Scheme for First Professional MBBS Examination in Biochemistry (including medical physics and molecular biology)

A. Written Paper:.

Papers I: Cell and sub cellular organelle, plasma membrane: signal transfer, chemistry of carbohydrates, lipid, protein, nucleic acid, enzymes, acid, base and buffer (including maintenance of acid base balance in the body), Biological oxidation, osmosis, Colloid immunological techniques (RIA, ELISP Separation technique, Instrumentation, Functional proteins e.g. Haemoglobin, myoglobin, collagen, alpha keratin, fibrin and elastase.

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

The four questions in each theory paper will ordinarily be as follows:
Q.1) One long essay type question (out of two) consisting of 2-4 small segments. Marks for each segment will be indicated separately. 12 Marks

Q.2) One or two short note type question, or, modified essay type questions with 2-3 segments having indication of the break-up of marks for each segment (One out of two or Two out of three). 14 Marks

Q.3) One short note type question, or, explanatory note type question (Four out of five). 12 Marks (3x4)

Q.4) Four short clinically oriented explanatory notes on statements / analytical type of questions 12 Marks (3x4)

Adequate emphasis will be given to questions on applied aspects.

B. Oral/Viva

i) Topics of 1st paper-10 marks ii) Topics of 2nd paper-10 marks Total marks-20.

Distribution of the topics during viva voce

Table 1-Cell structure, Cell membrane, Signal transmission, Mechanism of hormone action, Biological Oxidation, oxidative phosphorylation, Enzymes- classification, mode of action, allosteric enzyme, Clinical enzymes, Functional proteins- haemoglobins, myoglobin, collagen

Table 2- Medical physics- isotopes, radioisotopes, radioimmunoassay, ELISA, Chromatography, Colorimetry, Electrophoresis, Acid, Base, buffer, Acid-Base Balance, pH

of body fluids, colloids, Osmosis, transport-active, passive, facilitated, endocytosis, Digestion and absorption of foodstuffs

Table 3- Purines, Pyrimidines, Proteins, Vitamins, Inorganic elements- their chemistry, normal and abnormal Metabolism

Table 4- Molecular biology, genetics, Gene expression, DNA & RNA synthesis, Polymerase Chain reaction, Mutation, Genetic disorders of metabolism

Table 5- Cabohydrates and Lipids- their chemistry, normal and abnormal metabolism

Note- **When there shall be four examiners Topics of Tables 4 and 5 will be clubbed.**

C. Practical

i) Interpretation of charts:10 marks, ii)Urine analysis:10 marks, iii) Titration:10 marks iv) Clinical material analyses: 10 marks **Total marks-40**

D. Internal Assessment Marks: **Total marks-40**

Question pattern in written examination of Periodical institutional Assessment-

The number of questions in the written test will be four (4) ordinarily having the following distribution of marks.

Q.1) One long essay type question (out of two) consisting of 2-4 small segments. Marks for each segment will be indicated separately. *12 Marks*

Q.2) One or two short note type question, or, modified essay type questions with 2-3 segments having indication of the break-up of marks for each segment (One out of two orTwo out of three). *14 Marks*

Q.3) One short note type question, or, explanatory note type question (Four out of five). *12 Marks (3x4)*

Q.4) Four short clinically oriented explanatory notes onstatemets / analytical type of questions *12 Marks (3x4)*

SYLLABUS OF BIOCHEMISRY

FIRST PROFESSIONAL M.B.B.S COURSE

Departmental objective of teaching- learning of Biochemistry

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 sub-cellular 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 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 squealae.

7) Describe mechanisms involved in maintenance of body fluids and pH homeostasis.
8) Outline the molecular mechanisms of gene expression and regulations of the principles of genetic engineering and their application in medicine.
9) Summarize molecular concept of body defences and their application 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.

No. of lectures/tutorials: **Theory: 144 hrs.**

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 separations of sub-cellular fractions and their identification.
3) Simple building blocks; organization of macromolecules.

CHEMISTRY OF LIVING MATTERS

4) Carbohydrates: its nomenclature, classification with examples chemical structure of monosaccharides and disaccharides in Pyranose and Furanose form.
5) Isomerism: stereoisomers, optical isomers, epimers, anomens. Mutarotation, specific rotation.
6) Glycosidase 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) Classication 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 prostaglandin, leucotrienes and thromboxanes.
12) Classification and structure of phospholipids. Surfactant. Glycolipids.
13) Derived lipids: structure of cholesterol, steroid hormones, and bile acids.
14) Characterization of lipids: Saponification no. Iodine no. Acetyl no. Acid no., Polenski 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 structure 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, HbS, HbM, Thalassemia.

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

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

30) Structures and properties of DNA in different forms.

31) Structures and properties of m-RNA, tRNA, rRNA 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, and 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 non-functional enzymes, Clinical significance of enzymes

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

39) Isoenzymes: Properties, measurement and significance.

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

PHYSICAL ASPECTS OF LIVING MATTERS

41) Isotopes, radioisotopes, ionising radiations, Radio immunoassay.

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

43) Acid, Base and pH: Definition, Hendersan-Hasselbach equation.

44) Buffer: Definition, types and mechanisms of action

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

46) Biological oxidation: Enzymes involved, generation of super oxide free radicals, and role of cytochrome P 450.

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 bio membrane: Active passive, facilitated transport and endocytosis.

51) Information transfer through a biomembrane: Role of G proteins and cAMP, phosphatidylinositol 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) Tricarboxylic 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 haemoglobin.

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 body, 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 non oxidative 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 Tyrosin , 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 Heam. Chemistry of porphyrins. Enzymatic defects in Porphyria.

101 & 102) Degradation of Hem. Conjugated and unconjugated hyperbilirubinaemia

103) Biochemical mechanism of blood coagulation.

METABOLISM OF INORGANIC ELEMENTS AND VITAMINES

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.

112 & 113) Composition of intracellular and extracellular compartment fluids. Water and sodium balance. Role of kidney in its maintenance.

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 B12 in one carbon metabolism.

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

FUNCTIONAL TESTS

121) Renal clearance tests.

122) Liver function tests.

123) Thyroid function tests.

124) Gastric and Pancreatic function tests.

METABOLISM OF PURINE AND PYRIMIDINE

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

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 eukaryotic and prokaryotic DNA polymerase. DNA repair mechanism.

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

133 & 134) Steps of protein biosyntheses in Eukaryotes and Prokaryotes. Post translational modification of proteins.

135) Inhibitors of DNA, RNA and protein synthesis.

136) Genome and 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.

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 albumins) by following colours reaction: Biuret test, Millon's test, Xanthoproteic test.

LESSON 9-10: Identification of simple protein by heat and acid coagulation reaction; Identification of simple reaction by Esbach's precipitation reaction; identification of derived protein (gelatine 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 sulphuric 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 verify Lambert Beer law, handling of a colorimeter.

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

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

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

LESSON 26 & 27: To perform colorimetric estimation of serum creatinine.

(modified Folin-Wu alkaline pirate 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 haemolytic, 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 ketoacidosis.

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.

LESSON 39 & 40) Acid alkali titration: analysis of gastric acidity.

DEMONSTRATION

1) Amylase estimation.
2) AST & ALT.
3) Alkaline phosphates.
4) Paper chromatography.
5) Flame photometry.
6) End point analysis vis a vis kinetic study.
7) Thin layer chromatography.
8) Performance of semiautoanalyser.

Total Teaching hours: Theory (Lecture/Tutorial): 144 hrs. .
Demonstrations : 16 hrs.
Practical : 80 hrs

MODEL QUESTIONS (1 st Prof MBBS)

BIOCHEMISTRY
First Paper

Full Marks : 50 Time : Three Hours

The figures in the margin indicate full marks.

1. Answer any one of the following:
   a. Write down the steps of determination of the primary structure of a monomeric protein. 12

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

2. Answer any two of the following:
   a. Define Km and derive the rate of an enzyme catalyzed reaction when: [S]=Km, [S]>>Km, [S]<<Km. 1+2+2+2

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

c. 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 (1 st Prof MBBS)

BIOCHEMISTRY
Second Paper

Full Marks : 50 Time : Three Hours

The figures in the margin indicate full marks.

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.
b) Fructose leads to formation of more VLDL.
c) Metabolism of glucose is controlled by Phosphofructokinase.
d) Glycogen storage diseases often leads to hypoglycemia.