

BIOCHEMISTRY I - Examination in the 2nd Semester - 2008

The written test - the first part of the examination

The test consists of 25 questions. An essential knowledge ranging over all studied topics is required. Above all, the structural formulas of the cardinal compounds with biochemical significance, chemical equations of elemental reactions in major metabolic pathways (with particular formulas), and basic principles of metabolic control.

Only those students who gain 13 correct answers at a minimum will be permitted to sit for the oral examination.

List of questions for the oral examination

- 1 Structure of haemoglobin, structure-function relationships (the oxygen saturation curve, inducement of haemoglobin saturation and oxygen transport. Bohr effect).
- 2 Normal haemoglobin types in blood, haemoglobin concentration. Other forms (glycohaemoglobin, methaemoglobin, carboxyhaemoglobin) and abnormal haemoglobins.
- 3 Enzymes - structure and catalytic function, characteristics of biocatalysis. Enzyme-substrate interaction, examples of mechanisms of enzyme-catalyzed reactions. The term "isoenzymes".
- 4 Kinetics of enzyme-catalyzed monomolecular reactions: the term reaction rate, factors affecting the rates of enzyme-catalyzed reactions. The progress curves, the Michaelis-Menten plots (saturation curves), the K_m value and its significance.
- 5 The enzyme activity (the term, units of enzyme activity U and katal, catalytic concentration) and assays of enzymes (the conditions used in enzyme assays, the kinetics arranged by the substrate concentration, the kinetic and/or constant-time method).
- 6 Factors affecting catalytic activity of enzymes (the optimal conditions, activators and inhibitors, basal types of inhibitors, the distinguishing competitive from noncompetitive inhibition using saturation curves. The roles of metal ions in enzymatic catalysis (cofactors, metals as activators and inhibitors, examples of metalloenzymes).
- 7 Regulation of the catalytic activity of enzymes by covalent modification (namely conversions of proenzymes, reversible phosphorylations, activation of protein kinases). Allosteric proteins and enzymes (cooperativity, allosteric activation and inhibition).
- 8 The roles of hydrogen and oxygen in the energy exchange of living systems (foodstuffs for chemotrophs, three stages in the extraction of energy from nutrients, reducing equivalents), production of ATP by oxidative phosphorylation and by phosphorylation on the substrate level.
- 9 Transport across membranes (various types of passive and active transport mechanisms, characters of transporters and ionophores, examples).
- 10 Mitochondria (general structure, overview of the main roles in metabolism). Transporter systems in the inner mitochondrial membrane (transport and transporter types, examples).
- 11 Pyridine nucleotide-dependent dehydrogenases (structures of coenzymes, function).
- 12 Flavoproteins (structures and function of the flavin prosthetic group, function of flavin dehydrogenases).
- 13 Cytochromes of the mitochondrial respiratory chain (the main structural features, the roles in mitochondrial complexes) and of monooxygenase hydroxylating systems (cytochrome P450).
- 14 The mitochondrial respiratory chain (function, the main components of the mitochondrial complexes, the proton-motive force, the respiratory control).
- 15 Ubiquinone (structure, function) and iron-sulphur proteins (the term, function).

- 16 Energetics of the respiratory chain, oxidative phosphorylation (structure and function of the ATP synthase, coupling of phosphorylation to electron transport, respiratory control, uncouplers).
- 17 Transport of glucose into cells. Glucose transporters – types.
- 18 The glycolytic pathway - localization, the reactions of glycolysis, regulation of glycolysis.
- 19 The glycolysis under anaerobic conditions - the role of lactate dehydrogenase reaction, the Cori cycle; the LD isoenzymes.
- 20 The energetic yield of glycolysis under anaerobic and anaerobic conditions.
- 21 The oxidative decarboxylation of pyruvate and other 2-oxoacids (localization, the roles of particular coenzymes in the pyruvate and 2-oxoglutarate dehydrogenase complexes, energetics, significance).
- 22 The citric acid cycle - localization, reactions of the cycle; the amphibolic role of the cycle (the final pathway for the oxidation of nutrients, and the pathways originating from the cycle).
- 23 The energetic yield and regulation of the citric acid cycle. The anaplerotic reactions (replenishing the intermediates of the cycle).
- 24 Gluconeogenesis (localization, substrates and the course of gluconeogenesis, regulation), relationship between glycolysis and glyconeogenesis.
- 25 Glycogen synthesis - localization, reactions, control mechanisms.
- 26 Glycogenolysis in the liver and skeletal muscle - the steps and control of glycogen degradation, inherited disorders.
- 27 Metabolism of fructose and galactose, defects.
- 28 The pentose phosphate pathway (localization, the sequence of reactions, physiological importance).
- 29 The origin of reactive oxygen species, oxygen radicals detoxification (enzymes and natural antioxidants).
- 30 Glutathione - structure, functions (reducing effect, conjugations with GSH).
- 31 Lipid peroxidation. Tocopherols and other lipophilic antioxidants.
- 32 Synthesis of amino sugars and sialic acids, significance for the synthesis of glycoproteins and proteoglycans. Synthesis and metabolism of glucuronic acid (the uronic acid pathway).
- 33 Naturally-occurring tensides (structural types, micelles, biomembranes, tensides in lipid digestion).
- 34 Biosynthesis of fatty acids, control mechanisms; biosynthesis of triacylglycerols.
- 35 Desaturation of fatty acids. Polyunsaturated fatty acids (sources and interconversions, significance).
- 36 The transfer of long-chain fatty acyl-CoA into the mitochondria and the transfer of acetyl-CoA into the cytosol (control mechanisms).
- 37 Coenzymes of acyl transferases, transfer of acyls (coenzyme A and phosphopantetheine, lipoamide, carnitine).
- 38 The oxidative breakdown of fatty acids (localization, the reaction sequence, energetic yield, control mechanism).
- 39 Ketogenesis - localization, the pathway and the control of it; the utilization of ketone bodies. The circumstances causing ketoacidosis.
- 40 Metabolism of glycerophospholipids (biosynthesis and degradation).
- 41 Metabolism of sphingolipids (biosynthesis and degradation).
- 42 Membrane structure, the assembly and recycling of membranes. Specialized structures of plasma membrane – lipid rafts, caveols, tight junctions.

- 43 Eicosanoids (basic structural types, the main steps of the synthesis, the basal features of their function, inhibitors of eicosanoid production as anti-inflammatory agents).
- 44 Biosynthesis of cholesterol (the most important reactions and stages, regulation), excretion of cholesterol and the cholesterol balance in the body.
- 45 Synthesis of bile acids - localization, main steps of the synthesis, secretion and elimination from the body.
- 46 Intracellular degradation of proteins.
- 47 Deamination of amino acids and transamination (deamination types, reaction course, coenzymes, consequence of reactions in removal of amino groups from amino acids).
- 48 Detoxification of ammonia (the ureosynthetic cycle, glutamine, glutamate).
- 49 Glucogenic and ketogenic amino acids ("families" according to the resulting amphibolic intermediates, reversible interconversions of amino acids, essential amino acids).
- 50 Metabolism of dicarboxylic amino acids.
- 51 Conversions of glycine and serine, the utilization in anabolic pathways (one-carbon units, aminolevulinate, purine, creatine, conjugation to aromatic acids).
- 52 Conversions of arginine, utilization of the guanidine part (biosynthesis of creatine, nitroxide formation).
- 53 Metabolites and specialized products of proline, histidine, and tryptophan significant in metabolism.
- 54 Hydroxylation of phenylalanine, tyrosine, and tryptophan (coenzyme, phenylketonuria, DOPA, serotonin).
- 55 Catabolism of tyrosine; metabolic disorders of tyrosine catabolism.
- 56 Metabolism of sulphur-containing amino acids. Selenocysteine.
- 57 Significance and the basic features of the branched-chain amino acids catabolism.
- 58 Nutritionally essential amino acids. Biosynthesis of nonessential amino acids (Asp, Glu, Ser, Pro, Cys, Tyr).
- 59 Biosynthesis of haem. Porphyrins.
- 60 Decarboxylation of amino acids (coenzyme, some physiologically important reaction products and significance of them).
- 61 Biosynthesis of catecholamines.
- 62 Biosynthesis of creatine, function in muscles, conversion and excretion.
- 63 The basic steps in purine and pyrimidine nucleotide biosynthesis (the compounds donating the nitrogen and carbon atoms of the heterocyclic rings) and the regulation.
- 64 Catabolism of purine and pyrimidine nucleotides and elimination of the end-products.
- 65 Folate and tetrahydrofolate (structures, relations to 4-aminobenzoate and action of sulfonamides); one-carbon units - sources, transfer and interconversions, the utilization).
- 66 L-Ascorbate - sources, utilization in biochemical redox reactions (examples).
- 67 Thiamine - the physiological role of TDP (examples of reactions demanding TDP).
- 68 Methylation and carboxylation - reaction sequences, enzymes and coenzymes, the roles in metabolism.
- 69 DNA organization and replication in eukaryotes (topoisomerases and other factors involved in replication, particular steps, and polarity of replication).
- 70 RNA synthesis (RNA polymerases, transcription signals in eukaryotic cells).

- 71 Species of RNA and the functions of them, processing of the primary transcripts generating the functional RNA types.
- 72 Regulation of eukaryotic gene expression.
- 73 Proteosynthesis (ribosome components, formation of the initiation complex, peptide elongation cycle and termination of protein synthesis).
- 74 Posttranslational processing of proteins (various types of covalent modification), Golgi complex and glycosylation of proteins.