

**MINISTRY OF EDUCATION OF THE REPUBLIC OF AZERBAIJAN
KHAZAR UNIVERSITY**

**SCHOOL OF SCIENCE AND ENGINEERING
DEPARTMENT OF LIFE SCIENCES**

Advanced biotechnology

SYLLABUS

Academic year and semester
Fall 2026

Agreed

Approved

**Head of Department:
PhD. Jamala Eldarova**

Identification	Subject	BIOT, Advanced Biotechnology, 6 ECTs
	Department	Life Sciences
	Program (Undergraduate, Graduate)	Undergraduate
	Term	Fall 2026
	Instructor	Dr. Aynura Rzayeva
	Email:	arzayeva@khazar.org
	Classroom/hours	Bakikhanov settlement, Elshan Mehdiyev street. 478, Every Wednesday at 11:50
Prerequisites	Introduction to Biotechnology	
Language	English	
Compulsory/Elective	Compulsory	
Textbooks and course materials	Main textbooks: 1. Biotechnology of Microbial Enzymes – Brahmachari, 2nd Edition (2023) 2. Biocatalysis and Biotransformations - Sánchez Montero & Alcántara León (2026) 3. Principles of Fermentation Technology – Stanbury et al., 4th Edition (2026) 4. From ancestral fermentations to engineered food consortia, Giles-Gómez et al., Current Opinion in Biotechnology, doi.org/10.1016/j.copbio.2026.103554 (2026) 5. Exploring the Functionality of Microbes in Fermented Foods: 6. Technological Advancements and Future Directions, Singh & Kumar, Fermentation Journal, doi.org/10.3390/fermentation11060300 (2025) 7. Microbiome engineering: Current applications and their future, Loon Foo et al. Biotechnology Journal, DOI 10.1002/biot.201600099 (2017) 8. Principles in Microbiome Engineering – Matthew W. Chang (2022) 9. Industrial Biotechnology – Wittmann & C. Liao (2017) 10. Smart Nanomaterials for Bioencapsulation – Guillermo R. Casto et al. (2023) 11. Handbook of Biopolymers – Sabu Thomas et al. (2023) 12. Innovations in Food Packaging - Jung H. Han (2014) 13. Advancing Biotechnology: From Science to Therapeutics and Informatics – Rani et al. (2025) 14. Principles and Applications of Environmental Biotechnology for a Sustainable Future – Singh (2017) 15. Biorefineries - Nasib Qureshi et al. (2014)	
Course description	This course provides an advanced, applied overview of modern biotechnology, with an emphasis on industrial biocatalysis, fermentation and bioprocess engineering, production and recovery of bioproducts, functional biotechnology, biomaterials, and environmental biotechnology. The course covers enzyme technologies, microbial fermentation, bioreactor operation and scale-up, precision fermentation, downstream processing, bioactive and functional ingredients, encapsulation and controlled release, biopolymers, active and intelligent packaging, biosensors, bioremediation, wastewater treatment, and waste valorization. Particular attention is given to the design, optimization, and application of sustainable biotechnological processes for producing chemicals, functional ingredients, materials, energy, and other high-value bioproducts.	
Course objectives	The course aims to develop students' advanced understanding of enzyme, microbial, and bioprocess technologies used in modern biotechnology, with particular emphasis on fermentation, bioreactor operation, process optimization, scale-up, and downstream processing. It provides knowledge of biotechnological approaches for producing chemicals, bioactive compounds, functional ingredients, biopolymers, and other high-value bioproducts, while introducing applications of encapsulation and controlled-release systems, active and intelligent packaging, and biosensor technologies. The	

	course also addresses environmental and sustainable biotechnology through bioremediation, biological wastewater treatment, waste valorization, biorefineries, biofuels, and circular bioeconomy, while developing students' ability to analyze, compare, and select appropriate biotechnological processes for industrial, food, and environmental applications.		
Learning Outcomes	Upon successful completion of the course, students will be able to: • Explain and evaluate advanced enzyme and biocatalytic technologies, including enzyme immobilization and stabilization strategies. • Analyze and optimize microbial fermentation processes by considering key biological and process parameters. • Evaluate bioreactor operation, process control, mass transfer, and scale-up requirements for biotechnological production. • Select and justify appropriate recovery, separation, and purification methods for different bioproducts. • Assess biotechnological approaches for the production of chemicals, bioactive compounds, functional ingredients, and other high-value bioproducts. • Explain and apply the principles of functional microbial biotechnology, encapsulation, controlled release, biopolymers, active and intelligent packaging, and biosensor technologies. • Evaluate biotechnological approaches to bioremediation, biological wastewater treatment, waste valorization, biorefineries, and renewable bioenergy production. • Design and critically assess integrated biotechnological processes for industrial, food, and environmental applications, considering process efficiency and sustainability.		
Teaching methods	Case analysis		x
	Group discussion		x
	Lecture		x
	Simulation		x
Evaluation Criteria	Methods	Date/deadlines	Percentage (%)
	Midterm Exam	November	30
	Quizzes	Each month	10
	Practical Assignments	Each class	10
	Activity	Each class	5
	Attendance	Each class	5
	Final Exam	January	40
	Total		100
Class Policy	Course Organization Course topics will be presented through lectures, visual materials, scientific literature, problem-solving activities, discussions, and, where appropriate, practical examples from contemporary science and industry. Students' understanding may be assessed through quizzes, oral or written questions, assignments, presentations, laboratory work, and examinations, as specified in the course syllabus. Students are expected to participate actively and come to class prepared. Questions and scientific discussion are encouraged. Attendance and Punctuality Regular attendance is expected. Students who miss classes for legitimate reasons should follow the relevant faculty/university procedures. Students who exceed the permitted absence limit may not be eligible to take the examination. Students arriving more than 10 minutes late may be recorded as absent but may normally join the class if this does not disrupt the lesson or create a laboratory safety concern. Respect and Classroom Conduct		

Students and the instructor are expected to maintain a respectful and professional learning environment. Scientific questions, different interpretations, and respectful disagreement are welcome.

Disruptive behavior, unauthorized conversations, disrespect toward others, and activities unrelated to the class are not acceptable. Mobile phones should be kept silent and should not be used for unrelated activities during class. Laptops and tablets may be used when they support legitimate academic activities, including calculations, scientific literature searches, data analysis, note-taking, or instructor-approved exercises.

Students will not be penalized or ridiculed for asking questions, giving an incorrect answer, or making an honest academic mistake.

Practical Assignments

Practical assignments may include laboratory work, case studies, process calculations, data analysis, or biotechnology-related problem-solving tasks. Assessment will be based on scientific understanding, correct application of methods, interpretation of results, and quality of submitted work.

Activity

Activity is assessed through active participation in class discussions, problem-solving exercises, case analyses, group activities, and responses to course-related questions throughout the semester.

Laboratory Work and Safety

The course includes two laboratory sessions designed to reinforce theoretical concepts through practical work. Students must follow all laboratory safety requirements, including wearing laboratory coats (bring their own laboratory coats) and other required PPE, handling chemicals or biological materials safely, operating equipment correctly, and disposing of waste appropriately.

Laboratory work must be documented systematically and honestly. Records should include, where applicable, the principle/objective, procedure, results, calculations, discussion, and conclusions.

Unexpected or unsuccessful experimental results should be reported and interpreted scientifically. Fabrication or deliberate modification of experimental data is prohibited.

A student who disregards safety instructions or creates a safety risk may not be allowed to continue the laboratory activity.

Quizzes, Assignments and Examinations

Assessment requirements, criteria, and major deadlines will be communicated in advance and applied consistently.

Students who miss a quiz, presentation, laboratory assessment, or other assessed activity for a legitimate reason should inform the instructor as early as reasonably possible and follow the relevant university procedure. Where permitted, a make-up assessment may be arranged.

Examinations and matters concerning examination absence or eligibility are governed by faculty and university regulations.

Presentations and Group Work

Presentations should demonstrate understanding of the subject, appropriate use of scientific information, and the ability to explain and discuss relevant concepts rather than simply reproduce information.

In group activities, every student is expected to contribute meaningfully and remain responsible for their own contribution.

Academic Integrity

Cheating, plagiarism, unauthorized collaboration, copying another student's work, fabrication or falsification of data, use of unauthorized materials, or presenting another person's work as one's own is unacceptable.

Sources must be acknowledged appropriately. Violations of academic or examination rules will be handled according to university regulations.

Responsible Use of Artificial Intelligence AI tools may be used for learning activities when permitted by the instructor. Students remain responsible for the accuracy, scientific validity, and integrity of everything they submit and must verify AI-generated information and references. AI must not replace the student's own work in assessments requiring individual performance and must never be used to fabricate data, observations, calculations, results, or references. Unauthorized AI use will be treated as unauthorized academic assistance. Scientific and Professional Relevance Students will be encouraged to connect theoretical knowledge with scientific literature, experimental evidence, laboratory practice, problem-solving, and relevant contemporary scientific or industrial applications. The aim is not only to memorize information but to develop the ability to understand, analyse, apply, and communicate scientific knowledge responsibly. Course Completion Students must meet the attendance, assessment, laboratory, and examination requirements established by the university and the individual course syllabus. Where the institutional passing threshold is 60%, students must achieve at least 60% to complete the course successfully.			
Tentative Schedule			
Week	Date/Day (tentative)	Topics	Textbook/Assignments
1	16.09.2026	Industrial Enzymes and Biocatalytic Processes	[1] p. 11-19, 25-54, 405-437
2	23.09.2026	Enzyme Immobilization and Biocatalyst Stabilization	[2] p. 41-84
3	30.09.2026	Microbial Fermentation and Process Optimization	[3] p. 1-22, [4]
4	07.10.2026	Bioreactor Engineering, Process Control and Scale-Up	[5] p. 489-563
5	14.10.2026	Precision Fermentation for Production of Chemicals and High-Value Bioproducts	[6]
6	21.10.2026	Recovery, Separation and Purification of Bioproducts	[3] p. 805-911
7	28.10.2026	Microbiome and Functional Microbial Biotechnology	[7], [8] p. 93-111
8		Midterm Exam	
9	11.11.2026	Biotechnological Production of Bioactive Compounds and Functional Ingredients	[9] p. 271-329
10	18.11.2026	Bioencapsulation and Controlled-Release Technologies	[10] p. 125-146
11	25.11.2026	Biopolymers and Biodegradable Polymers: Production, Properties and Applications	[11] p. 3-25, 28-54
12	02.12.2026	Active and Intelligent Packaging Technologies	[11] p. 3-11, 13-33, 172-204
13	09.12.2026	Biosensors and Bioanalytical Technologies	[13] p. 342-363, [14] p. 27-37
14	16.12.2026	Bioremediation and Biological Wastewater Treatment	[13] p. 85-142, 173-232
15	23.12.2026	Waste Valorization, Biorefineries and Circular Bioeconomy	[13] p. 293-313, [15] p. 37-54
		Final Exam	