**AL-FARABI KAZAKH NATIONAL UNIVERSITY**

**Faculty of Biology and Biotechnology**

**Department of Biotechnology**

**EDUCATIONAL AND METHODOLOGICAL COMPLEX OF DISCIPLINE**

102108 «MICROBIAL GENETICS AND ENGINEERING»

«**8D05111 – Microbiology**»

**Almaty 2024**

Educational and methodological complex of discipline was compiled by Dr. Azhar Malik, PhD.

Based on the educational program «8D05111 – Microbiology»

Considered and recommended at a meeting of the biotechnology department from

September 05, 2024, Protocol No. 1

Head of the Department Kistaubayeva A.S.

(signature)

**Examination program on "Microbial genetics and engineering".**

Contribution of the genetics of microorganisms to the development of the basic concepts of modern genetics. Classical and modern definition of gene. An understanding of the genome. Modern methods of genome research. Organization of genetic information of bacteria. Structural units and features. Organization of genetic apparatus and life cycles of microorganisms. Organization of genes in the chromosome. Structural and functional organization of genomes of microorganisms as objects of genetic research. Structural elements of genomes. Bacterial viruses, bacteriophages and their recombination mechanisms. Regulation of activity of genes of microorganisms. Operon model of regulation of prokaryotic gene activity. Processes of genetic exchange in bacterial cells. Control of gene expression in prokaryotes. Bacterial chromosome structure and replication. Genetic processes in eukaryotic microorganisms. Levels of structural and functional organization of genetic material in the cell nucleus and mechanisms of its formation. Structure of chromosomes of eukaryotes. Features of regulation of eukaryote gene activity. Extrachromosomal genetic systems in prokaryotes. Bacterial plasmids, their classification and phenotypic characteristics. Replication of plasmids. Integration of plasmids into chromosomes. Genetic analysis in bacteria using plasmids. Methods of genetic analysis. Comparison of structural features of genes of prokaryotes and eukaryotes. Types of variability of microorganisms. Mutations in fungi, algae and bacteria. Mutation of bacteriophages. Reverse mutations. Understanding mutational systems and mutational analysis. Variability of bacteria in a population.

Mobile elements of microorganisms. Sequences and transposons of insertional bacteria. Mechanisms of transposition. Genetic effects resulting from penetration into the genome of migrants. Mobile elements and natural selection. The role of transposons in the evolution of bacteria. Genetic engineering. Biotechnology. Cloning of genes in bacterial cells. Genetic engineering in various fields. Use of microorganisms in genetic engineering. Gene, genetic and cell engineering. Methods for the design of hybrid molecules DNA in vitro. Development of recombinant DNA methods and culture of isolated tissues and cells. Construction of recombinant DNA. Vector systems in genetic engineering. Significance of engineering plasmids, epistomes, gene prophages. Enzymes that cut and bind DNA (restrictases, ligases). Vectors based on plasmids and bacteriophages. Using vectors for cloning and transfer. Methods of selection of recombinant vector structures. Microorganisms used in genetic engineering. Reasons for the impossibility of genetically engineered proteins and their natural counterparts. Genetic engineering of yeast. Yeast vectors. Optional markers. Genetic transformation in prokaryotes, requirements for vectors. Metabolic engineering. Concept of metabolism, reprogramming of bacterial metabolism.

**APPRAISAL POLICY**

**STANDARD EXAMINATION: WRITTEN, OFFLINE**

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|  | **Criterion/ score** | **Descriptors** | | | | |
|  | **Very good** | **Good** | **Satisfying** | **Unsatisfactory** | |
| **№** | **90–100% (27-30 )** | **70–89% (21-26)** | **50–69% (15-20)** | **25–49% (8-14 )** | **0–24% (0-7)** |
| **1 question**  **30 points** | **Course theory and**  **know and understand concepts** | "Excellent" is awarded for a comprehensive explanation of the question, with detailed evidence for each conclusion and statement, logically structured and supported by examples from the developed topics.  In Microbial Genetics and Genetic Engineering, he exemplifies processes in microorganisms using knowledge gained from lectures and seminars. | The grade "Good" is assigned to an answer that covers the question fully, but not completely, contains abbreviated arguments of the main rules and allows to break the logic and order of the presentation of the material. Terms used in microbial genetics and microbial engineering  improper use  maybe | The grade "Satisfactory" is assigned to an answer that does not fully cover the questions presented in the ticket, proves the main ideas superficially, allows compositional imbalances in the narrative, violates the logic and sequence of the material narrative. Microbial genetics does not show the basic principles of engineering with examples in lectures and seminars. | Inadequate coverage of the questions, incorrect reasoning, factual and verbal errors, predicting the wrong conclusion.  Failure to provide evidence on the genetics of microorganisms and the importance of their use in engineering, errors of not writing the answer clearly,  incorrect conclusion  make | Ignorance of basic concepts and theories; Violation of the rule of final control.  Microbial genetics and engineering major  concepts, principles of prevention, importance of correct diagnosis, control  not knowing the rules and regulations.  Final observation  driving rules  breach. |
| **2 question**  **30 points** | **Application of selected methodology and technology to real practical tasks** | Genetics of microorganisms and microbial engineering  practical  solves problems.  Completing the study assignment in full, giving a detailed, reasoned answer to the question, and then solving the practical problems of the course; | Microbial Genetics and Engineering  practical  tasks and problems in full  is left unresolved  incomplete answer to the question, reading task  partial performance  Completion of the educational task in part, not completely, giving a reasoned answer to the question posed without fully solving the practical problems of the course; illiterate use of scientific language norms for the course; | Lack of full coverage of techniques used in microbial genetics and engineering. The material is fragmentary  narrative, logical  breaking the sequence,  real inaccuracies are allowed.  The material is fragmented, factual and semantic inaccuracies are allowed, breaking the logical sequence, the theoretical knowledge of the course is applied superficially.. | To solve the problem on the genetics of microorganisms and their application in engineering  irrational method or  incomplete answer  plan;  solve tasks  tasks on solving microbial engineering problems  performance in general | For problem solving in microbial genetics and engineering  inability to use knowledge correctly;  conclusion and  make generalizations  not get  Final observation  rules of conduct  breach.  Inability to use knowledge and algorithms to solve tasks; inability to draw conclusions and conclusions. Principles of final control бұзу. |
| **3 question**  **40 points** | **Evaluation and analysis of the application of the selected methodology to the proposed practical task, justification of the obtained result** | In Genetics and Engineering of Microorganisms  methods used  and technology, principles  accurate, specific and  correct  1-2 inaccuracies are allowed in the presentation of material that does not affect the scientific position and used methodology and technology in a consistent, logical and correct basis, compliance with the norms of literacy, scientific language, general correct conclusions | Conceptual microbial genetics and genetic engineering  material  inaccuracy in use, generalization  and the exact p. of the findings  3-4 inaccuracies in the use of conceptual material, small errors in generalizations and conclusions are allowed, which do not affect the good overall level of the task. | Application of processes in microbial engineering, genetics of microorganisms in production  conclusions about are clear  Inconclusive and inefficient Conclusions about the application of grounded scientific rules are imprecise and inconclusive, there are stylistic and grammatical errors, and there is also a lack of accuracy in processing the results of a practical decision. | The task about the requirements and principles in the genetics of microorganisms is rough  with mistakes  done, to questions  the answers are incomplete  The task was completed with gross errors, the answers to the questions were incomplete, conceptual materials and arguments were poorly used. | For problem solving in microbial genetics and engineering  inability to use knowledge correctly;  conclusion and  make generalizations  not get  The task was not completed, there were no answers to the questions, analysis materials and tools were not used. Principles of final control бұзу. |

Exam tickets consist of 3 questions. A maximum of 100 points for correctly completed tasks, including 30 points for the first question, 30 points for the second question, and 40 points for the third question.

**Literature:**

1. Maloy, S. R., Cronan, J. E., & Freifelder, D. (1994). Microbial Genetics. Jones & Bartlett Learning.

2. Madigan, M., Martinko, J., Bender, K., Buckley, D., & Stahl, D. (2015). Brock Biology of Microorganisms. Pearson.

3. Lander, E. S. et al. (2016). CRISPR-Cas: A Laboratory Manual. Cold Spring Harbor Laboratory Press.

4. Buckingham and Flaw’s, “Molecular Diagnostics: Fundamentals, Methods and Clinical Applications”, F.A. DavisCompany; Firstedition, 2007.

5. Jens Kurreck, Cy Aaron Stein, Molecular Medicine: An Introduction, 2016

6. Doudna, J. A., & Sternberg, S. H. (2017). A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution. Houghton Mifflin Harcourt.

7. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory Press.

8. Gasser, R. B., & von Samson-Himmelstjerna, G. (2016). Genomics and Molecular Genetics of Parasites. Springer.

**Additional materials:**

Scientific articles from the journals Nature Microbiology, Journal of Bacteriology, Applied and Environmental Microbiology.

**Research infrastructure**

1. Classes of Biology and Biotechnology department of KazNU

2. Research Institute of Sustainability of Ecology of Bioresources

3.

**Internet resources**

1. http://elibrary.kaznu.kz/ru

2. MOOC / video lectures, etc.

3. Google Scholar

4. Sciencedirect.com

5. academia.edu

6. researchgate