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OPPORTUNITIES FOR IMPLEMENTING THE BIOECONOMY IN THE PHARMACEUTICAL BUSINESS

This study examines the bioeconomy's role in the pharmaceutical sector, emphasizing biotechnology's impact and forecasts for biological products up to 2028. It highlights growth trends and significance, alongside employment and productivity metrics in 2015 and 2020. A case study on Gilead Sciences illustrates how biotechnology influences its growth, and a flowchart outlines future bioeconomy development. The bioeconomy utilizes biological resources to create products that enhance environmental sustainability and human health. The dynamic pharmaceutical industry, focused on medication research and production, requires effective entrepreneurial coordination. Entrepreneurship is characterized by competitiveness, risk-taking, and market opportunities and intersects with bioeconomy and pharmaceuticals. It empowers pharmaceutical firms to develop eco-friendly, effective drugs and fosters collaboration essential for advancing biological innovations. By adopting bioeconomic principles, pharmaceutical companies can enhance public health and promote sustainable resource use.

Key words: bioeconomy, bioeconomy in pharmaceuticals, circular economy, sustainable development, pharmaceutical businesses, biotechnology.

Statement of the problem and its connection with important scientific and practical tasks. The bioeconomy utilizes biological resources to create innovative goods and services that contribute to environmental conservation and human health. The pharmaceutical industry, a dynamic sector of the bioeconomy, is involved in developing and manufacturing of medicines. Entrepreneurship within this field requires competitiveness, creativity, and the ability to identify and exploit market opportunities. The bioeconomy offers pharmaceutical company's new ways for researching and producing biological drugs with less environmental impact and higher efficacy. This supports the development of both the bioeconomy and the pharmaceutical industry, which rely on entrepreneurship to implement innovation and problem-solving. Outlooks indicate that by 2028, biologics will surpass small molecules in drug sales, signaling a shift towards biologics. However, achieving bioeconomic goals requires overcoming barriers such as insufficient R&D funding, low collaboration between science, education, and business, and intense competition from foreign pharmaceutical manufacturers.

The analysis of the latest publications on the problem. The possibilities of introducing a bioeconomy have been studied by many domestic scientists: V. Baidala, V. Bugaychuk, V. Butenko, O. Vdovichena, V. Vostriakova, I. Grabchuk, I. Gushcha, M. Dobrivska, L. Ilkiv, T. Kachala, A. Klymenko, O. Kucher, O. Litvak, V. Lymar, I. Nesterenko, N. Petrukha, S. Petrukha, V. Proskura, S. Proskurina, A. Proshchalykina, O. Ryabchenko, M. Talavirya, V. Zhebka, M. Yaremova and others. However, the issue of the possibility of introducing bioeconomy into pharmaceutical companies requires additional research.

When considering the bioeconomy's role in the circular economy [1] and sustainable development [2], it can be defined as the application of biological resources, processes, and principles for the development of new goods and services that satisfy consumer demands while also taking into account the environmental, social, and economic aspects of sustainable development [2; 3]. It also involves boosting the productivity, innovation, and competitiveness of various economic sectors and ensuring the population's health and well-being.

Forming of the aims of the research. The po-

tential applications of the bioeconomy in a pharmaceutical firm have been examined in this research.

Giving an account of the main results and their substantiation. Because bioeconomy contributes to lowering reliance on non-renewable resources, raising the proportion of renewable energy sources, cutting greenhouse gas emissions, protecting ecosystems and biodiversity, and shielding of the environment from pollution and climate change, it also directly influences the growth of the circular economy.

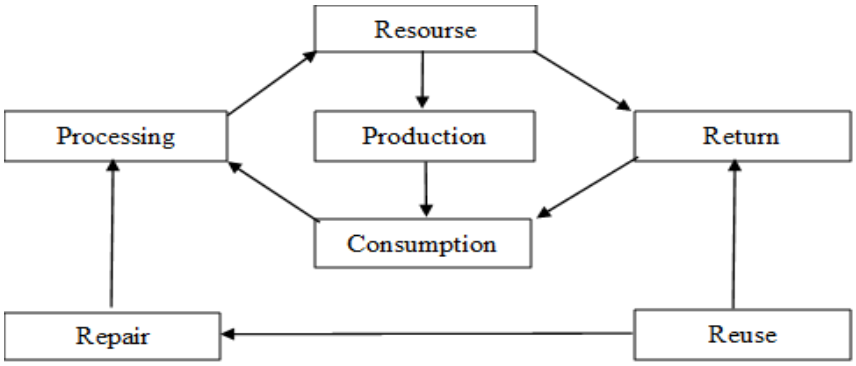

Fig. 1. Circular economy*

*compiled by the author using the following sources [4]

The global population reached 8 billion on November 15, 2022, marking a significant moment in human history. The growth rate is approximately 0.91% in 2024, with an annual increase of about 73 million people. The peak growth rate was around 2% in the late 1960s and has since declined. The population is expected to grow more slowly in the 21st century, reaching 9 billion by 2037, and projected to reach 10 billion by 2057, with an estimate of 10.4 billion by 2100.

Table 1

World Population (2024 and historical data) and World Population Forecast (2025-2100)*

Year (July 1)	Population	Yearly % Change (%)	Yearly Change (people)	Median Age (years)	Fertility Rate (children/woman)	Density (P/Km²)
2023	8,045,311,447	0,88 %	70,206,291	30.5	2.31	54
2024	8,118,835,999	0,91 %	73,524,552	30.7	2.31	55
2025	8,191,988,453	0,88 %	70,207,115	31	2.30	55
2030	8,546,141,327	0,85 %	70,830,575	32	2.27	57
2035	8,879,397,401	0,77 %	66,651,215	33	2.23	60
2040	9,188,250,492	0,69 %	61,770,618	34	2.21	62
2045	9,467,543,575	0,60 %	55,858,617	35	2.18	64
2050	9,709,491,761	0,51 %	48,389,637	36	2.15	65
2058	10,008,310,111	-	-	-	-	67
2100	10,349,323,038	-	-	-	-	69

*Compiled by the author using the following sources [5]

To address environmental concerns, a shift towards a sustainable economy and society is crucial. The concept of "inclusive development" is central to this transformation, aiming for equitable wealth distribution and capitalizing on globalization and technological progress. The current economic model, based on unsustainable resource use, must evolve to prioritize sustainability, focusing on job creation, skill development, poverty reduction, and system modernization.

The European Commission monitors progress towards a sustainable economy with specific metrics. The Europe 2020 policy sets targets for a knowledge-driven economy, R&D enhancement, emission reduction, renewable energy growth, educational improvement, and poverty eradication, in line with bioeconomy strategies for comprehensive development.

Europe 2020 Project, the EU's strategy for growth, focuses on inclusivity, sustainability, and smart economics, integrating the bioeconomy as a key element. The strategy aims to boost employment, invest 3% of GDP in R&D, cut greenhouse emissions by 20%, increase renewable energy usage to 20%, enhance education, and reduce poverty by 25% [6].

By 2020, the EU had largely met its targets, except for poverty reduction. Employment rates reached 72.4%, R&D investment reached 2.23% of GDP, greenhouse gas emissions fell by 24%, renewable energy accounted for 20.1% of total consumption, and energy efficiency improved by 24%.

Table 2

Smart, sustainable and inclusive development strategy [6]

HEADLINE TARGET		
– Raise the employment rate of the population aged 20-64 from the current 69% to at least 75% – Achieve the target of investing 3% of GDP in R&D in particular by improving the conditions for R&D investment by the private sector, and develop a new indicator to track innovations. – Reduce greenhouse gas emissions by at least 20% compared to 1990 levels or by 30% if the conditions are favorable, increase the share of renewable energy in our final energy consumption to 20%, and achieve a 20% increase in energy efficiency. – Reduce the share of early school leavers to 10% from the current 15% and increase the share of the population aged 30-34 having completed higher education from 31% to at least 40%. – Reduce the number of Europeans living below national poverty lines by 25%, lifting 20 million people out of poverty.		
SMART GROWTH	**SUSTAINABLE GROWTH**	**INCLUSIVE GROWTH**
INNOVATIONS EU flagship initiative "Innovation Union" is designed to improve framework conditions and access to finance for research and innovation so as to strengthen the innovation chain and boost levels of investment throughout the Union.	***CLIMATE, ENERGY AND MOBILITY*** EU flagship initiative "Resource efficient Europe" is designed to help decouple economic growth from the use of resources, by decarbonizing our economy, increasing the use of renewable sources, modernizing our transport sector and promoting energy efficiency.	***EMPLOYMENT AND SKILLS*** EU flagship initiative "An agenda for new skills and jobs" is designed to modernize labour markets by facilitating labour mobility and the development of skills throughout the lifecycle with a view to increase labour participation and better match labour supply and demand.
EDUCATION EU flagship initiative "Youth on the move" is designed to enhance the performance of education systems and to reinforce the international attractiveness of Europe's higher education.		
DIGITAL SOCIETY EU flagship initiative "A digital agenda for Europe" is designed to speed up the roll-out of high-speed internet and reap the benefits of a digital single market for households and firms.	***COMPETITIVENESS*** EU flagship initiative "An industrial policy for the globalization era"is designed to improve the business environment, especially for SMEs, and to support the development of a strong and sustainable industrial base able to compete globally.	***FIGHTING POVERTY*** EU flagship initiative "European platform against poverty" is designed to ensure social and territorial cohesion so that the benefits of growth and jobs are widely shared and people experiencing poverty and social exclusion are enabled to live in dignity and take an active part in social life.

Educational goals were achieved with early school leaving at 9.9% and higher education attainment at 40.3%. However, the number of people at risk of poverty rose to 91.4 million, indicating challenges in unemployment, income inequality, and social protection.

Based on the document [7], which contains four scenarios for the development of the bioeconomy in Europe until 2050, here is a table that shows the main indicators for each of these scenarios.

Table 3

Scenarios for Europe by 2050 [6]

Scenario	Description	Expected Development
Do it for us	Radical changes in the supply systems, but society resists significant changes in demand (consumption) away from Business as Usual (BAU)	Low
Do it together	Both the political system and society are aligned to achieve the climate-neutrality goal and the SDGs. Businesses quickly adapt and are part of the change. The transformative process includes all actors.	High
Do it yourselves	The political system shows an incapacity to implement significant climate and SDG policies. However, consumers change their attitudes and behaviour under the thrust of increasingly influential social movements and the aftermath of a series of dramatic crises. Subsequently, the resulting change in demand (both patterns and levels) drives the supply system to adapt.	Medium

Continue of table 3

Scenario	Description	Expected Development
Do what is unavoidable	Lifestyles do not change significantly from BAU patterns (but consumption levels rise), and the political system is not able or supportive to implement/enforce proactive policies, limiting itself to adopt – with some delay – measures in reaction to crises.	Low

The bioeconomy in Europe is projected to flourish by 2050, bolstered by the Europe 2020 strategy which promotes biotechnology for sustainable development across the sectors like agriculture, forestry, and pharmaceuticals. The global biopharmaceutical market, valued at USD 300 billion in 2018, is growing at 8.5% annually, with the EU and countries like China, India, and the US as key players [8; 9].

In the US, the National Institutes of Health (NIH) funds biomedical research, aiding the development of new health products. Canada's Ministry of Public Health oversees pharmaceuticals, ensuring the safety and efficacy of new medical products. Both countries are reducing imported medication reliance by developing domestic bioresources, like genetically modified Escherichia coli for insulin production in the US.

Ukraine's pharmaceutical sector, primarily producing conventional drugs, contributed UAH 24.4 billion to the economy and exported USD 1.1 billion in 2019. However, only a small percentage of Ukrainian pharmaceutical companies engage in biotechnological research [10; 11]. To expand its global market share, Ukraine needs to increase R&D investment, enhance workforce skills, foster innovative enterprises, improve regulations, and seek international collaboration in the bioeconomy.

Implementing the bioeconomy could significantly enhance the pharmaceutical industry's productivity, innovation, and competitiveness, while also improving public health. Biotechnology plays a crucial role in developing new drugs, vaccines, and medical tools. However, the bioeconomy faces challenges such as resource scarcity, high R&D costs, regulatory complexities, and ethical concerns.

To support the bioeconomy's growth in pharmaceuticals, it's essential to increase research funding, foster cross-sectoral collaboration, improve specialist training, establish clear regulations, ensure product safety, and engage the public [12].

Gilead Sciences exemplifies the impact of biotechnology on pharmaceuticals. It has developed Veklury (remdesivir), the first approved treatment for COVID-19; Yescarta (axicabtagene ciloleucel), a CAR T-cell therapy for certain lymphomas; and Sovaldi (sofosbuvir), an oral treatment for hepatitis C, all through biotechnological methods [13].

Gilead's success, reflected in its substantial revenue, underscores the potential of biotechnology in advancing pharmaceuticals and expanding global market presence [14].

Table 4

Gilead Sciences's revenue from 2019 to 2022 [14]

Year	Revenue, million dollars
2022	27,391
2021	27,281
2020	24,682
2019	22,449

Biotechnology has significantly influenced Gilead Sciences, enabling the creation of innovative medications for diseases ranging from cancer to viral infections. This advancement has ensured high-quality, safe products that adhere to global standards, bolstering Gilead's position in the pharmaceutical market and fostering research and collaboration within the bioeconomy.

Roche, a Swiss pharmaceutical giant, invests substantially in biotechnology to produce treatments for various diseases, utilizing advanced techniques like genetic engineering and cell therapy. These investments are pivotal for developing enhanced patient solutions and will continue to shape the bioeconomy's trajectory in the future.

Take action to examine more closely at Figure 2 to see how biotechnology will impact the bioeconomy in the future.

The bioeconomy's impact on the pharmaceutical industry extends beyond creating new, affordable medications for a range of diseases. It leverages biological systems to produce safer and more effective treatments, enhances the nutritional value of food, and fosters economic growth by generating jobs within the bioeconomy sector.

The research findings indicate that the bioeconomy's collaboration with pharmaceutical companies is essential for creating new pharmaceutical products that align with consumer needs and sustainable development principles. This partnership enhances public health and drives innovation and competitiveness within the pharmaceutical industry.

The bioeconomy and the pharmaceutical sector do, however, also confront a number of obstacles and shortfalls, including the scarcity and competition for biomass, the high costs associated with research and development, the low commercialization speed and efficiency, the lack of funding and regulations, the ethical and legal ambiguities, the low level of consumer awareness and demand, etc [15].

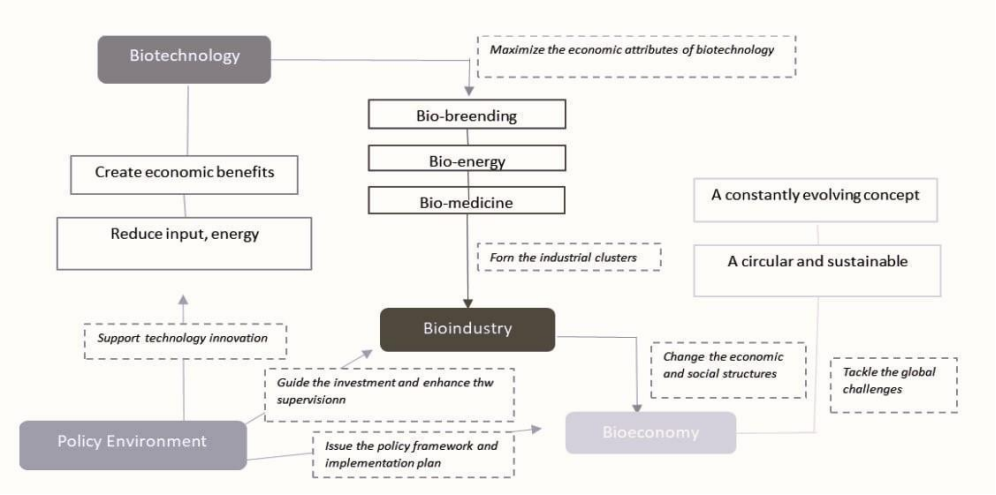

Fig. 2. A flowchart of the development of future bioeconomy*
*compiled by the author using the following sources [15]

To overcome these challenges, a comprehensive strategy is needed, focusing on:

- Increased investment in research to improve biomass productivity and develop new biotechnologies.
- Promotion of a circular and sustainable bioeconomy that utilizes renewable resources and minimizes waste.
- Strengthening collaborations between the pharmaceutical industry, bioeconomy sectors, and other organizations to address issues and share resources.
- Enhancing consumer awareness through information campaigns and education.
- Simplifying the legislative and regulatory framework to support intellectual property protection, biosafety, and international cooperation.

Different countries have unique approaches to developing the bioeconomy and pharmaceutical industry, influenced by their specific contexts. The U.S. leads in biotech innovations due to significant R&D investments, while the EU's Europe 2020 strategy focuses on creating an inclusive and sustainable economy [16]. The global competitiveness of the pharmaceutical industry is evident, with Europe producing a significant portion of the world's pharmaceuticals. These findings justify the need for continued investment and collaboration to advance the bioeconomy and pharmaceutical sector.

Conclusions and prospects of the further investigations. The bioeconomy emerges as a transformative economic strategy that prioritizes the sustainable use of biological resources, aiming to enhance quality of life, economic competitiveness, and environmental protection. It encourages the development of innovative technologies, especially in biotechnology, which is instrumental in creating new pharmaceuticals, vaccines, and gene therapies.

Future research should explore the implementation of the bioeconomy in regions like Ukraine, leveraging its strategic position, scientific base, and natural resources; the development of a robust scientific understanding, legal framework, and innovative methods to apply scientific advancements in production within the bioeconomy; the global expansion of the bioeconomy, with a focus on international cooperation, stakeholders' involvement, and the creation of supportive institutional and financial environments, as evidenced by initiatives in the EU, US, Canada, and other nations.

These findings underscore the bioeconomy's potential to revolutionize the pharmaceutical industry and to have the broader economic landscape, provided that the necessary frameworks and collaborations are established.

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МОЖЛИВОСТІ ВПРОВАДЖЕННЯ БІОЕКОНОМІКИ У ФАРМАЦЕВТИЧНІ ПІДПРИЄМСТВА

В статті досліджено роль біоекономіки у фармацевтичній промисловості, акцентуючи увагу на біотехнологіях як ключовому факторі інновацій та сталого розвитку. Біоекономіка використовує біологічні ресурси для створення нових лікарських засобів і терапевтичних рішень, що є основою для інновацій у сфері охорони здоров'я. Прогнозується, що до 2028 року біофармацевтичний ринок значно зросте через підвищений попит на інноваційні рішення, підкреслюючи необхідність адаптації методів виробництва до більш екологічних практик. Аналіз динаміки робочої сили свідчить про важливу роль біотехнологій у підвищенні економічних показників фармацевтичного сектора. Впровадження біотехнологій збільшує продуктивність праці та заробітну плату, а попит на навички фахівців забезпечує їм вищі доходи. У статті особливу увагу приділено інтеграції принципів біоекономіки та циркулярної економіки, що сприяє сталому розвитку та зменшенню відходів. Демографічні зміни, такі як зростання населення та поширення хронічних захворювань, підкреслюють потребу в біоекономічних ініціативах у сфері охорони здоров'я. Приклад компанії “Gilead Sciences” демонструє, як біотехнології сприяють розробці нових лікарських засобів для лікування вірусних інфекцій. За результатами дослідження зроблено висновок, що біоекономіка має значний потенціал для підвищення продуктивності, інноваційності

та сталого розвитку у фармацевтичному секторі. Компанії, які впроваджують принципи біоекономіки та циркулярної економіки, здобувають конкурентні переваги на ринку, де екологічна свідомість стає дедалі значущою. Біоекономіка є важливою стратегією для майбутнього зростання галузі, оскільки дозволяє досягти балансу між економічною вигодою та екологічною стійкістю. Подальші дослідження необхідні для ефективної інтеграції біоекономічних принципів у виробничі процеси, а також для виявлення нових можливостей застосування екологічних стандартів, з особливим акцентом на напрямки, що сприятимуть підвищенню ефективності виробництва та мінімізації негативного впливу на довкілля.

Ключові слова: біоекономіка, біоекономіка у фармацевтиці, циркулярна економіка, сталий розвиток, фармацевтичні підприємства, біотехнології.

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