SYLLABUS
Fall semester 2025-2026 academic year
Educational program *7M05109 Биотехнология, daily,*
1 course (Autumn)

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)**		
Methods of molecular biotechology	The number of IWS is 6	1,7	3,3		2,5	The number of IWST is 5. This is a teacher's guide. for the preparation of the IWS.

ACADEMIC INFORMATION ABOUT THE COURSE				
Learning Format	**Cycle, component**	**Lecture types**	**Types of practical classes**	**Form and platform final control**
Choose Offline/online/ hybrid	Selectable Component	Offline	Offline	Univer standart
Lecturer - (s)	Kenzhebayeva Saule Sagindykovna			
e-mail :	Saule.Kenzhabaeva@kaznu.edu.kz			
Phone :				
Assistant - (s)	no			
e-mail :				
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ACADEMIC COURSE PRESENTATION

Purpose of the course	**Expected Learning Outcomes (LO) ***	**Indicators of LO achievement (ID)**
To acquaint Ms students with the peculiarities of the essence and applications of the main methods used in modern biotechnology in studying processes at the various level of organization of living organisms and to show their relationship with the purpose of research, to form the ability and skills to apply the basic methods of research in cellular and molecular biotechnology, microbiology, used in the analysis of biological objects and products obtained in the implementation of	1. To describe the principles and applications of main methods of cellular approaches used in biotechnology including cellular membrane structures, study of nucleic acids and proteins, genetic engineering, to analyze information when deciding practical tasks.	1.1.To determine the key biochemical methods for studying cell membrane structures.
		1.2. To analyze the methods Isolation of cell membrane fractions
	2. To classify and determine the key biophysical methods for studying cell membrane structures.	2.1. Explains how Nuclear magnetic resonance spectroscopy (NMR spectroscopy) method. Surface plasmon resonance (SPR). 2.2. Demonstrates knowledges methods to study dynamics and interactions of biological membranes. 2.3. Shows methods for determining the electrical characteristics of membranes. Defines Biochemical methods for studying biological membranes. Identification of cellular membrane fractions by microscopic analysis
	3.To determine the key biochemical methods for studying cell membrane structures	3.1. Indicates methods of solubilization and reconstruction of membranes 3.2. Shows methods of isolation of cell membrane fractions.
		3.5. makes final conclusions from the data obtained;
	4. To demonstrate the knowledges and principles of main proteome methods ; describe the schemes used to characterize their basic area of application;	4.1. Classifies Ion-exchange chromatography, Affinity chromatography, Protein electrophoresis

biotechnological processes, to reveal their basic principles and use the latest trends and technologies to obtain targeted genetically modified or engineered products for various fields of application. various information		4.2 Illustrates determination of protein composition, marker enzyme activity and cell surface protein biotinylation for identification of cellular membrane fractions
	5. To interpret the molecular methods used for research and practical purposes of biotechnology.	5.1. Shows general principles of nucleic acid isolation Isolation of total DNA from plant tissues. Isolation of total DNA from plant tissues Total DNA isolation method using 5 M potassium acetate. Total DNA isolation method using CTAB detergent.; 5.2 iscovers methods of the features of the essence for extraction, modification, purification and analysis of nucleic acids. Hybridization and nucleic acids various blotting techniques Method of Southern blotting The Northern blotting method. DNA microarray. Reverse northern blotting RNA-seq (Next-Gen sequencing) Single-molecule real-time RNA sequencing. Single-cell RNA sequencing (scRNA-Seq)..
	6. To solve the main methods of genetic engineering.	6.1. Illustrates RNA interference (RNAi) method and synthetic biology and de novo gene synthesis.
		6.2. Explains how Recombinant DNA (rDNA) technology used for genetic improvement of living organisms. Applications of polymerase chain reaction (PCR). Gene editing (CRISPR-Cas9). Gene transfer techniques. Direct transformation (non-viral methods) method and no direct transduction (viral-mediated gene transfer).
Prerequisites	Plant anatomy and morphology, Cytology and histology, Plants physiology	
Postrequisites	Regulation of physiological processes of plants productivity, Agronomy, Agriculture	
Learning Resources	**Literature: main,** 1. Ma Q.P. Biotechnology: Recent Developments, Emerging Trends, and Implications for Business. 2021. In book: Technological Breakthroughs and Future Business Opportunities in Education, Health, and Outer Space (pp.112-132). DOI:10.4018/978-1-7998-6772-2.ch007 2. Advances in Industrial Biotechnology, Chapter: 1 Industrial Biotechnology: An Overview, I. K. International Publishingh House Pvt. Ltd., New Delhi, Banglore, India Eds: Ram Sarup Singh, Ashok Pndey, Christian Larroche. 3. Gupta, V., Sengupta, M., Prakash, J., Tripathy, Baishnab Charan.An Introduction to Biotechnology". 2016, *Basic and Applied Aspects of Biotechnology*. pp. 1–21. doi:10.1007/978-981-10-0875-7_1. 4. Riaz M, Yasmeen E, Saleem B, Hameed MK, Saeed Almheiri MT, Saeed Al Mir RO, Alameri G, Khamis Alghafri JS and Gururani MA (2025) Evolution of agricultural biotechnology is the paradigm shift in crop resilience and development: a review. Front. Plant Sci. 16:1585826. doi: 10.3389/fpls.2025.1585826. 5. EFSA GMO Panel (EFSA Panel on Genetically Modified Organisms), Mullins, E., Bresson, J.-L., Dewhurst, I. C., Epstein, M. M., Firbank, L. G., Guerche, P., Hejatko, J., Moreno, F. J., Naegeli, H., Nogué, F., Rostoks, N., Sánchez Serrano, J. J., Savoini, G., Veromann, E., Veronesi, F., 6. Cocconcelli, P. S., Glandorf, D., Herman, L., Dalmay, T. (2024). New developments in biotechnology applied to microorganisms. *EFSA Journal*, 22(7), e8895. https://doi.org/10.2903/j.efsa.2024.8895 7. Yılmaz R. Modern biotechnology breakthroughs to food and agricultural research in developing countries. GM Crops Food. 2019;10(1):12-16. doi: 10.1080/21645698.2019.1600969. Epub 2019 May 6. PMID: 31055997; PMCID: PMC6592639.	

	8. Forero DA, Chand V. Methods in molecular biology and genetics: looking to the future. BMC Res Notes. 2023 Mar 2;16(1):26. doi: 10.1186/s13104-023-06298-y. PMID: 36864454; PMCID: PMC9980850. **Additional:** Kristiina Himanen (2015). Cell cycle regulation during plant growth and development, Jörg D. Becker (2012) Decision- Making in the Plant Cell Cycle.Canal BQ-n.9. Atkin OK, Bloomfield KJ, Reich PB, et al. (2015) Global variability in leaf respiration in relation to climate, plant functional types and leaf traits. New Phytologist 2016: 614–636. Kim, Yu Seon; Smoak, Mollie M.; Melchiorri, Anthony J.; Mikos, Antonios G. (1 January 2019). "An Overview of the Tissue Engineering Market in the United States from 2011 to 2018". *Tissue Engineering. Part A*. **25** (1–2): 1–8. Malek-Khatabi, A.; Javar, H.A.; Dashtimoghadam, E.; Ansari, S.; Hasani-Sadrabadi, M.M.; Moshaverinia, A. (2020)."In situ bone tissue engineering using gene delivery nanocomplexes". *Acta Biomaterialia*. **108**: 326–336 **Research infrastructure** 1.Teaching room 408 of biology and biotechnology fact **Professional scientific databases** 1.data base of NSBI **Internet resources** https://unacademy.com/lesson/introduction-to-bioprocess-engineering/2VOHJWDZ www.youtube.com http://bioprocessint.com/manufacturing/continuesbioprocessing *https:www.*chemengonline.com/industrial-microorganisms/ *http://www.* slideshare.net/MRakibulIslam/industrial-microorganisms. https://fiveable.me/biotechnology-3-oviedo-high-school-umrao-fall-24/unit-1/current-techniques-biotechnology-applications/study-guide/oosgWaKYSGUKTMrw **Software** (optionally)

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 Saule.Kenzhabaeva@kaznu.edu.kz *contacts* or via video link in MS Teams enter a permanent link 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				Assessment Methods	
Grade	**Digital equivalent points**	**points, % content**	**Assessment according to the traditional system**	**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.	
A	4.0 _	95-100	Great		
A-	3.67	90-94			
B+	3.33	85-89	Fine		
B	3.0	80-84		**Formative and summative assessment** The teacher introduces his own types of assessment or uses the proposed option	**Points % content** The teacher enters his score into points in accordance with the calendar (schedule). The exam does not change and the final score in the course.
B-	2.67	75-79		Activity at lectures	5
C+	2.33	70-74		Work in practical classes	20
C	2.0	65-69	Satisfactorily	Independent work	25
C-	1.67	60-64		Design and creative activity	10
D+	1.33	55-59	Unsatisfactory	Final control (exam)	40
D	1.0	50-54		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 *Physiological processes in on plants*		
1	**L 1.** Theme Introduction to modern methods. The subject of modern BT methods. The use of methods in different biotechnology areas (agricultural biotechnology and breeding, microbial and environmental biotechnology).	**1**	**0**
	PW 1. Theme Modern biotechnology for food and agriculture. Application and trends of biotechnology in sustainable agriculture. Evolution' of agricultural biotechnology	2	7
	L.2. Theme Methods of study of membrane structures. Development of methods for cell disruption. Methods of identification of subcellular fractions.	**1**	**0**
	PC 2. Theme Determination of protein composition, marker enzyme activity and cell surface protein biotinylation for identification of cellular membrane fractions	3	10
	IWS P 1. Consultations on the implementation of **IWST 1** ATTENTION. Number of IWST (6), IWS (5) for 15 weeks Isolation of nuclear and mitochondria membranes. Using membrane vesicles to study ion transport. Study of passive transport of K+ and Na+ ions on membrane vesicles. Methods for determining the electrical characteristics of membranes	**2**	**10**
3	**L 3.** Theme. Biophysical methods for studying membrane structures. The method of electron paramagnetic resonance (EPR) spectroscopy. Nuclear magnetic resonance spectroscopy (NMR spectroscopy) method. Surface plasmon resonance (SPR)	**1**	**0**
	PC 3 Theme. Methods for determining the electrical characteristics of membranes. Radioisotope uptake assays. Stopped-flow system. Methods of studying ions channels. Solubilization and reconstruction of membranes. Types of microscopies.	2	7
	IWST 2. Control work, test, individual / group project, essay, situational task, testing, portfolio, etc. at the teacher's choice.	2	15
4	**L 4.** Theme. Membranes structure study by choice and use of detergents and mechanisms of their effect.	1	0
	PC 4. Theme. Methods of solubilization and reconstruction of membrane structures.	2	7
5	**L 5.** Theme. Proteomic methods study. Proteins isolation, purification and study methods	2	0

	PC 5. Theme Western blotting method (protein immunoblot). Describe enzyme activity analysis by electrophoresis	2	7
	IWST3. Theme. Applications of methods for quantitative determination of proteins. Mass spectrometry in protein research. Electrospray ionization (ESI) in proteomic analysis. Quantitative mass spectrometry in protein studies	1	15
6	**L. 6.** Methods of Analysis and characterization of proteins		
	PC 6. Proteins-next generation sequencing. Protein N-terminal amino acid analysis. Protein C-terminal amino acid analysis. Edman degradation sequencing peptides and proteins		
7	**L 7.** Main principles of electrophoresis		
	PC 7. Isoelectric focusing, two-dimensional electrophoresis for protein separation (2DE). Isotachophoresis. Methods for quantitative determination of proteins		
	MODULE 2. Molecular methods used in biotechnology		
8	**L 8.** Theme. General principles of nucleic acid isolation	2	0
	PC 8. Theme. Isolation of total DNA from plant tissues. Total DNA isolation method using 5 M potassium acetate. Total DNA isolation method using CTAB detergent Method for isolating total DNA from plants with increased phenol content. Method for isolating chloroplast and mitochondrial DNA. **Midterm control 1**	4	7
	IWST 4. Consultations on the implementation of **IWS 2.** Molecular methods used in biotechnology.	1	15
9	**L 9.** Methods of nucleic acid structure analysis. Hybridization and nucleic acids various blotting techniques. Method of Southern blotting. The Northern blotting method. DNA microarray. Reverse northern blotting. RNA-seq (Next-Gen sequencing)	2	0
	PC 9. Theme. Single-molecule real-time RNA sequencing. Single-cell RNA sequencing (scRNA-Seq). DNA sequencing methods. Sanger dideoxy (primer extension/chain-termination) DNA sequencing Microfluidic Sanger sequencing. Maxam–Gilbert sequencing DNA next-generation sequencing. Next-generation sequencing platforms	4	10
	IWST 5. Mass spectrometry /MS sequencing, ESI, MALDI-TOF) for protein sequencing.	2	15
10	**L10.** Methods of study genes expression	1	0
	PC 10. Method of serial analysis of gene expression (SAGE) and DNA microarray	2	7
11	**L11.** Molecular markers. Types. Applications in biotechnology. Principles of marker assisted selection (MAS) in crop plants	1	0
	PC 11. KASP markers (Kompetitive allele specific PCR). RNA-based molecular markers. Types. The types of protein based molecular markers in biotechnology. Genome-wide association study (GWAS). Types. Sample of genome-wide association study (GWAS) protocol	2	7
	IWST 6. Genome-wide association study (GWAS). Types. Sample of genome-wide association study (GWAS) protocol Quantitative trait locus (QTL). Marker-assisted selection (MAS)	1	10
12	**L 12.** Genetic engineering, Techniques. Application	1	0
	PC 12. Theme. Genetically modified organisms such fungi, viruses, plants, crops, animals, gene therapy and for bioremediation.	2	7
13	**L 13.** Omics driven bioengineering. Metabolic engineering.	1	0
	PC13. Theme. Plant metabolic Engineering. Approaches to Plant Metabolic Engineering. L.11. Theme. Biomolecular enginering. Biomolecular engineering for manipulation of carbohydrates, proteins, nucleic acids and lipids.	2	7
	IWST 4. Theme. Examples using biochemical engineering for developing products and processes Use of algae for biogas, green diesel, food supplementation. Algae-based energy harvester. Species. The techniques used for inserting the isolated gene into the host genome. Recent advancements using genome editing techniques, notably CRISPR for , the production of GMOs.	1	15
14	**L.14.** RNA interference (RNAi) method applied in genetic engineering. Synthetic biology and de novo gene synthesis	1	0
	PC. 14. Theme. Methods of RNAi delivery in cells**.** The methods of RNAi delivery in cells including the various approaches: Applications of gene function studies – applied in functional genomics to study gene roles, antiviral therapy – RNAi targets virapplies like *HIV,* Hepatitis B, and SARS-CoV-2, cancer research and agricultural biotechnology.	2	7
15	**L.15** Theme. Cell engineering. Tissue engineering	2	0
	PC. 15. Examples for cell and tissue engineering. Bioartificial organs. Stem cells. **Midterm control 2**	2	16
Midterm control 2			**100**

Dean _____Kurmanbayeva M.S.

Head of Department _____Kistaybayeva A.S.

Lecturer _____Kenzhebayeva S.S.

RUBRICTOR FOR CRITERIAL ASSESSMENT OF FINAL CONTROL

Discipline: «Plants Physiology" **Form:** written exam, standard form, offline **Platform:** IS Univer

№	Criterion/score	Дескрипторы				
		Great	**Fine**	**Satisfactorily**	**UnSatisfactorily**	
		90–100% (27-30 баллов)	**70–89% (21-26 баллов)**	**50–69% (15-20 баллов)**	**25–49% (8-14 баллов)**	**0–24% (0-7 баллов)**
1 question 33 scores	Understanding the theoretical basis of Plants Physiology	The answer contains an exhaustive disclosure of the question, a detailed argumentation of each conclusion and statement, is built logically and consistently, supported by examples	The answer contains a full, but not exhaustive coverage of the issue, a shortened argumentation of the main provisions, allows violation of the logic and sequence of the presentation of the material. Stylistic errors and inaccurate use of terms are allowed in the response.	The answer contains incomplete coverage of the issue, the main provisions are superficially reasoned, violations of logic and sequence of presentation of the material are allowed in the presentation, theoretical provisions are not illustrated with practical examples	The answer contains incorrect coverage of the question posed, erroneous argumentation, factual errors, incorrect conclusions.	Ignorance of basic concepts. Violation of the Rules of the final control
2 question 33 scores	Application of physiological methods to solve problems of productivity of agricultural pplants. Based on specific examples, present regulations for physiological processes/or explain the use of specific methods and practical applications	Full completion of the task, a detailed, reasoned answer to the question, followed by the solution of a practical problem. Consistent, logical and correct justification of scientific provisions and the applied methodology and technology, literacy, compliance with the norms of scientific language, 1-2 inaccuracies in the presentation	Partial completion of the task, incomplete, sometimes reasoned answer to a question with an incomplete solution of a practical problem; illiterate use of the norms of scientific language. 3-4 inaccuracies in the use of conceptual material, minor errors in	The material is presented in fragments, with a violation of logical sequence, factual and semantic inaccuracies are allowed, theoretical knowledge of the course is used superficially. Conclusions on the applicability of sound scientific provisions are vague and unconvincing, there are stylistic and grammatical errors, as well as inaccuracies in	An irrational method of solving a task or an insufficiently thought-out response plan; inability to solve tasks, perform tasks in general; assumption of more than 4 errors and shortcomings; the presence of gross errors; conceptual material and argumentation are poorly used.	The task has not been completed, there are no answers to the questions posed, materials and analysis tools have not been used. Violation of the Rules of the final control.

№	Criterion/score	Дескрипторы				
		Great	Fine	Satisfactorily	UnSatisfactorily	
		90–100% (36-40 баллов)	70–89% (35-28 баллов)	50–69% (27-20 баллов)	25–49% (19-10 баллов)	0–24% (0-9 баллов)
3 question **34scores**	Analysis of the applicability of the key physiological methods to the proposed practical task, justification of the result obtained	Consistent, logical and correct justification of scientific positions and the applied methodology and technology, literacy, compliance with the norms of scientific language, 1-2 inaccuracies in the presentation of the material are allowed, which do not affect the generally correct you - water (+visualization of justification results using graphical data).	Allowed 3-4 неточности в использовании понятийного материала, незначительные погрешности в обобщениях и выводах, которые не влияют на хороший общий уровень выполнения задания.	Conclusions on the applicability of well-founded scientific principles are vague and unconvincing, there are stylistic and grammatical errors, as well as inaccuracies in processing the results of a practical solution	The task was completed with gross errors, the answers to the questions were incomplete, the conceptual material and argumentation were poorly used.	The task has not been completed, there are no answers to the questions posed, materials and analysis tools have not been used. Violation of the Rules for conducting final control.

Exam tickets consist of 3 questions. For correctly completed tasks, the maximum is 100 points, of which 33 points for the fir st question, 33 points for the second question, and 34 points for the third question.

Formula for calculating the final grade:
Final grade = score for question 1 + score for question 2 + score for question 3

Additional Information:

Letter Grade	Grade Point Value	Percentage	Conventional Grade
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	
FX	0,5	25-49	Failure
F	0	0-24	
I (Incomplete)	-	-	Incomplete (shall not be taken into account when calculating GPA)
AU (Audit)	-	-	Audit (shall not be taken into account when calculating GPA)
Cert.	-	30-60 50-100	"Certification" (shall not be taken into account when calculating GPA)
Uncert.	-	0-29 0-49	"Uncertification" (shall not be taken into account when calculating GPA)
R-difference	-	-	"Discipline difference on curriculum" (shall not be taken into account when calculating GPA)

Dean _____Kurmanbayeva M.S.

Head of Department _____Kistaybayeva A.S.

Lecturer _____Kenzhebayeva S.S.