AL- FARABI KAZAKH NATIONAL UNIVERSITY

Approved
at the meeting of the academic
committee (SMC)
al-Farabi KazNU
Vice Rector for Academic Affairs
_____ A.K. Hikmetov
protocol №. 6 from June 22, 2020

PROGRAM
OF ENTRANCE EXAM FOR DOCTORS PhD IN EDUCATIONAL PROGRAM
"8D05105" – BIOTECHNOLOGY

Almaty, 2020

The program is compiled in accordance with the educational program "8D05105" - Biotechnology. The program was composed of: Doctor of Biological Sciences, Professor Mukasheva T.D., Doctor of Biological Sciences, Professor Zayadan B.K., Doctor of Biological Sciences, Professor Kenzhebayeva S, Doctor of Biological Sciences, Professor Aytasheva Z.G., Doctor of Biological Sciences Bisenbayev A.K.

The program was considered at a meeting of the Department of Biotechnology
Protocol No. ___36____ of ___19 may_____ 2020

Head of Department _____ Kistaubayeva A.S.

The program was considered at a meeting of the Department of Molecular Biology and Genetics
Protocol No. __38___ of ___19 May_____ 2020

Head of Department _____ Zhunusbayeva Zh.K.

Approved at a meeting of the faculty bureau
Minutes No. __10____ dated ____22 May____ 2020
Chairman of the method bureau _____ Yurikova O.Yu.

Approved at the meeting of the Scientific Council
Protocol No. __10____ of _____29 May_____ 2020

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

Scientific Secretary _____ M. Bauenova

CONTENT

1. Goals and objectives of the entrance exam in the educational program (EP) "8D05105" –Biotechnology

The aim of the entrance examination for doctoral studies in the EP "8D05105" -Biotechnology is to assess the level of knowledge acquired by an applicant during training in a master's degree, necessary for the successful development of special competencies formed in the process of training for a doctoral educational program.

The objective of the exam is to:

- determine the compliance of the level of masters training with the basic requirements for training in doctoral studies;
- assess the level of training of applicants for the disciplines in accordance with the approved program for the specialty;
- evaluate the knowledge of the applicant in the field of modern scientific achievements and problems of biotechnological science and production;
- assess the level of competencies required for training in doctoral studies.

Examination form - entrance examination for doctoral studies in the EP “8D05105” - Biotechnology is carried out in writing, at the request of the applicant in one of three languages (Kazakh, Russian, English) as part of the implementation of the concept of trilingual education.

2. **Requirements for the level of training of people entering PhD doctoral studies in the specialty Biotechnology**

Entrance examinations are allowed for masters who have completed the educational process in accordance with the requirements of a working and individual curriculum and work training programs. The main criterion for the completeness of the educational process is the development of the necessary volume of a theoretical training course, pedagogical and research practices of masters in accordance with the requirements of the State general educational standard for higher / postgraduate education No. 1080 of 08.23.2018.

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.

Applicants to the entrance exam must provide an integrative answer, demonstrating the knowledge gained in studying of various academic disciplines in the master program, and also show the ability to analyze and evaluate new information.

3. Prerequisites of the educational program

“Modern methods in biotechnology”, “Genetics and genomics of microorganisms”, “Chromosomal and genetic engineering”

4. The list of exam topics

1**. Objects of biotechnology**. Industrial valuable microorganisms - bacteria, actinomycetes, yeast, mold fungi, microalgae.

2. **Storage of industrial strains of microorganisms**. Methods of long-term preservation and protection against damage by phages of industrial strains of microorganisms.

3. **The cultivation of microorganisms**. The patterns of their growth and cultivation. Optimization of microorganism cultivation processes.

4. **Features of the microorganisms metabolism** . Features of energy metabolism in prokaryotes. Ways to solve energy problems by chemo-organotrophs and chemolithotrophs. Features of bacterial photosynthesis.

5. **Control of biotechnological and microbiological production**. Microbial pollutants of biotechnological industries and the fight against them. Production and sanitary-microbiological control of production.

6. **The functioning of microbial synthesis enterprises**. Biosafety problems of products of modern biotechnological production.

7. **Pathogens and foodborne diseases**. Food poisoning and infections. Food Disease Prevention.

8. **Microbiological basis of fermentation**. Alcohol production. Microorganisms used in the production of ethyl alcohol, acetone, butanol.

9. **Getting a beer.** Brewing. Microbiological processes occurring in the wandering wort.

10. **Microbial processing of plant materials**. Winemaking. Microbiological processes in winemaking.

11. **Microbiological basis of food production**. Getting dairy products. Types of products of the dairy industry. Characterization of microorganisms used in milk processing industries.

12. **Microbiological processing of meat**. Microflora of smoked and dried sausages. Technology for producing fermented sausages.

13. **The production of bread**. Bakery production. Microflora of wheat and rye dough. Stimulation of the vital activity of microorganisms in the test.

14. **Production of protein preparations**. Obtaining proteins from yeast. Obtaining proteins from phototrophic microorganisms.

15. **Obtaining biological active additives (BAA**). Nutraceuticals, parapharmaceuticals, prebiotic, their functional role. Classification of dietary supplements.

16. **The production of enzymes**. Microorganisms - producers of enzyme preparations and their production.

17. **Production of organic acids.** Microorganisms are producers of lactic, acetic, citric, malic, itaconic and other organic acids. Directions for increasing production efficiency.

18. **The production of amino acids**. Microorganisms are producers of amino acids. The benefits of microbial synthesis. Optimization of cultivation conditions.

19. **Obtaining drugs**. Medicinal, prophylactic and diagnostic preparations. Antibiotics and their producers. Antibiotic resistance and ways to overcome it.

20. **Getting vitamins**. Vitamins preparations. Microorganisms producing vitamins. Biosynthesis of vitamins and their industrial production.

21. **Obtaining probiotics**. Properties and selection criteria for strains of probiotic microorganisms. Classification of probiotic preparations. Biotechnology of obtaining probiotics.

22. **Bioenergy**. Biomethanogenesis. Getting alcohol. Hydrogen production.

23. **Engineering enzymology**. Immobilized enzymes. The use of immobilized enzymes in biotechnology.

24. **Improvement and acceleration of the selection process by the methods of chromosome engineering and biotechnology.** The use of cell and tissue culture. Haploid technology based on androgenesis. Combination of chromosome engineering methods and anther culture in plant breeding.

25. **Genomic analysis of soft wheat**. Types of wheat and formulas of their genomes.

Genetic structure of soft wheat and related cereals. The initial numbering of chromosomes and their assignment to the corresponding genomes.

26. **Methods for creating a series of aneuploid lines of common wheat and genetic analysis of wheat traits using a series of nullisomics and monosomics**. Tasks, status and methods of work on creating a new monosomal series based on monosomal lines of Chines Spring variety. Comparative karyological analysis of monosomal, disomic, and euploid common wheat plants.

27. **Chemical and radiation mutagenesis as a method of increasing the diversity of the starting 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.

28. **The genetic system that regulates the course of meiosis in aneuploids**.

The conjugation mechanism between homologous and homeologous chromosomes of different genomes. Violation of meiosis due to conjugation of homeologous chromosomes.

29. **Monosomal analysis and localization of genes that control valuable traits of wheat in certain chromosome**s.Localization of genes in the F2 population. Statistical analysis to determine the so-called "critical" chromosomes.

30. **Features and advantage of anther culture and chromosome engineering when transferring chromosomes from common wheat varieties to other wheat varieties or species**.

The effectiveness of the use of chromosome engineering and anther culture in vitro to accelerate and reduce the cost of the selection process.

31. **Creation of isogenic lines and morphological marking of monosomal lines.**

Aneuploidy and the introduction of alien genetic variation. Search and selection of morphologically labeled wheat traits for their introduction into the recipient variety.

32. **The sharing of chromosomal engineering and biotechnology**.

The use of cell and tissue culture. Callussogenesis, morphogenesis. Haploid technology based on androgenesis.

33. **Intersortual chromosome substitution in common wheat**. The implementation of the backcross program for the simultaneous creation of three series of aneuploids: monotelosomics, ditelosomics and monosomics of common wheat.

34. **Methods and schemes for creating lines with intersortion chromosome substitution**.

Chromosome transfer methods and genotype construction. Switching of univalent chromosomes in monosomics and their consequences in aneuploid analysis.

35. **Cytogenetics of wheat mutants.**

Chemical and radiation mutagenesis as a method of increasing the diversity of the starting material for hybridization. Methods of cytogenetic analysis of wheat mutants.

36. **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.

37. **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.

38. **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.

39. **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.

40. **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.

41. **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.

42. **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.

43. **Mobile genes and their use in genetic engineering**

Mobile IS-elements and bacterial transposons. 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.

44. **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.

45. **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.

46. **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.

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

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

49. **Solubilization and reconstruction of membrane structures**. Criteria for the selection of detergents, their characteristics. Methods of isolation and modification of membrane proteins and peptides.

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

51. **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.

52. **Methods of studying the ionic permeability of biological membranes**. Calorimetric methods for the study of proteins. Spectral methods for the study of proteins.

53. **Proteomic methods for the study of proteins**. Methods for the isolation and purification of proteins. Centrifugation, salt fractionation, gel filtration, dialysis.

54. **Types of membrane filtration for protein isolation**. Ultrafiltration methods, reverse phase chromatography, distribution chromatography, gel chromatography.

55. **Methods of separation and identification of proteins**. Gel electrophoresis. Isoelectric focusing.

56. **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.

57. **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.

58. **Methods of RNA isolation from biological objects**. The main methodological techniques. RNA analysis.

59. **Methods of nucleic acid hybridization**. Hybridization conditions, probe selection. Blot hybridization method.

60. **Modern methods of nucleic acid sequencing**. Stages and types of nucleic acid sequencing methods. The principles of radio autography.

61. **The principle of polymerase chain reactions (PCR)**. Method principle, steps, reaction components. Necessary equipment for PCR.

62. **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.

63. **Methods of genetic engineering**. The concept of recombinant structure. The mechanism of creating recombinant DNA.

64. **The practical application of genetic engineering**. Obtaining transgenic plants and animals.

65. **Industrial protein synthesis with the participation of recombinant microorganisms**. Recombinant vaccines. Stages of creating recombinant RNA.

66. **Synthetic genes and their cloning**. The construction of synthetic genes. Methods used to create and transfer them to the biological system.

67. **Practical and commercial use of recombinant DNA.** Expression of transferred genes. Transcription of eukaryotic genes in cell-free extracts, microorganisms to obtain commercial products.

68. **Methods of molecular diagnosis of genetic diseases**. Direct and indirect DNA diagnostic methods. From the tasks and disadvantages.

69. **Immunological methods in biotechnology.** Selection of experimental animals to obtain serum. Methods of immunodiagnostics.

70. **Immunofluorescence and immunohistochemical analysis**. Their characteristics and scope.

5. List of recommended literature

Main literature:

1. Сазыкин Ю.О., Орехов С.Н., Чакалева И.И. Биотехнология. М., 2006.
2. Егорова Т.А., Клунова С.М., Живухина Е.А. Основы биотехнологии. М. 2006.
3. Волова Т.Г. Биотехнология. Новосибирск, 1999.
4. Алмаганбетов К.Х. Биотехнология , 2007
5. Емцев В.Т., Е.Н.. Мишустин., Микробиология, Дрофа, Москва.2005
6. John E.Smith Biotechnology, Cambridge, 2009
7. Бондаренко В.М., Мацулевич Т.В. Дисбактериоз кишечника как клинико-лабораторный синдром: современное состояние проблемы. - М., Гэотар-Медиа. - 2007.
8. Геннис Р. Биомембраны: Молекулярная структура и функции/пер. с англ. М.: Мир, 1997. - 624 с.
9. Биологические мембраны: Методы/ пер. с англ., под ред. Финдлея Дж.Б., Эванза У.Г. - М.: Мир, 1990. - С. 196-250.
10. Нолтинг Б. Новейшие методы исследования биосистем. М. Техносфера, 2005. 254 с.
11. Остерман Л. А. Методы исследования белков и нуклеиновых кислот. - М.: МЦНМО, 2002. - 248 с.
12. Булычев А.А., Вехотуров В.Н., Гуляев Б.А. и соавт. Современные методы биофизических исследований. М. Высшая школа. 1988. 359с.
13. Карцева А.А. Жидкостная хроматография в медицине - Соросовский образовательный журнал. -Т. 6. - №11. - 2000.
14. Отто М. Методы аналитической химии (в 2-х томах). - М.: Техносфера, 2004.
15. Сингер М., Берг П. Гены и геномы. М. : Мир. 1998. т.1. - 373 с. т.2. – 391 с.
16. Щелкунов С.Н. Генетическая инженерия. Ч.1. Новосибирск.: НГУ. 1994. – 304 с.
17. Глик Б., Пастернак Дж. Молекулярная биотехнология. М.: Мир, 2002. - 589 с.
18. Ройт А., Бростофф Дж., Мейл Д. Иммунология. - М.: Мир, 2000. -592 с.
19. Шулембаева К.К. Хромосомная инженерия, 2005 г.

20. Пухальский В.А., Соловьев А.А., Бадаева Е.Д. Практикум по цитологии и цитогенетике растений. - М.: КолосС, 2007. - С.62-67.
21. Жимулев И.Ф. Общая и молекулярная генетика. Новосибирск, 2003, стр.
22. Шулембаева К.К. Анеуплоидия в селекционно-генетических исследованиях пшеницы. Монография. Алматы, 2005. – С. 35-70.
23. Смирнов В.Г. Цитогенетика. М., 1991.
24. Лелли Я. Перевод с англ. Н.Б. Ронис. Селекция пшеницы. Теория и практика. Москва. «Колос», 1980. стр .44-133.
25. Босток К., Самнер Э. Хромосома эукариотической клетки. М., 1981.
26. С.Н. Щелкунов “Генетическая инженерия”, СУИ, Новосибирск – 2004.
27. Б. Глик, Дж. Пастернак “Молекулярная биотехнология. Принципы и применение”, М., “Мир”, 2002.
28. Дж. Уотсон, Дж. Туз, Д. Курц. Рекомбинантные ДНК. М., Мир, 1986.
29. Т. Маниатис, Э. Фрич, Дж. Сэмбрук. Методы генетической инженерии. Молекулярное клонирование. М., Мир, 1984.
30. Новое в клонировании ДНК. Методы. М., Мир, 1989 (под ред. Д. Гловера).
31. Б. Льюин. Гены. М., Мир, 1987.
32. Мобильность генома растений. М., ВО “Агропромиздат”, 1990 (под ред. Б. Хон и Е. С. Деннис).
33. Э. С. Пирузян. Основы генетической инженерии растений. М., Наука, 1988.

Additional literature:

1. Бурьян Н.И., Тюрин Л.В. Микробиология виноделия. М.,2007.
2. Главачек Ф., Лхотский А. Пивоварение /Пер. с чешск. М., 2001.
3. Евтушенков А. Н. Введение в биотехнологию: курс лекций/ А. Н. Евтушенков, Ю. К. Фомичев. – Мн.: БГУ, 2004., 1998.
4. А. Остерман. Методы исследования белков и нуклеиновых кислот. Электрофорез и ультрацентрифугирование. М., Наука, 1981.
5. Безбородов А.М. Ферментативные процессы в биотехнологии 2008. М. 335 с.
6. Бергквист П., Харди К., Оудега Б. и соавт. Плазмиды. Методы. М. Мир. 1989. 267с.
7. Эванс У., Море Д.Д., Брайтман Э. Биологические мембраны. Методы. М. Мир. 1990. 424с.
8. Тихонов. А.Н. Электронный парамагнитный резонанс в биологии/ Соровский образовательный журнал. – 1997.-№ 1. С. 8-15.
9. Калашникова Е.А., Кочиева Е.З., Миронова О.Ю. Практикум по сельскохозяйственно» биотехнологии. - М. :Колосс, 2006. - 144 с.
10. Сингер М., Берг П. Гены и геномы: В 2 т. М.: Мир, 1998.
11. Есырева Е.Д., Шулембаева К.К. и др. Методическое указание «Большой практикум по цитогенетике». Алматы «Ќазаќ университеті». 2002
12. Коваль С.Ф., Коваль В.С., Шаманин В.П. Изогенные линии пшеницы: Монография. Омск, 2001. – С. 152.
13. Г.Стент, Р.Кэлиндар. Молекулярная генетика. М. Мир, 1981.
14. Дж.Уотсон. Молекулярная биология гена. М., Мир, 1979.
15. Генная инженерия (под ред. Акад. А.А.Баева). Молекулярная биология, т. 123, 4.1, М., ВИНИТИ, 1977.

16. М. Пташне. Переключение генов. Регуляция генной активности и фаг λ. М., Мир, 1988.
17. Г. Мейнелл. Бактериальные плазмиды. М., Мир, 1976.
18. Л. А. Остерман. Методы исследования белков и нуклеиновых кислот. Электрофорез и ультрацентрифугирование. М., Наука, 1981.

Criterion for assessing knowledge of the EP "8D05105" –Biotechnology

Letter Grade	The digital equivalent of points	% content	Traditional system assessment
A	4,0	95-100	Excellent
A-	3,67	90-94	
B+	3,33	85-89	Good
B	3,0	80-84	
B-	2,67	75-79	
C+	2,33	70-74	
C	2,0	65-69	Satisfactory
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; knowledge of modern methods used in the field of biotechnology; understanding of the essence and relationship of the biotechnological processes under consideration; solid knowledge of the main provisions of related disciplines; 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 +" good - a fairly complete knowledge of theoretical and practical knowledge in the areas of biotechnology; full knowledge of modern methods used in the field of biotechnology; 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” - Satisfactory: The answers indicate a significant lack of understanding of the problems, various general scientific and specific scientific approaches and methods of study accepted in the biological branch of knowledge, as well as political and socio-economic phenomena. He has only the skills to use modern methods to simplify research and practical work, the inability to analyze problems caused by anthropogenic processes, ideas about time as a life factor and about the features of

the temporary organization of biological processes at different levels of organization from cellular to organismic, population.

Essentially correct answers are given to all theoretical questions, but either with inaccuracies in the logical sequence, without examples and with errors in the wording. The practical task was completed with errors or not in full.

“F” - Unsatisfactory: The answer is not given, or contains gross errors. The logical sequence is broken. The practical task is not done.

Failure to respond or answers indicate a complete lack of understanding of the problem. Understanding the nature of the general patterns of energy conversion in the form of heat and work between different biosystems.