Syllabus of Biochemistry (including medical physics and molecular biology) for first professional MBBS students of the University of Health Sciences.

Departmental objective:

Knowledge:

At the end of the course the student will be able to -

1) Describe the molecular and functional organization of a cell and list its subcellular components.

2) Delineate structure , function and interrelationship of biomolecules and consequences of deviation from the normal.

3) Summarize the fundamental aspects of enzymology and clinical application wherein regulation of enzyme activity is altered

4) Describe digestion and assimilation of nutrients and consequently or malnutrition consequences of malnutrition.

5) Integrate the various aspects of metabolism and their regulatory pathways.

6) Explain the biochemical basis of inherited disorders with their associated sequelae.

7) Describe mechanisms involved in maintainance of body fluids and p H homeostasis.

8) Outline the molecular mechanisms of gene expression and regulations of the principles of genetic engineering and their application in medicine

9) Summerise molecular concept of body defences and their applicaton in medicine

10) Outline the biochemical basis of environmental health hazards, biochemical basis of cancer and carcinogenesis

11) Familiarize with the principles of various conventional and specialized laboratory investigations and interpretation of a given data.

12) Suggest experiments to support theoretical concepts and clinical diagnosis.

PROPOSED SYLLABUS OF BIOCHEMISTRY FOR FIRST PROFESSIONAL M.B.B.S COURSE

No.of Theory: 144 hrs.

Lectures/tutorials: GENERAL REVIEW

1) Origin of life . Molecular logic of living matters .Why biochemistry has been included in the medical curriculum.

2) A review of cellular structure and functions in chemical terms ; Special reference to separation of subcellular fractions and their identification.

3) Simple building blocks ; organization of macromolecules.

CHEMISTRY OF LIVING MATTERS

4) Carbohydrates : its nomenclature , classification with examples chemical structures of monosaccharides and disaccharides in pyranose and furanose form.

5) Isomerism : stereoisomers , optical isomers , epimers , anomers .Mutarotation, specific rotation.

6) Glycosidic linkage ; deoxy and amino sugars and homopolysaccharides, their chemical structures and importance.

7) Chemical structures of heteropolysaccharides , glycosaminoglycans and glycoproteins.

8) Carbohydrates in bacterial cell wall and blood group substances.

9) Interpretation of chemical reactions of carbohydrates.

10)Classification of lipids .Chemical structure of simple lipids .Nomenclature of saturated and unsaturated fatty acids.

11) Essential fatty acids ; Importance of omega 3 fatty acids ; structure and functions of prostaglandins, leucotrienes and thromboxanes.

12) Classification and structure of phospholipids .Surfactant .Glycolipids.

13) Derived lipids : structure of cholesterol, steroid hormones , bile acids.

14) Characterisation of lipids: Saponification no. Iodine no. Acid no. Acetyl no. Polensky no. R.M. no. Thin layer chromatography , gas liquid chromatography

15) Proteins : Classification, chemical and physical properties

16)Bonds maintaining protein structure , organization of protein structure, alpha helix and beta pleated sheath .Globular proteins and fibrous proteins.

17) Classification and chemical structures of amino acids

18) Chemical reactions of amino acids ; Isoelectric pH , acid base properties of amino acids.

19) Methods of protein separation ; Gel filtration , electrophoresis ultracentrifugation.

20) Determination of primary structure of proteins .Ninhydrin reaction.

21) Separation of amino acids ; Paper chromatography , Thin layer chromatography, High performance liquid chromatography , SDS polyacrylamide gel electrophoresis.

22 & 23) Classification and structure of immunoglobulins and other plasma proteins.

24,25 & 26) Structure , function and relationship of a protein : Haemoglobin and myoglobin ;Role of 2,3 DPG , Hb S ,Hb M , Thalassemia.

27& 28) Structure ,function and relationship of a protein : Collagen , Keratin

Fibrin and Elastin.

29) Chemical structure of Purine , Pyrimidine ,Nucleoside ,Nucleotide and

derived nucleotides

30) Structures and properties of DNA in different forms.

31) Structures and properties of m-RNA ,t- RNA ,r-RNA and hn-RNA.

ENZYMES

32) I.U.B. classification of enzymes with examples .Apoenzyme , coenzyme, holoenzyme and cofactors

33) Kinetics of enzymes : Reaction velocity, order of reaction, specific activity, Michaelis-Menten equation .Significance of Km.

34) Factors affecting enzymatic activity : temperature , pH , substrate concentration and enzyme concentration.

35) Inhibitors of enzyme action : Competitive , non- competitive, irreversible and suicidal . Lineweaber — Burk plot.

36) Enzyme : Mode of action, allosteric and covalent regulation.

37) Functional and nonfunctional enzymes . Clinical significance of enzymes

38) Measurement of enzyme activity and interpretation of units. Measurement with coupled reactions.

39) Isozymes : Properties , measurement and significance

40) Principles of enzyme linked immunosorbent assay (ELISA).

PHYSICAL ASPECTS OF LIVING MA1TERS

41) Isotopes , radioisotopes , ionizing radiations , Radioimmunoassay.

42) Colloid, crystalloid, osmotic pressure and colloidal osmotic pressure.

43) Acid, base and Ph: Definition, Hendersan —Hasselbach equation.

44) Buffer: Definition , types and mechanism of action

45) Laws of thermodynamics , redox potential , free energy , high energy bonds.

46) Biological oxidation: Enzymes involved , generation of superoxide free radicals , role of cytochrome P450.

47) Components of mitochondrial respiratory chain , its organization and function .Sites of ATP formation, inhibitors and uncouplers.

48) Mechanism of oxidative phosphorylation, inhibitors , ATP/ADP cycle.

49) Shuttle mechanism : Glycerophosphate shuttle , Malate shuttle and creatine phosphate shuttle.

50) Mechanism of transport or absorption across a biomembrane : Active passive , facilitated transport and endocytosis.

51) Information transfer through a biomembrane : Role of G proteins and c AMP, phophatidylinositol pathway.

METABOLISM

52) Metabolism : An overview . Control of a metabolic pathway.

53) Methods of study.

54) Mechanism of hormone action.

METABOLISM OF CARBOHYDRATES

55) Digestion and absorption of carbohydrates . Lactose intolerance.

56,57 & 58) Fate of glucose after absorption . Glycolytic pathway: Chemical structures of intermediates , allosteric control of key enzymes , inhibitors energy production and hormonal control.

59,60) Glycogenesis and Glycogenolysis : Covalent modification of enzymes, hormonal control ,glycogen storage disease

61) Conversion of Pyruvate to Acetyl coA .Control of Pyruvate dehydrogenase complex.

62, 63 & 64) Tricarboxilic acid cycle : Chemical structure of intermediates sites of ATP production, regulatory mechanism.

65) Normal and abnormal metabolism of Fructose and Galactose.

66) Gluconeogenesis : From Lactate , Glycerol and Glucogenic amino acids Control of key gluconeogenetic enzymes.

67) Pentose phosphate pathway : Importance of generation of NADPH Glutathione and red cell membrane integrity.

68) Formation of Glucuronic acid and its significance. Its structural resemblance with Ascorbic acid.

69 & 70) Glucose tolerance test: oral and intravenous. Procedure and interpretation. Glycosuria, glycosylated hemoglobin.

METABOLISM OF LIPIDS

71) Digestion and absorption of fats: Micelle formation. Reconstitution of lipid in mucosal cell. Role of bile and pancreatic secretion.

72) Transport of lipids: Classification of lipoproteins, their chemical structure, composition; apoproteins.

73 &74) Metabolism of chylomicrons, VLDL, LDL, HDL; disorders of lipoprotein metabolism.

75) Oxidation of fatty acids (alpha, beta, and omega): saturated and unsaturated; odd carbon atom and even carbon atom fatty acids. Role of Carnitine.

76) Energetic and disorders of fatty acid oxidation.

77) Formation and degradation of ketone bodies, ketosis.

78) Metabolism of lipids in liver; causes and prevention of fatty liver, lipotropic factors.

79) Metabolism of lipids in adipose tissues and its hormonal controls.

80 & 81) Biosynthesis of fatty acids: De novo and on existing primer chain. Process of chain elongation. Detailed action of Biotin; multienzyme complex concept.

82 & 83) Biosynthesis of cholesterol: metabolic steps, control of rate limiting steps. Cholesterol lowering drugs: their mechanism of action.

84 &85) Formation of bile acids and steroid hormones. Biosynthesis of Triacylglycerol and Phospholipids and its degradation.

86, 87, & 88) chemical structure, synthesis, secretion, transport and degradation of insulin, mechanism of action. Insulin receptors. Insulin like growth factors.

89) Structure and mechanism of action of Glucagon.

METABOLISM OF PROTEINS

90) Dietary protein, its biological value and digestibility coefficient .Protein malnutrition . Essential amino acids.

91) Digestion of proteins; absorption of amino acids , gama- glutamyl cycle.

92) Fate of amino acid after absorption . Process of transamination : Role of Pyridoxal phosphate.

93) Oxidative and nonoxidative deamination , decarboxylation and transmethylation .Formation of Creatinine.

94) Formation and disposal of ammonia . Urea formation . Disorders of Urea cycle . Formation of Nitric oxide.

95 & 96) Normal and abnormal metabolism of Phenylalanine and Tyrosine Formation of Melanin. Formation and degradation of Catecholamines.

97) Normal and abnormal metabolism of sulphur containing amino acids.

98) Normal and abnormal metabolism of Tryptophan.

99) Normal and abnormal metabolism of Histidine. Inborn errors of metabolism in relation to protein metabolism.

100) Synthesis of Haem . Chemistry of porphyrins . Enzymatic defects in Porphyria.

l01& 102) Degradation of Haem . Conjugated and unconjugated hyperbilirubinaemia

103) Biochemical mechanism of blood coagulation.

METABOLISM OF INORGANIC ELEMENTS AND VITAMINS

104 & 105) Metabolism of Iron : dietary source, digestion, absorption ,transport utilization and storage.

106& 107) Normal and abnormal metabolism of Calcium and Phosphorous Dietary source, digestion, absorption, transport, utilization and excretion. Mechanism of bone formation.

108) Chemical structure and synthesis of Vitamin D. Its hormone like action on Calcium and Phosphorous metabolism.

109& 110) Chemical structure,synthesis and degradation of Parathyroid hormone. Its action on Calcium and Phosphorous metabolism.

111) Role of micronutrient e.g. Zinc and Selenium in the body.

11 2& 113) Composition of intracellular and extracellular compartment fluid .Water and Sodium balance . Role of kidney in its maintainance.

114) Respiratory and renal mechanism for pH regulation.

115) Disorders of acid base balance and its compensation; Anion gap.

116) Chemistry and action of Vitamin A, Hypervitaminosis . Role of Retinoic acid.

117) Chemistry of Vitamin E; its action as an antioxidant.

118) Chemistry and function of Vitamin K.

119) Chemistry and function of Folic acid and Vitamin B 12 in one carbon metabolism.

120) Chemistry and function of riboflavin, pantothenate, and nicotinamide.

FUNCTIONAL TESTS

124) Renal clearance tests.

1 Liver function tests.

123) Thyroid function tests.

124) Gastric and Pancreatic function tests.

METABOLISM OF PUTRINE AND PYRIMIDINE

125) Source of carbon and nitrogen in the synthesis of purine and pyrimidine. Purine salvage pathway.

126) Catabolism of purine and pyrimidine.

127) Disorders of purine and pyrimidine metabolism.

GENETIC ASPECTS

128) Gene: mutation, genetic code.

129) Regulation of gene expression: Lac-Operon and His-Operon model. Role of histone and non histone proteins.

130) Replication of DNA. Difference between eukaryoric and prokaryotic DNA polymerase. DNA repair mechanism.

131 & 132) Role of different forms of RNA. Process of transcription, RNA repication, post transcriptional modification.

133 & 134) Steps of protein biosynrhesis in Eukatyotes and Prokaryotes. Posttranslational modification of protein.

135) Inhibitors of DNA, RNA and protein synthesis.

136) Genome of Retrovirus; Cell cycle, Apoptosis.

CANCER AND XENOBIOTICS

137&138) Biochemistry of cancer: chemical and physical carcinogens, Oncogenes and Proto-oncogenes.

139 & 140) Metabolism of Xenobiotics: different types, detoxification, and its impact on the body.

GENETIC METHODOLOGY

141) RFLP AND \TNTR: Explanation and their application in medicine.

142) Principles of Southern blotting, Northern blotting and Western blotting, and their application in biology and medicine.

143) Steps of cDNA synthesis in vitro. Principles of recombinant DNA technology.

144) Principles of polymerase chain reaction, concept of genomic library and its application.

125) Source of carbon and nitrogen in the synthesis of purine and pyrimidine. Purine salvage pathway.

126) Catabolism of purine and pyrimidine.

127) Disorders of purine and pyrimidine metabolism.

GENETIC ASPECTS

128) Gene: mutation, genetic code.

129) Regulation of gene expression: Lac-Operon and His-Operon model. Role of histone and non histone proteins.

130) Replication of DNA. Difference between eukaryoric and prokaryotic DNA polymerase. DNA repair mechanism.

131 &132) Role of different forms of RNA. Process of transcription, RNA replcation, post transcriptional modification.

133 & 134) Steps of protein biosynrhesis in Eukatyotes and Prokaryotes. Posttranslational modification of protein.

135) Inhibitors of DNA, RNA and protein synthesis.

136) Genome of Retrovirus; Cell cycle, Apoptosis.

CANCER AND XENOBIOTICS

137&138) Biochemistry of cancer: chemical and physical carcinogens, Oncogenes and Proto-oncogenes.

139 & 140) Metabolism of Xenobiotics: different types, detoxification, and its impact on the body.

GENETIC METHODOLOGY

141) RFLP AND VNTR: Explanation and their application in medicine.

142) Principles of Southern blotting, Northern blotting and Western blotting, and their application in biology and medicine.

143) Steps of cDNA synthesis in vitro. Principles of recombinant DNA technology.

144) Principles of polymerase chain reaction, concept of genomic library and its application.

SKILL DEVELOPMENT (Practical): 80 hours.

LESSON 1-4: Monosaccharides (glucose, fructose), disaccharides (lactose, sucrose), polysaccharides (starch, dextrin).

LESSON 5-6: Identification of any one of the unknown carbohydrates.

LESSON 7-8: Identification of simple protein (egg albumin) by following colour reaction:

Biuret test, Millon's test, Xanthoproteic test.

LESSON 9-10: Identification of simple protein by heat and acid coagulation reaction;

Identification of simple protein by Esbach's precipitation reaction;

Identification of derived protein (gelatin and peptone) by the above mentioned reaction.

LESSON 11: Identification of glycerol by acrolein test.

To perform the experiment with cholesterol crystal to test solubility and reaction of cholesterol dissolved in chloroform with sulfuric acid.

LESSON 12 & 13: Identification of presence of following pathological constituents in urine (albumin, sugar, bile salt, bile pigment, ketone body, blood).

LESSON 14&15: To perform the experiment to verif Lambert Beer law, handling of a colorimeter.

LESSON 16-19: To perform colorimetric estimation of blood sugar (Folin-Wu method or glucose oxidase method).

LESSON 20-23: To perform colorimetric estimation of blood urea (DAM method).

LESSON 24&25) To perform colorimetric estimatio of total protein (Biuret method).

LESSON 26&27: To perform colorimetric estimation of serum creatinine (Modified Folin-Wu alkaline picrate method).

Interpretation of the different biochemical data of blood and urine.

LESSON 28: To diagnose the case of chronic renal failure.

LESSON 29) To diagnose the case of hemolytic, hepatic, and obstructive jaundice.

LESSON 30: To diagnose the case of hyperlipoproteinemia.

LESSON 31: To diagnose the case of renal glycosuria.

LESSON 32: To diagnose the case of diabetic ketoacidosis.

LESSON 33: To diagnose the case of myocardial infarction.

LESSON 34: To diagnose the case of starvation krtoacidosis.

LESSON 35: To diagnose the case of acidosis (metabolic and respiratory).

LESSON 36: To diagnose the case of alkalosis (metabolic and respiratory).

LESSON 37: To interpret the electrophoretogram of serum protein (normal and abnormal)

LESSON 38: To determine the Rf value of different sugar from a given paper chromatogram.

LESSON39 & 40) Acid alkali titration: analysis of gastric acidity.

DEMONSTRATION **16 hours.**

1) Amylase estimation,

2) AST&ALT,

3) Alkaline phosphatase,

4) Paper chromatography,

5) Flame photometry,

6) End point analysis vis a vis kinetic study,

7) Thin layer chromatography,

8) Performance of a semiautoanalyser.

Teaching hours:

Theory (Lecture/ Tutorial): 144 hrs.

Practical : 80 hrs.

Demonstrations : 16 hrs.

PLAN OF FIRST PROFESSIONAL MBBS EXAMINATION IN BIOCHEMISTRY

Examination will consist of two written papers : Viva voce and Practical examination having following break up figure marks :

1) Written papers— Two, each 50 marks.

2) Viva voce — 20 marks.

3) Practical — 40 marks

Written Papers:

Papers 1: Cell and subcellular organelle, plasma membrane: signal transfer, chemistry of carbohydrate, lipid, protein, nucleic acid, enzymes, acid, base and buffer (including maintenance of acid base balance in the body), Isotopes and radioactivity, Enzymes, Digestion and absorption of carbohydrate, Protein and lipids, Biological oxidation, osmosis, Colloid immunological techniques (RIA, ELISP Sepaeration techniques, Instrumentation, Functional proteins e.g. Hemoglobin, myoglobin, collagen, alpha keratin, fibrin and elastase.

Paper II: Metabolism of carbohydrates, lipids, proteins, purine, ptrimidine and minerals. Vitamins, Nucleic acid and protein biostnthesis. Regulation of gene expression. Oncogenes and tumourogenesis. Recombinant DNP technology, Xenobiotics and its metabolism. Molecular endocrinology. Heme synthesis and degradation. Functional tests.

Note : Each paper must contain one essay type question of 15 marks with one alternative; two modified essay type questions each of 10 marks, out of three; five short questions (analytical/explanatory) each of 3 marks, out of seven.

Practical : Interpretation of charts : lOmarks,

Urine analysis : 10 marks,

Titration : 10 marks

Clinical material analysis': 10 marks

Viva voce : **20 marks**

Table - I 10 marks (Pper - I)

Table — II 10 marks (Paper — 2)

Internal assessment: 40 marks.(Theory: 20 marks,

Practical: 20 marks)

Theory: Twenty marks have been allotted.

Considering the duration of course, continuous monthly assessment on the basis of lectures covered in each month is advisable. Total Ten marks will be allotted for monthly assessments which will be conducted throughout the course. On completion of the course a test examination in the light of a final examination has to be carried out which will also be a lpart of internal assessment. Ten marks will be allotted for the final examination.

Practical :

The answer script of the students who will get more than 75% mark will have to be produced at the time of final examination to the external examiners if they so desire.

The evaluation of practical record book will be made in the internal assessment. Marks allotted for Practical record books is 5.

Practical examination has to be carried out on the completion of course and 15 marks has to allotted for this purpose.

MODEL QUESTIONS IN BIOCHEMISTRY

FIRST PROFESSIONAL M.B.B.S EXAMINATION

BIOCHEMISTRY

1st Paper F.M-50

1. Answer any one of the following:

Write down the steps of determination of the primary structure of a monomeric protein. 12

Describe the process of digestion and absorption of triglyceride in the intestine. 12

2. Answer any two of the following:

. Define Km and derive the rate of an enzyme catalyzed reaction when:

[S]=Km, [S]>>Km, [S]<<Km. 1+2+2+2

. Describe the chemiosmotic hypothesis of oxidative phosphorylation with the help of a diagram. 2+5

. Mention the difference between competitive and non-competitive inhibition with Lineweaver Burk plot. 2+5

3. Give an explanatory note on the following (any four): 3x4=12

a) Active site of an enzyme.

b) Role of blood buffer in the maintenance of acid base balance.

c) Watson-Crick model of the DNA.

d) Pseudo nucleotide as coenzyme.

e) Fluid mosaic model of biomembrane.

4. Explain the following statements: 3+3+3+3

a) Glucose enhances the absorption of the Na+ from the intestine.

b) Coenzymes are the co-substrates in the enzymes.

c) Lecithin is an amphipathic molecule.

d) Immunoglobulins are classified on the basis of type of heavy chain present in them.

MODEL QUESTIONS IN BIOCHEMISTRY

FIRST PROFESSIONAL M.B.B.S EXAMINATION

BIOCHEMISTRY

(SECOND PAPER) F.M-50

1) Describe only one of the following:

a) Describe the glycolytic pathway in erythrocytes. Calculate the total energy production when one more of glucose is utilized by them. Indicate the importance of 2,3 DPG generated in this pathway. 8+2+2=12

b) Describe the formation of urea in the body. Mention how ammonia is disposed off by other methods. 8+4=12

2) Describe any two of the following:

a) Describe the chemical composition and indicate the metabolism of very low density Lipoprotein (VLDL) with the help of a flow diagram. 2+5=7

b) Write down the chemical structure and mechanism of action of insulin. 3+4=7

c) Mention the steps of heme biosynthesis with its control mechanism. 5+2=7

3) Give an explanatory notes on any four of the following: 3+3+3+3=12

a) Genetic code
b) Recombinant DNA technology
c) Cyt P450
d) Polymerase chain reaction.
e) Point mutation.

4) Explain the following statements: 3+3+3+3=12

a) Glucose can be converted to fatty acids but the fatty acids cannot be converted to glucose in human.
a) Fructose leads to formation of more VLDL.
a) Metabolism of glucose is controlled by Phosphofructokinase.
a) Glycogen storage diseases often leads to hypoglycemia.