KAZAKH NATIONAL UNIVERSITY named after AL-FARABI

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Scientific and Methodological Council
KazNU named after al-farabi
protocol №_____from «_____»_____г.
Vice Rector for Academic Affairs
_____A.K. Khikmetov

PROGRAM
ENTRANCE EXAM FOR ENTRANCE DOCTORS PHD
IN EDUCATION
«8D051 - ENVIRONMENTAL BIOTECHNOLOGY»

ALMATY

The program is compiled in accordance with the State educational standard for the specialty " 8D051-environmental Biotechnology». The program was composed by: doctor of biological sciences, professor Zayadan B.K., candidate of biological sciences, associate professor, Sadvakasova A.K., candidate of biological sciences, associate professor Kirbaeva D.K.

The program was reviewed at the meeting of the Department of biotechnology
Protocol № _____from_____2020.

Head of department _____ **Kistaubaeva A.S.**

Approved at the meeting of the methodological bureau of the faculty
Protocol №_____ from _____2020.
Chairman of the methodological bureau _____ O. Yurikova

Approved at the meeting of the Scientific Council
Protocol №_____ from _____2020.

Chairman of the Scientific Council,
Dean of the faculty _____ **B.K. Zayadan**

Scientific secretary _____ **M.O. Bauenova**

CONTENT

1. Goals and objectives of the entrance exam in the specialty "8D051 - Environmental Biotechnology".

The purpose of the entrance exam for applicants to the doctoral program in the specialty "8D051 - environmental Biotechnology" is to identify the amount of knowledge that they have acquired while studying for a master's degree. As well as to assess the compliance of universal competencies of the applicant to the doctoral program, necessary for the successful development of special competencies formed in the course of training in the doctoral educational program. The purpose of the exam is to assess the ability and readiness of future doctoral students to search, select, synthesize and concretize information; evaluate the students ' awareness of the subject of study in the doctoral educational program; assess the readiness of the applicant to use modern information resources in the learning process, evaluate the ability to formulate and solve modern scientific and practical problems in science and industry, teach at universities, successfully carry out research and management activities in various biotechnological industries and organizations.

The exam form is written.

2. Requirements for the level of training of persons entering the PhD program in the specialty "8D051 - environmental Biotechnology".

The previous minimum level of education of people who want to master the educational programs of doctoral studies is the master's program. Applicants to doctoral studies should have general professional competencies corresponding to the level of training of masters, be able to formulate and study new problems from various fields of modern biotechnology; be able to organize work on a scientific basis, use the knowledge in laboratory and production conditions.

3. Prerequisites for the educational program

“Ecological biotechnology”, “Xenobiotic metabolism”, “Modern methods in biotechnology”, “Photobiotechnology”, “Genetics with the basics of genetic engineering”.

4. Exam Topics

Biological methods of wastewater treatment and solid waste disposal. Biomethanogenesis - microbiology, biochemistry and process parameters. Requirements for processed raw materials.
The effectiveness of biomethanogenesis and the degree of conversion of the mass of waste into the product. Composition and calorific value of biogas. Elimination and recycling of landfill waste. Neutralization of toxic products. Elimination and processing of solid household waste. Biomethane and composting – Microbiology, biochemistry and process parameters. Neutralization of toxic products.

Transgenic microorganisms are effective biodestructors of xenobiotics.

Methods for producing recombinant DNA. Recombinant microorganisms - destructors pesticides, petroleum products and other pollutants. Transgenic microorganisms are effective biodestructors of xenobiotics.

Bioremediation. Design criteria for biotechnological cleaning processes. Biological products used in bioremediation of the environment. Wastewater treatment processes. Water quality and cleaning methods. Environmental bioremediation: biodegradation of heavy metals, purification from oil and oil products, atmosphere bioremediation. Principles and approaches for the purification of gas emissions. Types of biocatalysts and apparatuses for these processes. Characterization of various biological products used in the treatment of contaminated water and soil. Industrial apparatus for the digestion of wastewater. Septenki. Anaerobic biofilter. Active sludge - components and chemistry of action. Characteristics of biofilm and activated sludge.

Technological bioenergy. Technological bioenergy and safe methods of reproduction and energy

conversion. Methanotenes and biomethanogenesis as a process of waste elimination and an ecological method of obtaining energy carriers. Types and arrangement of methanotanks.

Biotechnology and ecologization of agricultural technologies.

Ecological and biotechnological alternatives in agriculture. Bio-fertilizers: characteristics, principles of production and application. Bioherbicides: principles of preparation and application.

Destructible biopolymers. Destructible biopolymers are an ecological alternative to synthetic non-destructible plastics. Modern scale of production and application of polyhydroxyalkanoates.

Biomonitoring of water ecosystem pollution. Feature of bioindication at the cellular, organismal, population and coenotic levels. Specific and non-specific indicator reactions of aquatic animals and plants. Biomonitoring and biotesting of environment. An integrated methodology of biomonitoring.

Classification of toxicants and poisonings. Principles of classification of poisons: General and special. Specific and non-specific effects of harmful substances. The main types of specific actions. Concept of the toxicity receptor. Theory of toxicity receptors. Characteristics of the venom-receptor relationship. Influence of the "poison-receptor" type of communication on the manifestation of toxicity

Determination of Toxicological characteristics. The order of hygienic regulation of chemicals. The stages of determining the Toxicological characteristics. The limiting characteristic is set. Temporary Toxicological characteristics. Accelerated the establishment of sanitary standards for chemical substances.Calculation methods for the determination of Toxicological substances.

The effect of toxicants on a biological object. Combined effect on a biological object. Additivity, synergy and antagonism in the combined action of harmful environmental factors. Features of repeated exposure of harmful substances to a biological object. Accumulation of poisons (material and functional). Tolerance. Sensitization.

The concept of biotransformation of xenobiotics. Concept of phase I and II of xenobiotic metabolism. The first phase of metabolism. Mechanisms of phase I of xenobiotic metabolism: redox transformations, hydrolysis. Enzymes that activate the processes of phase I of xenobiotic metabolism. The second phase of metabolism. Mechanisms of phase II metabolism of xenobiotics: conjugation (acetylation, conjugation with glucuronic acid, with sulfates, with amino acids). Concept of lethal synthesis.

Effects of substances on populations and ecosystems. Populations and ecosystems as objects of exposure to harmful substances. Communities and ecosystems as objects of exposure to harmful substances. Changes in species diversity and abundance. Sustainability and transformation of ecosystems. The specificity of the metabolism of chemicals in ecosystems, transport, biodegradation and bioconcentration. Maximum permissible environmental load. Features of Toxicological rationing in ecosystems.

Objects of ecological biotechnology. Industrially valuable microorganisms – bacteria, actinomycetes, yeast, microalgae.

Storage of industrial strains of microorganisms. Methods of long-term preservation and protection from phage damage of industrial strains of microorganisms.

Cultivation of heterotrophic and phototrophic microorganisms. Regularities of their growth and cultivation. Optimization of microbial culture processes.

Features of the metabolism of microorganisms. Features of energy metabolism in prokaryotes. Ways to solve energy problems by chemoorganotrophs and chemolithotrophs. Features of bacterial photosynthesis.

Control of biotechnological and microbiological production. Microbes-pollutants of biotechnological production and their control. Production and sanitary-microbiological control of production facilities.

Microbial processing of plant waste. Microbiological processes of processing plant raw materials.

Microbiological bases of the processing of animal waste.Production of protein preparations. Obtaining proteins from yeast. Obtaining proteins from phototrophic microorganisms.

Obtaining biologically active additives (BAA). Nutraceuticals, parapharmaceuticals, prebiotics, their functional role. Classification of dietary biologically active additives (BAA).

Bioenergetics. Biomethane. Getting alcohol. Biodiesel. Hydrogen production.

Engineering Enzymology. Immobilized enzymes. application of immobilized enzymes in biotechnology.

Improvement and acceleration of the selection process by methods of chromosomal engineering and biotechnology.

Using cell and tissue culture. Haploid technology on the basis of androgenesis. Combination of methods of chromosomal engineering and anther culture in plant breeding

Chemical and radiation mutagenesis as a method of increasing the diversity of the source material for hybridization.

Methods of cytogenetic analysis of wheat mutants. Types of intrachromosomal and interchromosomal mutations: heterozygous translocations, inversions and duplications, heteromorphic bivalents and their consequences.

Basic principles of genetic engineering. Implementation of genetic information.

The definition of the subject of genetic engineering, its place in the development of molecular genetics and biology in general. Introduction of the concept of recombinant DNA. The main prerequisites for the emergence of genetic engineering.

Genetic elements that regulate the expression of prokaryotic genes.

Ideas about the regulation of gene expression at their transcription levels, as well as the translation of their corresponding matrix (m) RNA. Bacterial genes with related functions are organized into operons, the theory of J. Mono and F. Jacob on the example of a lactose (lac) operon.

Methods for creating recombinant DNA molecules. Nucleic acid metabolism enzymes used in genetic engineering. Characterization of restriction enzymes, their classification. Isoshizomers. 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.

Cloning methods for recombinant DNA molecules.

General characteristics of bacterial plasmids as autonomously replicating minichromosomes. Episomes, non-transmissible plasmids.

Methods for isolating cloned genes.

Selection of bacterial clones that have received recombinant plasmids using genes that determine antibiotic resistance (insert inactivation). Southern blotting and Southern and northern blotting. Screening gene libraries using oligonucleotide probes. Enzymatic, immunological and enzyme immunoassay (ELISA) methods for the identification of protein products of genes and the actual nucleic acids (digoxygenin, triple helix of nucleic acids). Using the method of polymerase chain reaction (PCR) to identify, amplify and isolate specific sections of DNA.

Methods of studying membrane structures in biotechnology. Separation of subcellular components. Identification of cellular components and criteria for their purification.

Methods used to isolate and study lipids of membrane structures. Separation and analysis of lipid components of membranes. Identification of lipid components of membranes.

Methods for the isolation and identification of fatty acids. Types of chromatography used to quantify fatty acids. Their advantages and disadvantages.

Principles of protein isolation from biological objects. The main criteria for the purity of protein preparations. Qualitative and quantitative methods for the determination of proteins.

Методы выделения и анализа нуклеиновых кислот. Основные критерии их чистоты. Количественное определение нуклеиновых кислот. Выбор методов для анализа

нуклеиновых кислот.
Methods of isolation and analysis of nucleic acids. The main criteria for their purity. Quantification of nucleic acids. Selection of methods for nucleic acid analysis.
Modern methods of nucleic acid sequencing. Stages and types of nucleic acid sequencing methods. The principles of radio autography.
The principle of polymerase chain reactions (PCR). Method principle, steps, reaction components. Necessary equipment for PCR.
Varieties of polymerase chain reactions (PCR). The use of polymerase chain reactions for the analysis of the primary structure of nucleic acids. The use of PCR.
Methods of genetic engineering. The concept of recombinant structure. The mechanism of creating recombinant DNA.
The practical application of genetic engineering. Obtaining transgenic plants and animals.

5. 5. List of recommended literature

Main literature:

1. Kuznetsov, A. E. Scientific foundations of ecobiotechnology / A. N. Kuznetsov, N. B. Gradova. - M.: Mir, 2006 .-- 504 p.

2. Zayadan B.K. Ecological biotechnology of phototrophic microorganisms Monograph. Almaty, “Arys”, - 2011. P.368

3. Zayadan B.K. Phototrophs microorganismdeter Biotechnologies. Monograph.-Pavlodar, 2010 S. 421.

4. Kaplin, V. G. Fundamentals of ecotociscology / V. G. Kaplin. - M.: Kolos, 2007 .-- 231 p.

5. Kuznetsov, A. E. Applied ecobiotechnology: In 2 volumes: textbook. allowance. T.1. / A.E. Kuznetsov, N. B. Gradova, S.V. Lushnikov. - 2nd ed., - M.: BINOM. Laboratory of Knowledge, 2012 .-- 629 p.

6. Applied ecobiotechnology. In 2 t.: Textbook. allowance. T.2 / A.E. Kuznetsov, N. B. Gradova, S.V. Lushnikov, etc. - M.: BINOM. Laboratory of Knowledge, 2010 .-- 488 p.

7. Volova, T. G. Biodegradable polymers: synthesis, properties, application: monograph / Volova T. G. and Shishatskaya E. I; under the editorship of E.J. Sinski. - Krasnoyarsk: Krasnoyarsk writer, - 2011.

8. Volova, T. G. Biotechnology: a training manual / T. G. Volova; open ed. I.I. Gitelzon. - 2nd ed., Revised. - Krasnoyarsk: KrasSU, 2002 .-- 266 p.

9. Biological plant protection products. Technologies for their manufacture and application. / Ed. V.A. Pavlyushina, K.E. Voronin. - SPb .: VIZR, 2005 .-- 360 s.

10. Introduction to biotechnology. Version 1.0 [Electronic resource]: electron. textbook.-method. complex / T. G. Volova, N. A. Voinov, E. I. Shishatskaya, G. S. Kalacheva. - Elektron. Dan. (91 Mb). - Krasnoyarsk: IPK SFU, 2008. (State registration number at the Federal State Unitary Enterprise Scientific and Information Center "Informregister" 0320802394 dated November 21, 2008).

11. Volova, T. G. Introduction to biotechnology: textbook. allowance / T. G. Volova. - Krasnoyarsk: IPK SFU, 2008 .-- 188 p.

12. Ganiev, M. M. Chemical plant protection products / M. M. Ganiev, V. D. Nedorezkov. - M.: Kolos, 2006 .-- 248 p.

13. Glick, B. Molecular Biotechnology: Principles and Application = Molecular Biotechnology. Principles and Applications of Recombinant DNA: translation from English / B. Glick, D. Pasternak; under the editorship of N.K. Yankovsky. - M.: Mir, 2002 .-- 589 p.

14. Degrees, A. V. Soil biomonitoring / A. V. Gradusov, F. K. Alimova, N. G. Zakharova. - Kazan: KSU, 2009 .-- 47 p.

15. Sazykin Yu.O., Orekhov S.N., Chakaleva I.I. Biotechnology. M., 2006.

16. Egorova T.A., Klunova S.M., Zhivukhina E.A. The basics of biotechnology. M. 2006.

17. Volova T.G. Biotechnology. Novosibirsk, 1999.

18. Zayadan B.K. Phototrophic microorganisms in environmental monitoring and bioremediation of polluted water ecosystems Monograph. – Almaty, P. 380.

19. Almaganbetov K.Kh. Biotechnology, 2007

20. Emtsev V.T., E.N. Mishustin., Microbiology, Bustard, Moscow. 2005

21. John E. Smith Biotechnology, Cambridge, 2009

22. Zayadan BK, Ecologists қ biotechnology. Оқu алыpaly. Almaty, “Kazakh University”, 2014 316 b

23. Gaysina L.A., Fazlutdinova A.I., Kabirov P.P. Modern methods of isolation and cultivation of algae. Tutorial. Ufa Publishing House of BSPU. 2008.15

24. Gennis R. Biomembranes: Molecular structure and functions / Per. from English M.: Mir, 1997 .-- 624 p.

25. Biological membranes: Methods / trans. from English, ed. Findlay J.B., Evanza W.G. - M .: Mir, 1990 .-- S. 196-250.

26. Nolting B. The latest research methods of biosystems. M. Technosphere, 2005.254 s.

27. Osterman L. A. Methods for the study of proteins and nucleic acids. - M.: MCCNMO, 2002 .-- 248 p.

28. Bulychev A.A., Vekhoturov V.N., Gulyaev B.A. et al. Modern methods of biophysical research. M. High school. 1988.335 s.

29. Prudnikova, S.V. Ecological role of polyhydroxyalkanoates: patterns of biodegradation in the environment and interactions with microorganisms: monograph / S.V. Prudnikova, T. G. Volova / - Krasnoyarsk: Krasnoyarsk writer, - 2012.

30. Ryabov, I. N. Radioecology of fish in water bodies in the zone of influence of the accident at the Chernobyl nuclear power plant. / Ryabov I.N. - M.: Tov-in scientific publications of KMK, 2004, - 215 p.

31. Modern problems and methods of biotechnology: textbook.-method. complex discipline / comp. T. G. Volova. - Krasnoyarsk: IPK SFU, 2009. - (Modern problems and methods of biotechnology: UMKD No. 1323-2008 / head of the creative team of T. G. Volov).

32. Shtilman, M. I. Polymers of biomedical use / M. I. Shtilman // M .: IKC "Akademkniga", 2006 - 399 p.

33. Evans, G.G. and Furlong J. Environmental Biotechnology: Theory and Application / Evans, G.G. and Furlong J. John Wiley & Sons. - 2011. - 290 p.

Additional literature:

1. Naumova, R. P. Ecological biotechnology / R. P. Naumova, S. K. Zaripova. - Kazan: Unipress, 2002 .-- 253 p.

2. Nikolaev M. I., Kiselev G. Yu., Bubenchikov A. A. The possibility of using biofuels in Russia and the Omsk region // Modern Science and Practice, No. 4. - 2015 .-- 71-76.
3. Gelfand E. D. New developments in the production of liquid biofuels. - 2012.
4. Markov S.A. Biohydrogen: the possible use of algae and bacteria to produce molecular hydrogen // Alternat. energy and ecol. - 2007. - 45, No. 1. - S. 30-35.
5. Evtushenkov A. N. Introduction to biotechnology: course of lectures / A. N. Evtushenkov, Yu. K. Fomichev. - Mn .: BSU, 2004., 1998.
6. A. Osterman. Research methods for proteins and nucleic acids. Electrophoresis and ultracentrifugation. M., Science, 1981.
7. Bezborodov A.M. Enzymatic processes in biotechnology
2008.M. 335 s.
8. Bergquist P., Hardy K., Odega B. et al. Plasmids Methods M. World. 1989.267 s.
9. Evans U., Sea DD, Brightman E. Biological membranes. Methods M. World. 1990.442 s.
10. Kalashnikova E.A., Kochieva E.Z., Mironova O.Yu. Workshop on agricultural "biotechnology. - M.: Colossus, 2006 .-- 144 p.
11. Singer M., Berg P. Genes and genomes: In 2 vols. M.: Mir, 1998.
12. G. Stent, R. Kalindar. Molecular genetics. M. Mir, 1981.
13. J. Watson. Molecular biology of the gene. M., World, 1979.
14. Genetic engineering (under the editorship of Academician A.A. Baev). Molecular Biology, T. 123, 4.1, M., VINITI, 1977.
15. M. Ptashne. Switching genes. Regulation of gene activity and phage □. M., World, 1988.
16. G. Meinell. Bacterial plasmids. M., World, 1976.
17. L.A. Osterman. Research methods for proteins and nucleic acids. Electrophoresis and ultracentrifugation. M., Science, 1981.
18. Alimova, F.K. Industrial use of mushrooms of the genus Trichoderma / F.K. Alimova. - Kazan: UNIPRESS DAS, 2006 .-- 268 p.
19. Biological plant protection products. Technologies for their manufacture and application. / Ed. V.A. Pavlyushina, K.E. Voronin. - SPb .: VIZR, 2005 .-- 360 s.
20. Biotechnology. Principles and applications. Biotechnology Principles and Applications: Translated from English / Ed. : I.D. Higgins, D. Best, D. Jones. - M.: Mir, 1988 .-- 477 p.

Criteria for assessing knowledge in the educational program "8D051 - Environmental Biotechnology", PhD doctoral studies

Rating by letter system	Digital equivalent of points	percentage content	Evaluation using the traditional system
A	4,0	95-100	Excellent
A-	3,67	90-94	
B+	3,33	85-89	Well
B	3,0	80-84	
B-	2,67	75-79	
C+	2,33	70-74	
C	2,0	65-69	satisfactorily
C-	1,67	60-64	
D+	1,33	55-59	
D-	1,0	50-54	
F	0	0-49	unsatisfactory

"A" excellent - deep knowledge of theoretical and practical knowledge in the areas of biotechnology of the fouling environment; knowledge of modern methods used in the field of biotechnology of the fouling medium; understanding of the essence and relationship of the biotechnological processes under consideration; solid knowledge of the main provisions of related disciplines of biotechnology; correct, logically consistent, complete and specific answers to all questions of the examination ticket and additional questions of members of the examination commission.
“B”, “C +” well - a fairly complete knowledge of theoretical and practical knowledge in the areas of biotechnology of the fouling medium; full knowledge of modern methods used in the field of biotechnology of the fouling medium; understanding of the essence and relationship of the biotechnological processes under consideration; correct, consistent, specific answers to the questions posed with the free elimination of comments on individual, particular aspects of the answers.
“C” “D” is satisfactory - incomplete knowledge of theoretical and practical knowledge in the areas of biotechnology of the fouling environment and understanding of the main issues of the program; non-specific, without gross errors answers to the questions posed when eliminating inaccuracies and errors in leading questions of examiners.
“F” unsatisfactory — incorrect answer to at least one of the main questions: gross errors in the answer, lack of understanding of the essence of the stated problems; uncertain and inaccurate answers to additional questions.