APPROVED
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The program of the entrance exam for applicants to the PhD for the group of educational programs D082 - «Biotechnology»

1. 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, 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.

BLOCK	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 on the basis of the university before the entrance exam.

2. Procedure for the entrance examination.

1. Applicants for doctoral studies in the group of educational programs D082 -

«Biotechnology» write 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.

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 "Modern methods in biotechnology"

Methods used in recombinant DNA technology. Nucleic acid metabolism enzymes used in genetic engineering. Characterization of restriction enzymes, their classification. Isoschizomers. Restriction maps and restriction fragments. Methods for constructing a recombinant DNA molecule, obtaining a cDNA gene, restriction, ligation and methods for transferring genes into cells of various organisms.

Methods of cloned genes isolation . Selection of clones of bacteria that have received recombinant plasmids using genes that determine antibiotic resistance (inactivation by insertion). Southern and northern blotting. Screening of gene libraries using oligonucleotide probes. Enzymatic, immunological and enzyme-linked immunosorbent (ELISA) methods for identifying protein products of genes and nucleic acids proper (digoxigenin, triple helix of nucleic acids). Use of the polymerase chain reaction (PCR) method for identification, amplification and isolation of specific DNA regions.

Methods of transformation of plant protoplasts, cells and tissues. Tumor-inducing plasmids induced by some soil bacteria. Genetic engineering of plants. Crown galls are plant tumors. Tumor-inducing plasmids (Ti-plasmids). Mutants of Ti-plasmids. Integration of T-DNA with the plant chromosome. Ti plasmid DNA as vector. Transformation of plant cells and protoplasts. Mobilization of T-DNA using the vir-segment of the Ti-plasmid. Attached T-DNA vectors enable whole plant regeneration from a single cell. T-DNA insertion can be used to isolate plant genes. Practical application of plant genetic engineering using Ti-plasmids.

Physical and biophysical methods. Spectral methods for studying stationary properties of biological systems. The method of electronic and paramagnetic resonance, nuclear magnetic resonance. Methods for studying the ionic permeability of biological membranes. Calorimetric methods for the study of proteins. Spectral methods for the study of proteins. Proteomic methods for studying proteins. Methods for the isolation and purification of proteins. Centrifugation, salt fractionation, gel filtration, dialysis. Types of membrane filtration for the isolation of proteins. Ultrafiltration methods, reverse phase chromatography, partition chromatography, gel chromatography. Principles and devices of microscopes.

Discipline "Chromosomal and genetic engineering"

Advantages of the eukaryotic cloning system for genetic research and for studying the regulation of eukaryotic gene expression using the example of yeast cells.

Yeast spheroplasts. Expression of yeast genes in E. coli bacteria. Shuttle vectors. Yeast plasmids. Improve transformation efficiency with additional replication origin points (offline replication elements,EAP). Stabilization of yeast plasmids by introducing centromeric (CEN) yeast DNA. The hairpins at the ends of yeast chromosomes are telomeres. Directed insertion of cloned DNA into yeast

chromosomes. Organization and regulation of gene expression in yeast. Metabolic engineering.

Discipline "Physiology of resistance of microorganisms"

Biotechnology objects. Industrial microorganisms - bacteria, actinomycetes, yeasts, molds,microalgae.

Storage of industrial strains of microorganisms. Methods for long-term preservation and protection against phage damage to industrial strains of microorganisms.

Cultivation of microorganisms. Regularities of their growth and cultivation. Optimization of microorganism cultivation processes.

Control of biotechnological and microbiological production. Microbes-pollutants of biotechnological industries and the fight against them. Production and sanitary-microbiological control of production facilities. Microorganisms in medicine, agriculture, food biotechnology.

Probiotics production. Properties and selection criteria for strains of probiotic microorganisms. Classification of probiotic drugs. Biotechnology for obtaining probiotics.

Discipline "Regulation of the genome"

Engineering enzymology. Immobilized enzymes. application of immobilized enzymes in biotechnology. Synthetic and functional genomics.Genetic modification of viruses. Function of the protein domain encoded by the R genes. The role of the specific allele of the R-gene. Extrachromosomal factors of heredity. New antibacterial drugs using genomics and proteomics. Targeted delivery of drugs and therapeutic genes. Metagenomics in the study of pro- and eukaryotic genomes.

Discipline "Biotechnology of agricultural plants"

Clonal micropropagation and plant health. Methods of clonal micropropagation of plants, stages of microclonal reproduction, factors affecting the process of microclonal reproduction, improvement of planting material from viruses. Overcoming in vitro progamous and postgamous incompatibility. Progamous and postgamous incompatibility with distant hybridization. In vitro fertilization. A culture of isolated charges. Endosperm culture.

Haploid technology. Anther culture. Using haploproducers and distant hybridization in obtaining haploid tissues. Obtaining haploid plants in the culture of female haploid. Possibilities of haploid technologies.

Cellular Engineering. Protoplast culture. Isolation and production of viable protoplasts.Cultivation of protoplasts. Plant regeneration in protoplast culture.

Somatic hybridization. The principles of somatic hybridization. Genetic bases of somatic hybridization. Somatic hybridization of distant plant species. Breeding methods for somatic hybrids. Methods for the analysis of hybrid plants. Practical application of somatic hybridization.

Cell selection. Cell selection methods. Selection of resistant cells. Stability of the trait of resistance. Induced mutagenesis. Features of mutagenesis and selection of mutants in vitro. Effect of mutagens on the survival of cells cultured in vitro. Methods for the selection of cell variants.

Somaclonal options. Somaclonal variability. Natural genetic diversity of plant cells. Genome variability during in vitro cultivation. Cytoplasmon variability in somaclonal variants. The value of the genotype and the original explant. Influence of cultivation conditions on plant regeneration. Genetic analysis of somaclones. Practical use and prospects for the use of somaclonal variability.

Genetic engineering of plants. Transformation of plants with Ti-plasmid from Agrobacterium tumefaciens. Vector systems based on Si-plasmids. Methods for transferring genes into plant cells. The use of reporter genes in the transformation of plant cells. Isolation of various promoters and their use. Introduction of foreign genes into chloroplast DNA. Obtaining transgenic plants that do not contain marker genes.

Application of genetic engineering of plants. Breeding of plants resistant to insects - pests, viruses, herbicides, fungi and bacteria.Obtaining plants that are resistant to various stress factors and aging. Oxidative stress, salt stress. Fruit ripening. Use of phytopathogen toxins in the selection of disease-resistant plant forms. Isolation of salt tolerant forms of plants by direct and indirect selection in tissue culture. Selection of cold-resistant forms.

Discipline "Biotechnology of the production of biotechnologically active substances"

Classification of products of biotechnological industries. Natural macromolecules -proteins, enzymes, hormones, vitamins, polysaccharides, polyesters, antibiotics, biogenic stimulants, pesticides isolated from the cells of microorganisms, tissues and organs of plants and animals.

Basic principles of obtaining proteins and methods of their purification. The use of microorganisms (yeast, bacteria, algae, fungi) for the production of protein. Protein purification methods. Extract preparation Cell disruption and extraction. Optimization and clarification of the extract. Methods used in the purification of particle-associated proteins and enzymes.

Methods for the isolation of biologically active substances from plant materials. Features of extraction from plant materials with a cellular structure. Extraction stages and their quantitative characteristics. The main factors affecting the completeness and rate of extraction. Requirements for extractants.

The main types of extraction (maceration, percolation, repercolation, accelerated fractional maceration by the counterflow method, circulating extraction, continuous countercurrent extraction with mixing of raw materials and extractant, extraction with liquefied gases). Intensification of extraction processes (extraction using a rotary-pulsating apparatus, using ultrasound, using electrical discharges, using electroplasmolis and electrodialysis).

Industrial production of biologically active substances from plant cell culture. Preparation of the medium for the cultivation of the producer and inoculum. Biosynthesis of biologically active substances. Isolation, purification of biologically active substances and obtaining end products.

Biotechnology of enzymes production. Scope and sources of enzymes. Selection of strain and cultivation conditions. Technology of cultivation of

microorganisms - producers of enzymes, isolation and stabilization of enzymes. The use of enzymes of microorganisms.

Amino acid production. Biotechnology for the synthesis of amino acids and their purification. Obtaining amino acids using immobilized cells and enzymes. Obtaining optical isomers of amino acids by using acylases of microorganisms.

Vitamin production. General characteristics of vitamins. Obtaining water-soluble (vitamin B1, B2, B6, Sun, PP, B3, B12, vitamin C) vitamins. Obtaining fat-soluble (ergosterol, vitamin D2) vitamins. Obtaining carotenoids.

Organic acid production. Obtaining organic acids (citric, lactic, acetic, propionic, itaconic,gluconic, fumaric acids) for use in the food and pharmaceutical industries, in technology and as chemical raw materials.

Principles of technical equipment for bio-production. Hardware design for microbiological production. Management of technological processes of biosynthesis of biologically active substances. Waste from biotechnological industries and their neutralization and disposal.

III. Список использованных источников

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