

СЕКЦІЯ 11.

АГРАРНІ НАУКИ ТА ПРОДОВОЛЬСТВО

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BIOTECHNOLOGY AS A TOOL FOR SOLVING GLOBAL FOOD SECURITY CHALLENGES

Modern biology has moved far beyond the classical science of living organisms that existed in the 19th century. Today, it is no longer limited to the study of the surrounding world but has become a tool for transforming it to meet human needs and demands. According to scientists, humans occupy the highest stage of evolution, standing at the top of the trophic chain—from unicellular organisms (fungi, bacteria, protozoa) to humans. Farm animals, poultry, and fish represent an intermediate stage in this chain [1–3].

One of the most significant and defining events in biology over the past half-century has been the emergence of biotechnology as an applied branch of biological science.

The foundation of modern industrial biotechnology is microbiology in all its numerous branches and specializations. Among the achievements of microbiologists in animal husbandry are the production of enzymes, amino acids, vitamins, antibiotics, and various pharmaceuticals manufactured by the pharmacological industry.

Biotechnologies in animal reproduction are of exceptional importance for improving productivity and preserving the gene pool of livestock breeds. Through methods such as artificial insemination, embryo transfer, and cryopreservation, the rapid multiplication of valuable breeding animals is possible. This not only enhances the hereditary qualities of livestock but also effectively combats animal infertility. An important direction is the use of DNA technologies to monitor hereditary diseases and increase resistance to illnesses. Thus, biotechnology ensures the stable development of animal husbandry and its adaptation to modern challenges [1,4–6,11]. In the near future, our country will undoubtedly restore—and even surpass—its lost global positions in this field. The country has accumulated enormous experience, with numerous examples to draw upon. The available resources are sufficient to give a powerful impetus to development.

The importance of the field is underscored by the fact that the global population is growing, while arable land is decreasing (due to soil and wind erosion, climate change, salinization, pollution, and the misuse of agricultural lands). Combating hunger, poverty, and underdevelopment is one of the most urgent global challenges that civilized society must solve jointly, within the framework of economic unions, alliances, and agreements.

How can we ensure food security for a constantly growing global population? Biotechnology offers one of the solutions. Biochemistry comes to the aid of

biotechnology. It is well known that plant biomass, which is renewable by nature, can serve as raw material for biochemical processes that use biosynthesis to create essential nutrients necessary for the development of living organisms. Moreover, the action of different representatives of the microbial world is strictly specific: each transforms only certain compounds and exclusively in the direction characteristic of its genus. Gathered into starter cultures, multienzyme compositions, and various polyenzymes, microorganisms enter into biochemical reactions at a strictly defined time and under specific conditions.

It is important to emphasize the significance of using enzymes for the efficient solution of tasks such as carbohydrate production — the foundation for the food, feed, oil and fat, sugar, alcohol, and brewing industries — particularly when plant residues from these productions are used as raw materials. The bioconversion of such waste and its role in feeding farm animals is expected to increase further. Proper utilization of these residues can significantly reduce the consumption of feed grains in livestock, poultry, and fish farming without compromising productivity.

Biochemistry has enabled the industrial use of enzymes — biological catalysts. In terms of their activity, they surpass artificial (synthetic) catalysts. In the presence of such catalysts, chemical reactions occur without relatively high temperatures or pressures, and at an extremely rapid rate.

Microorganisms also produce carbohydrates, lipids, vitamins, and mineral substances; their productivity is many times higher than that of plants and farm animals.

Figure 1 shows the doubling time of different unicellular microorganisms, predators, herbivorous animals, birds, and fish.

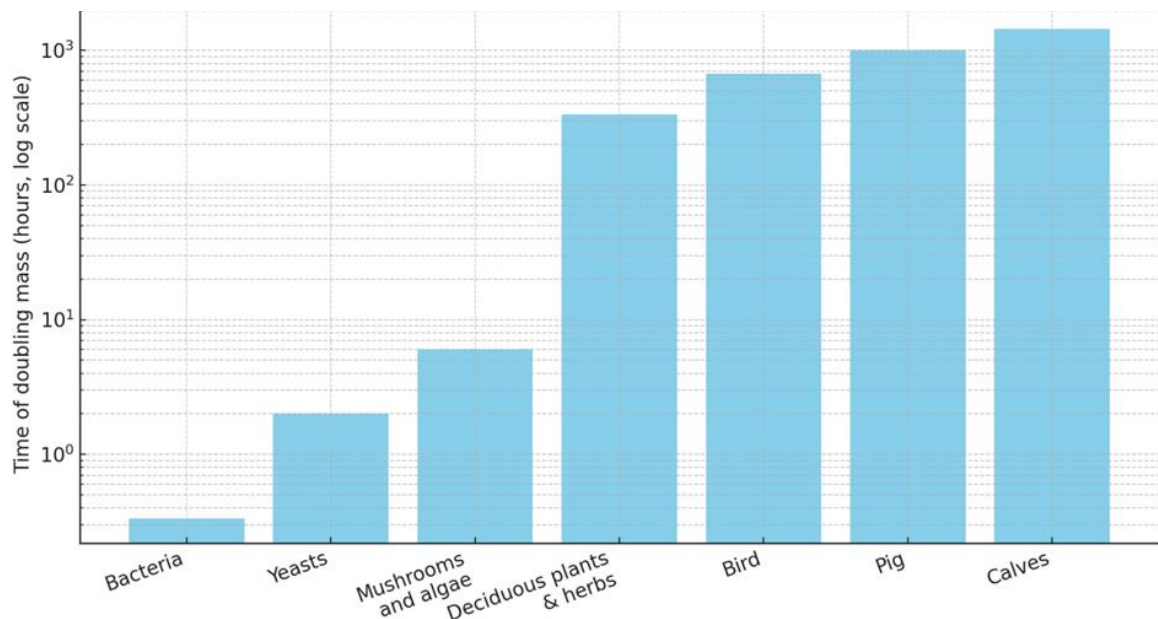


Fig. 1. Doubling time of different organisms

The data show that microorganisms grow 500 times faster than the most productive agricultural crops and 1,000–5,000 times faster than the fastest-growing animal breeds. As is known, microorganisms are capable of accumulating large amounts of protein (up to 60–70% of dry mass). The resulting biomass is used as an excellent feed enhancer and serves for the production of fermented protein feed supplements. To produce such

supplements, biotechnologies based on the use of yeasts, fungi, and bacteria are most often applied.

The industrial use of microorganisms and enzymes clearly highlights the positive aspects of biotechnology:

- the possibility of using renewable raw materials;
- relatively mild conditions of the industrial process;
- reduction in the number of process steps;
- virtually minimal environmental pollution.

Genetic modification and modern genomic methods open new prospects for accelerated improvement of living organisms and the creation of more efficient farming systems. These approaches make it possible to significantly increase productivity compared to traditional agricultural methods. At the same time, the development of biotechnology is accompanied by serious global debates regarding its impact on the future of world agriculture. In most cases, these discussions reflect the positions of developed countries and insufficiently consider the urgent needs of developing countries, particularly the challenge of ensuring food security for low-income populations. Scientists emphasize that biotechnology, especially genetic modification, can become one of the key tools for overcoming the food crisis and meeting the long-term needs of low-income countries. However, its implementation requires a clearly defined policy framework to ensure control over potential risks to human health, the environment, and socio-economic development [7–10,12].

It should be noted that the successful use of biotechnology is possible only when scientific innovations are combined with international cooperation, a transparent regulatory system, and adaptation of technologies to the specific conditions of each region. An important aspect is also the formation of public trust in new technologies through proper communication, educational programs, and raising public awareness.

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