

ORAL QUESTIONS FOR EXAMINATION FROM BIOCHEMISTRY

DENTISTRY

BIOLOGIC OXIDATIONS

- 1. Ways of oxidation of compounds in cells, enzymes and coenzymes of oxidation-reduction reactions**
 - ✓ three mechanisms of oxidation
 - ✓ expression of oxidation-reduction potential
 - ✓ formulas of basic coenzymes of oxidoreductases (flavin coenzyme, NAD)
 - ✓ enzymes of oxidation-reduction reaction – to each group one example
- 2. Electron transfer in respiratory chain, terminal oxidation, Mitchell theory**
 - ✓ composition of carriers for electrons in respiratory chain
 - ✓ principle of organization of carriers in terminal oxidation
 - ✓ in scheme explain transport of electrons from $\text{NADH}+\text{H}^+$ to oxygen according to Mitchell theory
- 3. Synthesis of ATP in the process of oxidative phosphorylation**
 - ✓ principle of generation of proton gradient
 - ✓ use of proton gradient for synthesis of ATP
 - ✓ function of basic subunits of mitochondrial ATP-ase (reaction in formulas)
 - ✓ inhibitors of terminal oxidation and action of uncouplers and their consequence
- 4. Energy rich compounds – their synthesis and significance**

Types of energy rich bonds

 - ✓ to each type one compound in formula
 - ✓ reaction how this compound is formed and examples where is used (for each group at least one example)
- 5. Transport across biological membranes**

Types of transport

 - ✓ passive (to each type two examples)
 - simple diffusion
 - facilitated diffusion
 - ✓ active
 - primary
 - secondary
 - ✓ transport of macromolecules across membrane
 - exocytosis – examples
 - endocytosis – examples
 - ✓ group translocation
 - ✓ transport
 - of reducing equivalents into mitochondria
 - of acetyl-CoA into cytosol

CITRIC ACID CYCLE

6. Sources for acetyl-CoA synthesis, main ways of acetyl-CoA utilization

Immediate reactions of synthesis of acetyl-CoA from

- ✓ glucose
- ✓ fatty acids

The first step of utilization of acetyl-CoA in

- ✓ the main process for synthesis of ATP
- ✓ fatty acids synthesis
- ✓ ketone bodies synthesis

7. Conversion of pyruvate into acetyl-CoA, enzymes and coenzymes of pyruvate dehydrogenase complex

Reaction

- ✓ all the steps during synthesis of acetyl-CoA from pyruvate
- ✓ fate of acetyl-CoA in scheme
 - in ↑ [ATP]
 - in ↓ [ATP]

8. Oxidation of acetyl-CoA in mitochondria – reactions of Krebs cycle

Complete cycle in formulas, names of enzymes

- ✓ formula of acceptor of hydrogens from coenzyme of isocitrate dehydrogenase (ICDH), 2-ketoglutarate dehydrogenase (GDH) and malate dehydrogenase (MDH)

9. Significance of citric acid cycle for energy metabolism, energy yield and regulation of Krebs cycle

Completely in formulas, enzymes, regulatory enzymes

- ✓ formula of acceptor of hydrogens from coenzyme of succinate dehydrogenase

10. Meaning of citric acid cycle for metabolism of carbohydrates, lipids and amino acids

Completely in formulas, names of enzymes

- ✓ meaning of Krebs cycle for energy yield from glucose and fatty acids (palmitate)
- ✓ role of Krebs cycle in synthesis of glucose from methionine

CARBOHYDRATES

11. Sources of carbohydrates in food, digestion of carbohydrates and their absorption from the intestine

In formulas

- ✓ final product of starch (glycogen) hydrolysis by amylase
- ✓ production of free glucose in GIT
- ✓ absorption of glucose in scheme

12. Degradation of glucose by glycolysis in aerobic conditions (reactions, enzymes)

Completely in reactions, names of enzymes, energy yield

- ✓ next fate of pyruvate

13. Significance of aerobic glycolysis for energy metabolism of the cell, energy yield of glycolysis in aerobic conditions

Glycolysis reaction completely in formulas

- ✓ name of enzymes
- ✓ energy yield of glycolysis
- ✓ energy yield of complete oxidation of glucose
- ✓ next fate of pyruvate

14. Degradation of glucose by glycolysis in anaerobic conditions, energy yield, further utilization of lactate

- ✓ reactions of glycolysis completely in formulas and name of enzymes
- ✓ energy yield of glucose oxidation in anaerobic conditions
- ✓ next fate of lactate
 - in liver
 - in myocardium

15. Metabolic and hormonal regulation of glycolysis

Reaction of glycolysis

- ✓ names of regulatory enzymes
- ✓ activators + inhibitors
- ✓ hormones regulating glycolysis including mechanism of their action

16. Reversibility of reactions of glycolysis, bypass of irreversible reactions in gluconeogenesis

- ✓ write irreversible reactions of glycolysis
- ✓ reactions what by pass these steps in gluconeogenesis + their organ and subcellular location
- ✓ main substrates for gluconeogenesis
- ✓ basic regulation

17. Gluconeogenesis – utilization of noncarbohydrate compounds for glucose synthesis, inter-organ cooperation

- ✓ reactions typical for gluconeogenesis
- ✓ main substrates
- ✓ the first reaction which allows utilization of part TAG for gluconeogenesis
- ✓ in scheme how amino acids can be used for gluconeogenesis (through intermediates of Krebs cycle)
- ✓ explain if ketone bodies can be used for gluconeogenesis and why

18. Metabolic and hormonal regulation of gluconeogenesis

- ✓ regulatory enzymes
- ✓ the role of hormones in regulation of gluconeogenesis including mechanism of their action
- ✓ reactions in formulas

19. Synthesis of carbohydrate stores in the body and their mobilization, synthesis and degradation of glycogen

- ✓ in formulas both – synthesis and degradation
- ✓ difference between muscle and liver glycogen
- ✓ regulatory enzymes and their control

20. Metabolic and hormonal regulation of glycogen metabolism

- ✓ synthesis and degradation in formulas
- ✓ regulatory enzymes
- ✓ hormones which influence glycogen metabolism including mechanism of their action
- ✓ differences in the regulation of glycogen metabolism between muscle and liver

21. Pentose phosphate pathway and its significance

- ✓ reactions + enzymes till ribose 5-phosphate including formula of coenzyme
- ✓ meaning of pentose phosphate pathway
- ✓ name at least 5 processes where products of pentose phosphate pathway are used

22. NADPH – synthesis in the cell and significance for cellular metabolism

NADPH₂-formula

- ✓ write in formulas reactions where NADPH₂ is formed
- ✓ name processes where NADPH₂ is used
 - in lipid metabolism (one of those reactions in formulas)
 - in nucleotide metabolism

23. NADPH – synthesis in the cell and significance for cellular metabolism

NADPH₂-formula

- ✓ write in formulas reactions where NADPH₂ is formed
- ✓ name processes where NADPH₂ is used
 - in lipid metabolism (one of those reactions in formulas)
 - in nucleotide metabolism
- ✓ explain role of NADPH₂ as antioxidant defense
 - role of NADPH₂ in phagocytosis
 - in scheme explain role of NADPH₂ in biotransformation

24. Hormonal regulation of blood glucose level

- ✓ hormone secreted in hyperglycaemia and its effects
- ✓ receptor
- ✓ role in carbohydrate metabolism (one of reactions activated by insulin in formulas)
- ✓ role in lipid metabolism
- ✓ hormones secreted in hypoglycaemia and their effect (including mechanism of their action)
- ✓ receptors
- ✓ role in carbohydrates metabolism name all enzymes influenced by these hormones

25. Defects of hormonal regulation of glucose metabolism – diabetes mellitus and its metabolic consequences

- ✓ explain what is the most frequent defect in blood glucose regulation
- ✓ types of diabetes
- ✓ consequences of hyperglycaemia
 - short term
 - long term
- ✓ explain cause of metabolic acidosis in diabetes including formulas of compounds causing acidosis

LIPIDS

26. Digestion and absorption of lipids in the intestine, transport of exogenous lipids in the body

- ✓ in formulas reaction catalyzed by pancreatic lipase
- ✓ role of bile acids in lipid digestion
- ✓ name of the enzyme + reaction required for utilization of dietary fats by peripheral tissues

27. Oxidation of fatty acids – activation, transport into mitochondria, β-oxidation

- ✓ organ and subcellular location of oxidation of fatty acids (FA)
- ✓ activation of FA including intermediate of activation
- ✓ transport into place of oxidation
- ✓ reactions of β-oxidation
- ✓ odd carbon FA oxidation

28. Significance of β -oxidation for the energy metabolism of the cell, energy yield of β -oxidation

- ✓ reactions of β -oxidation
 - activation of FA
 - transport
 - oxidation – enzymes and coenzymes
- ✓ energy yield
 - principle for calculation
 - calculate energy yield of stearic acid
- ✓ regulation of β -oxidation

29. Utilization of cholesterol in the body, synthesis of bile acids

- ✓ formula of cholesterol
- ✓ name all processes where cholesterol is used in human organism
- ✓ conversion of cholesterol in the liver, meaning of products
 - regulatory enzyme
 - conjugation and meaning of this process
- ✓ utilization of cholesterol in endocrine glands

30. Lipoproteins – composition, synthesis and significance of individual lipoproteins

- ✓ composition
 - lipid
 - protein (types of apoproteins and their roles)
- ✓ types of lipoproteins
 - synthesis of lipoproteins (organ) and their roles
 - utilization of lipoproteins in the organism including reaction required for utilization of exo- and endogenous TAG

31. Transport of cholesterol in the body, role of lipoproteins in cholesterol metabolism

- ✓ explain risk role of LDL and protective role of HDL
- ✓ factors influencing level of LDL and HDL

32. Transport of exogenous and endogenous triacylglycerols and roles of apoproteins in their metabolism

- ✓ types of lipoproteins which transport TAG
- ✓ organs where are formed
- ✓ utilization of TAG from lipoproteins by peripheral tissues + enzyme required for utilization
- ✓ factors which influence this process

33. Roles of liver and adipose tissue in lipid metabolism, synthesis of lipid stores and their mobilization

- ✓ organ and subcellular location
- ✓ synthesis of TAG source of alcoholic component, difference between adipose and liver tissues
- ✓ reactions of TAG synthesis
- ✓ mobilization of FA from lipid stores
 - reaction
 - enzyme and its hormonal regulation (including mechanism)

34. Ketone bodies – their synthesis and significance. Synthesis of ketone bodies in pathologic conditions

- ✓ organ and subcellular location
- ✓ substrate
- ✓ reactions of ketone bodies – synthesis + enzymes
- ✓ utilization of ketone bodies in the organism
- ✓ regulation of ketone bodies
- ✓ states when ketone bodies are formed in higher amounts and their consequence

AMINO ACIDS

35. Deamination of amino acids – oxidative deamination, transamination, deamination of serine and cysteine

- ✓ meaning of amino acids (AA) deamination (where are used products of deamination)
- ✓ reactions
 - oxidative deamination two examples with different coenzymes
 - transamination and role in deamination of AA
- ✓ deamination of serine and cysteine including coenzyme
- ✓ explain toxicity of ammonia

36. Production of ammonia in the cells, fixation of ammonia, transport of ammonia and its utilization

- ✓ reactions of ammonia synthesis (in formulas – at least two examples)
- ✓ explain toxicity of ammonia
- ✓ transport of ammonia from the cells into place of its detoxification
- ✓ detoxification of ammonia urea cycle (reaction, enzymes)

37. Utilization of carbon skeleton of amino acids

- ✓ glucogenic and ketogenic amino acids
- ✓ reactions how carbon skeleton is formed (two examples)
- ✓ in scheme show how glucogenic amino acids can be used for gluconeogenesis

38. Transamination of amino acids, roles of transamination reactions in amino acid metabolism

- ✓ reaction catalyzed by transaminases including formula of coenzyme
- ✓ explain meaning of transaminases in anabolic and catabolic processes
- ✓ write reaction catalyzed by ALT
- ✓ tissue distribution of ALT and AST

39. Metabolism of phenylalanine and tyrosine. Defects in metabolism of phenylalanine and tyrosine

- ✓ reactions of catecholamine synthesis completely in formulas
- ✓ rest by scheme
- ✓ describe how phenylalanine and tyrosine can be used for gluconeogenesis
- ✓ defects in metabolism of phenylalanine and tyrosine

40. Metabolism of glutamate and aspartate

- ✓ synthesis of glutamate and aspartate
- ✓ deamination of aspartate and glutamate
- ✓ meaning of products of glutamate metabolism
 - GABA
 - glutamine including reaction how are formed
- ✓ role of aspartate in nucleotide metabolism and ammonia detoxification

41. Synthesis of creatine and creatinine

- ✓ completely in formulas including name of the enzymes and tissue distribution
- ✓ excretion of creatinine and use of creatinine for examination of kidney function

NUCLEOTIDES

42. Significance of nucleotides for metabolism

- ✓ roles of nucleotides in metabolism
- ✓ including reactions where GTP, UTP, CTP are used as a source of energy
- ✓ formulas of nucleotide important in regulatory processes and explain their roles

43. Synthesis of IMP by de novo pathway and its regulation

- ✓ reactions of IMP synthesis till the step what was said in the lecture
- ✓ sources of atoms in purine heterocycle
- ✓ regulatory enzymes and factors what activate and inhibit purine synthesis

44. Synthesis of AMP and GMP from IMP. Regulation of purine nucleotide synthesis

- ✓ sources of atoms in purine heterocycle of IMP
- ✓ synthesis of AMP and GMP from IMP completely in formulas, enzymes and sources of energy
- ✓ regulatory enzymes and factors what act as activators and inhibitors
 - what is consequence of defect of regulation of purine synthesis

45. Synthesis of pyrimidine nucleotides de novo. Synthesis of CTP and regulation of pyrimidine nucleotide synthesis, synthesis of TMP

- ✓ reaction of synthesis completely in formulas and names of enzymes
- ✓ synthesis of CTP
- ✓ synthesis of deoxynucleotides
- ✓ synthesis of thymine nucleotides
- ✓ regulatory enzyme and factors what activate and inhibit pyrimidine nucleotide synthesis

46. Salvage pathways of purine nucleotide synthesis

- ✓ compare salvage and de novo pathway of nucleotide synthesis
- ✓ write what are substrates for salvage pathways and what is their origin
- ✓ reaction of salvage pathways completely in formulas
- ✓ what is consequence of decreased activity of salvage pathways enzymes

47. Degradation of purine nucleotides

- ✓ reactions of degradation completely in formulas including names of enzymes and intermediates
- ✓ what are chemical characteristics of final product of degradation
- ✓ explain where in metabolism could be used intermediates of degradation

48. Synthesis of uric acid and its excretion. Hyperuricaemia – gout

Synthesis of uric acid

- ✓ completely reactions in formulas and names of the enzymes
- ✓ excretion of uric acid and mechanisms what are involved in excretion of uric acid

Hyperuricaemia

- ✓ types and causes
- ✓ differences between metabolic and renal
- ✓ consequences of hyperuricaemia

REGULATIONS

49. Enzymes and their role in regulation of metabolism. Mechanisms of regulation of enzyme activities in the cells

- ✓ basic principles of regulation of metabolic processes in the cells
- ✓ feed back and feed forward regulation (write two examples)
- ✓ covalent modification (mechanisms, two examples)
- ✓ induction, repression (describe two examples)

50. Covalent modifications of enzyme proteins and their role in regulation of metabolism

- ✓ mechanisms of covalent modification
- ✓ the most frequent mechanism of covalent modification in human organism
- ✓ write one example from carbohydrate metabolism and one example from lipid metabolism where enzyme activity is changed by covalent modification

51. Mechanisms of transfer of chemical signals into the cells

- ✓ describe mechanisms how hormones/neurotransmitter influence function of target cells
- ✓ types of receptors and mechanisms of their function
 - intracellular – example
 - membrane – examples two

52. G-proteins and their role in mediation of regulatory effects

- ✓ composition of G-proteins
- ✓ roles of subunits of G-proteins
- ✓ steps during activation of G-proteins (including reaction catalyzed by α subunit)
- ✓ types of G-proteins (at least three examples)

53. cAMP – its synthesis and degradation. Role of cAMP in regulation of metabolism

- ✓ synthesis of cAMP
- ✓ degradation of cAMP
- ✓ mechanism for activation of the enzyme producing cAMP (G-protein)
- ✓ role of cAMP in regulation of metabolic pathways
- ✓ one example of processes from carbohydrate metabolism, one example from lipid metabolism which are influenced by cAMP

54. Phosphatidyl inositols and their roles in regulation of metabolism

- ✓ synthesis of 2nd messengers from phosphatidyl inositols (in formulas)
 - including name of the enzyme and
 - type of G-protein which activates the process
- ✓ role of product of phosphatidyl inositol hydrolysis in regulation of functions of the organisms (for both products give examples)

55. Vegetative nervous system. Neurotransmitters of vegetative nervous system, role of vegetative nervous system in regulation of metabolism and physiologic functions

- ✓ neurotransmitters of vegetative nervous system
 - sympathetic
 - parasympathetic
- ✓ role of vegetative nervous system in regulation of metabolic and physiological processes

56. Synthesis and degradation of neurotransmitters of adrenergic neurotransmission

- ✓ synthesis of adrenergic neurotransmitters (completely in formulas and names of the enzymes)
- ✓ degradation of catecholamines (in formulas)
- ✓ main roles of catecholamines in regulation (by words)

57. Synthesis and degradation of neurotransmitters of cholinergic neurotransmission

- ✓ synthesis of cholinergic neurotransmitter (completely in formulas and enzymes)
- ✓ degradation of cholinergic neurotransmitter (in formulas and name of the enzyme and location)
- ✓ main role of cholinergic neurotransmitter in regulation

58. Cholinergic receptors and mechanism of transfer of the information after their stimulation

- ✓ formula of neurotransmitter bound to cholinergic receptors
- ✓ classification of cholinergic receptors
- ✓ explain how cholinergic receptors stimulation leads to the contraction of smooth muscle (type of receptor + mechanism of smooth – muscle contraction)

59. Adrenergic receptors and mechanism of transfer of the information after their stimulation

- ✓ formula of neurotransmitter bound to adrenergic receptors
- ✓ classification of adrenergic receptors
- ✓ explain how adrenergic receptors stimulation influences functions of myocardium

HORMONES

60. General mechanisms of hormone action

- ✓ explain mechanism of the action of lipid soluble hormones
- ✓ explain mechanism of the action of water soluble hormones (tyrosine kinase linked receptor and G-proteins receptors)

61. Calcitropic factors (parathyroid hormone, calcitonin, vitamin D) and their roles in regulation of calcium and phosphate metabolism

- ✓ role of calcium in human organism
- ✓ regulation of its concentration

62. Insulin

- ✓ regulation of its secretion, receptor for insulin and mechanism of its action
- ✓ write in formula one example of reaction from carbohydrate metabolism and lipid metabolism what are inhibited in presence of insulin, explain mechanism

63. Glucagon

- ✓ regulation of its secretion, mechanism of the action (receptor, second messenger – formation and formula)
- ✓ write in formula one example of reaction from carbohydrate metabolism and lipid metabolism what are inhibited in the presence of glucagon, explain mechanism

64. Hormones of adrenal cortex – their metabolic roles and regulation of their secretion

- ✓ regulation of their secretion
 - glucocorticoids
 - mineralocorticoids
- ✓ mechanism of their action
- ✓ metabolic role of glucocorticoids
- ✓ function of mineralocorticoids

65. Hormones of adrenal medulla

- ✓ synthesis and degradation
- ✓ regulation of secretion
- ✓ role of hormones of adrenal medulla in regulation of metabolism (receptors their tissue distribution and mechanism of the action)
- ✓ physiological function

VITAMINS

66. Vitamins and their significance as the coenzymes in metabolism of carbohydrates, lipids and proteins

- ✓ write vitamins and their coenzymes forms important in oxidation-reduction processes
- ✓ write example of the reaction where as a coenzyme active form of vitamin B₁ is required and consequence of each of this vitamin
- ✓ which vitamin is important as coenzyme in amino acids metabolism
- ✓ example of one reaction with this coenzyme

67. Folic acid and vitamin B₁₂

- ✓ source of one carbon groups
- ✓ utilization of one carbon groups (three examples)
- ✓ consequence of deficiency of folic acid B₁₂
- ✓ write two reactions (completely in formulas) where B₁₂ vitamins is coenzyme

DIGESTION AND LIVER FUNCTIONS

68. Composition of digestive juices, their secretion and regulation of the process

- ✓ write reactions (in formulas) required for digestion of polysaccharides and lipids

69. Roles of stomach and pancreas and liver in the process of digestion

- ✓ production and regulation of HCl, complete mechanism
- ✓ write reaction catalyzed by pancreatic amylase and pancreatic lipase

70. Synthesis of heme and its regulation. Biological roles of heme proteins

- ✓ biological role of heme proteins
- ✓ write at least of four examples of heme proteins
- ✓ in formulas write synthesis of porphobilinogen
- ✓ regulation of heme synthesis in the liver and hemopoietic tissue

71. Degradation of hemoglobin

- ✓ organ and subcellular location
- ✓ transport of degradation product in blood
- ✓ its conversion in the liver
- ✓ fate of it in GIT

72. Roles of liver in bilirubin metabolism

- ✓ production of bilirubin
- ✓ organ and subcellular location
- ✓ conversion of bilirubin in the liver (and its subcellular location)
- ✓ formula of compound required for conjugation of bilirubin

73. Icterus (jaundice) classification and differential diagnostics

- ✓ types of jaundices
- ✓ biochemical findings and changes in blood, faeces and urine for each type of jaundice

74. Liver – basic functions in metabolism of carbohydrates, lipids and proteins in scheme

- ✓ in formulas explain pathway by which liver is able to increase blood glucose level
- ✓ formulas of compounds formed in the liver during starvation and may cause acidosis

75. Role of liver in regulation of blood glucose

- ✓ write on formula one of processes by which liver participate in regulation of blood glucose level

76. Blood plasma proteins and their functions in the body

- ✓ explain role of plasma proteins and their osmotic pressure in transport of the fluid through blood vessel wall
- ✓ name at least five important transport proteins in the blood
- ✓ describe structure of immunoglobulins

WATER AND MINERAL METABOLISM

77. Roles of water, Na⁺, K⁺ and Cl⁻ in the body and regulation of their metabolism

- ✓ distribution of water and its roles in the organism
- ✓ distribution of Na⁺, K⁺ in the organism and their roles
- ✓ regulation of water content in the body
- ✓ regulation of sodium, potassium (renin-angiotensin system)

78. Acid-base balance regulation

- ✓ buffer system in the blood, in cells and kidneys
- ✓ role of respiratory system
- ✓ role of the kidney

79. Functions of the kidney

- ✓ excretion – calculation of rate of glomerular filtration
- ✓ maintenance of homeostasis
- ✓ metabolic roles of the kidney
- ✓ regulation of blood pressure by kidney

INTRODUCTION INTO CLINICAL BIOCHEMISTRY

80. Enzymes in blood plasma and their significance for biochemical diagnosis

- ✓ types of enzymes in the blood and their changes during the diseases
- ✓ factors what influence enzyme activity in the blood
- ✓ isoenzymes and their meaning for diagnosis (two examples)