Industrial biotechnologies. Main market segments

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Abstract. The current state of the biotechnology market in Russia is difficult to assess from different points of view. On the one hand, the country is significantly behind compared to the leading countries in this industry in terms of production volumes, level of market development and growth rates. On the other hand, in Russia there is a growing demand for biotechnological products from consumers. This growth is driven by factors such as an increasing population, changing healthcare needs and increased awareness of the benefits of biotechnology solutions. This growing demand represents an opportunity for both Russian and foreign biotechnology companies. However, there are a number of problems, among which are the high dependence on imports of key biotechnological products, as well as the lack of our own innovative products in this area. To strengthen the competitiveness of the biotechnology market and ensure domestic innovative products, measures are needed to stimulate investment in research and development, promote research and educational institutions, create a supportive regulatory environment and develop human capital in this area.

1 Introduction

Biotechnology represents the convergence of natural and engineering sciences, allowing us to harness the potential of living organisms and their derivatives to create and modify animal breeds, agricultural plant varieties, products, and processes for various applications. Its primary domains of application include medicine, agriculture, the food industry, as well as addressing energy, environmental, and scientific challenges [1]. Biology has seen significant advancements in recent decades, leading to the emergence of a multidisciplinary field known as physical and chemical biology. This field encompasses biochemistry, biophysics, molecular biology, genetics, bioorganic chemistry, and other related disciplines, enabling us to address long-standing biological questions and opening up new possibilities for biological production [2].

Biotechnology, a product of these advancements, has rapidly evolved over the past two decades and matured into a robust discipline. The growing knowledge of life processes not only enables the adaptation of these processes for practical purposes but also their precise control and the creation of entirely novel systems that hold promise for various practical

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applications, even if they don't exist in nature. In essence, biotechnology is a comprehensive set of techniques for the deliberate manipulation of the life processes of living organisms to industrially produce valuable products [6].

Biotechnology has rapidly advanced in recent years due to several distinctive characteristics:

1. Knowledge-Intensive Production: Biotechnological production is highly reliant on knowledge, and its development leads to a significant increase in economic efficiency.

2. Seamless Transition from Fundamental to Applied Research: Biotechnology blurs the lines between fundamental and applied research. There is minimal time between achieving fundamental results and developing practical applications in this field.

3. Utilizing Natural Diversity: Biotechnology is built on the use of cells and biological molecules, providing extensive opportunities for harnessing natural diversity. The outcomes of fundamental biotechnological research are programmable and have significant practical implications.

4. Sustainability and Resource Management: Biotechnology offers the potential to replace non-renewable resources with renewable ones, making it a solution for issues related to the depletion of non-renewable natural resources [7].

It's important to note that the United States leads the global bioindustry, accounting for over half of its turnover. For comparison, the funding allocated for biotechnology is approximately $100 billion in the United States, $1 billion in China, $0.04 billion in Russia, and several million dollars in Kazakhstan for targeted research and development in the field of biotechnology. The member states of the Customs Union and the Common Economic Space have been implementing national projects and a joint interstate target program called "Innovative Biotechnologies" within the framework of the EurAsEC since May 2010.

2 Research Methodology

Large-scale chemical biotechnologies are fundamentally grounded in the concept of applying similar principles to those observed in living organisms and directing them to function within a controlled environment for the production of essential products (fig.1). Several characteristic features can be identified for chemical biotechnologies.

First, they involve the use of nutrient-rich raw materials, which can either be of plant or animal origin and are abundant in simple carbohydrates or polysaccharides. In cases involving polysaccharides, a more or less complex stage is typically required to convert them into a form that is more readily absorbed.

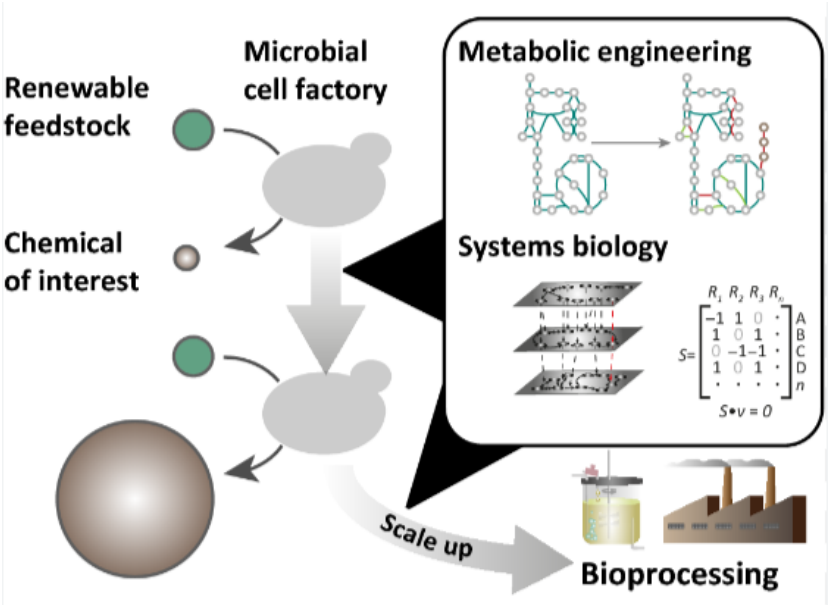

Fig. 1. Bioprocess Technology

Secondly, biotechnologies either employ living organisms directly, which feed on these raw materials under anaerobic conditions, or they reconstruct the biochemical processes taking place in living cells through the use of synthetic or natural enzymatic systems. An alternative approach is the utilization of genetically modified living organisms, where their natural metabolic pathways are modified to favor the production of desired products.

In light of these distinctive features, this study does not cover the production of biodiesel and glycerol, as there is no actual biochemical transformation of the raw material involved. For instance, in biodiesel production, vegetable oil undergoes traditional chemical processing. However, it's important to note that the diesel fraction obtained in this process could theoretically be subjected to traditional steam pyrolysis to produce classic petrochemical products such as ethylene, propylene, and aromatic compounds.

It is essential to recognize that key success factors may not remain constant. They can evolve in response to industry characteristics, economic and market changes, and the stage of the industry's life cycle, as well as the stage of an individual enterprise's development.

3 Results and Discussions

The global experience in organizing biotechnological production offers valuable insights that can be adapted to individual countries. Learning from successful models and approaches from around the world can help expedite the development and competitiveness of the biotechnology industry within a given nation.

Effective corporate governance plays a pivotal role in ensuring the success of biotechnology enterprises [4]. This involves setting strategic objectives, regulatory compliance, ethical considerations, risk management, and efficient decision-making processes. Corporate governance practices should be adapted to the unique characteristics of biotech companies.

Additionally, a comprehensive analysis of the sources of financing for biotechnology companies is essential [6]. These enterprises often rely on various funding sources, such as venture capital, government grants, strategic partnerships, and public markets.

Understanding the interplay of these financial sources is crucial for ensuring sustainable growth.

Marketing activities are equally vital for biotech companies, as they need to identify and cater to specific market needs [7]. The healthcare and life sciences sectors often require a deep understanding of customer demands, regulatory environments, and market dynamics. Biotech firms must position their products effectively, communicate their value propositions, and navigate complex pathways to market entry.

Future research should delve deeper into the specific nuances of corporate governance within the biotech sector. Examining financing sources, including alternative funding options such as impact investments or public-private partnerships, can broaden the industry's capital base [8]. Additionally, research into innovative marketing strategies, including patient-centric approaches and international market expansion, will contribute to the growth and success of biotechnology enterprises.

The development and maturation of the biotechnology industry contribute to not only economic growth but also advancements in healthcare, agriculture, energy, and various other sectors. As a result, fostering a supportive environment for biotechnology research and commercialization can yield long-term benefits for both the national economy and global society.Leading companies (fig.2) in the field of biotechnology over a short period (from 1978 to 1982 - the period of the explosion of the global market for genetically engineered products) increased their assets by more than 30 times; at the same time, their annual income increased from 5 to 67 million dollars.

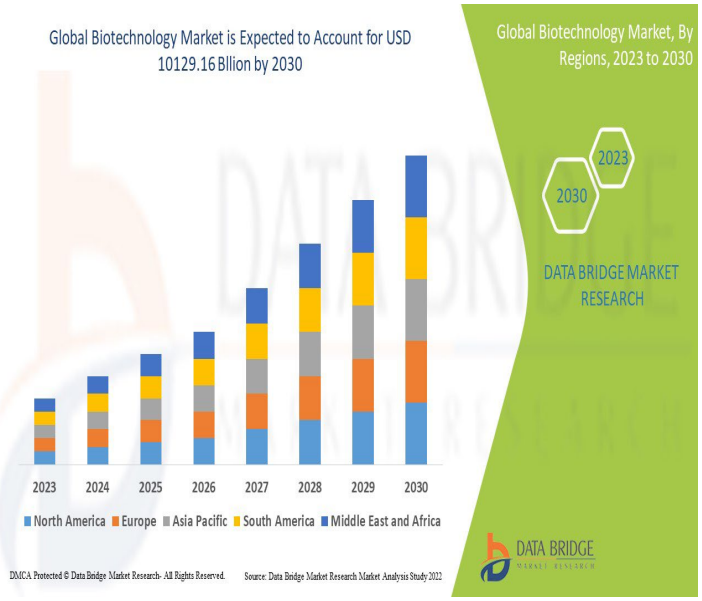

Fig. 2. Biotechnology Market Growth Rate.

Countless international and national scientific conferences, publications, as well as reports and analyses conducted by leading consulting firms, stock analysts, and various governmental and non-profit entities are dedicated to investigating trends in the biotechnology field [10]. They delve into its role in the worldwide landscape and address the challenges of assessing its impact on national economies. Projections indicate that biotechnology is poised to be the most rapidly growing sector of the 21st-century economy. According to renowned experts, biotechnology is expected to contribute 2.7% of the GDP in developed nations by 2030, and its impact on developing countries is predicted to be even more substantial.

By harnessing biotechnological advancements, it is envisioned that by 2030, roughly 80% of medical products, 35% of chemical industry outputs, and 50% of agricultural production will originate from biotechnology applications. Looking further ahead, the global bioenergy market is estimated to yield $150 billion by 2050, with renewable sources providing approximately 30% of the world's total energy demand. [11]

In the realm of biotechnology, the United States, Germany, Great Britain, China, and Japan have made significant strides and are considered leaders in the field. In contrast, Russia's current presence in the global biotechnology market is estimated to be a mere one-tenth of one percent.

4 Conclusions

In recent decades, alongside the development of a comprehensive bioeconomy rooted in the principles of interdisciplinarity, transdisciplinarity, and multidisciplinarity of biotechnologies, various processes have gained momentum, primarily driven by external factors, including global and pervasive digitalization. This digital revolution has led to the widespread intellectualization of society. Consequently, the modern higher education system faces a crucial dilemma regarding the prioritization of competencies to impart to students. It must decide between emphasizing highly specialized (hard) competencies or universal competencies.

While traditional education focused on imparting students with specialized competencies, the education system of the 21st century places greater emphasis on cultivating universal and adaptable competencies. These encompass cognitive abilities, systems thinking, problem-solving skills, content manipulation skills, social and industrial proficiency, resource management capabilities, technical know-how, and physical dexterity.

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