Chapter 13

PHARMACEUTICAL INDUSTRY AS A COMPONENT OF THE SUSTAINABLE DEVELOPMENT OF THE HEALTH CARE SYSTEM

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INTRODUCTION

The world pharmaceutical industry and the world market of pharmaceutical products demonstrate dynamic development. Despite low growth rates and stagnation in the world economy in recent years, the pharmaceutical market continues to develop, remaining one of the most profitable sectors of the world economy. Its growth rate is approximately 6–10% per year. Unlike other commodity markets and industries, where the net profit equals, on average, 5% of the total revenue, in the pharmaceutical industry this index reaches 18% per year[1].

The growth in sales of pharmaceuticals (pharmaceuticals) was made possible by several factors. First, there is a global increase in morbidity due to the increased impact of man-made factors and the deterioration of the ecological situation, as well as the threat of epidemics of such diseases as atypical pneumonia, bird flu, and the Covid-19 pandemic. Secondly, this is the trend of "population aging" in the developed countries of Western Europe, North America, and Japan. Thirdly, in China, India, and the countries of Central and Eastern Europe, the growth of population incomes at the beginning of the 21st century. leads to the use of more expensive and high-quality drugs.

The growth of the pharmaceutical market is also facilitated by the rapid development of such relatively new market areas as the segment of biologically active supplements (BAS), generics and homeopathic medicines. Today, the share of generics in the markets of the USA, Great Britain, Canada and Germany has reached 30% and, according to experts, it may continue to increase[1].

The international "division of labor" in the field of pharmaceuticals and medical devices (MD) production is reflected in the following statistics: of the

[1] Історія фармації. URL: https://profbook.com.ua/index.php?route=product/product/download&product_id=8309&download_id=1445

50 largest pharmaceutical companies, which occupy more than 80% of the market, 20 companies are based in the USA (39.2% of the world pharmaceutical market), 18 companies – in Europe (33.3% of the market), 11 companies – in Japan (7.8% of the market) and one – in Israel[1]. In today's world, the pharmaceutical industry plays an important role in providing the population with high-quality and effective medicines and drugs. The growing need for new medicinal products (MP), as well as constant scientific and technological progress, prompts drug manufacturers to search for innovative solutions and development strategies. One of the key aspects of this industry is the activities of the world's leading manufacturers of pharmaceuticals, which influence the formation of the medical (pharmaceutical) market and have a significant impact on the health of the population.

Proper training of specialists in the pharmaceutical industry in institutions of higher education (HEI) guarantees the sustainability of the development of both the industry itself and the entire public health care system in individual countries[2]. In Ukraine today there is a threat regarding the provision of proper pharmaceutical education, since the specialisation 226.02 "Industrial pharmacy" within the specialty 226 "Pharmacy, industrial pharmacy" Fields of knowledge 22 Health care is carried out only in five ZVO in the future[3]. In addition, there are attempts to separate this particular specialisation and transfer it from Knowledge Branch 22 "Health Care" to another Knowledge Branch. However, the regulatory legal acts regulating the activities of the pharmaceutical industry, in particular industrial pharmacy, in our country are regulated by the Ministry of Health of Ukraine. That is why it is important for legislators, industry professionals, scientists to understand the impossibility of separation between different fields of knowledge and, accordingly, subordination to different ministries of industry sectors – pharmaceutical industrial production, wholesale and retail provision of medicines to the population.

The goal of our research was to systematize information about the most influential and innovative manufacturing pharmaceutical companies in the world. The main tasks included the study of the history of the industrial production of drugs and the development of modern pharmaceutical companies, the analysis of their key products, research and technologies, the assessment of the impact on medical practice and the state of global health of the population due to pharmaceutical pollution, as well as the analysis of financial indicators and development strategies industry.

[2] Aelita K., Oksana L., Iryna H., Anna K., Vira L. The Comparative Analysis of Components of Pharmacy Education Programs in Universities of EU Countries and Ukraine. Arch Pharm Pract. 2024;15(1):23-32. DOI https://doi.org/10.51847/8Lt9YBxFk6

[3] Krychkovska A. M., Hubytska I. I., Venhryn N.M. Integration into the European Union: current state and problems of pharmaceutical education in Ukraine. DOI https://doi.org/10.30525/978-9934-26-401-6-30

1. The history of the development of the pharmaceutical industry and the leaders of the world pharmaceutical market of medicines

The production of pharmaceuticals has been known since ancient times. The emergence of industrial enterprises for the production of medicines dates back to the end of the 19th century. They began to appear especially quickly at the beginning of the 20th century. after the discovery of synthetic drugs. The production of medicines developed most intensively in Germany, Great Britain, and Switzerland. Before the Second World War, Germany dominated the world market in terms of the range of munitions. In the 1970s, the production of synthetic drugs, including antibiotics, increased in the USA and Great Britain. The development of the pharmaceutical industry relies on the achievements of chemical science[4]. This industry has a long history of development. As a rule, the following three stages of formation and development of the pharmaceutical industry are distinguished: 1. Pre-industrial stage – characterised by the absence of mass production of pharmaceuticals; 2. Industrial stage – the beginning of mass production of drugs based on simple chemical compounds; 3. The modern stage (post-industrial) – the development of science has led to the emergence of more than 300,000 medicines not only production, but also the search for new active substances and the development of biotechnology.

In the 19th and 20th centuries, the process of making medicines was different from the modern one. Initially, many medicines were prepared by hand, and this was a difficult and sometimes dangerous procedure. Doctors and apothecaries used natural ingredients such as plants, herbs, minerals, and animal products to make medicines.

The industrial revolution in the 19th century played an important role in the development of the pharmaceutical industry. The advent of new technologies, such as chemical synthesis and pharmaceutical analysis, has made it possible to create drugs with greater precision and efficiency. The first mass production of drugs appeared at the end of the 19th and the beginning of the 20th centuries, which made it possible to provide the population with affordable drugs. In the 20th century, the pharmaceutical industry experienced significant development and transformation. The discovery of antibiotics made a breakthrough in pharmacotherapy and saved millions of lives. Protection against pathogenic microorganisms became more effective, which allowed operations and treatment of infectious diseases with a higher probability of success. Pharmaceutical companies began to produce more and more sophisticated drugs that provided more precise and targeted therapy. Advances in biotechnology and genetic engineering have opened up new possibilities for the creation of biological medicines, such as biological agents and vaccines, which have revolutionised modern medicine.

[4] Фармацевтична промисловість. URL: https://uk.wikipedia.org/wiki/

Thus, the history of the pharmaceutical industry reflects the complex path from the manual preparation of medicines to the high-tech production of modern pharmaceuticals, which is based on a high level of scientific research and technology. In addition, new approaches to the pharmacotherapy of cancer, cardiovascular diseases and other diseases have appeared, which has opened wide opportunities for the development of the pharmaceutical industry.

In the development of Ukrainian pharmacy from its inception in the 13th century. and to the formation of the prototype of a modern pharmacy at the beginning of the 20th century. distinguish three main stages that fall into certain historical periods: the princely era (1256–1349), the first Polish (1349–1772), and the Austrian (1772–1918) era[5].

The emergence of temple medicine is characteristic of the princely age, which lasted less than a century. At this time, medical centres with pharmacies began to appear at the Lviv churches of John the Baptist (XIII century), the Dominican Cathedral (XIV century), the monastery of St. Yuri (XIV century). Medical practice and use of drugs were based mainly on the traditions of folk medicine[5].

A feature of the second stage, which lasted more than four centuries and was epidemiologically unfavourable for Halychyna (the western region of Ukraine) (epidemics of 1348, 1362, 1365, 1464, 1467), was the construction of the first drinking water supply in the city of Lviv in the territory of the modern country water (1404) and purification system.

The second stage was characterised by an invitation in the 15th century. from European countries to the city of Lviv, the first certified doctors and pharmacists, as well as the appearance of Ukrainian pharmacists (Vasyl Rusyn, 1445), the opening of the first official public pharmacy in Lviv (1490), the establishment of a barbershop on the Western European model (1512)[5]. At the beginning of the 16th century in the city of Lviv, national-religious brotherhoods and non-union associations of specialists arose, which, among other things, created hospitals and shelters for the sick and poor. The "Sanitary patent" (1773) of the governor of the Austro-Hungarian government prohibited doctors and pharmacists from performing their professional duties without the appropriate diplomas. The same document established the rules for the proper activity of doctors and pharmacists for the first time: doctors were forbidden to manufacture medicines, and pharmacists were forbidden to treat patients independently[5]. The magistrate imposed a fine on the owner for violating the organization of the pharmacy's work. The deceased owner of the pharmacy was replaced by a visiting pharmacist, the position did not pass to family members. Apothecaries undertook to prepare and sell medicines only

[5] Історія створення фармацевтичної промисловості в Україні. URL: http://www.mif-ua.com/archive/article/21672

according to a doctor's prescription, indicating their surname on the labels[5]. The further strengthening of state influence on the development of pharmacy is connected with the unification of medical and sanitary affairs in the Austro-Hungarian Empire and the extension in 1776 to the territory of Galicia of the "Main Sanitary Statute" of Austria-Hungary (1770), the establishment of a state the price list for medicines (1777), the abolition of the Polish and the introduction of the Viennese metric system of measures, the ban on the importation of first-aid kits from other countries into Galicia.

At the end of the 18th and the beginning of the 19th centuries. Galician pharmacies performed a double function: trade establishments with their production and sale of medicines, veterinary drugs, cosmetics and medical facilities for providing first pre-medical medical aid. Pharmacies prepared such medicinal forms as: powders, solutions, syrups, balms, elixirs, essences, decoctions ("lads"), oil extracts, plasters, various ointments, pills ("rolls"), tablets ("little bits"), lozenges ("lefties"), suppositories ("carnations"), oxymels ("honeys")[5].

During the time of Bohdan Khmelnytskyi, Ukraine was divided into 16 regiments. In regimental towns there were medical centres with pharmacies that served mainly the Cossack elite. In the cities of the Polish-Lithuanian Commonwealth, private pharmacies appeared only in the second half of the 17th century. – in the cities of Kamianets-Podilskyi, Lutsk, Kremyantse, Vinnytsia, Korsun, Bohuslav, Uman, Zhytomyr. The number of pharmacies on the Right Bank increased significantly after its reunification with the Left Bank. At that time, the assortment of pharmaceuticals was dominated by: plants (80%), substances of chemical origin (9–10%) and substances of animal origin (7%)[5].

From the middle of the XIX century. homeopathic pharmacies became widespread. According to the minutes of the meeting of the Regional Health Council dated June 23, 1883, homeopathic medicines were allowed to be manufactured exclusively by a doctor's prescription and only those pharmacies that had the right to do so. As a result of government regulation of the pharmacy service in Galicia in the 19th century. there were several types of pharmacies that differed from each other both in purpose and in the form of work organization: royal, public, military, district, homeopathic, village, home, and drug stores[5]. The most common were public pharmacies, which had prescription and dispatch departments, mechanical and prescription rooms, a warehouse for materials, a medicine room, a drying room, and a library. Here it was allowed to prepare pharmacopoeial drugs, universal drugs and drugs with poisonous and potent substances prescribed by doctors on special prescription forms. The right to run a public pharmacy was granted exclusively to doctors of chemistry or masters of pharmacy[5]. The first district pharmacies of Ukraine (prototypes of modern central district pharmacies) appeared in the second half of the 19th century, which is connected with the

establishment of district professional pharmacy associations. As a rule, pharmacies headed by heads of professional associations were given the status of district. The most famous of them was the district pharmacy in Lviv "Under the Black Eagle", founded in 1735 by the military master Wilhelm Natorpt to provide medicines to the military units located in the city and government officials of the City Council (from 1966 to today – a pharmacy-museum of the city of Lviv). Assortment of Ukrainian pharmacies of the XVI–XIX centuries. 80% consisted of medicinal plants of plant origin (medicinal plant raw materials – LRS), chemical substances made up 6.7–10%, substances of animal origin – 7–10%. From medicinal forms, pharmacies prepared: infusions, decoctions, mixtures, drops, syrups, teas, powders, ointments, suppositories, plasters. Fierce competition prompted pharmacists to also produce medicinal wines, mineral waters, meat broths, vegetable (plant) extracts, soups in briquettes, cosmetic products, etc.[5] Characteristic for Ukrainian pharmacy in the 19th century. problems arose: pharmacy monopoly, competitive struggle for obtaining a concession to run a pharmacy, discrimination of the rights of pharmacists-employees who were employed by the pharmacist-owner[5].

In the 20s of the XIX century. several large pharmaceutical enterprises were created, which specialised in the production of various drugs for the domestic market of the country. After gaining independence in 1991, the Ukrainian pharmaceutical industry began active development. Many former state-owned enterprises reoriented themselves to work in the new conditions of the market economy. New private pharmaceutical companies appeared, which began to actively develop drugs. The development of the Ukrainian pharmaceutical industry was facilitated by such factors as the availability of qualified medical (pharmaceutical) and scientific personnel, the availability of natural resources for the production of raw materials for pharmaceuticals, as well as the opening of opportunities to export their products to foreign markets. Also, an important area of development is the introduction of new technologies, research and development of new drugs by scientific institutions and private companies.

Today, Ukrainian pharmacy has been modernised and has become competitive, domestic manufacturers are entering the European market, and a wide range of drugs is presented on the domestic market. Industrial production of pharmaceutical products in Ukraine is carried out by about 120 enterprises. The largest Ukrainian pharmaceutical manufacturers are: PJSC "Farmak", "Borshchagiv chemical and pharmaceutical plant", Corporation "Arterium" ("Kyivmedpreparat", "Halychpharm"), "Darnytsia", "Zdorovya", "Lekhim". The five main manufacturing companies account for more than 50% of the products produced in the country. The largest Ukrainian manufacturers that export their products are: PJSC "Farmak", Corporation "Arterium",

Corporation "Zdorovya", PJSC "Borshchagiv Chemical-Pharmaceutical Plant", Pharmaceutical Company "Darnytsia".

The dynamic development of the pharmaceutical industry of Ukraine is based on six components: pharmaceutical education, science, the pharmaceutical industry, the state system of drug quality control, the pharmacy network and the information field of pharmacy. Only under the condition of coordinated and effective work of all these components is it possible to achieve the main goal of pharmacy – ensuring the health of the nation.

Ukraine's desire to integrate into the European economic and educational space has affected the main trends in the development of the pharmaceutical industry. In the spheres of production and circulation of medicinal products, world standards of good practices are widely implemented: production, pharmaceutical (pharmacy), laboratory and distribution.

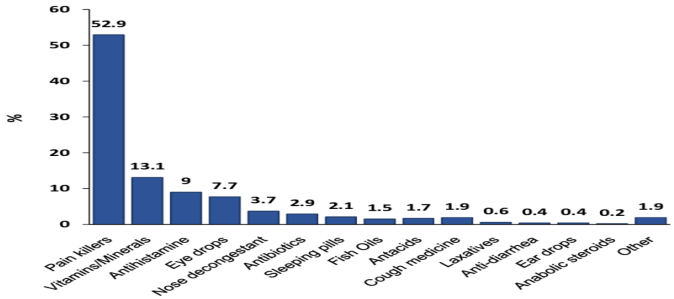
Good Manufacturing Practice (GMP) is a set of rules regarding the organization of production and quality control, which are an element of the quality assurance system. Compliance with GMP requirements ensures stable production of LP in accordance with the requirements of scientific and technical documentation and quality control in accordance with quality control methods (QC). EU Directive 89/341/EEC states that "the quality of medicinal products must be determined by compliance with GMP principles." Low-quality medicines are not only dangerous for people's health, but also lead to material losses for both the state and the consumer. GMP contains a number of indicators (requirements) that must be met by enterprises producing pharmaceutical products. It maximally takes into account factors that affect the quality of medicines: buildings and premises, personnel, equipment, organization and implementation of the technological process, documentation, control over the production process, quality control of finished products, etc.[6].

Official guidelines on GMP are the legal and substantive basis of GMP rules and an important reference material for the design, construction and reconstruction of enterprises in the pharmaceutical industry. They are used as basic requirements for licensing and inspection of these enterprises, as well as as training and methodical guides for enterprise employees and state inspectors. These rules are also the basis of the international system of confirmation of compliance (certification) of the quality of drugs intended for export, proposed by the WHO. Currently, the following official GMP guidelines are best known: international – WHO; regional – countries of the EU (EU), participants of the Pharmaceutical Inspection Convention (PIC), Association of Southeast Asian Nations (ASEAN); national – US Food and Drug Administration (FDA) and other organizations. In Ukraine, there is an

[6] Належна виробнича практика. URL: https://www.pharmencyclopedia.com.ua/article/1167/nalezhna-virobnicha-praktika

effective Instruction ST-N MOZ 424.0:2015 "Medical products. Good manufacturing practice", which corresponds to the GMP rules in the EU[7].

The pharmaceutical market is a powerful industrial sector that is among the TOP 5 most profitable sectors of the world's economic complex. The development of this field is an extremely important aspect and the development of effective and safe medicines is a priority for all the leading countries of the world. This is due to the great importance of these products, because, as mentioned above, there is a high level of morbidity and aging of the world population. The availability of a particular drug can mean the difference between life and death for people. Medicines also contribute to the enrichment of their manufacturers by billions of dollars. The profit of pharmaceutical companies is estimated at $ 300 billion[8]. Much of this amount comes from sales of extremely popular prescription drugs. Most of the best-selling drugs are produced by the world's largest pharmaceutical companies, which dominate the industry. The ten largest pharmaceutical companies are responsible for 11 of the 15 best-selling drugs in the world[8]. For example, the Swiss drug manufacturer Roche developed and sells three of the 15 best-selling drugs in the world, the British pharmaceutical company AstraZeneca sells two. Together, the two companies sold drugs worth $34.3 billion in 2014. A wide range of factors ultimately determine whether or not a drug becomes popular. It is clear that the most important factor, in addition to ensuring effective treatment, is the prevalence of the disease that the drug treats. Picture 1 shows the most popular drugs for self-medication used by people[9].



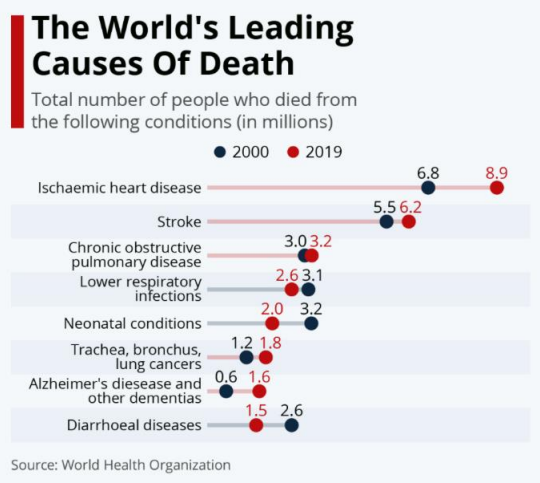
Pic. 1. The most popular medicines for self-medication

[7] Чинна настанова GMP. URL:https://aipm.org.ua/moz-ukrayini-zatverdzheno-novu-nastanovu-z-gmp.

[8] Top pharmaceutical drugs. URL: https://www.statista.com/topics/1497/top-pharmaceutical-drugs

[9] Найпоширеніші неінфекційні хвороби. URL: https://biz.nv.ua/ukr/markets/smertelni-hvorobi-v-ukrajini-naybilsh-poshireni-zahvoryuvannya-jih-likuvannya-i-novi-rozrobki-50322218.html.

According to the World Health Organization (WHO), the most common non-communicable diseases in the world this year. They account for 71% of deaths, which is 41 million people a year. Coronary heart disease, stroke, chronic obstructive pulmonary disease, lower respiratory tract infections, and sudden infant death syndrome are among the top ten that have remained unchanged for many years. As well as lung cancer, Alzheimer's disease, dementia, diarrhoea, diabetes and kidney disease (Pic. 2)[9].



Pic. 2. WHO statistics on the most common causes of death in the world

The most popular groups of drugs for the pharmacotherapy of these diseases: antibiotics (amoxicillin, azithromycin); antiviral drugs (oseltamivir for influenza, lopinavir/ritonavir for HIV/AIDS); antidepressants (sertraline, fluoxetine); antihypertensive drugs (amlodipine, metoprolol); anticancer drugs (paclitaxel for breast cancer, carboplatin for ovarian cancer); drugs for the treatment of diabetes (metformin, insulin, glibenclamide); drugs for the treatment of diseases of the nervous system (aripiprazole for schizophrenia, setraline for the treatment of panic attacks).

These drugs are used both in monotherapy and in combination with other drugs, depending on the nature of the disease and the individual characteristics of the patient.

The number of medicines in the world is growing so fast that statistics constantly have to be updated. The growth of the range of drugs is occurring in various fields of medicine: from the treatment of diseases of the cardiovascular system to new antiviral drugs, vaccines, immunomodulators,

and drugs for the treatment of oncological and chronic diseases. This is due to the constant scientific progress in the medical field, the development of biotechnology and genetic engineering, as well as the growing understanding of the molecular mechanisms of diseases. In addition, the growing interest in the development of personalised and precisely adjusted drugs for the individual needs of the patient also contributes to the increase in the number of new drugs on the market.

The Covid-19 pandemic in 2020 also made adjustments to the global pharmaceutical production. Since April 2020, various medical institutions and pharmaceutical companies have developed and tested more than 40 drugs that could potentially protect against COVID-19. As of November 15, 2021, according to official WHO reports, 7.52 billion doses of the vaccine against COVID19 have been administered in the world, 52.2% of the world's population received the first dose[10].

Due to the Covid-19 pandemic, the term "mRNA vaccine" became known to the general public. Many people learned about this term precisely because of the vaccine from the companies Pfizer-BioNTech and Moderna. However, as recently as 2019, it was believed that the widespread use of mRNA vaccines was at least five years away. The Covid-19 pandemic accelerated the development of this field of medicine by half a decade[11].

Therefore, pharmaceutical companies today play a leading role in the development of methods of treatment for the ten leading causes of death in the world – coronary heart disease, stroke, chronic obstructive pulmonary disease, lower respiratory tract infections, neonatal conditions, cancer of the trachea, bronchi, lungs, Alzheimer's disease and others dementia, diarrheic diseases, diabetes, kidney diseases.

The main characteristics of the manufacturing companies included in the ranking of the world's leading pharmaceutical manufacturers (as of 2024) were studied[12]:

1. Pfizer Company. The American multinational pharmaceutical and biotechnology company Pfizer, which occupies 9% of the world market, specialises in the production of medicines for humans and is best known for Viagra. It also makes drugs for immunological, cardiac, oncological and neurological diseases, as well as vaccines against COVID-19, which contributed to its record total revenue of more than 100 billion US dollars in

[10] Вакцина проти COVID-19. URL: https://uk.wikipedia.org/wiki/%D0%92%D0%B0%D0%BA%D1%86%D0%B8%D0%BD%D0%B0_%D0%BF%D1%80%D0%BE%D1%82%D0%B8_COVID-19

[11] Як мРНК-вакцини зробили революцію у медицині. URL: https://www.bbc.com/ukrainian/vert-fut-59406693.

[12] Top 10 pharmaceutical companies in the world. URL: https://www.panda-int.com/insights/top-10-pharmaceutical-giants-of/

2022. Founded in New York in 1849 by Charles Pfizer and Charles Earhart, it is now based in Groton, Connecticut, and has 83,000 employees[13].

2. AbbVie Company. Founded in 2013, with more than 50,000 employees in 70 countries. US-based AbbVie had $58 billion in drug sales in 2022 thanks to its immunology and neurology specialties, which include oncology, dermatology, metabolic diseases and neurological disorders. Humira, the best-selling rheumatoid arthritis drug, brought in more than $21 billion for the company last year.

3. Johnson & Johnson (J&J) Company. Johnson & Johnson, also known as J&J, is based in New Jersey, USA, and manufactures pharmaceuticals, medical products, and consumer health products. Founded in 1886, J&J has grown to become one of the largest pharmaceutical companies in the world, with revenues of $52.6 billion in 2022 based on sales of pharmaceuticals and vaccines alone. In 2022, the company spent approximately $14.6 billion on research and development, which allowed it to increase revenue to $95 billion. The company's headquarters in New Brunswick employs more than 155,800 people.

4. Merck & Co. Founded in 1891, Merck & Co is one of the leading pharmaceutical companies headquartered in New Jersey, USA, and has approximately 69,000 employees worldwide. Focusing on biopharmaceuticals for the treatment of diabetes and cancer, the company also produces vaccines and deals in animal health. In 2022, its total revenue will be almost $59.3 billion thanks to the success of drugs like Keytruda, a cancer drug that accounts for almost 40% of its sales.

5. Novartis Company. The Swiss company Novartis has more than 100,000 employees in 155 countries and is one of the oldest pharmaceutical companies in existence, having been founded more than 250 years ago. Its total revenue in 2022 is estimated to be USD 50.54 billion due to its diverse portfolio of drugs and CFs, which includes veterinary drugs, vaccines, contact lenses, generics, and drugs such as clozepine, carbamazepine, and diclofenac.

6. Roche Company. Specialising in oncology, ophthalmology, immunology, infectious diseases and neurology, LPs accounted for more than 70% of Roche's total 2022 revenue of $69.4 billion. Founded in 1896 by Fritz Hoffmann-La Roche, the global health organization headquartered in Basel, Switzerland, was the first company to synthesise vitamin C on an industrial scale. The leading drug is Herceptin – drug for the treatment of breast cancer. The company employs 103,600 people.

7. Bristol-Myers Squibb Company. Based in New York, USA, BMS dates back to the 1800s, but took on its modern form in 1989 through the merger of Squibb Corporation and Bristol Myers & Company. Best known for its range

[13] Історія успіху компанії Pfizer. URL: https://24tv.ua/istoriya-uspihu-farmatsevtichnoyi-kompaniyi-pfizer-novini-v-sviti_n1475552

of pharmaceuticals and biologics, it was one of the first pharmaceutical companies to begin research and development of anti-cancer drugs in the 1970s. With approximately 35,000 employees, the company focuses on immunology, oncology, cardiovascular disease and haematology, with a particular interest in conditions such as hepatitis and HIV infection. In 2022, its total revenue was 46.2 billion US dollars.

8. Sanofi Company. The French company Sanofi has more than 91,000 employees in 90 countries and focuses its activities on general medicines, specialised medical care and vaccines. The company focuses on immunology, oncology and anti-inflammatory drugs, and its eczema drug Dupixent, which is approved for eosinophilic esophagitis and asthma, is expected to generate total revenue of $45 billion in 2022.

9. AstraZeneca Company. AstraZeneca, based in Cambridge, United Kingdom, with total revenue of more than US$44 billion in 2022, specialises in preventive medicines as well as the treatment of major diseases such as oncology, gastrointestinal disorders, neurology, infections, inflammation and cardiovascular – vascular diseases. Founded in 1999, the company employs more than 83,000 people in more than 60 locations in Europe, Africa, Asia-Pacific and the Americas.

10. GSK Company. Formed by the merger of Glaxo Wellcome and SmithKline Beecham in 2000, GSK specialises in biologics, pharmaceuticals and vaccines, while its subsidiary Haleon Group focuses on consumer healthcare products. GSK's focus on biopharmaceuticals has led to the company's total revenue of $36.75 billion in 2022. UK-based GSK employs around 70,000 people who research and develop products to treat diseases such as diabetes, asthma, cancer, viruses and mental health problems.

2. Trends in the development of the modern pharmaceutical industry and the impact of pharmaceutical companies on the environment: pharmaceutical pollution

We analysed in detail the history of the emergence and development of the leaders of the pharmaceutical industry, the ways in which these companies achieved commercial and financial success.

Pfizer Company: In 1849, two German chemists, Charles Pfizer and Charles Earhart, moved to the United States of America in search of a better life. With a loan of 2.5 thousand dollars, they founded Charles Pfizer & Company[11]. The first product of the LZ Santonin company was an effective remedy against worms, which at that time troubled many residents of the United States. Medicines have been improved, given the shape and taste of lollipops. Rapid growth began 30 years later – with the start of sales of citric acid. The requests were made by producers of carbonated drinks Coca-Cola and Pepsi. During the Second World War, as a response to the request of the American government, Pfizer began to mass-produce the drug Penicillin. An

antimicrobial antibiotic saved the lives of soldiers, who often died not so much from the complexity of their wounds as from blood infection. In 2020, Pfizer and BioNTech entered into a collaboration to study and develop mRNA vaccine candidates against COVID-19. On July 27, 2020, the companies announced the initiation of a global (excluding China) phase 2/3 safety and efficacy clinical trial to evaluate the BNT162b2 mRNA vaccine candidate.

The research (October 2021) found that a booster dose of a COVID-19 vaccine developed by Pfizer and BioNTech restored the effectiveness of protection against the virus to 95.6%, including against the Delta variant. Among the well-known LPs: Lyrica, Viagra, Celebrex, Diflucan, Prevenar, Medrol, Inspra, Xalatan, etc.[14].

AbbVie company. One of AbbVie's main areas of activity is the development of drugs for the treatment of chronic and severe diseases, in particular: Lupron (Leuprorelin) – this drug is used to treat prostate cancer, testicular cancer, uterine cancer, as well as to treat endometriosis and uterine fibroids; Humira (Adalimumab) – Humira is one of the most famous drugs in the world. It is used to treat rheumatoid arthritis, Crohn's disease, psoriasis, ankylosing spondylitis and other inflammatory diseases; Viekira Pak (Ombitasvir/Paritaprevir/Ritonavir/Dasabuvir) – intended for combined antiviral therapy, chronic hepatitis C; Imbruvica (Ibrutinib) – LP is used to treat lymphoma and leukemia, including chronic lymphocytic leukemia (CLL) and Mantoux lymphoma. Skyyri (Glecaprevir/Pibrentasvir) – this drug is indicated for the treatment of hepatitis C in adult patients without cirrhosis or with compensated cirrhosis. AbbVie is also actively engaged in research and development of new drugs in various fields of medicine, such as oncology, hepatology, rheumatology and other fields. The company has a significant impact on the global drug market and continues to develop through innovative research and management strategies[15].

Johnson & Johnson Company. American company, a large manufacturer of cosmetic and sanitary-hygienic products, as well as medical equipment. The corporation includes about 230 subsidiary companies in more than 50 countries; Johnson & Johnson products are sold in more than 175 countries. Preparations for pre-sterilisation treatment, disinfection and chemical sterilisation are presented on the territory of Ukraine. In 2011, they took second place in the ranking of the most respected companies. During the COVID-19 pandemic, a Johnson & Johnson subsidiary, Janssen Pharmaceutica, developed a single-dose vaccine against the virus that was certified for use in the United States and the European Union. The vaccine contains a neutralised human adenovirus into which DNA encoding the spike

[14] Pfizer. URL: https://tabletki.ua/uk/producer/142/
[15] AbbVie. URL: https://tabletki.ua/uk/producer/229/

protein of the SARS-CoV-2 virus has been inserted[16]. Well-known drugs: Tyzine, Imodium, Vermox, Motilium, Microlax, Nicorette[17].

Merck & Co. The company bills itself as a "global research and pharmaceutical company" that "discovers, develops, manufactures and markets a wide range of innovative products to improve human and animal health, directly and through its joint ventures." The company also publishes The Merck Manuals, a series of periodicals for therapists and nurses. This includes the Merck Manual of Diagnosis and Therapy – a world bestseller among medical books. The most famous drugs: "Arcoxia", «M-M-RvaxPro", "Elocom", "Orgametril", "Triderm", "Celestoderm-B", etc. Merck scientist Maurice Gillman was awarded as the scientist who saved the most lives in the 20th century. Among his achievements[18]: "Vaccine against hepatitis B", which was the first used for vaccination to prevent cancerous hepatoma of the liver, cancerous potential complications of the hepatitis B virus, "Vaccines against meningitis and pneumonia".

Novartis company. Novartis makes a wide range of medicines for the treatment of various diseases, including cardiovascular diseases, oncology, neurological and respiratory diseases, as well as medicines for the treatment of diabetes and other chronic diseases. In July 2018, the company decided to close the research center for the development of antiviral and antibacterial drugs in San Francisco in order to optimise scientific research activities and the desire to concentrate on the creation of drugs for the treatment of oncological diseases (gene therapy), as well as on new research in the field neurology and ophthalmology[19]. The most famous drugs: "Tobradex", "Voltaren", "Azarga", "Travatan", "Neoral", "Ciloxan", "Aclasta"[20].

Roche Company. For more than 100 years, the Roche company has made a significant contribution to global health care. Twenty-four drugs, including vital antibiotics, antimalarial and chemotherapeutic drugs, are included in the WHO List of essential drugs. The company gained special popularity in connection with the development of Tamiflu, an anti-influenza drug, the effectiveness of which has not been clinically proven. Roche manufactures a range of diagnostic equipment. Means of self-monitoring of diabetes – glucometers, Akku-Chek insulin pumps, equipment for medical laboratories– hematological, biochemical analyzers, urine analyzers, hemostasis analyzers, blood gas analyzers, as well as PCR analyzers. Known drugs: "Xenical", "Valium", "Avastin", "Pegasis", "Mabtera", "Herceptin", "Pulmozym", "Bonviva", "Tsimeven", "Tamiflu", etc.[21].

[16] Johnson & Johnson. URL: https://uk.wikipedia.org/wiki/Johnson_%26_Johnson
[17] Johnson & Johnson. URL: https://tabletki.ua/uk/producer/166/
[18] Merck & Co. URL: https://uk.wikipedia.org/wiki/Merck_%26_Co
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[20] Novartis. URL: https://tabletki.ua/uk/producer/1789/
[21] Roche. URL: https://uk.wikipedia.org/wiki/Hoffmann-La_Roche

Bristol-Myers Squibb. Bristol-Myers Squibb Company is an American multinational pharmaceutical company headquartered in Princeton, New Jersey. BMS is one of the largest pharmaceutical companies in the world and is consistently included in the list of the 500 largest US corporations according to Fortune magazine. Bristol Myers Squibb manufactures prescription pharmaceuticals and biologics in several therapeutic areas, including cancer, HIV/AIDS, cardiovascular disease, diabetes, hepatitis, rheumatoid arthritis and psychiatric disorders. The Squibb Corporation was a major supplier of medical supplies to the Union Army during the American Civil War, providing portable medical kits containing morphine, surgical anesthetics, and quinine to treat malaria (which was endemic in much of the Eastern United States at the time). In 1989, Bristol-Myers and Squibb merged to become Bristol-Myers Squibb[22]. In 1999, current US President Bill Clinton awarded Bristol-Myers Squibb the National Medal of Technology, the nation's highest award for technological achievement – "for extending and improving human life through innovative pharmaceutical research and development, and for redefining the science of clinical research through innovative and highly sophisticated clinical trials, which are recognized models in the industry".

The company's best-known drugs: Opdivo (Nivolumab) is an immunotherapeutic drug used to treat various types of cancer, such as lung cancer, kidney cancer, skin cancer, melanoma, and others. It works by stimulating the body's immune system to fight cancer cells. Eliquis (Apixaban) is an anticoagulant that reduces blood clotting. It is used to prevent blood clots in patients with atrial fibrillation, and to treat and prevent deep vein thrombosis and pulmonary embolism. Reyataz (Atazanavir) is an antiretroviral drug used as part of combination therapy for the treatment of HIV infection (AIDS). It helps reduce the level of the HIV virus in the body and supports the immune system. Orencia (Abatacept) is a biologic drug used to treat rheumatoid arthritis and psoriatic arthritis. It works by blocking inflammatory processes in the joints and reducing the symptoms of the disease. Sprycel (Dasatinib) is an anticancer drug used to treat chronic myeloid leukemia (CML) and the chronic blast crisis phase.

The following is a selective list of investigational drugs in development as of 2023: Luspatercept is a first-line drug for the treatment of anemia in adults with low– and intermediate-risk myelodysplastic syndromes (MDS) who may require regular blood transfusions. Beclabuvir is in phase 3 clinical trials. An antiviral drug used to treat infections caused by the hepatitis C virus. BMS-906024 is a phase 1 clinical trial. Intended for the treatment of breast cancer, lung cancer, colon cancer and leukemia. BMS-955176 – phase 2 clinical trials. Intended for the treatment of HIV infection. Elotuzumab is a phase 3 clinical trial drug based on humanized monoclonal antibodies for the

[22] Bristol-Myers Squibb. URL: https://en.wikipedia.org/wiki/Bristol-Myers_Squibb

treatment of myeloma. Fostemsavir was approved in the US in July 2020 for the treatment of patients with HIV/AIDS. Lulizumab pegol – phase 2 clinical trials. Intended for the treatment of autoimmune diseases[22].

Sanofi company. Sanofi is a large pharmaceutical company headquartered in France that specialises in the development and production of medicines for a wide range of diseases. The company's core businesses include vaccines, cardiovascular drugs, oncology drugs, diabetes drugs and other medical products. Sanofi-Pasteur's vaccines division markets vaccines against the following infectious diseases: cholera, diphtheria, infection caused by *Haemophilus influenzae* type b (HCV infection), meningococcal infection, pertussis, pneumococcal infection, tetanus, tuberculosis, typhoid, paratyphoid, hepatitis A, hepatitis B, influenza, Japanese encephalitis, measles, mumps, polio, rabies, rubella, chicken pox, yellow fever. Some of the most well-known Sanofi drugs are Essentiale, Amaryl (Glimepiride), Arava (Leflunomide), Granocyte (Lenograstim), Dalfaz (Alfuzosin), Clexan (Enoxaparin), Cordaron (Amiodarone), Lokren (Betaxolol), No-shpa (Drotaverine), Plavix (Clopidogrel), Rovamycin (Spiramycin), Solian (Amisulpride), Sofradex (framycetin sulfate, gramicidin, dexamethasone), Tavanik (Levofloxacin), Taxotere (Docetaxel), Telfast (Fexofenadine), Trental (Pentoxifylline), Festal (Pancreatin), Oxol (Oxaliplatin), Bronchicum (Plant composition), Depakin (Valproic acid), Insuman (Human insulins), Cogitum (acetylaminosuccinic acid), Apidra (insulin glulisine), Ultracaine D-C (Articaine + Epinephrine), Maalox (Algeldrate + Magnesium hydroxide), Lantus (insulin glargine), Aprovel (Irbesartan) / CoAprovel (Irbesartan + Hydrochlorothiazide), OptiPen Pro1 syringe pen, Magne B6 (Magnesium-Pyridoxine)[23].

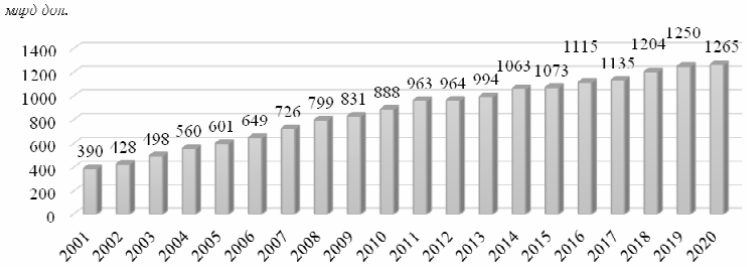
AstraZeneca. "AstraZeneca" develops, manufactures and sells pharmaceuticals for the treatment of disorders of the gastrointestinal tract, cardiovascular, neurological and mental diseases, anticancer drugs and others. The headquarters of the company is located in Cambridge, Great Britain. The main research center is located in Södertelje, Sweden. The company also has research centres in the USA, Great Britain, Sweden and India. AstraZeneca has developed a coronavirus vaccine known as Vaxzevria (also known as ChAdOx1 nCoV-19) in collaboration with the University of Oxford. This vaccine was one of the first to receive emergency approval for use in the fight against the COVID-19 pandemic. The most well-known drugs produced by AstraZeneca are: Crestor (rosuvastatin) – a drug for lowering the level of cholesterol in the blood; Nexium (esomeprazole) – a drug for the treatment of diseases of the stomach and intestines, such as ulcers and reflux; Symbicort (budesonide/formoterol) is a combined inhalation drug for the treatment of

[23] Sanofi. URL: https://uk.wikipedia.org/wiki/Sanofi

asthma and chronic obstructive pulmonary disease; Farxiga (dapagliflozin) is a drug for the treatment of type 2 diabetes[24].

GSK company. GlaxoSmithKline is a multinational medical, pharmaceutical, microbiological company, headquartered in Brentford (Greater London, United Kingdom). The corporation was formed in 2000 by the merger of Glaxo Wellcome and SmithKline Beecham. GlaxoSmithKline Pharmaceuticals (GSK) produces medical drugs and vaccines. Medicines for many diseases: cancer, HIV/AIDS, asthma, infections, diabetes, heart, digestive system, mental disorders, etc. Produces a large number of drugs for health Amoxil, Abacavir. The company produces a number of well-known brands: Panadol, Solpadein, Zovirax, Aquafresh, Lucozad and Nicorette/Nikitin. Vaccines for children and adults to prevent hepatitis A and B, diphtheria, tetanus, whooping cough, measles, mumps, rubella, polio, typhoid, bacterial meningitis and influenza. In 2020, the company "GlaxoSmithKline" jointly with the company "Sanofi" began the development of another vaccine against COVID-19, developed on the basis of a recombinant protein[25].

In recent years, the global pharmaceutical market has shown a growing trend (Pic. 3), so, at the end of 2020, the global pharmaceutical market was estimated at 1.265 trillion dollars, which is 324% more than the income in 2001, and by the end of the forecasted estimate of the pharmaceutical market by 2025 is 1.7 billion dollars. $[26].



Pic. 3. Revenue of the global pharmaceutical market from 2001 to 2020 (in billions of dollars)

As of 2021, the largest pharmaceutical market was the US market, as it generated about 40% of the total revenue of the global pharmaceutical industry[26].

[24] AstraZeneca. URL: https://uk.wikipedia.org/wiki/AstraZeneca

[25] GSK. URL: https://uk.wikipedia.org/wiki/GlaxoSmithKline

[26] Research and Markets (2021), "Pharmaceuticals Global Market Report 2021: COVID-19 Impact and Recovery to 2030". URL: https://www.researchandmarkets.com/reports/5292738/pharmaceuticals-global-marketreport-2021-covid (Accessed 11 November 2021).

During the period of quarantine restrictions due to COVID-19, the majority of large multinational companies (TNCs) refocused their research and development into the vaccine area, with more than half of the MNCs suspending their existing clinical trials. Companies also complained about a decrease in productivity. due to telecommuting by 75%, and only 50% of the industry was operating at normal capacity. In addition, COVID-19 has forced pharmaceutical companies to focus on research, with companies actively investing in R&D and the number of new drug approvals in 2020 was the second highest in the last ten years. So, recent events have brought a significant number of adjustments to the functioning and development of enterprises, however, it has provided an opportunity for companies to find their weak points for further improvement. The growing power of pharmaceutical giants (TNCs) creates a number of threats to humanity, which is associated with the impossibility of controlling such enterprises, and in the conditions of quarantine restrictions, the pharmaceutical industry has become the guarantor of public safety and the only way to solve the problem[27].

Over the past few years, the pharmaceutical sector has seen a period of accelerated technology adoption, driven by factors such as pandemics, inflation, new therapeutic techniques and new ways of working. This has led to new strategies in sourcing, manufacturing and supply chain operations.

2023 has become the year of artificial intelligence (AI). In pharmacy and broader biomedical research, artificial intelligence has contributed to profound paradigm shifts of what is possible. Interestingly, in 2023, 2.2 million new chemical structures were discovered using the generative artificial intelligence tool GNoME. This breakthrough, equivalent to almost 800 years of knowledge, opens the way to the production of unknown materials and technologies[28].

In the pharmaceutical industry, AI is used to improve the process of drug development and production, optimise clinical trials, market research and many other tasks. The revolutionary technology is being used to analyse vast amounts of data, identify patterns and correlations, and make predictions that can help scientists more efficiently develop and track pharmaceutical products. AI can be used to analyse the structure of a target protein and predict which drug molecules can bind to it. It helps researchers identify potential active ingredients in drugs that will be more effective and safer than traditional drugs. AI is also being used to improve the clinical trial process by identifying patients who are eligible for a particular experimental treatment and predicting the likelihood of adverse events. This will allow pharmaceutical companies to

[27] Економічний огляд ситуації на світовому ринку фармацевтичної продукції. URL: http://www.economy.nayka.com.ua/pdf/11_2021/17.pdf (дата звернення: 25.11.2021). DOI: 10.32702/2307-2105-2021.11.15

[28] Pharmaceutical Industry in 2024. URL: https://www.avenga.com/magazine/pharmaceutical-industry-trends/?region=ua .

design more efficient and effective clinical trials, ultimately leading to more effective drugs and faster regulatory approval. In addition, thanks to such optimisation, the cycle of clinical research will become financially less expensive.

Environmental monitoring in the pharmaceutical industry is critical to ensuring sustainable and environmentally responsible practices. Over the past 30 years, international organizations and operators of the pharmaceutical industry have increasingly faced the problem of the harmful impact of pharmaceutical products on the environment on a global scale. With this in mind, in 2022 the Parliament of the European Union approved regulation (EU) 2022/1307 with a list of pharmaceuticals that are mandatory for control in water bodies, as well as methods of their determination[29].

Eco-monitoring at a pharmaceutical enterprise includes: water quality analysis, monitoring of water sources and discharges to prevent pollution and protect aquatic organisms; waste management: proper disposal of chemical and biological waste to prevent pollution of ecosystems; preservation of biodiversity: protection of natural habitats and biodiversity around production sites; compliance: ensuring compliance with environmental norms and standards; use of "Green Chemistry" technologies: promoting the use of environmentally friendly processes and materials; life cycle assessment: the impact of pharmaceutical products on the environment – from production to disposal.

Pharmaceutical products enter the environment at various stages of their life cycle, but especially at the stage of industrial pharmaceutical production. Micropollutants in water are tiny, often trace amounts of chemicals that are produced during the manufacturing process of pharmaceuticals and can end up in water sources. The greatest concern of the global environmental community is drug residues and microplastics. These compounds spread extremely rapidly in surface water through human and animal urine and through improper disposal, posing a potential threat to human health after drinking water consumption. Strong pharmaceutical pollution is also observed in sewage collectors under health care facilities, which have stationary departments, since pharmaceuticals are metabolised (transformed) in the human body from complex chemical compounds to substances that are also not simple in terms of chemical structure. In addition, from 30 to 50% of the injected drug dose is excreted unchanged from the human body.

The Thermo Scientific company developed a simple method for the simultaneous determination of trace levels of compounds of pharmaceutical preparations of various groups and personal hygiene products using solid-

[29] Вплив діяльності фармацевтичних підприємств на довкілля. URL: https://promoboz.com/journal/2023/5-98-october/vplyv-diyalnosti-farmatsevtychnyh-pidpryyemstv-na-navkolyshnye-seredovyshhe-ta-monitoryng-poverhnevyh-vod-vid-kompaniyi-himlaborreaktyv/

phase extraction and tandem chromatography-mass spectrometry with liquid chromatography (HPLC-MS/MS)[29]. Analysis stages include:

1. Selection of samples. The sample is taken in a sterile dish and preserved with the help of acids. Storage temperature – -4 degrees Celsius.

2. Concentration and extraction. C18 SPE cartridges are used for extraction. Methanol and methyl tert-butyl ether are used as eluents.

3. Carrying out identification using the HPLC-MS/MS method on devices.

4. Processing of results.

The analysis is very important because the presence of micro-pollutants in water can have consequences for ecology and human health. If they enter drinking water sources, they can potentially disrupt aquatic ecosystems and pose risks.

The full impact of most PPE and personal care products on the environment is unknown, but there are concerns about the potential for harm because they can not only act on their own, but also interact unpredictably when mixed with other environmental chemicals. In addition, some drugs and drugs are active in very low concentrations, but can be released frequently and continuously in large quantities. For example, it has been found that frogs can be affected by a class of antidepressants that can significantly slow down their development. The increased presence of estrogen and other synthetic hormones in wastewater as a result of birth control and hormone therapy is associated with increased feminisation of fish and other aquatic life. The chemicals have the effect of feminizing or masculinising various fish, thus affecting their reproductive performance. It is clear that the consumption of such fish by a person will also affect the state of his health.

To clean water from pharmaceutical pollution, special treatment facilities are installed. Treatment plants work on the basis of physical, chemical and biological processes to remove chemicals and other pollutants from wastewater. They are usually equipped with a mechanism for separating solid particles (cotton swabs, cloth, hygiene products, etc.) that are in the water. They can also be equipped with filters that separate smaller particles that enter the water. Today, the following are most often used at the stage of cleaning from micro-pollutants: membranes (which can be used instead of biological treatment); ozonisation; activated carbon (powder or granular); UV treatment; treatment with potassium ferrate; sand filtration (which is sometimes added as a last step after the above)[30].

In the world, up to 80% of tablets are packed in blister packs, which are the most convenient type of packaging. The cavity of the blister pack mainly consists of polyvinyl chloride (PVC), polypropylene (PP), polyester (PET) or aluminum (Al). If consumers use proper disposal methods, all of these materials can be recycled and the harmful impact on the environment

[30] Очисні споруди. URL: https://uk.wikipedia.org/wiki/

minimised. However, the problem arises with improper disposal or incineration, or disposal as normal household waste. The burning of blister packs directly causes air pollution with the combustion products of polypropylene, polyester and polyvinyl chloride. Although polypropylene and polyester are harmful to the environment, the most toxic effect is due to the combustion of polyvinyl chloride, as it forms hydrochloric acid (HCl), which is an irritant in the lower and upper respiratory tract, which can cause negative consequences for humans. Disposing of blister packs as normal waste will lead to the accumulation of harmful compounds in the soil and groundwater, which leads to pollution, because the biodegradation processes of compounds such as PVC, PP and PET are very slow. As a result, ecologically harmful consequences are observed, such as disruption of human habitats. Also, ingestion of pharmaceutical pollution factors in animals affects the secretion of gastric enzymes and steroid hormones, which can cause health problems.

The first step in processing can be the separation of Al and polymers using a hydrometallurgical method that uses hydrochloric acid. PVC can then be recycled using mechanical or chemical methods. The latest trend is to use biodegradable, environmentally friendly materials, also called biopolymers, such as derivatives of starch, cellulose, proteins, chitin and xylan to package LPs and reduce the negative impact on the environment.

Pharmaceutical companies in today's world play an extremely important role in providing the population with drugs and CF. Their achievements in research and development of new drugs often exceed expectations, contributing to improving the quality of life of patients and reducing mortality from various diseases. However, at the same time, there is a problem of the negative impact that the pharmaceutical industry can have on the environment and society. It is important not only to develop new medicines, but also responsible production that minimises environmental pollution and preserves the planet's resources for future generations. Therefore, cooperation between pharmaceutical companies, scientific institutions, governments and the public is key to creating an effective and ethical system for meeting the medical needs of society.

CONCLUSIONS

The pharmaceutical industry is one of the most important industries for the world because of its impact on nations' health, economy and scientific progress. It provides humanity with the necessary drugs for the prevention, diagnosis and treatment of various diseases. In addition, the pharmaceutical industry has a huge economic impact, creating jobs, paying taxes and ensuring economic stability in many countries. Investments in the research and development of new drugs contribute to scientific and technological progress, making the pharmaceutical industry a key driver of innovation in the medical field.

After analysing the information on the world's leading manufacturers of pharmaceuticals, several key trends can be identified. First, there is an increase in investment in research and development of new drugs, especially in the areas of oncology, neurology and immunology. This indicates a constant demand for innovative medicines for the treatment of complex diseases. Also during the 2020 pandemic, when the number of cases of COVID-19 was rapidly increasing, international organizations, including the World Health Organization and the Coalition on Innovation for Epidemic Preparedness, vaccine developers, governments and industry assessed the magnitude of vaccine needs.

The second trend is the growing role of biotechnology in the production of medicines. Pharmaceutical companies are actively developing biological drugs that are highly effective and have fewer side effects compared to traditional drugs. The third important aspect is the globalisation of the pharmaceutical market. Large companies are actively expanding their presence in new markets, especially in countries with a high level of demand for medical services. This requires drug manufacturers to adapt to different regulatory requirements and cultural characteristics of different regions.

Therefore, pharmaceutical industries are an important link in the modern medical system, as they are responsible for the creation, production and supply of drugs to the market. The main goal of these companies is to provide high-quality and effective medicines for the treatment of diseases, maintaining the health of the population and improving the quality of life of patients. That is why the proper training of specialists for the Field of knowledge 22 Health care, specialties 226 Pharmacy, industrial pharmacy, specializstions 226.02 Industrial pharmacy should take place within one branch of the national economy of Ukraine and regulation of activities within the pharmaceutical industry should be ensured by one governing legislature.

SUMMARY

The world pharmaceutical industry and the world market of pharmaceutical products demonstrate dynamic development. The increase in the production and sale of drugs became possible due to the global increase in morbidity due to the increased impact of man-made factors and the deterioration of the environmental situation, the threat of epidemics of such diseases as atypical pneumonia, bird flu, and the Covid-19 pandemic. Proper training of specialists in the pharmaceutical industry in higher education institutions guarantees the sustainability of the development of both the industry itself and the entire system of public health care in individual countries. The goal of our research was to systematise information about the most influential and innovative manufacturing pharmaceutical companies in the world. The main tasks included the study of the history of the industrial production of drugs and the development of modern pharmaceutical

companies, the analysis of their key products, research and technologies, the assessment of the impact on medical practice and the state of global health of the population due to pharmaceutical pollution, as well as the analysis of financial indicators and development strategies industry.

The tasks of pharmaceutical industries include not only the development of new drugs and the production of large volumes of drugs. They are also obliged to adhere to high standards of quality and safety of production, to conduct necessary clinical studies to confirm the effectiveness and safety of drugs, and to provide adequate informational support for medical professionals, practicing pharmacists and patients. Pharmaceutical companies also actively cooperate with medical institutions, scientific centres and universities to constantly improve the scientific research base and develop new drugs. This cooperation makes it possible to implement advanced scientific and technological developments in production, to attract young specialists to cooperation, and also to introduce new medicines to the market faster. Compliance with international quality standards (for example, GMP) and health regulations is also an important aspect of pharmaceutical production. This ensures the reliability, effectiveness and safety of medicines, as well as the trust of both health professionals and patients. In general, pharmaceutical industries are active in many directions, aimed at the constant improvement of pharmacotherapy, ensuring the quality and safety of drugs, improving the qualifications of industry professionals, as well as increasing the availability of effective medical care for the population.

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