

Knowledge of the basic metabolic pathways gone through in Biochemistry I will be required.

The written test – the first part of the examination – consists of 25 questions. As a rule, 10 questions are bent on the knowledge acquired in the practical exercises. Remaining 15 questions are bent on an essential knowledge ranging over all studied topics.

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

The major topics for questions regarding practicals

- Principles of optical and electrophoretic laboratory techniques.
- Laboratory methods and assessment of the results. Sampling of blood, processing of samples.
- Basic calculations used in biochemical laboratories - diluting of solutions, converting molarities to mass concentrations and the other way round, calculations dealing with the 24h excretion of compounds into the urine.
- Total serum protein and albumin - the normal values in health, some states causing a decline or rise in serum albumin and total protein levels.
- Biochemical markers of heart infarction. Estimation of CK-MB activity, myoglobin, and troponins in the diagnosis of heart infarction.
- Electrophoretic separation of serum proteins: five major fractions and the typical pattern (approximate percentages), the dominant components in the globulin fractions.
- Bilirubin in blood serum - the unconjugated and conjugated bilirubin, the upper limit for normal concentrations of total serum bilirubin. Three main types of hyperbilirubinaemia with corresponding findings in serum, urine, and faeces.
- The causes of increased catalytic concentrations of ALP, AST, ALT, CK, LD, and amylase in blood serum, the clinical significance of the assays.
- Blood glucose - the mean concentration, the reactions involved in the enzymatic assay of glucose. The oral glucose tolerance test and the principle of the test evaluation. The significance of glycohaemoglobin determination. Late complications of diabetes – microalbuminuria.
- The serum lipids and approximate concentrations of the major lipid classes in blood serum. The major classes of lipoproteins and their relative sizes, constituents, and functions. Cholesterol concentration in serum, the significance of the HDL- and LDL-cholesterol concentration changes.
- Considering of the blood urea concentration and of its excretion: clinical significance, application to an estimate of the nitrogen balance (total nitrogen excretion).
- Serum creatinine and the urinary excretion of creatinine (mean values in healthy adults), clinical significance of the determination in serum and urine; calculations of the creatinine clearance and of tubular reabsorption of water from given data, the principle of calculating the clearances and the fractional excretions of other urinary constituents.
- The physiological values of the main parameters of acid-base balance in arterial blood and of concentrations of buffer bases in blood and plasma.
- Urinalysis (urine collection, pH, osmolality). The main "abnormal" urine components (the approximate amounts excreted into the urine of healthy individuals, principles of the chemical tests for urine proteins, glucose, ketone bodies, haemoglobin, bilirubin and urobilinoids), interpretation of the results in routine urinalysis.
- Renal calculi - the main components (calcium oxalate, uric acid, calcium phosphate), principles of the simplified chemical analysis based on the differences in the solubility of the components (in acidic or alkaline reagents).

- Principles of the main immunochemical assays used in clinical biochemistry (immunonephelometry and immunoturbidimetry, immunodiffusion methods, immunoelectrophoresis, competitive radioimmunoassays and enzyme immunoassays, ELISA).

List of questions for the oral examination

- 1 Factors influencing results of laboratory examination (three phases of examination, biological and analytical factors, sample collection and handling of samples, interpretation of results, reference interval and its calculation, critical difference).
- 2 The significance of (both functional and non-functional) enzyme assays in blood serum. Isoenzymes - multiple forms of LD and CK.
- 3 Provision of glucose in different states, the factors increasing susceptibility of glucose (glucagon, adrenaline, cortisol). Glucosuria.
- 4 The basic metabolic disorder in diabetes mellitus: the cause of ketoacidosis or of hyperosmolar coma.
- 5 Lipids in blood plasma and the major classes of lipoproteins (differences in the lipid and apolipoprotein content, in size, in properties and in electrophoretic mobility, the origin in enterocytes and hepatocytes).
- 6 Transformation of chylomicrons and VLDL.
- 7 Metabolism of high-density lipoproteins.
- 8 The movements of cholesterol and its elimination. The balance of sterols and the bile acids transformation.
- 9 The metabolic interrelationships among body organs predominating in a well-fed state (absorptive phase).
- 10 The metabolic interrelationships among body organs predominating after a brief fast (post-absorptive phase) and during prolonged fasting (starvation).
- 11 Proteins in human nutrition, the biological value of proteins, nitrogen balance and simple methods for assessing the catabolic periods.
- 12 The specific functions of the liver in metabolism, proteosynthesis, and in excretion.
- 13 Ammonium transport, the glutamine cycle and the glucose-alanine cycle.
- 14 Degradation of haemoglobin, formation of bile pigments.
- 15 Metabolism and excretion of bile pigments. The main types of hyperbilirubinaemia.
- 16 Metabolism of iron (absorption, transfer and distribution in the body, functions, iron balance).
- 17 Biochemical tests used for identification of liver injuries (detection of cell damage, cholestasis, reduced proteosynthetic capacity, etc.).
- 18 The metabolism of xenobiotics - stage I of their biotransformation (various types of transformation, examples, mixed-function monooxygenases – function of *cyt* P450).
- 19 The metabolism of xenobiotics - stage II (conjugation). Reaction types, reactant activation, products – examples).
- 20 Alcohols and phenols as xenobiotics and their transformation (ethanol and ethylene glycol, salicylates and acetaminophen).
- 21 Principles of metabolism control (control of enzyme activity and of protein synthesis, control of transport across membranes, extracellular signals).
- 22 General features of hormone synthesis, secretion, transport, and inactivation in relation to signal intensity received by the target cell.
- 23 Membrane receptors cooperating with G-proteins (types of receptors and G-proteins, corresponding intracellular messengers).
- 24 Plasma membrane phosphatidylinositols and the phosphoinositide cascade, the role in signal transduction.
- 25 Protein kinases (main classes) and phosphoprotein phosphatases, regulation of their activity.

- 26 Insulin (synthesis, regulation of secretion, fate, insulin receptor and results of its activation). Oral glucose tolerance test.
- 27 Intracellular hormones receptors, their activation and consequences.
- 28 The role of hypothalamic and pituitary hormones – a brief survey, functions.
- 29 Synthesis of thyroid hormones (description, localization, secretion and its control).
- 30 Intracellular Ca^{2+} distribution - calcium channels, carriers, Ca^{2+} -dependent proteins (e.g. calmodulin) and enzymes, relations to cell functions.
- 31 Calciferols (calcitriol) - structure, sources, transformations, effects, mechanism of action.
- 32 Calcium and (inorganic) phosphate metabolism - distribution in the body, mineral deposits and soluble forms, the role of PTH, calcitriol, calcitonin.
- 33 Synthesis and inactivation of catecholamines, degradation products.
- 34 Glucocorticoids - structure, biosynthesis, function, regulation of secretion.
- 35 Mineralocorticoids - structure, biosynthesis, function, regulation of secretion, the renin-angiotensin system.
- 36 Alkali cations - distribution in various compartments, approx. daily intake and output, control of the excretion (angiotensin-aldosterone, natriuretic peptides), consequences of retention or of heavy losses of electrolytes.
- 37 Sex hormones (structure, biosynthesis, function, sites of secretion and their regulation, inactivation).
- 38 Neurons - components of an axon membrane and myelin, provision of energy and nutrient requirements, relationship of neurotransmitters to amino acids (a survey).
- 39 Membrane potential of a neuron, depolarization and the action potential propagation. Voltage-operated and receptor-operated (ligand-gated) ion channels.
- 40 Adrenergic synapse (release and inactivation of the transmitter, the types of adrenergic receptors, signal transduction).
- 41 Cholinergic synapse (biosynthesis of the neurotransmitter and the release of it, two principal types of acetylcholine receptors and mechanisms of their function).
- 42 Acetylcholinesterase and its inhibitors (examples of organophosphate insecticides, typical signs of toxic effects, the first aid - the counteractive alkaloid).
- 43 Inhibitory GABAergic synapse (GABA_A receptors, the effect of benzodiazepines and other ligands).
- 44 Retinol and its derivatives - the biological role, biochemistry of visual excitation (activation of transducin, consequences in decrease of cGMP with hyperpolarization and in decreased Ca^{2+} stimulating guanylate cyclase).
- 45 Distribution of body water, factors influencing the distribution of body water and its excretion (ADH, aldosterone, natriuretic peptides), consequences of retention or of dehydration.
- 46 Osmotic and oncotic pressure of blood plasma, plasma osmolality (values of the main parameters, empirical relations for a rough estimate of plasma osmolality) and osmolality regulation.
- 47 Electrolyte status of blood plasma. Relation of ion concentrations to acid-base balance (buffer base and strong ion difference, anion gap).
- 48 Transport of CO_2 in blood: $p\text{CO}_2$ in arterial and venous blood, $[\text{HCO}_3^-]$, carbaminohaemoglobin, physically dissolved CO_2 , the ratio $[\text{HCO}_3^-]/[\text{CO}_2+\text{H}_2\text{CO}_3]$.
- 49 The acidic products of metabolism (H^+ -producing processes, approximate daily amounts of formed non-volatile acids, the origin of metabolic acidosis and alkalosis).
- 50 Buffering systems in blood, blood plasma (components, concentrations), the main buffer bases in interstitial and intracellular fluids.
- 51 The role of the kidney and of the liver in acid-base balance.
- 52 Blood acid-base parameters (reference values, changes of the values in acute disturbances and in the

course of their compensation).

- 53 Filtration of the plasma through the glomeruli (composition and permeability of the filtration medium, glomerular filtration rate – creatinine clearance, glomerular proteinuria).
- 54 Reabsorption and secretion in the renal tubules (water, electrolytes - natriuresis, low molecular compounds – glucose, amino acids, uric acid, tubular proteinuria), the term fractional excretion E/F.
- 55 Nitrogenous urinary constituents (substances from which they are derived, average daily excretions, the major factors on which the excreted amounts depend).
- 56 Nitrogenous low-molecular constituents of blood plasma (the parent compounds and main factors influencing concentrations of urea, creatinine, urate, ammonium, amino acids).
- 57 Digestion in the mouth and in the stomach (constituents of the saliva, the gastric secretion, secretion of HCl, humoral control of hydrochloric acid output).
- 58 The bile - formation, composition, functions of the constituents.
- 59 Digestion and absorption of saccharides (amylases and intestinal brush-border enzymes).
- 60 Digestion and absorption of lipids from the GIT (incl. chylomicrons, the fate of them).
- 61 Proteolytic enzymes of the digestive tract (secretion, activation, specificity), absorption of amino acids and peptides.
- 62 Biochemistry of large intestine.
- 63 Collagen and elastin (structural features, biosynthesis of collagen).
- 64 Lysine – the role of lysyl residues in connective tissue (covalent crosslinks of collagen fibrils, desmosine of elastin).
- 65 The bone - hormonal control of bone mineralization. Biochemical markers of bone formation and of bone resorption.
- 66 Structure of contractile elements of skeletal muscle fibres (sarcomere, the proteins of thick and thin filaments, functions).
- 67 The contraction (and relaxation) cycle of skeletal muscles.
- 68 Provision of energy for muscle contraction and relaxation (substrates and pathways depending on the intensity as well as duration of muscular work or exercise).
- 69 Differences in mechanisms of cardiac and smooth muscle contraction. Biochemical markers of myocardial damage.
- 70 Nitroxide synthase, the origin of endogenous NO (function, explanation of organic nitrates vasodilating effect).
- 71 Major fractions of the plasma proteins, main components in electrophoretic fractions (albumin, haptoglobin, transferrin, examples of the acute-phase proteins, their origin and natural functions, principles of appreciating the alterations in individual plasma proteins).
- 72 Blood clotting cascade. Fibrinogen, transformation to fibrin, and fibrinolysis.
- 73 Vitamin K - the biochemical function, significance for blood clotting.
- 74 Inhibitors of blood clotting - anticoagulants *in vivo* (function of heparin and coumarin derivatives) and *in vitro* (prevention of blood clotting, blood plasma).
- 75 Red blood cells (metabolism, membrane, blood group determining structures).
- 76 Methaemoglobin in normal blood (origin, reduction to Hb), inherited and acquired methaemoglobinaemia (nitrates and nitrites in the environment).
- 77 Leukocytes – metabolism.
- 78 Antigens and antibodies (the terms complete antigen - immunogen, hapten, sequential and conformational immunogenic determinants - epitopes, classification of the human immunoglobulins and their molecular structures, specific roles of different Ig domains).
- 79 The antibody-antigen reaction (formation of an immune complex, precipitation and agglutination as secondary reactions).