APPROVED
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Protocol №14 dated 16.06.2026

The admission exam

program for applicants to the PhD for the group of educational programs D082 - «Biotechnology»

I General provisions

1. The program was developed in accordance with the Order of the Minister of Education and Science of the Republic of Kazakhstan dated from 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, passing a test for readiness for doctoral studies (hereinafter referred to as TRDS), an exam in the profile of a group of educational programs and an interview.

Section	Points
Interview	30
Essay	20
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 4 hours, during which the applicant writes an essay, passes a test for readiness for doctoral studies, and answers an electronic examination. The interview is conducted based on the university before the entrance exam.

II Procedure for the admission examination

1. Applicants for doctoral studies in the group of educational programs D082
- «Biotechnology» writes a problematic / thematic essay. The volume of the essay is at least 250-300 words.

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.

The electronic examination ticket consists of 3 questions.

Topics for exam preparation for the group of educational programs D082 - Biotechnology»

Course «Modern methods in biotechnology»

Methods for creating recombinant DNA molecules. Nucleic acid metabolism enzymes used in genetic engineering. Characteristics, classification, and isoenzymes of restriction enzymes. Restriction maps and restriction fragments. Methods for cDNA synthesis, restriction, ligation, transformation, and transfection.

Methods for isolating and identifying cloned genes. Selection of bacterial clones containing recombinant plasmids. Southern and Northern blotting, screening of gene libraries using oligonucleotide probes. ELISA, immunological, and enzymatic methods. PCR, real-time PCR, DNA sequencing, next-generation sequencing (NGS) technologies, and genomic data analysis.

Methods for transforming plant protoplasts, cells, and tissues. Agrobacterium tumefaciens, Ti plasmids, T-DNA, and functions of the vir region. Binary vectors, reporter and selective markers. Practical applications of plant genetic engineering.

Physical, biophysical, and analytical methods. Spectrophotometry, fluorimetry, electron paramagnetic resonance, nuclear magnetic resonance. Methods for the study, isolation, and purification of proteins: centrifugation, salt fractionation, dialysis, ultrafiltration, gel filtration, ion-exchange, reverse-phase, and affinity chromatography. Fundamentals of proteomics, metabolomics, and bioinformatics analysis.

Next-generation sequencing (NGS) technologies, methods of whole-genome and transcriptomic analysis. Fundamentals of bioinformatics and genomic data processing. Integrated analysis of genomic, transcriptomic, proteomic, and metabolomic data (multi-omics approaches).

Course «Chromosomal and genetic engineering»

The importance of eukaryotic cloning systems in genetic research. Regulation of eukaryotic gene expression using yeast cells as an example. Yeast spheroplasts, expression of yeast genes in E. coli cells, transfer vectors, and yeast plasmids.

Elements of autonomous replication, CEN sequences, telomeres, and chromosomal stability. Targeted integration of cloned DNA into yeast chromosomes. Organization and regulation of gene expression. Metabolic engineering, genome editing technologies, and the application of CRISPR/Cas systems in biotechnology.

Modern genome editing technologies. Principles of operation of CRISPR/Cas9, CRISPR/Cas12, and other programmable nucleases. Methods of precision genome editing and their application in medicine, agriculture, and industrial biotechnology. Main directions and prospects for the development of gene therapy.

Course «Physiology of microbial resistance»

Objects of biotechnology: bacteria, actinomycetes, yeast, molds, microalgae, and cyanobacteria. Physiological characteristics and productivity of industrial strains.

Methods for storing industrial strains of microorganisms. Lyophilization, cryopreservation, freezing, storage under mineral oil, and maintenance of culture collections. Methods of protection against bacteriophages.

Principles of microorganism cultivation. Optimization of cultivation processes, composition of culture media, pH, temperature, aeration, mixing, and light conditions. Bioreactors and control of fermentation processes.

Control of biotechnological and microbiological production. Sources of contamination and methods for combating them. Production and sanitary-microbiological control. Use of microorganisms in medicine, agriculture, food, and environmental biotechnology.

Production of probiotics. Properties of probiotic strains, selection criteria, safety, stability, and technological suitability. Classification of probiotic preparations and stages of their production.

Course «Genome regulation and functional genomics»

Engineering enzymology and immobilized enzymes. Immobilization methods, carriers, enzyme stability, and their application in biotechnological production.

Synthetic and functional genomics. Genomic data analysis, transcriptomics, proteomics, metagenomics, and systems biology. Modern approaches to the study of prokaryotic and eukaryotic genomes.

Genetic modification of viruses. Targeted delivery of drugs and therapeutic genes. Search for new antibacterial drugs based on genomics and proteomics. R-genes, protein domains, and extrachromosomal factors of inheritance.

Transcriptomics, epigenetics, and molecular mechanisms of gene expression regulation. Basic principles of synthetic biology. Design of biological systems and creation of genetic constructs. Systems biology and modeling of cellular networks. Metabolic engineering and control of biological product synthesis.

Course «Biotechnology of agricultural plants»

Clonal micropropagation and plant disease control. Methods, stages, and factors influencing microclonal propagation. Virus control in planting material.

Overcoming pre- and post-gametogenic incompatibility under in vitro conditions. Remote hybridization, in vitro fertilization, culture of isolated embryos and endosperm.

Haploid technologies. Culture of anthers and microspores, culture of the female gametophyte, production of haploid and doubled haploid plants, their significance in breeding.

Cell engineering. Isolation, culture, and fusion of protoplasts; plant regeneration. Somatic hybridization; methods for selecting and analyzing hybrids.

Cellular breeding, induced mutagenesis, and somaclonal variation. Production of forms resistant to salt stress, low temperatures, phytopathogens, and other stress factors.

Plant genetic engineering. Ti-plasmid-based vector systems, methods for gene transfer into plant cells, reporter genes, chloroplast genome transformation, and the production of markerless transgenic plants. Development of plants resistant to pests, viruses, herbicides, fungal and bacterial diseases.

Course «Biotechnology of biologically active substances production»

Classification of biotechnology products. Proteins, enzymes, hormones, vitamins, polysaccharides, antibiotics, biogenic stimulants, pesticides, and other biologically active substances.

Basic principles of protein production and methods of purification. Use of yeast, bacteria, microalgae, and fungi for protein production. Cell lysis, extraction, purification of extracts, and protein fractionation.

Extraction of bioactive compounds from plant materials. Stages of extraction, requirements for extractants, maceration, percolation, repercolation, counter-current extraction, and process intensification using ultrasonic and electrical methods.

Industrial production of biologically active substances from plant cell cultures. Selection of the producer, preparation of culture media, biosynthesis, isolation, purification, and production of the final product.

Production of enzymes, amino acids, vitamins, and organic acids. Selection of strains, cultivation conditions, isolation, and stabilization of enzymes. Use of immobilized cells and enzymes.

Principles of technical equipment for biotechnology production facilities. Instrumentation for microbiological production facilities, process control, quality control, decontamination, and waste disposal.

Production of biopharmaceuticals. Technologies to produce recombinant proteins, monoclonal antibodies, and vaccines. GMP requirements and quality control systems in biopharmaceutical production.

III List of References

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