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Landscape of biotechnological innovations: Analysis of the patent portfolio operating in the Russian Federation for the period from 2005 to 2024

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The aim. To conduct a comparative analysis of long-term trends and structural features of patenting in the field of biotechnology at the national and regional levels.

Materials and methods. The study is based on data from two patent offices: the Federal Service for Intellectual Property (Rospatent) and the Eurasian Patent Office (EAPO) for the period from 2005 to 2024. The methodology includes a quantitative analysis of patent applications with classification by applicant countries and industry areas of biotechnology.

Results. It was found that the share of biotechnological patents is 4.68% in Rospatent and 8.33% in EAPO. The phenomenon of strategic duality was revealed: in the Russian Federation, Russian applicants dominate (61% of patents), while in the EAPO their share is only 9%, while non-residents form extensive patent portfolios there. The dynamics of patent activity demonstrates a clear correlation with external factors: an increase in the activity of non-residents in the EAPO after 2014 and a shift in industry priorities in the Russian Federation from medical to industrial biotechnology after 2019. At the same time, domestic patent activity in Rospatent has decreased by 16.5% the last five years.

Conclusion. The results indicate a systemic imbalance: Russia pursues a predominantly internally oriented patent strategy, focusing on the domestic market, and is significantly inferior in the formation of legal positions in the Eurasian space. The predominance of foreign patents in the EAPO creates long-term risks for the competitiveness of Russian developments in the region. The data obtained can be useful in the development of state programs to improve Russia's competitiveness in the framework of biotechnological areas in the global market.

Keywords: patent; patent portfolio; biotechnology; innovation; competitiveness; economic trend

Abbreviations: CNIPA — China National Intellectual Property Administration; EPO — European Patent Office; JPO — Japan Patent Office; IP5 — USPTO, EPO, JPO, KIPO and CNIPA; KIPO — Korean Intellectual Property Office; USPTO — United States Patent and Trademark Office; WIPO — World Intellectual Property Organization; DNA — deoxyribonucleic acid; EAPATIS — Eurasian Patent Information System; EAPO — Eurasian Patent Office; IPC — International Patent Classification; RNA — ribonucleic acid; Rospatent — Federal Service for Intellectual Property; FIPS — Federal Institute of Industrial Property.

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Ландшафт биотехнологических инноваций: анализ патентного портфеля, действующего на территории Российской Федерации, за период с 2005 по 2024 гг.

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Цель. Провести сравнительный анализ долгосрочных тенденций и структурных особенностей патентования в сфере биотехнологий на национальном и региональном уровнях.

Материалы и методы. Исследование основано на данных двух патентных ведомств: Федеральной службы по интеллектуальной собственности (Роспатент) и Евразийского патентного ведомства (ЕАПВ) за период с 2005 по 2024 гг. Методология включает количественный анализ патентов с учетом стран-правообладателей и отраслевых направлений биотехнологии.

Результаты. Установлено, что доля биотехнологических патентов составляет 4,68% в Роспатенте и 8,33% в ЕАПВ. Выявлен феномен стратегической двойственности: в РФ российские заявители доминируют (61% патентов), тогда как в ЕАПВ их доля составляет лишь 9%, при этом нерезиденты формируют обширные патентные портфели. Динамика патентной активности демонстрирует четкую корреляцию с внешними факторами: рост активности не российских заявителей в ЕАПВ после 2014 г. и сдвиг отраслевых приоритетов в РФ от медицинских к промышленным биотехнологиям после 2019 г. При этом отечественная патентная активность по данным баз данных Роспатента в последние 5 лет снизилась на 16,5%.

Заключение. Результаты свидетельствуют о системном дисбалансе: Россия реализует преимущественно внутренне-ориентированную патентную стратегию, фокусируясь на внутреннем рынке, и значительно уступает в формировании правовых позиций на евразийском пространстве. Преобладание иностранных патентов, зарегистрированных в ЕАПВ, создает долгосрочные риски для конкурентоспособности российских разработок в регионе. Полученные данные могут быть полезны при разработке государственных программ по повышению конкурентоспособности России в рамках биотехнологических направлений на мировом рынке.

Ключевые слова: патент; патентный портфель; биотехнология; инновации; конкурентоспособность; экономический тренд

Список сокращений: CNIPA — Национальное управление интеллектуальной собственности Китая; EPO — Европейское патентное ведомство; JPO — Патентное ведомство Японии; IP5 — USPTO, EPO, JPO, KIPO и CNIPA; KIPO — Корейское ведомство интеллектуальной собственности; USPTO — Ведомство по патентам и товарным знакам США; ВОИС — Всемирная организация интеллектуальной собственности; ДНК — дезоксирибонуклеиновая кислота; ЕАПАТИС — Евразийская патентная информационная система; ЕАПВ — Евразийское патентное ведомство; МПК — Международная патентная классификация; РНК — рибонуклеиновая кислота; Роспатент — Федеральная служба по интеллектуальной собственности; ФИПС — Федеральный институт промышленной собственности.

INTRODUCTION

Biotechnology permeates many areas of the economy, from healthcare and agriculture to industry and ecology [1–3]. It is one of the key factors in addressing global challenges such as ensuring food security, improving the quality of medical care, and transitioning to an environmentally sustainable economy [4–6].

Recently, investor interest in the field of biotechnology has been growing worldwide [7–9]. For example, if in 2013 there were about 40 biotechnology companies in the US market [10–12], then in 2020 investor interest was at peak [13–15]. Thus, in the first half of 2020, US biotechnology companies attracted $9.4 billion in investments, exceeding the 2018 figure (over $6.5 billion). The market volume for these

technologies is projected to be $30.7 billion in 2025, and up to $121.9 billion[1] by 2034 (average annual growth rate is 14.8 %) [16–18].

In Russia, the volume of the biotechnology market reached 440 billion[2] rubles in 2024. In 2025, the large-scale National Project "Bioeconomy" was launched to create the necessary infrastructure for processing biomass in the country, and stimulate the development of innovations for agriculture, environmental protection, and drug manufacturing. Its goal is to achieve technological superiority in the field of bioeconomy and reduce import dependence by half. According to the forecast of the Center for Industry Expertise (CIE) of the Russian Agricultural Bank[3], the biotechnology market could grow to 700 billion rubles by 2028, and by 2036, Russia intends to become one of the leading countries in this sector[4] [19]. For this purpose, the technological platform "Bioindustry and Bioresources," known as "BioTech2030"[5], has been established. An urgent task for these programs is to identify prospects, the pace of innovative development in the industry, and to improve the effectiveness of state policy aimed at supporting innovations and implementing their development programs [22–24].

The effectiveness of such state programs is aimed to stimulate the creation and implementation of innovations through their monitoring using patent activity analysis, appears to be effective, helping to determine which sectors demonstrate the greatest progress and which are slowing down [25–27]. For instance, the World Intellectual Property Organization (WIPO) recognizes patent information as a unique source of information playing an important role in strategic business plans for both countries and companies[6].

In 2024, the Joint Research Centre (JRC) of the European Commission conducted an analysis of patent activity in the field of emerging biotechnologies [28]. The overall research scheme in Figure 1.

The study examined patents granted in at least two patent offices of the IP5 consortium: USPTO (USA), EPO (EU), JPO (Japan), KIPO (Korea), and CNIPA (China)[7]. All documents were grouped according to the International Patent Classification (IPC) categories into four directions of biotechnology: agricultural, industrial, medical, and horizontal (application in various fields). The conducted analysis showed that biotechnology patents constitute about 5 % of the total number of patents granted in the IP5 countries for the period from 2001 to 2020. Moreover, over 96 % of patents in this sector relate to developments in industry and medicine. The leader in the number of patents in the field of biotechnology is the USA (39 %); the European Union is in second place (18 %, regional patents granted by the EPO); and China is in third place (10 %). The results of the conducted research allow for the formation of a picture of global trends in biotechnology patenting.

At the same time, the specifics of the Russian national patent landscape in the field of biotechnology are insufficiently known. Our study analyzed the distribution of patents for inventions related to biotechnological directions, operating in Russia, granted by Rospatent and the Eurasian Patent Office (EAPO) in 2005–2024. The inclusion of EAPO patents in the analysis is due to the fact that patents granted by EAPO are valid in Russia. The analysis focuses on four key areas identified by European Commission specialists. The relevance of patent documentation for assessing the innovative potential of a country and individual companies in this field, and for identifying risks of excessive penetration of foreign inventors into the market, is due to its unique properties: such documentation is structured, unified for most countries, and includes information about the invention, its claims, description, and drawings, which facilitates its study by researchers worldwide, accelerating data search, trend analysis, and competitor research directions. Patents are published at early stages of development, long before their market appearance, which allows for a quick assessment of innovation implementation potential, promising market segments, and risks of rights infringement.

The IPC is a useful tool for searching for the necessary information in patent documents. Developed by WIPO in 1971, the IPC has become firmly established as the most durable patent classification[8]. It serves as the basis for systematizing patent documents in over

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100 countries, covering more than 75,000 categories, grouped into 8 main sections. Each IPC level reflects a specific technical area, simplifying the search and study of patent information [29, 30].

THE AIM. To conduct a comparative analysis of long-term trends and structural features of patenting in the field of biotechnology at the national and regional levels from 2005 to 2024.

MATERIALS AND METHODS

An analysis of invention patents registered from January 1, 2005, to December 31, 2024, in Rospatent and EAPO was conducted using the databases of the Federal Institute of Industrial Property (FIPS)[9] and the Eurasian Patent Information System (EAPATIS)[10]. The choice of this time period is related to the analysis of long-term trends under significant geopolitical changes. The lower boundary (2005) was chosen because by this time the Eurasian Patent System had already completed its 10-year establishment phase. The comparison of patent activity allowed for a comparable analysis of two systems: the National (Rospatent) and the Regional (EAPO). The upper boundary (2024) is determined by the relevance of the data for forming a modern picture, including assessing the impact of key events of the last decade, such as the sanctions regime since 2014 and the COVID-19 pandemic. The chosen period is statistically significant, allowing for the leveling of short-term fluctuations and the identification of long-term trends. Furthermore, it is precisely 20 years that is the maximum term of validity for an invention patent.

Within the chosen period, the number of inventions related to biotechnology as a whole identified in the FIPS database was 26,805 units, and 3,601 units in the EAPO database (in all selected EAPO patents, Russia is indicated as the country for which legal protection is sought). Their grouping and analysis were carried out using the color classification proposed by the Joint Research Centre (JRC) of the European Commission's Science and Information Service. According to this classification, biotechnology is divided into four color categories of application: red (medicine, healthcare), white (industry), green (agriculture), and horizontal (various fields of application). Each color is associated with a set of IPC categories[11] [31–34].

Thus, agriculture (green category) includes IPC indices such as: A01H1/0 (methods of modifying genotypes), A01H4/00 (breeding of plants from tissue cultures), A01K67/00 (breeding of animals, feeding of animals, or breeding of new animal breeds; new or modified animal breeds). Medicine and healthcare (red category) includes the most numerous group of IPC categories (categories are given in abbreviated form): A61K35/12-768 (materials from mammals; compositions containing undifferentiated tissues or cells; compositions containing non-embryonic stem cells; genetically modified cells — vaccines, drugs containing antigens or antibodies, microorganisms, materials derived from them); categories related to drugs containing peptides (A61K38/00), antigens or antibodies (A61K39/00), genetic material (A61K48/00), areas of organic chemistry — compounds of unknown structure: antibiotics (C07G11/00), vitamins (C07G13/00), hormones (C07G15/00), various peptides (C07K4/00, C07K14/00, C07K17/00, C07K19/00), immunoglobulins and antibodies (C07K16/00), various types of analyses: chemical analysis of biomaterials (blood, urine) and immunological tests (G01N33/50), immunological analysis, biospecific binding (G01N33/53, G01N33/54), investigation of materials by special methods — with an inorganic carrier, a carrier — a biological cell or its fragment (G01N33/55), using microorganisms causing venereal diseases; enzymes or isoenzymes; cancer; hepatitis; monoclonal antibodies; limulus lysate (G01N33/57), immunological tests — using proteins, peptides, or amino acids (G01N33/68), hormones (G01N33/74), human chorionic gonadotropin (G01N33/76), thyroid hormones (G01N33/78), prostaglandins (G01N33/88), using fats, e.g., cholesterol (G01N33/92). The white category (industry) includes categories: biological treatment of water, characterized by the microorganisms used (C02F3/34), devices for enzymology or microbiology (C12M), microorganisms or enzymes; their compositions; reproduction, preservation, or maintenance of microorganisms; mutations or genetic engineering; culture media (C12N), fermentation or enzymatic synthesis of chemical compounds or compositions, or separation of racemic mixtures into optical isomers (C12P), methods of measurement or testing using enzymes, nucleic acids, or microorganisms; compositions or indicator papers therefor; methods of obtaining such compositions; control of conditions in microbiological or enzymatic processes (C12Q). The horizontal category includes categories: combinatorial chemistry;

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libraries, e.g., chemical — directed molecular evolution of macromolecules, e.g., RNA, DNA, or proteins (C40B10/00); libraries contained in microorganisms or discovered by microorganisms, e.g., bacteria or animal cells; contained in vectors or discovered by vectors, e.g., plasmids; containing only microorganisms or vectors (C40B40/02), containing nucleotides or polynucleotides or their derivatives (C40B40/06), containing RNA or DNA that encode proteins, e.g., gene libraries (C40B40/08); methods of preparing libraries — biochemical, e.g., using enzymes or whole living microorganisms (C40B50/06), investigation or analysis of materials by electrical, electrochemical, or magnetic means — biochemical electrodes (G01N27/327); information and communication technologies specifically adapted for particular application fields: bioinformatics (information and communication technologies specifically adapted for processing genetic data or protein-related data in computational molecular biology; computer chemistry; chemoinformatics; computational materials science) (before 2018: G06F19/10-24; after 2018: G16C, G16B, G16Z).

Statistical analysis

The article uses data on patent activity in the field of biotechnology in the Russian Federation. Patent selection was carried out according to IPC categories. For this purpose, available statistical data based on data from Rospatent and the Eurasian Patent Office (EAPO) were used.

RESULTS

From 2005 to 2024, patents in the field of biotechnology accounted for 4.5 % (26,805 units) of the total number of patents registered in Rospatent (593,866 Russian Federation patents were registered across all technologies), and 8.33 % (3,601 units) in EAPO (43,229 Eurasian patents across all technologies). Over the study period, the annual ratio of patents obtained by residents (inventors from Russia) in Rospatent exceeded the number of patents obtained by non-residents (inventors from other countries). Over 20 years, non-residents received 39 % of the total number of patents related to biotechnology, while Russians received 61 %. This data demonstrates either a lack of interest from non-residents in promoting biotechnological developments in the Russian market, or, in the opinion of foreigners, a lack of competition in this field in Russia.

In Eurasia, the patent activity of Russians shows the opposite — their activity is extremely low: over the study period, they received only 9 % of all patents obtained in this period in the field of biotechnology, while inventors from other countries received many times more. The leaders in the number of patents in the field of biotechnology in the Russian Federation over the last 20 years are Russia and the USA (Table 1). However, while in Rospatent more than 58 % of patents in this field belong to Russian inventors, and only 12 % to American inventors, in EAPO the share of patents from Russians is only 8.66 %, while the share of inventors from the USA is 38.27 %. Inventors from other countries predominantly chose to register their biotechnological inventions in Rospatent rather than EAPO. This may be due to the strategy of promoting patented developments in the Eurasian markets. As a rule, they are registered in other countries during export, localization of production, or in joint projects. The decision on foreign patenting requires the presence of industrial capacities in the country for product manufacturing. If these are insufficient or absent, the risk of infringement of exclusive rights is reduced, and financial investments in such patenting are not advisable.

The number of countries that most actively obtained exclusive rights in the field of biotechnology in the Russian Federation from 2005 to 2024 were identified (see Table 1).

They demonstrated a steady growth in their patent portfolios in the field of biotechnology in the Russian Federation throughout the study period (USA, UK, Korea, China). Others reduced their patent activity only in 2020–2024 (Switzerland, France).

The USA has shown a stable growth trend in the number of biotechnology patents obtained in Russia over the past 20 years (from 2005 to 2024), it increased by more than 3.7 times. The UK also shows steady growth from 2005 to 2024, with an increase in the number of patents obtained in Russia by 2.5 times, Korea — by 10.4 times, China — by 12.9 times.

To understand patent activity trends, it is important that an invention patent is valid for 20 years (Article 1363, Paragraph 1 of the Civil Code of the Russian Federation, Part Four). A valid patent grants the right holder the ability to dispose of the exclusive right to what is patented, including prohibiting others from using it (Article 1229, Paragraph 1 of the Civil Code of the Russian Federation). Obtaining patents by non-residents in other countries indicates their desire for long-term promotion of their developments in that market.

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It is worth noting that although after the growth in patent activity from 2005 to 2019, a number of countries showed a decrease in 2020–2024, the number of patents still remained at a level comparable to 2005–2009 (Switzerland, France) (Table 2).

From 2020 to 2024, Russia registered 16.48 % fewer patents compared to the period 2005–2009. This may indicate a lack of tangible results related to current state support.

In EAPO, an increase in patent activity of the aforementioned TOP-10 countries in the field of biotechnology from 2005 to 2024 was also noted (Table 3). The highest activity over the analyzed 20 years in EAPO was shown by the USA (growth of more than 27.7 times), Russia (growth of 34 times), and Germany (growth of 12 times).

Since 2015, a stable growth trend in patent activity has been observed according to the EAPO patent register, with a peak intensity in 2020–2024. From 2005 to 2014, 356 patents in the field of biotechnology were granted within EAPO, and over the next 10 years, this number increased ninefold. A possible reason is the sanction pressure from, in particular, EU countries (including Germany, Netherlands) since 2014 for Russia, but not for Eurasia[12]. An increase in patenting activity in EAPO in the field of biotechnology is noticeable in the example of Germany. Thus, since 2015, an increase in patents obtained by inventors from Germany has been observed in EAPO: from 2005 to 2014, 34 patents were registered, and from 2015 to 2024, this figure increased 7.3 times.

Obtaining a Eurasian patent is attractive to inventors because it provides protection in 8 member states of the Eurasian Patent Organization (EAPO) simultaneously: Azerbaijan, Armenia, Belarus, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Turkmenistan, based on a single application, which makes the process of obtaining it simpler and more cost-effective than filing applications in each country separately.

In the context of global economic transformation, countries in the Eurasian region attract the attention of foreign investors due to their rich natural resources, human and industrial potential, infrastructure, and favorable geopolitical location [35–37].

Analysis of invention patents related to biotechnology showed that over the 20-year period, the attention of inventors registering their developments in Rospatent and EAPO was primarily focused on industrial and medical biotechnologies. According to Russian Federation patents, inventions in the industrial biotechnology sector accounted for 13,309 units, healthcare — 12,561, agriculture — 858, and horizontal (multisectoral) biotechnologies — 73. Moreover, while medical biotechnology dominated from 2005 to 2019, industrial biotechnology has dominated since 2020 (Table 4). In Eurasia, on the contrary, patent activity in healthcare has increased from 2015 to 2024 (Table 5). This difference in trends between national and regional offices is likely related to the beginning of growth in industrial production in Russia in preparation for and ensuring the conduct of the Special Military Operation (SMO). The growth in EAPO patent activity in healthcare may reflect the global trend of 2019–2020 in creating and patenting new drugs and vaccines based on biotechnology, in connection with the pandemic and risks of future epidemics.

Analysis of the four directions of biotechnology, considered through the lens of patents granted by Rospatent (Table 6), showed that Russia and the USA are leaders in patenting in three biotechnological directions — medicine, industry, and agriculture. According to identified Russian Federation patents, inventors from Russia received 8,246 patents in the medical field, and inventors from the USA — 1,540 patents. In the industrial sector, inventors from Russia obtained 8,178 patents, and from the USA — 1,791 patents. For agricultural developments, inventors from Russia obtained 727 patents, and from the USA — 115 patents. Patenting of developments in the horizontal biotechnology sector in Russia was only attractive to inventors from the UK (21 Russian Federation patents), the USA (17 Russian Federation patents), and Switzerland (13 Russian Federation patents).

The study of EAPO patents showed similar trends (Table 7). The medical category is most attractive to inventors from the USA (901 EAPO patents), Russia (176), and Germany (174). These countries are also attracted to the industrial sector with the highest number of patents from inventors from the USA, Russia, and Germany. The agricultural and horizontal sectors are not particularly popular in the Eurasian region. This may be explained by the fact that Russia has large agricultural lands where farming is conducted more traditionally, making patenting irrelevant. Furthermore, the USA may have different methods of conducting agriculture and, consequently, uses

[12] The history of EU sanctions against Russia // TASS. – Available from: https://tass.ru/info/2322 9017?ysclid=mbhodqhgi0779152711

biotechnological developments that are not relevant to Russia and the Eurasian region. The scarcity of the horizontal biotechnology sector is unlikely to be reliably assessed due to its very limited scope. This includes isolated, almost random, cases of patenting on specific topical subjects that do not represent a trend for Russia or the Eurasian region during the period under review.

Being among the leaders in the number of patents does not always indicate technological sovereignty in a particular field, as it is necessary to consider what exactly the patents were granted for [38–40]. Patenting of specific cases of application or obtaining known products and technologies does not lead to technological sovereignty; it only complements the reliability of legal protection and defense of a key development, which in the field of biotechnology can be a compound, a gene construct, a nucleotide sequence, an amino acid sequence, a protein, etc. [41–42].

As part of a comparative study of the patent strategy of Russian and foreign inventors in biotechnology, the direction of peptides was analyzed. Peptides are classified under IPC categories: C07K — peptides, A61K38 — medicinal preparations containing peptides. From 2005 to 2024, Rospatent registered 7,518 patents for inventions related to peptides: 2,592 from Russian inventors and 4,926 from other countries. During the same period, EAPO issued 1,938 patents dedicated to peptides. Of these, 114 were obtained by inventors from the Russian Federation, and 1,824 from other countries. Moreover, inventors from other countries showed stable inventive activity and demand in patenting inventions related to peptides, in contrast to inventors from Russia, who, despite increased government attention to biotechnology, halved their inventive activity in this field (Table 8) and only slightly increased the number of EAPO patents obtained by Russians (Table 9). Non-Russian inventors showed record growth, increasing the number of EAPO patents by 2.9 times from 2020 to 2024 compared to 2015–2019.

Although the period 2020–2024 is marked by a decrease in the activity of Russian inventors in the field of peptides, there is a positive trend: residents have begun to focus more on patenting products (key commercially attractive developments). This trend is observed in both Russian patents and EAPO patents (Tables 10 and 11).

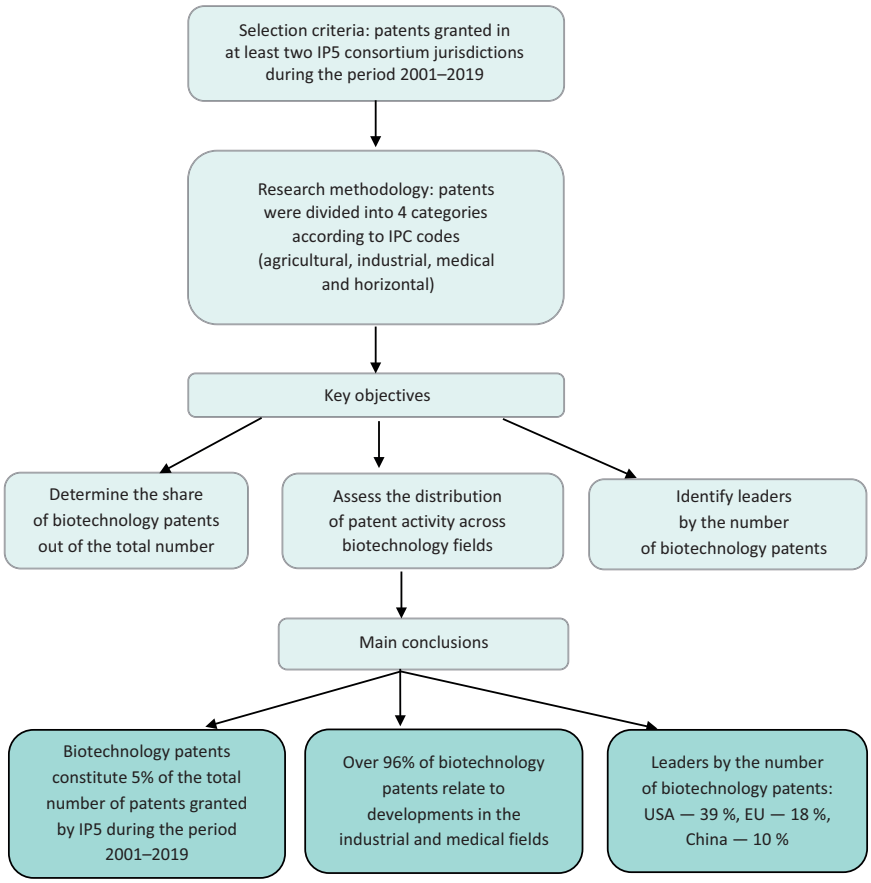

Figure 1 — Scheme of patent activity analysis in emerging biotechnologies conducted by JRC.

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Table 1 — TOP-10 countries that most actively obtained exclusive rights for their developments in biotechnology in the Russian Federation from 2005 to 2024

Country	Number of patents obtained in Rospatent, units	Country	Number of patents obtained in EAPO, units.
Russian Federation	16 376	USA	1 378
USA	3 401	Russian Federation	312
Switzerland	875	Germany	282
Germany	874	Netherlands	216
Japan	844	Switzerland	209
Korea	608	France	134
France	538	United Kingdom	134
United Kingdom	381	Japan	127
China	379	Denmark	116
Denmark	265	Belgium	102

Table 2 — Dynamics of patent acquisition in Rospatent by inventors from TOP-10 countries over 20 years

Applicant country	Number of RF patents obtained			
	2005–2009	2010–2014	2015–2019	2020–2024
Russian Federation	3 992	4 442	4 608	3 334
USA	325	704	1 164	1 208
Germany	174	197	271	232
Switzerland	116	200	336	223
Japan	109	224	267	244
France	63	128	205	142
United Kingdom	55	68	120	138
Denmark	43	79	68	75
Republic of Korea	31	60	193	324
Netherlands	23	99	138	94
Belgium	20	33	45	49
China	18	37	91	233

Table 3 — Dynamics of patent acquisition in EAPO by inventors from countries included in the TOP-10 over 20 years

Applicant country	Number of EAPO patents obtained			
	2005–2009	2010–2014	2015–2019	2020–2024
USA	34	41	364	941
Russian Federation	5	31	116	170
Germany	14	20	79	168
Switzerland	7	19	66	117
Netherlands	0	0	61	104
United Kingdom	2	8	30	96
Japan	7	5	32	83
Belgium	1	3	29	69
China	0	1	19	62
Denmark	10	14	34	58

Table 4 — Data on the distribution of registered patents in Rospatent by year and according to color classification

Biotechnology directions	Number of RF patents obtained			
	2005–2009	2010–2014	2015–2019	2020–2024
Healthcare	3 042	3 552	4 123	1 844
Industry	4 993	3 634	2 982	2 000
Agriculture	323	211	281	134
Horizontal biotechnologies	0	32	50	18

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Table 5 — Data on the distribution of registered patents in EAPO by year and according to color classification

Biotechnology directions	Number of EAPO patents obtained			
	2005–2009	2010–2014	2015–2019	2020–2024
Healthcare	0	13	610	1 556
Industry	137	206	399	633
Agriculture	0	0	12	134
Horizontal biotechnologies	0	0	0	6

Table 6 — Statistical data on the distribution of registered patents in Rospatent by country and according to classification by direction

Applicant country	Healthcare	Industry	Agriculture	Horizontal direction
Russian Federation	8 246	8 178	727	7
USA	1 540	1 791	115	17
Germany	444	464	3	2
Switzerland	488	389	2	13
France	269	271	8	0
United Kingdom	167	199	3	21
Japan	380	474	8	4
China	126	254	2	0
Korea	209	408	1	1
Denmark	138	133	0	0

Table 7 — Data on the distribution of registered patents in EAPO by country and according to color classification

Applicant country	Healthcare	Industry	Agriculture	Horizontal direction
USA	901	467	6	4
Russian Federation	176	130	1	5
Germany	174	105	0	3
Netherlands	73	0	0	8
Switzerland	135	73	0	2
France	81	48	0	5
United Kingdom	93	79	0	2
Japan	69	60	0	0
Denmark	55	59	0	2
Belgium	77	24	0	1

Table 8 — Dynamics of RF patent acquisition for developments related to peptides

Applicant	Patent acquisition period, years			
	2005–2009	2010–2014	2015–2019	2020–2024
Resident	680	800	791	321
Non-resident	633	1 124	1 582	1 587

Table 9 — Dynamics of EAPO patent acquisition for developments related to peptides

Applicant	Patent acquisition period, years			
	2005–2009	2010–2014	2015–2019	2020–2024
Resident	1	6	47	60
Non-resident	32	44	443	1 305

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Table 10 — Patenting objects in RF patents for developments related to peptides

Applicant \ Patenting object	Patent acquisition period, years							
	2005–2009		2010–2014		2015–2019		2020–2024	
	product	"method" only	product	"method" only	product	"method" only	product	"method" only
Resident	236	444	375	425	316	475	233	88
Non-resident	511	122	944	180	1 443	139	1 489	98

Table 11 — Patenting objects in EAPO patents for developments related to peptides

Applicant \ Patenting object	Patent acquisition period, years							
	2005–2009		2010–2014		2015–2019		2020–2024	
	product	"method" only	product	"method" only	product	"method" only	product	"method" only
Resident	0	1	6	0	40	7	54	6
Non-resident	29	3	41	3	375	68	1 188	117

DISCUSSION

The conducted analysis of patent activity in the field of biotechnology for the period 2005–2024 reveals a complex and ambiguous picture of the Russian Federation's positioning in both national and regional markets. The obtained data indicate structural imbalances and a dependence of patenting dynamics on geopolitical and macroeconomic factors.

In the domestic market, there is a stable dominance of Russian applicants, who account for 61 % of the total number of invention patents related to biotechnology. This may be an indicator of significant scientific and technical potential and active inventive activity in the country. However, simultaneously, this situation allows for the hypothesis of insufficient competition or limited commercial attractiveness of the Russian biotechnology market for leading foreign players, with the exception of strategically oriented companies from the USA, China, and a number of other countries, which demonstrate a steady growth in their patent portfolios.

In the context of the Eurasian Patent Office (EAPO), the picture changes radically. The share of Russian patents here is only 9 %, which indicates a critically low level of external patent activity by domestic developers. The Eurasian space has become a zone of strategic dominance for non-residents, primarily from the USA (38.27 %) and European Union countries. This creates a paradoxical situation: inventions created in Russia are actively protected within national borders, but their legal protection and potential market opportunities across the entire Eurasian region are extremely limited. In the future, this could lead to legal and commercial barriers for Russian developments in the Eurasian market.

The dynamics of patent activity show a clear correlation with the foreign policy context. The sharp increase in patenting through EAPO by Germany, the Netherlands, and other countries since 2014–2015 can be seen as an element of economic strategy under sanctions, allowing them to maintain legal positions and control over technologies in the Eurasian market. The corresponding growth in Russia's indicators in EAPO (34-fold over 20 years) reflects the course towards Eurasian economic integration. However, a negative signal is the decrease in the absolute number of domestic patent applications in Rospatent in the last five-year period (by 16.48 % compared to the baseline period 2005–2009). This trend suggests the need for additional state support measures in the context of declared goals for achieving technological sovereignty.

Significant differences are also observed in the sector structure of patent flows. In Russia, since 2019, a shift in priorities from medical to industrial biotechnology has been noted, which is a direct consequence of import substitution policies and preparation for changes in foreign economic conditions. This trend reflects the adaptation of the national innovation system to the geopolitical situation. In EAPO, on the contrary, the global trend associated with the COVID-19 pandemic — growth in activity in the field of medical biotechnology — persists and is strengthening. This emphasizes that for international companies, the Eurasian region remains a promising market for high-tech medical products.

Thus, the study conducted showed that Russia demonstrates a patent strategy focused on the domestic market and sectors related to increased industrial production. At the same time, there is a noticeable lag in establishing legal positions in the integrated Eurasian market, where foreign companies hold dominant positions. To change this trend, a

comprehensive set of measures is required, going beyond general support for inventiveness. Targeted programs to stimulate foreign patenting, in-depth analysis of foreign patent portfolios to identify niches and minimize legal risks, as well as the development of a balanced sector policy that combines the development of critically important industrial biotechnologies with support for competitive medical research oriented towards global and regional markets are necessary.

Study Limitations

This study, despite the representativeness of the data and the identified significant trends, has several methodological limitations that are important to consider when interpreting the results and planning future work:

- The study operates with data on granted patents; however, several years can pass between the moment of application filing, the decision on commercialization, and the granting of a patent. Thus, the obtained data may not fully reflect the current decline or growth in inventive activity due to administrative delays.
- The study focuses on the number of patents and their affiliation with sector but does not assess their qualitative aspects — technological significance, commercial potential, and so on. Consequently, leadership in the number of patents does not necessarily mean leadership in breakthrough developments.
- The analysis of dynamics focuses on leading countries, which provides a general picture but may overlook important specific changes in the activity of smaller players or the emergence of new ones.
- The study analyzes the supply of technologies (patents) but does not consider the demand for them from industry and the market. Low patent activity in any area may be a consequence of the absence of visible demand or production capacities for implementation, which is partly noted in the text but is not the subject of in-depth analysis.

The indicated limitations do not negate the main conclusions of the study regarding the structural imbalance of patent strategies and the dominance of non-residents in EAPO, but they set the framework for their correct interpretation.

CONCLUSION

The field of biotechnology demonstrates continuous growth due to technological progress and increased investment driven by the global need for innovations across various industries. Growth determines the development of the industry, which companies will have to pay attention to in order to maintain competitiveness. A legal framework is needed that creates conditions for effective management of patent-protected innovations, as a key factor of competitiveness in the global biotechnology market and for achieving technological sovereignty. In leading biotechnology countries like the USA and China, the state pays special attention to this aspect. This indicates the importance of active state participation in regulating and stimulating the development of this industry to ensure its sustainable growth and maintain competitiveness. The level of biotechnology development is clearly reflected in the quantity and quality of invention patents in this field. To adequately assess the potential of created innovations in their various aspects, it is advisable to classify them by categories, which serves as an important tool for understanding their economic impact. Patent activity objectively reflects the economic trends of the industry, contributing to its monitoring and forecasting the effectiveness of state support programs.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS CONTRIBUTION

Tatiana N. Erivantseva — conceptualization, data collection, analysis of literary sources, writing — original draft; Alexey V. Alekhin — writing — review & editing. All authors made an equivalent and equal contribution to the preparation of the publication. All authors confirm that their authorship meets the international ICMJE criteria (all authors made a significant contribution to the development of the concept and preparation of the article, read and approved the final version before publication).

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