

# Portal: Questions for final examination in biochemistry

## I. PHYSICAL, BIOANORGANIC AND BIOORGANIC CHEMISTRY

1. Physical and chemical properties of water, its importance in human organism
2. Solubility of compounds, analytical and colloidal dispersions, diffusion, osmosis, dialysis, oncotic pressure, biochemical examples
3. Energetics of chemical reactions, enthalpy, entropy, Gibbs' energy, metabolic applications
4. Kinetics of reversible and consecutive reactions, chemical equilibrium, equilibrium law
5. Kinetics of chemical reactions, application to enzymology
6. Catalysts and biocatalysts, importance for biochemistry
7. Electrolytic dissociation, dissociation constant, strong and weak electrolytes, biochemical examples
8. Brønsted's theory of acids and bases, equilibrium in protolytic reaction biochemical examples
9. Ionic product of water, pH and its importance for medicine
10. Ampholytes, isoelectric point, biochemical examples
11. Buffer solution, pH calculation, importance in human organism
12. Oxidation and reduction, biochemical examples
13. Redox potential, dependency on the concentration of the reactants and pH, biochemical examples
14. Solubility product, biochemical examples
15. Complex formation, importance for biochemistry and medicine
16. Chemical properties of basic biogenic elements. Reactive forms of oxygen
17. Biologically and toxicologically important elements of the main groups of the periodic table
18. Biologically and toxicologically important nontransition elements. Nitrogen inorganic compounds of biological importance
19. Trace elements ? biological and metabolic importance
20. Structure of organic compounds, isomerism, examples in metabolic pathways
21. Relationship between structures and properties of organic compounds, biochemical examples
22. Medically and toxicologically important halogeno and nitroderivatives of hydrocarbons
23. Medically important sulphur-containing derivatives of hydrocarbons
24. Amines, importance in biochemistry
25. Alcohols, phenols, aldehydes, ketones, biochemical examples
26. Carboxylic acids, biochemical examples
27. Esters of carboxylic and inorganic acids, biochemical examples
28. Functional and substituted derivatives of carboxylic acids, biochemical examples
29. Importance of nitrogen, oxygen and sulphur-containing heterocycles
30. Proteogenic amino acids, division, structures, reactions, peptides, biological importance
31. Proteins - structure, properties and functions. Conformation of proteins, importance for their biological function
32. Saccharides, classification, structure, stereochemistry, biological importance
33. Reactions of saccharides, disaccharides, N- and O- glycosidic bond, examples
34. Homopolysaccharides and heteropolysaccharides
35. Proteoglycans, glycoproteins, structure, properties
36. Lipids, definition, classification, structure, properties, functions in human organism
37. Phosphatidic acid and its derivatives
38. Phospho- and glycosphingolipids, structure properties, function in human organism
39. Sterols, classification, structure, properties, functions in human organism
40. Bile acids and steroid hormones ? structure, properties and function in human organism

## II. METABOLISM

1. Structure of enzymes (coenzymes, oligomeric structure). Multiple forms of enzymes and isoenzymes. Medical application of enzymology
2. Enzymatic activity, influence of physical and chemical conditions, regulation (expression, allosteric effects, covalent modification)
3. Respiratory chain Oxidative phosphorylation
4. Energy-rich compounds, substrate level phosphorylation, drive of endergonic reactions
5. Citric acid cycle, amphibolic character of the citric acid cycle, regulation
6. Cell membrane - structure, assembly, function, transport across membranes
7. Common mechanisms of amino acids conversion, deamination, transamination, nitrogen balance
8. Formation and detoxification of ammonia, urea cycle and its regulation, hyperammonaemia
9. Catabolism of the carbon skeleton of amino acids, integration of amino acids into metabolic pathways
10. Amino acids of pyruvate, oxalacetate and 2-oxoglutarate family, their catabolism
11. Amino acids of succinyl CoA family, their catabolism
12. Metabolism of branched amino acids
13. Metabolism of phenylalanine and tyrosine, defects
14. Metabolism of tryptophan, major and minor pathways, defects in its resorption
15. Metabolism of sulphur-containing amino acids
16. Conversion of amino acids into special products (formation, conversion and importance of creatine, formation,

- conversion and importance of S-adenosylmethionine)
- 17. Biosynthesis, biodegradation and function of the most important biogenic amines and catecholamines
- 18. Glycolysis, regulation
- 19. Gluconeogenesis, regulation
- 20. Degradation and synthesis of glycogen, regulation, defects
- 21. Pentose phosphate pathways, regulation
- 22. Metabolism of galactose and fructose, defects
- 23. Metabolism of glucuronic acid and its metabolic importance
- 24. Biosynthesis "de novo" of saturated fatty acids, regulation. Origin of acetyl CoA for biosynthesis of palmitate
- 25. Palmitate as substrate for synthesis of unsaturated fatty acids and long-chain fatty acids
- 26. Formation of ketone bodies from acetyl-CoA, metabolic causes and importance
- 27. Carnitine system, oxidation of fatty acids, energy balance
- 28. Biosynthesis, conversion and transport of triacylglycerols
- 29. Structure, metabolism and function of phosphatide acid and phospholipids
- 30. Biosynthesis of sphingosine, sphingolipids, structure, properties and function in organism
- 31. Synthesis and degradation of eicosanoids, cyclooxygenase and lipoxygenase pathways
- 32. Biosynthesis of cholesterol and its regulation, role of HMG-CoA reductase. Transport of the endogenous and exogenous cholesterol
- 33. Conversion and excretion of cholesterol, bile acids
- 34. Biosynthesis, degradation and function of steroid hormones
- 35. Transport of lipids, role of lipoproteins, structure of lipoprotein particles. Formation, conversion, and role of chylomicrons, VLDL, LDL and HDL lipoproteins
- 36. Biosynthesis of hem, defects of synthesis, porphyrias
- 37. Degradation of tetrapyrroles, hyperbilirubinaemia, jaundices
- 38. Pyrimidine nucleotides, metabolism, regulation, inhibitors, defects
- 39. Purine nucleotides, metabolism, regulation, inhibitors, defects
- 40. Biosynthesis of deoxyribonucleotides and its regulation, inhibitors

### **III. FUNDAMENTALS OF ORGAN AND FUNCTIONAL BIOCHEMISTRY.**

- 1. Regulation and coordination of carbohydrate and lipid metabolism
- 2. Glycaemia and its regulation. Glucose tolerance test. Glycosylated haemoglobin
- 3. Metabolic interrelation between glucose and other nutrients; Cori cycle
- 4. Metabolism of fat tissue
- 5. Regulation of haeme biosynthesis; differences between the hepatocyte and erythroid cell; iron metabolism
- 6. Regulation of metabolism at the neurohumoral level, integration systems of the organism
- 7. Hormonal regulation of water and mineral metabolism
- 8. Hormonal regulation of bone metabolism
- 9. The integration of metabolism and the provision of tissue fuel
- 10. Biochemical processes in the stomach; gastric juice; gastric mucins, acid-resistant lipases
- 11. Intestinal digestion; role of the pancreas in the digestion
- 12. Biochemical functions of hepatocytes and liver; assessment of liver function and damage
- 13. Biotransformation of endogenous and exogenous compounds; phases of the biotransformation. Toxic and carcinogenic compounds in the environment
- 14. Buffer systems of the organism
- 15. Bicarbonate system, its significance in maintaining the acido-base balance
- 16. The role of haemoglobin, proteins and phosphates in maintaining the acido-base balance
- 17. Erythrocyte metabolism
- 18. Haemocoagulation
- 19. Urine, properties and its physiological and pathological constituents
- 20. Collagen family ? structure, properties, metabolism, function
- 21. Adhesive glycoproteins of the extracellular matrix
- 22. Biochemistry of the cartilage and bone
- 23. Biochemistry of the skin. Biochemical basis of touch
- 24. Contractile apparatus, the control of smooth and skeletal muscle contraction
- 25. Biochemistry of vision - Wald cycle, transducin cycle, the role of cGMP-gated ion channels
- 26. Biochemistry of hearing
- 27. Biochemistry of olfaction
- 28. Biochemistry of taste
- 29. Biochemical events in the synapsis; neurotransmitters
- 30. Receptors ? structure and function
- 31. Steroid hormones and their functions in regulatory processes
- 32. Peptide hormones and their functions in regulatory processes
- 33. Thyroid hormones and their functions in regulatory processes
- 34. Prostaglandins, thromboxanes, leukotrienes, lipoxins. Hydroxyepoxytriene acids
- 35. Molecular basis of the humoral immune response
- 36. Molecular basis of the cellular immune response
- 37. Lipid-soluble vitamins
- 38. Water-soluble vitamins
- 39. Structure, constituents and properties of cell membranes
- 40. Membrane transport

### **IV. BASIC CELLULAR AND MOLECULAR BIOLOGY**

1. Signal transduction, membrane receptors and their ligands, G-proteins
2. Second messenger pathways and signal transduction
3. Signalling using Ras proteins, cascade of kinases, JAK-STAT signaling pathway
4. Activation of phospholipases in signal transduction
5. NO signalling. Overview of signalling pathways and significance
6. Intracellular receptors and their ligands, HSP, interactions of intracellular receptors with DNA
7. Intercellular communication
8. Structure and function of nucleic acids
9. Organization of prokaryotic, eukaryotic and mitochondrial genome
10. Replication of eukaryotic DNA, DNA replication apparatus and its regulation
11. DNA repair
12. Transcription of eukaryotic DNA, transcription apparatus and its regulation, cis- and trans-regulation elements
13. mRNA, structure, synthesis, posttranscriptional modifications, RNA interference
14. Regulation of gene expression at the level of transcription
15. Genetic code and its properties
16. Eukaryotic, prokaryotic and mitochondrial translation
17. Regulation of gene expression at the level of translation, inhibitors of translation, antibiotics as translation inhibitors
18. Posttranslational modification of proteins
19. Protein transport and targeting, modification and sorting of proteins in Golgi apparatus
20. Biosynthesis of glycoproteins, their structure and significance
21. Restriction enzymes and their usage, DNA modification and construction of recombinant DNA molecules
22. DNA cloning, transfer of foreign genetic information into bacterial and mammalian cells
23. DNA diagnostics, techniques, RFLP
24. Gene therapy, transfer of the genetic material in gene therapy
25. Blotting, hybridization techniques and their application in clinical diagnostics, hybridization probes
26. Methods of cell fractionation, electrophoretic analysis of nucleic acids and proteins
27. Polymerase chain reaction, PCR applications in clinical diagnostics, RT-PCR and application of this technique, DNA sequencing
28. Hereditary diseases and their diagnostics
29. Hereditary predisposition to cancer and its diagnostics
30. Types of human gene mutations, hereditary and somatic mutations
31. Polymorphisms, significance and detection, minisatellite and microsatellite markers and their analysis
32. Retroviruses and pararetroviruses, structure and replication
33. Protooncogenes and tumor suppressor genes
34. Cell cycle, cyclins and cdks complexes
35. Regulation of cell cycle, the role of tumor suppressor genes
36. Ubiquitination and proteasomal degradation of proteins
37. Apoptosis, initiation, control and effector phase, death receptors and their ligands, caspases
38. Apoptosis, intrinsic and extrinsic activation pathways, the role of mitochondria in apoptosis
39. Epigenetics, DNA methylation, histone modifications, epigenetic effects in humans
40. DNA recombination, the roles of homologous and nonhomologous recombination