APPROVED
at the meeting of the Academic Council of NJSC Al-Farabi Kazakh National University
Protocol №14 dated 16.06.2026

The program of the entrance exam for applicants to the PhD for the group of educational programs D080 - «Biology»

I. General provisions.

1. The program was drawn up in accordance with the Order of the Minister of Education and Science of the Republic of Kazakhstan dated October 31, 2018 No. 600 "On Approval of the Model Rules for Admission to Education in Educational Organizations Implementing Educational Programs of Higher and Postgraduate Education" (hereinafter referred to as the Model Rules).

2. The entrance exam for doctoral studies consists of writing an essay, an exam in the profile of a group of educational programs and an interview.

Блок	Баллы
1. Interview	30
2. Essay	20
3. Exam according to the profile of the group of the educational program	50
Total admission score	100/75

3. The duration of the entrance exam is 3 hours 10 minutes, during which the applicant writes an essay and answers the electronic examination ticket. The interview is conducted at the university premises before the entrance exam.

II. Procedure for the entrance examination.

1. Applicants for doctoral studies in the group of educational programs D080

- «Biology» write a problematic / thematic essay. The volume of the essay is at least 250words.

The purpose of the essay is to determine the level of analytical and creative abilities, expressed in the ability to build one's own argumentation based on theoretical knowledge, social and personal experience.

Types of essays:

- motivational essay revealing the motivation for research activities;
- scientific-analytical essay justifying the relevance and methodology of the planned research;
- problem/thematic essay reflecting various aspects of scientific knowledge in the subject area.

2. The electronic examination card consists of 3 questions

Topics for exam preparation according to the profile of the group of the

educational program:

Discipline **"Theoretical biology"**

System of the organic world. The law of the unity and diversity of life, or the law of Saint-Hilaire. The law of the globality of life, or the first law of Vernadsky. Biological evolution. The law of organic expediency, or Aristotle's law. Natural selection law, or Darwin's law.

Individual development of the body. The law of ontogenetic aging and renewal, or Krenke's law. The law of the integrity of ontogenesis, or Driesch's law.

Physiological and biochemical essence of life. The law of the chemical composition of living matter, or Engels's first law. The law of the systemic organization of biochemical processes, or Bertalanffy's law.

Genetic-cybernetic essence of life. The law of information conditioning of biological systems, or Waldington's law. The law of discreteness and continuity of biological information, or the Morgan-Ephrussi law.

Man and the life of the planet. The law of the leading role of labor in the formation and development of man, or the second law of Engels. The law of the biospheric role of reason, or the second law of Vernadsky.

Discipline **"Cell Biology"**

Cell theory. Cell is an elemental unit of living. Cell is a single system of conjugated

functional units. The homology of the cells. Poultry from poultry. Single and multicellular

organization. Cell density.

Cytology methods. Light microscopy. Vital (life) study of cells. Study of fixed cells. Electronic microscopy: correction of corporal objects, ultramicroscopy, other special methods of electronic microscopy of biological chemicals. Fractionation of cells.

The structure and chemistry of the cell nucleus. Morphology of nuclear structures. Pole of nuclear structures in the life of the cell. Nuclear components of the prokapiot. The nucleus of eucapiotic cells. Euchromatine and Heteroxomatine. Chromo cycle. General morphology of mitotic chromosome. Cellular cycle eukapiot. Endo preparation and poliploidy. The spatial arrangement of the chromosome in the interphase nucleus.

Chromatin structure and chemistry. DNA chemistry. Replication of eucapiotic DNA The main proteins of chromatine are hystones. Functional properties of hystones. The first level of DNA computation. Structural pole of nycleocom. Hykleocoms for replication and transcription. The second level of DNA compression is 30 nm fibrillation. Pure proteins. The DHK smoke domains are the third level of the structural organization of the chromate.

The nucleolus is a source of ribosomes. Construction of ribos. What determines the number of nuclei in the cell. The multiplicity of the commercially available genes. Amplified nuclei. The structure and functioning of the rRNA ribocom genes. Nucleus structure. Fibrillary center and nucleus organizer. Structural types of nuclei. Proteins of the nucleus. General scheme for the operation of the nucleus as a special locus of synthesis. New, non-canonical functions of the nucleus. Nucleus During Mitosis: Peripheral Chromatic Material.

Nuclear shell. Nucleus components. Pole of the nuclear membrane in the nuclear-cytoplasmic exchange. Import of capiophilic proteins. Export from the nucleus to the cytoplasm of the Dynamic of the nuclear membrane in mitosis.

Cytoplasm. Hyaloplasm and organelles. General properties of biological membranes.

The basic membrane membrane is a double layer of lipids. Membrane proteins are embedded in the bilipid layer. Lipids and proteins of membranes have a lateral mobility. Cellular membranes are symmetrical. Different membranes have different properties. Membranes are adapted with cytoplasmic proteins. The growth of cytoplasmic membranes occurs due to the absorption of ready-made membrane bubbles

Plasma membrane. Barrier-transport field of plasma. Transmixed transfer of ions and low-molecular connections. Vesicular transfer: endocytosis and exocytosis. Receptor pole of the plasmolem. Shiny knowledge. Special intercellular connections (contacts). Cellular wall (shell) of plants. Cellular bacterial casings.

The vacuolar system within the cell transport. General diagram of the functioning of the vacuum system. Granular endoplasmic petikulum. Conveying transport of soluble proteins. Transport of insecure (membrane) proteins. Synthesis of cell membranes. The transport between the endoplasmic pepticulum and the Golgi apparatus.

Golgi apparatus. Fine structure of the Golgi apparatus. Golgi's secret function. Modification of proteins in the Golgi apparatus. Coping of squirrels in the Golgi apparatus.

Lysosomes. General characteristics of lysocoma. Morphological heterogeneity of lysosome. Lysosomal pathologies.

Smooth reticulum and other membrane vocules. Glad (agranular) endoplasmic petikule. Baki or pacific cells. Spheres. Peroxides (microbodies). Secretion of proteins and formation of membranes and bacteria.

Cytoplasm: cell energy supply systems. Mitochondria - structure and function. General morphology. Ultrasound mitoxonium. Functions of mitoxonds. Oxidative phosphophyration in bacteria. Increase in the number of mitoxonds. Automatic production of mitoxonds. Hondriom.

The musculoskeletal system of the cell. Intermediate filaments. Microfilaments.

Microtubules. General properties of microfilaments. Actin-myosin components of nonmuscular cells. Muscle cells. General characteristics of microtubules. Micropipe organization centers. Dineins and kinesins are motor proteins.

Cell center. Centers and centers. Center cycle. Basal bodies, structure and movement of the cords and ciliates. Bacteria propulsion system.

Cell division mechanisms. Mitotic cell division. Meiosis. General organization of mitosis. Various types of mitosis eukapiot. Mophology of mitotic figure. Centers and kinetoxop. Dynamics of mitosis. Self-organization of the microtubule system. Cell mitosis. Separation of bacterial cells. The characteristics of the pre-phase I of the meiotic division. Stage I of myyotic division.

Regulation of the cell cycle. Cell death: necrosis and apoptosis. Factop of mitosis stimulation. Cyclins. Regulation of cells y milk nourishing. Cell cycle reference points.

Discipline **"Environmental protection and conservation of biological diversity"**

Discipline and tasks "Environmental Protection and Biodiversity Conservation".

Environmental Protection. Improving the natural state of the environment. Rational use of

Natural Resources. A system of state and public events aimed at ensuring the harmonious interaction of nature and society on the basis of the preservation and improvement of Natural Resources. Methods of Environmental Protection. Analysis. Composition of Biological Diversity. Storage. identification, conservation and implementation of measures for sustainable, effective use of Biological Diversity and its composition.

General state of the natural environment.

The state of the environment today. Man and the environment. Basic conditions for

Environmental Protection. Environmental pollution. Problems of Biological Diversity today. Storage. Sustainable use of Biological Diversity. Regular use of its components. Obtaining benefits related to the use of genetic resources in a fair and equal way.

Methods for assessing the current ecological state of biodiversity.

The doctrine of biogeocenosis is the scientific and theoretical basis for the sustainability of ecosystems and biodiversity. Plant component of the ecosystem (biogeocenosis). Autotrophic part of biota in biogeocenosis. Phototrophs, their functions and features. Diversity of ecosystems. Flora and fauna of protected middle regions and certain regions. The regional inventory of flora and fauna and specially protected areas are known. Biodiversity Protection Priorities. Long-term monitoring of the state of the biosystem. Goals and objectives of the strategy; strategic directions for the protection and effective use of biological diversity. Be able to use the legal framework for the protection and optimal use of biological diversity. Biological monitoring construction system. Protected areas and biodiversity. Inventory of forest ecosystems. End of inventory of moss flora. Inventory and listing of algal flora.

Obligations to protect the environment and preserve biodiversity.

Development of a National Biodiversity Conservation implementation plan and strategy. Financial support of the plan's activities. Identification of objects for protection. Assessment of the isk to bioanalysis under the influence of farming. Monitoring the state of Biological Diversity, creating a database of data on the problem. Control of genetically modified organisms. Legal approval of the protection of rare and endangered species. Implementation of measures to reproduce disappearing species. Take measures for regular use.Biological diversity of mixtures. Development of environmental knowledge. Education and upbringing. Collection of data on the calculation of Biological Diversity interests. Carrying out work on planning and implementing economic projects.

Environmental Protection, ways to preserve biodiversity.

Factors of the external environment, inhibiting the passage of the population cycle and inhibiting the sequence of Biological Diversity. Bringing a schematic version of specially protected areas and building nature reserves, national dachas and Botanical Gardens. Conservation of forest ecosystems and effective use of their components. In-situ conservation of mountain productive forests of Kazakhstan. A number of protected floodplain zones are of international importance, according to the Ramsar Convention. Development of the legal framework effective use and protection of Biological Diversity. Strengthening regional ties and international cooperation in the field of Biological Diversity. Issuance of certificates to specially protected areas, drawing up development schemes, drawing up reserves, national dachas and Botanical Gardens. Biodiversity protection, protection goals. Protection of the agroal diversity of the mountain ecosystem in the conditions of in situ. Protection categories. Rational use of the biodiversity of the Balkhash and Alakol Lakes, Protection of their biodiversity, protection from desertification. Protection of Caspian biodiversity.

Discipline "**Organization and planning of scientific research" (Genetics and molecular biology)**

The subject and objectives of modern genetics

Methodology of modern genetics. Using the laws of classical genetics in systems analysis. Empirical levels and procedures of scientific inquiry. Subjects, objectives, prospects, and methods of different genetics (pharmacogenetics, environmental genetics, radiation genetics, medical genetics, oncogenetics, immunogenetics, etc.). Heredity, inheritance, heritability.

Model objects and their role in genetic research.

Biological features of model objects and their role in genetic research. The main differences in the organization of cells of prokaryotes and eukaryotes. Application of knowledge about the life cycles of plants and animals in genetic experiments. The selection of a model object following the purpose and objectives of the study. Bioethics issues and risks. Statistical methods for data interpretation in genetic research.

Molecular genetic methods of analysis in genetic research.

The use of molecular genetic methods to study the mechanisms of genetic processes (gene expression, translation, transcription, DNA repair, methylation, and genomic imprinting, etc.), the action of individual genes, and intergenic interactions. Methods for identifying factors in the development of carcinogenesis. Methods for molecular genetic assessment of oncological diseases. Methods for the molecular genetic study of gametogenesis. Molecular diagnostics.

The use of genetic methods to solve problems in the food industry, agriculture, medicine.

Solving the problems of the food industry, agriculture based on genetic methods. Genetic background of modern methods of artificial insemination in humans (IVF). Polymerase chain reaction (PCR) method: principle, steps, reaction components, varieties, and equipment for PCR. Prospects and problems of using stem cells.

General principles and methods of genetic engineering.

An overview of enzymes used in genetic engineering. Genetic engineering of cultured mammalian cells. DNA based vector systems. The introduction of DNA into cells. Obtaining crops with higher yields and resistance to pests. Modern methods of plant transformation. Plant viruses as vectors for genetic engineering. The use of transgenic plants.

Radiation genetics.

Hereditary disorders in radiation injury. Routes of entry of radionuclides into the body. Radiation genetics methods. Nuclear medicine. "Peaceful" atom. Biodosimetry

The main directions of genetic analysis

The classical approach from phenotype to genotype and molecular genetic methods from genotype to phenotype. Mendel's laws. Chromosomal theory of heredity of the Morgan school.

Modern achievements in the breeding of cereals.

Methods of chromosome engineering of wheat. Problems of hetero-, poly- and aneuploidy of plants. Chromosomal abnormalities on the example of plants and, in particular, cereals. Development of the nomenclature of chromosomes. The discovery, study, and use of aneuploids. Methods for creating a series of aneuploid lines of soft wheat. Schemes for producing aneuploids. Chemical and radiation mutagenesis as a method of increasing the diversity of the starting material for hybridization.

The structure and properties of chromosomes.

Chromosomal rearrangements. Comparative analysis of prokaryotic and eukaryotic

chromosomes and their properties. Euchromatin and heterochromatic regions of chromosomes. Methods for localizing genes in chromosomes.

The use of mutations in genetic analysis.

Endogenous and exogenous sources of mutations. Gene, chromosomal and genomic mutations, their classification, and examples of diseases associated with the occurrence of mutations. Mobile elements as a source of mutations. Induced and spontaneous mutagenesis.

The evolutionary views of de Lamarck and Darwin.

Evolutionary views of Lamarck. Driving forces of progressive evolution (gradation) and speciation. The contradictory views of Lamarck. The main driving forces of evolution, according to Darwin. Fundamentals of Darwin's theory. The main provisions of the synthetic theory of evolution.

A population is an elementary unit of an evolutionary process.

A population is an elementary unit of evolution. Genetic heterogeneity and population polymorphism. The genetic unity of the population. Hardy-Weinberg Law. The conditions under which the Hardy-Weinberg equilibrium holds.

Genetic foundations of evolution.

Variability: phenotypic, genotypic, paratypic, modification. Modifications. Reaction rate. The concept of the adaptive rate.

Elementary factors of evolution.

Evolutionary factors are causing changes in the genotypic structure of the population. Natural selection and the significance of probability and chance.

Biological and evolutionary significance of species.

The general concept of the species, characteristic of the difficulty in its universal application. The reasons for the increase in the number of species. Speciation. Instant speciation. Gradual and sympatric speciation.

Anthropogenesis.

The place of man in the system of the animal world. The ancestors of man. The main stages of the evolution of Homo. The main stages of the development of Homo sapiens. The role of labor and social lifestyle in human evolution. Influence on the human evolution of elementary evolutionary factors.

Discipline "Virology"

General concepts and history: The aim of virology as a science, the role of viruses in nature, and the history of the development of this field.

Structure and chemical composition: The structure of virions (viral particles), their genetic material (DNA or RNA), and the protein capsid (coat).

Classification and nomenclature: Taxonomy (systematic position) and nomenclature (names) of viruses.

Molecular virology. This section reveals the "secret" of the virus at the molecular level: how its genes function and how it controls the host cell.

Genome replication: Strategies for replicating genetic information in different viruses (DNA viruses, RNA viruses).

Transcription and translation: The processes of converting viral gene information into protein.

Specific virology (Taxa and diseases)
This section examines specific types of viruses and the diseases they cause. These topics cover a wide range of viral infections, their diagnosis, prevention, and treatment methods.

Respiratory tract viruses: Influenza virus, paramyxoviruses, adenoviruses, coronaviruses (including SARS-CoV-2).

Gastrointestinal viruses: Rotaviruses, enteroviruses, hepatitis A, B, C viruses.

Neurotropic and other viruses: Rabies virus, tick-borne encephalitis virus, herpes viruses, HIV.

Highly dangerous viruses: Ebola virus, smallpox virus.

Diagnosis, treatment, and prevention
The applied part of virology, i.e., the practical application of knowledge.

Diagnostic methods: Basic methods for detecting viruses (PCR, serological methods, antibody detection, etc.).

Antiviral drugs: Medications that inhibit viral replication and their molecular targets.

Vaccines: Types of vaccines (live, inactivated, subunit, mRNA vaccines), their development history and use.

Biosafety: Safety measures and principles for working with dangerous viruses.

Use of viruses: Oncolytic viruses (destroying cancer cells) and other applications of viruses in science and biotechnology.

III List of references

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