AL-FARABI KAZAKH NATIONAL UNIVERSITY
Faculty of biology and biotechnology
Department of Molecular biology and genetics

APPROVED by
Dean of Faculty

Kurmanbaeva M.S.
"29" 08 2025, protocol №1

EDUCATIONAL-METHODICAL COMPLEX OF DISCIPLINE

«68001 Chromosomal and genetic engineering»

«7M05109-Biotechnology»

Course	1
Semester	1
Number of credits	5 (1,70+3,30+0)

Almaty 2025

Educational-methodical complex of the discipline «68001 Chromosomal and genetic engineering» is made by Associated Professor, candidate of biological science Aigul Kuzembayevna Amirova_based on the educational program «7M05109-Biotechnology».

Considered and recommended at the meeting of the department of Molecular Biology and Genetics from «29» 08 2025, protocol № 1

Head of department _____ Zh.K. Zhunusbayeva

SYLLABUS
Fall semester 2025 – 2026 academic year
Educational program "7M05109-Biotechnology", 1 course

ID and name of course	Independent work of the student (IWS)	Number of credits			General number of credits	Independent work of the student under the guidance of a teacher (IWST)
		Lectures (L)	Practical classes (PC)	Lab. classes (LC)		
68001 Chromosomal and genetic engineering	5	1,70	3,30	-	5	6.

ACADEMIC INFORMATION ABOUT THE COURSE

Learning Format	Cycle, component	Lecture types	Types of practical classes	Form and platform final control
Offline	P, UC	problematic, analytical lecture	problem solving, situational tasks	Traditional written exam, Univer, offline of the exam
Lecturer / assistant	associate professor Aigul Amirova			
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ACADEMIC COURSE PRESENTATION

Purpose of the course	Expected Learning Outcomes (LO) *	Indicators of LO achievement (ID)
To form the ability to put into practice the molecular genetic methods of chromosomal and genetic engineering. In studying the discipline, the following aspects will be addressed: the evolution of genomic analysis, the problems of plant aneuploidy; methods for creating a series of aneuploid lines, chromosomal localization of genes and intervarietal replacement of chromosomes; structural and functional organization of the genetic apparatus of pro- and eukaryotes; mechanisms of regulation of gene expression; various methods and approaches for the production	1.: To understand the importance of chromosome and genetic engineering in biotechnology and the methodologies used. Establish the relationship between the research methods used and the structure of chromosomes and the organization of DNA sequences in general.	1.1 Explains the relationship between modern biotechnology and other disciplines and identifies the achievements of modern biotechnology in the field of chromosome engineering.
		1.2 Describes all the structural elements of chromosomes of eukaryotic and prokaryotic organisms.
	2. To understand the differences between chromosomes in different species. To assess the potential of chromosomes for selection and reproduction.	2.1 Classifies chromosomes and identify their similarities and differences.
		2.2 Shows the relationship between mutations in chromosomes and their functionality.
	3. To interpret the potential of using newly engineered genomes to produce useful substances and properties in organisms in biotechnology.	3.1 Demonstrates knowledge of obtaining spontaneous mutations and creating individual mutant lines.
		3.2 Demonstrates the principles of selection and types of crossing of organisms, and substantiates the practical application of chromosome engineering methodologies.
	4. To apply knowledge from various fields of biotechnology to genetic engineering to create genetically modified organisms with beneficial properties.	4.1 Applies acquired knowledge to understand the principles of genetic engineering.
		4.2 Demonstrates the utility of genetic engineering in solving gene therapy problems.
	5. To carry out projects, establish methods and manage them; be able to find and make decisions to solve problems in the field of genetic engineering.	5.1 Determines the potential of each method for generating project ideas.
		5.2 Explains modern methods and examines the potential of genetic engineering in the modern world to solve future problems.

and cloning of recombinant DNA; in vitro mutagenesis; selective suppression of gene expression using antisense RNA; RNA interference.		
Prerequisites	"Modern methods in biotechnology"	
Postrequisites	"Preparation of the Master's Thesis"	
Learning Resources	**Literature:** main, additional. 1. Reconstruction of the common wheat genome based on chromosome engineering and isolated hybridization [Text]: monograph / K. K. Shulembaeva, A. A. Tokubaeva; Al-Farabi Kazakh National University. - Almaty: Kazakh University, 2019. - 240 p.: ill., table. - Bibliography: pp. 223-240. - 500 (circulation) copies. - ISBN 978-601-04-3860-6 2. Ogurtsov A. N., Bliznyuk O. N., Masalitina N. Yu. Fundamentals of genetic engineering and bioengineering. Textbook. Part 1: Molecular basis of gene technologies. Kharkov: NTU "KhPI", 2018. 288 p. 3. Nefedova L.N., Application of Molecular Research Methods in Genetics: A Textbook / L.N. Nefedova. - M.: NITs Infra-M, 2012. - 104 p.: 60x88 1/16. - (Higher education: Bachelor's degree). (cover) ISBN 978-5-16-005494-0, http://znanium.com/bookread.php?book=302262 4. Theory of Laboratory Biochemical Research. Fundamentals of Biochemistry [Text]: a textbook for secondary specialized schools / [responsible V. Kuznetsov]; Ministry of Defense of the Russian Federation. - 6th ed., revised. - Rostov n / D: Phoenix, 2014. - 397, [2] p.: table. - (Secondary vocational education). - Bibliography: pp. 381-382. - ISBN 978-5-222-22003-0 5. Fundamentals of Molecular Biology [Text]: lecture course / T. A. Muminov, E. U. Kuandykov; [Kaz. National Medical University named after S. D. Asfendiyarov]. - Almaty: SSK, 2017. - 222, [1] p.: ill. - ISBN 978-601-310-323-5 **Internet resources** 1 . http://elibrary.kaznu.kz/ru 2. MOOC / video lectures, etc. 3. https://www.coursera.org/ 4. https://www.edx.org/	

Academic course policy	The academic policy of the course is determined by the Academic Policy and the Policy of Academic Integrity of Al-Farabi Kazakh National University . Documents are available on the main page of IS Univer . **Integration of science and education.** The research work of students, undergraduates and doctoral students is a deepening of the educational process. It is organized directly at the departments, laboratories, scientific and design departments of the university, in student scientific and technical associations. Independent work of students at all levels of education is aimed at developing research skills and competencies based on obtaining new knowledge using modern research and information technologies. A research university teacher integrates the results of scientific activities into the topics of lectures and seminars (practical) classes, laboratory classes and into the tasks of the IWST, IWS, which are reflected in the syllabus and are responsible for the relevance of the topics of training sessions and assignments. **Attendance.** The deadline for each task is indicated in the calendar (schedule) for the implementation of the content of the course. Failure to meet deadlines results in loss of points. **Academic honesty.** Practical/laboratory classes, IWS develop the student's independence, critical thinking, and creativity. Plagiarism, forgery, the use of cheat sheets, cheating at all stages of completing tasks are unacceptable. Compliance with academic honesty during the period of theoretical training and at exams, in addition to the main policies, is regulated by the "Rules for the final control" , "Instructions for the final control of the autumn / spring semester of the current academic year" , "Regulations on checking students' text documents for borrowings". Documents are available on the main page of IS Univer . **Basic principles of inclusive education.** The educational environment of the university is conceived as a safe place where there is always support and equal attitude from the teacher to all students and students to each other, regardless of gender, race / ethnicity, religious beliefs, socio-economic status, physical health of the student, etc. All people need the support and friendship of peers and fellow students. For all students, progress is more about what they can do than what they can't. Diversity enhances all aspects of life.

	All students, especially those with disabilities, can receive counseling assistance by phone / e- mail aigul_amir@mail.ru or via video link in ZOOM: https://us05web.zoom.us/j/88254829221?pwd=mIjuOjokfnvcjeA41Z1O0kDDQ3EG3N.1 *to the meeting.* **Integration MOOC (massive open online course).** In the case of integrating MOOC into the course, all students need to register for MOOC. The deadlines for passing MOOC modules must be strictly observed in accordance with the course study schedule. **ATTENTION!** The deadline for each task is indicated in the calendar (schedule) for the implementation of the content of the course, as well as in the MOOC. Failure to meet deadlines results in loss of points.

INFORMATION ABOUT TEACHING, LEARNING AND ASSESSMENT

Score-rating letter system of assessment of accounting for educational achievements

Grade	Digital equivalent points	points, % content	Assessment according to the traditional system
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	Satisfactorily
C-	1.67	60-64	
D+	1.33	55-59	
D	1.0	50-54	
Fx	0,5	25-49	Unsatisfactory
F	0	0-24	

Assessment Methods

Criteria-based assessment is the process of correlating actual learning outcomes with expected learning outcomes based on clearly defined criteria. Based on formative and summative assessment.

Formative assessment is a type of assessment that is carried out in the course of daily learning activities. It is the current measure of progress. Provides an operational relationship between the student and the teacher. It allows you to determine the capabilities of the student, identify difficulties, help achieve the best results, timely correct the educational process for the teacher. The performance of tasks, the activity of work in the classroom during lectures, seminars, practical exercises (discussions, quizzes, debates, round tables, laboratory work, etc.) are evaluated. Acquired knowledge and competencies are assessed.

Summative assessment - type of assessment, which is carried out upon completion of the study of the section in accordance with the program of the course. Conducted 3-4 times per semester when performing IWS. This is the assessment of mastering the expected learning outcomes in relation to the descriptors. Allows you to determine and fix the level of mastering the course for a certain period. Learning outcomes are evaluated.

Formative and summative assessment	**Points % content**
Activity at lectures	5
Work in practical classes	20
Independent work	25
Design and creative activity	10
Final control (exam)	40
TOTAL	100

Calendar (schedule) for the implementation of the content of the course. Methods of teaching and learning.

A week	Topic name	Number of hours	Max. ball
	MODULE 1. Chromosomal and genetic engineering: achievements and prospects.		
1	**L 1.** Introduction. Goals and objectives of chromosome and genetic engineering. History of the development of chromosome and genetic engineering technologies.	1	
	Seminar 1. Chromosome engineering methods. Solving problems: gene mutations and protein synthesis.	2	
2	**L 2.** Chromosome structure and DNA sequence organization. DNA packaging in chromosomes. Karyotype and ideogram. Euchromatin and heterochromatin.	1	
	PC 2. Chromosomal abnormalities. Mutations in chromosomes: quantitative and structural variability.	2	
	IWST P 1. Consultations on the implementation of IWS 1	1	
3	**L 3.** Chromosomes of viruses and bacteria, mitochondria and chloroplasts.	1	
	PC 3. Centromere and telomere regions of chromosomes. Structure of centromeres and telomeres. Repeated DNA sequences. Satellite DNA, gene copies.	2	
4	**L 4.** Lampbrush chromosomes.	1	
	PC 4. Quantitative changes in chromosomes: autopolyploidy, allopolyploidy.	2	10
	IWS 1. Chromosomal engineering: achievements and prospects. Morganism – the chromosomal theory of heredity. Chromosomes of viruses, prokaryotes, and eukaryotic cellular organelles. Differential staining of chromosomes. The mechanism of DNA compaction in chromosomes. Variability of hereditary material. Quantitative and structural variability of chromosomes in the evolution of species, medicine, and the creation of new agricultural products. Mechanisms of mutagenesis, DNA repair, crossing over, and conversion. Diminution of chromatin and chromosomes. Use of polytene chromosomes in genetic analysis.	2	20
5	**L 5.** Политения как явление. Политенные хромосомы.	1	
	PC 5. Quantitative Chromosome Changes: Duplications, Translocations, Deletions, and Inversions. Problem Solving.	2	10
	IWST 2. Consultations on the implementation of IWS 2		

6	**L 6.** Use of monosomic, nullisomic wheat genetic lines for gene mapping and genomic studies.	1	
	PC 6. Prospects for chromosome engineering.	2	10
	IWS 2. Plant and Animal Breeding. Genetic foundations of evolution, the possibility of restoring the genetic basis for breeding ancient cultivated species with a depleted gene pool. Types of crossings and their practical application. N.I. Vavilov's law of homologous variability. Genetic crossing schemes with chromosomal construction to obtain new productive forms. Use of sex regulation systems, lethal genes, and gene combinations.		10
7	**L 7.** Genomic projects, forecasts for the development of these projects.	1	
	PC 7. Modern gene mapping methods, creation of genomic libraries. The "chromosome walking" method.	2	10
	IWST 3. Consultation on the implementation of IWS 3	2	
8	**L 8.** Basic principles of genetic engineering. Implementation of genetic information. Plasmids. Vectors. Methods for creating recombinant DNA molecules.	1	
	PC 8. Genetic engineering enzymes. Recombinant DNA and hereditary diseases.	2	10
	IWS 3. Detection of discontinuous genes and specific nucleotide sequences at the boundaries between exons and introns. Processing of primary transcripts of eukaryotic genes. Alternative splicing. Regulatory regions at the 5' and 3' ends of eukaryotic genes. Characterization of repressors as elements controlling the synthesis of inducible enzymes. Operon organization of bacterial genes. The model of F. Jacob and J. Monod using the lactose (lac) operon as an example. Genomic organization of cauliflower mosaic virus (CaMV) and the mechanism of transcription.	1	20
Midterm control 1			**100**
9	**L 9.** Methods of transformation of plant protoplasts, cells and tissues.	1	
	PC 9. Advantages and disadvantages of genetic transformation methods.	2	7
10	**L 10.** Агробактериальная трансформация растений.	1	
	PC 10. Structure and mechanism of insertion of the Ti plasmid of *A. tumefaciens*. Integration of T-DNA with the plant chromosome.	2	7
	IWST 4. Consultation on the implementation of IWS 4	1	
11	**L 11.** Bioballistic transformation. Gene gun.	1	
	PC 11. The principle of operation of the gene gun.	2	7
	IWS 4. Using radioactive probes to detect cloned genes. Basic methods for obtaining radioactive nucleic acids (nick translation, labeling of 5' and/or 3' ends). Two-hybrid analysis. Reporter genes. Genetic elements regulating gene expression in prokaryotes. Basic methods of DNA sequencing. What are the principles of each of these methods? DNA replication. Enzymes and other proteins involved in DNA replication. General characteristics of bacterial plasmids as autonomously replicating Mini chromosomes. Episomes, non-transmissible plasmids. Plasmid copy number in a cell.	1	25
12	**L12.** Genetic transformation of animals.	1	
	PC 12. Methods of genetic transformation of animals.	2	7
	IWST 5. Consultation on the implementation of IWS 5	1	
13	**L 13.** CRISPR/Cas technologies.	1	
	PC 13. Gene therapy and CRISPR/Cas technologies.	2	7
	IWS 5. The latest significant discoveries in genetic engineering and their applications. Genome editing using CRISPR/Cas technology. Genes of agricultural plants and animals modified using the CRISPR/Cas system. Methods for delivering CRISPR/Cas components into living cells.		25
14	**L 14.** Animal cloning.	1	
	PC 14. Animal cloning methods.	2	7
15	**L 15.** Gene therapy. Personalized medicine.	1	
	PC 15. Modern genome editing technologies such as CRISPR/Cas9 and new opportunities for treating hereditary diseases.	2	8
	IWST 6. Consultation on the final exam	1	
Midterm control 2			**100**
Final control (exam)			**100**
TOTAL for course			**100**

Dean _____ **Kurmanbaeva M.S.**

Chair of the Academic Committee
on the Quality of Teaching and Learning _____ **Asrandina S.Sh.**

Head of Department _____ **Zhunusbayeva Zh.K.**

Lecturer _____ **Amirova A.K.**

RUBRICATOR OF THE SUMMATIVE ASSESSMENT

CRITERIA EVALUATION OF LEARNING OUTCOMES

Example 1. Group presentation on the topics IWS 3. "Detection of discontinuous genes and specific nucleotide sequences at the boundaries between exons and introns. Processing of primary transcripts of eukaryotic genes. Alternative splicing. Regulatory regions at the 5' and 3' ends of eukaryotic genes. Characterization of repressors as elements controlling the synthesis of inducible enzymes. Operonic organization of bacterial genes. The model of F. Jacob and J. Monod using the lactose (lac) operon as an example. Genomic organization of the cauliflower mosaic virus (CaMV) and the mechanism of transcription." (25% of 100% MC)

Criterion	"Excellent" 20-25%	"Good" 15-20%	"Satisfactory" 10-15%	"Unsatisfactory" 0-10%
Understanding of the theories, concepts and technologies used in the field of genetic engineering.	Deep understanding of theories, concepts and technologies used in the field of genetic engineering.	Understanding theories, concepts and technologies in the field of genetic engineering. Links (citations) to key sources are provided.	Limited understanding of theories, concepts of professional identity and teacher professionalism. Limited references (citations) to key sources are provided.	Superficial understanding / lack of understanding of theories, concepts of professional identity and professionalism of the teacher. Relevant references (citations) to key sources are not provided.
Awareness of modern methods of genome analysis and recombinant DNA construction.	Has a good understanding of theories, principles and methods, key concepts and the role of genetic engineering in improving living organisms, the relationship between chromosomal engineering and genetic engineering and other modern technologies of human genome editing and gene therapy.	Limited awareness of genetic transformation techniques. Limited analysis of the topic, poorly supported by theoretical and empirical research.	Little awareness of genetic engineering methods. Little theoretical or practical research.	There is little or no connection between the concepts of a teacher's professional identity and the context of Kazakhstan. Little or no use of empirical research.
Definition of the area of practical application/recommendation	Offers sound policy and/or practical recommendations, proposals for improving the professional identity and professionalism of teachers in Kazakhstan.	Limited knowledge of genetic engineering techniques used in practice.	Limited policy and practical recommendations. Recommendations are non-essential, not based on rigorous analysis, and are shallow.	Little or no policy and practice advice, or advice of very low quality.
Presentation, teamwork	Excellent, attractive presentation, excellent quality of visuals, slides, materials, excellent teamwork.	Good engagement, good quality of visuals, slides or other materials, good level of teamwork.	Low level of engagement, low quality of materials, poor level of teamwork.	Lack of presentation and speech.

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