

GENETIC ENGINEERING AND ITS IMPORTANCE IN BIOTECHNOLOGY

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Abstract

This article examines genetic engineering and its importance in biotechnology. Specifically, it covers the concept, history, and main methods of genetic engineering. The application, advantages, and potential challenges of genetic engineering in medicine, agriculture, industry, and ecology are discussed. Information on the capabilities and prospects of modern gene editing technologies is also provided.

Keywords: Biotechnology, genetic engineering, recombinant DNA, gene editing, genetically modified organisms, biological products, biotechnology in medicine, biotechnology in agriculture.

Introduction

Biotechnology is one of the fastest-growing fields of modern biological science. It is based on the use of living organisms, cells, enzymes, and other biological systems for the benefit of humanity. A key part of this field is genetic engineering—the technology of creating organisms with new properties through the targeted modification of their genetic material. Humanity currently faces various global challenges: disease, food shortages, environmental pollution, and questions about the efficiency of industrial production. Biotechnology and genetic engineering play a vital role in addressing these issues. For example, genetic engineering can be used to create high-yielding plants resistant to diseases and pests, produce biological substances essential for human medicine, and implement environmentally friendly technologies. The essence of genetic engineering is that it goes beyond simply modifying the external characteristics of organisms; it also enables targeted control of their internal molecular systems. This opens up new possibilities for scientific advancement and helps to better understand the

biological processes of living organisms. Thus, genetic engineering is an integral part of modern biotechnology, and its application is widespread in medicine, agriculture, industry, and ecology. The introductory section aims to cover the main topic of the article and explain the importance of genetic engineering and biotechnology to the reader. In this regard, the article examines in detail the concept of genetic engineering, its main methods, its application in biotechnology, and its prospects. This knowledge is not only of scientific interest but can also be effectively applied in practical applications.

Genetic engineering is the art and science of purposefully modifying the genetic information (DNA) of living organisms. It allows for the creation of desired characteristics by introducing new genes into an organism, editing existing genes, or deleting specific genes. These processes are carried out using recombinant DNA technology and are widely used in various fields, including medicine, agriculture, and industry. The science of genetic engineering emerged in the second half of the 20th century. In the 1970s, the impetus for its development came from discoveries in molecular biology, such as restriction enzymes and ligases. It was during this period that scientists developed methods for cutting, multiplying, and inserting DNA molecules into various organisms. As a result, it became possible to produce biologically active substances important for humans on an industrial scale using bacteria. In 1973, Stanley Cohen and Herbert Boyer created the first recombinant DNA molecule, which they introduced into the bacterium *E. coli*. This scientific experiment shaped the basic paradigm of genetic engineering and laid the foundation for the development of biotechnology worldwide. At the same time, the science of genetic engineering has raised social and ethical questions for humanity, as gene editing has made it possible to influence living systems. Today, genetic engineering is widely used not only in laboratories but also in practical applications. For example, in medicine, practical results have been achieved, such as the production of insulin using bacteria, the creation of disease-resistant plants in agriculture, and the optimization of enzyme synthesis in industry. Thus, genetic engineering has become one of the most important fields translating scientific advances into practical applications.

Genetic engineering is accomplished using a variety of methods and technologies. These methods are central to the fields of biology and biotechnology, and each

method is selected based on the intended purpose. The most commonly used basic methods are:

1. Isolation of the desired gene. The process of genetic modification begins with the selective isolation of the desired gene. This process is typically performed using restriction enzymes. Restriction enzymes isolate the target gene by cutting the DNA molecule at a specific location. The isolated gene is then prepared for cloning and other processes.
2. Gene amplification (cloning). The isolated gene is amplified through cloning. This process involves amplifying the gene using a plasmid, virus, or other vector. This produces multiple copies, allowing for the manipulation of genetic material in the laboratory. The cloning process is important for creating new DNA molecules and their use in further research.
3. Introduction of the gene into the recipient cell. The amplified gene is introduced into the recipient cell. This process is called transformation. Bacteria, yeast, animal cells, or plant cells are used as the gene recipient system. The recipient cell introduces the new gene into its genome and begins synthesizing the desired protein or trait.
4. Selection and expression. Successful transformations are selected from among the cells into which the new gene has been introduced. In the selected cells, the new gene begins to function, producing the desired biological product (protein, enzyme, hormone). This stage ensures the practical outcome of the genetic engineering process.
5. Modern gene editing technologies. In recent years, modern gene editing methods such as CRISPR-Cas9 have emerged. This technology has made it much easier to cut, edit, and insert new genes at a precisely defined location within the gene. CRISPR technology is widely used not only in scientific research but also in medicine and agriculture.

Genetic engineering plays a vital role in various fields of biotechnology. This technology is widely used to improve human life and the environment. Its main applications are listed below:

1. Importance in Medicine. Genetic engineering has revolutionized the field of medicine. For example: Insulin Production: Insulin was previously obtained from animals, but it is now produced using genetically modified bacteria. This method has improved the safety and effectiveness of the product. Biological Drugs:

Interferons, growth hormones, and vaccines are produced using genetic engineering. Gene Therapy: It is used as a promising method for treating hereditary diseases and genetic defects.

2. Importance in Agriculture. In agriculture, genetic engineering is used to create genetically modified plants. These plants exhibit high yields, are resistant to diseases and pests, and adapt to adverse climatic conditions. This results in increased food security and improved quality of agricultural products.

3. Importance in Industry. In industrial biotechnology, genetic engineering is used to produce enzymes, amino acids, vitamins, and biofuels. Genetically modified microorganisms synthesize useful products with high efficiency. This contributes to the development of environmentally friendly and resource-saving technologies.

4. Importance in Ecology. Genetic engineering is also useful for solving environmental problems. For example, during bioremediation, contaminated soil and water can be purified using specialized microorganisms. This technology is an effective tool for environmental protection.

5. Importance in Science. Genetic engineering enables a deeper understanding of the fundamental laws of biology. Gene editing allows for the control of cellular processes, determination of gene function, and the creation of new biotechnological products.

Genetic engineering is a crucial area of biotechnology and offers a number of advantages. Using gene editing and recombinant DNA technologies, biological products are produced quickly and efficiently. Biotechnological processes consume fewer natural resources and deliver high yields. Microorganisms used in industrial processes involving genetic engineering are environmentally friendly. Genetically modified plants also increase productivity and reduce food insecurity. In medicine, insulin, growth hormone, vaccines, and other drugs are produced using genetic engineering, providing patients with safe, high-quality medications. However, genetic engineering is not without its challenges. Genetically modified organisms can impact natural ecosystems when released into the environment. Gene editing raises ethical issues regarding human or animal cells. Furthermore, genetic engineering technologies require highly skilled personnel and specialized equipment. However, these challenges can be mitigated through scientific oversight and strict procedures.

In conclusion, genetic engineering is an integral part of biotechnology and is of paramount importance to human life and the development of society. It creates new opportunities in medicine, agriculture, industry, and the environment. It increases the efficiency of biological production, ensures food safety, and protects the environment. At the same time, attention must be paid to biosafety and ethical issues associated with genetic engineering. In the future, gene editing technologies will continue to develop, playing a significant role in solving global problems and creating new opportunities for humanity.

REFERENCES:

1. Tashmuxeamedova Sh.S. Biotexnologiya. Toshkent: Mehr-nuri, 2024.
2. Sobirov P.S., Kaxarov A.K., Xushvaqtoov A.A., Shatakov E.S. Genetika va biotexnologiya. Toshkent: O'zbekiston faylasuflari milliy jamiyati nashriyoti, 2019.
3. Kornilov X.M., Rahimov M.M. Biotexnologiya asoslari. Toshkent: Extremum Press, 2010.
4. Artikova R.M. Gen muhandisligi. Toshkent: ToshDAU, 2023.
5. Usmonova Sh. Zamonaviy biotexnologiyaning tibbiyotdagi o'rni: gen muhandisligi yutuqlari va istiqbollar. Modern Science and Research, 2025.