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-NANOTECHNOLOGY IN THE FOOD INDUSTRY»

ALMATY

The program is compiled in accordance with the State educational standard for the specialty "8D051- Nanotechnology in the food industry». The program was composed by: doctor of biological sciences, professor Ivashchenko A.T., doctor of chemical sciences, professor, Shoinbekova S.A., candidate of biological sciences, professor Niyazova R.Ye.

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

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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- Nanotechnology in the food industry

The purpose of the entrance exam for applicants for doctoral studies in the specialty "Nanotechnology in the food industry" is to identify the amount of knowledge that they acquired while studying in the master school. And also to assess the conformity of the universal competencies of the applicant to doctoral studies, necessary for the successful development of special competencies formed in the process of training according to the doctoral educational program. The objective of the exam is to assess the ability and willingness of future doctoral students to search, select, synthesize and specify information; to evaluate the awareness of the subject of study in the doctoral educational program; assess the willingness of the applicant to use modern information resources in the learning process, assess 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 in writing.

2. Requirements for the level of training of people entering PhD doctoral programs in specialty 8D051- Nanotechnology in the food industry

The previous minimum level of education of whom 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 industry conditions.

3. Prerequisites of the educational program

“Modern methods in biotechnology”, “Postgenomic technologies”, “Proteomics”, “Protein engineering”.

4. The list of exam topics

1. **Objects of biotechnology**. Industrial valuable microorganisms - bacteria, actinomycetes, yeast, mold fungi, microalgae.
2. **The structure of cells**. Prokaryotes, eukaryotes. The structure and functions of organelles.
3. **Storage of industrial strains of microorganisms**. Methods of long-term preservation and protection against damage by phages of industrial strains of microorganisms.
4. **The cultivation of microorganisms**. The patterns of their growth and cultivation. Optimization of microorganism cultivation processes.
5. **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.
6. **Control of biotechnological and microbiological production**. Microbial pollutants of biotechnological industries and the fight against them. Production and sanitary-microbiological control of production.
7. **The functioning of microbial synthesis enterprises**. Biosafety problems of products of modern biotechnological production.

8. **Pathogens and foodborne diseases**. Food poisoning and infections. Food disease prevention
9. **Microbiological basis of fermentation**. Alcohol production. Microorganisms used in the production of ethyl alcohol, acetone, butanol.
10. **Microbiological basis of food production**. Getting dairy products. Types of products of the dairy industry. Characterization of microorganisms used in milk processing industries.
11. **Microbiological processing of meat.** Microflora of smoked and dried sausages. Technology for producing fermented sausages.
12. **The production of bread**. Bakery production. Microflora of wheat and rye dough. Stimulation of the vital activity of microorganisms in the test.
13. **Production of protein preparations.** Obtaining proteins from yeast. Obtaining proteins from phototrophic microorganisms.
14. **Obtaining biological active additives (BAA**). Nutraceuticals, parapharmaceuticals, prebiotics, their functional role. Classification of dietary supplements.
15. **The production of enzymes**. Microorganisms - producers of enzyme preparations and their production.
16. **Production of organic acids.** Microorganisms are producers of lactic, acetic, citric, malic, itaconic and other organic acids. Directions for increasing production efficiency.
17. **The production of amino acids**. Microorganisms are producers of amino acids. The benefits of microbial synthesis. Optimization of cultivation conditions.
18. **Obtaining drugs**. Medicinal, prophylactic and diagnostic preparations. Antibiotics and their producers. Antibiotic resistance and ways to overcome it.
19. **Getting vitamins**. Vitamin preparations. Microorganisms producing vitamins. Biosynthesis of vitamins and their industrial production.
20. **Obtaining probiotics**. Properties and selection criteria for strains of probiotic microorganisms. Classification of probiotic preparations. Biotechnology of obtaining probiotics.
21. **Bioenergy**. Biomethanogenesis. Getting alcohol. Hydrogen production.
22. **Engineering enzymology**. Immobilized enzymes. Types of immobilization. The use of immobilized enzymes in biotechnology.
23. **The basic concepts of nanoworld**. Basic terms and concepts. Nanoscale. The main classes of nanoscale systems. The place of nanoscale objects in the world around us. Definition of concepts: nanotechnology, nanomaterials, nanosystem devices, nanostructure.
24. **Nanoobjects.** Criteria for the determination of nanomaterials: critical size and functional properties. Quantum nanostructures of various dimensions: 0D-, 1D-, and 2D-structures. Quantum dots. The main types of nanoscale systems. Carbon nanostructures (fullerenes and nanotubes). Non-carbon nanostructures. Bionanoobjects. Prospects for nanotechnology.
25. **Introduction to nanotechnology**. Primary nanomaterials (carbon nanotubes, fullerenes, graphene) at the present stage of nanotechnology.
26. **The formation of nanostructures**. The history of the development of methods for the synthesis of nanomaterials; two main technological approaches: dispersive (“top-down”), condensation (“bottom-up”). Methods for producing nanostructured materials. The concept of embryo formation. The mechanisms of homogeneous and heterogeneous embryo formation. The formation of clusters and nanoparticles. The formation of complex nanostructures.
27. **The concept of self-organization**. Self-organization of nanoscale ordered structures. Self-organization of biological systems.
28. **The joint use of chromosomal engineering and biotechnology**. The use of cell and tissue culture. Callusogenesis, morphogenesis.

29. **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.
30. **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.
31. **Methods for creating recombinant DNA molecules**. Nucleic acid metabolism enzymes used in genetic engineering. Characterization of restriction enzymes, their classification. 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.
32. **Methods for cloning recombinant DNA molecules**. General characteristics of bacterial plasmids as autonomously replicating minichromosomes. Episomes, non-transmissible plasmids. The number of copies of the plasmid in the cell. Other vector - host systems: bacteriophage λ, cosmids, bacteriophage M13. Cloning fragments in a specific orientation. Probes for detecting cloned genes. Identification of specific cDNA clones using nucleic acid hybridization.
33. **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.
34. **Methods of identification of bioinformation polymers**. 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.
35. **Plant viruses as vectors for genetic engineering**. Classification of plant viruses by the type of their genetic material. Groups of heminiviruses and caulimoviruses as the most suitable for the role of genetic vectors. Characterization of cauliflower mosaic virus (CaMV) as a typical representative of the caulimovirus group. Areas of the CaMV genome most suitable for introducing foreign DNA. Methods of plant transformation with vectors based on CaMV virus. The main advantages and disadvantages of CaMV-based vectors.
36. **Recombinant DNA and hereditary diseases**. Mendelian inheritance of hereditary diseases. Congenital metabolic defects. Identification of hereditary diseases using DNA analysis. β-Thalassemia: nonsense mutations and frame-shift mutations; mutations that disrupt transcription; mutations that disrupt RNA processing. Sickle cell anemia. Prospects for gene therapy.
37. **Mobile genes and their use in genetic engineering.** Mobile IS-elements and transposons of bacteria. Mobile Ty1-transposons of yeast. Isolation and characterization of mobile Ds- and Ac- elements of maize. Mobile P- and copia- elements of Drosophila. The movement of the transposon consists in the formation of a new transposon. The possible origin of the genomes of RNA-containing oncogenic viruses from mobile genetic elements and the existence of two functionally different classes of transposons. Use of movable elements for genetic engineering on Drosophila embryos.
38. **Methods for the selection of cloned recombinant DNA**. Selection of bacterial clones that have received recombinant plasmids using genes that determine antibiotic resistance (insert inactivation). Reporter genes used as markers for the selection of transformed bacterial clones.

39. **Methods of transformation of plant protoplasts, cells and tissues. Tumor inducing plasmids induced by certain soil bacteria**. Genetic engineering of plants. Crowned galls are plant tumors. Plasmids inducing tumors (Ti plasmids). Mutants of Ti plasmids. Integration of T-DNA with the plant chromosome. Ti plasmid DNA as a vector. Transformation of plant cells and protoplasts. Mobilization of T-DNA using the vir segment of the Ti plasmid. The attuned vectors based on T-DNA make it possible to regenerate a whole plant from one cell. T-DNA embedding can be used to isolate plant genes. The practical application of genetic engineering of plants using Ti plasmids.
40. **Advantages of the eukaryotic cloning system for genetic research and for studying the regulation of the expression of eukaryotic genes on the example of yeast cells**. Spheroplasts of yeast. Yeast gene expression in E. coli bacteria. Shuttle vectors. Yeast plasmids. Improving the efficiency of transformation with the help of additional points of origin of replication (elements of autonomous replication, EDA). Stabilization of yeast plasmids by the introduction of centromere (CEN) yeast DNA. Studs at the ends of yeast chromosomes - telomeres. Directed incorporation of cloned DNA into yeast chromosomes. Organization and regulation of gene expression in yeast.
41. **Methods of studying membrane structures in biotechnology**. Separation of subcellular components. Identification of cellular components and criteria for their purification.
42. **Methods used to isolate and study lipids of membrane structures**. Separation and analysis of lipid components of membranes. Identification of lipid components of membranes.
43. **Solubilization and reconstruction of membrane structures**. Criteria for the selection of detergents, their characteristics. Methods of isolation and modification of membrane proteins and peptides.
44. **Methods of isolation and identification of fatty acids**. Types of chromatography used to quantify fatty acids. Their advantages and disadvantages.
45. **Physical and biophysical methods used to study membrane systems**. Spectral methods for studying the stationary properties of biological systems. Method of electron and paramagnetic resonance, nuclear magnetic resonance.
46. **Methods of studying the ionic permeability of biological membranes**. Calorimetric methods for the study of proteins. Spectral methods for the study of proteins.
47. **Proteomic methods for the study of proteins**. Methods for the isolation and purification of proteins. Centrifugation, salt fractionation, gel filtration, dialysis.
48. **Types of membrane filtration for protein isolation**. Ultrafiltration methods, reverse phase chromatography, distribution chromatography, gel chromatography.
49. **Methods of separation and identification of proteins**. Gel electrophoresis. Isoelectric focusing.
50. **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.
51. **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.
52. **Methods of RNA isolation from biological objects**. The main methodological techniques. RNA analysis.
53. **Methods of hybridization of nucleic acids**. Hybridization conditions, probe selection. Blot hybridization method.
54. **Modern methods of nucleic acid sequencing**. Stages and types of nucleic acid sequencing methods. The principles of radio autography.
55. **The principle of polymerase chain reactions (PCR**). Method principle, steps, reaction components. Necessary equipment for PCR.
56. **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.

57. **Methods of genetic engineering**. The concept of recombinant structure. The mechanism of creating recombinant DNA.
58. **The practical application of genetic engineering**. Obtaining transgenic plants and animals.
59. **Industrial protein synthesis with the participation of recombinant microorganisms**. Recombinant vaccines. Stages of creating recombinant RNA.
60. **Synthetic genes and their cloning**. The construction of synthetic genes. Methods used to create and transfer them to the biological system.
61. **Practical and commercial use of recombinant DNA**. Expression of transferred genes. Transcription of eukaryotic genes in cell-free extracts, microorganisms to obtain commercial products.
62. **Methods of molecular diagnosis of genetic diseases**. Direct and indirect DNA diagnostic methods. From the tasks and disadvantages.
63. **Immunological methods in biotechnology**. Selection of experimental animals to obtain serum. Methods of immunodiagnostics.
64. **Immunofluorescence and immunohistochemical analysis**. Their characteristics and scope.
65. **Nutrigenomics.** The effect of food on gene expression. Individual genetic differences in the susceptibility of food ingredients and their metabolic pathways. The prospect of nutrigenomics in the development of individualized dietary recommendations.
66. **Nano-functional food**. Nanotechnology in food production. Types of nanomaterials and nanostructures, their use in food engineering. Nanocapsulation. Nanocomposite packaging materials. Functionalized nanostructured materials. Potential benefits of nanotechnology in food safety. Regulation of nanotechnology in the food industry.
67. **New trends in the production of functional foods**. Classification and benefits of functional foods. New approaches in enhancing the functionality of fermented products. Probiotics and prebiotics as functional food ingredients. Stabilization of probiotics for industrial use. Symbiotic food. Innovations and modern research problems in the fortification of products with minerals, Omega-3 polyunsaturated fatty acids, vitamins and antioxidants. Biofortification and metabolic engineering.
68. **Innovative technologies for processing bioactive components for functional foods**. New technologies in the processing of functional and nutraceutical extruded products.
69. **Innovations in the technology of extraction of flavonoids and antioxidants**. Technology for microencapsulation of bioactive functional ingredients in food.
70. **Nano-packaging of food products**. Requirements for innovative food packaging. Edible films and coatings.

5. List of recommended references

Main literature:

1. Sazykin Yu.O., Orekhov S.N., Chakaleva I.I. Biotechnology. M., 2006. (In Russian)
2. Egorova T.A., Klunova S.M., Zhivukhina E.A. The basics of biotechnology. M. 2006. (In Russian)
3. Volova T.G. Biotechnology. Novosibirsk, 1999. (In Russian)
4. Almaganbetov K.Kh. Biotechnology, 2007 (In Russian)
5. Emtsev VT, E.N. Mishustin., Microbiology, Bustard, Moscow. 2005 (In Russian)
6. John E. Smith Biotechnology, Cambridge, 2009
7. Bondarenko V.M., Matsulevich T.V. Intestinal dysbiosis as a clinical laboratory syndrome: current state of the problem. - M., Geotar-Media. - 2007. (In Russian)

8. Gennis R. Biomembranes: Molecular structure and functions / Springer-Verlag New York, 2020.
9. Biological membranes: Methods / ed. Findlay J.B., Evanza W.G. - Oxford University Press, 1987.
10. Nolting B. The latest research methods of biosystems. M. Technosphere, 2005.254 p. (In Russian)
11. Osterman L. A. Methods for the study of proteins and nucleic acids. - Springer-Verlag Berlin Heidelberg, 1984
12. Bulychev A.A., Verkhoturov V.N., Gulyaev B.A. et al. Modern methods of biophysical research. M. High school. 1988. 335 p. (In Russian)
13. Kartseva A.A. Liquid Chromatography in Medicine - Soros Educational Journal. -T. 6. - No. 11. - 2000. (In Russian)
14. Otto M. Methods of analytical chemistry (in 2 volumes). - M .: Technosphere, 2004. (In Russian)
15. Singer M., Berg P. Genes and genomes. University Science Books, 1991.
16. Shchelkunov S.N. Genetic Engineering. Part 1. Novosibirsk .: NSU. 1994 .-- 304 p. (In Russian)
17. Glick B., Pasternak J. Molecular biotechnology. M .: Mir, 2002 .-- 589 p. (In Russian)
18. Royt A., Brostoff J., Mail D. Immunology. - Mosby Ltd.; 6th edition, 2001
19. Shulembaeva K.K. Chromosomal Engineering, 2005 (In Russian)
20. Pukhalsky V.A., Soloviev A.A., Badaeva E.D. Workshop on cytology and cytogenetics of plants. - M.: KolosS, 2007 .-- P.62-67. (In Russian)
21. Zhimulev I.F. General and molecular genetics. Novosibirsk, 2003, p. (In Russian)
22. Shulembaeva K.K. Aneuploidy in breeding and genetic studies of wheat. Monograph. Almaty, 2005 .-- S. 35-70. (In Russian)
23. Smirnov V.G. Cytogenetics. M., 1991. (In Russian)
24. Lelli J. Wheat breeding. Theory and practice. Budapest (Hungary) Akademiai Kiado, 2015.
25. Bostok K., Sumner E. Chromosome of a eukaryotic cell. North-Holland Publ., 1978
26. S.N. Shchelkunov “Genetic Engineering”, IMS, Novosibirsk - 2004. (In Russian)
27. B. Glick, J. Pasternak “Molecular Biotechnology. Principles and application ”, Washington DC: Amer.Soc.of Microbiology, 2003
28. James D. Watson, Watson, Watson James D., Richard M. Myers, Amy A. Caudy, University Richard M Myers, Jan A. Witkowski. Recombinant DNA: Genes and Genomes: A Short Course. W. H. Freeman, 2007.
29. T. Maniatis, E. Fritsch, J. Sambrook. Methods of genetic engineering. Molecular Cloning M., World, 1984.
30. New in DNA cloning. Methods M., Mir, 1989 (edited by D. Glover). (In Russian)
31. B. Lewin. Genes. Jones & Bartlett Publishers.
32. Mobility of the plant genome. M., VO "Agropromizdat", 1990 (under the editorship of B. Hon and E. S. Dennis). (In Russian)
33. E. S. Piruzyan. Fundamentals of plant genetic engineering. M., Science, 1988. (In Russian)
34. Owens F., Pool Jr. C. Nanotechnology. Publisher: Technosphere. 2010.336 p. (In Russian)
35. Nanotechnology, metrology, standardization and certification. Ed. M.V. Kovalchuk, P.A. Todua Ed .: Technosphere. 2009.136 p. (In Russian)
36. M.M. Alfimova. Entertaining nanotechnology. Publishing Bean. Knowledge laboratory. Moscow. 2011. (In Russian)
37. E. Roduner. Size effects in nanomaterials. Publisher: Technosphere. 2010.352 p. (In Russian)
38. Volkov G.M. Volume nanomaterials Publisher: KnoRus Textbook. 2011 168 p. (In Russian)
39. V. E. Borisenko, S. Ossicini, What is What in the Nano-world (Wiley-VCH, Weinheim, 2004) (In Russian)
40. Nanotechnology - The ABC for everyone, Abramchuk N.S., Avdoshenko S.M., Baranov A.N. et al. Publisher: FIZMATLIT, Year: 2008, Pages: 368 (In Russian)

41. Springer's Handbook of Nanotechnology Ed. Bhushana B. Publishing: Technosphere, Type of publication: Reference Year: 2010 Pages: 832
42. Fundamentals of Nanotechnology and Nanomaterials, Vityaz PA, Svidunovich NA, Publisher: Vysheyshaya shkola Edition Type: Textbook Year: 2010 Pages: 302 (In Russian)

Additional literature:

1. Buryan N.I., Tyurin L.V. Microbiology of winemaking. M., 2007. (In Russian)
2. Glavachek F., Lhotsky A. Brewing / Trans. from Czech M., 2001. (In Russian)
3. Evtushenkov A. N. Introduction to biotechnology: course of lectures / A. N. Evtushenkov, Yu. K. Fomichev. - Mn .: BSU, 2004., 1998. (In Russian)
4. A. Osterman. Research methods for proteins and nucleic acids. Electrophoresis and ultracentrifugation. M., Science, 1981. (In Russian)
5. Bezborodov A.M. Enzymatic processes in biotechnology 2008.M. 335 p. (In Russian)
6. Bergquist P., Hardy K., Odega B. et al. Plasmids Methods M. World. 1989.267 p. (In Russian)
7. Evans U., Sea DD, Brightman E. Biological membranes. Methods M. World. 1990.442 p. (In Russian)
8. Tikhonov. A.N. Electronic paramagnetic resonance in biology / Sorov educational journal. - 1997.-No 1. S. 8-15. (In Russian)
9. Kalashnikova E.A., Kochieva E.Z., Mironova O.Yu. Workshop on agricultural "biotechnology. - M.: Colossus, 2006 .-- 144 p. (In Russian)
10. Singer M., Berg P. Genes and genomes: In 2 vols. M.: Mir, 1998. (In Russian)
11. Esyreva E.D., Shulembaeva K.K. and others. Guideline "Big workshop on cytogenetics." Almaty "Kazakh University". 2002 (In Russian)
12. Koval S.F., Koval V.S., Shamanin V.P. Isogenic Wheat Lines: Monograph. Omsk, 2001 .-- C. 152. (In Russian)
13. G. Stent, R. Kalindar. Molecular genetics. W.H. Freeman znd Company, San Francisco, 1978.
14. J. Watson. Molecular biology of the gene. W. A. Benjamin, 1965.
15. Genetic engineering (under the editorship of Academician A.A. Baev). Molecular Biology, T. 123, 4.1, M., VINITI, 1977. (In Russian)
16. M. Ptashne. Switching genes. Regulation of gene activity and phage □. Cold Spring harbor, New York, 2004
17. G. Meinell. Bacterial plasmids. Macmillan, 1972.
18. L.A. Osterman. Research methods for proteins and nucleic acids. Electrophoresis and ultracentrifugation. M., Science, 1981. (In Russian)
19. Sergeev G.B. Nanochemistry. M.: Publishing House of Moscow State University. 2003.288 p. (In Russian)
20. Pool C., Owens F. Nanotechnology. M .: Technosphere. 2005.336 p. (In Russian)
21. Gusev A.I. Nanometrics, nanostructures, nanotechnology. M: FIZMTLIT. 2005.416 p. (In Russian)
22. Suzdalev I.P. Physical chemistry of nanoclusters, nanostructures and nanomaterials. M .: KomKniga. 2006.592 p. (In Russian)
23. Bokshtein B.S., Yaroslavtsev A.B. Diffusion of atoms and ions in solids. M .: MISIS. 2005.362 p. (In Russian)
24. Smirnov V.M. Chemistry of nanostructures. Synthesis, structure, properties: Textbook. St. Petersburg: Publishing House of St. Petersburg University. 1996.108 p. (In Russian)
25. Rusanov A.I. Thermodynamic foundations of mechanochemistry. - SPb .: Nauka, 2006.– 221 p. 14 (In Russian)

Criteria for assessing knowledge in the educational program

"8D051- Nanotechnology in the food industry", 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.