

ENTRANCE EXAMINATION IN BIOLOGY

FOR APPLICANTS TO BACHELOR'S PROGRAMMES

Entrance test procedure

1. The entrance test is conducted in accordance with the current Rules for admission to the bachelor's and specialty programs and the MIPT entrance tests regulations.
2. The entrance examination in biology has written and oral parts.
3. The entrance examination consists of three parts.
4. The written part includes tasks with a short answer and tasks with a detailed answer. The first part of the entrance test is a multiple choice task. The first part lasts 45 minutes.
5. In the second part of the entrance test applicants are expected to fulfill the tasks and give brief answers to a number of questions. The second part lasts 1 hour.
6. The final grade is formed from the grades received for each of the parts of the entrance test: 30% of the final grade is the grade for the oral part, 20% – for the first written part, 40% – for the second written part.
7. The third part is an oral interview on the tasks and program of the entrance test. The third part lasts no more than 1 hour, 15 minutes of which the applicant can prepare their answer. In this part of the entrance test the applicant may be asked to illustrate the answer with a drawing, in this case the duration can be increased by 5 minutes.

General guidance

Biology exam requires:

1. knowledge of the basic concepts and laws describing the structure, life and evolution of living organisms;
2. knowledge of the structure and life of plants, animals, humans as well as main groups of plants and animals;
3. being able to support conclusions; correct usage of terms when explaining natural phenomena with examples from practical human activities.

List of Topics

I. Plants

- Botany as a plant science. Flowering plant and its structure.
- Seed. Seed structure of dicotyledonous and monocotyledonous plants. Seed composition. Conditions for seed germination. Seed respiration. Seedling nutrition and growth. Sowing time and seeding depth.
- Root. Development of the root from the embryonic root. Types of roots. Types of root systems (pivotal and fibrous).
- External and internal structure of the root in relation to its functions. Root zone. Root growth. Tissue concept. Absorption of water and mineral salts by the roots. Fertilizers. Root respiration. Root modifications. Root in plant life.
- Leaf. External structure of the leaf. The internal leaf structure in relation to its functions, cuticle and stomata, the main tissue of the leaf, conductive bundles. Leaf respiration. Photosynthesis. Leaf transpiration. The importance of leaves in plant life. The role of green plants in nature and human life.
- Stem, concept of stem. Vegetative and floral buds, their structure and location on the stem. The development of the shoot from the bud. Stem growth. Stem branching. Crown formation. The internal structure of a woody stem in relation to its functions: bark, cambium, wood, pith. Stem thickening. Growth ring formation. The movement of mineral and organic substances along the stem. The value of the stem. Modified shoots: rhizomes, tuber, bulb, their structure, biological and economic value.

- Vegetative propagation of flowering plants. Reproduction of plants by shoots, roots, leaves in nature and cultivation (modified shoots, stem and root cuttings, layering, cutting, grafting). Role of vegetative plant reproduction in nature and economy.
- Flower and fruit. Flower structure: peduncle, receptacle, perianth (calyx and corolla), stamens, pistil or pistils. The structure of the stamen and pistil. Inflorescences and their biological significance. Cross-pollination by insects, wind. Self-pollination. Fertilization. Seed and fruit formation. The value of flowers, fruits and seeds in nature and human life.
- Plant and environment. The interconnection of organs. The main vital functions of a plant organism and its relationship with the environment.
- Classification of flowering plants. The variety of wild and cultivated flowering plants and their classification. Elementary concepts of systematic (taxonomic) categories - species, genus, family, class. The meaning of international plant names.
- Class of dicotyledonous plants. Family of Cruciferae, Rosaceae, Fabaceae, Solanaceae, Asteraceae.
- Class of monocotyledonous plants. Family of Poaceae, Family of Liliaceae.
- Distinctive features of plants of the main families; their biological characteristics and national economic significance. Typical cultivated and wild plants of these families. The influence of economic activity on the species diversity of flowering plants.
- The main groups of plants. Algae. The structure and activity of unicellular algae (chlamydomonas, pleurococcus, chlorella). Reproduction of algae. Filamentous algae. The value of algae in nature and economy.
- Mosses. Green mosses. The structure and reproduction of cuckoo flax. Sphagnum moss, features of its structure. Peat formation, its significance. Equisetidae. Lycopodium. Fern. Structure and reproduction.
- Gymnosperms. The structure and reproduction of gymnosperms (for example, pine and spruce). Distribution of conifers, their importance in nature, in the national economy.
- Angiosperms (flowering plants). Adaptation of angiosperms to various habitats and dominance in modern flora.
- The influence of human economic activity on the species diversity of plants. Plant protection.
- The development of the plant world on Earth. The main stages of the historical development and complication of the plant world on Earth. Selection of cultivated plants by man. Achievements of Russian scientists in breeding new varieties of plants.
- Bacteria, fungi, lichens. Bacteria. The structure and life of bacteria. The spread of bacteria in air, soil, water, living organisms. The role of bacteria in nature, medicine, agriculture and industry. Disease-causing bacteria and the fight against them.
- Fungi. General characteristics of fungi. Cap mushrooms, their structure, nutrition, reproduction. Living conditions of mushrooms in the forest. Edible and poisonous mushrooms. Mold fungi. Yeast. Parasitic fungi that cause plant diseases. The role of fungi in nature and agriculture.
- Lichens. Lichen structure. Symbiosis. Nutrient absorption. Reproduction. The role of lichen in nature and economy.

II. Animals

- Zoology as a science. Role of animals in nature and human life. Similarity and dissimilarity between animals and plants. Classification of animals.
- Unicellular eukariotic organisms. General characteristics. Common amoeba. Habitat. Locomotion. Nutrition. Respiration. Osmoregulation. Reproduction. Encysting.
- Green euglena as a unicellular organism with animal and plant characteristics.
- Infusoria Paramecium caudatum. Structure, physiology and life cycle.
- Diversity and significance of unicellular organisms. The malaria plasmodium as the causative agent of malaria. Eliminating malaria as a mass disease.
- Type Cnidaria. General characteristics of the type. Hydra - the freshwater polyp. Habitat and external structure. Ray symmetry. Internal structure (bilayer, variety of cells). Nutrition. Respiration. Nervous system. Reflex. Regeneration. Sexual and asexual reproduction.

- Type Flatworms. General characteristics of the type. The structure of planaria - musculature, nutrition, respiration, excretion, nervous system, reproduction. Regeneration. The life cycle of the main flukes and tapeworms.
- Type Roundworms. General characteristics of the type. External structure. Body cavity. Nutrition. Reproduction and development. The variety of parasitic worms and fight against them.
- Type Ringworms. General characteristics of the type. Habitat. External structure. Tissues. Skin and muscle sac. Body cavity. Digestive system, blood circulation, excretion. Life processes. Nervous system. Regeneration. Reproduction.
- Type Mollusks. General characteristics of the type. The class bivalves as exemplified by the Anodonta, the class gastropods as exemplified by the grape snail. Squid as a Cephalopod.
- Type Arthropods. General characteristics of the type. Crustacean class. Crayfish. Habitat. External structure. Reproduction. Internal structure. Digestive, circulatory and respiratory systems. Excretory organs. Nutrition, respiration, excretion. Features of vital processes. Nervous system and senses.
- Class Arachnids. European garden spider. Habitat. External structure. Fishing web, its structure and significance. Nutrition, respiration, reproduction. The role of ticks in nature and their practical significance. Measures to protect humans from ticks.
- Class Insects. Chafer. External and internal structure. Life process. Reproduction. Types of development.
- Insect orders with complete transformation. Lepidoptera. Cabbage White. Silkworm. Sericulture. Diptera. Indoor fly, gadflies. Hymenoptera. Honey bee and ants. Instinct. Insects with incomplete transformation. Orthoptera. Migratory locust is a dangerous agricultural pest. The role of insects in nature, their role in economy.
- Type Chordates. General characteristics of the type. Class Leptocardii. Lancelet as the pimpest chordate animal. Habitat. Structure. Chord. Features of the internal structure. Lancelet resemblance to vertebrates and invertebrates.
- Class Pisces. General characteristics of the class. River perch. Habitat. External structure. Skeleton and musculature. Body cavity. Digestive, circulatory, respiratory systems. Swimming bladder. Nervous system and sensory organs. Behavior. Reproduction and development. Caring for offspring.
- Diversity of fish. Orders of fish: sharks, sturgeon, herring, carp, cross-finned. The economic value of fish, fishing. Fish farming. Pond farming. The influence of human activities on the number of fish.
- Class Amphibia. General characteristics of the class. Frog. Habitat peculiarities. External structure. Skeleton and musculature. Features of internal organ structure and vital processes. Nervous system and sensory organs. Reproduction and development. The diversity of amphibians and their role in ecosystems. The origin of amphibians.
- Class Reptilia. General characteristics of the class. Sand lizard. Habitat, external structure. Features of the internal structure. Reproduction. Regeneration. Diversity of modern reptiles. Ancient reptiles: dinosaurs, teriodonts. The origin of reptiles.
- Class Aves. General characteristics of the class. Dove. Habitat. External structure. Skeleton and musculature. Body cavity. Features of the internal structure and life processes. Nervous system and sensory organs. Behavior. Reproduction and development. Seasonal phenomena in birds life, nesting, migrations and flights. The origin of birds. Adaptation of birds to different habitats. The role of birds in nature and their importance in human life.
- Class Mammalia. General characteristics of the class. Domestic dog. External structure. Skeleton and musculature. Body cavities. Organ system. Nervous system and sensory organs. Behavior. Reproduction and development. Caring for offspring. Orders of mammals. The origin of mammals. Chyroptera: bats. Rodents. Carnivores: dogs, cats. Pinnipeds. Cetaceans. Artiodactyls. Features of the structure of the digestive system of ruminants. Cattle breeds. Boar. Domestic pigs. Equid-hoofed animals. Wild horse. Primates. The role of mammals in nature and in human life. Influence of human activity on the number and species diversity of mammals, their protection.

III. Human and human health

- Human anatomy, physiology and hygiene, the structure and functions of the human body and the conditions for maintaining its health. Hygienic aspects of environmental protection.
- General overview of the human body. Introduction to human body (organs and organ systems). Elementary information about the structure, functions and reproduction of cells. Reflex. Brief information about the structure and functions of tissues. Tissues (epithelial, connective, muscle and nervous).
- Muscular and skeletal systems. The importance of the muscular and skeletal systems. The structure of the human skeleton. Bone joints: immobile, semi-mobile joints. Composition, structure (macroscopic) and growth of bones. Muscles, their structure and function. Neural regulation of muscle activity. Joint movements. Reflex arc. Muscle work. Influence of rhythm and load on muscle work. Muscle fatigue. The importance of exercise for the correct formation of the skeleton and muscles.
- Blood. The internal environment of the body: blood, tissue fluid, lymph. The relative constancy of the internal environment. Blood composition: plasma, corpuscles. Blood groups. The importance of blood transfusion. Blood clotting as a defense reaction. Erythrocytes and leukocytes, their structure and function. I. I. Mechnikov's doctrine about the protective properties of blood. Fighting epidemics. Immunity.
- Circulatory system. Circulatory organs: heart and blood vessels (arteries, capillaries, veins). Large and small circles of blood circulation. Heart, its structure and work. Heart automaticity. The concept of the nervous and humoral regulation of the heart. The movement of blood through the vessels. Pulse. Blood pressure. Hygiene of the cardiovascular system.
- Breathing. The meaning of respiration. Respiratory organs, their structure and function. Voice apparatus. Gas exchange in the lungs and tissues. Respiratory movements. Lung vital capacity. The concept of humoral and nervous regulation of respiration. Respiratory hygiene.
- Digestion. Nutrients and Foods. Digestion, enzymes and their role in digestion. The structure of the digestive system. Digestion in the oral cavity. Swallowing. Works of I.P. Pavlov on the study of the activity of the salivary glands. Digestion in the stomach. The concept of the neuro-humoral regulation of gastric secretion. Works of I.P. Pavlov on the study of digestion in the stomach. Liver, pancreas and their role in digestion. Changes in nutrients in the intestines. Absorption. Rational approaches to nutrition.
- Metabolism. Water-salt, protein, fat and carbohydrate metabolism. Decomposition and oxidation of organic matter in cells. Enzymes. Plastic and energy metabolism are two sides of a single metabolic process. The exchange of substances between the body and the environment. Nutritional norm. The importance of proper nutrition. Vitamins and their importance for the body.
- Renal and urinary systems. Organs of the urinary system. Kidney function. The structure of the kidneys. The value of metabolic products excretion.
- Skin. The structure and function of the skin. The role of the skin in the regulation of heat transfer. Body hardening. Hygiene of skin and clothes.
- Nervous system. The importance of the nervous system. The structure and function of the spinal cord and parts of the brain: oblong, middle, intermediate, cerebellum. The concept of the autonomic nervous system. Large hemispheres of the brain. Significance of the cerebral cortex.
- Analyzers. Sensory organs. The meaning of the senses. The structure and function of the visual system. Hygiene of vision. The structure and functions of the organ of hearing. Hearing hygiene.
- Higher nervous activity. Unconditioned and conditioned reflexes. Formation and biological significance of conditioned reflexes. Inhibition of conditioned reflexes. The role of I.M. Sechenov and I.P. Pavlov in the creation of the higher nervous activity doctrine; its essence. Consciousness and thinking of a person as a function of the higher parts of the brain. The anti-scientific nature of religious ideas about the soul. Hygiene of physical and mental labor. The harmful effects of smoking and alcohol consumption on the nervous system.
- Endocrine glands. The value of the endocrine glands. The concept of hormones. The role of humoral regulation in the body.
- The development of the human body. Reproduction of organisms. Sex glands and sex cells. Fertilization. Development of the human embryo. Features of the development of children's and adolescent organisms.

IV. General biology

- General biology as a field of basic laws of life. The importance of biology for medicine, agriculture and other branches of the national economy.
- Doctrine of evolution.
- Brief information about the pre-Darwinian period of biology. The main provisions of the evolutionary theory by Charles Darwin. The importance of the theory of evolution for the development of natural science.
- Criteria of the species. A population as a unit of species and evolution. The concept of plant varieties and animal breeds.
- Driving forces of evolution: heredity, struggle for life, variability, natural selection. The leading role of natural selection in evolution.
- Artificial selection and hereditary variability are the basis for breeding domestic animals and varieties of cultivated plants. Creation of new highly productive animal breeds and plant varieties.
- The emergence of adaptation. The relative nature of fitness.
- Microevolution. Speciation.
- Evolution results: adaptation of organisms, diversity of species.
- The use of the evolutionary biology in agricultural practice and in nature conservation.

Development of the organic world

- Evidence for the evolution of the organic world. The main directions of evolution. Aromorphosis, idioadaptation. Correlation between different directions of evolution. Biological progress and regression. A brief history of the development of the organic world.
- The main aromorphoses in the evolution of the organic world.
- The main directions of angiosperm, insect, bird and mammal evolution in the Cenozoic era.
- The impact of human activities on biodiversity, natural communities, their protection.

The origin of man

- Charles Darwin on the origin of man from animals.
- The driving forces of anthropogenesis: social and biological factors. The leading role of social laws in the social progress of mankind.
- The most ancient, ancient and fossil people of the modern type.
- Human races, their origin and unity. The anti-scientific, reactionary essence of social Darwinism and racism.

Fundamentals of Ecology

- The subject and tasks of ecology, mathematical modeling in ecology. Environmental factors. Human activity as an environmental factor. The complex effect of factors on organisms. Limiting factors. Photoperiodism. Species, its ecological characteristics.
- Population. Factors causing changes in population size, methods of its regulation.
- Rational use of species, preservation of species diversity.
- Biogeocenosis. Populations relations in biogeocenosis. Food chains. Rule of the ecological pyramid. Self-regulation. Change of biogeocenoses. Agroecosystems. Increasing the productivity of agroecosystems based on land melioration, new technologies for growing plants.
- Protection of biogeocenoses.
- Fundamentals of biosphere doctrine.
- Biosphere and its boundaries. Biomass of land surface, oceans, soil. Circulation of substances and the conversion of energy in the biosphere. V.I. Vernadsky about the origin of the biosphere.

Fundamentals of Cytology

- The main provisions of the cell theory. A cell as a structural and functional unit of living things. The structure and function of the nucleus, cytoplasm and its main organelles. Features of prokaryotes and eukaryotes cell structure.
- Chemical elements in the cell. Water and other inorganic substances, their role in the cell. Organic substances: lipids, ATP, biopolymers (carbohydrates, proteins, nucleic acids), their role in the cell. Enzymes, their role in life processes. DNA replication.
- Metabolism and energy conversion are the basis of cell life. Energy metabolism in the cell. The value of ATP in energy metabolism.
- Plastic metabolism. Photosynthesis. Protein biosynthesis. Gene and its role in biosynthesis. DNA code. Matrix synthesis reactions. The relationship between the processes of plastic and energy metabolism.
- Viruses, features of their structure and activity.

Reproduction and development of organisms

- Cell division, meiosis and fertilization are the basis for the reproduction and individual development of organisms. Preparing the cell for division. Duplication of DNA molecules. Chromosomes, their haploid and diploid set, constancy of number and shape.
- Sexual and asexual reproduction of organisms. Sex cells. Meiosis. Development of eggs and sperm. Fertilization.
- Embryonic development (by the example of a frog). Postembryonic development. The harmful effects of alcohol and nicotine on the development of the human body.
- The emergence of life on Earth.

Fundamentals of Genetics

- The main principals of heredity and variability of organisms and their cytological basis.
- Subject, tasks and methods of genetics.
- Mono- and dihybrid crossing. The laws of heredity established by G. Mendel. Dominant and recessive traits. Allelic genes. Phenotype and genotype. Homozygote and heterozygote. First generation uniformity.
- The intermediate nature of inheritance. The law of segregation. The statistical nature of the segregation phenomena. Cytological bases of uniformity of the first generation and segregation in the second generation. The law of independent assortment and its cytological foundations.
- Concatenated inheritance. Loss of linkage. Chromosome crossing.
- Genotype as a holistic historically developed system. Genetics of sex. Chromosomal theory of heredity.
- The importance of genetics for medicine and health care. The harmful effects of nicotine, alcohol and other drugs on human heredity.
- The role of the genotype and environmental conditions in the formation of the phenotype. Modification variability. Reaction norm. Statistical patterns of modification variability.
- Mutations, their causes. Vavilov's law of homologous series in hereditary variation. Experimental production of mutations.
- Mutations as material for artificial and natural selection. Environmental pollution with mutagens and its consequences.
- Genetics and the theory of evolution. Population genetics. Forms of natural selection: driving and stabilizing.

Fundamentals of artificial selection

- Genetic foundations of plant, animal and microorganism selection.
- The tasks of modern breeding. N.I. Vavilov on the origin of cultivated plants. The value of the source material for breeding.
- Plant breeding. Basic breeding methods: hybridization and artificial selection. The role of natural selection in breeding. Self-pollination of cross-pollinated plants. Heterosis. Polyploidy and distant hybridization. Achievements in plant breeding.
- Animal breeding. Crossing types and breeding methods. Method of analysis of hereditary economically valuable traits in breeding animals. Remote hybridization of domestic animals.
- Selection of bacteria, fungi, its importance for the microbiological industry (obtaining antibiotics, enzyme preparations, fodder yeast, etc.). The main areas of biotechnology (microbiological industry, genetic and cell engineering).

Biosphere and scientific and technological progress

- Biosphere in the period of scientific and technological progress and human health. Environmental problems: protection from pollution, preservation of natural reserves and natural monuments, species diversity, biocenoses, landscapes.

Literature

1. Reece, Jane B., and Neil A. Campbell. 2011. Campbell biology. Boston: Benjamin Cummings / Pearson.
2. Mustafin A.G. Biology. For school graduates and entering universities. Tutorial. Publishing: Knorus, 2020
3. Zayats R.G., Rachkovskaya I.V., Davydov V.V. Biology for entering universitites. Publishing: Feniks, 2017.