

APPROVED:

Head of Admission Committee SE «DMA»

Professor T. O. Pertseva

«16» 06 2017.



PROGRAM  
Entrance exams in Biology

Dnipro

2017

The Program is based on «External Independent Testing in Biology» approved by the Department of General Secondary and Pre-school Education, Ministry of Education and Science of Ukraine 03.02. 2016, N 17.

The objectives of the exam in biology are:

- identification of biological knowledge of students;
- assessment of the degree of preparedness of general secondary school pupils for the further study in higher education establishments.

The program content is structured by levels of life organization and is composed of «Introduction» and units «Molecular level of life organization», «Cellular level of life organization», «Non-cellular forms of life», «Organismic level of life organization», «Supraorganismic levels of life organization», «The historical development of the organic world», which in turn are divided into themes.

The program is aimed at the ability of applicants to:

- characterize biological concepts, regularities, laws and theories;
- use notions of processes and phenomena of wildlife;
- compare the processes of life at different levels of organization (molecular, cellular, organismic, population- species, ecosystemic, biospheric);
- establish causal relationships in wildlife, to be able to classify objects;

#### **Title of the unit, theme. Knowledge. Subject skills and methods of learning activities**

**Introduction.** The main features of living. Levels of life organization: molecular, cellular, organismic, population- species, ecosystemic, biospheric.

#### **The molecular level of life organization**

Inorganic compounds in the body. Classification of chemical elements according to their content in the body (macronutrients, including organogenic elements, trace elements). The consequences of inadequate or excess intake of chemical elements (I, F, Fe, Ca, K) in human organism. The concept of endemic diseases. The role of water, salts and other inorganic compounds in the body. The structure, properties and functions of organic compounds. The concept of biopolymers and their monomers. Proteins. Nucleic acids. Carbohydrates. Lipids. Exchange of substances (metabolism). Plastic (assimilation) and energy (dissimilation) exchange. Aerobic and anaerobic respiration. Cells division. Cellular cycle. Interphase, its periods. Mitosis, its phases. Human karyotype (autosomes, heterochromosomes). Chromosome set of the nucleus (haploid, diploid, polyploid). Meiotic cell division, its phases. Conjugation of homologous chromosomes. Crossing over. Biosynthesis of proteins and its stages. Genetic code and its properties. Codon, anticodon, start-codon, stop-codon. Transcription. Exons, introns. Translation. Photosynthesis, its phases, meaning.

#### **Non-cellular forms of life. Viruses, prions, viroids.**

Viruses their chemical composition, structure and reproduction. The mechanism of invasion of viruses into the body and host cells. The role of viruses in nature and human life. Prions. Viroids.

#### **Organismic level of life organization. Bacteria.**

General characteristics of prokaryotes (bacteria, cyanobacteria). Features of the structure and processes of life activity of prokaryotes (nutrition, respiration, reproduction, sporogenesis, encystment, exchange with inherited information). Examples of human diseases that are caused by bacteria (tonsillitis, diphtheria, tuberculosis, cholera, typhus, botulism, salmonellosis).

## **Plants**

The structure of the plant body. General characteristics of the plant kingdom. Classification of plants. Life forms of plants. Peculiarities of organization of unicellular and multicellular plants. The lower and higher plants. Tissues of multicellular plants: generating (meristem) coating (epidermis, cork), basic (storing, pneumatic, assimilating), mechanical, conducting, their structure and functions. Xylem. Phloem. Fibrovascular bundle. Vegetative organs of plants. Root and its functions. Types of roots. The root system and its types (rod, fascicular). Root zones and their functions. The structure of the root. Modification of roots (storage roots, bulbous (fleshy roots), breathing, basic, tenants, aerial, root-suckers), their biological significance. Shoot and its functionality. Structure of the shoot. Branching of the shoot: value and types (dichotomous, monopodial, sympodial). Modifications of the shoot (underground and aboveground). The stem and its functions. The internal structure of woody stems. Leaf, its structure and functions. Modifications of the leaf. Leaf fall. The bud - shoot germ. The structure of the bud. Variety of buds by location on the shoot (apical and lateral), by the structure (vegetative and generative). Generative organs of metasperms: (flower, seed, fruit). Flower - organ of gamogenesis of plants. Structure and functions of the flower. Formula of the flower. Inflorescences, their types and biological significance. Seed and fruit: structure and functions. The formation of seed and fruit. The types of fruits (bean, stone fruit (drupe), seed case (capsule), seedpod, silicle, achene (acnium), caryopsis (weevil), berry, apple, walnut). Collective fruits (infructescence), their biological significance. Plant nutrition (mineral nutrition, aerial nutrition - photosynthesis). Breathing of plants. Transpiration. Moving of substances along the plant. Ascending and descending flow of substances in the plant. The concept of the life cycle of higher plants (rotation of generations, sporophyte, gametophyte). Irritability and movements of plants. Green algae: unicellular (chlorella, chlamidomonada) and multicellular (spirogyra, ulva, ulotrix). Brown algae: (bladderwrack, wrack (Fucus). Red algae (phyllofora, slack (Porphyra), coralline alga). Diatom algae: (navicula, pinnula). Moss-like (anophyte-like) (polytrich, claviform). Equisetaceous (sylvan horsetail, bottle brush). Fern-like (pentatoma, salvinia). Gymnosperms (ginkgo, common yew, thuja, pine-tree, fir-tree, juniperus, cedar, welwitchia, cycas (sago palm). Angiospermous plants. Classification of angiospermous plants. Classes: Monocotyledonous. Dicotyledonous. Crucifera family: (representatives: wild radish, cabbage, mustard, rape (colza). Rosa family: (representatives: strawberry, brier (Rosa canina), witch tree, apple tree, cherry tree, currant.

## **Mushrooms. (Fungi). Lichens**

General characteristics of Mushrooms (Fungi) kingdom. Features of the structure and processes of life activity of pileate mushrooms, fungi, yeasts, fungi-parasites.

A variety of mushrooms: pileate (butter mushroom, aspen mushroom, edible boletus (white mushrooms), Armillaria, champignons, pleurotus mushrooms, Amanita, Amanita phalloides), mold fungi (Mucor, Penici, Aspergillus) fungi-parasites (smuts, rusts, powdery mildews and polypores). Mycorrhiza. Lichens - symbiotic organisms. The structure and features of life activity of lichens, their significance. A variety of lichens (graphis, parmelia, xantorrhiza, usnea, reindeer lichen, cetraria).

## **Animals**

General characteristics of the Animal kingdom. Principles of classification of animals.

Peculiarities of organization of unicellular and multicellular animals. The overall plan of animals body: symmetry (bilateral, radial); integuments of the body (vestiture); locomotor system (external skeleton, internal skeleton, hydrostatic skeleton); Body cavity (primary, secondary, mixed); organs, organ systems and their functions. Irritability, movement, nutrition, respiration, excretion, transport of substances (agents), reproduction, growth of animals. The types of animals development: direct and indirect (with complete and incomplete metamorphosis). Regulation of functions in multicellular animals. The concept of reflexes and instincts. Unicellular animals. Features of the structure and processes of life activity (nutrition, respiration, excretion, osmotic regulation, movement, irritability, reproduction, encystment). Fresh-water fish (amoeba Proteus, Euglena green, Paramecium caudatum) and sea-water fish (foraminifera, radiolarians) unicellular, their role in nature and in human life. The role of marine unicellular in the formation of sedimentary rocks and as "leading of fossils". Symbiotic unicellular animals: mutualists, commensals, parasites (Entamoeba histolytica, Trypanosoma, malaria plasmodium). Multicellular animals. Characteristic features of multicellular animals, their difference from unicellular ones. Type of Spongia. General characteristics of the type. Features of the structure and processes of life. Type of Coelenterates or Cnidaria. General characteristics of the type. Features of the structure and processes of life. A variety of coelenterates (jellyfish and polyps). Coral polyps and formation of coral reefs. Type Flatworms. General characteristics of the type. A variety of flatworms: classes: ciliated worms (milky white planarian), flukes (liver flukes and cat's flukes). Diphylobothrium worms (bovine and pork tapeworm, Echinococcus, diphylobothrium wide); structure, developmental cycles. Adaptability of flatworms to the parasitic life type. Type of Aschelminthes or threadworms (Nematodes). General characteristics of the type. Nonsymbiotic Nematodes, their role in the nature. Round worms - parasites of plants, animals and humans (ascaride, pinworm, trichinella), diseases caused by them. Type of Annelida. General characteristics of the type. Class of polychaete worms (nereis, lugworm). Class of oligochaete worms (earthworms, tubifex).

Habitat and lifestyle. Leeches Class (Medical Leech). The role of annelid worms in nature and in human life. The role of worms in processes of soil-formation. Type of Shellfish or Soft-bodied. General characteristics of the type. Classes: gastropods (pond snake (*Lymnaea*), grapevine snail), Bivalves (*Anodonta*, oysters, pearl margaritifera), Cephalopods (calmar (squid), cuttlefish, octopus). Characteristic features of the structure and processes of life, distribution. The role of mollusks in nature and human life. Type Arthropods. General characteristics of the type. A variety of arthropods, their habitat and way of life. Shellfish. General characteristics, external and internal structure, habitat. A variety of crustaceans (river crayfish, crabs, shrimps, lice, daphnia, cyclops, carp-eaters. Their role in nature and human life. Protection of crustaceans. Arachnid. General characteristics, features of external and internal structure, processes of vital activity, habitat. A variety of arachnids (rows of spiders, mites). Their role in nature and human life. Insects. General characteristics, habitat. Features of external and internal structure. Types of mouthparts. Functions of the fatty body. The ability of insects to fly. Types of development. Insects order with incomplete (Oorthopteroid, Lice) and complete (Coleoptera or Beetles, Lepidoptera, or Butterflies, Hymenoptera, Diptera, Fleas) transformation. Characteristics of the orders, typical representatives, role in nature and human life. Home insects. Chord type. General characteristics, habitat. A variety of chordates. Acrania Subtype. General characteristics. Cephalochordates Class. Features of external and internal structure, processes of vital activity of lancelets. Subtype Vertebral, or Cranial. General characteristics. Class Cartilaginous fish. Features of the structure, processes of life. A variety of cartilaginous fishes (sharks and skates). Class Bony fish. Features of external and internal structure, processes of vital activity. Spawning, caring for the offspring. A variety of bone fishes: orders of Sturgeon, Clupea, Salmoniformes, Perciformes, Carpiformes; Subclasses Crosspterygean and Dipnoi (Lungfish). Characteristics and types of development of mammals. A variety of mammals. Prototheria - oviparous mammals. Marsupialia. Placental mammals: orders of Insectivores, Chiroptera, Rodents, Carnivora, Pinnipeds, Cetaceans, Artiodactyls, Solipades, Primates.

**Man** The position of man in the system of the organic world. Tissues of the human body (epithelial, muscular, nervous, connective) their structure and functions. Musculoskeletal system. The structure, growth and connection of bones. Muscular tissues. Structure and functions of skeletal muscles. Work, tone, strength and fatigue of muscles. Composition and function of blood. Structure and function of erythrocytes, leukocytes and platelets. Blood groups. Blood transfusion. Blood coagulation. Immunity, its types. Functions and structure of the circulatory system.

Circulation. Structure of the heart. Heart muscle. Automaton of the heart. Heart cycle. Heart rate, systolic and minute blood volume. Blood vessels, their structure and functions. Circles of blood circulation. Movement of blood through blood vessels. Arterial pressure. Lymph circulation. Lymph, its composition. External and cellular respiration. Functions and structure of the respiratory system. Gas exchange in the lungs and tissues. Breathing movements and their regulation. Nutrition and digestion. Structure and functions of the digestive system. Digestion in the oral cavity, stomach, intestines. Absorption. Regulation of digestion. Vitamins, their properties. Systems that provide excretion of metabolic products (urinary, respiratory, digestive, skin). Functions and structure of the kidneys. Formation and excretion of urine. Structure and function of the skin. Humoral regulation. Endocrine system. Hormones. Functions of glands of internal and mixed secretion. Consequences of impaired functions of the endocrine glands. Nervous regulation. Reflex. Reflex arch. Nervous system: central and peripheral. Structure and function of the spinal cord and brain. The autonomic nervous system (sympathetic and parasympathetic). Significance of neuromuscular regulation; Mechanisms of the neuro-humoral regulation of the processes of digestion, respiration, circulation, thermoregulation, secretion, support and movement, metabolism and energy; significance of signal systems in the perception of the environment. Sensory systems, their meaning. Functions and structure of sensory systems. General properties of sensory systems. Sense organs. Receptors. Structure and functions of the organs of vision, hearing and balance. Perception of the image of objects, light, color, sound and balance of the body. Hygiene of hearing and vision. Higher nervous activity of man. Unconditional and conditioned reflexes. Formation of conditioned reflexes. Inhibition of conditioned reflexes. The first and second signal systems. Types of temperament.

### **Reproduction of organisms**

Forms of reproduction of organisms (asexual, sexual). Methods of asexual reproduction of unicellular (division, schizogony, gemmination, sporulation) and multicellular organisms (vegetative reproduction, sporulation). Cloning of organisms. Parthenogenesis. Polyembryonia. Conjugation, copulation. Sexual reproduction. Stages of formation of sexual cells. Fertilization and its forms. Sexual maturation of man.

**Individual development of organisms.** Ontogenesis. Periods of individual development of organisms. Embryonic period (embryonic fission, formation of morula, blastula, gastrula, histogenesis, organogenesis, phenomenon of embryonic induction). Post-embryonic development, its types and stages in humans.

## **Heredity and variations.**

Genetics. Methods of genetic research (including human heredity). Basic concepts of genetics: genes (structural and regulatory), gene allele, gene locus, dominant and recessive status of characters, homozygote, heterozygote, genotype, phenotype, gene pool, heredity, variations, clean line. Regularities of heredity, established by G. Mendel and their statistical nature. The law of purity of gametes. Methods for testing genotype of hybrid individuals. Intermediate nature of inheritance. Sex-linked inheritance. Chromosome theory of heredity. Genetic basis of sex determination in different groups of organisms. Cytoplasmic heredity. Modified (non-hereditary) variability, its properties and statistical patterns. The norm of the reaction. Variational series. Hereditary variation and its types: combinative and mutational. Types of mutations. Mutagenic factors. The law of homologous series of hereditary variation of eukaryotes; classical and updated methods of biotechnology.

## **Supraorganismal levels of organization of life**

Environmental factors: abiotic, biotic, anthropogenic. The concept of limiting factor. The law of the optimum. Ecological valence of the species (limits of endurance). Euribiotic and stenobiotic organisms. Forms of biotic bonds (competition, predation, grazing, mutualism, commensalism, parasitism). Adaptation of organisms. Photoperiodism.

Population-specific level of organization of life. Ecosystems. Criteria of the species. Areal. Ecological niche. Structure of the species. Population. Population structure (age, spatial, sexual). Population waves. Energy conversion in ecosystems. Producers. Consumers. Decomposers. Supply chains. The rule of the ecological pyramid. Successions. Biosphere. Noosphere. Living matter of the biosphere, its properties and functions. The cycle of substances and energy in the biosphere as the necessary conditions for its existence. Modern ecological problems: The doctrine of V.I. Vernadsky on the biosphere and the noosphere. The Red and Green lists, nature protection.

## **Historical development of the organic world.**

Evolution. Phylogenesis. Evolutionary hypothesis of J.-B. Lamarck. The main postulates of the evolutionary theory of Charles Darwin. Biogenetic law of Haeckel-Muller. Divergence and convergence, similar and homologous organs, rudiments and atavisms, analogous and homologous organs, rudiments and atavisms; protective, precautionary colors; intraspecies and interspecies struggle for existence. Synthetic theory of evolution. Microevolution. Natural selection.

Speciation. The Macroevolution. Biological progress and regress. Periods of biological progress (aromorphosis, idioadaptation and general degeneration). Principles of the classification of organisms. Division of geological history of the Earth into eras. The main evolutionary events in the Proterozoic (Vendian) period, the Paleozoic (Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian periods), the Mesozoic (Triassic, Jurassic, Cretaceous) and the Cenozoic (Paleogene, Neogene, Anthropogenous periods). Complication of animal and plant life in the process of evolution.