

**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.