

Al-Farabi Kazakh National University
Faculty of Biology and Biotechnology
Department of Genetic and Molecular Biology
Educational program by specialty 6B05101 - «Biological engineering» and 6B05103 -
“Biotechnology”
7 semester 2025-2026 Academic year
Methodological Guidelines for the Discipline: 2149 "Genetic Engineering"

1. Course Overview and Objectives

The course aims to provide students with a fundamental understanding of the techniques and applications used to manipulate the genetic material of organisms.

Primary Objective: To master the theoretical basis and practical skills required for DNA cloning, transformation, and genome editing.

Learning Outcomes: By the end of the course, students should be able to design a recombinant DNA molecule, select appropriate vectors, and understand the ethical implications of biotechnological advancements.

2. Key Thematic Pillars

The curriculum is divided into several core modules:

Molecular Tools: Study of restriction enzymes, ligases, and polymerases.

Vector Systems: Analysis of plasmids, viral vectors, and artificial chromosomes.

Recombinant DNA Technology: Steps of gene cloning, selection, and screening methods (e.g., Blue-white screening).

Advanced Techniques: PCR (Polymerase Chain Reaction), DNA sequencing (NGS), and CRISPR/Cas9 genome editing.

Applications: Genetic modification in agriculture (GMOs), medicine (gene therapy), and industrial biotechnology.

3. Teaching Methodology

To ensure effective learning, a blended approach is recommended:

Lectures: Focus on conceptual clarity and current scientific breakthroughs.

Laboratory Sessions: Hands-on experience is critical. Students must perform DNA extraction, gel electrophoresis, and bacterial transformation.

Case Studies: Analysis of real-world scenarios, such as the development of the insulin gene or drought-resistant crops.

Independent Study: Researching peer-reviewed journals to stay updated on emerging technologies like synthetic biology.

4. Assessment and Evaluation

Student progress should be evaluated through:

Quizzes: Short tests on molecular mechanisms.

Lab Reports: Documenting experimental procedures, results, and troubleshooting.

Final Project: Designing a theoretical experiment to solve a specific biological problem using genetic engineering tools.

Exams: Assessment of comprehensive theoretical knowledge.

5. Ethical and Safety Standards

Biosafety: Strict adherence to laboratory safety protocols (Levels BSL-1/BSL-2) is mandatory.

Bioethics: Dedicated seminars on the ethical considerations of "designer babies," cloning, and environmental impact of GMOs are essential to cultivate responsible scientists.

6. Recommended Resources

Textbooks: "Molecular Cloning: A Laboratory Manual" (Sambrook & Russell); "Principles of Gene Manipulation and Genomics" (Primrose & Twyman).

Software: Benchling or SnapGene for plasmid mapping and primer design.