

**MINISTRY OF HEALTH OF UKRAINE
NATIONAL UNIVERSITY OF PHARMACY**



APPROVED BY
Chair of the Admissions Committee

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«14» April 2023

PROGRAM
of professional test for biology admission to study
according to the educational program

“LABORATORY DIAGNOSTICS”

(for foreign citizens and stateless persons,
who have completed general secondary education)

Specialty 224 “Technologies of medical diagnostics and treatment”

Subject area 22 “Public Health”

Level of higher education – first (bachelor's)

Educational degree – bachelor

Kharkiv, 2023

CONCEPT NOTE

The program of entrance tests in biology is concluded on the basis of the Program for external independent assessment in biology (approved by the Ministry of Education and Science of Ukraine, order № 1426 of 20.12.2018). The content of the program of entrance examinations in biology is divided into thematic blocks according to the key elements of the content of biology curricula for students of general secondary education. The program consists of 5 sections: "Introduction. Chemical composition, structure and functioning of cells. Realization of hereditary information", "Patterns of heredity and variability", "Biodiversity", "Human body as a biological system", "Fundamentals of ecology and evolutionary theory". The program for external independent assessment in biology is focused on master subject skills and achieving certain results in terms of methods of scientific knowledge; basic provisions of biological laws, rules, theories, patterns, hypotheses; essence of biological processes and phenomena; structures of biological objects; modern biological terminology and symbolism; skills: to explain, establish connections, make diagrams from tabular data and graphical images, recognize biological objects by their image, classify, draw conclusions, use knowledge in everyday life (substantiate the rules of behavior in the environment, disease prevention measures, methods home care).

CONTENT

Unit 1. Introduction. Chemical composition, structure and functioning of cells.

Implementation of hereditary information.

1.1. Introduction. Fundamental properties of living organisms. Biological systems levels of organization and their characteristics. Research methods in biology. The value of biological research in human life.

1.2 Chemical composition of cells. Classification of chemical elements according to their content in organisms. Organic and inorganic compounds and their role in the body. Water, its main properties and role in the body. Water as a solvent, hydrophobic and hydrophilic compounds. Biopolymers: the concept of their structure and conformation. Carbohydrates: monosaccharides (ribose, deoxyribose, glucose, fructose), oligosaccharides (sucrose, lactose), polysaccharides (starch, cellulose, chitin, glycogen). Basic properties and functions of carbohydrates in organisms. Lipids (fats, waxes, steroids, phospholipids). Basic properties and functions of lipids in organisms. Proteins. Amino acids as protein monomers. Levels of structural organization of proteins. Denaturation and renaturation of proteins. Basic biological functions of proteins. Enzymes, their properties and principles of functioning. Nucleic acids. Nucleotide structure. Structure and functions of DNA. The principle of complementarity. Nucleotide sequence and the concept of gene. Properties of

DNA. RNA and its types (mRNA, rRNA, tRNA). ATP. The role of ATP in energy supply.

1.3. Eukaryotic cell structure and functioning. The cell as basic unit of life. Methods of cell research. Basic properties and principles of eukaryotic cell structure. Cell membranes, their chemical composition, structure, properties and basic functions. Transport of substances across cell membranes. Cytoplasm, its components: cytoskeleton, organelles and inclusions. Single-membrane organelles: endoplasmic reticulum, Golgi apparatus, lysosomes, vacuoles. Double-membrane organelles: mitochondria, plastids (chloro-, leuco- and chromoplast). Mitochondria: structure, functional role. Chloroplasts: structure, functional role of chloroplasts. Autonomy of mitochondria and chloroplasts in the cell. Ribosomes: structure, functional role. Centrioles. Organelles of movement (flagella, eyelashes). Core: structure, functional role. Chromosomes: chemical composition, structure, functional role. Haploid and diploid sets of chromosomes. Homologous chromosomes. The main states of chromosomes: interphase noncompact and overcompact in the process of cell division. Chromosome doubling due to DNA replication. Morphology of supercompact /mitotic/ chromosomes. The concept of karyotype. Nucleolus, its functional role.

1.4 Metabolism and energy conversion. Metabolism, its general characteristics. The unity of the processes of synthesis and breakdown of substances in the body. Autotrophic and heterotrophic types of nutrition. Mixotrophic organisms. Cleavage of substances in the body (oxygen-free, oxygen). The concept of glycolysis, fermentation. The concept of cellular respiration. Mitochondria as the energy station of the cell. Photosynthesis. The main processes occurring in light-dependent and light-independent reactions /light and dark phases/ photosynthesis. The role of chlorophyll in light-dependent reactions /light phase/ photosynthesis. The value of photosynthesis for the existence of the biosphere. The concept of chemosynthesis.

1.5 Saving and implementation of genetic information. Genes, their structure and functional role. Mosaic structure of the eukaryotic gene (exons and introns). The concept of the genome. Transcription: matrix synthesis of RNA molecules. The concept of transcription regulation. Protein biosynthesis (translation). Genetic code and its main properties. The role of mRNA, tRNA and ribosomes in protein biosynthesis. DNA replication: a semi-conservative principle. DNA replication and cell cycle. Interphase and cell division. Mitosis, the main processes that occur during mitosis. Meiosis and its features in comparison with mitosis. Functional role of meiosis. The concept of DNA recombination during meiosis. Crossingover. The formation of gametes and their association in the zygote during fertilization. Sexual reproduction. The main forms of asexual reproduction of organisms. Individual development of an organism (ontogenesis). Embryonic development. The main stages of embryonic development in chordates (zygote

fragmentation, blastula and gastrula formation). The concept of cell differentiation during embryonic development. Stem cells. Post-embryonic development and its types.

Unit 2. Patterns of heredity and variability

2.1. Genetics is the science of the laws of heredity and variation in organisms. Classical methods of genetic research. Basic concepts of genetics. The basic principles of functioning genes in prokaryotes and eukaryotes.

2.2. Patterns of heredity of organisms. Regularities of heredity established by G. Mendel. Method of checking the genotype of hybrid individuals (analytical crossing). Multiple action of genes. A trait as a result of many genes manifestation. Gene interaction. Linked inheritance. Chromosomal theory of heredity. Genetic basis of sex determination in different groups of organisms. Chromosomal sex determination. Inheritance linked to the article. Chromosomal analysis as a method of detecting disorders in the structure of the karyotype. Hereditary diseases and defects of man, diseases of man with hereditary predisposition, their causes. Modern molecular genetic methods of research of human heredity.

2.3. Patterns of variability of organisms. Modification (non-hereditary) variability, its causes. The reaction rate. Variation series and variation curve. Hereditary variability and its types: combinatorial and mutational. Sources of combinatorial variability. Mutations and their properties. Types of mutations (genomic, chromosomal, point; somatic and generative). Mutagenic factors (physical, chemical and biological).

2.4. Selection of organisms. Biotechnology. The concept of plant variety, animal breed, strain of microorganisms. Artificial selection (individual and mass). Related and unrelated crossbreeding, interspecific (remote) hybridization, their genetic and biological consequences. Heterosis and its genetic basis. Methods of molecular genetics as a basis of modern biotechnologies: polymerase chain reaction, genetic engineering, DNA cloning, cell engineering. Cloning of organisms. Genetically modified organisms (GMOs): principles of creation.

Unit 3. Biodiversity

3.1 Systematics is the science of the diversity of organisms. Biodiversity of our planet as a consequence of evolution. Modern system of the organic world (domains: Archaea, Bacteria, Eukaryotes). Basic taxonomic units used in the taxonomy of organisms. Kind as the basic systematic unit. Biological concept of the species. Modern criteria of the species. The concept of phylogenetic taxonomy. Methods of graphical display of kinship of systematic groups of organisms.

3.2. Viruses. Viroids. Prions. Features of the organization and functioning of viruses.

Hypotheses of the origin of viruses. The role of viruses in evolution, the concept of horizontal gene transfer. Ways of penetration of viruses into the bodies of plants, animals and humans. Interaction of viruses with the host cell. Use of viruses in genetic engineering and biological methods of pest control. Prevention of human viral diseases. The concept of vaccination. The concept of viroids, prions.

3.3. Prokaryotic organisms. Cell structure of prokaryotes. Prokaryotic organisms (archaea, bacteria), features of their organization and functioning. Types of nutrition (photo- and chemosynthesis, heterotrophic) and respiration (anaerobic and aerobic) of prokaryotic organisms. Reproduction (division and budding of cells) and exchange of hereditary information (conjugation) in prokaryotic organisms. Relationships of prokaryotic organisms with other organisms (mutualism, commensalism, parasitism). The role of prokaryotes in nature and human life. Pathogenic bacteria and human diseases caused by them. Prevention and treatment of bacterial diseases

3.4. Algae. Features of the structure and vital processes of unicellular and multicellular algae. Representatives of algae: Green algae (chlamydomonas, chlorella, ulotrix, spirogyra, ulva), Diatoms algae (pinularia, navicula), Brown algae (kelp, fucus, sargassum), Red algae (porphyria).

3.5 Plants. Vegetative organs and vital functions of plants. Plant cells. The main groups of plant tissues: permanent – integumentary (skin, bark), conductive (vessels, sieve-like tubes), basic (photosynthetic, storage, including endosperm, mechanical); generative - apical and lateral. General characteristics of plants. The value of plants. Root. Types of roots (main, additional, lateral). Root system and its types (rod, fibrous). Root zones and their functions. The internal structure of the root in the area of root hairs. Modifications of the root (roots, tubers, tubular, respiratory, supporting, tenacious, air, roots – suckers). Shoot, its main parts (node, internode, leaf sinus). Types of shoots: erect, ascending, round, tenacious, creeping, creeping. The bud is a rudimentary shoot. The structure of the bud (scales, growth cone, rudimentary leaves). Varieties of buds by location on the shoot (apical and lateral/axillary/), by structure (vegetative and generative/flower/). Shoot structure: stem and leaves. Branching of a shoot, formation of a crown. Shoot modifications: underground (rhizome, underground stem tuber, bulbs) and aboveground (whiskers, tendrils, aboveground stem tuber, thorns). Stem. Internal structure of a wooden stem (core, wood, cambium, bast, bark, core rays, annual rings). Leaf: external structure (leaf base, petiole, leaf blade, stipules), internal structure (main tissue – columnar and spongy, stomata, veins (wood, bast), cuticle, skin), functions. Veining of leaves: parallel, arcuate, finger-shaped, pinnate, forked. Leaf arrangement: alternate, opposite, annular. Leaf variations (tendrils, thorns, scales, leaf-traps of insectivorous plants). Leaf fall. Vital functions of plants: nutrition (mineral, photosynthesis), respiration, transpiration.

Movement of substances on the plant. Plant growth and development. Plant movements (growth, hygroscopic).

3.6 *Fungi*. General characteristics of fungi. Features of the structure and processes of life on the example of mushrooms, molds and yeasts. Fungi saprotrophs, parasites, symbiotrophs. The value of mushrooms.

Unit 4. The human body as a biological system.

4.1. *The structure of the human body*. Tissues of the human body, their structure and function. Organs, organ systems. Regulatory systems of the human body.

4.2. *Nervous regulation*. The human nervous system. A neuron is a structural and functional unit of the nervous system. Reflex principle of the nervous system. Reflex arc, its components and functioning. Central and peripheral nervous systems. Structure and functions of the spinal cord and brain. Autonomic nervous system (sympathetic and parasympathetic divisions). Effects on the body.

4.3. *Humoral regulation. Human endocrine system*. Functions and structure of the endocrine system. Endocrine glands (endocrine and mixed glands). Hormones and neurohormones, their influence on vital processes. Functions of endocrine and mixed secretion glands, consequences of their violation. Differences between nervous and humoral regulation.

4.4. *The internal environment of the human body. Blood. Lymph*. The internal environment of the human body. Blood functions. Blood composition: plasma, shaped elements (erythrocytes, leukocytes, thrombocytes). Blood groups of the AB0 system. The concept of rhesus factor. Blood Transfusion. Blood coagulation. The composition and functions of the lymph.

4.5 *Blood and lymphatic systems of humans*. The structure of the circulatory and lymphatic systems. Circulation, its regulation. The structure of the heart. Properties of the heart muscle. Cardiac cycle, its phases. The work of the heart, its regulation. Blood vessels, their structure and function. Large and small circulatory system. Blood pressure. Lymphatic system, its structure and functions. Lymphatic circulation.

4.6. *Immunity. Human immune system*. Immunity, its types. Immune system, its composition and features of functioning. Mechanisms of antigen-antibody interaction. Allergic reactions. The concept of immunocorrection and immunotherapy. Prevention of infectious human diseases.

4.7 *Breathing. Human respiratory system*. Structure and functions of the respiratory system. Gas exchange processes in the lungs and tissues. Respiratory movements. Inhalation and exhalation processes. Neurohumoral regulation of respiration. The concept of vital capacity of the lungs. Composition of inhaled, exhaled and alveolar air.

4.8 *Digestion. Human digestive system.* Structure and functions of the digestive system. Digestive glands (salivary, liver, pancreas). Digestive juices. Structure and functions of teeth. Digestion in the mouth, stomach, intestines. Parietal digestion. Absorption.

4.9. *Metabolism and energy conversion in the human body.* Nutrition and metabolism. The concept of balanced/rational/nutrition. Protein, lipid, carbohydrate, water-mineral metabolism. The role of enzymes, ATP in ensuring metabolic processes. Vitamins, their role in metabolism. Neurohumoral regulation of metabolic processes.

4.10. *Excretion. Human urinary system.* Structure and functions of the urinary system. Structure and function of the kidneys. Nephron as a structural and functional unit of the kidneys. Processes of formation and excretion of urine, their regulation.

4.11. *Skin. Thermoregulation.* The structure and function of the skin. The role of the skin in the secretion of metabolic products. Thermoregulation and the role of the skin.

4.12 *The muscles and skeletal system of human.* Values, functions, structure of the musculoskeletal system. Chemical composition, structure, bone growth. Types of bone connections. Skeleton structure. Features of the human skeleton due to upright walking. Muscle tissue. Structure and functions of skeletal muscles. The main groups of skeletal muscles. The mechanism of muscle contraction. Work, tone, strength and muscle fatigue.

4.13 *Human sensory systems.* General characteristics of sensor systems. The role of sensory systems in ensuring the connection of the organism with the external environment. Sensory systems of sight, hearing, balance, smell, taste, touch, temperature, pain. Receptors, their types. Sense organs as peripheral parts of sensory systems. Structure and functions of hearing, vision and balance.

4.14 *Higher human nervous activity.* Nervous processes, their indicators. Unconditional and conditioned reflexes, instincts. Formation of conditioned reflexes. Formation of temporary neural connections, their significance for the formation of conditioned reflexes. Inhibition of conditioned reflexes. The first and second signaling systems. Teaching. Memory. Higher human nervous activity and its main types. Types of temperament. Sleep as a functional state of the body, its significance.

4.15. *Reproduction and human development.* The structure of the human reproductive system. Functions of the human gonads. The structure of human germ cells. Gametogenesis. Primary and secondary sexual characteristics. Periods of human ontogenesis. Development of embryo and fetus, placental function.

Unit 5. Fundamentals of ecology and evolutionary theory.

5.1. *Environmental factors.* Environmental factors and their classification. Regularities of influence of ecological factors on living organisms. Adaptation of living organisms to the action of environmental factors. Ecological valence. The concept of population. Structure

and characteristics of populations. Population parameters. Population waves. The concept of a minimum viable population.

5.2. *Fundamentals of evolutionary theory.* The concept of evolution. The evolutionary hypothesis of J.-B. Lamarck. The main provisions of Darwin's evolutionary theory. Factors changing the genetic structure of the population: mutations, isolation, migration, gene drift, natural selection.

Recommended literature

Basic

1. Lewis, R. Life. – Wm. C. Brown Publishers, 1995. – 884 p.
2. McKusick, V. A. Mendelian inheritance in man. Baltimore, 1990. – 2300 p.
3. Zakaria, A. Cell biology and basic biochemistry / From series Essential biology series for A level. – Afro Industries Ltd., Tanzania, 2005. – 144 p.

Auxiliary

1. Bochkov, N. P. Clinical genetics. M. : Med., 2001. – 417 p.
2. Collection of tasks in general and medical genetics: Textbook / V. P. Pishak, N. V. Chernovsky, T. Ye. Dyakov, R. E. Bulik. – Chernivtsi : Medical University, 2009. – 144 p.
3. Ecology : Textbook / V. P. Kucheryavyy. – Lviv : World, 2000. – 500 p.
4. Fundamentals of Medical Genetics: Textbook / V. P. Pishak, I. F. Meshchyshyn, O. V. Pishak. – Chernivtsi, 2000. – 248 p.
5. Kiselev, M. M. National being among ecological realities / M. M. Kiselev, F. M. Kanas. – K. : Tandel, 2000. – 320 p.
6. Korsak, K. V. Fundamentals of Ecology: A Manual / K. V. Korsak, O. V. Plahotnik. – K. : MAUP, 2000. – 240 p.
7. Kovalchuk, L. E. Human parasitology: A manual / L. E. Kovalchuk, P. M. Teluk, V. I. Shutak. – Ivano-Frankivsk : Lilia, 2004. – 108 p.
8. Medical biology. Guide for practical classes / Ed. Prof. O. V. Romanenko. – K. : Zdorovya, 2005. – 372 p.
9. Medical Genetics: Textbook. / N. A. Kulikova, L. E. Kovalchuk – Ternopil : Ukrmedkniga, 2004. – 173 p.
10. Pishak, V. P. Parasitic diseases in children / V. P. Pishak, Yu. I. Bazhora, O. P. Volosovets, R. E. Bulik. – Chernivtsi : BDMU, 2007. – 452 p.
11. Pishak, V. P. Training manual on medical biology, parasitology and genetics. Workshop / V. P. Pishak, O. I. Zakharchuk. – Chernivtsi : Medacademia, 2004. – 579 p.
12. Pishak, V.P. Medical biology. Test tasks with comments / V. P. Pishak [et al.] – Chernivtsi : Meduniversitet, 2011. – 227 p.
13. Vorobets, Z. D. Medical biology. Teaching a manual for students of medical and dental faculties / Z. D. Vorobets, L. M. Sergienko. – Lviv : Quart, 2003. – 84 p.

EVALUATION CRITERIA

The ticket consists of 20 test questions that have only one correct answer. For each correct answer, the entrant receives 10 points.

The maximum number of points that an entrant can receive for 20 tasks is 200 points. The minimum number of points for passing the test is 120.

Entrants who received 120 points or more according to the results of written testing are allowed to participate in the competition.

Protocol of the meeting of the Admissions Committee
№ 7 of April, 14, 2023.

**Chair of the Subject Commission,
associate professor**



Olena SHCHERBAK

**Executive secretary
of Admissions Committee, professor**



Stanislav POGORELOV