

LIST OF THE THEORETICAL QUESTIONS FOR STUDENTS OF MEDICAL FACULTY:

1. Biological chemistry as a science. The objectives and assignments of biochemistry and its principal trends and parts. The significance of biochemistry in the development of medical science and practical health care.
2. Enzymes: definition, properties of enzymes as biological catalysts, difference between enzymes and inorganic catalysts. Specificity of enzymes.
3. Nomenclature and classification of enzymes.
4. Simple and conjugated enzymes. Role of non-protein part of conjugated enzymes. Structure of enzymes: active centres and allosteric sites. Levels of structural organization of enzymes.
5. Enzyme kinetics. Factors affecting enzymatic activity (concentration of enzyme, concentration of substrate, effect of temperature, effect of pH). Michaelis-Menten constant and equation.
6. Enzyme inhibition (reversible, irreversible, competitive, non-competitive).
7. Regulation of enzyme activity in the living system (allosteric regulation, feedback regulation, covalent modification of enzymes, activation of latent enzymes by limited proteolysis, cyclic nucleotides in regulation of enzymatic processes).
8. Diagnostical importance of enzymes (plasma specific and non-plasma specific enzymes. Changes in enzymatic activity of blood plasma and serum as diagnostic indexes (markers) of pathological processes in distinct organs – myocardial infarction, acute pancreatitis, liver disease, pathology of muscle tissue. Isoenzymes, their role in enzymodiagnosics).
9. Conception of turnover of material and energy (metabolism). Characterization of catabolic, anabolic and amphibolic reactions and their significance. Catabolic transformation of biomolecules: proteins, carbohydrates, lipids, its characterization.
10. Tricarboxylic acid (TCA) cycle (sequence of TCA cycle reactions, characterization of enzymes and coenzymes participating TCA cycle, energetic effect of TCA cycle).
11. Biological oxidation of substrates in cells. Reactions of biological oxidation and their functional significance.
12. Pyridine and dependent flavine dehydrogenases, structure of NAD, NADP, FAD and FMN, their role in reactions of oxidation and reduction.
13. Molecular organization of electron transport chain of mitochondria. Supramolecular complexes of respiratory chain in inner membrane of mitochondria.
14. Oxidative phosphorylation. Sites of oxidative phosphorylation. P/O ratio. Mechanisms of oxidative phosphorylation: chemical coupling hypothesis, chemiosmotic theory.
15. The scheme of chemiosmotic mechanism of coupling of electron transport in respiratory chain with ATP synthesis. Molecular structure and principles of functioning of ATP-synthetase. Inhibitors of electron transport in a respiratory chain of mitochondria. Uncouplers of electron transport and oxidative phosphorylation in a respiratory chain of mitochondria.
16. Glucose as an important metabolite in carbohydrate metabolism: general scheme of sources and turnover of glucose in the organism
17. Glucose oxidation under anaerobic conditions – glycolysis. Enzymatic reactions of glycolysis, energetic effect, regulation. Reactions of substrate level phosphorylation in glycolysis.
18. Metabolic pathways and substrates of gluconeogenesis, mechanisms of regulation, compartmentalization of enzymes, biological significance of the process.
19. Relations between glycolysis and gluconeogenesis (Cori cycle). Irreversible reactions of glycolysis and their shunt pathways. Glucose-lactate and glucose-alanine cycles.
20. Pentosophosphate pathway (PPP) of glucose utilization (scheme of reactions in oxidative and nonoxidative stages of PPP, enzymes and coenzymes of PPP reactions, biological significance of PPP, disorders of PPP in red blood cells, enzymopathias of glucose-6-phosphate dehydrogenase).
21. Oxidative decarboxylation of pyruvic acid: structure of multienzyme pyruvate dehydrogenase complex, peculiarities of function of pyruvate dehydrogenase complex, mechanism of oxidative decarboxylation of pyruvate, role of vitamins and coenzymes in transformation of pyruvate to acetyl-CoA.

22. Enzymatic reactions of fructose turnover in human body. Hereditary enzymopathias of fructose metabolism. Enzymatic reactions of galactose metabolism in human body. Hereditary enzymopathias of galactose metabolism.
23. Mechanism and peculiarities of enzymatic reactions of glycogenesis and glycogenolysis. Peculiarities of hormonal regulation of glycogen metabolism in liver and muscles. Hereditary disorders in enzymes of glycogen synthesis and breakdown. Glycogenoses, aglycogenoses, their characterization and causes.
24. Insulin dependent and noninsulin dependent forms of diabetes mellitus. Characterization of metabolic disorders in diabetes mellitus.
25. Catabolism of triacylglycerols: characterization of intracellular lipolysis, its biological significance; enzymatic reactions; neurohumoral regulation of lipolysis: adrenalin, noradrenalin, glucagone, insulin; energetic balance of triacylglycerol oxidation.
26. Biosynthesis of triacylglycerols and phospholipids, the significance of phosphatidic acid.
27. β -Oxidation of long chain fatty acids: (location of the process of β -oxidation of fatty acids; activation of fatty acids, the role of carnitin in transport of fatty acids into mitochondria; the sequence of enzymatic reactions in β -oxidation of fatty acids; energetic balance of β -oxidation of fatty acids)
28. Metabolism of ketone bodies. (enzymatic reactions of ketone bodies biosynthesis; reactions of utilization of ketone bodies, energetic significance; metabolism of ketone bodies in pathology. Mechanism of excessive accumulation of ketone bodies in diabetes mellitus and in starvation; the notions of ketoacidosis, ketonemia, ketonuria).
29. Biosynthesis of cholesterol in human body: (localization of the process and its significance stages of cholesterol biosynthesis, enzymatic reactions of biosynthesis of mevalonic acid regulation of cholesterol synthesis)
30. Pathways of cholesterol biotransformation (esterification, production of bile acids and steroid hormones, synthesis of vitamin D₃, excretion from the body).
31. Atherosclerosis, mechanism of its development, role of genetic factors, hypercholesterolemia. Hypercholesterolemia in diabetes mellitus, myxoedema, obstructive jaundice, nephritic syndrome. Control of hypercholesterolemia
32. Pathways of formation and maintenance of free amino acid pool in human body. General pathways of free amino acid turnover.
33. Transamination of amino acids, substrates for transamination reaction. Mechanism of transamination. Reaction. Aminotransferases, their localization in tissues and organs. Clinical diagnostic significance of determination of aminotransferases activity.
34. Types of reactions of amino acid deamination their final products. Mechanism of oxidative deamination, oxidases of D- and L- aminoacids, their enzymatic activity and specificity.
35. Decarboxylation of amino acids, decarboxylases. Production of biogenic amines (GABA, histamine, serotonin, dopamine). Decarboxylation of amino acids in putrefaction of proteins in intestines. Oxidation of biogenic amines.
36. Pathways of ammonia production. Toxicity of ammonia and mechanisms of its detoxification. Circulatory transport of ammonia (glutamine, alanine).
37. Biosynthesis of urea: enzymatic reactions, hereditary defects of enzymes involved in urea synthesis (enzymopathias of urea synthesis).
38. Specific pathways of metabolism of aromatic amino acids phenylalanine and tyrosine, sequence of enzymatic reactions. Hereditary enzymopathias of phenylalanine and tyrosine metabolism – phenylketonuria, alkaptonuria, albinism.
39. Metabolism of sulfur containing amino acids, reactions of methylation.
40. Biosynthesis of porphyrins, scheme of enzymatic reactions of heme biosynthesis. Regulation of porphyrin synthesis. Classification of porphyries – erythropoietic (Gunter's disease), liver.
41. Biochemical functions of nucleic acids and nucleotides. Formation of nucleic acid chain from nucleotides.
42. Nucleic acids: structure, properties. Primary structure of nucleic acids, polarity of polynucleotides, specific features of DNA and RNA structure. Secondary structure of DNA, role of hydrogen bonds in stabilization of secondary structure (Chargaff rules, Watson-Crick model),

- ant parallelism of chains. Tertiary structure of DNA. Physico-chemical properties of DNA: interaction with cationic ligands; hyperchromic effect; denaturation and renaturation of DNA.
43. Structure, properties and biological functions of RNA. Types of RNA: mRNA, tRNA, rRNA, snRNA; specific features of structure (secondary and tertiary) of different RNA types.
 44. Biosynthesis of pyrimidine nucleotides: reactions, regulation. Orotic aciduria.
 45. Biosynthesis of deoxyribonucleotides. Formation of thymidyl nucleotides; inhibitors of dTMP biosynthesis as antitumor drugs. (structural analogs of dTMP, pterine derivatives).
 46. Catabolism of purine nucleotides; hereditary disorders of uric acid metabolism. Biochemical background of hyperuricemia, gout, Lesch-Nyhan syndrome.
 47. Biological significance of DNA replication. General scheme of DNA synthesis. Enzymes of DNA replication in prokaryotes and eukaryotes. Molecular mechanisms of DNA replication: topoisomerases, helicases, the significance of antiparallelism of DNA strands, Okazaki fragments. Stages of synthesis of daughter chains of DNA.
 48. General scheme of transcription. Coding and noncoding DNA chains. RNA polymerases of prokaryotes and eukaryotes. Stages and enzymes of RNA synthesis. Markers of transcription: promoter, initiator, termination segments of genome.
 49. Processing as posttranscriptional modification of RNA. Antibiotics, which inhibit transcription.
 50. Regulation of gene expression in prokaryotes: scheme of regulation according to F. Jacob and J. Monod. Structure of Lac-operon of E. coli. structural and regulatory genes, promoter, operator, regulatory gene and production of protein repressors, repression and induction of Lac-operon function.
 51. The genetic code, triplet structure, its properties. Table of genetic code.
 52. Protein synthesis system of ribosomes. Components of protein synthesis system. Transfer RNA and amino acid activation. Aminoacyl-tRNA synthetases, second genetic code.
 53. Stages and mechanisms of translation: initiation, elongation, termination. Initiating and terminating codons of mRNA. The role of protein factors of ribosomes in translation. Post-translational modification of peptide chains. Regulation of translation. Molecular mechanisms of translation control on example of globin synthesis.
 54. The influence of biologically active compounds on translation. Antibiotics as inhibitors of transcription and translation in prokaryotes and eukaryotes, their biomedical application.
 55. Hormones in a system of intercellular integration of physiological functions in human organism. Classification of hormones.
 56. Mechanisms of hormonal action - amino acid derivatives, peptide and protein hormones, steroid hormones. Regulatory sites in DNA, which interacts with hormone-receptor complexes.
 57. Messenger function of cyclic nucleotides, Ca/calmodulin system phosphoinositides. Serine, threonine and tyrosine protein kinases in effector response of the cell.
 58. Hormones of thyroid gland. Structure and function of thyroid hormones. Pathology of thyroid gland, metabolic disorders in hypo- and hyper- thyreosis. Endemic goiter and its prevention.
 59. Regulation of calcium turnover by parathyroid hormone (PTH) and calcitonin (CT). Calcitriol: biosynthesis, the effect on intestinal absorption of calcium and phosphates. Calcitonin - structure, the effect upon calcium and phosphate turnover. Biochemical characterization of disorders in calcium metabolism (rickets, osteoporosis). Hypo- and hyper- parathyroidism. Distribution of calcium in the body, molecular forms of calcium in blood plasma. Role of bone tissue, intestines and kidneys in support of calcium homeostasis.
 60. Hormones of pituitary gland, their role in regulation of endocrine glands function. Hormone family "growth hormone-prolactin-gonadotropins", pathology connected with disorders of GH, somatomedin, prolactin dysfunction.
 61. Glycoprotein hormones of hypophysis - TSH, FSH, ICSH, prolactin. Proopiomelanocortin - products of processing of this hormone precursor, (ACTH, lipotropins, endorphins).
 62. Hormones of neurohypophysis - oxytocin and vasopressin (ADH), pathology caused by disorder in ADH secretion.
 63. Steroids of suprarenal glands. Glucocorticoids: cortisol, cortisone, corticosterone, their role in regulation of gluconeogenesis, anti-inflammatory effects. Itsenko-Cushing syndrome.

Mineralocorticoids, role of aldosterone in regulation of water and mineral metabolism, Addison disease, aldosteronism.

64. Hormones of sexual glands. Estrogens – estradiol, estrion, estrone, physiological and biochemical effects, regulation of synthesis and secretion, connection with female month cycle. Androgens – testosterone, dihydrotestosterone, physiological and biochemical effects, regulation of biosynthesis and secretion.
65. Peculiarities of biochemical composition and metabolism of nervous tissue (chemical composition of brain, neurospecific proteins and lipids (gangliosides, cerebroside, cholesterol). Energetic metabolism in human brain tissue.
66. Neurotransmitters (acetylcholine, noradrenalin, dopamine, serotonin, excitatory and inhibitory amino acids), functional role, mechanism of action. Receptors for neurotransmitters and physiologically active substances.
67. Requirements of human organism in nutrients – carbohydrates, lipids, proteins. Biological value of some nutrients. Rational nutrition.
68. Enzymes, biochemistry of digestion and absorption of carbohydrates in gastrointestinal tract.
69. Enzymes, biochemistry of digestion and absorption of proteins in gastrointestinal tract.
70. Enzymes, biochemistry of digestion and absorption of lipids in gastrointestinal tract.
71. Vitamins as essential nutritional components. History of vitamins discovery and development of vitaminology. Causes of exo- and endogenous hypo- and avitaminoses.
72. Vitamin B₁ and B₂, their structure, biological function, sources of supplement, daily requirement. Symptoms of hypovitaminosis.
73. Structure and properties of vitamin H and pantothenic acid. Their significance in metabolism, daily requirement.
74. Vitamins B₆ and PP, their structure, biological function, nutritional sources, daily requirement. Symptoms of hypovitaminosis.
75. Vitamin C and P, their structure, biological function, daily requirement, manifestations of insufficiency in human organism.
76. Vitamins of D group, their structure, biological function, nutritional sources, daily requirement. Symptoms of hypo- and hypervitaminosis, avitaminosis.
77. Vitamin A, its structure, biological function, nutritional sources, daily requirement. Symptoms of hypo and hyper- vitaminosis.
78. Vitamins E, F, their structure, biological role, mechanism of action, daily requirement. Symptoms of insufficiency.
79. Antihemorrhagic vitamins (K group), their water soluble forms, structure, biological function, nutritional sources, mechanism of action, daily requirement, symptoms of insufficiency, application in medicine.
80. Hemoglobin, its structure, properties and molecular forms. Pathology of hemoglobin: hemoglobinopathias and thalassemias.
81. The function of hemoglobin oxygenation from partial pressure of oxygen, dissociation curve of oxyhemoglobin, Bohr effect.
82. Acid-base equilibrium of blood. Regulation of pH in biological fluids, disorders of acid-base equilibrium: metabolic and respiratory acidosis, metabolic and respiratory alkalosis, mechanisms of their development.
83. Buffer systems of blood, their types, role of different buffer systems in providement of constant pH of blood.
84. Main groups of blood proteins, their composition and content in normal conditions and in pathology. Albumins and globulins. Resolution of blood plasma proteins by method of protein electrophoresis.
85. Proteins of acute phase of inflammation: C-reactive protein (CRP), ceruloplasmin, haptoglobin, cryoglobulin, alpha-1 antitrypsin, alpha-2 macroglobulin, interferon, fibronectin, their diagnostic validity.
86. Enzymes of blood plasma: genuine (secretory), excretory, indicator (tissue) enzymes. Kallikrein-kinine and renin-angiotensin systems, their biological significance.

87. Definition of total and residual nitrogen in blood. Nonprotein nitrogen containing compounds of blood, their diagnostic significance. Nitrogenemia, its kinds and causes of development, differentiation in clinical conditions.
88. Functional and biochemical characteristics of intrinsic and extrinsic blood coagulation pathways.
89. Blood coagulation system; characteristics of coagulation factors.; intrinsic and extrinsic blood coagulation pathways. Role of vitamin K in reactions of hemocoagulation (carboxylation of glutamic acid residues, its role in Ca binding). Hereditary disorders of hemocoagulation.
90. Anticoagulation system of blood, functional characteristics of its components – heparin, antithrombin III, citric acid, prostacycline. Role of vascular endothelium.
91. Fibrinolytic system of blood: stages and factors of fibrinolysis. Medicinal influencing fibrinolytic process. Activators and inhibitors of plasmin.
92. Immunoglobulins: structure, biological function, mechanisms of immunoglobulin synthesis. Characteristics of distinct immunoglobulin classes of human blood.
93. Mediators and hormones of immune system; (interleukins, interferons, protein and peptide factors of cell growth and proliferation).
94. Role of liver in regulation of glycemia (glycogenesis and glycogen breakdown, gluconeogenesis), lipid metabolism, turnover of bile acids and bile pigments. Biochemical composition of bile.
95. Role of liver in turnover of bile pigments. Hemoglobin catabolism: production of biliverdin, its transformation to bilirubin, synthesis of bilirubin diglucuronide and excretion with bile. Pathobiochemistry of jaundices; hemolytic (prehepatic), parenchymatous (hepatic), occlusive (posthepatic). Enzymatic congenital jaundices.
96. Detoxification function of liver; biotransformation of xenobiotics and endogenous toxins. Types of reactions of biotransformation of foreign substances in liver.
97. Conjugation reactions in hepatocytes: biochemical mechanisms, functional significance.
98. Electron transport chains of endoplasmic reticulum. Genetic polymorphism and induction of biosynthesis of cytochrome P-450.
99. Biological role of water and its distribution in human body. Water balance, its types. Regulation of water and mineral metabolism, its disorders. Dehydration and rehydration.
100. Biological role of macroelements, trace elements and ultramicroelements. Human microelementoses: endogenous and exogenous causes (technogenic, yatrogenic, etc.).
101. Role of kidneys in regulation of volume, composition of electrolytes and acid-base equilibrium of biological fluids. Biochemical mechanisms of urine production (filtration, reabsorption, secretion and excretion). Characterization of renal clearance and renal threshold, their diagnostic significance.
102. Physico-chemical properties of urine: volume, color, odor, transparency, acidity (pH), its dependence from diet. Role of kidneys and lungs in regulation of acid-base equilibrium. Ammoniogenesis.
103. Pathological constituents of urine – blood, hemoglobin, creatin. Causes and pathways of their appearance in urine. Glucosuria, galactosuria and pentosuria, causes of their development. Clinical significance of their detection.
104. Clinical significance of detection and determination of indican, phenylpyruvic and homogentisic acids, ketone bodies and bile pigments in urine.
105. Fine structure and biochemical composition of myocytes; structural organization of sarcomers. Myofibril proteins: myosine, actin, tropomyosine, troponine complex. Molecular organization of thick and thin filaments.
106. Nitrogen containing and nitrogen free water soluble organic compounds of muscles, their structure and functional significance. Molecular mechanisms of muscle contraction: modern data on interaction of muscle filaments. Role of Ca ions in regulation of contraction and relax of striated and smooth muscles.
107. Modern concept on energetics of muscle contraction and relaxation. Macroergic compounds of muscles. Structure, production and role of ATP, creatine phosphate, creatine phosphokinases, sources of ATP in muscle cell; role of creatine phosphate in energetic supply of contraction. Pathobiochemistry of muscles - myopathias.

108. Proteins of connective tissue fibers: collagen, elastin, glycoproteins and proteoglycans. Biosynthesis of collagen and formation of fibrillar structures.
109. Complex carbohydrates of amorphous matrix of connective tissue – glycosaminoglycans. Mechanisms of formation of intercellular matrix by molecules of glycosaminoglycans – (hyaluronic acid, chondroitin-, dermatan-, keratan- sulphates). Distribution of glycosaminoglycans in different human organs and tissues.
110. Pathobiochemistry of connective tissue. Biochemical mechanisms of development of mucopolysaccharidoses and collagenoses, their biochemical diagnostics.

Practical skills

1. Detection of proteins in the blood serum by biuret method. The principle of the method, clinical and diagnostic value.
2. Explain the basic principles of investigation of the salivary amylase (using the iodine test for starch and Trommer reaction).
3. Prove the relative specificity of saliva amylase. What other types of specificity characteristic of enzymes?
4. Determination of diastase of urine. The principle of the method, the rate of clinical and diagnostic value.
5. Inhibition of enzymes of TCA cycle by malonic acid.
6. Determination of glucose in the blood serum, normal glucose concentration in the blood.
7. Determination of the final product of anaerobic glycolysis - lactic acid - by Uffelmann's reaction. The principle of the method.
8. Determination of acetone (ketone bodies) in urine. Identification of ketone bodies in blood and urine. Principles of the methods. The value of determination of ketone bodies in the blood and urine.
9. Determination of pyruvic acid in biological fluids with colorimetric method. Explain the principle of the method.
10. Quantitative determination of cholesterol in the blood serum. The principle of the method. What is normal value of cholesterol in the blood serum?
11. Determination of alanine aminotransferase and aspartate aminotransferase activities. The principle of the method. Clinical and diagnostic value of these enzymes.
12. Determination of urea in urine.
13. Determination of bile pigments in urine. Explain the pathway bile pigments production in the body.
14. Qualitative reaction on phenylpyruvate. Clinical and diagnostic importance of this test.
15. Determination of the main components of nucleoproteins. Explain principle of the method.
16. Determination of uric acid in biological fluids (blood, urine). Explain principle of the method.
17. Quantitative determination of vitamin C in urine. The principle of the method.
18. Determination of the creatine in blood serum and in the urine. Explain the principle of the method.
19. Polymerase chain reaction (PCR). Explain the principle of the method.
20. Physico-chemical properties of urine: volume, color, odor, transparency, acidity (pH), its dependence from diet.