

Teaching & Evaluation Scheme: Biochemistry

Semester/Year: First Year M.B.B.S.

Program Name: Bachelor of Medicine and Bachelor of Surgery

Effective from Academic Year: 2019-2020

Program Code: MB01

Course Code	Course Name	Hrs/Week			UA		IA		Total	
		L	P	Total	Max	Min	Max	Min	Max	Min
1BI101	Biochemistry-I	2	-	2	100	40	-	-	200	100
1BI102	Biochemistry-II	2	-	2	100	40	-	-		
1BI103	Biochemistry Practical	-	9	9	80	-	-	-	100	50
1BI104	Biochemistry Viva	-	-	-	20	-	-	-		
1BI105	Biochemistry IA Theory	-	-	-	-	-	100	40	200	100
1BI106	Biochemistry IA Practical	-	-	-	-	-	100	40		

SYLLABUS- THEORY AND PRACTICAL (BIOCHEMISTRY)

As per the guidelines suggested by MET cell of MCI, syllabus is divided into three heads namely must know, desirable to know and nice to know topics:

1. Must Know

Introduction: Scope of Biochemistry, Biotechnology, Molecular Biology, Biochemical Concept of Health and Disease

Biochemical Morphology of the Eukaryotic cell (Molecular and functional organization of cell and cellular organelles): Composition, functions and structure of cell membrane, Transport systems across the cell membrane and their mechanism, membrane receptors, Molecular and functional organization of sub-cellular organelles.

Chemistry of Carbohydrates: Definition, classification and importance of carbohydrates; chemistry, properties and functions of monosaccharides, disaccharides and polysaccharides; sugar derivatives and their biological importance; location, composition and functions of Glycosaminoglycans (mucopolysaccharides) and disorders.

Chemistry of Amino Acids and Proteins: Classification and properties of amino acids , biologically important peptides , classification , properties and functions of proteins , structural organization of proteins (with reference to hemoglobin, insulin and collagen). Plasma proteins – functions and clinical significance of various fractions, methods of separation (only principle). Acute phase proteins.

Chemistry and functions of Nucleic acids, Molecular Biology : Concept of nucleoside & nucleotide, Biologically important free nucleotides, Structure of DNA and RNAs , genetic code , DNA replication, Transcription , post – transcriptional processing , Translation, Post translational modifications ; inhibitors of protein biosynthesis. Molecular mechanism of gene expression & its regulation, Mutations , mutagens. Rb protein, p53, Apoptosis.

Chemistry of Lipids: Classification of lipids, Definition, distribution, classification, properties and function of fatty acids, triglycerides, phospholipids, sterols & others compound lipids, Structure, properties and functions of cholesterol.

Enzymology: Classification, properties and mechanism of enzyme action, Specificity, regulation (repression & induction) and inhibition of enzyme action; factors affecting enzyme activity, K_m value and its significance (derivation not required and no details of enzyme kinetics). Isoenzymes – definition and separation. Clinical importance (diagnostic, therapeutic and analytical) of enzymes and isoenzymes.

Bioenergetics – Electron transport chain: General concept of oxidation and reduction. Role of enzymes and coenzymes, structure of mitochondrion and organization of electron transport chain, oxidative phosphorylation, inhibitors and uncouplers. High energy compounds. Concept of substrate level phosphorylation.

Chemistry and Metabolism of Haemoglobin: Structure and functions of Porphyrin and Hemoglobin, Biosynthesis, catabolism and regulation of heme. Fate of bilirubin, Types of jaundice, porphyrias (in brief), types of normal and abnormal haemoglobin (HbS, Thalassaemia), derivatives of haemoglobin.

Vitamins: classification, sources, chemistry (in brief), active forms, Biochemical role, deficiency manifestations, recommended daily allowance (RDA) of fat soluble and water soluble vitamins. Hypervitaminosis.

Nutrition: Balance diet, quality of dietary protein, nitrogen balance, BMR, SDA, RQ, Nutritional importance of carbohydrates, proteins & lipids; Dietary fibre, Glycemic index, Assessment of nutritional value of proteins, Protein - energy malnutrition – Kwashiorkar and Marasmus.

Carbohydrate Metabolism: Biochemical aspects of digestion and absorption of carbohydrates. Glycolysis & its regulation; Rapaport Leubering cycle, TCA Cycle & its regulation, Cori's cycle, Gluconeogenesis, Hexose Monophosphate Shunt (HMP) pathway and its significance; Uronic acid pathway;

Biosynthesis & catabolism of Glycogen; Metabolism of Galactose and Galactosemia, Metabolism of Fructose, Sorbitol pathway ; Regulation of blood glucose level, Hormonal control, GTT, Glycosuria, Inborn errors of carbohydrate metabolism. Biochemistry of diabetes mellitus.

Amino acids and Protein Metabolism: Biochemical aspects of digestion and absorption of proteins. Fate of amino acids in the body - Oxidative & non-oxidative deamination; Transamination, Transamidination, decarboxylation. Ammonia toxicity & Fate of ammonia – urea cycle, Disorders of urea cycle.

Metabolism of individual amino acids – Glycine, Phenylalanine, Tyrosine, Tryptophan, sulphur containing amino acids and their inborn errors.

Lipid Metabolism: Biochemical aspects of digestion and absorption of lipids. Beta oxidation of fatty acids and its regulation, Biosynthesis of fatty acids and its regulation, Biosynthesis and transport of cholesterol and its regulation, catabolism of cholesterol, Metabolism of adipose tissue – lipogenesis & lipolysis, fatty liver & lipotropic factors, Ketogenesis, ketolysis & ketosis; Metabolism of plasma lipoproteins, Alcohol metabolism, inborn errors of lipid metabolism, Atherosclerosis.

Integration of metabolisms: Metabolic interrelationship of carbohydrates, lipids and protein metabolism. Metabolism in starvation.

Metabolism of Purines & pyrimidines: Biosynthesis of purines – sources of carbon & nitrogen of purine ring, conversion of IMP to GMP & AMP and regulatory steps only. Biosynthesis of pyrimidines & its regulation, salvage pathway, catabolism of purines & pyrimidines; Gout, Lesch – Nyhan syndrome, Orotic Aciduria.

Mineral Metabolism: sources, absorption, transport, functions, dietary requirement, excretion, deficiency manifestations (as applicable) of calcium, phosphorus, magnesium, Iron, Iodine, copper, sodium, potassium, chloride & Trace elements – manganese, selenium, zinc & fluoride. Role of vitamins & hormones in regulation of blood calcium level.

Hormones: General characteristics, classification, mechanism of hormone action, second messengers and their role.

Water and electrolyte balance, Body fluids: Distribution & composition. Water & electrolyte balance /imbalance in health & disease.

Acid - Base balance & pH: Acids & bases, Henderson – Hasselbalch equation, buffers, buffers of body fluids, Acid – base balance & pH homeostasis, Metabolic acidosis & alkalosis; Respiratory acidosis & alkalosis.

Organ Function Tests: Liver function tests; Kidney function tests and thyroid function tests; Cardiac profile.

Biotransformation (detoxification mechanism): Phase I reactions – oxidation, reduction & hydrolysis; Phase II reactions – conjugation.

2. Desirable to know

Genetic Engineering: recombinant DNA technology, restriction endonuclease, plasmids, chimeric molecule, applications of recombinant DNA technology in relation to medicine.

Molecular Biology Techniques: *Principle and applications* of DNA hybridization techniques, southern blot, northern blot, western blot, restriction length polymorphism (RFLP), DNA finger printing technique, polymerase chain reaction (PCR).

Molecular concept of body defence and their applications: Immunoglobulins: structure & functions. Free Radicals: Definition, generation, mode of action, damage done to biomolecules, Lipid peroxidation, free radical scavenging systems – enzymatic & non - enzymatic antioxidants , Role of free radicals in disease process.

Radioisotopes: Radiations, units of radioactivity, therapeutic and diagnostic uses of radioisotopes. Biological effects of radiations, Radiation hazards.

Biochemistry of cancer: Carcinogens, oncogenes, onco-suppressor genes, antimutagens, mechanism of carcinogenesis, tumor markers.

3. Nice to know

Environmental Biochemistry: Chemical hazards; air, water and noise pollution, Heavy metal poisons.

Biochemistry of AIDS: Transmission, Natural course of the disease, HIV genes and gene products, Immunology of AIDS, laboratory analysis anti – HIV drugs.

Advanced Techniques (LCD Topics): *Principle and applications of* - Electrophoresis, Chromatography, Colorimeter, Spectrophotometer, Flame photometer, pH meter and advanced techniques (RIA etc).

Curriculum for Practical Training in Biochemistry 1st M.B.B.S

Biochemistry practical's are designed to enable the students to understand the basic aspects of normal and abnormal conditions and interpretation of the investigations so as to help in clinical screening and diagnosis. Practical will be followed by the discussion on the theoretical concepts of disease, different techniques employed and instrumentation.

SYLLABUS FOR PRACTICAL

- 1) Tests for monosaccharides.
- 2) Tests for disaccharides.
- 3) Tests for polysaccharides.
- 4) Colour reactions of Proteins.
- 5) Precipitation reactions of proteins.
- 6) Estimation of plasma glucose.
- 7) Estimation of plasma urea.
- 8) Estimation of serum uric acid.
- 9) Estimation of serum creatinine.
- 10) Estimation of urine creatinine.
- 11) Estimation of serum total protein & albumin and calculation of A/G ratio.
- 12) Estimation of serum cholesterol.
- 13) Estimation of serum inorganic phosphorus.
- 14) Determination of serum amylase activity.
- 15) Normal urine: Physical characteristics and composition - organic & inorganic constituents.
- 16) Urine report: Physical characteristics and abnormal constituents.
- 17) C.S.F. – estimation of glucose.
- 18) C.S.F. – estimation of proteins.

Lecture cum Demonstration Topics.

- 1) Glucose tolerance test
- 2) pH meter.
- 3) Beer – Lambert's Law. Colorimeter, Spectrophotometer, Semi-automatic and automatic analyzer.
- 4) Electrophoresis.
- 5) Chromatography.

- 6) Cardiac profile
- 7) Diabetic profile
- 8) Lipid profile
- 9) Liver profile
- 10) Renal profile
- 11) Specialized techniques
- 12) Discussion of normal biochemical values of indices and their interpretation-interpretative

Syllabus Based on Competency Table published by Medical Council of India

Subject: Biochemistry

Year: First MBBS

Competency No.	Topics & Subtopics
1	Basic Biochemistry
1.1 Describe the molecular and functional organization of a cell and its subcellular components.	Molecular and functional organization of cell and its subcellular components
2	Enzymes
2.1 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
2.2 Observe the estimation of SGOT & SGPT	Estimation of SGOT (AST)& SGPT (ALT) with its normal range and clinical significance.
2.3	Mechanism of enzyme action, factors affecting enzyme activity, brief concept of enzyme

Describe and explain the basic principles of enzyme activity	kinetics with special reference to $V_{\max}$ & k_m .
2.4	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	
2.5 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
2.6 Discuss use of enzymes in laboratory investigations (Enzyme-based assays)	Analytical uses of Enzymes in laboratory investigations (enzyme based assays)
2.7 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
3	Chemistry & Metabolism of Carbohydrates
3.1 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
3.2 Describe the processes involved in digestion and assimilation of carbohydrates and storage. 3.3	Digestion & absorption, transport and storage of carbohydrates, Lactose intolerance and sucrase deficiency disorders

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

3.8 & 3.10 3.8: Discuss and interpret laboratory results of analytes associated with metabolism of carbohydrates. (to be clubbed with comp no 11.17- Diabetes Mellitus) 3.10 Interpret the results of blood glucose levels and other Laboratory investigations related to disorders of carbohydrate metabolism.	Interpretation of the results of blood glucose, Glycated hemoglobin & GTT as per WHO guidelines in Diabetes mellitus including gestational diabetes and other laboratory investigation like urinary glucose, urinary ketone bodies. Interpretation of the results of blood & urinary galactose levels in galactosemia. Interpretation of blood G6PD levels
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Competency No.	Topics & Subtopics
3.9 Discuss the mechanism and significance of blood glucose regulation in health and disease.	Regulation of blood glucose in fed and fasting state in normal health & changes in diabetes mellitus.
4	Chemistry & Metabolism of Lipids
4.1 Describe and discuss main classes of lipids (Essential/non-essential fatty acids, cholesterol and hormonal steroids, triglycerides, major phospholipids and sphingolipids) relevant to human system and their major functions.	Definition & classification of lipids including classification of fatty acids, their nomenclature, numbering, functions & biological importance of various lipids like fatty acids, cholesterol , hormonal steroids, triglycerides, major phospholipids and sphingolipids
4.2 Describe the processes involved in digestion and absorption of dietary lipids and also the key features of their metabolism	Digestion, absorption and transport of lipids along with abnormalities like lipid malabsorption. Metabolism of fatty acids (β-oxidation of even and odd carbon fatty acids), regulation, energetics and disorders associated with oxidation of fatty acids, Formation & fate of ketone bodies, its significance, regulation and associated disorders like ketosis. In brief de novo fatty acid biosynthesis- site & organs, precursors, enzyme complex,

product formed & regulatory steps.

Biosynthesis of triacylglycerol and fate of triacylglycerol formed in liver & adipose tissue, its significance and regulation, Metabolic role of adipose tissue and disorders of lipid transport and storage like fatty liver.

In brief Cholesterol biosynthesis- site & organs, precursors, key enzymes, product formed & regulatory step, metabolic fate & excretion

Competency No.	Topics & Subtopics
4.3 Explain the regulation of lipoprotein metabolism & associated disorders.	Metabolism of various lipoproteins and hyperlipoproteinemia's, hypolipoproteinemias- abetalipoproteinemias & Tangiers disease.
4.4 Describe the structure and functions of lipoproteins, their functions, interrelations & relations with atherosclerosis	Classification structure and functions of lipoproteins- (To be clubbed with 4.1) Metabolic interrelationship between various lipoproteins, Role of lipoproteins in transport of cholesterol and reverse cholesterol transport, atherosclerosis- (To be clubbed with 4.3)
4.5 & 4.7 Interpret laboratory results of analytes associated with metabolism of lipids	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.
4.6 Describe the therapeutic uses of prostaglandins and inhibitors of eicosanoid synthesis.	Various eicosanoid classes (prostaglandins, leukotrienes & thromboxanes), their functions. Key features of synthesis of eicosanoids and inhibitors of eicosanoid synthesis, therapeutic uses of prostaglandins
4.7 Interpret laboratory results of analytes associated with	Same as 4.5

metabolism of lipids.

5

Chemistry and Metabolism of Proteins

5.1

Describe and discuss structural organization of proteins.

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 & weak bonds with examples and clinical significance.

Competency No.	Topics & Subtopics
5.2 Describe and discuss functions of proteins and structure-function relationships in relevant areas e.g. hemoglobin and selected hemoglobinopathies	Definition, various classifications with examples and functions of proteins, plasma proteins, structure - function relationship of proteins like myoglobin, normal & abnormal hemoglobin
5.3 Describe the digestion and absorption of dietary proteins.	Digestion, absorption and transport of dietary proteins with related disorders like Hartnup disease, cystinuria & glycinuria.
5.4 Describe common disorders associated with protein metabolism.	Role of transamination & deamination reactions in metabolism of amino acids in the formation of ammonia with their clinical significance. Transport of ammonia, pathway of urea cycle, its significance, regulation and metabolic disorders associated with urea cycle. Metabolic pathways for Glycine, Phenylalanine & Tyrosine, Sulphur containing amino acids (Methionine, Cysteine & Cystine) and branch chain amino acids (Valine, Isoleucine & Leucine), their role in biosynthesis of variety of specialized biomolecules, associated metabolic disorders For Tryptophan- Only important biomolecules formed & clinical significance.
5.5 Interpret laboratory results of analytes associated with	Interpret laboratory results of protein metabolism for example: Levels of various metabolites in blood or urine in metabolic disorders like- urea cycle

metabolism of proteins.	disorders, Phenylketonuria, Tyrosinemia, Alkaptonuria, Hartnups disease, MSUD, cystinuria & homocystinuria
6	Metabolism and Homeostasis
6.1 Discuss the metabolic processes that take place in specific organs in the body in the fed and fasting states.	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.

Competency No.	Topics & Subtopics
6.2 Describe and discuss the metabolic processes in which nucleotides are involved.	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.
6.3 Describe the common disorders associated with nucleotide metabolism.	Disorder of nucleotide metabolism like gout, Lesch-Nyhan syndrome, orotic aciduria, with diagnostic tests & biochemical mechanism of nutritional & drug therapy.
6.4 Discuss the laboratory results of analytes associated with gout & Lesch-Nyhan syndrome.	Lab results of analytes related with gout & Lesch-Nyhan syndrome. Levels of uric acid in blood & urine and presence of urate crystals in synovial fluid in gout, levels of uric acid in blood
6.5 Describe the biochemical role of vitamins in the body and explain the manifestations of their deficiency	Sources, biochemical functions, daily requirement and deficiency manifestations of fat soluble vitamins (Vitamin A, D, E & K). Sources, biochemical functions and deficiency manifestations of water soluble vitamins (Thiamine, Riboflavin, Niacin, Pantothenic acid, Pyridoxine, Biotin, Folic acid, Cobalamin and vitamin C)
6.6	Electron transport chain, mechanism of oxidative phosphorylation (chemiosmotic

Describe the biochemical processes involved in generation of energy in cells.	theory), substrate level phosphorylation, Uncouplers & Inhibitors of electron transport chain , shuttle systems for transport of extra-mitochondrial NADH
6.7 Describe the processes involved in maintenance of normal pH, water & electrolyte balance of body fluids and the derangements associated with these.	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 & kidney in regulation of blood pH. Disorders associated with blood pH (acidosis and alkalosis) & their compensatory mechanisms, anion gap & its clinical importance.

Competency No.	Topics & Subtopics
	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.
6.8 Discuss and interpret results of Arterial Blood Gas (ABG) analysis in various disorders.	Interpretation of results of arterial blood gas (ABG) analysis in acidosis and alkalosis.
6.9 Describe the functions of various minerals in the body, their metabolism and homeostasis.	Dietary food sources, daily requirement, biochemical functions, metabolism and homeostasis of: Calcium, phosphorus & magnesium, trace elements (copper, fluoride, iodine, iron, manganese, selenium & zinc)
6.10 Enumerate and describe the disorders associated with mineral metabolism.	Clinical conditions related to plasma level alterations of: Calcium, phosphorus & magnesium Trace elements (copper, fluoride, iodine, iron, manganese, selenium & zinc)
6.11 Describe the functions of heme in the body and describe the processes involved in its metabolism and describe porphyrin	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),

metabolism	catabolism of heme, various types of jaundice
6.12 Describe the major types of hemoglobin and its derivatives found in the body and their physiological/ pathological relevance.	Types of normal human hemoglobin, types of normal & abnormal derivatives of hemoglobin, various hemoglobinopathies: Sickle cell anemia, Thalassemia

Competency No.	Topics & Subtopics
6.13 Describe the functions of the kidney, liver, thyroid and adrenal glands.	1.Functions of liver, disorders& liver function tests 2. Functions of kidney, disorders& kidney function tests 3.Functions of Thyroid, disorders& thyroid function tests 4.Functions of Adrenals , disorders& Adrenal function tests
6.14 Describe the tests that are commonly done in clinical practice to assess the functions of these organs (kidney, liver, thyroid and adrenal glands).	
6.15 Describe the abnormalities of kidney, liver, thyroid and adrenal glands.	
7	Molecular Biology
7.1 Describe the structure and functions of DNA and RNA and outline the cell cycle	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
7.2	Replication of DNA in Eukaryotes, inhibitors of DNA replication and different types of

Describe the processes involved in replication & repair of DNA and the transcription & translation mechanisms.	repair systems of DNA Transcription in Eukaryotes and posttranscriptional modifications, inhibitors, reverse transcription & its significance Genetic code and wobble hypothesis, Translation in Eukaryotes, inhibitors, chaperons , protein folding and posttranslational modifications
7.3	Causes and types of genetic mutations with examples. Regulation of Eukaryotic gene expression

Competency No.	Topics & Subtopics
Describe gene mutations and basic mechanism of regulation of gene expression	
7.4 Describe applications of molecular technologies like Recombinant DNA technology, PCR in the diagnosis and treatment of diseases with genetic basis.	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 & western blotting, mechanism of polymerase chain reaction and its application in medical diagnosis and treatment of genetic diseases.
7.5 Describe the role of xenobiotics in disease	Mechanisms of biotransformation of xenobiotics & associated diseases.
7.6 Describe the anti-oxidant defense systems in the body.	Enzymatic and non-enzymatic antioxidant defense systems in the body.
7.7 Describe the role of oxidative stress in the pathogenesis of conditions such as cancer, complications of diabetes mellitus and atherosclerosis.	Free radical, biological sources of reactive oxygen species (ROS) and oxidative damage, oxidative stress, roll of oxidative stress in cancer, diabetes mellitus & atherosclerosis.
8	Nutrition

8.1 Discuss the importance of various dietary components and explain importance of dietary fiber.	Importance of carbohydrates, lipids, proteins & vitamins, quality of proteins, various types of dietary fibers and their importance in the diet.
8.2 Describe the types and causes of protein energy malnutrition and its effects.	Protein energy malnutrition, Kwashiorkor and Marasmus their causes and effects.

Competency No.	Topics & Subtopics
8.3 Provide dietary advice for optimal health in childhood and adult, in disease conditions like diabetes mellitus, coronary artery disease and in pregnancy.	Balanced diet in adult, in childhood and in pregnancy for optimal health, dietary advice in diabetes mellitus & coronary heart disease
8.4 Describe the causes (including dietary habits), effects and health risks associated with being overweight/ obesity	Causes, effects and health risk associated with overweight/ obesity
8.5 Summarize the nutritional importance of commonly used items of food including fruits and vegetables (macro-molecules & its importance)	Nutritional importance of commonly used items of food like cereals, pulses, eggs, meat, fish, fruits and vegetables and their normal dietary requirements.
9	Extracellular Matrix
9.1 List the functions and components of the extracellular matrix (ECM).	Types & functions of the extracellular matrix (ECM), Components and functions of proteoglycans, glycoproteins & major proteins of ECM
9.2	Disorders associated with components of ECM like Osteogenesis imperfecta, Marfan's Syndrome , Mucopolysaccharidoses, Scurvy & Menkes Disease

Discuss the involvement of ECM components in health and disease.	
9.3 Describe protein targeting & sorting along with its associated disorders(It is non-core: N)	Types of protein targeting and sorting, disorders due to defects in mitochondrial targeting signals and defects in peroxisomal matrix protein import.
10	Oncogenesis and Immunity

Competency No.	Topics & Subtopics
10.1 Describe the cancer initiation, promotion oncogenes & oncogene activation. Also focus on p53 & apoptosis	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 .
10.2 Describe various biochemical tumor markers and the biochemical basis of cancer therapy.	Biochemical tumor markers, biochemical basis of chemotherapy, radiotherapy, hormonal therapy, targeted drug therapy and immunotherapy.
10.3 Describe the cellular and humoral components of the immune system & describe the types and structure of antibody	Cells of the Immune System, types of immune systems (Innate &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
10.4 Describe & discuss innate and adaptive immune responses, self/non-self-recognition and the central role of T-helper cells in immune responses	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 Disorders – Immunodeficiency, autoimmunity & hypersensitivity.
10.5	Antigens, concept involved in vaccine development and their types.

Describe antigens and concepts involved in vaccine development.	
11	Biochemical Laboratory Tests
11.1 Describe commonly used laboratory apparatus and equipments, good safe laboratory practice and waste disposal.	Common lab equipments and apparatus like test tubes, pipettes & other glassware , auto pipettes, centrifuge, balances, oven, water bath good safe laboratory practice , management of needle stick injury & latest guidelines of disposal of biomedical waste

Competency No.	Topics & Subtopics
11.2 Describe the preparation of buffers and estimation of pH.	Preparation of buffer –acidic and alkaline. Measurement of pH paper and pH meter
11.3 Describe the chemical components of normal urine.	Chemical constituents of normal urine
11.4 & 11.20 11.4: Perform urine analysis to estimate and determine normal and abnormal constituents. 11.20: Identify abnormal constituents in urine; interpret the findings and correlate these with pathological states.	Physical characteristics and organic constituents of urine. Collection of random & 24 hour urine sample Urine Report: Physical characteristics and abnormal constituents, urine dipsticks Interpretation of Urine Abnormalities
11.5 Describe screening of urine for inborn errors & describe the use of paper chromatography. Club Paper chromatography of amino acid & TLC from competency no 11.16	Urine: Screening of inborn errors. Paper chromatography for diagnosis of inborn errors
11.6 Describe the principles of colorimetry. (Club spectrophotometry from competency no 11.18)	Colorimeter- Principle, Beer and Lambert’s law & applications. Principles of spectrophotometry.
11.7,11.8, 11.21 & 11.22	

11.7- Demonstrate the estimation of serum creatinine and creatinine clearance 11.8- Demonstrate estimation of serum proteins, albumin and A:G ratio 11.21- Demonstrate estimation of glucose, creatinine, urea and total protein in serum. 11.22- Calculate albumin: globulin A:G ratio and creatinine clearance	Estimation of serum creatinine, urine creatinine and calculation of creatinine clearance and their clinical interpretation. Estimation of serum proteins, albumin and calculation of A/G ratio and their clinical interpretation. Estimation of plasma glucose, serum urea and their clinical interpretation.
11.9	Estimation of serum total cholesterol and HDL cholesterol, their ratio their clinical interpretation.

Competency No.	Topics & Subtopics
Demonstrate the estimation of serum total cholesterol and HDL cholesterol	
11.10 Demonstrate the estimation of triglycerides	Estimation of serum triglycerides and their clinical interpretation.
11.11 Demonstrate estimation of calcium and phosphorous	Estimation of serum calcium and phosphorus their clinical interpretation.
11.12 Demonstrate the estimation of serum bilirubin	Estimation of serum bilirubin: Total, direct and indirect, their clinical interpretation.
11.13 & 2.2 11.13- Demonstrate the estimation of SGOT/ SGPT	Estimation of SGOT (AST)/ SGPT(ALT) and their clinical interpretation.
11.14 Demonstrate the estimation of alkaline phosphatase	Estimation of serum ALP and their clinical interpretation.
11.15 Describe & discuss the composition of CSF	Physical characteristics and chemical composition of CSF
11.16 & 11.19 11.16- Observe use of commonly used equipment's/techniques	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

in biochemistry laboratory including:

- pH meter
- Paper chromatography of amino acid
- Protein electrophoresis
- TLC, PAGE
- Electrolyte analysis by ISE
- ABG analyzer
- ELISA
- Immunodiffusion
- Autoanalyser
- Quality control

(Paper chromatography of amino acid ,TLC clubbed with 11.5)

Competency No.	Topics & Subtopics
•DNA isolation from blood/ tissue 11.19 Outline the basic principles involved in the functioning of instruments commonly used in a biochemistry laboratory and their applications.	
11.17 Explain the basis and rationale of biochemical tests done in the following conditions: - diabetes mellitus, - dyslipidemia, - myocardial infarction, - renal failure, gout, - proteinuria, - nephrotic syndrome, - edema, - jaundice, - liver diseases, pancreatitis, disorders of acid- base balance, thyroid disorders.	Basis and rational of biochemical tests required in the following Conditions: - Diabetes mellitus-blood & urine glucose, microalbumin, ketone bodies and glycated hemoglobin – (Club with 3.8 & 3.10) - Dyslipidemia-lipid profile (Club with 4.5 & 4.7) - Myocardial infarction –CK, LDH, Troponin (Club with 2.6 & 2.7) - Renal failure & nephrotic syndrome, – BUN, Creatinine, urinary protein, cholesterol (Club with 3.8 & 3.10) - Gout- serum uric acid, synovial fluid analysis

	(Club with 6.3 & 6.4) - liver diseases & Jaundice- LFTs (Club with 6.1) Pancreatitis- serum amylase and lipase (Club with 2.5& 7 2.7) Disorder of acid base balance- ABG analysis for pH, pO₂, O₂ saturation pCO₂, HCO₃ and base excess (BE) (Club with 6.7,6.8) - Thyroid disorder – serum free and total T3 & T4 and serum TSH (Club with 6.1)
11.18 Discuss the principles of spectrophotometry. (Clubbed with 11.6)	Spectrophotometer –principle & use

Competency No.	Topics & Subtopics
11.19 Outline the basic principles involved in the functioning of instruments commonly used in a Biochemistry laboratory and their applications. (Clubbed with & 11.6 & 11.16)	Instruments commonly used in Biochemistry laboratory & their applications.
11.20 Identify abnormal constituents in urine, interpret the findings and correlate these with pathological states. (Clubbed with 11.4)	
11.21 Demonstrate estimation of glucose, creatinine, urea and total protein in serum. (Clubbed with 11.7, 11.8)	
11.22 Calculate albumin: globulin (A/G)ratio and creatinine clearance (Clubbed with 11.7, 11.8)	

11.23 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.	Energy contents of lipids, carbohydrates & proteins in common food items.
11.24 Enumerate advantages and/or disadvantages of use of unsaturated, saturated and trans fats in food.	Advantages of unsaturated fats, disadvantages of saturated and trans fats in food

BIOCHEMISTRY DEPARTMENT
NMCRC, VISNAGAR

EARLY CLINICAL EXPOSURE TOPICS

SR NO	TOPIC	Basic Science correlation/Clinical Skills	NAME
1	ENZYMES	Basic Science correlation	DR. PATKE
2	FAT SOLUBLE VITAMINS	Basic Science correlation	DR. VIDHI
3	WATER SOLUBLE VITAMINS	Basic Science correlation	DR. CHIRAG
4	HEART DISEASE	Clinical Skills	DR. KINJAL
5	JAUNDICE	Clinical Skills	DR. SANDIP
6	RENAL DISEASE	Clinical Skills	DR. PRASAD
7	DIABETES MELITUS	Clinical Skills	DR. VIRAL
8	ACID BASE BALANCE WITH ABG	Basic Science correlation	DR. SANDIP
9	PEM	Basic Science correlation	DR. CHIRAG
10	DIET IN VARIOUS DISEASE	Basic Science correlation	DR. PATKE

Extra topics: 1) Inborn error of metabolism

2) Hemoglobiopathies

DETAILED SYLLABUS FOR BIOCHEMISTRY

As per the guidelines suggested by MET cell of MCI, syllabus is divided into three heads namely must know, desirable to know and nice to know topics:

4. Must Know

Introduction: Scope of Biochemistry, Biotechnology, Molecular Biology, Biochemical Concept of Health and Disease

Biochemical Morphology of the Eukaryotic cell (Molecular and functional organization of cell and cellular organelles): Composition, functions and structure of cell membrane, Transport systems across the cell membrane and their mechanism, membrane receptors, Molecular and functional organization of sub-cellular organelles.

Chemistry of Carbohydrates: Definition, classification and importance of carbohydrates; chemistry, properties and functions of monosaccharides, disaccharides and polysaccharides; sugar derivatives and their biological importance; location, composition and functions of Glycosaminoglycans (mucopolysaccharides) and disorders.

Chemistry of Amino Acids and Proteins: Classification and properties of amino acids , biologically important peptides , classification , properties and functions of proteins , structural organization of proteins (with reference to hemoglobin, insulin and collagen). Plasma proteins – functions and clinical significance of various fractions, methods of separation (only principle). Acute phase proteins.

Chemistry and functions of Nucleic acids, Molecular Biology : Concept of nucleoside & nucleotide, Biologically important free nucleotides, Structure of DNA and RNAs , genetic code , DNA replication, Transcription , post – transcriptional processing , Translation, Post translational modifications ; inhibitors of protein biosynthesis. Molecular mechanism of gene expression & its regulation, Mutations , mutagens. Rb protein, p53, Apoptosis.

Chemistry of Lipids: Classification of lipids, Definition, distribution, classification, properties and function of fatty acids, triglycerides, phospholipids, sterols & others compound lipids, Structure, properties and functions of cholesterol.

Enzymology: Classification, properties and mechanism of enzyme action, Specificity, regulation (repression & induction) and inhibition of enzyme action; factors affecting enzyme activity, K_m value and its significance (derivation not required and no details of enzyme kinetics). Isoenzymes – definition and separation. Clinical importance (diagnostic, therapeutic and analytical) of enzymes and isoenzymes.

Bioenergetics – Electron transport chain: General concept of oxidation and reduction. Role of enzymes and coenzymes, structure of mitochondrion and organization of electron transport chain, oxidative phosphorylation, inhibitors and uncouplers. High energy compounds. Concept of substrate level phosphorylation.

Chemistry and Metabolism of Haemoglobin: Structure and functions of Porphyrin and Hemoglobin, Biosynthesis, catabolism and regulation of heme. Fate of bilirubin, Types of jaundice, porphyrias (in brief), types of normal and abnormal haemoglobin (HbS, Thalassaemia), derivatives of haemoglobin.

Vitamins: classification, sources, chemistry (in brief), active forms, Biochemical role, deficiency manifestations, recommended daily allowance (RDA) of fat soluble and water soluble vitamins. Hypervitaminosis.

Nutrition: Balance diet, quality of dietary protein, nitrogen balance, BMR, SDA, RQ, Nutritional importance of carbohydrates, proteins & lipids; Dietary fibre, Glycemic index, Assessment of nutritional value of proteins, Protein - energy malnutrition – Kwashiorkor and Marasmus.

Carbohydrate Metabolism: Biochemical aspects of digestion and absorption of carbohydrates. Glycolysis & its regulation; Rapaport Leubering cycle, TCA Cycle & its regulation, Cori's cycle, Gluconeogenesis, Hexose Monophosphate Shunt (HMP) pathway and its significance; Uronic acid pathway; Biosynthesis & catabolism of Glycogen; Metabolism of Galactose and Galactosemia,

Metabolism of Fructose, Sorbitol pathway ; Regulation of blood glucose level, Hormonal control, GTT, Glycosuria, Inborn errors of carbohydrate metabolism. Biochemistry of diabetes mellitus.

Amino acids and Protein Metabolism: Biochemical aspects of digestion and absorption of proteins. Fate of amino acids in the body - Oxidative & non-oxidative deamination; Transamination, Transamidation, decarboxylation. Ammonia toxicity & Fate of ammonia – urea cycle, Disorders of urea cycle.

Metabolism of individual amino acids – Glycine, Phenylalanine, Tyrosine, Tryptophan, sulphur containing amino acids and their inborn errors.

Lipid Metabolism: Biochemical aspects of digestion and absorption of lipids. Beta oxidation of fatty acids and its regulation, Biosynthesis of fatty acids and its regulation, Biosynthesis and transport of cholesterol and its regulation, catabolism of cholesterol, Metabolism of adipose tissue – lipogenesis & lipolysis, fatty liver & lipotropic factors, Ketogenesis, ketolysis & ketosis; Metabolism of plasma lipoproteins, Alcohol metabolism, inborn errors of lipid metabolism, Atherosclerosis.

Integration of metabolisms: Metabolic interrelationship of carbohydrates, lipids and protein metabolism. Metabolism in starvation.

Metabolism of Purines & pyrimidines: Biosynthesis of purines – sources of carbon & nitrogen of purine ring, conversion of IMP to GMP & AMP and regulatory steps only. Biosynthesis of pyrimidines & its regulation, salvage pathway, catabolism of purines & pyrimidines; Gout, Lesch – Nyhan syndrome, Orotic Aciduria.

Mineral Metabolism: sources, absorption, transport, functions, dietary requirement, excretion, deficiency manifestations (as applicable) of calcium, phosphorus, magnesium, Iron, Iodine, copper, sodium, potassium, chloride & Trace elements – manganese, selenium, zinc & fluoride. Role of vitamins & hormones in regulation of blood calcium level.

Hormones: General characteristics, classification, mechanism of hormone action, second messengers and their role.

Water and electrolyte balance, Body fluids: Distribution & composition. Water & electrolyte balance /imbalance in health & disease.

Acid - Base balance & pH: Acids & bases, Henderson – Hasselbalch equation, buffers, buffers of body fluids, Acid – base balance & pH homeostasis, Metabolic acidosis & alkalosis; Respiratory acidosis & alkalosis.

Organ Function Tests: Liver function tests; Kidney function tests and thyroid function tests; Cardiac profile.

Biotransformation (detoxification mechanism): Phase I reactions – oxidation, reduction & hydrolysis; Phase II reactions – conjugation.

5. Desirable to know

Genetic Engineering: recombinant DNA technology, restriction endonuclease, plasmids, chimeric molecule, applications of recombinant DNA technology in relation to medicine.

Molecular Biology Techniques: *Principle and applications* of DNA hybridization techniques, southern blot, northern blot, western blot, restriction length polymorphism (RFLP), DNA finger printing technique, polymerase chain reaction (PCR).

Molecular concept of body defence and their applications: Immunoglobulins: structure & functions. Free Radicals: Definition, generation, mode of action, damage done to biomolecules, Lipid peroxidation, free radical scavenging systems – enzymatic & non - enzymatic antioxidants , Role of free radicals in disease process.

Radioisotopes: Radiations, units of radioactivity, therapeutic and diagnostic uses of radioisotopes. Biological effects of radiations, Radiation hazards.

Biochemistry of cancer: Carcinogens, oncogenes, onco-suppressor genes, antimutagens, mechanism of carcinogenesis, tumor markers.

6. Nice to know

Environmental Biochemistry: Chemical hazards; air, water and noise pollution, Heavy metal poisons.

Biochemistry of AIDS: Transmission, Natural course of the disease, HIV genes and gene products, Immunology of AIDS, laboratory analysis anti – HIV drugs.

Advanced Techniques (LCD Topics): *Principle and applications of* - Electrophoresis, Chromatography, Colorimeter, Spectrophotometer, Flame photometer, pH meter and advanced techniques (RIA etc).

Curriculum for Practical Training in Biochemistry 1st M.B.B.S

Biochemistry practical's are designed to enable the students to understand the basic aspects of normal and abnormal conditions and interpretation of the investigations so as to help in clinical screening and diagnosis. Practical will be followed by the discussion on the theoretical concepts of disease, different techniques employed and instrumentation.

SYLLABUS FOR PRACTICAL

1. Tests for monosaccharides.
2. Tests for disaccharides.
3. Tests for polysaccharides.
4. Colour reactions of Proteins.
5. Precipitation reactions of proteins.
6. Estimation of plasma glucose.
7. Estimation of plasma urea.
8. Estimation of serum uric acid.
9. Estimation of serum creatinine.
10. Estimation of urine creatinine.
11. Estimation of serum total protein & albumin and calculation of A/G ratio.
12. Estimation of serum cholesterol.
13. Estimation of serum inorganic phosphorus.
14. Determination of serum amylase activity.
15. Normal urine: Physical characteristics and composition - organic & inorganic constituents.
16. Urine report: Physical characteristics and abnormal constituents.
17. C.S.F. – estimation of glucose.
18. C.S.F. – estimation of proteins.

Lecture cum Demonstration Topics.

1. Glucose tolerance test
2. pH meter.
3. Beer – Lambert's Law. Colorimeter, Spectrophotometer, Semi-automatic and automatic analyzer.
4. Electrophoresis.
5. Chromatography.
6. Cardiac profile
7. Diabetic profile
8. Lipid profile
9. Liver profile
10. Renal profile
11. Specialized techniques
12. Discussion of normal biochemical values of indices and their interpretation-interpretative