

Ministry of Health of Russian Federation
Pirogov Russian National Research Medical University (Pirogov Medical University)

**The program
of entrance test in Biology**

1. Scope and regulatory references.

Program entrance test is designed for entering the Federal State Autonomous Educational Institution of Higher Education «N.I. Pirogov Russian National Research Medical University» for higher education programs: bachelor's degree programs and specialty programs based on the requirements of the Federal state educational standard of secondary (complete) General education (order of the Ministry of education of the Russian Federation No. 413 of may 17, 2012).

2. Program of entrance examination in biology

Plants

Botany is the science of plants. Flora as an integral part of nature, its diversity, distribution on Earth. Flower plant and its structure.

Seed. The structure of seeds (on the example of dicotyledonous and monocotyledonous plants). Composition of seeds. Seed germination conditions. Seed breath. Nutrition and growth of sprouts. Sowing time and depth of seeding.

Root. Root development from the germ root. Types of roots. Types of root systems. External and internal structure of the root in connection with its functions. Root zones. Growth of roots. Absorption of water and mineral salts by roots. Mineral and organic fertilizers. Root breath. The importance of tillage, application of fertilizers, irrigation for the life of cultivated plants. Modifications of the root. The role of the root in plants.

Leaf. The external structure of the leaf. Leaves venation. The simple and complex leaves. Arrangement of leaves on the stem. Features of the internal structure of the leave in connection with its functions epidermis, palisade mesophyll parenchyma, spongy mesophyll parenchyma and vascular tissue. The breath of leaves. Photosynthesis. Transpiration of water. Defoliation. The importance of leaves in plant life. The role of green plants in nature and human life.

Stem - main axial organ of a vascular plants. Shoot - an immature plant or portion of

a plant. Vegetative and flower buds, their structure and arrangement on the stem. The development of the shoot from the bud. Branching of the stem. The formation of the tree crown. The internal structure of the tree stem in connection with its functions. Primary and secondary growth in plants. Formation of annual growth rings. Movement of mineral and organic substances on the stem. The value of the stem. Modified shoots: rhizome, tuber, bulb, their structure, biological and economic value.

Vegetative reproduction of flowering plants. Biological and economic value of vegetative reproduction.

Flower and fruit. Flower structure: peduncle, receptacle, calyx, corolla, stamens, pistil or pistils, stigma and ovary. Structure of stamen and pistil. Inflorescences and their biological significance. Cross-pollination with insects, wind. Selfing (self-fertilization). Double fertilization in flowering plants (*Angiosperms*). Formation of seeds and fruits. The importance of flowers, fruits and seeds in nature and human life.

Plant and environment. The main vital functions of the plant organism and its relationship with the environment.

The main groups of plants.

Algae. The structure and vital activity of unicellular algae (*Chlamydomonas*, *Chlorella*). Reproduction and life cycle of algae. The importance of algae in nature and economy.

Mosses (Bryophyta). Green moss, Sphagnum moss. Structure and life cycle of mosses.

Ferns, moths and equisetum. Structure and reproduction.

Gymnosperms. Structure and reproduction of gymnosperms (on the example of pine). Distribution of conifers, their importance in nature, in the national economy.

Angiosperms (flowering plants). Adaptation of angiosperms to different conditions of life on Earth and domination in modern flora. Taxonomy of flowering plants. Variety of wild and cultivated flowering plants and their classification. The dicotyledons and monocotyledons flowering plants. The influence of economic activity on the species

diversity of flowering plants. Protection of rare plant species. The evolution of plants on Earth. The main stages of historical development and complexity of flora on Earth. Creation of cultivated plants by man.

Bacteria, Fungi, Lichens.

Bacteria. Structure and vital activity of bacteria. The distribution of bacteria in the air, soil, water and living organisms. The role of bacteria in nature, medicine, agriculture and industry. Pathogenic bacteria and fight against them.

Mushrooms. General characteristics of mushrooms. Their structure, nutrition, reproduction. Living conditions of mushrooms in the forest. Edible and poisonous mushrooms. Fungi. Yeast. Fungi are parasites that cause diseases of plants and animals. The role of fungi in nature and economy.

Lichens. The structure of the lichen. Symbiosis. Reproduction. The role of lichen in nature and economy.

Animals

Zoology is the science of animals. The importance of animals in nature and human life. Similarity and difference of animals and plants. Classification of animals.

Protozoa. General characteristic. An amoebae as organisms
Living environment. Nutrition. Respiration. Excretion. Reproduction. Formation of cysts.

Euglena viridis is a single-celled organism with signs of animals and plants.

Infusoria. Features of the structure and processes of life. Irritability.

The diversity and importance of Protozoa. Malaria parasite - the causative agent of malaria. Prevention of malaria.

The phylum Coelenterata. General characteristics. Freshwater polyp Hydra. Habitat and external structure. The radial symmetry. Internal structure (double-layer, variety of cells). Nutrition. Respiration. Excretion. Reproduction. Nervous system. Reflex. Regeneration. Asexual and sexual reproduction. Marine coelenterates (polyps and jellyfish) and their significance.

The phylum Platyhelminthes (flatworms). General characteristics. External structure. Musculature. Nutrition. Respiration. Excretion. Nervous system. Reproduction. Regeneration. Free-living and parasitic flatworms. Life cycles of flukes and tapeworms. Adaptations to parasitism.

The phylum Round worms (Nematodes). General characteristics of the type. External structure. Body cavity. Nutrition. Reproduction and development. Medical significance. The variety of parasitic worms and the prevention of human.

The phylum Annelida (Annelid worms). General characteristics. Respiration. Excretion. Reproduction. Nervous system. Body cavity. Digestive, circulatory, excretory systems. Regeneration. Reproduction.

The phylum Mollusca. General characteristics. Respiration. Excretion. Reproduction. Nervous system. Body cavity. Digestive, circulatory, excretory systems. Reproduction.

The phylum Arthropoda. General characteristics.

The Class Crustacea. Crayfish. General characteristics. Respiration. Excretion. Reproduction. Nervous system and sensory organs. Body cavity. Digestive, circulatory, excretory systems. Reproduction.

The Class Arachnida. *Cross Spider* or Garden Spider. External and internal structure. Nutrition, respiration, reproduction. The role of ticks in nature and their practical value. Human protection measures against ticks.

The class. Insecta. Cockchafer (May bug). External and internal structure. The vital activity. Reproduction. Type of development.

Insect orders with complete metamorphosis. Coleoptera – Beetles. Diptera – Flies. Hymenoptera Ants, bees, sawflies, and wasps. Lepidoptera – Butterflies and moths. Biological way of pest control.

Insects with incomplete metamorphosis. Hemiptera (scale insects, aphids, whitefly, cicadas, leafhoppers and true bugs). Orthoptera (grasshoppers, locusts, and crickets). Blattodea (cockroaches and termites).

The role of insects in nature, their practical value. Preservation of their species diversity.

The phylum Chordata. General characteristics. The order lancelets (amphioxii). General characteristics. Respiration. Excretion. Reproduction. Nervous system. Body cavity. Digestive, circulatory, excretory systems. The similarity of lancelets with vertebrates and invertebrates.

Classes of Fish. General characteristics. External and internal structure. Skeleton and musculature. Body cavity. Digestive, circulatory, respiratory systems. Swim bladder. Nervous system and sensory organs. Behavior. Reproduction and development. Caring for offspring. Variety of fish. The Agnatha, the Chondrichthyes, and the Osteichthyes. Economic value of fish. Fishing. Artificial breeding of fish. The influence of human activity on the number of fish. The need for rational use of fish resources, their protection (protection of water from pollution, etc.).

The Class Amphibia. General characteristics. Frog. Features of the habitat. External structure. Skeleton and musculature. Features of the structure of internal organs and processes of life. Nervous system and sensory organs. Reproduction and development. The variety of amphibians and their significance. Origin of amphibians.

The class Reptilia. General characteristics. Sand lizard. External structure. Features of the internal structure. Reproduction. Regeneration. The diversity of modern reptiles. Order crocodilia (crocodilians), Order testudines (turtles), and Order squamata (lizards and snakes). Origin of reptiles.

The Class Birds (Aves). General characteristics. External structure. Skeleton and musculature. Body cavity. Nervous system and sensory organs. Behavior. Reproduction and development. Seasonal phenomena in the life of birds, nesting, migrations and flights. Origin of birds. Adaptation of birds to different habitats. Birds of parks, gardens, meadows and fields. Birds of the forest. Bird of prey. Birds of swamps and coastal waters. Birds of steppes and deserts. The role of birds in nature and their importance in human life.

The class Mammalia. General characteristics. Domestic dog. External structure. Skeleton and musculature. Body cavity. Organ system. Nervous system and sensory organs. Behavior. Reproduction and development. Caring for offspring. Subdivisions of the class Mammalia. The orders of placental mammals. The role of mammals in nature and in human life. Influence of human activity on the number and species diversity of mammals, their protection.

Man and his health

Human anatomy, physiology and hygiene are the sciences that study the structure and functions of the human organism and the conditions for maintaining its health. Hygienic aspects of environmental protection.

General overview of the human body. General acquaintance with the human body (organs and organ systems). Basic information about the structure, functions and reproduction of cells. Reflex. Brief information about the structure and functions of tissues. Tissues (epithelial, connective, muscular and nervous).

Musculoskeletal system. The value of the musculoskeletal system. The structure of the human skeleton. Connections of bones: cartilage, ligaments, joints. Composition, structure and growth of bone. Muscles, their structure and functions. Nervous regulation of muscle activity. Movement in joints. Reflex arc. Work of muscles. The influence of rhythm and load on the muscles. Muscle fatigue. The importance of exercise for the proper formation of the skeleton and muscles. Prevention of curvature of the spine and the development of flat feet.

Blood. Internal environment: blood, tissue fluid, lymph. Relative constancy of the internal environment. Composition of blood: plasma and formed elements. Blood group. The value of blood transfusion. Blood clotting as a protective reaction. Erythrocytes and leukocytes, their structure and functions. The protective properties of blood. Immunity.

Blood circulatory system. Circulatory system organs: heart and blood vessels

(arteries, capillaries, veins). Large and small circles of blood circulation. Heart, its structure and work. The cardiac cycle. The concept of nervous and humoral regulation of the heart. Blood flow through the vessels. Pulse. Blood pressure. Hygiene of the cardiovascular system.

Respiratory system. The value of breathing. Respiratory organs, their structure and function. Vocal apparatus. Gas exchange in lungs and tissues. Respiratory movement. The concept of humoral and nervous regulation of breathing. Respiratory hygiene.

Digestive system. Nutrients and food. Digestion, enzymes and their role in digestion. The structure of the digestive system. Digestion in the oral cavity. Swallow. Salivary glands. Digestion in the stomach. The concept of neuro-humoral regulation of gastric co-secretion. Liver, pancreas and their role in digestion. Change of nutrients in the intestine. Absorption of nutrients. Food hygiene.

Metabolism. Water-salt, protein, fat and carbohydrate metabolism. Decomposition and oxidation of organic substances in cells. Enzymes. Catabolism and anabolism are two sides of a process of metabolism. Metabolism between the organism and the environment. Vitamins and their importance for the body.

System of excretory organs. Organs of the urinary system. Structure and function of kidney. The value of the excretion of end products of metabolism .

Skin. Structure and functions of the skin. The role of skin in thermoregulation. Hygiene of skin and clothing.

Nervous system. The value of the nervous system. The structure and functions of the spinal cord and brain: cerebral hemispheres, thalamus and hypothalamus, midbrain cerebellum pons, medulla oblongata. Somatic and vegetative (autonomic) nervous system. Large hemispheres of the brain. The value of the cerebral cortex. The formation and biological significance of reflexes. Inhibition of reflexes. The consciousness and thinking of the person as a function of the higher parts of the brain.

Sense organs. The value of the senses. Structure and functions of the organs of vision. Vision hygiene. The structure and function of the organ of hearing. Hygiene of

the ear.

Endocrine glands. The value of endocrine glands. The concept of hormones. The role of humoral regulation in the body. The pineal gland, pituitary gland, pancreas, ovaries, testes, thyroid gland, parathyroid gland, hypothalamus and adrenal glands.

The development of the human. Reproduction of organisms. Sex glands and sex cells. Fertilization. Development of the human embryo. Features of development of children's and youthful organisms.

General biology

General biology - the subject of the basic laws of life phenomena. The importance of biology for medicine, agriculture and other sectors of the economy.

Evolution.

The main provisions of the evolutionary theory of Charles Darwin. The evolution by natural selection The value of the theory of evolution for the development of natural science.

Species criteria. Population is a unit of species and evolution. The concept of plant varieties and animal breeds.

Factor of evolution: heredity, struggle for existence, variability, natural selection. The leading role of natural selection in evolution.

Artificial selection and hereditary variability are the basis for breeding breeds of domestic animals and varieties of cultivated plants. Creation of new highly productive breeds of animals and plants.

Microevolution. Speciation. Results of evolution: adaptation of organisms, diversity of species, complexity of organisms. The use of the theory of evolution in agricultural practice and in the protection of nature.

Development of the organic world. Evidence of the evolution of the organic world. The main directions of evolution. Aromorphoses, idioadaptations and degenerations. Biological progression and regression. The emergence and development of life on

Earth. The main aromorphoses in the evolution of the organic world.

Anthropogenesis (origin of man). Social and biological factors of anthropogenesis. The leading role of the laws of social life in the social progress of humanity. Dryopithecus Australopithecus, Homo habilis, Homo erectus (Erect man), Neanderthal Man. Human races, their origin and unity.

Ecology

Environmental factors. Human activity as an environmental factor. Complex influence of factors on the organisms. Limiting factor. Photoperiodism.

Species, its environmental characteristics. Population. Factors causing changes in population size, methods of its regulation. Rational use of species, preservation of their diversity.

Ecological system. The relationship of populations in the ecosystem. ecological supply chain. An ecological pyramid. Self-regulation. Evolution of the ecosystems.

Agrocenosis. Increase of productivity of agrocenosis on the basis of land reclamation, introduction of new technologies of growing plants. Human influence on species diversity of animals and plants. Protection of ecosystems.

Biosphere. Biosphere and its borders. Biomass of the land surface of the World ocean, of the soil. Biomass, its gas, concentration, oxidation and reduction functions. The biogeochemical cycle or substance turnover and the transformation of energy in the biosphere.

Cytology.

Cell theory. A cell is a structural and functional unit of the living. Structure and function of the nucleus, cytoplasm and its major organoids. The structure of prokaryotic, and eukaryotic cells.

The content of chemical elements in the cell. Water and other inorganic substances, their role in the life of the cell. Organic substances: carbohydrates, lipids, biopolymers (polysaccharides, proteins, nucleic acids), their role in the cell. Enzymes, their role in the processes of life. DNA replication.

Metabolism and energy conversion - the basis of cell life. Catabolism in the cell, its essence and stages. ATP and its importance in metabolism and energy. ATP synthesis in the cell.

Anabolism. Photosynthesis. Ways to increase the productivity of agricultural plants. Biosynthesis of proteins. Gene and its role in biosynthesis. Genetic code. Biosynthesis of RNA. The relationship between the processes of anabolism and catabolism.

Viruses, their structure and activity. Medical significance of viruses.

Reproduction and individual development of organisms.

Cell division. Mitosis, meiosis and fertilization - the basis of reproduction and individual development of organisms. Preparation of cells for division. The doubling of DNA molecules. The main processes occurring in mitosis and meiosis. Chromosomes, their haploid and diploid set, constancy of number and form.

Sexual and asexual reproduction of organisms. Sex cell. Development of eggs and sperm. Fertilization.

Ontogenesis. Embryo development (on the example of animals). The main stages and processes of embryonic development. Postembryonic development. Harmful effects of alcohol and nicotine on the development of the human body.

Genetics.

Basic laws of heredity and variability of organisms and their cytological bases. Methods of genetics. Mono - and digibridge crossing. The laws of heredity established by G. Mendel. Dominant and recessive traits. Allele genes. Phenotype and genotype. Homozygous and heterozygous. Uniformity of the first generation hybrids. Intermediate inheritance with incomplete domination. Law of independent assortment of characteristics. Cytological basis of laws of heredity established by G. Mendel.

Chromosomal Theory of Inheritance and Genetic Linkage. Complit and incoplit linkage. The process of homologous recombination, or crossing over The interaction of genes.

Genetics of sex.

Genotype as an integral historically developed system.

Human genetics, its main methods and importance for medicine. Harmful effects of nicotine, alcohol and other drugs on human heredity.

The role of genotype and environmental conditions in phenotype formation. Modification variability. Statistical regularities of modification variability.

Mutations, their causes. Experimental production of mutations.

Mutations as a material for artificial and natural selection. Pollution of the environment by mutagens and its consequences.

Genetics and theory of evolution. Genetics of populations. Forms of natural selection: driving and stabilizing.

Basics of selection.

Genetic basis of plant, animal and microorganism breeding. Plant breeding. The main methods of selection: hybridization and artificial selection. Self-pollination of cross-pollinated plants. Heterosis. Polyploidy. Achievements of plant breeding.

Animal breeding. Types of crossing and breeding methods. Selection of bacteria, fungi, its importance for the microbiological industry.

3. Form of the entrance test

The entrance examination is conducted in the form of online test. The time assigned for the tasks is 210 minutes (3.5 astronomical hours). The time to start answering the questions is calculated from the moment of registration in the testing system.

4. Structure of the entrance test

The entrance test consists of four types of questions, including 50 tasks that differ in form and level of complexity.

- Tasks 1-20 include simple questions, suggesting the choice one of the four proposed answers. The entrant has to mark one correct answer.
- Tasks 21-40 include simple questions, involving the choice of three of the six

proposed answers. The entrant needs to make three correct answers.

- Tasks 41-45 include questions of correspondence that offer to fix multiple conditions to certain answers. The question contains the text of the question, the text of conditions and a set of answers. Choices for the answer will be displayed for each condition. The entrant must specify the correct answers for each condition.
- Tasks 46-50 include a list of biological processes, phenomena, practices. When performing tasks, the entrant establishes their correct sequence.

5. Indicators and criteria of the entrance test results, scale and evaluation procedure

When performing the tasks of the entrance test in biology, the entrant must show:

1. formation of ideas about the role and place of biology in the modern scientific picture of the world; understanding the role of biology in the formation of human outlook and functional literacy to solve practical problems;
2. the knowledge of basic concepts and representations of living nature, its level organization and evolution;
3. the maturity of skills to explain the results of biological experiments, to solve basic biological problems;
4. the maturity of knowledge system of general biological laws, theories and confident use of biological terminology and symbols, knowledge of basic concepts, laws relating to the structure, life and development of organisms, the development of living nature;
5. the ability to prove the conclusions, to operate with concepts in explaining the phenomena of nature with examples from agricultural and industrial production practice.

For tasks 1-20 one point is set for the correct answer, zero for the wrong.

For tasks 21-40 two points are set for the correct answer, the final score is reduced by one point for each wrong answer.

For tasks 41-45 four points are set for the correct answer.

For tasks 46-50 four points are set for the correct answer, the final score is reduced by two points for one wrong answer, zero for two wrong answers.

During testing the text of the question and answer choices are displayed randomly.

Test plan for the entrance test in biology

Number of questions	Type of test	Score for correct answer	Total
20	1	1	20
20	1	2	40
5	2	4	20
5	2	4	20
50	TOTAL		100

Thus, in general, the applicant who correctly completed the tasks 1-50 of the entrance test, gets 100 points.

The result of the entrance test is considered positive if the amount of points scored corresponds to the minimum number of points established by the relevant local regulatory act of Pirogov Russian National Research Medical University (Pirogov Medical University), or exceeds it.

Chairman of the subject commission on biology,

Docent

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