharides giving examples as energy fuel, glycosides and its therapeutic importance, disaccharides with examples and importance, polysaccharides with examples as storage form like glycogen, structural elements like glycosaminoglycan's in the human body, resistant starch, glycemic index, and dietary fiber. Clinical importance of dextran's

<p style="text-align: center;"><b>3.2</b></p> <p>Describe the processes involved in digestion and assimilation of carbohydrates and storage.</p> <p style="text-align: center;"><b>3.3</b></p>	<p>Digestion &amp; absorption, transport and storage of carbohydrates, Lactose intolerance and sucrose deficiency disorders</p>
--	---

<b>Competency No.</b>	<b>Topics &amp; Subtopics</b>
<p>Describe and discuss the digestion and assimilation of carbohydrates from food.</p>	
<p style="text-align: center;"><b>3.4</b></p> <p>Define and differentiate the pathways of carbohydrate metabolism (glycolysis, gluconeogenesis, glycogen metabolism, HMP shunt).</p>	<p>Pathway, energetics, regulation &amp; clinical diseases / disorders of - Glycolysis including Rappaport Leubering cycle, Gluconeogenesis, Glycogenesis, Glycogenolysis, HMP pathway, Uronic acid pathway, Galactose &amp; Fructose metabolism</p>
<p style="text-align: center;"><b>3.5</b></p> <p>Describe and discuss the regulation, functions and integration of carbohydrate along with associated diseases/disorders.</p>	
<p style="text-align: center;"><b>3.6</b></p> <p>Describe and discuss the concept of TCA cycle as an amphibolic pathway and its regulation.</p>	<p>TCA cycle Pathway, energetics, regulation &amp; its concepts as an amphibolic pathway</p>
<p style="text-align: center;"><b>3.7 To be clubbed with 3.4 &amp; 3.6</b></p> <p>Describe the common poisons that inhibit crucial enzymes of carbohydrate metabolism (eg: fluoride, arsenate)</p>	<p>Common poisons that inhibit crucial enzymes of carbohydrate metabolism like: Iodoacetate, fluoride &amp; arsenite as poisons that inhibit enzymes of glycolysis Fluoroacetate, arsenite &amp; malonate as poisons that inhibit enzymes of TCA cycle</p>

<p style="text-align: center;"><b>3.8 &amp; 3.10</b></p> <p><b>3.8:</b> Discuss and interpret laboratory results of analytes associated with metabolism of carbohydrates. (to be clubbed with comp no 11.17- Diabetes Mellitus)</p> <p style="text-align: center;"><b>3.10</b></p> <p>Interpret the results of blood glucose levels and other Laboratory investigations related to disorders of carbohydrate metabolism.</p>	<p>Interpretation of the results of blood glucose, Glycated hemoglobin &amp; GTT as per WHO guidelines in Diabetes mellitus including gestational diabetes and other laboratory investigation like urinary glucose, urinary ketone bodies.</p> <p>Interpretation of the results of blood &amp; urinary galactose levels in galactosemia.</p> <p>Interpretation of blood G6PD levels</p>
--	---

<b>Competency No.</b>	<b>Topics &amp; Subtopics</b>
<p style="text-align: center;"><b>3.9</b></p> <p>Discuss the mechanism and significance of blood glucose regulation in health and disease.</p>	<p>Regulation of blood glucose in fed and fasting state in normal health &amp; changes in diabetes mellitus.</p>
<p><b>4</b></p>	<p><b>Chemistry &amp; Metabolism of Lipids</b></p>
<p style="text-align: center;"><b>4.1</b></p> <p>Describe and discuss main classes of lipids (Essential/nonessential fatty acids, cholesterol and hormonal steroids, triglycerides, major phospholipids and sphingolipids) relevant to human system and their major functions.</p>	<p>Definition &amp; classification of lipids including classification of fatty acids, their nomenclature, numbering, functions &amp; biological importance of various lipids like fatty acids, cholesterol , hormonal steroids, triglycerides, major phospholipids and sphingolipids</p>

<p style="text-align: center;"><b>4.2</b></p> <p>Describe the processes involved in digestion and absorption of dietary lipids and also the key features of their metabolism</p>	<p>Digestion, absorption and transport of lipids along with abnormalities like lipid malabsorption.</p> <p>Metabolism of fatty acids (<math>\beta</math>-oxidation of even and odd carbon fatty acids), regulation, energetics and disorders associated with oxidation of fatty acids, Formation &amp; fate of ketone bodies, its significance, regulation and associated disorders like ketosis.</p> <p>In brief de novo fatty acid biosynthesis- site &amp; organs, precursors, enzyme complex, product formed &amp; regulatory steps.</p> <p>Biosynthesis of triacylglycerol and fate of triacylglycerol formed in liver &amp; adipose tissue, its significance and regulation, Metabolic role of adipose tissue and disorders of lipid transport and storage like fatty liver.</p> <p>In brief Cholesterol biosynthesis- site &amp; organs, precursors, key enzymes, product formed &amp; regulatory step, metabolic fate &amp; excretion</p>
--	---

<b>Competency No.</b>	<b>Topics &amp; Subtopics</b>
<p style="text-align: center;"><b>4.3</b></p> <p>Explain the regulation of lipoprotein metabolism &amp; associated disorders.</p>	<p>Metabolism of various lipoproteins and hyperlipoproteinemia's, hypolipoproteinemias, betalipoproteinemias &amp; Tangiers disease.</p>
<p style="text-align: center;"><b>4.4</b></p> <p>Describe the structure and functions of lipoproteins, their functions, interrelations &amp; relations with atherosclerosis</p>	<p>Classification structure and functions of lipoproteins- (To be clubbed with 4.1)</p> <p>Metabolic interrelationship between various lipoproteins, Role of lipoproteins in transport of cholesterol and reverse cholesterol transport, atherosclerosis- (To be clubbed with 4.3)</p>

<p style="text-align: center;"><b>4.5 &amp; 4.7</b></p> <p>Interpret laboratory results of analytes associated with metabolism of lipids</p>	<p>Various lipid profile tests with their biological reference intervals. Interpret lipid profile results in various disorders like hyper/hypolipoproteinemias, diabetes mellitus, nephrotic syndrome, disorders of thyroid etc.</p>
<p style="text-align: center;"><b>4.6</b></p> <p>Describe the therapeutic uses of prostaglandins and inhibitors of eicosanoid synthesis.</p>	<p>Various eicosanoid classes (prostaglandins, leukotrienes &amp; thromboxanes), their functions. Key features of synthesis of eicosanoids and inhibitors of eicosanoid synthesis, therapeutic uses of prostaglandins</p>
<p style="text-align: center;"><b>4.7</b></p> <p>Interpret laboratory results of analytes associated with metabolism of lipids.</p>	<p><b>Same as 4.5</b></p>
<p style="text-align: center;"><b>5</b> <b>5.1</b></p> <p>Describe and discuss structural organization of proteins.</p>	<p><b>Chemistry and Metabolism of Proteins</b></p> <p>General nature of amino acid, classification and importance of amino acids with examples, peptide bond formation, biologically important peptides, different levels of protein structure including disulfide &amp; weak bonds with examples and clinical significance.</p>

<b>Competency No.</b>	<b>Topics &amp; Subtopics</b>
<p style="text-align: center;"><b>5.2</b></p> <p>Describe and discuss functions of proteins and structurefunction relationships in relevant areas e.g. hemoglobin and selected hemoglobinopathies</p>	<p>Definition, various classifications with examples and functions of proteins, plasma proteins, structure - function relationship of proteins like myoglobin, normal &amp; abnormal hemoglobin</p>

<p style="text-align: center;"><b>5.3</b></p> <p>Describe the digestion and absorption of dietary proteins.</p>	<p>Digestion, absorption and transport of dietary proteins with related disorders like Hartnup disease, cystinuria &amp; glycinuria.</p>
<p style="text-align: center;"><b>5.4</b></p> <p>Describe common disorders associated with protein metabolism.</p>	<p>Role of transamination &amp; deamination reactions in metabolism of amino acids in the formation of ammonia with their clinical significance.</p> <p>Transport of ammonia, pathway of urea cycle, its significance, regulation and metabolic disorders associated with urea cycle.</p> <p>Metabolic pathways for Glycine, Phenylalanine &amp; Tyrosine, Sulphur containing amino acids (Methionine, Cysteine &amp; Cystine) and branch chain amino acids (Valine, Isoleucine &amp; Leucine), their role in biosynthesis of variety of specialized biomolecules, associated metabolic disorders</p> <p>For Tryptophan- Only important biomolecules formed &amp; clinical significance.</p>
<p style="text-align: center;"><b>5.5</b></p> <p>Interpret laboratory results of analytes associated with metabolism of proteins.</p>	<p>Interpret laboratory results of protein metabolism for example: Levels of various metabolites in blood or urine in metabolic disorders like- urea cycle disorders, Phenylketonuria, Tyrosinemia, Alkaptonuria, Hartnups disease, MSUD, cystinuria &amp; homocystinuria</p>
<p style="text-align: center;"><b>6</b></p>	<p style="text-align: center;"><b>Metabolism and Homeostasis</b></p>
<p style="text-align: center;"><b>6.1</b></p> <p>Discuss the metabolic processes that take place in specific organs in the body in the fed and fasting states.</p>	<p>Integration of carbohydrate, protein and lipid metabolism at cellular and tissue or organ level with its significance, Metabolic processes with role of specific organs in fed, fasting and starvation states.</p>

Competency No.	Topics & Subtopics
----------------	--------------------

<p style="text-align: center;"><b>6.2</b></p> <p>Describe and discuss the metabolic processes in which nucleotides are involved.</p>	<p>Important steps in de novo biosynthesis of purine and pyrimidine nucleotides and their regulation, enzymes of the nucleotide biosynthesis that are inhibited by anticancer drugs, salvage pathway for the synthesis of purine nucleotides with its significance, catabolism of purine and pyrimidine nucleotides.</p>
<p style="text-align: center;"><b>6.3</b></p> <p>Describe the common disorders associated with nucleotide metabolism.</p> <p style="text-align: center;"><b>6.4</b></p> <p>Discuss the laboratory results of analytes associated with gout &amp; Lesch-Nyhan syndrome.</p>	<p>Disorder of nucleotide metabolism like gout, Lesch-Nyhan syndrome, orotic aciduria, with diagnostic tests &amp; biochemical mechanism of nutritional &amp; drug therapy.</p> <p>Lab results of analytes related with gout &amp; Lesch-Nyhan syndrome. Levels of uric acid in blood &amp; urine and presence of urate crystals in synovial fluid in gout, levels of uric acid in blood</p>
<p style="text-align: center;"><b>6.5</b></p> <p>Describe the biochemical role of vitamins in the body and explain the manifestations of their deficiency</p>	<p>Sources, biochemical functions, daily requirement and deficiency manifestations of fat soluble vitamins (Vitamin A, D, E &amp; K).</p> <p>Sources, biochemical functions and deficiency manifestations of water soluble vitamins (Thiamine, Riboflavin, Niacin, Pantothenic acid, Pyridoxine, Biotin, Folic acid, Cobalamin and vitamin C)</p>
<p style="text-align: center;"><b>6.6</b></p> <p>Describe the biochemical processes involved in generation of energy in cells.</p>	<p>Electron transport chain, mechanism of oxidative phosphorylation (chemiosmotic theory), substrate level phosphorylation, Uncouplers &amp; Inhibitors of electron transport chain , shuttle systems for transport of extra-mitochondrial NADH</p>
<p style="text-align: center;"><b>6.7</b></p> <p>Describe the processes involved in maintenance of normal pH, water &amp; electrolyte balance of body fluids and the derangements associated with these.</p>	<p>Acids, bases and buffers, mechanism of action of buffer, dietary sources of acids, bases, normal pH of body fluids. Role of blood buffers, respiratory system &amp; kidney in regulation of blood pH.</p> <p>Disorders associated with blood pH (acidosis and alkalosis) &amp; their compensatory mechanisms, anion gap &amp; its clinical importance.</p>



Competency No.	Topics & Subtopics
<p style="text-align: center;"><b>6.8</b></p> <p>Discuss and interpret results of Arterial Blood Gas (ABG) analysis in various disorders.</p>	<p>Total body water and its compartmental distribution, various electrolytes- sodium, potassium and chloride, their distribution and clinical conditions related to their plasma level alterations, maintenance of normal water and electrolyte balance and disorders associated with water and electrolyte imbalance.</p> <p>Interpretation of results of arterial blood gas (ABG) analysis in acidosis and alkalosis.</p>
<p style="text-align: center;"><b>6.9</b></p> <p>Describe the functions of various minerals in the body, their metabolism and homeostasis.</p>	<p>Dietary food sources, daily requirement, biochemical functions, metabolism and homeostasis of: Calcium, phosphorus &amp; magnesium, trace elements (copper, fluoride, iodine, iron, manganese, selenium &amp; zinc)</p>
<p style="text-align: center;"><b>6.10</b></p> <p>Enumerate and describe the disorders associated with mineral metabolism.</p>	<p>Clinical conditions related to plasma level alterations of: Calcium, phosphorus &amp; magnesium Trace elements (copper, fluoride, iodine, iron, manganese, selenium &amp; zinc)</p>
<p style="text-align: center;"><b>6.11</b></p> <p>Describe the functions of heme in the body and describe the processes involved in its metabolism and describe porphyrin metabolism</p>	<p>Structure and functions of hemoglobin, role of 2,3-bisphosphoglycerate (BPG) in oxygen binding and delivery, biosynthesis of heme (iron containing porphyrin), its regulation, functions in the body, disorders of heme biosynthesis (various types of porphyria's), catabolism of heme, various types of jaundice</p>

<p style="text-align: center;"><b>6.12</b></p> <p>Describe the major types of hemoglobin and its derivatives found in the body and their physiological/ pathological relevance.</p>	<p>Types of normal human hemoglobin, types of normal &amp; abnormal derivatives of hemoglobin, various hemoglobinopathies: Sickle cell anemia, Thalassemia</p>
<p style="text-align: center;"><b>Competency No.</b></p>	<p style="text-align: center;"><b>Topics &amp; Subtopics</b></p>
<p style="text-align: center;"><b>6.13</b></p> <p>Describe the functions of the kidney, liver, thyroid and adrenal glands.</p>	<p>1. Functions of liver, disorders&amp; liver function tests</p>
<p style="text-align: center;"><b>6.14</b></p> <p>Describe the tests that are commonly done in clinical practice to assess the functions of these organs (kidney, liver, thyroid and adrenal glands).</p>	<p>2. Functions of kidney, disorders&amp; kidney function tests</p> <p>3. Functions of Thyroid, disorders&amp; thyroid function tests</p> <p>4. Functions of Adrenals , disorders&amp; Adrenal function tests</p>
<p style="text-align: center;"><b>6.15</b></p> <p>Describe the abnormalities of kidney, liver, thyroid and adrenal glands.</p>	
<p style="text-align: center;"><b>7</b></p>	<p><b>Molecular Biology</b></p>
<p style="text-align: center;"><b>7.1</b></p> <p>Describe the structure and functions of DNA and RNA and outline the cell cycle</p>	<p>Structure and functions of nucleotides, biologically important nucleotides and their importance, major types of synthetic analogs of nucleotides (antimetabolites) and their clinical significance, structure and functions of DNA and RNA, Phases of cell cycle</p>

<p style="text-align: center;"><b>7.2</b></p> <p>Describe the processes involved in replication &amp; repair of DNA and the transcription &amp; translation mechanisms.</p>	<p>Replication of DNA in Eukaryotes, inhibitors of DNA replication and different types of repair systems of DNA</p> <p>Transcription in Eukaryotes and posttranscriptional modifications, inhibitors, reverse transcription &amp; its significance</p> <p>Genetic code and wobble hypothesis, Translation in Eukaryotes, inhibitors, chaperons , protein folding and posttranslational modifications</p>
<p style="text-align: center;"><b>7.3</b></p>	<p>Causes and types of genetic mutations with examples.</p> <p>Regulation of Eukaryotic gene expression</p>

<b>Competency No.</b>	<b>Topics &amp; Subtopics</b>
<p>Describe gene mutations and basic mechanism of regulation of gene expression</p> <p style="text-align: center;"><b>7.4</b></p> <p>Describe applications of molecular technologies like Recombinant DNA technology, PCR in the diagnosis and treatment of diseases with genetic basis.</p>	<p>Recombinant DNA technology, restriction endonucleases, process of construction of recombinant DNA and its applications in medicine, DNA library, blot transfer techniques- southern blotting, northern blotting &amp; western blotting, mechanism of polymerase chain reaction and its application in medical diagnosis and treatment of genetic diseases.</p>
<p style="text-align: center;"><b>7.5</b></p> <p>Describe the role of xenobiotics in disease</p>	<p>Mechanisms of biotransformation of xenobiotics &amp; associated diseases.</p>
<p style="text-align: center;"><b>7.6</b></p> <p>Describe the anti-oxidant defense systems in the body.</p>	<p>Enzymatic and non-enzymatic antioxidant defense systems in the body.</p>

<p style="text-align: center;"><b>7.7</b></p> <p>Describe the role of oxidative stress in the pathogenesis of conditions such as cancer, complications of diabetes mellitus and atherosclerosis.</p>	<p>Free radical, biological sources of reactive oxygen species (ROS) and oxidative damage, oxidative stress, roll of oxidative stress in cancer, diabetes mellitus &amp; atherosclerosis.</p>
<p style="text-align: center;"><b>8</b></p>	<p><b>Nutrition</b></p>
<p style="text-align: center;"><b>8.1</b></p> <p>Discuss the importance of various dietary components and explain importance of dietary fiber.</p>	<p>Importance of carbohydrates, lipids, proteins &amp; vitamins, quality of proteins, various types of dietary fibers and their importance in the diet.</p>
<p style="text-align: center;"><b>8.2</b></p> <p>Describe the types and causes of protein energy malnutrition and its effects.</p>	<p>Protein energy malnutrition, Kwashiorkor and Marasmus their causes and effects.</p>

<b>Competency No.</b>	<b>Topics &amp; Subtopics</b>
<p style="text-align: center;"><b>8.3</b></p> <p>Provide dietary advice for optimal health in childhood and adult, in disease conditions like diabetes mellitus, coronary artery disease and in pregnancy.</p>	<p>Balanced diet in adult, in childhood and in pregnancy for optimal health, dietary advice in diabetes mellitus &amp; coronary heart disease</p>
<p style="text-align: center;"><b>8.4</b></p> <p>Describe the causes (including dietary habits), effects and health risks associated with being overweight/ obesity</p>	<p>Causes, effects and health risk associated with overweight/ obesity</p>

<p style="text-align: center;"><b>8.5</b></p> <p>Summarize the nutritional importance of commonly used items of food including fruits and vegetables (macro-molecules &amp; its importance)</p>	<p>Nutritional importance of commonly used items of food like cereals, pulses, eggs, meat, fish, fruits and vegetables and their normal dietary requirements.</p>
<p style="text-align: center;"><b>9</b></p>	<p><b>Extracellular Matrix</b></p>
<p style="text-align: center;"><b>9.1</b></p> <p>List the functions and components of the extracellular matrix (ECM).</p>	<p>Types &amp; functions of the extracellular matrix (ECM), Components and functions of proteoglycans, glycoproteins &amp; major proteins of ECM</p>
<p style="text-align: center;"><b>9.2</b></p> <p>Discuss the involvement of ECM components in health and disease.</p>	<p>Disorders associated with components of ECM like Osteogenesis imperfecta, Marfan's Syndrome , Mucopolysaccharidoses, Scurvy &amp; Menkes Disease</p>
<p style="text-align: center;"><b>9.3</b></p> <p>Describe protein targeting &amp; sorting along with its associated disorders(It is non-core: N)</p>	<p>Types of protein targeting and sorting, disorders due to defects in mitochondrial targeting signals and defects in peroxisomal matrix protein import.</p>
<p style="text-align: center;"><b>10</b></p>	<p><b>Oncogenesis and Immunity</b></p>

Competency No.	Topics & Subtopics
<p style="text-align: center;"><b>10.1</b></p> <p>Describe the cancer initiation, promotion oncogenes &amp; oncogene activation. Also focus on p53 &amp; apoptosis</p>	<p>Characteristics of cancer cell, molecular basis of cancer (carcinogenesis) ,various carcinogens and initiator, promoter of carcinogens, oncogenes and proto-oncogenes, tumor suppressor genes (retinoblastoma, RB and p53), mechanisms of apoptosis in physiologic and pathologic conditions .</p>

<p style="text-align: center;"><b>10.2</b></p> <p>Describe various biochemical tumor markers and the biochemical basis of cancer therapy.</p>	<p>Biochemical tumor markers, biochemical basis of chemotherapy, radiotherapy, hormonal therapy, targeted drug therapy and immunotherapy.</p>
<p style="text-align: center;"><b>10.3</b></p> <p>Describe the cellular and humoral components of the immune system &amp; describe the types and structure of antibody</p>	<p>Cells of the Immune System, types of immune systems (Innate &amp; adaptive), cellular and humoral components of innate and adaptive immune systems, B cell development and the formation of antibodies, types, structure and mechanism of action of antibodies (Immunoglobulins), primary and secondary response</p>
<p style="text-align: center;"><b>10.4</b></p> <p>Describe &amp; discuss innate and adaptive immune responses, self/non-self-recognition and the central role of T-helper cells in immune responses</p>	<p>Innate and adaptive immune systems, immunological memory, T lymphocytes development, role of helper T cells (CD4+ T cells) and cytotoxic T cells/killer cells/CD8+ T cells in immune responses, Brief concept of MHC</p> <p>Disorders – Immunodeficiency, autoimmunity &amp; hypersensitivity.</p>
<p style="text-align: center;"><b>10.5</b></p> <p>Describe antigens and concepts involved in vaccine development.</p>	<p>Antigens, concept involved in vaccine development and their types.</p>
<p style="text-align: center;"><b>11</b></p>	<p><b>Biochemical Laboratory Tests</b></p>
<p style="text-align: center;"><b>11.1</b></p> <p>Describe commonly used laboratory apparatus and equipments, good safe laboratory practice and waste disposal.</p>	<p>Common lab equipments and apparatus like test tubes, pipettes &amp; other glassware , auto pipettes, centrifuge, balances, oven, water bath good safe laboratory practice , management of needle stick injury &amp; latest guidelines of disposal of biomedical waste</p>

<b>Competency No.</b>	<b>Topics &amp; Subtopics</b>
-----------------------	-------------------------------

<p style="text-align: center;"><b>11.2</b></p> <p>Describe the preparation of buffers and estimation of pH.</p>	<p>Preparation of buffer –acidic and alkaline. Measurement of pH paper and pH meter</p>
<p style="text-align: center;"><b>11.3</b></p> <p>Describe the chemical components of normal urine.</p>	<p>Chemical constituents of normal urine</p>
<p style="text-align: center;"><b>11.4 &amp; 11.20</b></p> <p><b>11.4:</b> Perform urine analysis to estimate and determine normal and abnormal constituents.</p> <p><b>11.20:</b> Identify abnormal constituents in urine; interpret the findings and correlate these with pathological states.</p>	<p>Physical characteristics and organic constituents of urine. Collection of random &amp; 24 hour urine sample Urine Report: Physical characteristics and abnormal constituents, urine dipsticks</p> <p>Interpretation of Urine Abnormalities</p>
<p style="text-align: center;"><b>11.5</b></p> <p>Describe screening of urine for inborn errors &amp; describe the use of paper chromatography. Club Paper chromatography of amino acid &amp; TLC from competency no 11.16</p>	<p>Urine: Screening of inborn errors. Paper chromatography for diagnosis of inborn errors</p>
<p style="text-align: center;"><b>11.6</b></p> <p>Describe the principles of colorimetry. (Club spectrophotometry from competency no <b>11.18</b>)</p>	<p>Colorimeter- Principle, Beer and Lambert’s law &amp; applications. Principles of spectrophotometry.</p>
<p style="text-align: center;"><b>11.7,11.8, 11.21 &amp; 11.22</b></p> <p><b>11.7-</b> Demonstrate the estimation of serum creatinine and creatinine clearance</p> <p><b>11.8-</b> Demonstrate estimation of serum proteins, albumin and A:G ratio</p> <p><b>11.21-</b> Demonstrate estimation of glucose, creatinine, urea and total protein in serum.</p> <p><b>11.22-</b> Calculate albumin: globulin A:G ratio and creatinine clearance</p>	<p>Estimation of serum creatinine, urine creatinine and calculation of creatinine clearance and their clinical interpretation.</p> <p>Estimation of serum proteins, albumin and calculation of A/G ratio and their clinical interpretation.</p> <p>Estimation of plasma glucose, serum urea and their clinical interpretation.</p>
<p style="text-align: center;"><b>11.9</b></p>	<p>Estimation of serum total cholesterol and HDL cholesterol, their ratio their clinical interpretation.</p>

<b>Competency No.</b>	<b>Topics &amp; Subtopics</b>
Demonstrate the estimation of serum total cholesterol and HDL cholesterol <p style="text-align: center;"><b>11.10</b></p> Demonstrate the estimation of triglycerides	Estimation of serum triglycerides and their clinical interpretation.
<p style="text-align: center;"><b>11.11</b></p> Demonstrate estimation of calcium and phosphorous	Estimation of serum calcium and phosphorus their clinical interpretation.
<p style="text-align: center;"><b>11.12</b></p> Demonstrate the estimation of serum bilirubin	Estimation of serum bilirubin: Total, direct and indirect, their clinical interpretation.
<p style="text-align: center;"><b>11.13 &amp; 2.2</b></p> <b>11.13-</b> Demonstrate the estimation of SGOT/ SGPT	Estimation of SGOT (AST)/ SGPT(ALT) and their clinical interpretation.
<p style="text-align: center;"><b>11.14</b></p> Demonstrate the estimation of alkaline phosphatase	Estimation of serum ALP and their clinical interpretation.
<p style="text-align: center;"><b>11.15</b></p> Describe & discuss the composition of CSF	Physical characteristics and chemical composition of CSF



<p style="text-align: center;"><b>11.16 &amp; 11.19</b></p> <p><b>11.16-</b> Observe use of commonly used equipment's/techniques in biochemistry laboratory including:</p> <ul style="list-style-type: none"> <li>•pH meter</li> <li>•Paper chromatography of amino acid</li> <li>•Protein electrophoresis</li> <li>•TLC, PAGE</li> <li>•Electrolyte analysis by ISE</li> <li>•ABG analyzer</li> <li>•ELISA</li> <li>•Immunodiffusion</li> <li>•Autoanalyser</li> <li>•Quality control</li> </ul>	<p>Principle, application and working of following lab equipment's/techniques: pH meter, paper chromatography of amino acids, protein electrophoresis, TLC, PAGE, Electrolyte analysis by ISE, ABG analyzer, ELISA, immunodiffusion, auto analyzer, quality control, DNA isolation from blood/tissue</p> <p>(Paper chromatography of amino acid ,TLC clubbed with 11.5 )</p>
---	--

<b>Competency No.</b>	<b>Topics &amp; Subtopics</b>
<p>•DNA isolation from blood/ tissue</p> <p style="text-align: center;"><b>11.19</b></p> <p>Outline the basic principles involved in the functioning of instruments commonly used in a biochemistry laboratory and their applications.</p>	

<p style="text-align: center;"><b>11.17</b></p> <p>Explain the basis and rationale of biochemical tests done in the following conditions:</p> <ul style="list-style-type: none"> <li>- diabetes mellitus,</li> <li>- dyslipidemia,</li> <li>- myocardial infarction,</li> <li>- renal failure, gout,</li> <li>- proteinuria,</li> <li>- nephrotic syndrome,</li> <li>- edema,</li> <li>- jaundice,</li> <li>- liver diseases, pancreatitis, disorders of acid- base balance, thyroid disorders.</li> </ul>	<p>Basis and rationale of biochemical tests required in the following Conditions:</p> <ul style="list-style-type: none"> <li>- Diabetes mellitus-blood &amp; urine glucose, microalbumin, ketone bodies and glycated hemoglobin – (Club with 3.8 &amp; 3.10)</li> <li>- Dyslipidemia-lipid profile (Club with 4.5 &amp; 4.7)</li> <li>- Myocardial infarction –CK, LDH, Troponin (Club with 2.6 &amp; 2.7)</li> <li>- Renal failure &amp; nephrotic syndrome, – BUN, Creatinine, urinary protein, cholesterol (Club with 3.8 &amp; 3.10)</li> <li>- Gout- serum uric acid, synovial fluid analysis (Club with 6.3 &amp; 6.4)</li> <li>- liver diseases &amp; Jaundice- LFTs (Club with 6.1) Pancreatitis- serum amylase and lipase (Club with 2.5&amp; 7 2.7)</li> </ul> <p>Disorder of acid base balance- ABG analysis for pH, pO<sub>2</sub>, O<sub>2</sub> saturation pCO<sub>2</sub>, HCO<sub>3</sub> and base excess (BE) (Club with 6.7,6.8)</p> <ul style="list-style-type: none"> <li>- Thyroid disorder – serum free and total T3 &amp; T4 and serum TSH (Club with 6.1)</li> </ul>
<p style="text-align: center;"><b>11.18</b></p> <p>Discuss the principles of spectrophotometry. <b>(Clubbed with 11.6)</b></p>	<p>Spectrophotometer –principle &amp; use</p>
<p style="text-align: center;"><b>Competency No.</b></p>	<p style="text-align: center;"><b>Topics &amp; Subtopics</b></p>

<p style="text-align: center;"><b>11.19</b></p> <p>Outline the basic principles involved in the functioning of instruments commonly used in a Biochemistry laboratory and their applications. <b>(Clubbed with &amp; 11.6 &amp; 11.16)</b></p>	<p>Instruments commonly used in Biochemistry laboratory &amp; their applications.</p>
<p style="text-align: center;"><b>11.20</b></p> <p>Identify abnormal constituents in urine, interpret the findings and correlate these with pathological states. <b>(Clubbed with 11.4)</b></p>	
<p style="text-align: center;"><b>11.21</b></p> <p>Demonstrate estimation of glucose, creatinine, urea and total protein in serum. <b>(Clubbed with 11.7, 11.8)</b></p>	
<p style="text-align: center;"><b>11.22</b></p> <p>Calculate albumin: globulin (A/G)ratio and creatinine clearance <b>(Clubbed with 11.7, 11.8)</b></p>	
<p style="text-align: center;"><b>11.23</b></p> <p>Calculate energy content of different food items, identify food items with high and low glycemic index and explain the importance of these in the diet.</p>	<p>Energy contents of lipids, carbohydrates &amp; proteins in common food items.</p>
<p style="text-align: center;"><b>11.24</b></p> <p>Enumerate advantages and/or disadvantages of use of unsaturated, saturated and trans fats in food.</p>	<p>Advantages of unsaturated fats, disadvantages of saturated and trans fats in food</p>

Paper wise distribution of topics  
Year: First MBBS Subject: Biochemistry

Paper	Section	Topics	Competency nos. BI
I	A	MCQs on all topics of the paper I	
	B & C	Basic Biochemistry	1.1
		Enzymes	2.1-2.7
		Chemistry & metabolism of carbohydrates	3.1-3.10
		Chemistry & metabolism of lipids	4.1-4.7
		Biological oxidation	6.6
		Xenobiotics	7.5
		Antioxidants & defence system	7.6-7.7
		Nutrition	8.1-8.5
		Extracellular matrix	9.1-9.3
		Oncology , oncogenesis & immunity	10.1-10.5
		Biomedical waste	11.1
		Physical characteristics and chemical composition of CSF	11.15
		Energy contents of lipids, carbohydrates & proteins in common food items, Advantages of unsaturated fats. Disadvantages of saturated and trans fats in food	11.23 & 11.24
	AETCOM- 1.4		
For long answer question and scenario based / application questions, topics will not be repeated.			
II	A	MCQs on all topics of the paper II	
	B & C	Chemistry & metabolism of proteins	5.1-5.5
		Integration & starvation	6.1
		Nucleic acid metabolism	6.2-6.4
		Vitamins	6.5
		Water electrolyte balance & acid base balance	6.7-6.8
		Mineral metabolism	6.9-6.10
		Haemoglobin chemistry and metabolism	6.11-6.12

	Organ function test	6.13-6.15
	Molecular biology	7.1-7.3
	Genetic engineering	7.4
	Urine: Screening of inborn errors.	11.5
	Principle, application and working of following lab equipments/techniques: pH meter, paper chromatography of amino acids, protein electrophoresis, TLC, PAGE, Electrolyte analysis by ISE, ABG analyzer, ELISA, immunodiffusion, auto analyzer, quality control, DNA isolation from blood/tissue	11.16
For long answer question and scenario based / application questions, topics will not be repeated.		

## Internal Assessment

### Biochemisry

**Applicable w.e.f August 2019 onwards examination for batches admitted from June 2019 onwards**

S	I-Exam (December)			II-Exam (March )		
	Theory	Practical (Including 05 marks For Journals And Log Book)	Total Marks	Theory	Practical (Including 05 marks For Journals And Log Book)	Total Marks
1	100	50	150	100	50	150

Preliminary Examinations			Remedial internal assessment examination for <b>Non - eligible</b> students		
III-Exam (July)			October		
Theory	Practical Including 10 Marks for Journal & Log Book	Total Marks	Theory	Practical Including 10 Marks for Journal & Log Book	Total Marks
200	100	300	200	100	300

1. There will be 3 internal assessment examinations in the academic year. The structure of Preliminary examinations should be similar to the structure of University examination.
2. There will be only one additional examination for absent students (due to genuine reason) after approval by the Committee Constituted for the same. It should be taken after preliminary examination and before submission of internal assessment marks to the University.
3. First internal assessment examination will be held in December, second internal assessment examination will be held in March and third internal assessment examination will be held in July.
4. Internal assessment marks for theory and practical will be converted to out of 40. Internal assessment marks, after Conversion, should be submitted to university by 7<sup>th</sup> of August.
5. The student must secure at least 50% marks for total marks (combined in theory and practical / clinical: not less than 40% marks in theory and practical separately) assigned for internal assessment in a particular subject in order to be eligible for appearing at the final university examination of that subject. Internal assessment marks will reflect as separate head of passing at the summative examination.
6. **Remedial internal assessment examination for Non - eligible students:** Student who were not eligible due to less than 50% combined or less than 40% in any theory or practical, will re appear as repeater student for Prelim exam which will be conducted before Supplementary Exam. His/her internal assessment will be calculated on the basis of this Examination marks only. Students who will not be eligible in this Examination will appear with regular batch as repeater student.
7. The internal assessment marks of the remedial examination alone shall be considered and converted into out of 40.

### 8. Conversion Formula for calculation of marks in internal assessment examinations

	First IA	Second IA	Third IA (Prelim)	Total	Internal assessment marks: Conversion formula (out of 40)	Eligibility to appear for final University examination (after conversion out of 40) (40% Separately in Theory and Practical, 50% Combined)	
Theory	100	100	200	400	$\frac{\text{Total marks obtained}}{10}$	16 (minimum)	Total of Theory + Practical <u>Must</u> be 40.
Practical	50	50	100	200	$\frac{\text{Total marks obtained}}{5}$	16 (minimum)	

### 9. Conversion formula for calculation of marks in Remedial internal assessment examination

	Remedial Exam (Prelim)	Int. Assess. marks conversion formula (out of 40)	Eligibility to appear for Supplementary Exam. (after conversion out of 40 ) (40% Separately in Theory and Practical, 50% Combined)	
Theory	200	$\frac{\text{Total marks obtained}}{5}$	16 (minimum)	Total of Theory + Practical <u>Must</u> be 40.
Practical	100	$\frac{\text{Total marks obtained}}{2.5}$	16 (minimum)	

While preparing Final Marks of Internal Assessment, the rounding-off marks shall done as illustrated in following table

Internal Assessment Marks	Final rounded marks
15.01 to 15.49	15
15.50 to 15.99	16



**First Year MBBS Practical Mark's Structure Internal Assessment Examinations I & II (Applicable for batch admitted in M.B.B.S Course from Academic Year 2019-20 & onwards)**

<b>Biochemistry</b>						
<b>Practical</b>					<b>Oral/Viva</b>	<b>Total</b>
<b>Seat No.</b>	<b>Quantitative Experiment</b>	<b>Quantitative Experiment/Urine organic/Urine Report/Quality Control/Interpolation of lab Report /Interpolation of Special Technique</b>	<b>Spots</b>	<b>Journal/ Logbook</b>		
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>
<b>Max. Marks</b>	<b>15</b>	<b>15</b>	<b>5</b>	<b>5</b>	<b>10</b>	<b>50</b>

## First Year MBBS Practical Marks Structure (Prelim)

(Applicable w.e.f August 2019 onwards examination for batches admitted from June 2019 onwards)

### Biochemistry

Seat No	Case Based Quantitative Estimation	Urine Report/ Quantitative estimation	Quality Control	Interpretation of lab Reports & special techniques (Minimum 2 Interpretation)	Spots	Journal & Logbook	Practical Total	Viva Voce/ Oral	Practical/Viva Total Marks
	A	B	C	D	E	F	G	H	I
Max. Marks	25	15	10	20	10	10	90	10	100

*(Please Note - The above examination pattern will be applicable to the students admitted from Academic Year 2019-20 and onwards, which is informed to all Medical Colleges vide University letter No MUHS /X-1 /UG /1692 /2020 Date: 28/02/2020)*

**First Year MBBS Practical Marks Structure (MUHS Exam)**  
 (Applicable w.e.f August 2019 onwards examination for batches admitted from June 2019 onwards)  
**Biochemistry**

Seat No	Case Based Quantitative Estimation	Urine Report/ Quantitative estimation	Quality Control	Interpretation of lab Reports & special techniques (Minimum 2 Interpretation)	Spots	Practical Total	Viva Voce/ Oral	Practical/Viva Total Marks
	A	B	C	D	E	F	G	H
Max. Marks	25	15	10	20	10	80	20	100

*(Please Note - The above examination pattern will be applicable to the students admitted from Academic Year 2019-20 and onwards, which is informed to all Medical Colleges vide University letter No MUHS /X-1 /UG /1692 /2020 Date: 28/02/2020)*

**MAHARASHTRA UNIVERSITY OF HEALTH SCIENCES, NASHIK**  
**FORMAT / SKELETON OF QUESTION PAPER**

1. Course and Year : <b>First MBBS</b> <i>(applicable w.e.f. Sept. 2020&amp; onwards examinations)</i>	2. Subject Code : <b>Appendix - a</b>
3. Subject (PSP) : <b>Anatomy / Physiology / Biochemistry</b> (TT) :	
4. Paper : <b>I</b>	5. Total Marks : <b>100</b>
6. Total Time : <b>3 Hrs.</b>	7. Remu. (PS) : <b>Rs. 300/-</b>
	8. Remu. (PM) : <b>Rs. 350/-</b>
9. Web Pattern : [ ]	10. Web Skeleton : [ ]
11. Web Syllabus : [ ]	12. Web Old QP : [ ]

**Instructions:**

**SECTION "A" MCQ**

- 1) Fill ● (dark) the appropriate empty circle below the question number once only.
- 2) Use **blue/black** ball point pen only.
- 3) Each Question carries **One mark**.
- 4) A student will not be allotted any marks if he/she overwrites, strikes out or puts white ink on the circle once filled (darkened)
- 5) Do not write anything on the blank portion of the question paper if written anything, such type of act will be considered as an attempt to resort to unfair means.

**SECTION "A" MCQ (20 Marks)**

- Q1. Multiple Choice Questions (Total 20 MCQ of One mark each) **(4 MCQ Should be clinical application based)** (20x1=20)
- a) b) c) d) e) f) g) h) i) j)  
k) l) m) n) o) p) q) r) s) t)

**SECTION "B"**

**Instructions:**

- 1) Use **blue/black** ball point pen only.
- 2) **Do not** write anything on the **blank portion of the question paper**. If written anything, such type of act will be considered as an attempt to resort to unfair means.
- 3) **All questions are compulsory**.
- 4) The number to the **right** indicates **full marks**.
- 5) Draw diagrams **wherever** necessary.
- 6) Distribution of syllabus in Question Paper is only meant to cover entire syllabus within the stipulated frame. The Question paper pattern is a mere guideline. Questions can be asked from any paper's syllabus into any question paper. Students cannot claim that the Question is out of syllabus. As It is only for the placement sake, the distribution has been done.
- 7) Use a common answerbook for all sections.

**SECTION "B" (80 Marks)**

2. Brief answer questions (Any Ten out of Eleven) (10x 2= 20)  
a) b) c) d) e) f) g) h) i) j) k)
3. Short Answer Questions (Any Eight out of Nine) (8x5= 40)  
One SAQ has to be on AETCOM Module **(For Anatomy 1.1, 1.5, For Physiology 1.2.,1.3&For Biochemistry, 1.4) &** Minimum 2 SAQs should be Case Based Questions/ Clinically applied Questions.  
a) b) c) d) e) f) g) h) i)
4. Long Answer Questions (Any Two out of Three) (2x 10= 20)  
a) b) c)

**Note: All questions should be structured .Wherever necessary; split up of marks should be specified.**

**MAHARASHTRA UNIVERSITY OF HEALTH SCIENCES, NASHIK**  
**FORMAT / SKELETON OF QUESTION PAPER**

1. Course and Year : <b>First MBBS</b> <i>(applicable w.e.f. Sept. 2020&amp; onwards examinations)</i>	2. Subject Code : <b>Appendix - a</b>		
3. Subject (PSP) : <b>Anatomy / Physiology / Biochemistry</b> (TT) :			
4. Paper : : <b>II</b>	5. Total Marks : <b>100</b>	6. Total Time : <b>3 Hrs.</b>	7. Remu. (PS) : <b>Rs. 300/-</b>
			8. Remu. (PM) : <b>Rs. 350/-</b>
9. Web Pattern : [ ]	10. Web Skeleton : [ ]	11. Web Syllabus : [ ]	12. Web Old QP : [ ]

**Instructions:**

**SECTION "A" MCQ**

- 1) Fill ● (dark) the appropriate empty circle below the question number once only.
- 2) Use **blue/black** ball point pen only.
- 3) Each Question carries **One mark**.
- 4) A student will not be allotted any marks if he/she overwrites, strikes out or puts white ink on the circle once filled (darkened)
- 5) Do not write anything on the blank portion of the question paper if written anything, such type of act will be considered as an attempt to resort to unfair means.

**SECTION "A" MCQ (20 Marks)**

1. Multiple Choice Questions (Total 20 MCQ of One mark each) **(4 MCQ Should be clinical application based)** (20x1=20)
- a) b) c) d) e) f) g) h) i) j)  
k) l) m) n) o) p) q) r) s) t)

**SECTION "B"**

- Instructions:**
- 1) Use **blue/black** ball point pen only.
  - 2) **Do not** write anything on the **blank portion of the question paper**. If written anything, such type of act will be considered as an attempt to resort to unfair means.
  - 3) **All questions are compulsory.**
  - 4) The number to the **right** indicates **full marks**.
  - 5) Draw diagrams **wherever necessary**.
  - 6) Distribution of syllabus in Question Paper is only meant to cover entire syllabus within the stipulated frame. The Question paper pattern is a mere guideline. Questions can be asked from any paper's syllabus into any question paper. Students cannot claim that the Question is out of syllabus. As It is only for the placement sake, the distribution has been done.
  - 7) Use a common answer book for all sections.

**SECTION "B" (80 Marks)**

2. Brief answer questions (Any Ten out of Eleven) (10x 2= 20)  
a) b) c) d) e) f) g) h) i) j) k)
3. Short Answer Questions (Any Eight out of Nine) (8x5= 40)  
Minimum 2 SAQs should be Case Based Questions/ Clinically applied Questions.
4. a) b) c) d) e) f) g) h) i) (2x 10= 20)  
Long Answer Questions (Any Two out of Three)  
a) b) c)

**Note: All questions should be structured .Wherever necessary, split up of marks should be specified.**



**MAHARASHTRA UNIVERSITY OF HEALTH SCIENCES, NASHIK**

**MARKLIST FOR PRACTICAL / ORAL / VIVA VOCE**

**(Summer / Winter – 20...Exam (MBBS UG Courses)**

**(Applicable for batch admitted in M.B.B.S Course from Academic Year 2019-20 & onwards)**

**Course : FIRST MBBS**

**Subject : Biochemistry**

**CENTRE :**

**Marks : (Practical = Practical/Clinical + Viva ) Min. 50 Max. 100**

**Date : / /20**

**Batch :**

Practical							Oral/Viva	Total
Seat No.	Case Based Quantitative Estimation	Urine Report/ Quantitative estimation	Quality Control	Interpretation of lab Report & special techniques ( Minimum 2 interpretations)	Spots	Practical (Total)	Viva Voce/Oral Total	Practical/Viva Total Marks
	A	B	C	D	E	F	G	H
Max. Marks	25	15	10	20	10	80	20	100

**Note :** Both Examiners should jointly conduct practical examination for each student.  
 Verified above entries from Answerbooks and we hereby certify that the marks entered against each Seat Number are found correct.

NAME OF EXAMINER		COLLEGE	SIGNATURE WITH DATE	
1			Convenor	
2			Internal	
3			External	
4			External	

**BOOKS RECOMMENDED:****TEXT BOOKS ;**

1. Medical Biochemistry - U.Satyanarayan.
2. Biochemistry for Medical students by D.M.Vasudevan & Shree Kumari.
3. Medical Biochemistry by M.N. Chatterjea and Rana Shinde.
4. Text Book of Medical Biochemistry by Ramakrishnan, Prasannan & Rajan.
5. Medical Biochemistry by Debajyoti Das.
6. Biochemistry by A.C.Deb.

**REFERENCE BOOKS:**

1. Biochemistry by Pankaja Naik
2. Harper's Biochemistry.
3. Medical Biochemistry by N.V.Bhagwan.
4. Biochemistry by L.Stryer.
5. Biochemistry by Orten & Neuhans.
6. Text Book of Biochemistry for Medical Student-8<sup>th</sup> Edition-16 By- DM Vasudevan