Industrial biotechnologies: global technology trends

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Abstract. Because of the depletion and deterioration of fossil sources of raw materials, adverse climate change in populations, pollution, environmental pollution and other factors, it is important to develop a bioeconomy based on its use of new resources of raw materials and technology for processing them. It is worth noting that the most important task for development of industrial biotechnology, the pharmaceutical industry and forest complex, bioenergy and other products has to provide new raw materials with the required properties. In many ways, the problem is resolved by creating fast-growing plant for different purposes obtained by biotechnological methods, and also to obtain non-traditional renewable raw materials (microalgae, biomass of cultivated cells from high plants, etc.). Another special place is occupied by technologies for the production and use of unicellular organisms (microalgae, yeast and bacterial producers), as well as technologies for the production and use of unicellular organisms (microalgae, yeast and bacterial producers), as well as plant transformants. Plant transformants and microclonal propagation are also used in this field.

1 Introduction

Industrial biotechnologies represent a dynamic and transformative sector with the potential to revolutionize industries and address pressing global challenges. In recent years, this field has witnessed a surge in research, development, and implementation of biotechnological solutions across various industrial domains. From healthcare and agriculture to energy and environmental management, the impact of industrial biotechnologies is profound and far-reaching. This introduction sets the stage for a comprehensive exploration of global technology trends in industrial biotechnologies. It provides an overview of the key drivers, challenges, and opportunities that define this rapidly evolving landscape. As industries worldwide seek more sustainable, efficient, and environmentally responsible practices, industrial biotechnologies have emerged as a pivotal instrument in achieving these goals. In the following sections, we will delve into specific trends and innovations within industrial biotechnologies, highlighting their implications for sectors such as healthcare, agriculture, bioenergy, and waste management. Additionally, we will consider the broader societal and

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economic implications, emphasizing the role of biotechnology in advancing the United Nations' Sustainable Development Goals (SDGs). As we navigate the complex and ever-changing terrain of industrial biotechnologies, it becomes evident that collaboration among researchers, industries, policymakers, and the public is indispensable. Together, they can harness the potential of biotechnology to drive innovation, economic growth, and environmental sustainability. This exploration aims to shed light on the exciting developments and future prospects within industrial biotechnologies, ultimately contributing to a more informed and engaged global community.

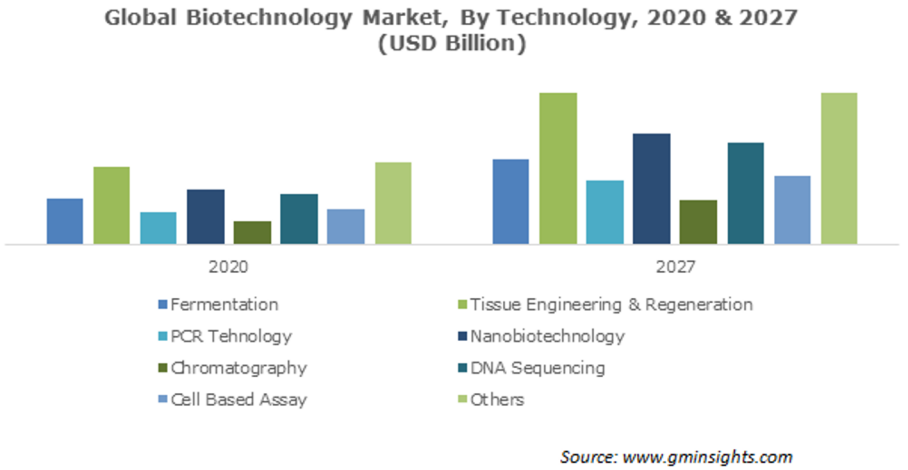

Fig. 1. Biotechnology Market Size

In Russia, industrial biotechnology is developing in various fields. For example

1. Agricultural biotechnology: Russian scientists develop resistant plant varieties that can withstand adverse climatic conditions and diseases.

2. Pharmaceutical biotechnology: Russian companies develop new drugs and biological agents, work on biomedical technologies.

3. Bioproducts and food industry: Various biotechnological methods are being developed for the production of biological additives, functional foods, as well as improving the quality and safety of food products.

4. Industrial biotechnologies: Microorganisms are also actively used in Russia for the production of chemicals, bioplastics and other materials.

5. Biofuels and bioenergy: research is aimed at obtaining energy and fuel from biological resources.

6. Biotechnologies in ecology: work is underway on the use of biotechnologies to solve environmental problems, for example, for the bioremediation of polluted areas. Biotechnological research and innovation: Russian scientific and educational institutions are actively involved in biotechnological research and development, contributing to innovation and the development of new technologies [4].

These are just a few examples of how the development of industrial biotechnology in Russia continues to grow and attract the attention of the scientific and business community.

2 Research Methodology

In examining global technology trends within the field of industrial biotechnologies, a systematic and comprehensive research methodology is crucial. This section outlines the

approach and methods employed to analyze and understand the evolving landscape of industrial biotechnologies. The research methodology encompasses the following key components:

Literature Review: A thorough review of existing academic, industry, and government literature is conducted to gain a comprehensive understanding of the subject matter. This involves the analysis of scientific publications, patents, reports, and policy documents related to industrial biotechnologies.

Data Collection: Data is collected from a variety of sources, including scientific databases, industry reports, and international organizations. This data encompasses technological advancements, market trends, investment patterns, and regulatory developments in the field.

Data Analysis: Analytical tools and techniques are applied to assess and interpret the collected data. This involves quantitative analysis of trends, such as the growth of biotechnological patents, investment flows, and the adoption of biotechnologies in different industrial sectors.

Case Studies: To provide a more in-depth understanding of specific trends and innovations, relevant case studies are examined. These case studies highlight the real-world applications and impacts of industrial biotechnologies in various industries.

Expert Interviews: Interviews with experts in the field, including researchers, industry professionals, and policymakers, are conducted to gather insights and perspectives on emerging trends and challenges.

Comparative Analysis: A comparative analysis of trends and developments is performed across different industrial sectors and regions. This allows for the identification of commonalities and variations in the adoption of biotechnological solutions.

Impact Assessment: The research methodology includes assessing the broader societal, economic, and environmental impacts of industrial biotechnologies. This involves considering their contributions to sustainable development and the achievement of global goals.

Future Prospects: The research methodology also explores the future prospects and potential disruptive innovations in industrial biotechnologies. It considers how these technologies may shape industries in the coming years.

Synthesis: The findings from the literature review, data analysis, case studies, interviews, and impact assessment are synthesized to provide a comprehensive overview of the global technology trends in industrial biotechnologies.

Report Composition: The results of the research are compiled into a structured and informative report that presents an analysis of the current state of industrial biotechnologies, future outlook, and their significance in the context of global technological advancements.

By following this research methodology, we aim to provide readers with a well-rounded understanding of the trends and developments in industrial biotechnologies and their implications for various industrial sectors and society as a whole. This research contributes to informed decision-making, innovation, and sustainable development in the rapidly evolving landscape of industrial biotechnologies.

3 Results and Discussions

In what biotechnology will play an important role in protecting the environment and creatings new materials to improve life (fig.2) World is rapidly moving intowards "bioeconomy", in what direction will be an economic order that depends on raw materials and energy, it cannot not say. The main force of technological developments in the field of bioeconomy is biorefining, that is, the production and creation of biofactories. Biofactory

technology will allow the smooth transition from the "chemical industry" that is made of fossil hydrocarbon raw materials to the "green" industry of semi-finished products and fine chemicals, such as fine chemical systems based on biomass (biomass) to the "green" industry of semi-finished products and fine industrial equipment.

A renewable feedstock can be any type of renewable feedstock, such as food crops and non-food biomass, industrial waste, carbon dioxide gases from the production of industrial plant [5]. The process of bioprocessing, raw materials are processed by the use of an entire set of techniques that include both traditional biological approaches and new developments in terms of metabolic engineering, bioinformatics, nanotechnology and high-performance analysis methods. Socalled "omic" (genomics) is one of them. Transcriptomics, proteomics, etc.). (Transcriptomics, proteinomics, etc.) is the name of. A wide range of target products with high added value can be obtained. For biorefining development, the long-term goal of BioRefining Development is to replace products derived from fossil raw materials (petrochemicals) with new products [6]. In the OECD, biotechnology will be used in 30% of all chemical products, 50% of agricultural product and 80% pharmaceuticals by 2030. In the amount of biotechnologies that are needed for this is about 40%. Biotechnology products can account for up to 2.7% of the total GDP in most countries, and even Russia will be more able. It is worth noting that Russia has unique natural resources, they have unlimited reserves of renewable plant raw materials and huge reserves of fresh water. The land in its own region is fertile with arable land, competent personnel and scientific schools. This is what it has to do with this global process.The Russian Federation is unable to exclude its own country in such a situation. A form of public-private partnership, "Biotechnology Industry and Bioresources" is the name of an innovation platform that will help to connect interests of state, science and business in building a bioeconomy. It is designed to align and harmonize all interests from the state, science and business in building a bioeconomy in Russia. In 2020, biotechnology will be 1% of Russia's total economic production. The goal for this is to achieve the level in order to reach 3% of the Russian GDP by 2030. biotechnology has an ambitious but achievable goal of attaining 3 percent from the national budget.

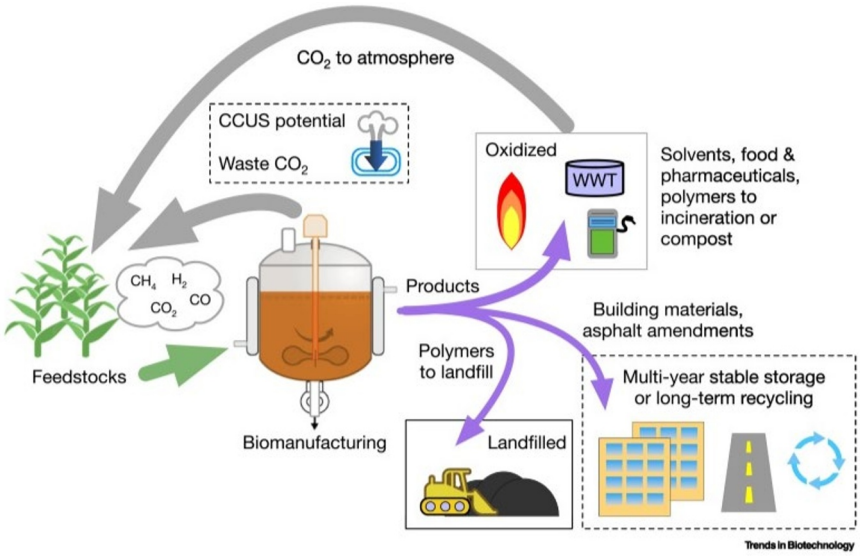

Fig. 2: Prospects for carbon-negative biomanufacturing: Trends in Biotechnology

In today's economy, three main sectors of technology development are key to innovation: information systems, nanotechnologies and biotechnological innovations. In the modern economy, three areas of technology development are key to innovation: information systems, nanotechnologies and biotechnological innovations. They are information techniques, nanotechnologies and biotechnology. The main ones in this area are information techniques, nanotechnologies and biotechnology. It is expected that the world market for biotechnology products will reach USD 2 trillion in 2025, but the global market for biotechnology product can grow from 5 to 30% per year by 2025. The world market for biotechnology products will be USD 2 trillion in 2025, but individual segments have different rate of development and are growing by 5 to 30% per year. Experts estimate that the global market for biotechnology products will be USD 2 trillion in 2025, but individual market segments have different rate of development and are growing by 5 to 30% per year. Russia's share of the entire world market in this sector is less than 0.1 percent. Today, Russia's share of the entire world market in this sector is less than 0.1 percent. Since the end of the year, it has been reduced to zero in many sectors (biodegradable materials, biofuels) for some years. Biotechnology is not an overestimated field, but it can be hardly overestimated. Biotechnology is not underestimated in the development of the Russian economy. The importance of biotechnology in the development of the Russian economy is not underestimated. On the basis of this, it is necessary to develop the long-term development of the social and national system. The main goal for the long-term development of the social and national system: possible losses from old market capitals, depreciation of most important export goodies on international food products due to substitution by newly produced raw materials, convincingly demonstrate that there should be a national biotechnology complex. At the expense of mass introduces in biotechnology and scientific products, modernization is not possible. In absence of mass introductions in the field, biotechnology and biotechnological products, modernization is not possible. There are no plans to modernize the industrial base of modern industrial production. The reason for this is that there are no plans to modernize the industrial base of modern industrial production. The modernization of many sectors (forestry and agri-food) is the transfer to biotechnological methods [8]. For many sectors (forestry and agri-food) modernization is the transfer to biotechnological methods [8]. The transfer to biotechnological products is the process of modernization in some of them (forestry sub-sectors with several undersections from industrial chemical industry, pharmaceutical Industry and Biomedical Health Sector), modernizing is the transfer to biotechnological products. At the same time, in some forest sectors there are more than two Subsectors: Industrial Pharmaceutical Industry or Biomedical Health Sector. For example, for many such forest sectors there are more than two Subsectors: Industrial Pharmaceutical Industry or Biomedical Health Sector. A new era of modernization is also extended by the use of biotechnological materials and methods. The most popular countries in the world with an large population of consumers from biotechnological products are mainly developed countries such as Canada, Japan and EU. The technological race has also joined many countries: China, India and Brazil are implementing major development programs across the whole range of biotechnology. It is intended to develop large-scale projects for the entire biotechnology range. The program is intending to develop large-scale projects for the entire spectrum of biotechnology.

Biotechnology products are used in a wide variety of areas:

- industry (chemicals, bioplastics, biocatalysts and industrial enzymes);
- agriculture (feed protein, vitamins, enzymes and other feed additives, plant protection products, probiotics, new varieties of cultivated plants and animal breeds);
- food production (food additives, starter cultures, food enzymes);
- forestry (fast-growing plants, plant protection products, timber processing products);

• environmental protection (products promoting waste disposal, bioremediation agents, etc.)

Industrial biotechnologies include large-scale, mainly microbiological, production of bioproducts used in various industries, agriculture, mining, food, environmental protection and other industries. Biological products for industrial use include such large-tonnage basic chemicals as organic acids and their derivatives, alcohols, alkenes, glycols, polyhydroxyalkanoates, biocatalysts and industrial enzymes, drugs that increase oil recovery, reagents for the production of pulp and paper products, etc. A number of chemical products are feedstock for the production of biopolymers, both biodegradable and stable [9]. Feed amino acids, vitamins, enzymes, antibiotics, probiotics, single-cell feed proteins and other biologically active substances are used in agriculture.

The direction of industrial biotechnology also includes the production of the main raw material of industrial biotechnology - various sugars - from renewable raw materials. Particularly promising are cellulose-containing products such as wood waste and agricultural waste. The most promising markets and product groups in this biotechnology segment are:

Table 1. The most promising markets in the segment biotechnology

Groups of innovative products and services	Feature
Large-capacity feed additives: - essential amino acids – vitamins - feed protein	Possibility to create new functional food Acceleration of catalytic processes, slowing down unwanted processes
Enzymes: – industrial enzymes and biocatalysts – feed and food enzymes	Increasing the digestibility of feed and food Possibility of prevention excessive environmental pollution environments
Chemicals including monomers for biodegradable polymers: - organic acids, alcohols, diols – hydrocarbons	Environmentally friendly and closed loop production Ecologization of crop production, including
Biological remedies plants (biopesticides, bioinsecticides) and biofertilizers	including by providing food and plant protection through natural biological objects
Polysaccharides, lignosulfonates and other means to increase oil production	

In the structure of the market, the main share falls on the amino acids lysine and threonine. While maintaining the existing growth rates, the supply of amino acids on the market by 2025 can reach 90-100 thousand tons and 265-300 million US dollars. The Russian Federation is currently building 2 plants for the production of lysine, one of which is a plant in the city of Shebekino, Belgorod Region, to produce 55 thousand tons of lysine sulfate according to the technology developed at FSUE GosNIIgenetika. Also, a plant for the production of lysine sulfate is being built in Volgodonsk, Rostov Region, according to the technology and together with the Evonik company (Germany). The Russian market of feed additives is completely dependent on imports of vitamins, among which the main place is occupied by riboflavin, ascorbic acid, folic acid, etc.

The most significant on an industrial scale are: citric acid (77% of the market volume), lactic acid (16%) and tartaric acid (6%). Imports account for 65% of the value estimate. At the same time, acids - monomers of biopolymers [10]: lactic and succinic acids have the greatest market potential. Based on the production of biopolymers, the Razgulay group of companies, together with the Federal State Unitary Enterprise GosNIIgenetika, with the

financial support of the Ministry of Education and Science of Russia and the Administration of the Republic of Bashkortostan, is developing a technology for the biotechnological production of lactic and succinic acids.

The Renova Group of Companies has announced a project to build a high-tech plant for the production of lactic acid biopolymers (PLA) in Russia with a capacity of up to 130 thousand tons per year and a total investment of 16 billion rubles. According to the company, the capacity of the new market is estimated at up to $4 billion in 2020. Biological preparations for industrial use also include industrial enzymes, oil biodegraders and preparations that increase oil recovery, reagents for the production of pulp and paper products [11]. Enzyme preparations are used in the production of food products, detergents, alcohol, leather production, as well as in agriculture as feed additives. As of 2023, the volume of the Russian market for industrial enzyme preparations was estimated at $183 million, with a projected annual growth rate of 10%.

4 Conclusions

For increasing the efficiency of production and ensuring food security in Russia, modern agrobiotechnologies are one of the foundational elements for increasing the efficiency of farming and development. The new areas of agrobiotechnology are in the field of biotechnologies, which include the use of plant and animal animals to obtain new bioproducts for industrial and medical purposes. It is especially important to expand the production of domestic entomophages and pollinators in modern conditions for solving the problems of import substitution. Now greenhouse vegetable growing is heavily dependent on imported entomophages and pollinators, the prices of which have increased significantly due to fluctuations in the foreign exchange market. It should be noted that the use of entomophages and pollinators is an indispensable element of industrial technologies for intensive crop production in protected ground, the area of which is steadily growing in Russia. Therefore, the expansion of domestic production of this type of biotechnological products is very timely and in demand. New greenhouse complexes use industrial plant growing technologies focused on biological plant protection, which is impossible in modern greenhouses without the use of entomophages. Lines of entomophages and pollinators should have a high genetic potential of traits that determine their reproduction and stress resistance. Therefore, these biotechnological products undergo mandatory selection and genetic improvement using modern molecular genetic methods. The main areas of work in this area will be:

- New varieties of agricultural plants;
- Breeds (types, lines) of animals with high genetic potential of productive traits and improved product quality;
- New biotechnological forms of trees with given characteristics;
- Microbial strains and microbial consortia designed to create symbiotic plant-microbial communities that provide plant nutrition with minerals and protect them from pathogens;
- Plants and animals - "biofactories" for obtaining bioproducts for industrial and medical purposes;
- Feed preservatives and silage cultures;
- Balanced feed and premixes;
- Lines of entomophages and insect pollinators for protection and increase of crop productivity in greenhouse crop production.

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