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## **RESEARCH OF BIOPHARMACEUTICAL CLUSTERS DEVELOPMENT IN EU COUNTRIES**

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### **ДОСЛІДЖЕННЯ РОЗВИТКУ БІОФАРМАЦЕВТИЧНИХ КЛАСТЕРІВ В КРАЇНАХ ЄС**

*The article analyzes the current state of clustering development in European countries. It has been determined that clusters correspond to the modern approach in economics and are one of the options for the development of high-tech industries. The branch direction of clustering of the EU countries is investigated: electronic technologies and communication, informatics, biotechnologies and bioresources, pharmaceuticals and cosmetics, public health services, agro-production and food production, oil and gas complex and chemistry, mechanical engineering, electronics, communications and transport, power, construction and development, light industry, forest complex. European countries are analyzed by the number of registered biopharmaceutical clusters, their features and examples of clusters in relation to the studied countries. The countries under consideration include Austria, Belgium, Great Britain, Denmark, Estonia, Spain, Italy, Germany, the Netherlands, Hungary, Finland, France, Switzerland. The rank of the European country in the FT Europe-500 rating according to the*

*total market clustering of biopharmaceutical clusters is studied. The specialization of biopharmaceutical clusters Munich, Berlin, Graz, Utrecht, Lelystad, Frankfurt, Mailand, Ghent, Vienna Biocenter, Berkshire, Oresund, Bio-valley has been studied. The definition of "biopharmaceutical cluster" and the purpose of its creation are proposed. The main distinctive features of the cluster approach in pharmacy and biotechnology are formed, the main of which is the possibility of developing innovative drugs with their subsequent production. The advantages of clustering are investigated. That is, the unification of subjects of production, distribution and sale of medicines, science and education, based on the mechanisms of public-private partnership. The goals of creating a biopharmaceutical cluster are determined. The interaction of the participants of the biopharmaceutical cluster in economic, organizational, managerial, social, legal, technical-technological, innovative, informational and ecological directions is determined. The effects of the functioning of the biopharmaceutical cluster for end users, cluster members and the regional economy are formed.*

*У статті проведено аналіз сучасного стану розвитку кластеризації в країнах Європи. Визначено, що кластери відповідають сучасному підходу в економіці та є одним з варіантів розвитку високотехнологічних виробництв. Досліджено галузеве спрямування кластеризації країн ЄС, а саме, а саме електронні технології і зв'язок, інформатика, біотехнології та біоресурси, фармацевтика і косметика, охорона здоров'я, агровиробництво і харчове виробництво, нафтогазовий комплекс та хімія, машинобудування, електроніка, комунікації і транспорт, енергетика, будівництво і девелопмент, легка промисловість, лісовий комплекс. Проаналізовано Європейські країни за кількістю зареєстрованих біофармацевтичних кластерів, їх особливості та наведено приклади кластерів стосовно досліджуваних країн. До досліджуваних країн належать Австрія, Бельгія, Великобританія, Данія, Естонія, Іспанія, Італія, Німеччина, Нідерланди, Угорщина, Фінляндія, Франція, Швейцарія. Досліджено ранг країни Європи в рейтингу FT Europe-500 за сумарною ринковою кластеризацією біофармацевтичних кластерів. Вивчено спеціалізацію біофармацевтичних кластерів München, Berlin, Graz, Utrecht, Lelystad, Frankfurt, Mailand, Gent, Vienna Biocenter, Berkshire, Oresund, Bio-valley. Запропоновано дефініцію «біофармацевтичний кластер», тобто об'єднання суб'єктів виробництва, дистрибуції та реалізації лікарських засобів, науки й освіти, на підставі механізмів приватно-державного партнерства. Визначено мету створення біофармацевтичного кластеру. Сформовані основні відмінні риси кластерного підходу в фармації та біотехнології, до головної з яких віднесено можливість розробки інноваційних лікарських засобів з наступним їх виробництвом. Досліджено переваги кластеризації. Визначено взаємодію учасників біофармацевтичного кластера за економічним, організаційним, управлінським, соціальним, правовим, техніко-технологічним, інноваційним, інформаційним та екологічним напрямками. Сформовано ефекти від функціонування біофармацевтичного кластера для кінцевих споживачів, учасників кластеру та регіональної економіки.*

**Keywords:** *cluster, biopharmaceutical cluster, high-tech production, EU, partners.*

**Ключові слова:** *кластер, біофармацевтичний кластер, високотехнологічне виробництво, ЄС, партнери.*

**Problem statement.** The modern development of enterprises is associated with their entry into international markets, increasing the level of competitiveness and strengthening cooperation through the use of better means of communication, increasing mobility of capital and labor, and, most importantly, the development of multifunctional innovations. Today, the development and strengthening of cooperation between companies, according to the experience of developed countries, is one of the most effective areas in both the professional sphere and in the scientific environment. As a result, clustering has become widespread in almost every country in the world.

**Analysis of recent research and publications.** The works of many foreign and domestic scientists are devoted to the problems of studying the principles of clustering. Including: Cortright J. [1], Ketels Ch. [2], Porter M. [3-5], Sölvell Ö. [6; 7], Scotch A. [8] etc. However, despite the significant achievements of these authors, some issues remain insufficiently addressed and require detailed research.

**The aim** of the article is to study the current state of clustering in the EU.

**Results.** Experts from the European Commission believe that clusters correspond to the modern approach of "open innovation". Innovations are created not in separate isolated organizations, but in a dynamic environment in which specialized organizations and highly skilled workers interact and complement each other by increasing the accumulation of existing knowledge and generating new ideas and products [9, p. 21].

The EU countries that are leading in the development of clustering in the field of medicine include Denmark, the Netherlands, France, Germany, Italy, Switzerland and Sweden (Table 1) [10].

**Table 1.**  
**Sectoral direction of clustering of EU countries**

Sectoral directions	Country
Agricultural production and food production	Finland, Belgium, France, Italy, the Netherlands
Construction and development	Finland, Belgium, the Netherlands
Biotechnology and bioresources	The Netherlands, France, Germany, Great Britain, Norway
Electronic technologies and communication, computer science	Switzerland, Finland
Energy	Norway, Finland
Communications and transport	The Netherlands, Norway, Ireland, Denmark, Finland, Belgium
Light industry	Switzerland, Austria, Italy, Sweden, Denmark, Finland
Forest complex	Finland
Mechanical engineering, electronics	The Netherlands, Italy, Germany, Norway, Ireland, Switzerland
Oil and gas complex and chemistry	Switzerland, Germany, Belgium
Health care	Sweden, Denmark, Switzerland, the Netherlands
Pharmaceuticals and cosmetics	Denmark, Sweden, France, Italy, Germany

It should be noted that according to the European Commission [11], the first place in terms of investment in research and development in the world is pharmaceuticals and biotechnology (18.9% of global investment in research and development), which are an example of high-tech clusters and actively developing in Europe. These industries generate significant innovations and related to various sectors of the national economy (Table 2).

**Table 2.**  
**European biopharmaceutical clusters**

European countries	Number of registered clusters	Features of cluster development	Example of clusters
Austria	1	Inferior to other countries because of the historically formed specialization	Vienna Biocenter (Vienna)
Belgium	5	Attractive geographical location Scientific and educational center	<ul style="list-style-type: none"> <li>• ARESA (cluster of clinical trials)</li> <li>• BioWin (Wallonia region)</li> <li>• Bioliège (Liege)</li> </ul>
United Kingdom	10	Availability of basic university science Development of a market instrument for financial support of innovations Even distribution of benefits by regional centers	<ul style="list-style-type: none"> <li>• Oxfordshire Bioscience Network (Oxford)</li> <li>• BioCity Nottingham (Nottingham)</li> <li>• BioDundee (Edinburgh, Scotland)</li> <li>• BioLondon</li> <li>• Biotech Manchester</li> </ul>
Denmark	5	Developed national health care system High level of biopharmaceutical research Opportunity for the development of international networks of innovation clusters in the Baltic Sea region	<ul style="list-style-type: none"> <li>• Medicon Valley Alliance</li> <li>• Biocenter East Jutland (East Jutland)</li> <li>• BioMedico Forum</li> </ul>
Estonia	3	The development of the tourism and hospitality industry as a priority of the country's economic policy contributes to the development of the supporting biopharmaceutical industry	<ul style="list-style-type: none"> <li>• Estonian Biotechnology</li> <li>• Tartu Teaduspark</li> </ul>
Spain	3	Significant state support for biotechnology Creation of bioregions	<ul style="list-style-type: none"> <li>• Biotechnology Cluster in Catalonia BioCat (Catalonia)</li> <li>• BioBasque (Bilbao)</li> </ul>

			<ul style="list-style-type: none"> <li>• Madrid Biocluster</li> </ul>
Italy	7	Much attention is given to research-based medical centers	<ul style="list-style-type: none"> <li>• Distretto biomedicale di Mirandola (Bologna)</li> <li>• Biomedical Science Park San Raffaele (Milan)</li> <li>• Toscana Life Sciences Foundation (Tuscany)</li> <li>• innovation cluster bioPmed (Turin)</li> </ul>
Germany	28	Leader in the number of biopharmaceutical clusters Cooperation with large pharmaceutical companies	<ul style="list-style-type: none"> <li>• Forum MedTech Pharma (Nuremberg)</li> <li>• BIO CITY LEIPZIG</li> <li>• BioRiver (Dusseldorf)</li> <li>• BioTOP Berlin-Brandenburg (Berlin)</li> </ul>
Netherlands	5	Significant production and scientific potential	<ul style="list-style-type: none"> <li>• Amsterdam Biomed Cluster</li> <li>• BioPartner, Leiden Bio Science Park (Amsterdam)</li> <li>• Springboard (Groningen)</li> </ul>
Hungary	6	The most developed biopharmaceutical industry among the EU-10 countries	<ul style="list-style-type: none"> <li>• Medical Biotechnology Innovation Cluster (Budapest)</li> <li>• Pharmapolis Debrecen (Debrecen)</li> <li>• Goodwill Biotech Cluster (Szeged)</li> </ul>
Finland	4	Developed scientific and educational infrastructure of large places	<ul style="list-style-type: none"> <li>• BioTurku (Turku)</li> <li>• Helsinki Region Centre of Expertise</li> <li>• SymBio (Helsinki)</li> </ul>
France	18	High level of development and diversification of the agricultural sector	<ul style="list-style-type: none"> <li>• BioValley (Alsace) (cross-border cluster)</li> <li>• Bioteam Paris Region (Region Ile-de-France, Paris)</li> <li>• EUROBIOMED (Marseille)</li> </ul>
Switzerland	6	The development of the pharmaceutical and biotechnology sector enables cluster organizations to participate in cross-border cluster projects	<ul style="list-style-type: none"> <li>• BioValley Basel</li> <li>• BioAlps Association (Geneva)</li> <li>• Biotech Center Zürich (Zurich)</li> </ul>

For example, München, Berlin and Graz biopharmaceutical clusters specialize in the production of anticancer drugs, DNA / protein chips, bioinformatics and functional genomics; Utrecht and Lelystad clusters - on bioinformatics, production of immunological, anticancer drugs, drugs for the treatment and prevention of metabolism; Frankfurt, Mailand and Gent clusters - in the production of anticancer, immunological drugs, drugs for blood clotting, for the treatment and prevention of metabolism; Wien and Berkshire clusters - in the production of neurological, antibacterial, anticancer drugs, drugs for the treatment and prevention of metabolism and inflammation of the musculoskeletal system. The Utrecht and Lelystad clusters focus on the production of similar therapeutic groups, but are located far from each other.

The Oresund cluster (Denmark and Sweden) consists of many pharmaceutical and biotechnology firms, university hospitals and universities, located in the German-Dutch border area, where regional clusters for the plastics, biotechnology and metalworking sectors operate; including the Medicon Valley.

The Bio-valley cluster is located in the Upper Rhine and South Baden (Germany), Switzerland and Alsace (France) and claims the role of a European biotechnology center [12; 13, p. 35].

It is interesting information on the market capitalization of the largest pharmaceutical and biotechnology companies in Europe, including the leaders are Switzerland, United Kingdom and France (Table. 3) [14; 15].

**Table 3.**  
**Ranking of European countries in the FT Europe-500 rating**

Ranking of countries by total market capitalization of pharmaceutical and biotechnology companies	Countries with biopharmaceutical companies rating Europe-500	Ranking of companies in the overall ranking Europe-500	Market capitalization, million dollars USA
1	Switzerland	5. Novartis	142 709,6
		6. Roche	140 875,6
		349. Actelion	809,0
		424. Lonza	323,8
2	United Kingdom	13. GlaxoSmithKline	99 657,42
		24. AstraZeneca	64 625,9
		200. Shire	12 388,9

3	France	4. Sanofi-Aventis	98 464,3
		445. Ipsen	4 114,7
4	Denmark	67. Novo Nordisk	39 840,7
		314. Novozymes	6 014,8
		350. H Lundbeck	3 703,5
5	Germany	374. Merck	5 246,5
		378. Qiagen	5 225,6

Germany ranked 5th due to the fact that many manufacturers of pharmaceuticals and biotechnology products (such as BASF and Bayer) are included in the chemical sector according to the FT-500 methodology.

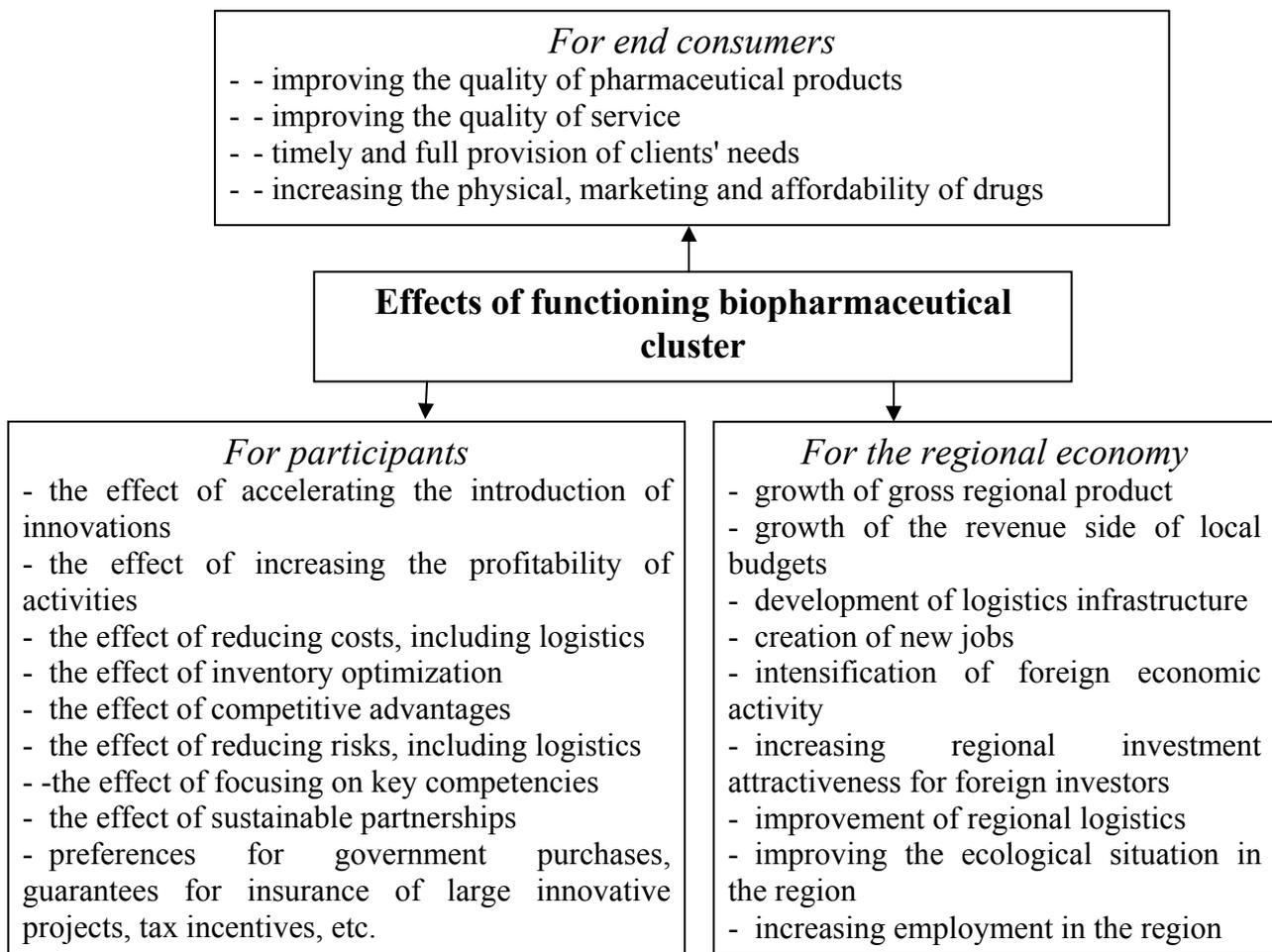
It should be noted that Slovenia and Hungary are in the TOP-10 with only one large pharmaceutical company, but this does not indicate the effective development of biotechnology clusters.

The generalization of experience allowed us to conclude that the biopharmaceutical cluster is an association of subjects of production, distribution and sale of drugs, science and education, providing and carrying out purposeful activities for the development, production and promotion on the domestic and foreign markets of competitive drugs. based on the mechanisms of public-private partnership.

Economic interaction of the participants of the biopharmaceutical cluster is the distribution and redistribution of resources in the process of cooperation to implement its strategy and provide participants with the necessary resources; organizational - the creation of an organizational structure that ensures effective interaction of participants; management - optimal use of resources and potential of the biopharmaceutical cluster to achieve a synergistic effect; social - creation of the mechanism of timeliness of providing the population with available medicines and development of the region, social responsibility of the pharmaceutical market subject, increase of level of employment of the population, increase in tax receipts to local and State budgets; legal - improvement of the regulatory framework, which is the basis for the interaction of cluster members; technical and technological - the possibility of using modern methods and the latest production technologies, logistics, marketing, information technology; innovative - the possibility of introducing innovations and original medicines production; information - the timeliness of providing all participants with the necessary information; ecological - the optimal impact of the subject of the pharmaceutical market on the environment and ensuring the ecological and hygienic safety of the region. In addition to the listed types of interaction, the production of original medicines requires solving the problem of their introduction into medical practice, that is, the problem of interaction in the provision of medical services.

A distinctive feature of the cluster approach in pharmacy is, on the one hand, the development of innovative drugs and their introduction into production, which, on the other hand, is the global goal of the domestic pharmaceutical sector, since the biopharmaceutical cluster should act as growth points of the domestic market on a regional and national scale. all stages of the life cycle of high-tech pharmaceutical products and become the basis for improving the foreign economic activity of the pharmaceutical sector as a whole. In addition, for the pharmaceutical sector, an important task is to provide the population with effective medicines at affordable prices and improve the environmental situation in the region, achieved through optimizing the use of resources in the region, that is, industry cooperation, and cost savings.

The formation of full-fledged biopharmaceutical clusters contributes to the spread of high-tech industries, the harmonization of technology standards and drug production organization, the development of not only inter-firm relations, but also effective interaction of the pharmaceutical sector with science and education, and influences the strategy of regional authorities. So, the purpose of creating a biopharmaceutical cluster in Ukraine is to increase the competitiveness of individual subjects of the pharmaceutical market, individual biopharmaceutical clusters and the pharmaceutical sector as a whole (Fig. 1) [16, p. 32-39; 17, p. 132-133].



**Fig. 1. Formation of the effects of functioning biopharmaceutical cluster**

**Conclusions from the study and prospects for further exploration in this direction.**

All members of biopharmaceutical clusters complement and enhance each other's competitive advantages. The advantages of clustering at the regional level are the spread of new high-tech industries, knowledge, pharmaceuticals, additional competitive advantages of cluster members through internal specialization and standardization, minimizing innovation costs, ensuring environmental stability, reducing environmental pollution, harmonizing the interests of participants in pharmaceutical clusters. with partners (suppliers, consumers, intermediaries, etc.) and actions in the logistics pharmaceutical chain, control and coordination of flow processes, timeliness of providing consumers with the necessary drugs at affordable prices.

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