Educational Institution
"GRODNO STATE MEDICAL UNIVERSITY" LIST OF EXAMINATION QUESTIONS on Biochemistry
for the medical faculty for international students
specialty 1-79 01 01 Medical Affair
2021/2022 academic year

I. INTRODUCTION

1. Major objectives of biochemistry. Role of biochemistry in medical education. Objects and methods of biochemistry.
2. History of biochemistry. Branches and research trends of biochemistry.

II. STRUCTURE AND FUNCTION OF PROTEINS

3. History of protein study. Proteins as the major components of the body. Functions of proteins. Shape of proteins. Protein content of the organs and tissues
4. Hydrolysis of proteins. Amino acids: structure and classification.
5. Colour reactions of amino acids and proteins. Methods for the quantitative determination of proteins in a solution.
6. Physico-chemical properties of proteins and protein solutions.
7. Methods for separation and purification of protein: ultracentrifugation, chromatography, electrophoresis.
8. Peptides: classification, representatives, biological functions.
9. Primary structure of proteins. Determination of primary structure, bonds which stabilize primary structure.
10. Secondary structure of proteins: types, bonds which stabilize secondary structure. Determination of secondary structure. Supersecondary structure.
11. Tertiary structure of proteins. Factors which stabilize tertiary structure. Determination of three-dimensional structure.
12. Denaturation of proteins, factors, practical use.
13. Quaternary structure of proteins. Factors which stabilize quaternary structure.
14. Proteins of organs and tissues. Changes of proteins in ontogenesis and disease.
15. Simple proteins; representatives, characteristics, biological functions.
16. Conjugated proteins; representatives, characteristics, biological functions.

III. ENZYMES

17. History of enzymes study. Active and allosteric centers in enzymes.
18. Mechanism of enzyme catalysis. Properties of enzymes.
19. Classification and nomenclature of enzymes. Isoenzymes.
20. The kinetics of enzymatic reactions. The Michaelis-Menten equation and Lineweaver-Burk plot.
21. Factors affecting enzymatic reaction rate (temperature, pH, substrate and enzyme concentration).

22. Simple and conjugated enzymes.
23. Cofactors of enzymes. Co-enzymatic functions of water-soluble vitamins.
24. Regulation of enzyme activity. Allosteric activators and inhibitors, covalent modifications, selective proteolysis.
25. Inhibition of enzymes. Application of inhibitors in medical practice (drugs as the inhibitors of enzymes).
26. Tissue-specific enzymes. Changes of enzymes in ontogenesis.
27. Changes of enzymes in disease. Enzymes in genetic diseases.
28. Blood plasma enzymes. Serum enzymes used in clinical diagnosis.
29. Use of enzymes as therapeutic agents.
30. Methods for enzyme activity determination. Units of enzyme activity.

IV. STRUCTURE AND FUNCTION OF NUCLEIC ACIDS. BIOSYNTHESIS OF NUCLEIC ACIDS AND PROTEIN. MOLECULAR BIOLOGY TECHNICS

31. DNA: composition, structure, cell localization, biological role. Denaturation and hybridization of nucleic acids.
32. RNA: types, composition, structures, cell localization, biological role.
33. Nucleoproteins: role of protein in higher structural organization of nucleic acids. Structure of chromatin.
34. Biosynthesis of DNA in eukaryotic cells: scheme, enzymes, regulation.
35. Reverse transcription, biological role.
36. Biosynthesis of RNA in eukaryotic cells: steps, enzymes. Regulation of transcription. Processing of RNA.
37. The genetic code: its characteristic features.
38. Activation of amino acids. Adaptor function of tRNA. Formation and structure of aminoacyl-tRNA.
39. Structure of eukaryotic ribosomes, their function in protein synthesis.
40. Biosynthesis of protein in eukaryotic cells: steps, scheme. Posttranslational processing of proteins.
41. Regulation of protein synthesis. Antibiotics as inhibitors of protein synthesis.
42. DNA fingerprint.
43. Polymerase chain reaction: stages and practical applications.
44. The blot-analysis of DNA and RNA. Western blot analysis.
45. Sequencing of DNA by the Sanger's method.
46. Genetic engineering, cloning of DNA.

V. HORMONES

47. General characteristics of hormones: classification, properties, types of biological action.
48. Classification of hormones on the chemical structure, on the place of their synthesis and on the mechanism of action. Target tissues and the cell receptors of hormones.

49. Mechanisms of action of hormones binding with the membrane receptors. Second messengers: cyclic purine nucleotides, calcium ions, products of hydrolysis of phosphatidylinositol. Diversity of protein kinases and their role in transmission of hormonal signal.
50. Mechanism of action of hormones binding with the intracellular receptors.
51. Thyroid hormones: structure, synthesis; target tissues, biological effects. Hyper- and hypofunction.
52. Parathyroid hormone and calcitonin: structure, target tissues, biological effects. Hyper- and hypofunction of parathyroid hormone.
53. Pancreatic hormones: insulin, glucagon. Structure, target tissues, biological effects. Hyper- and hypofunction.
54. Epinephrine (adrenaline) and norepinephrine (noradrenaline): structure, synthesis and inactivation, target tissues, biological effects. Hyperproduction of adrenaline.
55. Glucocorticoids: structure, target tissues, biological effects. Hyper- and hypofunction.
56. Mineralocorticoids: structure, target tissues, biological effects. Disorders of mineralocorticoid excess.
57. Female sex hormones: structure, target tissues, biological effects. Hyper- and hypofunction.
58. Male sex hormones: structure, target tissues, biological effects. Hyper- and hypofunction.
59. Hormones of hypothalamus and hypophysis, their biological action. Growth hormone, adrenocorticotropic hormone: target tissues, effects on metabolism. Hyper- and hypoproduction of growth hormone.
60. Eicosanoids (prostaglandins, thromboxanes, leukotrienes) and their role in the regulation of metabolism and functions.

VI. BIOCHEMISTRY OF NUTRITION AND DIGESTION. VITAMINS

61. Components of human food. The significance of nutrition for the vital activity. Pathological states related to nutrition disorders.
62. Dietary carbohydrates, lipids and proteins: daily requirements, characteristics, nutritional importance.
63. Essential food components: amino acids, fatty acids, their characteristics and biological importance.
64. Vitamins, general characteristics, classification, biological functions. Vitamin-like substances. Causes of hypo- and hypervitaminoses.
65. Vitamin A: biological role, symptoms of deficiency, daily requirements, and dietary sources. Hypervitaminosis A.
66. Vitamin E: biological role, symptoms of deficiency, daily requirements, and dietary sources.
67. Vitamin D: biological role, symptoms of deficiency, daily requirements, and dietary sources. Hypervitaminosis D.
68. Vitamin K: biological role, symptoms of deficiency, daily requirements, and dietary sources.

69. Vitamin B_1: coenzyme forms, biological role, symptoms of deficiency, daily requirements, and dietary sources.
70. Vitamin B_2: coenzyme forms, biological role, symptoms of deficiency, daily requirements, and dietary sources.
71. Vitamin PP: coenzyme forms, biological role, symptoms of deficiency, daily requirements, and dietary sources.
72. Vitamin B_6: coenzyme forms, biological role, symptoms of deficiency, daily requirements, and dietary sources.
73. Pantothenic acid: coenzyme forms, biological role, symptoms of deficiency, daily requirements, and dietary sources.
74. Folic acid: coenzyme forms, biological role, symptoms of deficiency, daily requirements, and dietary sources.
75. Vitamin H: coenzyme forms, biological role, symptoms of deficiency, daily requirements, and dietary sources.
76. Vitamin C: coenzyme forms, biological role, symptoms of deficiency, daily requirements, and dietary sources.
77. Vitamin B_{12}: coenzyme forms, biological role, symptoms of deficiency, daily requirements, and dietary sources.

VII. STRUCTURE AND FUNCTIONS OF MEMBRANES

78. Structure and functions of membranes. Lipids and proteins of membranes.
79. Properties of membranes. Transport mechanisms. Types of transport processes across membrane.

VIII. INTRODUCTION INTO METABOLISM

80. Metabolism and metabolic pathways. Experimental study of metabolism, use of radioisotope tracers.
81. The pathways for the catabolism of carbohydrates, proteins and lipids. The specific and common pathways of catabolism. Interrelations between anabolism and catabolism.

IX. ENERGY METABOLISM. TCA CYCLE.

82. Bioenergetics of the cell. Free energy. High-energy compounds: structure, biological role.
83. ATP: structure, biological role; the ways of its formation and use.
84. Biological oxidation and tissue respiration.
85. NAD^+($NADP^+$)-dependent dehydrogenases, structure of coenzyme, biological role.
86. FAD (FMN)-dependent dehydrogenases, structure of coenzyme, biological role.
87. Coenzyme Q, structure, biological role.
88. Cytochromes of the ETC, structure, biological role.
89. Electron transport chain (ETC), its structural organization and functioning. Electron transport chain complexes.

90. Oxidative phosphorylation. The chemiosmotic theory of oxidative phosphorylation. The P/O ratio. Substrate-level phosphorylation.
91. Regulation of ETC. Activators and inhibitors of the electron transport chain. Uncoupling of oxidation and phosphorylation.
92. General characteristics of oxidation processes. The role of oxygen in oxidative processes in the cell. Types of oxidation: enzymes, biological role.
93. Microsomal oxidation: scheme, biological role.
94. Reactive oxygen species: their tissue-damaging effects. Lipid peroxidation.
95. Antioxidant systems, role of enzymes.
96. The citric acid cycle: sequence of reactions.
97. The scheme of the citric acid cycle, its regulation and biological role.
98. Energy yield of the citric acid cycle. Relation of the citric acid cycle with the respiratory chain.

X. METABOLISM OF CARBOHYDRATES

99. General characteristics and classification of carbohydrates, biological functions. Carbohydrates of human tissues.
100. Dietary carbohydrates. Digestion and absorption of carbohydrates in the gastrointestinal tract.
101. The general scheme of pathways of glucose metabolism, their functions. Reactions of glucose phosphorylation and dephosphorylation of glucose 6-phosphate, biological role. Regulation.
102. Galactose and lactose metabolism. Hereditary disorders of galactose and lactose metabolism.
103. Fructose metabolism. Hereditary disorders of fructose metabolism.
104. Anaerobic glycolysis: reactions and biological significance.
105. Oxidation-reduction reactions in anaerobic glycolysis. Reactions of substrate-level phosphorylation in glycolysis.
106. Energy-producing reactions and biological role of anaerobic glycolysis. Regulation of anaerobic glycolysis.
107. Catabolism of glucose under aerobic conditions: reactions.
108. Alcoholic fermentation, reactions.
109. Pyruvate dehydrogenase complex: components, mechanism of the reaction, regulation, biological role.
110. Energy yield and biological role of aerobic degradation of glucose. Scheme of pyruvate metabolism.
111. Metabolism of lactate. Gluconeogenesis: scheme, metabolic precursors of glucose.
112. Key reactions of gluconeogenesis. Role of biotin. Biological role and regulation of gluconeogenesis.
113. Pentose phosphate pathway: oxidative and non-oxidative reactions. biological role.
114. Glucuronic acid pathway of glucose: major reactions, biological role.
115. Synthesis of glycogen. Regulation of glycogenesis.

116. Glycogen degradation, regulation. Physiological role of glycogen.
117. Disorders of glycogen metabolism: glycogenoses, aglycogenoses.
118. Hormonal regulation of glycemia. The role of insulin, adrenaline, glucagon and corticosteroids. Hyperglycemia and hypoglycemia, their causes. Methods for determination of glucose in the blood serum.
119. Disorders of carbohydrate metabolism in diabetes mellitus.
120. Glucose tolerance test. Diagnostic value.

XI. METABOLISM OF LIPIDS

121. Classification of lipids. Lipids of human tissues. Biological functions of lipids.
122. Dietary lipids. Digestion of lipids: emulsification, enzymatic hydrolysis, formation of micelles. The role of bile acids. Disorders in digestion and absorption of lipids in the gastrointestinal tract.
123. Resynthesis of fats in the intestinal wall. Formation of chylomicrons. Composition and metabolism of chylomicrons.
124. Fatty acids of human tissues: classification, representatives. Activation of fatty acids, transport of acyl CoA into mitochondrion.
125. β-Oxidation of fatty acids: reactions, energy production of β-oxidation, relation with citric acid cycle and electron transport chain.
126. Oxidation of odd-chain fatty acids.
127. Reactions of synthesis and utilization of ketone bodies. Mechanism of ketosis in diabetes mellitus and starvation. Ketoacidosis.
128. Biosynthesis of fatty acids: sources of acetyl CoA and NADPH in the cytoplasm, synthesis of malonyl CoA.
129. Biosynthesis of palmitic acid: sequence of reactions. The fatty acid synthase complex.
130. Metabolism of triacylglycerols: biosynthesis and lipolysis. Hormonal regulation of these processes.
131. Biosynthesis of phospholipids. Fatty infiltration of the liver. Lipotropic agents.
132. Metabolism of cholesterol in the body. Transport of cholesterol in the blood.
133. Biosynthesis of cholesterol: scheme, main steps. Initial reactions of cholesterol biosynthesis. Regulation of cholesterol synthesis..
134. Bile acids: representatives, structure, metabolism, biological functions. Cholelithiasis. Formation of cholesterol gall stones.
135. Metabolism of sphingolipids. Disorders of sphingolipid metabolism.
136. Hypercholesterolemia and atherosclerosis. Biochemical principles of treatment.
137. Transport of lipids in the blood, role of albumins. General characteristics of lipoproteins.
138. Metabolism of lipoproteins: formation and utilization. Lipoprotein lipase. Role of apoproteins.
139. Dislipoproteinemias: hyper- and hyplipoproteinemias.
140. Disorders in digestion and absorption of lipids in the gastrointestinal tract.
141. Obesity: disturbances of lipid metabolism.

XII. METABOLISM OF AMINO ACIDS

142. Dynamic state of body proteins. Nitrogen balance. Sources of amino acids in the body and ways of their use.
143. Dietary proteins. Digestion of proteins in the gastrointestinal tract. Absorption of amino acids.
144. Intestinal putrefaction of proteins (conversion of amino acids by intestinal bacteria).
145. Types of deamination of amino acids. Oxidative deamination and reductive amination. Biological role.
146. Transamination of amino acids, biological role. Coenzyme functions of vitamin B_6. Mechanism of transamination. Clinical significance of transaminase activity in the blood serum.
147. Transdeamination. Biological role.
148. Decarboxylation of amino acids. Types of decarboxylation, biological role. Biogenic amines: synthesis, functions, oxidation of biogenic amines.
149. Ways for formation and detoxification of ammonia. Intracellular detoxification of ammonia. Role of glutaminase in the maintenance of acid-base balance in the body.
150. Biosynthesis of urea (urea cycle). Disorders of the urea synthesis and excretion.
151. Metabolism of methionine, formation of S-adenosylmethionine, its role in transmethylation reactions. Synthesis of creatine.
152. Metabolism of phenylalanine and tyrosine. Disorders of phenylalanine and tyrosine metabolism (phenylketonuria, alkaptonuria, albinism).

XIII. METABOLISM OF NUCLEOTIDES

153. Biosynthesis of purine nucleotides: synthesis of phosphoribosylamine, origin of atoms in the purine ring. Inosinic acid as a precursor for synthesis of adenylic and guanylic acids. Regulation of synthesis of purine nucleotides.
154. Biosynthesis of pyrimidine nucleotides. Regulation of biosynthesis of pyrimidine nucleotides.
155. Degradation of nucleic acids in the gastrointestinal tract and tissues. Degradation of purine and pyrimidine nucleotides.
156. Re-utilization of nucleosides and nitrogenous bases for synthesis of nucleotides. Disorders of metabolism of nucleotides: xanthinuria, orotaciduria, gout.

XIV. WATER AND ELECTROLYTE METABOLISM. BIOCHEMISTRY OF THE KIDNEY AND URINE

157. Body water compartments. Composition, volume, osmolality, and pH of the body fluids. Functions of water in the organism. The water balance.
158. Regulation of electrolyte and water balance and pH in body fluids.
159. Water and electrolyte imbalance: dehydration and edema. Acid-base imbalance: acidosis and alkalosis.

160. Mineral components of tissues: classification, representatives, biological role.
161. Sodium, potassium; their biological role, metabolism, regulation of balance.
162. Calcium, phosphate; their biological role, metabolism, regulation of balance.
163. Trace elements (Fe, Cu, Co, I, Zn, Mn, Se), their biological role.
164. Kidney, biochemical functions, metabolism of the kidney. Role of kidney in regulation of pH balance.
165. General characteristics and composition of urine. Pathologic components of urine. Role of urine analysis in diagnosis.

XV. INTEGRATION OF METABOLISM

166. The levels of metabolism integration. The substrate-level interrelationships in metabolism. The role of TCA substrates in integration of metabolism.
167. Energy interrelations among catabolic and anabolic pathways.
168. Substrate-level relations among metabolism of carbohydrates and amino acids. Biosynthesis of lipids from carbohydrates and amino acids. Integration of metabolism by coenzymes.

XVI. REGULATION OF METABOLISM

169. The role of regulation of metabolism in functioning of organs and systems. Intracellular location of major metabolic pathways.
170. Regulation of metabolism: major mechanisms.

XVII. BIOCHEMISTRY OF THE LIVER

171. Role of the liver in carbohydrate, lipid, amino acid and protein metabolism.
172. Detoxifying function of liver.
173. Heme synthesis, reactions.
174. Function of liver in pigment metabolism. Bilirubin metabolism, scheme.
175. Disorders in bilirubin metabolism: jaundice, its types, differential diagnosis. Bile pigments in the blood, urine, feces.
176. Biochemical mechanisms of hepatic failure and hepatic coma. Biochemical tests for diagnosis of liver disorders.

XVIII. BIOCHEMISTRY OF THE BLOOD

177. Blood, general characteristics and functions. Specific features of metabolism in blood cells.
178. Hemoglobin, structure, derivatives. Transport of oxygen and carbon dioxide by the hemoglobin. Variants of hemoglobin in ontogenesis. Hypoxia. Hemoglobinopathies.
179. Metabolism of iron. Transferrin and ferritin. Iron deficiency anemia.
180. Plasma proteins, their characteristics. Classification of plasma proteins on the functions: transport proteins, complement proteins, kinins, blood clotting proteins, proteins of fibrinolytic system, immunoglobulins, and inhibitors of proteolysis.

181. Blood serum enzymes, their diagnostic value. Acute phase proteins.
182. Hemostasis. Blood coagulation factors. Role of platelets.
183. Intrinsic and extrinsic pathways of blood coagulation. Cascade mechanism for activation of coagulation factors. Role of vitamin K in blood coagulation.
184. Anticoagulant and fibrinolytic system.
185. Disorders of coagulation and anticoagulation systems. Thrombosis and hemophilias.

XIX. BIOCHEMISTRY OF NERVOUS SYSTEM

186. Morphochemical composition of nervous tissue. Transport of substrates into the brain, role of the blood-brain barrier. Axonal transport.
187. Specific features of carbohydrate, lipid and amino acid metabolism in nervous tissue. Energy metabolism in the brain.
188. Biochemical mechanisms of generation and transmission of nervous impulses. Molecular mechanisms of synaptic transmission.
189. Neurotransmitters: acetylcholine, catecholamines, serotonin, GABA. Metabolism, functions.

XX. BIOCHEMISTRY OF MUSCLES

190. Structure and composition of muscle tissue. Muscle proteins, their functions.
191. Biochemical mechanisms of muscle contraction and relaxation. Role of ions in regulation of muscle contraction.
192. Muscle energy metabolism. Sources of ATP for muscle contraction, role of creatine phosphate, creatine kinase.

XXI. BIOCHEMISTRY OF CONNECTIVE TISSUE

193. Chemical composition and structure of extracellular matrix (ground substance). Collagen, elastin; specific features of their structure and metabolism.
194. Proteoglycans, glycosaminoglycans, and glycoproteins of the connective tissue; specific features of their synthesis and degradation, biological role.

XXII. INTRODUCTION TO CLINICAL BIOCHEMISTRY

195. The role of clinical biochemistry in diagnostics and treatment of metabolic dysfunctions.
196. Basic and special biochemical tests.
197. Blood tests of clinical importance. Reference ranges of main values in adults.
198. Clinical significance of main analytes measured in laboratories: total protein, α-amylase, alanine aminotransferase, urea, uric acid, glucose, triacylglycerols, cholesterol, low density lipoproteins, hemoglobin, calcium, total bilirubin.

199. Urine tests of clinical importance. Reference ranges of main values in adults. Diagnostic importance of the determination of uric acid and urea in the urine.
200. Cerebrospinal fluid analysis: reference ranges of main values in adults. Diagnostic importance of the measurement of protein in the cerebrospinal fluid.

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It was approved by the meeting
of Department of Biochemistry
protocol №_11___ from__12.05.2022