

SCIENCE AND THE FUTURE

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ÖNSÖZ

Elm, insanlığın inkişafının əsas hərəkətverici qüvvələrindən biridir və onun gələcəyi həm ümidverici, həm də məsuliyyət tələb edən bir istiqamətdə irəliləyir. Texnologiyanın sürətli inkişafı ilə elm artıq yalnız laboratoriyalarla məhdudlaşmır; o, gündəlik həyatın ayrılmaz hissəsinə çevrilib. Süni intellekt, gen mühəndisliyi, kosmik araşdırmalar və kvant texnologiyaları kimi sahələr yaxın gələcəkdə dünyanı köklü şəkildə dəyişdirə bilər.

Gələcəyin elmi daha çox multidissiplinar olacaq. Yəni müxtəlif sahələr bir-biri ilə daha sıx əlaqədə işləyəcək və yeni kəşflər məhz bu əməkdaşlıqdan yaranacaq. Məsələn, biologiya ilə informatikanın birləşməsi yeni tibbi müalicə üsullarının yaranmasına səbəb olur. Eyni zamanda, süni intellekt elmi araşdırmaların sürətini artıraraq daha qısa müddətdə daha böyük nəticələr əldə etməyə imkan verir.

Odlar Yurdu Universitetinin Biologiya və Ekologiya kafedrası əməkdaşlarının təşəbbüsü ilə hazırlanmış, “Elm və Gələcək” adlandırılan bu kitabın oxucu kütləsi tərəfindən rəğbət görəcəyinə ümid edirik. Kitabda sadəcə Azərbaycanın elm adamlarının deyil, eyni zamanda qardaş Türkiyədən də tanınmış alimlərin qiymətli çalışmaları dərc edilmişdir.

Bu kitab multidissiplinar çalışmaları cəmindən təşkil olunmuşdur. Kitab 15 Fəsiləndirilmiş ibarətdir və hər bir fəsil fərqli mövzuları əhatə etmişdir. Günün tələbləri əsasında yazılmış olan bu kitabın hər bir fəslə, elmin gələcək inkişafına işıq tutur. Elmi düşüncə, gələcək perspektivlər zəkanın məhsulu olaraq bu kitabda birləşmişdir. Kitabda biologiya, genetik, fiziki-kimya, ekologiya və başqa bu kimi elm sahələrinə aid fəsillər vardır.

Bununla yanaşı, elmin gələcəyi yalnız texnoloji inkişafı ölçülmür. Etik məsələlər də getdikcə daha çox önəm qazanır. Genetik dəyişikliklər, məlumat təhlükəsizliyi və süni intellektin qərarvermə prosesində rolu kimi mövzular cəmiyyət tərəfindən diqqətlə dəyərləndirilməlidir. Elm inkişaf etdikcə, onun insanlıq üçün faydalı və təhlükəsiz şəkildə istifadə olunması əsas prioritet olmalıdır.

Nəticə etibarilə, elmin gələcəyi böyük imkanlar vəd edir. Doğru istiqamətdə yönləndirilərsə, elm bəşəriyyətin problemlərini həll etmək, həyat keyfiyyətini artırmaq və daha davamlı bir dünya qurmaq üçün ən güclü vasitələrdən biri olacaq.

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PREFACE

Science is one of the main driving forces of human development, and its future is moving in a direction that is both promising and demanding. With the rapid development of technology, science is no longer limited to laboratories; it has become an integral part of everyday life. Fields such as artificial intelligence, genetic engineering, space exploration, and quantum technologies can radically change the world in the near future.

The science of the future will be more multidisciplinary. That is, different fields will work in closer cooperation with each other, and new discoveries will arise from this cooperation. For example, the combination of Biology and Informatics leads to the emergence of new medical treatment methods. At the same time, artificial intelligence increases the speed of scientific research and allows for greater results in a shorter time.

We hope that this book, entitled “Science and the Future,” prepared at the initiative of the staff of the Department of Biology and Ecology of Odlar Yurdu University, will be popular with the readership. The book publishes valuable works not only by Azerbaijani scientists, but also by renowned scientists from brotherly Turkey.

This book is a collection of multidisciplinary studies. The book consists of 15 chapters, and each chapter covers different topics. Each chapter of this book, written based on the requirements of the day, sheds light on the future development of science. Scientific thinking and future perspectives are combined in this book as a product of intelligence. The book contains chapters on biology, genetics, physical chemistry, ecology and other such scientific fields.

At the same time, the future of science is not measured only by technological development. Ethical issues are also gaining increasing importance. Topics such as genetic changes, information security and the role of artificial intelligence in the decision-making process should be carefully evaluated by society. As science develops, its beneficial and safe use for humanity should be a top priority.

Consequently, the future of science promises great opportunities. If directed in the right direction, science will be one of the most powerful tools to solve humanity's problems, improve the quality of life, and build a more sustainable world.

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A GENERAL OVERVIEW OF BIRD HELMINTH FAUNA RESEARCH OF TÜRKİYE (2000–2025)

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1. PARASITOLOGY

Parasitology is a branch of biological science that studies parasitic interactions between living organisms, that is, the situation in which one organism (parasite) lives on or in another organism (host) and feeds on it. This science focuses on the morphology, life cycle, ecology, host-related relationships, and disease-causing roles of parasites (*Roberts, L.S., & Janovy, J., 2009*).

Parasitology is an important field within zoology, especially in understanding the systematic, physiological and ecological aspects of animals, because parasites directly affect the behavior, populations and evolutionary processes of host species (*Smyth, J.D., 1994*).

- Helminths (worms) are the subject of Helminthology, which is a broad field of Parasitology.
- the *Platyhelminthes* (Flatworms) phylum, the classes *Trematoda* and *Cestoda*,
- *Nemathelminthes* (roundworms), the classes *Nematoda* and *Nemathomorpha* (hair-wire worms),

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4. SUGGESTIONS FOR THE FUTURE

Field studies based on molecular and histopathological diagnostic techniques should be expanded.

Turkish helminth parasitology literature should be updated in a more integrated manner with international databases and ecological network projects.

It is very important to establish long-term monitoring programs nationwide to reveal the helminth fauna of bird species whose parasitic distribution has not yet been fully determined.

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CHAPTER 2

AMAZON FORESTS: THE GREEN LUNGS OF THE EARTH, THEIR FUTURE AND PROTECTION

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1. INTRODUCTION

Climate is a key environmental factor that, governs ecosystem functioning and dynamics at regional and global scales (*Hirota, M., et al 2011; Blois, J.L., et al 2013; Wieczynski, D.J., 2019*). Scientific research continues to refine the understanding of the interplay between climate change and the biosphere. In most cases, projections indicate that, climate change is likely to have an increasing impact on ecosystems and people. The impact of global warming on ecosystems is already evident, and the severity and frequency of these impacts are increasing. Ecosystem resilience is shaped in part by the strength of external stressors such as climate change and human-induced degradation activities (*Hirota, M., et al 2011; Barlow, J. et al 2018*). It is also shaped internally by the interactions between biodiversity and the environment, which suggest that, resilience to environmental change can be reshaped (*Scheffer, M., et al 2001; Dakos, M., 2019*). As global change intensifies, extreme weather events are becoming more frequent and intense (*Arneth, A., 2019*). More than 420 million hectares of forest were lost to deforestation between 1990 and 2020, with more than 90% of this loss occurring in tropical areas. Tropical forests account for 45% of the world's forested areas. Tropical forests are the most biologically diverse areas on Earth, both in absolute and density terms. Tropical forests are estimated to contain half or more of the

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40 years, that the death of moisture-loving tree species has increased, and that the forests' capacity to absorb carbon has significantly decreased. Cooperation among the eight Amazon countries is essential to achieving the Belem goals. Joint action must be taken to prevent illegal mining and land grabbing initiatives. Collective action is absolutely necessary to save the Amazon.

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APPLICATION OF LOCAL PLANTS IN PHYTOREMEDIATION PROCESS OF CONTAMINATED SOILS

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1. INTRODUCTION

As a result of intensive industrialization processes of the 20th and 21st centuries, accumulation of heavy metals and other toxic substances is observed in various components of the environment, especially in soils. Since these substances are not easily decomposed by natural processes, they remain in the soil ecosystem for a long time, changing the physical and chemical properties of the soil and posing a risk to plant, animal and human health. Soil pollution leads to a decrease in agricultural productivity, weakening food security and disruption of ecosystem services. The high cost and environmental risks of traditional remediation methods have necessitated the development of new alternative technologies. Phytoremediation is considered an environmentally safe, economically viable and socially acceptable approach in this context (*Aybar, M., Bilgin, A., Saghlam, B., 2015*).

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restoring soil productivity, and reducing ecological hazards. Future studies should be conducted to identify species with hyperaccumulator properties within the local flora, study their agro-biological characteristics, model phytoremediation, and conduct in-depth studies of soil-plant-microorganism interactions in order to increase the efficiency of the process.

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BIOLOGICAL BASIS OF GENETIC ENGINEERING AND THE FUTURE OF GMO

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1. INTRODUCTION

One of the most important directions of modern biology is genetic engineering. The topic of genetic engineering and GMO has become an object of extensive research in recent decades (*Pellegrini, M., & Fernandez, A., 2018*). As a result of the rapid development of molecular biology since the end of the 20th century, it has become possible to isolate, clone and transfer genes into target organisms (*Urnov, F.D., & Gregory, P.D., 2010*). The first genetically modified plants were created in the 1980s and were released for commercial use in the 1990s (*James, C., 2015*).

This field studies the purposeful modification and control of the genetic material of living organisms (*Zhu, H., & Zhu, J., 2019*). The development of genetic engineering has made it possible to establish such fields as molecular biology, biotechnology and bioinformatics. Its applications not only expand fundamental knowledge, but also create new opportunities in medicine, agriculture and solving environmental problems (*Giddings, L.V., 2020*). One of the most important results of genetic engineering is the creation of Genetically Modified Organisms (GMOs). The concept of GMO protects plants, animals

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DISTRIBUTION AND ANTIBIOTIC RESISTANCE PROFILING OF KLEBSIELLA PNEUMONIAE FROM TERTIARY CARE HOSPITAL IN MULTAN

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1. INTRODUCTION

One of the leading causes of morbidity and mortality in intensive care unit (ICU) is infectious diseases, among them multidrug resistant (MDR) bacterial isolates are not uncommon and has raised as an “urgent threat” for public health due to multidrug resistance (*Infectious Diseases Society of America, 2004*). *Klebsiella pneumoniae* is considered a gram-negative bacterium that commonly causes urinary tract infections (UTI), hospital and community-acquired infections after *E. coli* (*Sligl et al., 2006*). WHO has declared this superbug as a “priority pathogen”. Intensive care units (ICUs) are factory for distribution, increasing, and generating antimicrobial resistance in bacteria as patients are critically ill with frequent invasive procedures, prolonged hospital stay, inadequate use of antibiotics, increased age and surgical instruments contamination (*Yildirim et al., 2005*). Immunocompromised patients show increasing mortality rate of bacterial infections specifically *K. pneumoniae* because of colonization of multi-drug-resistant strains (*Kotlovsky et al., 2009*).

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capable to estimate the effectiveness of drugs against bacteria. Present study warrants that, controlling improper use of drugs can reduce the chances of multidrug resistance (MDR) rate in present days. Proper antibiotics policies should be formulated to combat these problems of antimicrobial resistance.

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CHAPTER 6

FUTURE TRENDS IN BIOTECHNOLOGY: AT THE INTERSECTION OF SCIENCE AND INDUSTRY

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1. INTRODUCTION

In the 21st century, biotechnology has become one of the most strategic scientific and industrial directions based on the practical application of scientific knowledge. The core essence of biotechnology consists of creating new products and technologies through the use of living organisms, cells, enzymes, and biological systems (*Nelson & Cox, 2022*). This field is based not only on the achievements of fundamental science but also on multifaceted applications that serve the sustainable development of the global economy, healthcare, and the environment.

The development of modern biotechnology has been shaped around four main directions: agricultural biotechnology, medical biotechnology, industrial biotechnology, and environmental biotechnology. These directions interact with each other, creating conditions for the emergence of new bioeconomic models and innovative production systems. For example, genetically modified crops in agriculture enable increased productivity and efficient use of resources (*OECD, 2023*). Medical biotechnology has led to revolutionary changes in the fields of personalized treatment, gene therapy, and the production of biological pharmaceuticals (*Yusibov & Streatfield, 2020*).

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Innovation and social benefit: The future development of biotechnology must be aimed not only at technological achievements but also at increasing human well-being, protecting ecological balance, and creating a sustainable bioeconomy.

In conclusion, biotechnology remains a multidisciplinary, scientifically, and economically strategic field of the 21st century. Its future development depends on the integration of science and industry, adherence to ethical and ecological principles, and the formation of a sustainable bioeconomy. The success of biotechnology can be evaluated not only by technological achievements but also within the framework of social responsibility and sustainable development.

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GENETIC ADAPTATION MECHANISMS IN DROUGHT-RESISTANT PLANT VARIETIES

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1. INTRODUCTION

Global climate change observed in recent decades has put serious pressure on the sustainability of agricultural systems. Changes in precipitation patterns, rising temperatures, and decreasing soil moisture are causing drought stress to occur over larger areas and for longer periods of time. Drought directly affects plant growth and development, reducing productivity and sometimes causing crop failure.

In these circumstances, the creation of drought-resistant plant varieties is considered one of the main directions of sustainable development of agriculture. The drought resistance of plants is determined not only by morphological and physiological characteristics, but also by the adaptation mechanisms formed at the genetic level. Genetic adaptation allows plants to maintain their vital functions under stress conditions.

Drought is one of the most severe abiotic stresses limiting agricultural productivity worldwide, particularly in regions dependent on rain-fed systems where water scarcity threatens food security and economic stability (*Boyer,*

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Looking ahead, interdisciplinary collaboration among geneticists, breeders, biotechnologists, and ecologists will be essential to translate laboratory insights into field-ready solutions. Future research should prioritize multi-omics integration, high-throughput phenotyping, and the study of combined stress factors to capture the complexity of real-world environments. By harnessing both natural genetic diversity and cutting-edge biotechnological innovations, agriculture can move toward resilient, sustainable production systems capable of withstanding the intensifying challenges of climate change.

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GLOBAL CARBON CYCLE AND CLIMATE

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1. INTRODUCTION

Anthropogenic climate change has emerged as one of the most complex and far-reaching challenges confronting the global economy, ecological systems, and social stability. Rising concentrations of greenhouse gases in the atmosphere have intensified climate-related risks, including extreme weather events, sea-level rise, and disruptions to food and energy systems. These risks transcend national borders, rendering climate change a fundamentally global problem that cannot be effectively addressed through isolated national policies alone.

The first comprehensive effort to conceptualize this challenge within a unified development framework was presented in the report *Our Common Future* by the World Commission on Environment and Development (*World Commission on Environment and Development, 1987*). The report introduced sustainable development as a guiding paradigm that seeks to balance economic growth, environmental protection, and social equity. Central to this concept is the recognition that economic systems are embedded within ecological limits and that long-term prosperity depends on maintaining environmental stability.

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IMPACT OF RADIATION POLLUTION ON ECOSYSTEMS AND ASSESSMENT OF ECOLOGICAL RISKS

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1. INTRODUCTION

In modern times, radiation pollution is of particular importance among environmental problems, since its impact is not limited to local areas, but creates serious risks for large ecosystems and human health. The intensification of human activity and technological development have increased the number of radiation sources, and ionizing and non-ionizing radiation emitted from both natural and artificial sources has disrupted the structural and functional balance of the environment. Radiation pollution affects soil, water, plant and animal ecosystems at different levels, and bioaccumulation and genetic changes of radionuclides lead to a decrease in biodiversity and an increase in ecological risks. In addition, human health is also at long-term risk as a result of the entry of radionuclides through food and water. The article extensively analyzes the sources of radiation pollution, its effects on ecosystems, biological mechanisms, methods of assessing environmental risks, monitoring and management.

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multidisciplinary approaches combining ecology, genetics, radiobiology, and environmental engineering to obtain more comprehensive results. In conclusion, sustainable environmental management requires continuous monitoring, scientific innovation, and international collaboration. By combining ecological risk assessment, advanced measurement techniques, and effective remediation strategies, it is possible to reduce the harmful effects of radiation pollution and protect biodiversity, ecosystem stability, and human health for future generations (*Environmental Advances*, 2025).

12. CONCLUSION

Radiation pollution is of serious importance among modern environmental problems and its effects are not limited to local areas but cover soil, water, plant and animal ecosystems. Natural and artificial radiation sources disrupt ecosystem structure, reduce biodiversity and cause genetic changes. Bioaccumulation of radionuclides entering food chains poses long-term risks to animal and human health, increases the likelihood of cancer and hereditary diseases. Ecological risk assessment, physical and radiological measurements, bioindicators and modeling methods allow for accurate assessment and monitoring of radiation effects. Management and rehabilitation of contaminated sites are essential to reduce radiation levels, protect the soil and aquatic environment, and ensure human health. Data from disasters show that, the ecological and social impacts of radiation contamination are long-term and widespread, so continuous monitoring and preventive measures are vital for the protection of ecosystems and society.

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CHAPTER 10

LIFE-SAVING PLANT THAT TREATS HAND BURNS (URTICA DIOICA L.)

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1. INTRODUCTION

Stinging nettle (*Urtica dioica* L.) is a perennial flowering plant commonly known as stinging nettle. It is a common, multipurpose crop that is sometimes overlooked. Nettle is native to Europe, Asia, North Africa, and North America. It is a plant that is edible and has nutritional and medicinal properties. Its leaves are deciduous, dark green in color, with serrated, hairy edges. Its flowers are small and green (Yalchin, B., 2011). Its leaves contain abundant amounts of fiber, minerals, vitamins, and antioxidant compounds such as polyphenols and carotenoids, as well as polyphenols and carotenoids. Nettle has antiproliferative, anti-inflammatory, antioxidant, analgesic, anti-infective, hypotensive, anti-ulcer properties in all parts of the plant (leaves, stems, roots, and seeds), as well as the ability to prevent cardiovascular diseases. Some local names for the plant in Anatolia include “chızlaghan, cızgan, dızlaghan, cınchar, dalagan, chızleghan, aghdalak and gicitken”. Nettle improves the reproductive performance of fish, making it a cost-effective aquaculture plant. Fertilizers and insecticides can

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The plant is also very healthy in terms of nutrition and is recommended for consumption as a food ingredient due to its high protein and iron content. During the study of the phytochemical composition of stinging nettle, it was found that, the compounds and their ratios in the root, stem, seeds, flowers, and leaves are different. In addition, these compounds and their amounts can vary depending on the methods used in the analysis of plant components. Considering these differences, the purpose of stinging nettle also varies. *Urtica dioica* sp. is most often used in the pharmaceutical and medical supply industry for the treatment of rheumatic diseases and skin diseases such as psoriasis and eczema. In addition, nettle is a plant that attracts a lot of attention due to its anticancer and antitumor properties. In pharmacotherapy, aqueous or alcoholic extracts or hydroalcoholic forms of the plant are more commonly used. The frequent use of the plant in medicine is due to its phenolic compounds, which are most abundant in fresh plant leaves. Other groups that are most common in plant leaves are phenolic acids and their amino forms. Polysaccharides and fatty acids predominate in the roots. Flavonols are the main phytochemicals in flowers and fatty acids in seeds. In addition, nettle is rich in vitamins A, B, C, E and K, as well as minerals such as iron, magnesium and calcium. Based on this information, the phytochemical components and therapeutic effects of nettle (*Urtica dioica* L.) have been studied and it can be concluded that it is a very important plant both in the food industry and in medicine and pharmacy.

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CHAPTER 11

MODERN METHODS OF MICROBIOLOGY AND THEIR IMPORTANCE IN HUMAN ACTIVITY

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1. INTRODUCTION

Microbiology is the scientific field that, studies microorganisms – bacteria, fungi, primitive unicellular organisms, algae, viruses at the molecular and cellular levels. This science also plays a major role in the development of modern biotechnology, biomedicine and ecological sciences.

The microbiome in the human body is involved in the regulation of immune homeostasis, biotransformation of nutrients, maintenance of the epithelial barrier and formation of neuro-immune interactions. Disruption of this microbiome balance results in a number of metabolic syndromes, autoimmune diseases and neuropsychological disorders, which further increases the clinical importance of microbiology (*Microbiology Institute of ANAS, 2018; Turnbaugh, P.J., et al., 2007*).

In recent time, the accuracy and speed of microbiology methodology diagnostics have increased significantly. PCR technology provides highly sensitive identification of pathogens based on the exponential multiplication of specific nucleic acid sequences. Next-generation sequencing (NGS) has become a standard approach for large-scale analysis of the functional and taxonomic diversity of the microbiome (*Shendure, J., & Ji, H., 2008*).

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Thus, microbiology is not only a subject of scientific research, but also a multidisciplinary application platform that, directly serves the goals of health, sustainability and technological development of modern society.

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CHAPTER 12

THE IMPACT OF PHYSICO-CHEMICAL PROCESSES AND ECONOMIC SYSTEMS ON ECOLOGY AND GREEN TECHNOLOGIES

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1. INTRODUCTION

Environmental problems such as climate change, air and water pollution, and resource depletion have intensified in recent decades. These challenges are closely linked to the rapid growth of industrial activities and consumption-based economic systems. While economic development has improved social welfare, it has also increased environmental stress through intensive use of energy and raw materials.

Physico-chemical processes form the scientific basis of industrial production, energy conversion, and material synthesis. Processes such as combustion, oxidation, electrolysis, and chemical catalysis are essential for modern technology but often lead to the release of harmful substances into the environment. Economic systems influence how these processes are implemented by determining production priorities, investment flows, and regulatory frameworks.

This article aims to analyze the combined impact of physico-chemical processes and economic systems on ecology and green technologies, emphasizing sustainable solutions for future development.

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Electrification of industrial heat processes, supported by renewable energy systems, reduces dependence on fossil fuel combustion (*International Energy Agency (IEA), 2023*). Electrochemical reactors, plasma technologies, and microwave-assisted synthesis offer lower-emission alternatives to conventional thermal processes (Levenspiel O., 1999).

Economic mechanisms such as green finance, climate funds, and sustainable investment frameworks accelerate technological transformation by reducing financial risks associated with innovation (*European Commission. Circular Economy Action Plan, 2020*).

As global environmental regulations become stricter, industries that adopt cleaner physico-chemical technologies gain long-term economic advantages.

12. CONCLUSION

Physico-chemical processes and economic systems play a decisive role in shaping ecological outcomes and technological development. While traditional industrial practices have contributed significantly to environmental degradation, green technologies provide effective solutions grounded in scientific innovation and sustainable economic principles.

Achieving long-term environmental protection requires a holistic approach that integrates advanced physico-chemical knowledge with environmentally responsible economic systems. Sustainable development can only be realized when ecological considerations are embedded into production processes, policy decisions, and economic planning. The synergy between ecology, economy, and technology represents a fundamental pathway toward a resilient and sustainable future.

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CHAPTER 13

THE SPREAD AND MECHANISMS OF ANTIBIOTIC RESISTANCE IN PATHOGENIC BACTERIAL SPECIES

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1. INTRODUCTION

In recent decades, the large-scale and uncontrolled use of antibiotics has led to a dramatic rise in antibiotic resistance among pathogenic bacterial species, transforming it into one of the most serious global challenges to public health. According to the World Health Organization, infections caused by resistant bacteria threaten the lives of millions of people each year and significantly undermine the effectiveness of existing treatment protocols. Antibiotic resistance not only complicates clinical practice but also increases the financial burden on healthcare systems, prolongs hospital stays, and elevates mortality rates. Therefore, investigating the dissemination of resistance in pathogenic bacteria and understanding its molecular mechanisms is considered one of the priority directions of modern microbiology (*Aminov, R.I., 2017*).

Resistance observed in certain pathogenic bacterial species is particularly alarming, as these microorganisms spread rapidly in hospital settings, cause severe clinical outcomes, and exhibit resistance even to the most potent classes of antibiotics. The development of resistance is associated with several complex biological processes: mutations occurring at target sites, the synthesis of enzymes such as β -lactamases, the hyperactivity of efflux pumps that expel antibiotics from the cell, and the dissemination of resistance genes through

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CHAPTER 14

NATIONAL CHARACTERISTICS OF ENVIRONMENTAL SECURITY OF AZERBAIJAN

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1. INTRODUCTION

Azerbaijan Republic is a country with rich natural resources and developed industries. It is an important task to implement complex measures to solve environmental problems that have been inherited by independent Azerbaijan for many years.

The current environmental situation has forced every country to put environmental problems into a global context. Currently, environmental protection issues are reflected in the program documents of leading international organizations. In 1992, at the international conference held in Rio de Janeiro on the initiative of the United Nations, it was noted that, the future development of the world will primarily depend on how environmental problems are solved. At this conference, solutions to environmental problems in the world were considered very seriously and important decisions were made, including the concept of “Sustainable development”, which has already become a program document of all international environmental organizations (*Mammadov G.S., Khalilov M.Y., 2003*).

After gaining independence, the Republic of Azerbaijan was not left out of the processes going on in the world and joined the Framework Convention mentioned in June 1992, and in January 1995, having ratified it, it became a

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An environmental organization is basically a non-governmental or public organization that works for the protection of the environment, the sustainable use of natural resources and the improvement of ecology. These organizations conduct research on environmental issues, conduct public education, and provide advice to the government or other organizations. They sometimes work to gain legislative support for environmental protection, combating climate change, protecting biodiversity, and implementing clean energy initiatives.

4. CONCLUSIONS

Strong measures are being taken in the direction of environmental safety protection. Environmental safety is protected. In the implementation of these security measures, legal entities are responsible for their work. The programs that form the basis of the ecological strategy of the environment have been adopted. Everyone should do their part in environmental safety. Successful implementation of environmental policy has been organized. Management measures have been implemented in the field of environmental protection. Relations with international organizations have been strengthened.

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CHAPTER 15

BIOMEDICAL POTENTIAL OF PLANTAGO MAJOR L.: GLOBAL EVIDENCE AND PERSPECTIVES FOR THE EVALUATION OF AZERBAIJANI POPULATIONS

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1. INTRODUCTION

Medicinal plants remain a cornerstone of both traditional healthcare systems and modern biomedical research. According to the World Health Organization, a substantial proportion of the global population relies on plant-based medicines for primary healthcare, and a significant fraction of approved pharmaceutical agents are derived directly or indirectly from natural products (*World Health Organization, 2013; Newman and Cragg, 2020*). In recent decades, renewed scientific interest in medicinal plants has been driven by the increasing prevalence of oxidative stress-related chronic diseases, the global rise of antimicrobial resistance, and the need for structurally diverse bioactive compounds with multi-target biological activity (*Ventola, 2015; Lobo et al., 2010; Atanasov et al., 2021*).

Oxidative stress is now recognized as a central pathological mechanism underlying inflammatory disorders, cardiovascular diseases, neurodegeneration, metabolic syndromes, and carcinogenesis (*Lobo et al., 2010; Halliwell and Gutteridge, 2015*). Simultaneously, the rapid emergence of multidrug-resistant bacterial and fungal pathogens has severely limited the efficacy of

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inhibitory effects on selected tumor cell lines. Although mechanistic evidence from related polyphenolic compounds indicates possible involvement of mitochondrial pathways and caspase activation (Atanasov *et al.*, 2018; Kim, Kang and Kim, 2018), direct apoptosis-focused studies on *P. major* extracts remain limited. This represents an important area requiring further investigation.

An additional factor influencing the biological activity of *Plantago major* is geographic variability. Environmental conditions, including soil composition, pollution exposure, altitude, and climate, can significantly affect the accumulation of secondary metabolites (Batiha *et al.*, 2020; Aras *et al.*, 2013). Studies have shown that plants growing under environmental stress may exhibit altered phenolic profiles and enhanced antioxidant responses. Such ecological influences highlight the potential for regional populations to exhibit distinct phytochemical characteristics and biological properties.

Azerbaijan, located within the Caucasus biodiversity hotspot, encompasses diverse ecological zones and supports widespread natural populations of *Plantago major*. Despite this, the phytochemical composition and biomedical properties of Azerbaijani populations remain largely unexplored. Considering the documented geographic variability reported in other regions, investigation of Azerbaijani *Plantago major* populations may reveal unique phytochemical profiles and biological activities.

Overall, the existing literature supports the classification of *Plantago major* as a promising medicinal plant with significant antioxidant, antimicrobial, and cytomodulatory potential. Continued investigation of this species, particularly in underexplored geographic regions, may contribute to a deeper understanding of its biomedical properties and its potential role in natural product-based therapeutic development.

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