MEDICAL UNIVERSITY OF PLOVDIV
FACULTY OF PHARMACY
DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY

QUESTIONNAIRE IN BIOCHEMISTRY
FOR STUDENTS OF PHARMACY FOR 2017/2018 ACADEMIC YEAR

1. Protein functions. Hetero-, iso- and aloproteins. Peptides, polypeptides and proteins. Amino acids as structural units of the proteins. Classification according to the chemical nature of the radical and the polarity at pH 7.0. Levels of organization of the protein molecule. Primary structure of the proteins.

2. Conformation. Properties of the peptide bond. Secondary structure. α-helix, β-sheet and random coil characterization. Tertiary structure – types of chemical bonds involved in it. Fibrous and globular proteins.

3. Quaternary structure – role in the regulation of the biological activity of the proteins. Maintaining mechanisms in the conformation of the proteins – involved enzymes and chaperons. Importance of the relation between structure and function of the proteins in medicine. Defects in receptor (familial hypercholesterolemia, diabetes insipidus). Diseases due to abnormal conformation (prion disease, Alzheimer's disease). Expression of point mutations (sickle cell anemia). Defects in post-translational processing of proteins (scurvy and glycosylated hemoglobin).

4. Isoelectric point and protein precipitation. Denaturation. Electrophoresis. Electrophoretic profiles of serum proteins, role in diagnosis. Chromatography. Principles of qualitative and quantitative analysis of proteins.

5. Nucleic acids – types and biological role. Chemical composition, chemical bonds in and between nucleotides. Free nucleotides with important biological meaning. Features of polynucleotide chains. Watson and Crick model. Purine and pyrimidine analogues as anticancer and antiviral agents.

6. Primary structure of nucleic acids. Conformation of DNA and different types of RNA. Nucleosomes. Importance of histone and nonhistone proteins for maintenance of the DNA conformation. Denaturation and renaturation of DNA. Hyperchromic effect and melting point. Ribozymes – role in the process of RNA maturation and their potential uses as inhibitors of gene expression.

7. Characteristics of enzymes as biological catalysts. Coenzymes and prosthetic groups. Enzyme names and classification. Mechanisms of enzyme catalysis. Enzyme–substrate complex. Active site. Specificity of enzyme action.

8. Water soluble vitamins (B_1, B_2, B_6, B_{12}, H, PP, C, pantothenic acid, folic acid). Coenzymes, vitamin derivatives.

9. Enzyme reactions kinetics. Dependence of the enzyme reaction rate on time, temperature, pH, enzyme concentration, substrate concentration. Michaelis – Menten equation about enzyme reaction velocity. Michaelis constant. Lineweaver – Burk plot (equation).

10. Reversible and irreversible inhibition. Competitive and noncompetitive inhibitors. Vmax and Km in the presence of competitive and uncompetitive inhibitor. Enzyme activators.

11. Enzyme activity regulation. Regulation of absolute enzyme amount – constitutive and inducible enzymes. Factors affecting the half-life of enzymes. Regulation of catalytic activity by compartmentalization and shuttle mechanisms, polyenzymatic complexes, phosphorylation – dephosphorylation and allosteric control. Retroinhibition.

12. Clinical significance of enzymes. Abnormal intracellular enzymes in serum (myocardial infarction, hepatitis). Changes of the typical functional serum enzymes. Diagnostic significance of isoenzymes (creatine phosphokinase and lactate dehydrogenase). Hereditary enzyme diseases (Gout, Lesch-Nyhan syndrome). Use of restrictases for proof of gene defects. Application of enzymes in therapy and medicines production. Therapy with enzymes antioxidants. Enzymes and enzyme inhibitors in cancer therapy.

13. Bioenergetics. Features of organisms as open chemical systems. The first and the second laws of thermodynamics and their application in living organisms. Coupling of endergonic with exergonic processes using macroergic compounds. Types of macroergic bonds and compounds. Central role of the system ATP/ADP.

14. Characteristics of biological oxidation. Substrates of biological oxidation and final hydrogen acceptors. Oxidoreductases. Important redox systems: NAD^+/NADH, $NADP^+$/NADPH, FMN/FMN.H_2, FAD/$FADH_2$, CoQ/$CoQH_2$, heme groups in cytochromes, lipoate, ascorbate.

15. Oxidative phosphorylation at substrate level: oxidative phosphorylation of glyceraldehyde-3-phosphate, enolase reaction, oxidative decarboxylation of α-keto acids (pyruvate dehydrogenase complex; role of the cofactors TPP, lipoate, CoA, FAD and NAD^+).

16. Respiratory chain – localization, function and molecular structure. Places for proton translocation. Oxidative phosphorylation coefficient (P/O). Respiratory control, phosphate potential. Inhibitors of electron transportation (barbiturates, antimycin A, KCN). Effect of barbiturates and alcohol combination. Mitochondrial diseases.

17. Chemiosmotic theory for the mechanism of oxidative phosphorylation in the respiratory chain. ATP synthase. Effect of uncoupling agents (2,4-dinitrophenol). Natural uncoupling agents. Oxidative phosphorylation inhibitors (oligomycin).

18. Free oxidation. Heat production. Role of thermogenin in mitochondria of brown adipose tissue. Electron transport in endoplasmic reticulum. Generation and neutralization of superoxide, hydrogen peroxide and hydroxyl free radical.

19. Citric acid cycle – importance in catabolism and anabolism. Chemical reactions, metabolic and energetic balance. Regulation mechanisms. Pyruvate dehydrogenase deficiency.

20. Glucose metabolism – absorption in the intestinal tract and glucose transport systems. Glycolysis – importance, chemical reactions, energy production under anaerobic and aerobic conditions. Tissue specificity of glycolysis. Metabolic fate of NADH, lactate and pyruvate. Relationship between glycolysis and respiratory chain – hydrogen transfer shuttle systems

from cytoplasm to mitochondria (malate-aspartate and glycerophosphate shuttle). Pasteur effect. Lactic acidosis. Hemolytic anemia caused by pyruvate kinase deficiency. Cancer and glycolysis.

21. Gluconeogenesis. Cellular compartmentalization and tissue localization. Importance. Overcoming the irreversible steps of glycolysis. Gluconeogenesis regulation. Gluconeogenesis substrates. Role of gluconeogenesis in the kidney. Fructose-1,6-bisphosphatase deficiency, hypoglycemia and premature babies, hypoglycemia and alcohol toxicity.

22. Pentose phosphate pathway. Importance. Oxidative, isomerase and transferase reactions. Glucose-6-phosphate dehydrogenase deficiency.

23. Galactose and fructose metabolism. Galactosemia. Essential fructosuria. Fructose intolerance.

24. Glycogen metabolism - degradation and synthesis. Muscles and liver peculiarities. Regulation. Glycogenoses.

25. Regulation of carbohydrate metabolism and blood sugar level. Involvement of the different tissues and organs. Cori cycle. Regulatory enzymes and hormones. Features of carbohydrate metabolism in various tissues.

26. Lipids – classification. Lipid digestion – enzymes. Lipid transport in the body. Composition, origin and functions of lipoprotein complexes. Lipoprotein complexes receptors. Familial hypercholesterolemia.

27. Cholesterol synthesis. Regulation. Removal from the body.

28. Cholesterol derivatives (steroid hormones, vitamin D, bile acids) – structure, synthesis and biological role.

29. Triacylglycerol metabolism - degradation and biosynthesis. Hormone-sensitive adipocyte lipase. Glycerol metabolism.

30. Oxidation of fatty acids with even and odd number of carbon atoms. Energetic balance. Enzyme defects of the oxidation.

31. Ketone bodies metabolism. Ketogenesis. Utilization and oxidation of ketone bodies in extrahepatic tissues. Ketonemia and ketonuria. Ketoacidosis during fasting and diabetes.

32. Fatty acids biosynthesis. Citrate shuttle. Role of acetyl-CoA carboxylase. Acylsintase – multifunctional enzyme. Desaturation of fatty acids. Essential fatty acids deficiency.

33. Metabolism (synthesis and degradation) of glycerophosphatides. Biological role of phospholipases A_1, A_2, C and D. Eicosanoid synthesis and biological activity. Cyclic and linear pathway of formation. COX-1 and COX-2 inhibitors. Sphingolipids – types, structure and importance. Sphingolipidoses.

34. Lipid metabolism disorders. Atherosclerosis, tissue ischemia and myocardial infarction. Obesity. Role of leptin in obesity. Fatty liver.

35. General reactions of amino acids degradation: oxidative deamination, transamination, transdeamination, decarboxylation - biogenic amines. Clinical significance of aminotransferases.

36. Ammonia detoxification by glutamate dehydrogenase reaction, glutamine synthesis, urea cycle and ammoniagenesis. Role of the liver, muscles and kidneys in the detoxification of ammonia. Relationship between urea cycle and citric acid cycle. Regulation of urea cycle.

37. General pathways for degradation of amino acid C-skeletons. Glucogenic and ketogenic amino acids. One-carbon-atom residues – types, sources, importance. Role of the S-adenosyl methionine derivatives and folic acid derivatives. Therapeutic application of folate analogues. Phenylalanine and tyrosine catabolism- phenylketonuria, tyrosinosis, alkaptonuria, albinism. Catabolism of tryptophan - pellagra.

38. Amino acids synthesis. Nonessential and essential amino acids. Common reactions in the synthesis of amino acids. Selenocysteine. Metabolism of arginine (synthesis of creatine phosphate, citrulline, nitric oxide, polyamines) and serine (synthesis of ethanolamine, choline, phospholipids).

39. Conversion of amino acids in specialized products – tryptophan (synthesis of NAD^+, serotonin, melatonin), tyrosine (synthesis of thyroid hormones, catecholamines, dopamine, melanins). Glutathione as a reducing agent and antioxidant. Glutamyl cycle. Products of glutamine and glutamate metabolism.

40. Purine nucleotide biosynthesis and degradation. Enzyme defects in purine metabolism (immunodeficiencies). Tissue specificity. Regulatory enzymes of biosynthesis. Purine analogues as antiviral agents. Hyperuricemia due to enzyme defects (Gout, Lesch-Nyhan syndrome). Xanthine oxidase inhibition. Biological role of uric acid.

41. Pyrimidine nucleotide biosynthesis and degradation. Regulatory enzymes. Allosteric response and orotic aciduria.

42. Porphyrins biosynthesis. Cellular localization and regulation of the biosynthesis pathway. Types of porphyrias.

43. Hemoglobin degradation. Bile pigments. Transportation of bile pigments in the body. Jaundice.

44. Integration of metabolism. Relationships between the metabolism of carbohydrate, lipids, amino acids and nucleotides. Role of key metabolites and key enzymes.

45. Integration of metabolism. Tissue and organ specificity. Adaptation during starvation.

46. Principles of intercellular communication and signal transduction. Organization and participants in signaling pathways. Types of extracellular signals. Membrane and intracellular receptors. Secondary messengers. Cyclic AMP (cAMP), adenylate cyclase system and G-proteins. Nitric oxide and cyclic GMP (cGMP).

REFERENCE FOR SELF - STUDY

1. Lecture course in Biochemistry for students of pharmacy by Assoc. prof. A. Bivolarska, MD, PhD, Chief ass. prof. G. Delcheva, PhD, academic year 2017/2018.
2. Ferrier D. ***Lippincott Biochemistry*** *6th Edition.* Editor R. Harvey. 2014.
3. Rodwell V, D Bender, K Botham, P Kennelly, P Weil. ***Harper's Illustrated Biochemistry***. 30th Edition., 2015.