Examination questions

1. History of biochemistry. Major objectives, branches and research trends of biochemistry. Role of biochemistry in medical education.
2. Proteins as the major components of the cell. Functions of proteins.
3. Structure of amino acids. Classification. Peptide bond formation. Hydrolysis of proteins.
4. Physicochemical properties of proteins. Shape of proteins. Molecular mass of proteins: methods of its estimation.
5. Precipitation reactions of proteins. Factors of proteins' stability in solution. Salting out. Denaturation of proteins.
6. Colour reactions of amino acids and proteins. Methods for the quantitative measurement of proteins in a solution. Total serum protein.
7. Primary structure of proteins. Determination of primary structure of proteins.
8. Secondary structure of proteins: types, bonds which stabilize secondary structure.
9. Tertiary structure of proteins. Factors which stabilize tertiary structure. Three-dimensional structure of protein. Native structure of proteins. Protein folding.
10. Quaternary structure of proteins. Factors which stabilize quaternary structure. Cooperative interactions (in hemoglobin). Domaine structure of proteins.
11. Methods for separation and purification of proteins.
12. Simple proteins; representatives, characteristics, biological functions.
13. Complex proteins; representatives, characteristics, biological functions.
14. Structure, bond of prosthetic group with an apoprotein, biological role of chromoproteins, nucleoproteins, lipoproteins, metalloproteins, glycoproteins, phosfoproteins.
15. DNA: composition, structure, cell localization, biological role. Denaturation of DNA.
16. RNA: types, composition, structures, cell localization, biological role.
17. Biosynthesis of DNA in eukaryotic cells: scheme, enzymes, regulation.
18. Biosynthesis of RNA in eukaryotic cells: stages, enzymes. Processing of RNA.
19. Biosynthesis of proteins. The genetic code: its characteristic features.
20. Activation of amino acids. Adaptor function of tRNA. Formation and structure of tRNA. Role of ribosomes in protein synthesis.
21. Regulation of protein synthesis. Operon concept. Antibiotics as inhibitors of protein synthesis.
22. Structure and properties of enzymes.
23. Mechanism of enzyme catalysis. Active and allosteric centers in enzymes. Specificity of enzymes.
24. Simple and complex enzymes. Cofactors of enzymes. Co-enzymatic functions of vitamins.
25. Classification and nomenclature of enzymes. Isoenzymes.
26. The kinetics of enzymatic reactions. Michaelis–Menten equation and the Lineweaver–Burk plot. The Michaelis-Menten constant
27. Factors affecting enzymatic reaction rate (temperature, pH, substrate and enzyme concentration).
28. Methods for examination of enzyme activity. Units of enzyme activity.
29. Activation and inhibition of enzymes.
30. Inhibition of enzymes. Application of inhibitors in medical practice (the inhibitors of enzymes as drugs).
31. Regulation of enzyme activity. Allosteric activators and inhibitors, covalent modification,

selective proteolysis.

32. Tissue-specific enzymes. Intracellular localization of enzymes.
33. Origin of serum enzymes. Serum enzymes which used in clinical diagnostics. Enzymes in genetic diseases.
34. Use of enzymes as drugs.
35. Biological role, symptoms of deficiency, daily requirements, dietary sources of fat-soluble vitamins: A, D, E, and K
36. Biological role, symptoms of deficiency, daily requirements, dietary sources of water-soluble vitamins: B-complex (thiamin, riboflavin, niacin, pyridoxine, folate, vitamin B_{12}, biotin, pantothenic acid) and vitamin C.
37. Biological membranes, their types. Structural components of cellular membranes and their role in the organisation of structure and functional activity biomembranes.
38. Modern model of the structural organisation of cellular membranes. Properties of membranes (fluidity, asymmetry, selective permeability).
39. Membrane functions (transport, reception, control of selective transport of substances, participation in transfer of hormonal influence).
40. Transport function of membrane. Passive transport. Active transport.
41. Transmembrane transfer of macromolecules.
42. Free-radical reactions and peroxidation of membrane lipids. Active forms of oxygen.
43. Antioxidant systems of an organism. Protection of membranes from lipid peroxidation. The role of vitamins in this process.
44. Biological role of hormones in an organism. Principles of organization of hormonal regulation system (hierarchical principle, feedback principle).
45. Classification of hormones by the chemical nature and nature of the second intermediary.
46. Chemical structure and the mechanism of action of hormones penetrating into cell.
47. Common mechanisms of secondary messenger systems (cAMP system, phosphoinositol system). Role of Ca^{2+}-ions in secondary messenger systems.
48. Hormones of hypothalamus, their chemical nature, the mechanism of action and a role in activity of glands of internal secretion.
49. Hormones of pituitary gland, chemical nature, action mechanism, biological role.
50. Hormones thyroid and parathyroid glands, chemical nature, mechanism of their action, biological role.
51. Hormones of adrenal cortex and adrenal medulla, chemical structure, mechanism of their action, biological role.
52. Pancreas hormones, chemical nature, action mechanism, biological role.
53. Sexual hormones, chemical nature, action mechanism, biological role.
54. Metabolism and metabolic pathways. Major end products of metabolism in human organism.
55. The common and specific pathways of catabolism. Interrelation between anabolism and catabolism. Nutrition and metabolism.
56. Regulation of metabolism.
57. Integration of metabolism. Interrelation of proteins', lipides' and carbohydrates' metabolism.
58. The oxidative decarboxylation of pyruvate. Structure of pyruvate dehydrogenase complex, its regulation.
59. The tricarboxylic acid cycle (TCA cycle), or the Krebs cycle. The citric acid cycle is a

central metabolic pathway which generates NADH and $FADH_2$ for use in electron transport chain.

60. Regulation and biological role of the citric acid cycle.
61. Bioenergetics of the cell. Free energy. High-energy compounds: structure, biological role.
62. General characteristics of oxidation processes. Types of oxidation: enzymes, biological role.
63. ATP: structure, biological role; the ways of its formation and use.
64. Biological oxidation and tissue respiration.
65. Electron transport chain (ETC), its structural organization and functioning. Regulation of ETC.
66. NAD(NADP)-dependent dehydrogenases, structure, biological role.
67. FAD (FMN)-dependent dehydrogenases, structure, biological role.
68. Coenzyme Q, structure, biological role. Cytochromes, structure, biological role.
69. Oxidative phosphorylation. The chemiosmotic theory of oxidative phosphorylation. The The Phosphate/Oxygen Ratio (P/O).
70. Activators and inhibitors of the electron transport chain. Uncoupling agents.
71. Microsomal oxidation: scheme, biological role.
72. Structure and functions of carbohydrates.
73. Digestion and absorption of carbohydrates in the gastrointestinal tract.
74. The general scheme of glucose metabolism. Reaction of glucose phosphorylation, its biological role.
75. Anaerobic glycolysis: reactions, enzymes and biological significance.
76. Aerobic glycolysis: reactions, enzymes. Energy-producing reactions and biological role of aerobic glycolysis. Regulation of aerobic glycolysis.
77. Gluconeogenesis: scheme, metabolic precursors of glucose, biological role, regulation.
78. Pentose phosphate pathway: oxidative and non-oxidative reactions, scheme, biological role.
79. Structure and physiological role of glycogen.
80. Synthesis of glycogen. Regulation of glycogenesis.
81. Glycogen degradation, reactions, enzymes, biological significance, regulation.
82. Disorders of glycogen metabolism. Glycogenosises, its types
83. Regulation of glucose level in serum. Hyperglycemia and hypoglycemia, their causes.
84. Disorders of carbohydrate metabolism in diabetes mellitus. Glucose tolerance test.
85. Classification of lipids. Lipids of human tissues. Biological functions of lipids.
86. The digestion and absorption of lipids in the gastrointestinal tract.
87. Intracellular lipolysis (mobilization of fat).
88. Fatty acids of human tissues: classification, representatives, biological functions. Essential fatty acids.
89. Activation of fatty acids, transport of acyl-CoA into mitochondrion.
90. β-Oxidation of saturated fatty acids: reactions, energy result of β-oxidation, connection with citric acid cycle and electron transport chain. Oxidation of unsaturated fatty acids.
91. Reactions of synthesis and utilization of ketone bodies. Hyperketonemia in diabetes mellitus and carbohydrate starvation. Ketoacidosis
92. Biosynthesis of fatty acids: sources of acetyl-CoA and NADPH in the cytoplasm, synthesis of malonyl CoA, Structure of fatty acid synthase.
93. Metabolism of triacylglycerols. Biosynthesis and catabolism of triacylglycerols, regulation.

94. Biosynthesis of sphingolipids. Disorders of sphingolipid metabolism.
95. Biosynthesis of phospholipids: initial substrates, scheme, relations with biosynthesis of triacylglycerols.
96. Biosynthesis of cholesterol: main steps, reactions of mevalonate biosynthesis. Regulation of cholesterol synthesis.
97. Metabolism of cholesterol in the human body. Cholesterol as the precursor of other steroids.
98. Transport of lipids in the blood. Lipoproteins of blood serum: structure, composition, metabolism.
99. Hyperlipoproteinemia. Hypercholesterolemia and atherosclerosis. Biochemical principles of treatment
100. Metabolism of proteins. Nitrogen balance. Sources of amino acids in the human organism and ways of their use.
101. General pathways of amino acid metabolism.
102. Deamination of amino acids. Types of deamination.
103. Oxidative deamination. Biological role of glutamatedehydrogenase.
104. Transdeamination or indirect deamination; its biological role.
105. Transamination of amino acids, biological role. Coenzyme functions of vitamin B_6. Mechanism of transamination. Clinical significance of transaminases activity testing in the blood serum.
106. Decarboxylation of amino acids. Types of decarboxylation, biological role.
107. Biogenic amines: synthesis, functions, oxidation of biogenic amines.
108. Formation and neutralization of ammonia. Tissular detoxification of ammonia.
109. Biosynthesis of urea (urea cycle). Disorders of the urea synthesis. Normal urea level in the blood and urine.
110. Metabolism of methionine. Role of methionine in transmethylation reactions. Synthesis of creatine.
111. Metabolism of phenylalanine and tyrosine. Disorders of phenylalanine and tyrosine metabolism (phenylketonuria, alkaptonuria, albinism).
112. Biosynthesis of purine nucleotides: synthesis of phosphoribosylamine, origin of atoms in the purine ring. Inosinic acid as a precursor for synthesis of AMP and GMP. Regulation of purine synthesis.
113. Degradation of purine nucleotides. Hyperuricemy. Podagra.
114. Biosynthesis of pyrimidine nucleotides: synthesis of orotic acid. Synthesis of deoxyribonucleotides.
115. Degradation of pyrimidine nucleotides.
116. Water distribution in human organism. Volume and osmotic pressure of biological fluids. The water balance.
117. Mineral components of tissues: representatives, biological role. Trace elements.
118. Sodium, potassium; their biological role, metabolism, regulation of balance.
119. Calcium, phosphate; their biological role, metabolism, regulation of balance.
120. Regulation of sodium and water balance. Role of aldosterone, renin-angiotensin system, antidiuretic hormone, atrial natriuretic peptides.
121. Regulation of acid-base balance and pH in biological fluids. Buffer systems of the body. Respiratory and renal mechanisms of pH regulation.
122. Kidney, biochemical functions, metabolism of the kidney. Role of kidney in regulation of

pH balance.

123. General characteristics and composition of urine. Pathologic components of urine. Role of urine analysis in diagnostics.
124. Blood, general characteristics and functions. Specific features of chemical composition, structure and metabolism of erythrocytes and leukocytes.
125. Hemoglobin, structure, its derivatives. Transport of oxygen and carbon dioxide. Heme synthesis.
126. Blood plasma and serum. Plasma proteins: albumin, globulins, transport proteins, inhibitors of proteolysis, immunoglobulins; their characteristics.
127. Blood serum enzymes, its diagnostic importance. Acute phase proteins.
128. Role of the liver in carbohydrate, lipid, amino acid and protein metabolism. Synthesis of plasma proteins in the liver.
129. Neutralizing functions of the liver.
130. Degradation of heme. Bilirubin metabolism.
131. Disorders in bilirubin metabolism: jaundice, its types
132. Chemical composition of nervous tissue. Transport of substrates into the brain, role of the blood/brain barrier.
133. Specifics of carbohydrate, lipid and amino acid metabolism in nervous tissue. Energy metabolism in the brain.
134. Biochemical mechanisms of formation and transmission of nervous impulses. Molecular mechanisms of synaptic transmission.
135. Neurotransmitters: acetylcholine, catecholamines, serotonin, GABA (γ-aminobutyric acid). Synthesis and metabolism of neurotransmitters in nervous tissue, functions.
136. Structure and composition of muscle tissue. Muscle proteins, their functions.
137. Biochemical mechanisms of muscle contraction and relaxation. Role of ions in regulation of muscle contraction.
138. Muscle energy metabolism. Sources of ATP, role of creatine phosphate, creatine kinase. Biochemistry of muscle fatigue.
139. Chemical composition and structure of extracellular matrix (ground substance). Collagen, elastin; specific features of their structure and metabolism, role of ascorbic acid.
140. Proteoglycans and glycoproteins of connective tissue; features of their synthesis and degradation, biological role.