MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
Sumy State University

APPROVE
Head of the admissions committee
_____ I.C. Kozic
26 _____ 2024 p.

PROGRAM
entrance exam during admission to study
to obtain the degree of "Doctor of Philosophy" in the specialty
91 "Biology and Biochemistry"

1. GENERAL PROVISIONS

This program describes the general principles of conducting the entrance exam in specialty 091 "Biology and Biochemistry".

Admission to the preparation of the Doctor of Philosophy in specialty 091 "Biology and Biochemistry" is based on the results of the entrance exam, which is conducted in the form of testing.

List of sections, materials from which are taken to the entrance exam:

1. Biology
2. Human anatomy
3. Physiology
4. Microbiology
5. Biochemistry.

At the entrance exam, a calm and friendly atmosphere should be provided, and the entrants should be allowed to independently and fully reveal the level of their knowledge and skills. Outsiders, without the permission of the head of the admissions committee, are not allowed in the premises where the entrance exam is held. Mobile phones must be switched off during the test.

The duration of the exam is 80 minutes.

2. TYPICAL QUESTIONS FROM THE SECTIONS THAT ARE TAKEN ON THE ENTRANCE EXAM

2.1. Contents of sections

Cell Structure

Cell theory, the main stages of its development.

Structural and functional organization of the eukaryotic cell. The difference between prokaryotes and eukaryotes, plant and animal cells, unicellular and multicellular organisms. Viruses as an intermediate link between living and non-living. Chemical composition of the cell: organic compounds, macro- and microelements. Water, the importance of hydrogen bonds in the life processes of cells. Cell membranes, their structure and functions, role in the formation of compartments. Transport of substances into and out of the cell: diffusion, osmosis, exo- and endocytosis, active and passive transport. Cytoplasm and cytoskeleton. Cytoplasmic organelles - membranous and non-membranous, their structure and functions. Relatively autonomous organelles. Inclusions in cells, their functions.

The nucleus is the central information apparatus of the cell. Nucleus as a derivative of chromosomes, its role in the formation of ribosomes. The cell as an open system. Assimilation and dissimilation. Organization of substance and energy flows in the cell. Stages of energy exchange. The energy supply of the cell, ATP. Energy distribution.

Cell Division.

Division of prokaryotic cells. Cell cycle in eukaryotes: interphase and mitotic division (mitosis, cytokinesis). Biological significance of mitosis. Mitotic activity of tissues. Violation of mitosis.

Cell cycle control. Growth factors. Cell specialization and differentiation.

Special methods of cell division: amitosis and schizogony. Meiosis: stages, behavior of chromosomes and chromatids, bivalents. Differences between meiosis and mitosis. Biological significance of meiosis. Gametogenesis: stages, methods of cell division. Differences between oogenesis and spermatogenesis. The structure of gametes. Fertilization as the restoration of the diploid set of chromosomes. The structure of the interphase core. Chromatin structure. Types of chromatins: euchromatin, heterochromatin, sex chromatin. Types of eukaryotic chromosomes: mitotic (metaphase), polytene, "lampbrush" type. The structure of the metaphase chromosome. Karyotype. Morphofunctional characteristics and classification of human chromosomes. Idiogram. Cytogenetic method: material for research, cytostatics, chromosomal analysis. Simple and differential staining. Application of karyotyping in medicine.

Classical Genetics

The concept of the probability of a random event. The probability of the simultaneous occurrence of several random events; the probability of the occurrence of any of several expected random events.

Genetics: subject and tasks, stages of development. Basic terms and concepts of genetics. Classical objects of genetics. Principles of hybridological analysis. Dihybrid crossing; the law of independent combination of features. Polyhybrid crossing. Chromosomal theory of heredity. Cytological foundations of Mendel's laws. Dominant and recessive normal and pathological human traits. Lethal and sublethal genes (sickle cell anemia, thalassemia, brachydactyly, achondroplasia). Deviation from the expected cleavage.

Interaction of Genes. Blood Groups. Linkage Of Genes.

Allelic genes. Types of interaction of allelic genes: complete dominance, incomplete dominance, co-dominance, super-dominance (super-dominance). Series of multiple alleles, causes of their occurrence. Human blood groups. Inheritance of human blood groups according to antigenic systems AB0, MN and Rhesus factor. Rhesus conflict. Non-allelic genes. Complementarity. Epistasis. Qualitative and quantitative signs. Polygenic traits; polymeric genes. Inheritance of quantitative traits: cumulative polymerization.

Non-cumulative polymerization, examples of inheritance of traits in humans. Morgan's experiments with linked genes as proof of the chromosomal theory of heredity. Morgan's Law. Clutch groups. Complete and incomplete linkage of genes. Nature of inheritance of linked genes. Crossing over, its mechanism, cytological evidence, biological significance. Factors affecting crossover. Genetic maps of chromosomes (linkage maps), purpose and methods of their compilation. Compilation of cytological maps of eukaryotic chromosomes, units of distance between genes. Methods of human chromosome mapping. Hybridization of somatic cells.

Genetics of Sex. Sex Linkage. Cytoplasmic Inheritance

Sex and sexual characteristics. Hermaphroditism. Sex determination in mammals, birds, reptiles, insects, worms, fish, and mollusks. Inheritance of human sex. Mechanisms of genetic sex determination in humans and their disorders. Bisexual nature of humans. The problem of sex reassignment and psychosocial aspects. Autosomes, sex chromosomes. Homo- and heterogametic sex. Biological significance of sex chromosomes. Structure of human X and Y chromosomes. Sex chromatin. Sex linkage. X-linked inheritance, holandric inheritance. Hemizygous genes. Sex-linked human diseases: hemophilia, color blindness, muscular dystrophy, phosphate diabetes (vitamin D-resistant rickets). Cytoplasmic inheritance.

Genotype and Phenotype. Variability.

Penetrance (examples are diseases with a hereditary predisposition).
Expressiveness (example – phenylketonuria).
Pleiotropy: primary and secondary pleiotropy (examples are sickle cell anemia, arachnodactyly).
Genes and external environment. Modifications and reaction rate. Long-term modifications. Statistical regularities of the manifestation of quantitative signs.
Gender and heredity. Sex-specific and sex-limited traits.

Variability, its forms, and manifestations at the organismal level: phenotypic and genotypic variability. Ontogenetic variability. Combinatorial variability, its sources. The role of variability in the adaptation of the organism to environmental conditions, its significance for evolution.
Genocopies and phenocopies.

Reproduction. Ontogenesis. Prenatal period. Postnatal period of ontogenesis. Anthropogenetics.

Regulation of gene function in ontogenesis. Experimental study of embryonic development. The problem of determination and interaction of blastomeres. Embryonic induction.

Regulation in the crushing process and its violations (twins, malformations, ugliness). Periods of human postembryonic development. Processes of growth and differentiation in the postnatal period of individual human development. Peculiarities of the postnatal period of individual human development in connection with its biosocial essence. Old age is the final stage of human ontogenesis. Theories of aging. Methods of genetic research. Man as a specific object of genetic analysis: disadvantages and advantages. Methods of studying human heredity. The twin method, its use in medicine. Concordance and discordance, heritability coefficient. Determination of the influence of genotype and environment in the manifestation of pathological signs of a person. Dermatoglyphic method. Finger patterns. Genealogical method: goals, rules for building pedigrees, symbols, methods of genetic analysis of pedigrees. The main types of inheritance of traits, and criteria for the inheritance of rare genes.

Anatomy of the locomotor apparatus.

General information about the skeleton. Classification of bones. Bones of the trunk: vertebrae, ribs, sternum. The principle of segmentation in the structure of the axial skeleton. General plan of the structure of the vertebrae. Features of cervical, thoracic, lumbar vertebrae, sacrum, and coccyx structures. Age and sex characteristics of the body bone structure.

Bones of the skull: brain and facial parts. The structure of the bones of the skull. Age and sex characteristics of the structure of the bones of the skull.

Anatomy of the bones of the upper and lower limbs: their divisions and structure. Homology of the bones of the upper and lower limbs.

Classification of connections between bones. Types of synarthroses. Diarthrosis: definition, main features of the joint, and their characteristics. Classification of joints.
Articulations between the bones of the trunk, skull, and upper and lower limbs.
Classification of muscles. Anatomy of the muscles and fascia of the trunk. Anatomy of muscles and fascias of the head and neck. Topography of the neck. Anatomy of the muscles and fascia of the upper and lower limbs. Topography of the upper and lower extremities.

Anatomy of internal organs.

Classification of internal organs: tubular and parenchymatous. The general plan of the structure of tubular organs.

Digestive system: organs, functions. Oral cavity: its parts. Organs of the oral cavity: teeth, palate, tongue, oral glands. Pharynx and stomach: topography, parts, wall structure. Stomach. Small and large intestines: divisions, wall structure. Macroscopic changes in the structure of the large and small intestine. Liver: topography, external structure, functions. Pathways of bile

secretion. Pancreas: parts, structure, functions. Peritoneum. Abdominal and peritoneal cavities, and their contents.

Respiratory system: organs, functions. Upper and lower respiratory tract: external nose, larynx, trachea, bronchi. Lungs: topography, external structure. Acinus. Pleura. Mediastinum.

Urinary system: organs, functions. Kidneys: topography, external and internal structure. Nephron. Urethra and urinary bladder: topography, parts, wall structure.

Genital systems. Male reproductive system: external and internal genitals, structure, functions. Female reproductive system: external and internal genitals, structure, functions.

Endocrine glands: classification, structure, functions.

Nervous system and sense organs.

Central nervous system. Spinal cord: topography, external and internal structure. Brain: divisions, their external and internal structure. Meninges. Intermembrane spaces and their contents.

Sense organs: hearing, sight, smell, and taste: their structure and functions.

Peripheral nervous system. Cranial nerves: classification, nuclei, exit of the nerve from the brain, from the skull, branches, and areas of innervation.

Spinal nerve: formation, composition of fibers, branches. Posterior branches of spinal nerves. Anterior branches of spinal nerves. Somatic nerve plexuses: cervical, brachial, lumbar, sacral, coccygeal: sources of formation, topography, branches, areas of innervation.

Cardiovascular system.

Anatomy of the heart: topography, external structure of the heart. Heart chambers, heart valves: their structure. The structure of the heart wall. Arteries and veins of the heart. Large and small circles of blood circulation.

Aorta: its parts. Thoracic and abdominal aorta: topography, classification of branches, areas of blood supply. Pelvic arteries, topography, classification, areas of blood supply.

Arteries of the upper limb: topography, parts, branches, and areas of blood supply. Arteries of the lower limb: topography, parts, branches, and areas of blood supply.

General anatomy of venous vessels. Superior vena cava: roots, tributaries, topography. Inferior vena cava: roots, classification of tributaries, topography. Portal hepatic vein: roots, tributaries, topography.

Veins of the upper extremity: classification. Superficial and deep veins of the upper limb: their characteristics, patterns of topography and structure. Veins of the lower extremity: classification. Superficial and deep veins of the lower extremity: their characteristics, patterns of topography and structure.

Lymphatic and immune systems: general structure plan.

The structure of the bacterial cell.

The structure of the bacterial cell: Nucleoid, Mesosomes, Ribosome's, Cell pool, Cytoplasm, Cell Membrane, Cell Wall, Flagella. Preparation technique for microscopy. Complex methods of staining microorganisms and the purpose of their use (Gram's method. Ziehl-Neelsen method for detecting acid-resistant bacteria). Bacterial capsule: structure, chemical composition, and functions. Methods of studying and identifying capsules (Buri-Gins method). Flagella: the structure, chemical composition, functions. Classification of bacteria by type of locomotion, location, and number of flagella. Methods of examination motility. Spores: structure, and functions. Formation and germination of spore. Spore staining.

Physiology of microorganisms.

Mechanisms of bacterial nutrition. Classification of bacteria by types of nutrition. Respiration of bacteria. Aerobes, anaerobes, microaerophiles, facultative anaerobes. Growth and

reproduction of microorganisms. Phases of bacterial population development.

Purposes and methods of culturing bacteria. Rules for working with bacterial cultures. Bacterial Culture Media, classification by purpose, and requirements. Bacterial Culture Media are used for the cultivation of anaerobes. Methods of isolation of pure cultures (aerobic and anaerobic microorganisms). Microbial techniques and methods. Cultural properties of microorganisms (growth on liquid and Solid media). Bacterial Culture Media are used to cultivate anaerobes. Methods of creating anaerobic conditions.

Sensitivity of microorganisms to physical and chemical factors.

Effects of physical factors on microorganisms: filtration, drying, radiation, ultrasound, and temperature. Effects of chemical factors on microorganisms: phenols, halogens, alcohols, acids, alkalis, oxidizers, aldehydes. Microbiological basis of aseptic and antiseptics. Sterilization: definition, purpose, types (thermal methods and monitoring of the impact of ionizing radiation, filtering, and chemical methods). Control of sterility. Disinfection: definition, purpose, types (physical and chemical methods). Disinfection effectiveness monitoring. Antibiotics: classification by mechanism of action. Determining the sensitivity of bacteria to antibiotics (disk diffusion and serial dilution methods). Resistance to antibiotics.

Immunology. Cellular immune response: definitions, types.

Primary and secondary immune responses. Memory cells have practical significance. Regulation of the immune response in the body: a list of factors and mechanisms. Immune response, definition, scheme, phases, and forms. Cells and humoral factors are involved in the immune response. Antibodies: definition, properties, production, practical use, monoclonal antibodies. Classes and subclasses of immunoglobulins (Ig): list, properties, functions, and determination of their content in blood. The main principles and aims of the serological tests in medical practice. Features of antiviral immunity.

General virology.

Properties of viruses (morphology and structure of virions). Classification of viruses. Virus reproduction (features of DNA and RNA virus reproduction). Microscopic methods of virus detection (electron microscopy, luminescence microscopy, and immunofluorescence method). Use of cell culture in virology. Use of chicken embryos and cultivation of viruses in them. Cultivation of viruses in cell culture. Cytopathic effect of viruses. Serological reactions in virology.

General Patterns of Nervous Regulation of Functions

Main features of nervous regulation of functions. Structure and functions of a neuron. Concept of reflexes, their classification. Reflex arc, functions of its individual elements. CNS synapses, their structure, information transmission mechanisms. Classification of mediators, their general characteristics. Characteristics of excitatory and inhibitory postsynaptic potentials. Mechanism of central excitation. The role of spatial and temporal summation in the emergence of central excitation. Functions of the spinal cord and its role in the regulation of motor functions. The role of the midbrain in the regulation of motor functions. The role of the cerebellum in the regulation of motor functions. Structural and functional features of the autonomic nervous system. Sympathetic, parasympathetic and metasympathetic department. Peculiarities of the reflex arc of the autonomic reflex. Vegetative ganglia, their functions. Influence of sympathetic, parasympathetic and metasympathetic departments on organs. Classification of autonomic reflexes. Reflex arc of the autonomic reflex. Research and use of autonomic reflexes in practical medicine.

Humoral Regulation of Vegetative Functions. The Role of Endocrine Glands in The Regulation of Body Functions.

Factors of humoral regulation, their characteristics and classification. Relationship between nervous and humoral regulation. Structural and functional organization of the endocrine system. Endocrine glands, endocrine cells, their hormones, and significance. Basic mechanisms of hormone action. Hormones that regulate calcium and phosphate homeostasis: parathyroid hormone, calcitonin, calcitriol. Influence of other hormones on calcium metabolism (glucocorticoids, somatotropin, thyroid hormones, estrogens, insulin). The role of vasopressin, oxytocin. Thyroid gland, its hormones (iodothyronine). Gonads. Sexual differentiation, development, and functions of the reproductive system. The period of puberty. Male reproductive system, its structure, and functions. Spermatogenesis. Endocrine function of testicles, regulation of testicular function. Female reproductive system, its structure, and functions. Ovarian hormones, their role, regulation of ovarian function. Monthly cycle. Pregnancy. Hormones of the placenta. Lactation. Hormones of the adrenal cortex, contours of regulation of their secretion, circadian rhythms of glucocorticoid secretion, their effects, and mechanisms of action on target cells.

Physiological Blood System.

General characteristics and composition of peripheral blood. The main functions of the physiological blood system. Functional significance of water and blood plasma electrolytes. Blood plasma proteins. Their composition and main functions. Erythrocyte sedimentation rate (ESR). Factors affecting this indicator. Physiological characteristics of formed blood elements. General characteristics of erythrocytes, their function. Structure of hemoglobin. Basic forms and compounds of hemoglobin. Leukocytes, their distribution in the body. Quantitative and qualitative composition of peripheral blood leukocytes. The main functions of certain types of leukocytes.
The concept of blood groups. Agglutinogens and agglutinins. Characteristics of blood groups of the AB0 system. The concept of hemostasis and its two main mechanisms. The structure of the hemostasis system. The role of the vascular wall and platelets in hemostasis.

Physiological Circulatory System.

General characteristics of the circulatory system, its structure. Physiological properties of the myocardium and their features. Automatism of the heart. Action potential of atypical cardiomyocytes of the pacemaker of the heart - sinoatrial node. Action potential of contractile myocardiocytes. The concept of the cycle of cardiac activity. Phase structure of the cardiac cycle. Characteristics of ventricular systole: periods of tension and expulsion. Characteristics of ventricular diastole: periods of relaxation and filling. The nature and mechanisms of the influence of the sympathetic and parasympathetic nervous system on the work of the heart. Functional classification of blood vessels. Pulse fluctuations of blood movement, volume, and pressure in arterial vessels. Blood pressure: systolic, diastolic, pulse, average.

Physiological Respiratory System.

Stages of breathing. The general structure and main functions of the external respiratory system. Functional characteristics of the structural elements of the external respiratory system: chest, respiratory muscles, pleural cavity, airways, lungs. Static indicators of lung ventilation. Concepts of lung volumes and lung capacities. Dynamic indicators of lung ventilation. Minute volume and lung capacity. The concept of the respiratory center.

Physiological System of Digestion.

The main functions of the digestive system: secretion, motility, absorption. Digestion: its types (cavity, membrane, intracellular), main stages. Basic principles and mechanisms of digestion regulation. Motility of the alimentary canal. Features of the structure and functions of the smooth muscles of the alimentary canal. Pancreatic juice, its composition, properties, and importance of the main components. The influence of various food substances on the secretion of pancreatic juice. Nervous and humoral mechanisms of regulation of pancreatic secretion. Bile, its composition, properties, and significance of the main components. Mechanisms of bile secretion and regulation of this process. Protective (barrier and antitoxic), metabolic and hemodynamic functions of the liver. Intestinal secretion, composition and properties of intestinal juice, its role in digestion. Regulation of intestinal secretion.

The Physiological Excretory System.

The excretory system, its structure, and functions. Excretory organs (kidneys, skin, lungs, digestive tract) and their role in maintaining the body's homeostasis. The nephron as the structural and functional unit of the kidney. The main processes of urine formation: filtration, reabsorption, secretion. Filtration mechanisms, composition of primary urine. Regulation of filtration rate. Reabsorption in the tubules, its mechanisms. Final urine, its composition, quantity. Regulation of kidney function. Diuresis. Composition of primary and secondary urine. Regulation of calcium and phosphate ion concentrations with the participation of the kidneys. The role of the kidneys in regulating the acid-base balance of the internal environment.

Modern trends in the development of biochemistry.

Biochemistry as a science. The place of biochemistry among other medical and biological disciplines. History of biochemistry; development of biochemical research in Ukraine.

Achievements and prospects for the development of biochemistry, theoretical and molecular biology, biotechnology, genetic engineering and their importance for the diagnosis and treatment of the main human diseases - cardiovascular, oncological, infectious, etc.

The purpose of biochemical laboratory research.

Errors in laboratory research: errors in the preparation, collection and storage of material for research, analytical (laboratory) errors, errors in the interpretation of results.

Proteins and peptides: amino acid composition of proteins, levels of their structural organization, and biological functions.

The chemical composition of living organisms, its features compared to objects of inanimate nature. Chemical composition of the human body.

General characteristics and biological functions of proteins and peptides. Amino acid composition of proteins and peptides; structure, classification and physicochemical properties of amino acids. Methods of studying and researching amino acids and proteins in biological fluids. Color reactions on amino acids. Chromatographic methods of separation of amino acids.

Physicochemical properties of proteins.

Methods of protein isolation from biological objects, their fractionation and structure analysis; distribution of proteins by electrophoresis, methods of studying the amino acid composition and structure of proteins and peptides.

Modern classifications of proteins. General characteristics and biological role of proteins. Natural peptides: classification, biochemical characteristics.

Complex proteins: classification, representatives of individual classes, their content in the human body. General characteristics of chromoproteins, structural features, biological role.

Hemoproteins: myoglobin, hemoglobin, cytochromes, their biological functions and structural features. Flavoproteins: structural features and biological role in the human body. Glycoproteins: classification, structural features, distribution, biological functions.

Nucleotides: structure, structural components, nomenclature, biological role. Minor nitrogenous bases and nucleotides. Minor nitrogenous bases and nucleotides. Free nucleotides: their participation in metabolic reactions and regulation of biochemical processes. Cyclic nucleotides. Nucleic acids: peculiarities of structural organization, biological functions of DNA and RNA.

Enzymes and coenzymes. Regulation of metabolism.

Enzymes as biological catalysts of metabolic reactions; properties of enzymes. Enzyme activity measurement units: international units, catal, specific enzyme activity.

Nomenclature of enzymes and their classification by type of reaction: oxidoreductases, transferases, hydrolases, lyases, isomerases, ligases. The structure of enzyme proteins. Isoenzymes as multiple molecular forms of proteins, the result of expression of different genetic loci/

Enzyme fractionation methods (ultracentrifugation, gel chromatography, ion exchange chromatography, affinity chromatography, electrophoresis) and enzyme activity analysis.

Mechanisms of enzyme action: thermodynamic laws of enzymatic catalysis; active centers of enzymes. Enzymatic transformation of substrates under the catalytic action of an enzyme using the example of chymotrypsin and acetylcholinesterase. Methods of determining the activity of enzymes by the amount of product that is formed under the action of the enzyme per unit of time, by the amount of substrate consumed per unit of time.

Kinetics of enzymatic reactions: the dependence of the rate of reactions on the concentration of the enzyme, substrate, pH and temperature. Processing of the Michaelis-Menten equation using the method of double reciprocals - the Lineweaver-Burk equation. Inhibitors and activators of enzymes.

Physiologically active compounds and xenobiotics as reversible (competitive, non-competitive) and irreversible enzyme inhibitors.

Cofactors and coenzymes. Structure and properties of coenzymes; vitamins as precursors in the biosynthesis of coenzymes. Regulation of enzymatic processes.

Regulation pathways and mechanisms: allosteric interactions in enzymes; covalent modification of enzymes; action of regulatory effector proteins (calmodulin, proteinases, proteinase inhibitors). Cyclic nucleotides as regulators of enzymatic reactions and biological functions of the cell.

Basic laws of metabolism, tricarboxylic acid cycle. Bioenergetic processes: biological oxidation, oxidative phosphorylation, ATP synthesis.

General patterns of metabolism; catabolic, anabolic and amphibolic modes of metabolism.

Exergonic and endergonic biochemical reactions; the role of ATP and other high-energy phosphates in the coupling of processes occurring with the release and storage of energy. Stages of catabolism of biomolecules in the body.

General characteristics of the tricarboxylic acid cycle: functioning scheme, sequence of reactions, characteristics of enzymes, biochemical significance.

Enzymatic reactions of tricarboxylic acid cycle. Features of the functioning of pyruvate dehydrogenase and α-ketoglutarate dehydrogenase multienzyme complexes. Substrate phosphorylation reactions in the tricarboxylic acid cycle. The total balance of ATP molecules (energy balance) formed during the functioning of the cycle.

Pathways of ATP synthesis in cells: substrate and oxidative phosphorylation. Formation of ATP in cells under anaerobic and aerobic conditions. Advantages of aerobic oxidation of nutrient compounds.

Molecular organization of the mitochondrial chain of biological oxidation. The sequence of electron transfer in the respiratory chain. Components of the respiratory chain as redox pairs of cofactors: NAD, flavoproteins, coenzyme Q, cytochromes, their redox potentials.

Molecular complexes of the inner mitochondria membranes: NADH-coenzyme Q-reductase; succinate-coenzyme Q-reductase; coenzyme Q-cytochrome c-reductase; cytochrome c oxidase. Pathways of inclusion of reducing equivalents in the mitochondrial respiratory chain.

The chemiosmotic theory of oxidative phosphorylation is a molecular mechanism for generating ATP in the process of biological oxidation. ATP synthetases, their functional significance.

Conditions for effective coupling of oxidation and phosphorylation in mitochondria: integrity of the mitochondrial membrane, the presence of all components of the transport chain, specific intramembrane topography of transporters, the presence of a sufficient amount of ADP and inorganic phosphate.

Electron transport inhibitors (rotinone, amytal, antimycin A, cyanides, carbon monoxide) and oxidative phosphorylation uncouplers (2,4-dinitrophenol, thyroid hormones, free fatty acids).

Carbohydrate metabolism and its regulation.

Pathways of intracellular carbohydrate catabolism; aerobic and anaerobic oxidation of glucose.

Anaerobic oxidation of glucose - glycolysis: enzymatic reactions of glycolysis, energy, regulation. Glycolytic oxidoreduction, substrate phosphorylation in glycolysis.

Stages of aerobic oxidation of glucose, oxidative decarboxylation of pyruvate, multienzyme pyruvate dehydrogenase complex - features of functioning involving three enzymes and five coenzymes. Shuttle mechanisms of glycolytic NADH oxidation.

Cleavage and biosynthesis of glycogen: enzymatic reactions of glycogenesis and glycogenolysis; cascade mechanisms of cAMP-dependent regulation of glycogen phosphorylase and glycogen synthase activities. Hormonal regulation of glycogen metabolism in muscles and liver.

Glucose biosynthesis - gluconeogenesis: physiological significance, enzymatic reactions, regulatory enzymes. Metabolic pathway of gluconeogenesis: substrates of gluconeogenesis, compartmentalization of the conversion of pyruvate to phosphoenol pyruvate. Lactate and alanine as substrates of gluconeogenesis, glucose-lactate (Cori cycle) and glucose-alanine cycles.

Pentose phosphate pathway (Hexose monophosphate shunt - HMP) of glucose oxidation; scheme, biological significance, features of functioning in different tissues. The sequence of enzymatic reactions of HMP, the oxidative stage and the stage of isomeric transformations of pentose, hexose and heptose phosphates.

The metabolic pathway and enzymatic reactions of fructose conversion in the human body. Metabolic pathway and enzymatic reactions of galactose conversion in the human body.

Hormones are regulators of glucose metabolism (glucagon, epinephrine, glucocorticoids, somatotropin, insulin - effects and mechanisms of action on the level of glucosemia).

Lipid metabolism and its regulation.

Lipids: structure, classification, biological functions of the main classes. Fatty acid composition of lipids - saturated and unsaturated fatty acids (physicochemical properties, content in human tissue lipids).

Catabolism of triacylglycerols: sequence of reactions, mechanism of regulation of triacylglycerol lipase activity. Neurohumoral regulation of lipolysis.

Fatty acid oxidation (β-oxidation): activation of fatty acids, the role of carnitine in the transport of fatty acids into mitochondria, sequence of enzymatic reactions. Energy effect of β-oxidation of fatty acids. Metabolism of glycerol.

Ketone bodies. Reactions of biosynthesis and utilization of ketone bodies, their physiological significance.

Biosynthesis of triacylglycerol. Biosynthesis of phosphoglycerides. Metabolism of sphingolipids.

Biosynthesis of saturated fatty acids (palmitate), enzymatic reactions - synthesis of malonyl-CoA, acyl-transporting protein, source of NADPH necessary for biosynthesis of fatty acids. Regulation of the biosynthesis process at the level of acetyl-CoA-carboxylase and at the level of fatty acid synthetase.

Cholesterol biosynthesis: metabolic precursors; scheme of the sequence of synthesis reactions. Regulation of cholesterol synthesis.

Pathways of biotransformation of cholesterol: esterification; formation of bile acids, steroid hormones, vitamin D3; excretion of cholesterol from the body. The role of cytochrome P-450 in the biotransformation of physiologically active steroids.

Classes of blood lipoproteins: chemical composition, formation, biological role, fractionation methods; apoproteins.

Biosynthesis of unsaturated fatty acids: formation of monoene fatty acids; features of transformations of polyene fatty acids. General idea about vitamin F: daily requirement, sources, biological role, consequences of deficiency.

Features of lipogenesis and lipolysis in adipose tissue; relationship with carbohydrate metabolism. Hormonal regulation of processes.

Mechanisms of regulation of the main pathways of lipid metabolism. Hormonal regulation of lipid metabolism. Relationship between lipid and carbohydrate metabolism.

Metabolism of amino acids.

Pathways of formation and maintenance of the pool of free amino acids in the human body. General pathways for the conversion of free amino acids.

Transamination of amino acids: reactions; biochemical significance; mechanisms of action of aminotransferases. Deamination of amino acids. Mechanism of indirect deamination

L-amino acids. Decarboxylation of amino acids: enzymes, physiological significance.

Pathways for ammonia formation. Toxicity of ammonia and mechanisms of its neutralization. Circulatory transport of ammonia (glutamine, alanine).

Biosynthesis of urea: enzymatic reactions.

General pathways of metabolism of the carbon skeleton of amino acids in the human body. Glucogenic and ketogenic amino acids.

Metabolism of sulfur-containing amino acids; methylation reactions.

Arginine metabolism; Biological role of nitric oxide, NO synthase.

Specialized pathways of metabolism of cyclic amino acids phenylalanine and tyrosine, sequence of enzymatic reactions.

Basics of molecular biology.

Biosynthesis of purine nucleotides: IMP synthesis scheme; formation of AMP, GMP, ATP, GTP. Regulation of biosynthesis of purine nucleotides according to the principles of negative (retroinhibition) and positive feedback.

Biosynthesis of pyrimidine nucleotides: reactions; regulation.

Catabolism of purine nucleotides.

Biological significance of DNA replication. The essence of the discovery of J. Watson and Fr. Scream (1953). Semi-conservative replication mechanism; scheme of the experiment by M. Mezelson and F. Stahl.

General scheme of DNA biosynthesis. Molecular mechanisms of DNA replication: topological problems (topoisomerases, helicases); the value of antiparallelism of DNA chains; fragments of Okazaki. Stages of synthesis of daughter chains of DNA molecules.

General transcription scheme; coding and non-coding DNA strands. RNA polymerases of prokaryotes and eukaryotes. Transcription signals: promoter, initiator, terminator regions of the genome.

Processing is a post-transcriptional modification of RNA. Antibiotics as transcription inhibitors.

Genetic (biological) code; triplet code structure, its properties. Genetic code table.

Ribosomal protein synthesis system. Components of the protein-synthesizing system of ribosomes. The stages and mechanisms of translation: initiation, elongation, termination. Initiating and terminating mRNA codons; the role of ribosomal protein factors in translation.

Post-translational modification of peptide chains.

Molecular mechanisms of hormone action on target cells. Biochemistry of hormonal regulation.

Hormones and other bioregulators in the system of intercellular integration of human body functions, their chemical nature, classes of hormones.

Synthesis and secretion of hormones. Circulatory transport of hormones. Targets of hormonal action; types of cell reactions to hormone action.

Molecular and cellular mechanisms of action of protein-peptide hormones and biogenic amines.

The sequence of processes in the implementation of molecular and cellular mechanisms of action of steroid and thyroid hormones.

Hormones of the hypothalamic-pituitary system. Liberins and statins of the hypothalamus.

Hormones of the anterior lobe of the pituitary gland.

Hormones of the posterior lobe of the pituitary gland. Vasopressin (antidiuretic hormone); pathology associated with a violation of ADH production. Oxytocin.

Pancreatic hormones. Insulin - structure, biosynthesis and secretion; influence on the metabolism of carbohydrates, lipids, amino acids and proteins. Glucagon.

Thyroid hormones. Structure and biosynthesis of thyroid hormones. Biological effects of T_4 and T_3.

Biogenic amines with hormonal and mediator properties: structure, biosynthesis, physiological effects, biochemical mechanisms of action. Catecholamines - epinephrine, nonepinephrine, dopamine.

Eicosanoids: general characteristics.

Parathyroid hormone – structure, mechanism of hypercalcemic action. Calcitriol: biosynthesis; influence on the absorption of Ca^{2+} and phosphates in the intestines. Calcitonin - structure, influence on calcium and phosphate metabolism.

Steroid hormones: nomenclature, classification.

Biochemistry of human nutrition. Vitamins as food components.

General characteristics of nutrient digestion. Enzymes, biochemical mechanisms of digestion of food proteins, carbohydrates, lipids in certain parts of the digestive tract.

General characteristics of vitamins as components of human nutrition; water-soluble and fat-soluble vitamins; vitamin deficiency diseases. Exogenous and endogenous hypo- and avitaminosis.

Coenzyme vitamins (B1, B2, PP, B6, B12) - biochemical functions; sources and daily requirement.

Coenzyme vitamins - PP, H, folic acid - structure, biochemical functions; sources and daily requirement. Biochemical characteristics of vitamins C and P - chemical structure, biological role, sources and daily requirement.

Methods of determining water-soluble vitamins in biological material.

Fat-soluble vitamins (A, E, K, F, D) - biological properties, role in metabolism, manifestations of deficiency and hypervitaminosis. Bioantioxidant properties of coenzyme and fat-soluble vitamins.

Biological role and distribution of water in the body. Regulation and violation of water-salt metabolism. Biological functions of macroelements (Na, K, Ca, Mg, P), manifestations of their deficiency. The role of trace elements in human nutrition; manifestations of trace element deficiency. Biological role and metabolism of iron in the body.

Functional biochemistry of organs and tissues.

Physiological and biochemical functions of blood.

Respiratory function of erythrocytes. Hemoglobin: structure, properties, mechanisms of participation in the transport of oxygen and carbon dioxide. Variants of human hemoglobins.

The acid-base state of the human body. Mechanisms of regulation and maintenance of acid-base balance: blood buffer systems, lung and kidney function.

Blood plasma proteins and their clinical and biochemical characteristics; blood protein fractions. Blood plasma enzymes; value in enzymodiagnosis of diseases of internal organs.

Non-protein (nitrogenous and nonnitrogenous) organic compounds of blood plasma. Inorganic components of plasma. Classes of blood plasma lipoproteins: chemical composition; apoproteins.

The homeostatic role of the liver in metabolism in the human body. Biochemical functions of hepatocytes. Carbohydrate (glycogenous), lipid-regulating, protein, urea-forming, pigment, bile-forming functions of the liver. Biochemical composition of bile.

The role of the liver in the exchange of bile pigments. Hemoglobin catabolism: rupture of the tetrapyrrole ring of heme, breakdown of verdoglobin, conversion of biliverdin to bilirubin, formation of bilirubin-diglucuronide, excretion of bile.

Detoxification function of the liver; biotransformation of xenobiotics and endogenous toxins.

Types of reactions of biotransformation of foreign chemical compounds in the liver. Reactions of microsomal oxidation; inducers and inhibitors of microsomal monooxygenases. Conjugation reactions in hepatocytes: biochemical mechanisms, functional significance.

Electron transport chains of the endoplasmic reticulum.

Myofibril proteins: myosin, actin, tropomyosin, troponin.

Bioenergetics of muscle tissue: sources of ATP in muscles; the role of creatine phosphate in providing energy for muscle contraction. Cellular organization and peculiarities of heart muscle tissue metabolism, its connection with metabolism in the nervous, endocrine systems, liver, lungs, blood vessels. Features of bioenergetic processes in the myocardium and regulation of cardiomyocyte contraction.

General characteristics of the morphology and biochemical composition of connective tissue. Biochemical structure of the intercellular substance of loose fibrous connective tissue: fibers (collagen, reticular, elastic); the main amorphous substance.

Proteins of connective tissue fibers: collagens, elastin, glycoproteins and proteoglycans. Collagen biosynthesis and formation of fibrillar structures.

Complex carbohydrates of the main amorphous matrix of connective tissue are glycosaminoglycans (mucopolysaccharides). Mechanisms of participation of glycosaminoglycan molecules (hyaluronic acid, chondroitin sulfates, dermatan sulfates, keratan sulfates) in the structure of the main substance of loose fibrous connective tissue. Distribution of various glycosaminoglycans in human organs and tissues.

Features of the biochemical composition and metabolism of the nervous system. Chemical composition of the brain; neurospecific proteins and lipids (gangliosides, cerebrosides, cholesterol). Features of the amino acid composition of the brain; the role of the glutamic acid system.

Energy metabolism in the human brain, the importance of aerobic glucose oxidation.

Alignment and coordination of metabolic processes in the body. Integrating systems. Hormonal regulation of metabolism: anabolic and catabolic hormones. Stages of biomolecules splitting. General energy supply of various metabolic processes.

The relationship between the metabolism of carbohydrates, lipids, and proteins. Common precursors and intermediates. Relationship of metabolism in individual organs and tissues: liver and adipose tissue, liver and muscles, liver and kidneys, liver and nervous tissue.

2.2 A list of questions from the sections that are given for the entrance exam

1. Features of the structure of the trunk bones.
2. Features of the structure of the upper limb bones.
3. Features of the structure of the lower limb bones.
4. Features of the skull bones.
5. Skull as a whole.
6. Features of the structure of the joints of the upper and lower limbs.
7. Muscles and topography of the trunk, head and neck.
8. Muscles and topography of the upper limb.
9. Muscles and topography of the lower limb.
10. Anatomy of the digestive system organs.
11. Anatomy of the respiratory system organs.
12. Anatomy of the urinary system organs.
13. Anatomy of the reproductive system organs.
14. Anatomy of the spinal cord.
15. Structure of medulla oblongata, pons, and cerebellum.
16. Anatomy of the middle and intermediate brain.
17. Anatomy of the terminal brain.
18. Conductive pathways of the brain and spinal cord.
19. Meninges of the brain and spinal cord.
20. Brain ventricles. Pathways of formation and circulation of cerebrospinal fluid.
21. Structure of the heart.
22. Arteries of the trunk, head, and neck.
23. Arteries of the lower and upper extremities.
24. Branches of the thoracic and abdominal aorta.
25. Arteries and veins of the pelvis.
26. System of superior vena cava.
27. Vessels and nerves of the upper limb.
28. Vessels and nerves of the lower limb.

29. Structure of organs of the endocrine system.
30. Lymphatic and immune systems.
31. Structure of the organ of vision.
32. Structure of the organ of hearing and balance.
33. Methods of microscopic study of microorganisms (technique of cultures smear preparation). Simple and complex methods of microorganism staining.
34. Complex methods of the specimens staining – Gram staining: principle and staining procedure of the method. Purpose of each step in the Gram staining procedure and microscopic picture.
35. Method of detection of capsules in bacteria. Burri-Gins staining, principles and stain procedure, and microscopic picture.
36. Flagella: the structure, chemical composition, and functions. Methods of examination motility.
37. Spores: structure, and functions. Formation and germination of spore. Spore staining.
37. Nutrition of bacteria: mechanisms of nutrient transfer from the external environment into the cell: passive diffusion, active transport.
38. Basic requirements for nutrient media and their classification (by consistency, by purpose, by composition). Examples of nutrient media and their use.
39. Methods of isolation of a pure culture of aerobic and anaerobic microorganisms.
40. The concept of sterilization. Purpose and methods of thermal sterilization. Sterilization with solutions of chemical substances. Sterilization efficiency control methods.
41. Definition of disinfection. Examples of disinfectants and their requirements. Methods of controlling the effectiveness of disinfection.
42. Antibiotics: definition, classification. Mechanisms of action of antibiotics. The problem of resistance: definition, mechanisms. Tests of antimicrobial drugs: sensitivity tests, disk diffusion, and interpreting the action of the results.
43. Immune response, definition, scheme, phases, and forms. Cellular factors and mechanisms of immune response.
44. Properties of antibodies and their production. Types of immunoglobulins, their properties, and their content in blood. Serological reactions: purpose and principle of presentation.
45. Microscopic methods in virology (electron microscopy, luminescence microscopy, and immunofluorescence method).
46. Cultivation of viruses in chicken embryos and cell culture. Cytopathic effect of viruses.
47. Reflexes, their classification. Reflex arc, functions of its individual elements. Patterns of impulse conduction along the reflex arc.
48. Synapses of the central nervous system (CNS), their classification, functioning mechanisms. CNS mediators, general characteristics of their action.
49. The role of the spinal cord in regulating motor and vegetative functions of the body.
50. Features of the structural-functional organization of the parasympathetic nervous system. The influence of this system on the body's functions.
51. Endocrine function of the adrenal cortex. Mineralocorticoids: regulation of secretion, mechanisms of action, functional effects.
52. Endocrine function of the thyroid gland. Regulation of secretion, mechanisms of action, functional and metabolic effects of its hormones.
53. General functional characteristics of erythrocytes. Their properties and functions. Osmotic resistance of erythrocytes.
54. Leukocytes, their distribution in the body. Quantitative and qualitative composition of leukocytes in peripheral blood. Main functions of individual types of leukocytes. Leukocyte formula.

55. Phase structure of the cardiac cycle. Characteristics of individual periods and phases of heart function.
56. Conduction of impulses through the cardiac conduction system to the working myocardium. Features of the cardiac conduction system.
57. Characteristics of hemodynamic parameters: blood pressure in vessels, hemodynamic resistance, blood viscosity, tension of the vascular wall. Arterial pressure, its types. Methods of measuring arterial pressure.
58. Biomechanics of respiration: mechanisms of inhalation and exhalation. Static and dynamic indicators of lung ventilation.
59. The significance of the stomach in the processes of digestion. Motor and secretory functions of the stomach. Gastric juice, its composition, properties, and significance of its main components. Mechanisms of gastric secretion.
60. Secretory function of the small intestine. Composition, properties, and significance of the main components of intestinal juice.
61. Tubular reabsorption and secretion in the kidneys, their mechanisms. Physiological significance of these processes.
62. General characteristics and biological functions of proteins and peptides. Amino acid composition of proteins and peptides: structure, modern classifications, biological role. Physico-chemical properties of amino acids. Levels of structural organization of proteins. Chemical bonds in a protein molecule.
63. Physico-chemical properties of proteins. Methods of protein isolation from biological objects, their fractionation and structure analysis.
64. Modern classifications of proteins. General characteristics of simple proteins, their role. Natural peptides. Complex proteins: classification, representatives, presence in the human body.
65. Nucleotides: structure, structural components, nomenclature, biological role.
66. Nucleic acids: peculiarities of structural organization, physical and chemical properties, biological functions of DNA and RNA. Physicochemical properties of nucleic acids.
67. Chemical nature of enzymes. General characteristics of enzymes as biological catalysts. International classification and nomenclature of enzymes. Classes of enzymes.
68. Chemical structure of enzymes: structure of enzyme proteins, oligomeric proteins-enzymes. Functional enzyme systems. Cofactors and coenzymes: Mechanism of enzyme action: hypotheses of enzymatic catalysis by E. Fischer and D. Koshland.
69. Mechanisms of enzymes action: stages of enzymatic catalysis, formation of an enzyme-substrate complex. Thermodynamic regularities of enzymatic catalysis.
70. Kinetics of enzymatic reactions: dependence of the reaction rate on the concentration of the substrate, enzyme, pH and temperature. The Michaelis-Menten equation and a graphic representation of its components. General principles and methods of determining the unit of activity and amount of enzymes. The plural forms of enzymes are isozymes.
71. Regulation of enzyme activity. Activators, inhibitors. Types of inhibition of enzyme activity. Ways and mechanisms of regulation of enzymatic processes.
72. General patterns of metabolism: catabolic, anabolic and amphibolic pathways of metabolism. Anaplerotic reactions. Stages of catabolism of biomolecules in the body.
73. General characteristics of the citric acid cycle: intracellular localization, biological role, scheme of functioning. Regulation and energy balance of the citric acid cycle.
74. Exergonic and endergonic biochemical reactions. The role of ATP and other macroergic phosphates in coupling exergonic and endergonic processes.

75. Molecular organization of the mitochondrial chain of biological oxidation. Components of the respiratory chain, their redox potentials, molecular complexes of the inner membranes of mitochondria.
76. Chemiosmotic theory of oxidative phosphorylation: mechanism of conjugation. ATP synthetase of mitochondria.
77. Inhibitors and uncouplers of electron transport and oxidative phosphorylation, their biomedical significance.
78. Carbohydrates: definition, classification. Structure, properties, role of representatives of individual classes.
79. Anaerobic oxidation of glucose: sequence of reactions, enzymes. Aerobic oxidation of glucose: stages, energy balance. Shuttle mechanisms of glycolytic NADH oxidation.
80. The phosphorolytic pathway of glycogen cleavage in the liver and muscles. Regulation of glycogen phosphorylase activity. Glycogen biosynthesis: enzymatic reactions, physiological values. Regulation of glycogen synthase activity.
81. Gluconeogenesis: substrates, enzymes and physiological significance of the process. Glucose-lactate (Cori cycle) and glucose-alanine cycle. Pentose-phosphate pathway of glucose oxidation: process scheme, biological significance, regulation.
82. Metabolic pathways of fructose and galactose conversion.
83. General characteristics of lipids: structure, functions of representatives of individual classes. Fatty acids, structure, role.
84. TAG catabolism in adipose tissue: sequence of reactions, mechanisms of regulation of TAG-lipase activity. Neurohumoral regulation of lipolysis.
85. Reactions of fatty acid oxidation (β-oxidation), the role of carnitine in the transport of fatty acids in mitochondria.
86. Ketone bodies. Reactions of biosynthesis and utilization of ketone bodies, physiological importance.
87. Biosynthesis of higher fatty acids. Stages and reactions of the biosynthesis of saturated fatty acids (palmitate).
88. Biosynthesis of triacylglycerols. Characteristics of lipogenesis in adipocytes. Circulatory transport of lipids. Blood plasma lipoproteins.
89. Cholesterol biosynthesis: scheme of reactions, regulation of synthesis. Pathways of biotransformation of cholesterol.
90. The pool of free amino acids in the body: ways of obtaining and using free amino acids in tissues.
91. Transamination of amino acids: reactions and their biochemical significance, mechanism of action of aminotransferases. Clinical and diagnostic value of determination of transaminases. Direct and indirect deamination of free L-amino acids in tissues. Decarboxylation of L-amino acids in the human body. Physiological value of biogenic amines.
92. Pathways of formation and neutralization of ammonia in the body. Biosynthesis of urea: the sequence of enzymatic reactions of biosynthesis, genetic anomalies of enzymes of the urea cycle.
93. General pathway of metabolism of carbon skeletons of amino acids in the human body. Glucogenic and ketogenic amino acids.
94. Metabolism of sulfur-containing amino acids; methylation reactions. Biosynthesis and biological role of creatine and creatine phosphate.
95. Specialized metabolic pathways of cyclic amino acids - phenylalanine and tyrosine.
96. Biosynthesis of purine nucleotides: scheme of IMP synthesis reactions; formation of AMP and GMP; mechanisms of regulation.
97. Biosynthesis of pyrimidine nucleotides: scheme of reactions; regulation of synthesis.

98. Catabolism of purine nucleotides; hereditary disorders of uric acid metabolism.
99. DNA replication: biological significance; semi-conservative mechanism of replication.
100. RNA transcription: RNA polymerases of prokaryotes and eukaryotes, transcription signals (promoter, initiator and terminator regions of the genome). Processing - post-transcriptional modification of newly synthesized mRNAs.
101. Genetic (biological) code: triplet structure of the code, its properties. The main components of the protein synthetic system. Stages and mechanisms of translation (protein biosynthesis) in ribosomes: initiation, elongation and termination. Post-translational modification of peptide chains. Regulation of termination.
102. Genetic engineering: construction of recombinant DNA; gene cloning; genetic engineering synthesis of enzymes, hormones, interferons, etc.
103. General characteristics of hormones. Classification of hormones: by chemical structure, by mechanism of action, by their functions. Synthesis, secretion and transport of hormones. Mechanisms of regulation of hormone secretion based on the principle of positive and negative feedback. Examples.
104. Molecular and cellular mechanisms of action of protein-peptide hormones and biogenic amines. Cascade systems of chemical signal transmission of the bioregulator.
105. Scheme of molecular and cellular mechanisms of action of steroid and thyroid hormones. Molecular organization of DNA regulatory sites that interact with hormone receptors.
106. Hormones of the hypothalamus - pituitary system. Liberins and statins. Hormones of the anterior lobe of the pituitary gland.
107. Hormones of the posterior lobe of the pituitary gland. Vasopressin, oxytocin. Pathology associated with a violation of the release of antidiuretic hormone (ADH).
108. Pancreatic hormones - insulin and glucagon. Structure, secretion, role in the exchange of carbohydrates, lipids, and proteins.
109. Thyroid hormones. Structure, biosynthesis, biological effects of T_3, T_4.
110. Biogenic amines with hormonal and mediator properties: structure, biosynthesis, physiological effects, biochemical mechanisms of action of catecholamines (epinephrine, nonepinephrine, dopamine).
111. Steroid hormones: nomenclature, classification, genesis from cholesterol, biochemical effects.
112. Eicosanoids: general characteristics, nomenclature, biosynthesis, biological and pharmacological properties, their clinical application.
113. Hormonal regulation of calcium homeostasis in the body. Violation of calcium homeostasis (rickets, osteoporosis).
114. Mechanisms of conversion of nutrients (proteins, carbohydrates, lipids) in the digestive tract. Enzymes of the stomach and intestines.
115. Microelements in human nutrition. Biological functions of individual trace elements; manifestations of trace element deficiency. Vitamins in human nutrition. Water-soluble and fat-soluble vitamins; exogenous and endogenous causes of vitamin deficiency.
116. Water-soluble vitamins: structure, metabolic role, mechanism of action, sources, daily requirement.
117. Fat-soluble vitamins: structure, metabolic role, mechanism of action, sources, daily requirement.
118. Biochemical and physiological functions of blood in the human body. Respiratory function of erythrocytes. Hemoglobin: mechanisms of participation in the transport of oxygen and carbon dioxide. Blood buffer systems. Violation of the acid-base balance in the body (metabolic and respiratory acidosis, alkalosis).

119. Biochemical composition of human blood. Blood plasma proteins and their biochemical characteristics. Blood plasma enzymes. Non-protein organic components of blood plasma.
120. Biochemical functions of the liver: carbohydrate and protein synthesis, urea formation. Bile-forming function of the liver, regulation of blood lipid composition; role in the metabolism of vitamins and minerals, nucleic acids, and amino acids. The role of the liver in the metabolism of bile pigments.
121. Detoxification function of the liver; types of biotransformation reactions of xenobiotics and endogenous toxins. Reactions of microsomal oxidation. Cytochrome P-450; electron transport chains in the membranes of the endoplasmic reticulum of hepatocytes. Conjugation reactions in hepatocytes: biochemical mechanisms, functional significance.
122. Biochemical composition of muscles. Myofibril proteins: myosin, actin, tropomyosin, troponin. Bioenergetics of muscle tissue; sources of ATP; the role of creatine phosphate in providing energy for muscle contraction. Features of bioenergetic processes in the myocardium and regulation of cardiomyocyte contraction.
123. Proteins of connective tissue fibers: collagen, elastin, glycoproteins, and proteoglycans. Collagen biosynthesis.
124. Biochemistry of the nervous system: peculiarities of the biochemical composition and metabolism of the brain. Energy metabolism in the human brain. The value of aerobic oxidation of glucose.
125. The relationship between the exchange of carbohydrates, lipids, and proteins. Common precursors and intermediates. Relationship of metabolism in individual organs and tissues.

3. STRUCTURE OF EXAMINATION TASKS

The exam is conducted in the form of a written test. The examination ticket for the entrance test for postgraduate studies in the specialty 091 "Biology and Biochemistry" contains 50 test tasks (each ticket includes 10 questions from biology, anatomy, physiology, microbiology, and biochemistry) of the same level, which makes it possible to comprehensively check the theoretical knowledge of the entrant. Each question on the exam ticket has several answer options, one of which is correct. Entrance tests are conducted based on examination tickets prepared in full accordance with the sections defined by this program.

A sample test task is given in Appendix 1.

The duration of the entrance exam is 80 minutes.

4. ANSWER EVALUATION CRITERIA

General requirements.

The commission evaluates the entrant's written answers to test tasks on a 100-200 point scale. Entrants who scored less than 100 points receive an "unsatisfactory" rating and are not allowed to further participate in the competitive selection. Entrants who scored 100 or more points are allowed to participate in the competitive selection.

To receive a positive grade on the entrance test, the applicant needs to pass the minimum acceptable test threshold at the level of 0.30 or 30% of the total number of test points.

Test points are awarded for each correct answer to the task, and 0 points are awarded for an incorrect answer. The received test scores for the entrance test are converted into a 100-200 point scale (with rounding to the nearest whole, according to the rules of mathematical rounding) according to the following algorithm:

$$O = Omin + k \cdot (N - r \cdot T), \text{ where}$$

O	–	assessment from the entrance test on a scale of 100-200 points;
Omin	–	the minimum score from the entrance test on a scale of 100-200 points, at which the entrant is allowed to participate in the competitive selection;
k	–	the coefficient of transfer of test scores to a scale of 100-200 points, while:

$$k = 100 / T \cdot (1 - r)$$

r	–	the minimum acceptable test threshold with an accuracy of 0.01, which is set in the range from 0 to 1, but not less than 0.10;
T	–	загальна кількість тестових балів, яку вступник може отримати під час вступного випробування;
N	–	the number of test points that the entrant received during the entrance test.

Provided that the number of test points that the entrant received during the entrance test (N) is "0", then the entrant receives an "unsatisfactory" grade and is not allowed to participate in the competitive selection.

Calculation of test points.

For each correct answer to a test question, 4 test points are awarded. Incorrect answer - 0 points.

The total number of test points (T) that an entrant can receive during the entrance test is 200 test points.

The number of test points for the entrance exam (N) is calculated as the sum of test points excluding the test points removed for correcting the answer sheet.

Corrections Policy.

For every five corrections, 1 test point is deducted from the total number of test points (T) that the entrant can receive on the entrance test.

LIST OF RECOMMENDED LITERATURE

1. Blackburn, Simon, David Moffat, and Omar Faiz. Anatomy at a Glance. 3rd ed. Wiley, 2011. Web. 14 Oct. 2022.
2. Human anatomy: textbook: in 3 volumes / ed. by VG Koveshnikov. - 2nd ed., corrected. and edited. - Lviv: Magnolia, 2021.
3. Netter F. Atlas of Human Anatomy: 7-th edition. – Philadelphia.: Elsevier, 2019. – 791 p.
4. USMLE Step 1: Biochemistry and Medical Genetics: Lecture Notes / Editors S. Turco, R. Lane, R.M. Harden. — New York: Kaplan, 2019. — 409 p.
5. Bender D. A. Harper's illustrated biochemistry / D.A. Bender, K.M. Botham, P.J. Kennelly, P.A. Weil. - 30th edition. - Lange Medical Books / McGraw-Hill, 2017. - 821 p.
6. Lieberman M. A. Marks' Basic Medical Biochemistry: A Clinical Approach / Michael A. Lieberman, Alisa Peet. – 5th edition. – Wolters Kluwer, 2017. – 1008 p.
7. General Microbiology / L. Bruslind. – 1st edition. – Corvallis, Or: Oregon State University, 2020. 206 p.
8. USMLE Step 1: Immunology and Microbiology: Lecture Notes / Editors T. L. Alley, K.Moscatello, C. Keller. - New York: Kaplan, 2019. 511 p.

9. Medical microbiology and immunology: textbook / M. Z. Tymkiv, O. P. Korniychuk, S. Y. Pavliy et al. – Vinnytsia: Nova Knyha, 2019. – 416 p.

Approved at a meeting of the admissions committee.
Protocol N 11 from 08 квітня 2024 p.

Responsible secretary
admissions committee _____ I. Roy

Head
subject commission _____ A. Loboda

Appendix 1

SUMY STATE UNIVERSITY

APPROVE
Head of the admissions committee
_____
____ _____ 20__ p.

EXAMINATION TASK
entrance exam during admission to study
to obtain the degree of "Doctor of Philosophy" in the specialty
091 "Biology and Biochemistry"

Variant №___

1	Intercostal nerves are	A) muscular branches of the lumbar plexus B) short branches of the brachial plexus C) long branches of the brachial plexus D) anterior branches of thoracic spinal nerves E) posterior branches of thoracic spinal nerves
2	The white matter of the spinal cord is formed by:	A) fasciculus B) bodies of neurons C) conductive ways D) receptors E) outgrowths of neurons
3	What is the name of the I cervical vertebra?	A) axis B) prominent C) transverse D) Atlas E) carotid
4	Where and how does the lesser circle of blood circulation begin?	A) from the left ventricle through the aorta B) from the left atrium through the aorta C) from the right atrium through the pulmonary trunk D) from the right ventricle through the pulmonary trunk E) from the left ventricle through the pulmonary trunk
5	The subdural space is located:	A) between dura mater and pia mater B) between dura mater and arachnoid mater C) between the outer and inner layers of the dura mater D) between the dura mater and periosteum of bones E) between arachnoid mater and pia mater
6	Hollow organs do NOT include:	A) lungs B) esophagus C) uterus D) urinary bladder E) large intestine

7	What venous vessels form the superior vena cava?	A) right and left internal iliac veins B) right and left renal veins C) right and left brachiocephalic veins D) right and left external iliac veins E) right and left common iliac veins
8	IV ventricle is a cavity:	A) cerebral hemisphere B) spinal cord C) midbrain D) diencephalon E) rhombencephalon
9	What is the name of the outer layer of the heart wall?	A) endocardium B) myocardium C) pericardium D) adventitia E) epicardium
10	VII pair of cranial nerves is called	A) accessory nerve B) optic nerve C) trigeminal nerve D) olfactory nerve E) facial nerve
11	What law was used for the genetic structure of the population:	A) Vavilov B) Mendel C) Morgan D) Hardy-Weinberg E) Haeckel-Müller
12	At what stage of cell division is the human karyotype studied?	A) Prophase B) Metaphase C) Anaphase D) Telophase E) Interphase
13	What is the name of the diploid set of chromosomes of a cell?	A) Genotype B) Gene C) Genome D) Locus E) Karyotype
14	What is the function of ribosomes?	A) Protein synthesis B) Lipid synthesis C) Nucleic acid synthesis D) Carbohydrate synthesis E) DNA synthesis
15	Which research method is not used in anthropogenetics?	A) Genealogical B) Hybridological C) Population-statistical D) Cytological E) Twin (method)
16	What is the name of the interaction of non-allelic genes, in which the gene of one allelic pair suppresses the action of the dominant gene of the other allelic pair?	A) Pleiotropy B) Polymerism C) Epistasis D) Codominance E) Dominance
17	In the process of human development, two lordosis and two kyphosis are formed, which is explained by the development of a person's ability to:	A) Sitting B) Lying C) Crawling D) Upright walking E) Bending
18	What level of organization ensures the existence of the cellular level of life?	A) Tissue B) Organismal C) Population-species D) Molecular E) Biogeocenotic

19	The presence of genetically different cells with different karyotypes in tissues (plants, animals, humans) is called:	A) Genetic mosaic B) Chromosomal aberration C) Gene mutation D) Polyploidy E) Aneuploidy
20	What process in the cell ensures the constancy of the number of chromosomes?	A) Mitosis B) Amitosis C) Meiosis D) Endomitosis E) Schizogony
21	Which one of the following agents simultaneously contains both DNA and RNA?	A) Prions. B) Viruses. C) Viroids. D) Bacteria. E) Plasmids.
22	Which of the following are prokaryotes?	A) Fungi. B) Protozoa. C) Viruses. D) Prions. E) Archaebacteria.
23	Which of the following structures is NOT part of the bacterial cell envelope?	A) Peptidoglycan. B) Lipopolysaccharide. C) Gas vacuole. D) Capsule. E) S-layer.
24	Which of the following components is present in gram-positive bacteria but not in gram-negative bacteria?	A) Peptidoglycan. B) Capsule. C) Flagella. D) Teichoic acid. E) Diaminopimelic acid.
25	The process by which microorganisms form ATP during the fermentation of glucose is characterized by	A) Coupling of ATP production with the transfer of electrons. B) Substrate phosphorylation. C) The reduction of oxygen. D) Denitrification. E) Anaerobic respiration.
26	What is a characteristic of the adaptive immune response and not of the innate response?	A) Clonal expansion of effector cells. B) Chemical barriers. C) Physical barriers. D) Inflammatory mediators. E) Phagocytosis.
27	What cells belong to mononuclear phagocytes?	A) Neutrophils. B) Erythrocytes. C) Macrophages. D) Thrombocytes. E) Lymphocytes.
28	What type of interaction of a virus with a cell ends with the formation of a new generation and the death of infected cells?	A) Abortive type. B) Productive type. C) Integrative type. D) All the listed types. E) None of the listed types.
29	The cytoplasmic membrane of bacteria:	A) Defines cell shape. B) Causes cell sensitization. C) Is a protein synthesizing system. D) Participates in the transport of substances. E) Is a chemotaxis factor.

30	It is known that bacterial cells contain additional genetic structures that may be separated from bacterial nucleoid as independent elements or be integrated with the nucleoid. Additional genetic structures allow for the additional features of those bacteria. What is the name of those additional genetic structures?	A) Prophage. B) Nucleotides. C) Plasmids. D) Is-sequences. E) Wondering genes.
31	Which amino acid is glucogenic?	A) Glutamic acid. B) Alanine. C) Leucine. D) Lysine. E) Valine.
32	What metabolite accumulates in the blood with thiamine deficiency?	A) Alanine. B) Pyruvate. C) Succinate. D) Citrate. E) Malate.
33	What is the name of the process of ATP synthesis involving the respiratory chain of mitochondria?	A) Reductive phosphorylation. B) Substrate phosphorylation. C) Oxidative phosphorylation. D) Photosynthetic phosphorylation. E) Free oxidation.
34	Synthesis of ATP in body cells occurs in substrate phosphorylation reactions with the participation of macroergic compounds. Which compound belongs to such macroergs?	A) Creatine phosphate. B) Adenosine monophosphate. C) Creatinine. D) Glucose-6-phosphate. E) Creatine.
35	Name the hormone that reduces the concentration of glucose in the blood due to its transport and utilization in tissues.	A) epinephrine B) thyroxine C) insulin D) aldosterone E) glucagon
36	An experimental animal that was on a protein-free diet developed fatty infiltration of the liver due to a deficiency of methylating agents. Name the compound that is a donor of methyl groups in the synthesis of phospholipids of hepatocyte membranes.	A) Linoleic acid. B) Methionine C) Cholesterol. D) Acetoacetate. E) Choline
37	Name the process of carbohydrate metabolism that produces reduced NADP for the synthesis of fatty acids, cholesterol and the neutralization of xenobiotics?	A) Aerobic glycolysis. C) Anaerobic glycolysis. C) Gluconeogenesis. D) Pentose phosphate pathway. E) Glycogenolysis.
38	Microsomal oxidation is a universal biological system for the oxidation of toxic compounds, steroid hormones, and cholesterol. What cytochrome is part of the oxygenase chain of microsomes?	A) Cytochrome a. B) Cytochrome a_3. C) Cytochrome b. D) Cytochrome c. E) Cytochrome P_{450}.
39	Deficiency of which compounds is the cause of steatorrhea when eating fatty food?	A) Phospholipids. B) Fatty acids. C) Bile acids. D) Triglycerides. E) Chylomicrons.
40	Arachidonic acid as an essential component of food is a precursor of biologically active substances. What compound is synthesized from it?	A) Ethanolamine. C) Choline. C) Norepinephrine. D) Triiodothyronine. E) Prostaglandin E_1.
41	Name the proteolytic enzyme of gastric juice	A) Carboxypeptidase B) Elastase C) Trypsin D) Amylase E) Pepsin

42	What blood cells belong to agranulocytes?	A) Monocytes B) Epithelial cells C) Eosinophils D) Osteoblasts E) Basophils
43	What ions ensure the release of the mediator into the synaptic cleft?	A) Calcium B) Bicarbonates C) Sodium D) Potassium E) Chlorine
44	The division of blood into groups is related to the antigenic composition of which cells?	A) Thrombocytes B) Erythrocytes C) Lymphocytes D) Monocytes E) Basophils
45	What indicator allows you to evaluate the filtration process in the kidneys?	A) Transmural pressure B) Nernst formula C) Stroke volume D) Clearance E) Respiratory quotient
46	Among the named substances, choose the components of the fibrinolysis system	A) Heparin B) Fibrin C) Plasmin D) Thromboplastin E) Renin
47	Where is the respiratory center?	A) In the thalamus B) In the medulla oblongata C) In the hypothalamus D) In the cerebral cortex E) In the hippocampus
48	Which scientist explained the filtration-reabsorption mechanism in capillaries?	A) Starling B) Nernst C) Fick D) Bayliss E) Poiseuille
49	The leukocyte formula is:	A) Percentage ratio between different forms of leukocytes in peripheral blood B) Percentage of leukocytes relative to all formed elements in the blood C) Absolute content of specific forms of leukocytes in a unit volume of blood D) Percentage of mature forms of leukocytes relative to their precursors E) No correct answer
50	What gland produces cortisol?	A) By the sex glands B) By the pancreas C) By the thyroid gland D) By the adrenal medulla E) By the adrenal cortex

Head of the subject commission _____

Appendix 2

SUMY STATE UNIVERSITY

ANSWER SHEET
entrance exam during admission to study
to obtain the degree of "Doctor of Philosophy" in the specialty
091 "Biology and Biochemistry"

Variant №___

№ питання	A	B	C	D	E
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

№ питання	A	B	C	D	E
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					

№ питання	A	B	C	D	E
35					
36					
37					
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					

WARNING!!! Tasks have several answer options, among which only one is correct. Choose the option that you think is correct and mark it as shown in the sample. The number of corrections affects the overall rating of the work!

A	B	C	D	E
X				

The number of correct answers is — _____;
The number of points for them is — _____;
The number of corrections is — _____;
Deducted points for correction — _____;
Total points including removed

_____
(number and letter)

Head of Commission

_____ _____
(signature) (surname, initials)

Members of the Commission

_____ _____
(signature) (surname, initials)

_____ _____
(signature) (surname, initials)