QUESTIONS FOR ORAL PART OF EXAM FROM "MEDICAL CHEMISTRY"

study branch - GENERAL MEDICINE

academic year 2020-2021

1. Chemical bond - definition of coordination bond, explanation of the terms central atom, ligand and coordination number. Explanation of the term chelating ligand (two examples of biologically important chelating ligands). Characteristics of hydrogen bond, the importance of hydrogen bond in biological systems (two examples).
2. Natrium, potassium and sulfur - physiological function of sodium and potassium, biologically important molecules containing sulfur (at least 4), application of sodium thiosulphate in medicine.
3. Calcium, magnesium and phosphorus - physiological function of calcium, compounds in which calcium is found in bones and teeth. Physiological function of magnesium. Biologically important compounds containing phosphorus (examples).
4. Iron - deficiency and excess of iron (causes and consequences). Functions of transferrin and ferritin. Description of heme, functions of hemoglobin and 2 examples of pathological derivatives of hemoglobin. Function of catalase (including corresponding reaction).
5. Copper - Wilson's disease, therapy of Wilson's disease (the name and formula of the compound used in the Wilson's disease treatment). Functions of ceruloplasmin and cytochrome c oxidase. Function of Cu/Zn-SOD (including the summary reaction catalyzed by the enzyme and 2 steps in which it runs), carbonic anhydrase and alcohol dehydrogenase (including corresponding reactions).
6. Zinc, cobalt and manganese – physiological function of zinc in general. Functions of carbonic anhydrase and alcohol dehydrogenase (including corresponding reactions). Form of cobalt occurrence in the organism, functions. Function of manganese.
7. Toxic elements - the factors influencing the toxicity of metal ions and the reasons of their toxicity (what is the metal ions toxicity based on). Chelation therapy – what are chelating agents from the chemical point of view, basic principles that define efficiency of chelating agents. 3 examples of therapeutic chelating agents.
8. Dispersed systems - classification and properties, Tyndall effect, physiological solution, isotonic, hypotonic and hypertonic environment and behavior of erythrocytes in these environments
9. Dispersed systems - true solutions, characteristics, properties, colligative properties of solutions - diffusion, osmosis, dialysis, osmolarity, osmotic pressure, ionic strength
10. Dispersed systems - colloidal solutions, their properties and types, sols, gels, foam, emulsions, emulsification process, biologically important emulsifiers and their role in the organism.
11. Dispersed systems - classification of colloids according to the affinity of dispersed molecules with dispersion medium, properties of individual groups, oncotic pressure, formation of edema, examples of colloids in the organism

12. Mechanism of redox processes, significance of redox potential. Biological oxidations and their importance in metabolic processes. Factors influencing the rate of chemical and biochemical reactions, mechanism of catalysis, biocatalysis.
13. Concept of equilibrium of chemical and biochemical reactions. Equilibrium constant and its meaning. Disturbing the chemical equilibrium, Le Chatelier´s principle and its application in physiology.
14. Acid-base equilibrium in organism - theories of acids and bases, ion product of water and its meaning, strength of acids and bases, pH scale and calculation of pH.
15. Effects of pH changes on organism, Buffer solutions - their composition, function and mechanism of effect, buffer capacity. Henderson-Hasselbalch equation.
16. Buffers and control of pH in organism - the main buffers in biological system, their composition and mechanism of their effect.
17. Organism as thermodynamic system - characteristics of a biological system from thermodynamic point of view. Energy conversion and energy utilization in living systems. The 1^{st} law of thermodynamics, internal energy, Hess law. Exothermic and endothermic reactions.
18. The 2^{nd} law of thermodynamics, entropy and biological system, mutual relationship between information and entropy. Gibbs free energy, standard Gibbs free energy, spontaneity of reactions.
19. Gibbs free energy and effect of reactant and product concentrations. Coupling of exergonic and endergonic reactions. Importance of ATP and its hydrolysis. Another energy rich compounds.
20. Reactivity of organic compounds – reactive site in a molecule, the factors influencing reactivity (inductive and mesomeric effects).
21. Halogen- and hydroxyderivatives of hydrocarbons – biochemically and toxicologically significant structures and reactions (alcohols, phenols).
22. Oxo compounds – biochemically and toxicologically important structures and reactions (aldehydes, ketones, hemiacetals/acetals, aldol condensation).
23. Carboxylic acids – biochemically important structures, reactions (formation of carboxylic acids, decarboxylation, explain term acyl) and biological function.
24. Functional derivatives of carboxylic acids – biologically significant structures. Urea and its derivatives.
25. Substitutional derivatives of carboxylic acids – structure and biochemically significant reactions of hydroxy and oxo acids.
26. Organic compounds containing nitrogen and sulfur (biologically important amines, thiols) – structure and biochemically significant properties (reactions). Biologically significant heterocyclic structures and their derivatives.
27. Biological properties of monosaccharides, isomeric forms and their biochemically important reactions (formation of esters with trihydrogen phosphoric acid, formation of glycoside bonds).
28. Reduction of monosaccharides. Oxidation of monosaccharides (glucuronic acid – its structure and properties).

29. Glycosides – disaccharides, homopolysaccharides (homoglycans). Their structure and biological importance.
30. Heteropolysaccharides (heteroglycans) – monomeric units, classification into the classes, biological importance of heparin.
31. Glycoconjugates – basic structure, proteoglycans and glycoproteins, importance of saccharide component in glycoconjugates.
32. Lipids - functions and classification. Simple lipids - non-hydrolyzable and hydrolyzable. Structure, properties and importance.
33. Phospholipids - classification according to the basic alcohol and the nature of the non-lipid component, structure and biological function.
34. Glycolipids - classification according to the basic alcohol and the nature of the non-lipid component, structure and biological function.
35. Biomembranes - structure, asymmetry of cell membranes, lipid rafts and biological function. Classification and importance of cell membrane proteins.
36. Lipoproteins - basic characteristics of the structure of a lipoprotein particle, classes of lipoproteins according to their density and their biological functions.
37. Arachidonic acid, scheme of eicosanoids formation, their biological significance and practical application. Structure and biological function of prostaglandins.
38. Terpenes - important structures, biological function, relation to lipid-soluble vitamins. Steroids - basic structure and stereo structure, classification and biological functions of individual groups of steroids.
39. Biochemically important reactions of amino acids (decarboxylation deamination, peptide bond formation).
40. Peptides –, biological function. Peptide hormones. Glutathione – structure, biological function.
41. Proteins, basic characteristics, classification, structure (primary, secondary, tertiary, quaternary structure biological functions.
42. Heteroproteins, division into groups and their function.
43. Haemoproteins – classification, characteristic and biological function. Hemoglobin, myoglobin, cytochromes. Proteins of blood plasma and immunoglobulins – basic structure and biological function.
44. Nucleic acids – characteristics, the structure of basic structural units, tautomeric forms and complementarity of purine and pyrimidine bases, minority bases.
45. DNA – characteristics, structure, Chargaff´s rules, DNA types, biological function.
46. Chemical modification of nucleotides. Chemical and physical mutagens.
47. RNA – structure, types (m-RNA, r-RNA, t-RNA), biological functions.
48. Classification of vitamins according to their solubility - individual names of vitamins, and the most important biological functions of individual vitamins. Antivitamins
49. Vitamin A - retinol, mechanism of vision. Vitamins D, their activation and functions.
50. Vitamin E, vitamin K - biochemical and physiological significance (vitamin K cycle).

51. B vitamins (B_1, B_2, B_6, B_7, B_{12}). Biochemical and physiological significance and their functions.
52. Niacin, pantothenic acid, folic acid - biochemical and physiological significance.
53. Biochemical and physiological significance of vitamin C. Oxidation-reduction function in cells, cooperation with vitamin E.
54. Coenzymes NAD^+/ NADH, $NADP^+$/NADPH, their structure, mechanism of action. Coenzyme Q.
55. Coenzymes transferring groups of atoms - adenosine phosphates as coenzymes not derived from vitamins (ATP, ADP, AMP, cAMP). Lipoic acid - biochemical and physiological significance.
56. Simple enzymes and holoenzymes. Mechanism of enzyme reaction. Kinetics of enzyme reactions - Michaelis - Menten equation and graphical evaluation of the K_M constant (according to Michaelis - Menten and Lineweaver -Burke).
57. Catalytic (active) site of the enzyme - the theory of substrate-enzyme binding. Influence of apoenzyme and coenzyme structure on enzyme activity - specificity of enzymes. Isoenzymes - biological significance, write examples.
58. Physicochemical factors influencing the activity of enzymes. Characteristics, graphs of the dependence of the reaction rate on a given factor.
59. Inhibition of enzymes - classification, inhibition by iodoacetamide and diisopropyl fluorophosphate.
60. Inhibition of enzymes - competitive, non-competitive, un-competitive. Characteristics of individual types, graphs of the dependence of the reaction rate on the substrate concentration.
61. Types of regulation of enzyme activity without changing the number of enzyme molecules. Participation of metal ions in the activation of enzymes. Compartmentalization of enzymes
62. Covalent modifications of enzyme activity (e.g. phosphorylation and dephosphorylation). Limited proteolysis, mechanism of activation of some proteolytic enzymes (pepsinogen and chymotrypsinogen) and their importance for protein metabolism.
63. Types of regulation of enzyme activity with changing the number of enzyme molecules. Inductive and constitutive enzymes, induction, repression, organelles of protein degradation, classification and specificity of proteases
64. Allosteric regulation of enzyme activity. Cooperative and sequential model of allosteric activation. Conversion of isocitrate to α-ketoglutarate - enzyme activators and inhibitors. Feed-forward activation, feed-back inhibition.
65. Classification and nomenclature of enzymes, examples of reactions catalyzed by individual classes of enzymes.
66. Multisubstrate reactions, ternary complex and ping-pong mechanisms, write an example.
67. Importance of enzymes in biochemistry and medicine (use of allopurinol, aspirin, ethanol), enzyme disorders (lactose and sucrose intolerance).