

KIROV STATE MEDICAL UNIVERSITY
Ministry of Health of Russian Federation
BIOLOGY ENTRANCE EXAMINATION REQUIREMENTS
FOR APPLICANTS

These requirements are made according to the guidelines in the Federal State Educational Standards of RF for secondary education.

Entrance Examination Requirements for applicants. Discipline: **Biology**

Applicants planning to be admitted to Kirov SMU are expected to demonstrate the following education level in Biology:

- to know the basic terminology, fundamental biological principles, laws and patterns: cell theory; structural and functional interdependence in the organism; structural organization in nature; the laws of organic evolution; the biodiversity and biological classification; environmental patterns;
- to be able to ground their conclusions using biological terms; to explain natural phenomena; to apply their knowledge in practice.

Entrance Examination in Biology: Contents

Plants

Basics of Flowering Plants (angiosperms)

Flowering Plant, its parts: the root and the shoot; the structure of the shoot: the stem, the leaves, the buds; the flower as a modified shoot. Fruits and seeds, their adjustment to spreading in nature. Organic and inorganic composition of the plants.

Cellular structure of a plant.

Magnifying devices (magnifying glass, microscope).

The cell and its structure: the membrane, the cytoplasm, the nucleus, the plastids, the vacuoles. The vital activity of the cell: cytoplasm movement, cell nutrition, cell growth and reproduction.

The root

The root. Types of roots. Types of root systems. Soil, its function in the plant life-cycle. Soil conservaton.

The inner and outer structure of the root. Zones of the root. The root growth. The main functions of the root: water and minerals absorption, anchoring in the soil. Root respiration. Fertilizers. The significance of soil treatment and fertilizing. Root plants, their roles in human activity.

The shoot

The shoot. The bud as a plumule, its structure. The shoot formation from the bud.

The leaf

The leaf. The outer structure of the leaf. Venation. The structure of the leaf: simple and complex types. Phyllotaxy (leaf arrangement). Peculiarities of the leaf microstructure correlated with its functions.

Photosynthesis.

Respiration. Water evaporation. Leaf modification. Abscission. The necessity of protection from air pollution. Interior houseplants; tree and shrub planting.

The stem. Stem growth. Crown formation. The inner structure of the tree stem in correlation with its functions. Tree stem widening. Annual rings formation. Mineral and organic substances transport within a plant. Storage compounds accumulation.

Modified shoots: rhizome, root tuber, bulb, their structure, biological and agricultural significance.

Plant Propagation

Plant propagation and its role. Types of plant propagation.

Micropropagation. Micropropagation and its role in nature and plant breeding.

Seed propagation. A flower as a modified shoot. The role of the flower in the plant propagation. The structure of the perianth, stamen, pistil. Inflorescences, their biological purpose. Cross pollination by means of insects and wind. Self-pollination.

Syngamy. Seed and fruit formation, their role in nature and human life. Industrial harvesting of wild-growing species and the harm it does to the nature. Protection of angiosperms.

Seed structure (dicotyledons and monocotyledons), their chemical composition. Conditions for seed germination. Seed respiration. Sprout nutrition and growth. Agricultural engineering basics for seeding and growing.

Plants and environment

A plant as a holistic organism. Interdependence of cells, tissues, organs. The fundamental processes of a life-cycle in a plant organism. Plant association (phytocoenosis). Environmental factors in animate nature and abiocoen connected with human activity. Correlation of these factors and plants in the examples of forest species, meadow species etc. Adaptation of the plants to co-existence in the forest, meadow, etc. The role of the plants in nature and for humans.

The influence of human activity on the forest species, meadow species. Protection of plants, their habitat, nature conservation regulations and acts.

Groups of plants

Algae. Structure and life-cycle of unicellular and multicellular algae. Reproduction of algae. Filamentous algae. Marine algae. The role of algae in nature and human activity. Protection of algae.

Mosses (anophytes). Their structure and propagation (examples of the local species). Peat formation and purpose. The role of mosses for the sterrhium habitat and its value as a resource material.

Ferns. Their structure and propagation. Their role in nature and human activity. Horsetails (*Equisetum*). Club-mosses (*Lycopodium*).

Gymnosperms (naked-seeded plants). Their structure and propagation (examples of the pine, fir-tree or other conifers). Their dispersal, role in nature and human activity. Biotic control and regulation of conifers. Restoration of coniferous forests.

Angiosperms (flowering plants). Peculiarities of their structure and lifecycle as higher plants, their prevalence on the Earth. Diversification of angiosperms.

Class: dicotyledons. Families: Cruciferae (*Brassicaceae*), *Rosaceae*, Legumes, *Solanaceae*, composite family (aster family), Mallow family (*Malvaceae*), goosefoot family (*Chenopodiaceae*), grape family (depending on the location and climate).

Class: monocotyledons. Families: Lily family, gramineous plants, bluegrass.

Peculiarities of the plants from these families, their bio-characteristics, practical value in human activity.

The influence of human activity on the diversification of angiosperms. Conservation and restoration of rare species.

Agricultural plants

The most common agricultural plants (gramineous plants, fruit and berry crops, vegetables, oil plants, industrial crops), biological and technological issues of their engineering.

Origin of domestic plants. Cultivar/variety. Scientific achievements in selection.

Plants development

Diversification of plants and their origin. Evidence of evolution in plants. The main stages of evolution in plants: monocellular and bicellular algae; photosynthesis; emergence of plants onto the land (psilophytes, mosses, ferns, horsetails (*Equisetum*), gymnosperms, angiosperms). Biological amplification due to evolution. Phylogenetic relatedness in plants.

Prevalence of angiosperms at present, their diversification and spreading on the Earth. The influence of human activity on the plants. Conservation of the diversity in plants.

Bacteria. Fungi. Lichens.

Bacteria

Structure and life-cycle of bacteria, their reproduction. Their spreading in the air, soil, water, living organisms. Their role in nature, industry, medicine, agriculture. Pathogenic bacteria, antibacterial control.

Fungi. Lichens.

Basic description of fungi. Pileate fungi, their structure, nutrition. Fungi-plants symbiosis. Edible and poisonous mushrooms. Tips for mushroom harvesting. Conservation regulation. Prevention for mushroom poisoning. Mold fungi.

Penicillium, its application in production of antibiotics. Yeast fungi. Pathogenous parasitic fungi. The role of fungi in nature and human activity.

Structure of the lichens. Homobium. Nutrition. Reproduction. The role of lichens in nature.

Animals

Outline

Diversity of wildlife. The principle differences of animals and plants, their similarities. Classification of animals.

Unicellulars as the most primitive and oldest animals

Amoeba proteus. Structural peculiarities in a single-cell animal organisms. Habitat. Motion. Nutrition. Respiration. Excretion. Reproduction. Cystogenesis. Reactivity.

Diversity of single-cell animals: Euglena green, its structural and nutritional peculiarities, Paramecium caudatum, malaria parasite, sea-living protozoa. Reactivity.

The role of single-cell animal organisms in nature and human activity. Outline.

Phylum: multicellular animals

Fresh water hydra. Habitat. Outer and inner structure. Radial symmetry. Double-layer structure. Multicellular structure. Cell specifications. Types of cells, their functions, cell cycle processes. The nervous system. Reflex. Regeneration. Reproduction.

Diversity of Coelenterata (coral polyps and medusas), their purpose. Outline of the phylum.

Phylum: Flat worms (Nemertina). Their diversity. White planaria. Double-sided symmetry. Liver fluke, structure, life cycle peculiarities. Other parasitic worms. Outline of the phylum. Anti-parasitic measures.

The phylum: nematodes (roundworms). Ascarids and pinworms - Nematodes commonly parasitic on humans. Prevention for ascariasis.

The phylum: annelids (segmented worms), their diversity. The earthworm, its habitat, structure, motion mechanism. Tissues, organs, systems of organs. Life cycle processes. Regeneration. Reproduction. The role of earthworms in soil formation. Outline of the phylum.

The phylum: molluscs (mussels). Anodonta. Its habitat. Structural, digestive, respiratory and reproduction peculiarities.

The diversity of molluscs (*Lymnaea stagnalis*/great pond snail, *Helix pomatia*/escargot, slugs, oyster, mussels). Their role in nature and human activity. Outline of the phylum.

Anthropods

Class: crustaceans. Their habitat. Structural peculiarities. Life cycle processes. Reproduction. Their diversity. Outline of the class.

Class: arachnids. Structural, digestive, respiratory and reproduction peculiarities. Their behavior correlated with on-land living. Outline of the phylum.

Ticks (Acari). Structure. Ticks as agricultural pests, pest control methods. Parasitic ticks as infectious agents and pathogen carriers. Outline of the class.

Class: Insects. Structural peculiarities and life cycle processes (beetle). Reproduction. Development types.

The main orders of insects.

Lepidopterans. Structural indicators of adjustment to the habitat. Reproduction and wing development (*Holometabolism*). Silkworm (*Bombyx*). Silk farming.

Dipterans. The housefly (*Musca domestica*) as a carrier of infectious human pathogens. Housefly control methods.

Hymenopterans. Honeybee (*Apis*). Honeybee colony hierarchy and life cycle: waggle dance, wintering. Instincts as the inborn behavior pattern of insects. Bee farming. Outline of the class.

Diversity of insects (Colorado potato beetle, ants, ichneumonidae), their role in nature; pragmatic and aesthetic purposes. Biological methods of pest control in agriculture to protect the crops. Insect protection. Outline of the class.

Chordate

Lancelet (*Brancheostoma*). Habitat. Structural peculiarities of the lower chordates. Outline of the phylum.

Class: Fish (*Pisces*). Habitat. Muscular and skeletal peculiarities. Perigastrium. Anatomical peculiarities correlated with physiology. Metabolism. The nervous system and sensorium. Reflexes. Behavior.

Reproduction, spawning season, development. Adjustment to the habitat. Migration. Fish diversity (orders: herrings, crossopterygians etc.).

Economic value of the fish. Fish farming, pond breeding. Fish protection.

Class: Amphibians. Frogs. Structural and motion peculiarities in correlation with the habitat. The nervous system and sensorium. Reproduction and development.

Amphibians and their diversity (orders: salamanders/ Urodela, tailless amphibians/ Anurans). Their origin, value, protection. Outline of the class.

Class: reptiles. The lizard. Habitat, structural, reproduction and behavioral peculiarities in correlation with on-land living. Regeneration.

Diversity of reptiles (orders: scaled reptiles/ *Squamata*, turtles and tortoises, crocodiles), their pragmatic value and protection. Origin and evolution of *Squamata*. Primeval reptiles: dinosaurs, theriodonts. Outline of the class.

Class: birds/ *Aves*. Muscular and skeletal peculiarities. Morphology and metabolism peculiarities correlated with the flying capacity. Complexity of the nervous system and sensorium; behavior.

Origin and evolution of birds. Reproduction and development. Nestlings nurturing.

Adjustment to season changing (nesting, migration).

Birds living in parks, meadows, forests, bogs, on coastline, water bodies, in steppes, deserts; birds of prey (raptors).

The role of birds in nature and human activity. Bird conservation network. Outline of the class.

Poultry farming. Origin and evolution of domestic poultry, breeds.

Class: mammals. Muscular and skeletal peculiarities. Morphology and metabolism peculiarities correlated with the flying capacity. Complexity of the nervous system and sensorium; behavior. Reproduction and development. Nurturing.

Origin and evolution of mammals. Prototheria. Marsupials.

Order: Placentals/ *Placentalia*. Insectivorous mammals/ *Eulipotyphla* and bats/ *Chiroptera*. Rodents/*Rodentia*. Lagomorphs. Predacious mammals. Pinnipedians and cetaceans. Ungulates. Primates.

Farm mammals. The role of mammals in nature and human activity. Multiple species conservation via biotic control, mammal habitats conservation network. Cattle, sheep, pigs, horses. Origin of animal domestication. Keeping, feeding, breeding, issues of farming. Outline of the class.

The history of animal evolution. The evidence of animal evolution: anatomical, embryological, paleontological comparison. Origin of single-cell organisms. Origin of multi-cellular organisms. Complexity of structure and life cycle in vertebrates throughout evolution. Human-animal affinity.

Biocenosis

Organisms and their habitat. Fundamental environmental factors, their influence on the plants and animals. Biocenoses (forest, meadow, water body). The functions of the plants, animals, fungi and bacteria in the biocenosis. Interrelations in the biocenosis. Food chains.

The role of the biocenoses in human activity. Influence of human activity on the biocenoses, their conservation.

Human beings and human health

Human body: outline. Knowledge of human anatomy, physiology and personal hygiene and its role in health care. Human beings and the environment.

The cell structure (cytoplasm, nucleus, ribosomes, mitochondria, membrane). Major cell life-cycle processes (nutrition, respiration, reproduction). Anatomy and physiology of the main tissues: outline. Reflexes. Nervous and humoral regulation of the organism. The human body as a holistic organism. Organs, systems of organs.

Musculoskeletal system. Its purpose. Human skeleton, similarities of human and animal skeletons. Skeletal peculiarities correlated with work activity and bipedalism. Types of bone connection. Bone composition, structure and peculiarities, bone development. First aid in soft tissue bruising, ligament strains, dislocations, fractures.

Muscles, their functions. The main human muscle classes. Muscle physiology. Static and dynamic exertion. Rhythm and exertion, their influence on the muscular activity.

Blood and circulation. The inner environment of the human body (blood, tissue fluid, lymph), its relative consistency. The role of blood and circulation. Blood composition. Plasma. Blood coagulation as a protective mechanism. The structure and functions of erythrocytes and leucocytes.

Immunity. I.I. Mechnikov's theory of immunity, its role.

Infectious diseases. Infectious diseases control. Immunization methods. Prevention for HIV and aids. Blood groups/types. Blood transfusion. Blood donation.

Organs engaged in blood circulation: the heart and vessels (arteries, veins, capillaries). The heart: anatomy and physiology. The systemic circulation, the pulmonary circulation. Lymph circulation. Blood pressure. Nervous and humoral regulation of the heart and vessels. Prevention for cardiovascular diseases.

First aid in bleeding. Tobacco smoking and alcohol intake, how they affect the heart and vessels.

Respiration. Significance of respiration. Respiratory organs: anatomy and physiology.

The vocal apparatus. Gas exchange in the lungs and tissues. Respiration rate. The vital capacity of the lungs. Nervous and humoral regulation of respiration.

CPR: cardiopulmonary resuscitation.

Airborne infectious diseases, prevention for airborne transmitted infections, hygienic routines for infected patients.

Respiratory organs hygiene layouts.

Tobacco smoking, how it affects the respiratory organs.

Air pollution control.

Digestion. The role of digestion. Nutrients and food products. Digestive organs: anatomy and physiology.

Teeth. Prevention for dental diseases.

Digestive enzymes, their function.

I.P. Pavlov's theory: role in the study of digestive organs.

The liver and the pancreas: their functions in digestion.

Absorption. Digestion regulation. Hygienic standards for healthy eating.

Prevention for helminthic invasions and gastro-intestinal disorders, food poisoning, first aid. Tobacco smoking and alcohol intake, how they affect the digestion.

Metabolism. Excretion. Outline. Constructive metabolism and energy metabolism, their interdependence. Proteins, fats, carbohydrates, water, minerals: their functions in the human organism. Toxins and alcohol, how they affect the human organism. Vitamins. Their role in metabolism. The main types of vitamin deficiency (hypovitaminosis). The main types of hypervitaminosis.

Vitamin preservation in food products. Dietary standards. Healthy eating regimen. Dietary recommendations for schoolchildren.

Urinary tract organs, their functions, prevention for urinary tract diseases.

The skin. The anatomy and physiology of the skin. The skin and thermoregulation. Cold air and water treatment. Skin hygiene. Hygienic recommendations for clothes and footwear. Preventive and first aid measures in heat stroke and sunstroke, burns, frostbite injuries, electric shock.

Internal secretion glands. Their role in anthropogenesis, control of the somatic functions. Hormones. Gonads and their functions in the organism. Puberty. Hygienic recommendations for adolescent males and females.

The nervous system. Sensorium. Higher nervous activity. The nervous system, its role in somatic regulation and coordination, behavior control, interaction with the environment. The central and peripheral nervous systems. The brain and spinal cord: anatomy and physiology. The autonomic nervous system, its role in regulating the viscera.

The cerebral cortex. Sense organs, their functions. Analyzers. Anatomy and physiology, hygiene.

Conditioned stimuli and unconditioned responses. Conditioning and inhibition: biological role. Peculiarities of higher nervous activity in humans. Speech and thinking. Consciousness as a function of the brain. Social factors of human behavior.

I. M. Sechenov and I.P. Pavlov: their roles in higher nervous activity study.

Sleep, its role in human health. Hygienic recommendations. Changes in working activity rate during the day. Daily routine recommendations for schoolchildren. Tobacco smoking and alcohol intake, how they affect the nervous system.

The reproductive system. Fertilization and prenatal development. Child birth. Child growth and development. Hygienic recommendations for infants. Tobacco smoking and alcohol intake, how they affect the fetus.

General Biology

The role of biology in agricultural and industrial activities, medicine, hygiene, nature conservation. Major bio-related patterns. Biological hierarchy: cell, organism, species, biocenosis, biosphere.

Basics of Cytology. The main ideas of the cell theory. The cell is a structural and functional unit of all living organisms. The nucleus, membrane, cytoplasm: structure and functions. Structural peculiarities of procaryotic, eucaryotic, autotrophic and heterotrophic organisms.

Chemical composition of the cell. Water, inorganic substances, their function in the cell life cycle. Organic substances: carbs, lipids, proteins, nucleic acids, ATP (adenosine triphosphate): their functions in the cell. Enzymes, their functions in the life cycle regulation. DNA auto-reduplication.

Metabolism and energy converting as vital conditions for a living cell. Energy metabolism, its purpose. The role of ATP in energy metabolism. DNA code.

Constructive metabolism. Photosynthesis. Protein synthesis. Genes and their role in biosynthesis. Matrix/ template synthesis reactions.

Viruses, structural and physiological peculiarities. HIV infection, aids.

Reproduction and individual development of organisms

Cell division as a fundamental mechanism of reproduction and individual development of organisms. Pre-division processes in the cell. Chromosomes, haploid number and diploid number, number and form consistency. Cell division, its significance.

Sexual and asexual reproduction. Gametes. Meiosis. Female and male cells (ovum, sperm). Fertilization.

Embryogenesis (animals). Post-natal development. Tobacco smoking and alcohol intake, how they affect the human being.

Fundamentals of Genetics

Genetics is the study of genes, genetic variation and heredity in living organisms. The main instruments of genetics. Monohybrid crossing and dihybrid crossing. Progeny analysis. G. Mendel's inheritance laws. Dominant and recessive biological traits. Allele genes. Phenotype and genotype. Homozygote and heterozygote. Uniformity in the first generation.

Intermediate inheritance. Discrete inheritance (Law of segregation of genes). Static segregation. Cytological base: uniformity in the first generation and discrete inheritance in second generation. Law of Independent Assortment and its cytological background.

Gene linkage. Impaired gene linkage. Decussation (crossing) of chromosomes.

Genotype as a historically generated unit. Genetics of sex (sex-determination system). Chromosome inheritance theory. The role of genetics in medicine and healthcare. Tobacco smoking, drug-abuse and alcohol intake, how they affect the human inheritance mechanisms.

Genotype and environment: their role in phenotyping. Modification variability. Reaction norm. Statistical patterns for modification variability

Mutations, their causes. Law of homologous series in hereditary variability by N.I. Vavilov (Vavilov's Law). Experimental mutations. Mutations as a background for natural selection and artificial selection. Mutagenic pollution of the environment, its effects.

Genetics and evolution theory. Population genetics. Patterns of natural selection. Selection types: directional selection and stabilizing selection.

Fundamentals of selection

N.I. Vavilov: the Origin, Variation, Immunity and Breeding of Cultivated Plants

The major selection techniques: hybridization and natural selection. The role of the natural selection in plant breeding.

Plant breeding. Self-pollination of cross-pollinated plants. Heterosis. Polyploidy and remote hybridization.

Animal breeding. Crossing types and breeding techniques. Utility character genetic analysis of breeding stock. Remote hybridization of domestic animals.

Bioengineering, its main instruments: micro-biosynthesis, gene and cell engineering. Biotechnologies in selection/breeding.

Evolution theory

Pre-Darwinian layouts on the animate nature evolution.

The main layouts of Darwinian evolution theory. The role of Ch. Darwin's study in natural history.

Species, criteria. Population as a unit of the species and evolution.

Evolution pressure. The significant role of natural selection in evolution. Adjustment mechanisms. Relative nature of adjustment/fitness.

Artificial selection and genetic variability – fundamentals for breeding domestic animals and cultivated plants.

Microevolution. Species formation. Present-day layouts.

Outcomes of evolution: biological adjustment/fitness, species variability.

The main evolution tendencies: aromorphosis, idioadaptation. Biological progression and regression. Correlation of varied evolution tendencies. Evolution patterns. Outcomes of evolution.

Life on the Earth: origins and development. Organic nature: history-related outline. Origin and descent of Man. Archantropines, primitive people, modern-type people.

Ch. Darwin: the descent of man.

Social and biological factors of anthropogenesis. Social life influence on the mankind social development.

Human races, their origin and unanimity.

Fundamentals of ecology/ environmental studies.

The domain and purposes of environmental studies. Environmental factors: abiotic and biotic, anthropogenic. Their combined effect on the organism.

Photoperiodism. Living environments. Eco-niche.

Species, its eco-characteristics. Population, number shift, population control.
Pragmatic use of species, species diversity conservation.

Biogeocenosis. Population growth within a biogeocenosis, their correlation.
Food chains.

Fundamentals of biosphere study

Biosphere. V.I. Vernadskiy: origin of biosphere. Borderlines of biosphere. On-land biomass. Biomass of the global ocean, soil. The living being and its functions. Exchange cycle and energy conversion in the biosphere. Noosphere.