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SECTION 1

SOCIO-ECOLOGICAL, ETHICAL AND PEDAGOGICAL PROBLEMS OF OUR TIME

SOCIAL STEREOTYPES AND PERSONALITY DISORDERS

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Abstract. This article examines the influence of social stereotypes on the perception of people with personality disorders and their integration into society.

Keywords: social stereotypes, personality disorders, stigma, mental health.

Social stereotypes are simplified and generalized ideas about social groups that are formed based on cultural and historical characteristics. In the context of personality disorders, they often lead to bias and discrimination. Personality disorders are characterized by persistent patterns of thinking, perception, and behavior that significantly deviate from accepted cultural norms [1].

Among the most common stereotypes is the notion that people with personality disorders are dangerous to society, manipulative, or simply have a "bad character." These myths are untrue, as personality disorders are serious mental health conditions that require professional treatment and support. For example, people with borderline personality disorder often experience intense emotions and require understanding rather than judgment.

Stigma creates significant barriers to help and social integration. People with personality disorders often face social isolation, employment discrimination, and limited access to healthcare. Constant exposure to negative stereotypes can lead to low self-esteem, shame, and difficulties in social interactions.

Overcoming stereotypes requires comprehensive measures, including educational programs for the public, accurate coverage of mental health issues in the media, and the creation of a supportive social environment. Public initiatives aimed at disseminating reliable information about the nature of personality disorders and their treatment options play an important role [2].

Researching social stereotypes regarding personality disorders is essential for creating an inclusive society and improving the quality of life of patients. Understanding and overcoming stigma contributes to the formation of more equitable and supportive attitudes toward people with mental disorders [3].

Thus, established ideas about people with personality disorders are often distorted and lead to bias and discrimination. These conditions, being serious illnesses, require understanding and professional assistance, not judgment. Stigma prevents people from receiving the necessary treatment and fully participating in society. To combat this, education, responsible media coverage, and the creation of a supportive environment are necessary, which will ultimately help build a more equitable and inclusive society.

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PARADOX OF THE FREEDOM: PHILOSOPHY OF THE CHOICE AND PSYCHOLOGY OF THE RESPONSIBILITY

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The article examines the paradox of freedom in the context of philosophy and psychology.

Keywords: freedom, choice, responsibility, existentialism, self-regulation.

The problem of freedom is one of the central themes of philosophy and psychology of personality [4].

From a philosophical point of view, freedom is seen as a balance between individual desires and social responsibility. For existentialist thinkers, including J.-P. Sartre, it is not the absence of limitations but an awareness of being “in a situation.” A person is free to choose, yet every choice is made within circumstances and entails responsibility for one’s own existence. Only by accepting this responsibility does a person form authentic meaning and essence of life [2].

Modern psychology views responsibility as a form of internal self-regulation of behavior [1]. Studies in moral psychology emphasize that the experience of freedom is associated with cognitive autonomy, but it also requires mature impulse control and ethical awareness.

Furthermore, the phenomenon of freedom is closely linked to the concept of intrinsic motivation. When a person's actions are driven by conscious values, rather than external pressure, freedom acquires genuine psychological content. This state corresponds to the concept of autonomy in self-determination theory, where freedom is a prerequisite for personal growth and self-realization.

Research on retirement planning has shown that individuals presented with a wider range of investment options were more likely to make active decisions, develop a sense of agency, and experience greater satisfaction compared to those who had fewer alternatives.

The problem of choice in contemporary society reinforces the paradox of freedom: an excessive number of alternatives generates anxiety and cognitive overload. The classic study by S. Iyengar and M. Lepper (2000) demonstrated that when faced with too many options, people were less likely to make decisions and more likely to feel regret.

The paradox of choice also extends to creativity and innovation. A study by Iyengar et al. (2012) explored the relationship between choice and creativity, showing that the opportunity to choose promotes greater creativity and innovation. However, an overabundance of options leads to excessive focus on making the “right” choice, resulting in cognitive overload, stress, and reduced creative output [3].

Thus, freedom is not arbitrariness but the ability to make conscious decisions and take responsibility for their consequences. The paradox of freedom lies in the fact that it can be achieved only through self-limitation and the development of inner maturity. Without self-control and reflection, freedom turns into an illusion of willfulness, losing its existential meaning.

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PROBLEMS OF ACCESSIBILITY OF URBAN ENVIRONMENT FOR PEOPLE WITH DISABILITIES

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The paper discusses problems of accessibility of the urban environment for people with disabilities and analyzes society's attitude towards inclusion issues. A sociological survey among young people aged 18-30 was conducted, revealing main barriers – architectural, informational, and social. Causes of their persistence and shortcomings of existing solutions are analyzed. Special attention is paid to the concept of universal design as a way to create an environment comfortable and safe for all city residents regardless of their physical abilities.

Keywords: people with disabilities, urban environment, accessibility, universal design, inclusion, physical barriers, informational barriers, social attitude, sociological survey, equal opportunities.

People with disabilities include those with musculoskeletal, visual, auditory, or mental impairments. In urban areas, they face the following problems:

- Physical barriers: stairs, narrow passages, transportation that is difficult to use.
- Perception issues: lack of audible signals, tactile tiles.
- Information difficulties: inconvenient navigation, no formats for people with different needs (Braille, plain language).
- Social attitude: prejudice and misunderstanding [2].

The solution to these problems is universal design. It involves creating an environment, goods, and services that are initially convenient for use by everyone, regardless of age, body type, physical capabilities, or disability. It aims to ensure equal opportunities for all and is an important component of an accessible environment [3].

To assess society's readiness for changes towards inclusivity in the urban environment, we conducted a sociological survey among people aged 18-30.

The survey results showed the following:

Most respondents (58.8%) rated urban accessibility as average to poor (3 out of 5). The most inconvenient were leisure places (cafes, cinemas – one-third rated 2) and streets (stops, sidewalks). When asked about their knowledge of the problem and willingness to help, most (91.2%) said they were willing to help someone with mobility difficulties. However, many (38.2%) fear doing harm because they do not know how to act properly. Some (7.4%) encounter such situations frequently.

Few (17.6%) know about universal design, indicating that people see the problem but do not know how to solve it. Optimistically, the majority (86.7%) believe that an accessible urban environment benefits everyone – elderly, parents with strollers, people with disabilities or injuries.

Analysis of responses about obstacles revealed four main reasons:

1. Financial and systemic problems (~50%): lack of funds.

2. Poor organization (~30%): authorities are not interested, work for appearances, or are incompetent.

3. Societal and informational issues (~15%): people with disabilities are rarely seen in public spaces, so the problem is often forgotten.

4. Technical problems (~5%): low-quality implementation (crooked ramps, inconvenient buttons). The survey showed that people recognize the problem and empathize, but do not see it being solved. The main obstacle is not only the lack of funds but also the unwillingness of authorities to act and the silencing of the issue in public discourse.

Our recommendations for improving accessible urban environments:

- Inform: raise awareness about universal design as a solution beneficial for all.
- Educate: train officials and designers to create accessible environments genuinely, not superficially.
- Support those pursuing changes: assist organizations proposing comprehensive, not piecemeal, urban improvements.

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THE INFLUENCE OF NATURE ON STRESS REDUCE

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The article examines the role of being in nature in reducing stress levels and improving cognitive functions and the physiological mechanisms of the influence of nature on stress reduction.

Keywords: stress, health, cognitive functions, nature, physiological processes

In today's fast-paced world, characterized by a constant flow of information and increased productivity demands, stress and cognitive decline have become common problems. Urbanization, digitalization, and a lack of leisure time negatively impact physical and mental health, leading to decreased productivity, poor mood, and increased vulnerability to various diseases [1]. In this context, increasing attention is being paid to the potential of nature as a powerful tool for restoring the body's resources, reducing stress, and improving cognitive function.

The positive influence of nature is based on Wilson's biophilia hypothesis: humans are genetically predisposed to interact with nature because, through evolution, survival depended on it. Nature is associated with safety and resources, inducing peace and reducing stress [3].

Being in nature reduces stress in a comprehensive manner: it lowers cortisol levels and activates the parasympathetic system (relaxation), reduces blood pressure and heart rate (the calming effect of sounds), strengthens the immune system (activation of NK cells, phytoncides), and improves sleep (regulation of circadian rhythms).

In addition to reducing stress, nature improves cognitive function: it restores attention (gentle stimulation, improved concentration and memory), increases creativity (free exploration, new ideas), improves mood and reduces depression (endorphins), and potentially improves working memory. [2] Integrating nature into your life:

1. Regularly spend time in nature
2. Create "green" corners at home/work
3. Incorporate nature into your routine (walks, outdoor lunches)
4. Practice mindfulness in nature, participate in environmental activities.

Thus, nature effectively reduces stress and improves cognitive function through physiological, psychological, and behavioral factors. Integrating nature into our lives is becoming essential for maintaining well-being in the modern world, so we should strive for closer interaction with it.

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ARTIFICIAL INTELLIGENCE IN MEDICINE

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Keywords: artificial intelligence, medicine.

Artificial intelligence (AI) is a branch of computer science dedicated to creating systems that can perform tasks traditionally requiring human intelligence: self-learning, pattern recognition, decision-making, and solving complex problems. In recent years, AI technologies have rapidly developed and are being actively implemented in various fields, including healthcare.

The implementation of AI in the clinic opens up new opportunities to improve the quality of diagnostics, optimize the treatment and prevention of diseases, as well as to improve the efficiency of medical organizations and improve patient health outcomes.

One of the most notable applications is the automated analysis of medical images (X-rays, CT scans, MRI, ultrasound). Modern algorithms are able to quickly and accurately detect changes that sometimes go unnoticed during visual analysis. Successful applications include the diagnosis of lung cancer, breast tumors, strokes, and other pathologies. AI also allows for the integration and processing of large amounts of heterogeneous data about patients – genetic information, medical history, lifestyle data – to develop personalized treatment plans that take into account individual biological and clinical characteristics. In pharmaceutical research, AI accelerates the search and evaluation of potential drug compounds by analyzing large libraries of molecules and predicting their properties and interactions with biological targets. This reduces the time and costs of developing new drugs and makes clinical trials more targeted. At the level of healthcare management, AI is used to predict epidemiological trends, optimize logistics (inventory of medicines, distribution of equipment), plan workflows, and evaluate the effectiveness of medical programs. Clinical decision support systems provide doctors with quick access to a large amount of medical knowledge, help formulate differential diagnoses, select therapies, and predict outcomes, which enhances the quality of decision-making.

Despite all the advantages, there are also serious challenges: the need for large and high-quality datasets, the risk of bias and underrepresentation of certain patient groups, problems with the explainability of "black boxes," issues of medical data confidentiality, as well as the need for strict clinical validation and adequate regulation. Overall, AI has significant potential to transform medicine, but its widespread and safe implementation requires a comprehensive solution to technical, ethical, and regulatory challenges. Only under the condition of reliable data, transparent algorithms, and appropriate standards, can AI become a reliable tool for doctors and improve the quality of medical care.

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HUMAN HEALTH AS A SUBJECT OF PHYLOSOPHICAL AND MEDICAL KNOWLEDGE

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This paper examines the topic of health in philosophy and medicine. The influence of philosophical perspectives on human health and the relationship between philosophical and medical knowledge are analyzed. The influence of modern medicine and philosophy as a complex of two sciences in clearly understanding and appreciating the importance of health, namely its maintenance, treatment, and promotion, is demonstrated.

Keywords: health, harmonious body condition, ancient physician Hippocrates, purpose of a healthy life, universal human values.

Currently, there is no single, generally accepted definition of the term "health" that satisfies all aspects of modern society. It is well known that medicine guards public health. Therefore, logically, it is within the field of modern healthcare that a universal interpretation of the term "health" will be developed, applicable to all aspects of life. Health is a state of complete physical, social, and mental well-being [1; p.5]. Medicine studies the chemical and biological aspects of the body's functioning with the goal of identifying norms and anomalies, seeking ways to achieve high levels of public health. Medical knowledge specializes in the study of the biological and chemical processes that support the normal functioning of the body and maintain its harmonious state. Therefore, medical science faces the question: is health limited only to physical and psychological well-being? From a philosophical perspective, human health is the optimal flow of vital processes, allowing for the longest possible lifespan, free from disease. Therefore, health is a natural object of study for philosophical science, which analyzes not so much the medical aspects of public health as the eternal questions of the purpose of a healthy life, as well as the importance of health for humans [2].

The philosophy of health answers profound questions about the meaning of life and the role of vital forces in achieving harmony and happiness. While for some philosophers happiness is unattainable without physical health (Socrates, Hippocrates), for others it is merely a fleeting moment, not worth paying attention to (Marcus Aurelius).

Medicine as a science is a complex of methods for treating, maintaining, and restoring the body. The ancient physician Hippocrates asserted: "Anatomy in union with physiology is the queen of medicine"[3]. Without specific knowledge in anatomy, physiology, histology, embryology, and other medical and biological sciences, it would be impossible to master and understand the foundations of medicine [3]. At the same time, philosophy analyzes the general foundations of approaches to understanding the importance of physical health for humans.

Thus, having examined the role of philosophy and medicine in human health, we can conclude that these sciences are closely interconnected in analyzing the aforementioned aspects. However, these two branches of knowledge simultaneously view human health from two different perspectives: while for medicine, it is a subject of research for the treatment of pathologies, for philosophy it is an object of intellectual reflection in terms of universal human values. By complementing each other, these two sciences create a broader understanding of the human body and human attempts to understand health issues. Thus, it is clear that philosophical knowledge complements medical research, enriching people's understanding of general health issues. Therefore, the study of medicine from a philosophical perspective is an integral part of medical knowledge in the broad sense of the word.

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ETHICS OF CARING FOR FUTURE GENERATIONS AS A BASIS FOR SUSTAINABLE DEVELOPMENT

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This article examines the concept of ethics of caring for future generations as a fundamental element of the paradigm of sustainable development. An ethical approach focused on intergenerational responsibility asserts the need to conserve natural, social and cultural resources to ensure a decent life not only for current but also future generations. In the context of global environmental challenges such as climate change, loss of biodiversity, and depletion of natural resources, the ethics of caring is becoming a key principle in shaping a sustainable civilization.

Keywords: ethics of care, intergenerational responsibility, sustainable development, environmental ethics, moral philosophy, solidarity, ecology of the future.

The theoretical basis of the research is the work of Hans Jonas, Nancy Fraser, Carol Gilligan and other thinkers who developed the idea of responsibility as a central category of morality. Unlike traditional utilitarian and deontological approaches, the ethics of caring emphasizes the importance of attention, empathy, and solidarity as moral virtues applicable not only to human relationships, but also to human interaction with nature. This perspective allows us to rethink sustainable development as not just a balance of economic, social and environmental aspects, but as an expression of moral duty to future generations.

Modern global challenges – climate change, depletion of natural resources, social inequality – raise the issue of moral responsibility of the current generation to the future. The concept of sustainable development, enshrined in UN documents, implies not only an economic and environmental balance, but also an ethical dimension, expressed in caring for those who come after us.[3]

The ethics of caring, which was originally formed in feminist philosophy, has been actively interpreted in recent decades as a universal approach applicable to global ethics and sustainable development.[4] Its main idea is to recognize the interdependence of all forms of life and the need for moral sensitivity to the "other" – be it man, nature, or the future generation.

Traditional theories of justice focused on the relationship between contemporaries, leaving the issue of future generations in the shadows. The ethics of caring offers a different perspective – not a contractual one, but a relational one. It proceeds from the recognition of the moral bond between generations, which implies responsibility not out of calculation, but out of empathy and solidarity.[5]

Caring for the future should be considered as one of the cornerstones of the concept of a sustainable society. This is not an abstract concept, but a practical requirement that includes the development of environmental awareness, ethical education, and a rethinking of consumer values.

In the context of environmental ethics, concern for future generations is expressed in the desire to minimize environmental damage and preserve the biosphere as a common heritage. The idea of sustainability becomes not only an economic or political, but also a moral category.[1]The preservation of ecological balance is a manifestation of collective care, where a person ceases to be the center of the world, giving way to ecosystem thinking.

The transition to sustainable development is impossible without a change in the ethical paradigm. Modern society requires an individual to be able to think not only in terms of "here and now", but also taking into account the interests of the future. This implies abandoning the logic of short-term gain in favor of strategic thinking based on the principles of responsibility and care.[2]

Thus, the ethics of caring becomes the methodological basis for sustainable development.: It combines moral, environmental and social dimensions, forming a holistic approach to building a just and harmonious future.

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GAMIFICATION AS A MEANS OF SOLVING ETHICAL AND PEDAGOGICAL PROBLEMS

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The article explores the potential of gamification to address ethical and pedagogical problems related to adolescents' self-determination in the Republic of Belarus. It proposes a model of an online quest game for conscious career guidance featuring interactive tasks, a rating system, and virtual currency to enhance engagement and self-reflection among high school students.

Keywords: gamification, career guidance, self-determination, adolescents, ethical and pedagogical issues, conscious choice.

Gamification as a Means of Solving Ethical and Pedagogical Problems of Adolescents' Self-Determination

The process of professional self-determination during adolescence is associated with a number of ethical and pedagogical challenges. Traditional methods of career guidance often fail to immerse students in real professional contexts, leading to disappointment and frequent changes of specialization [1, 2]. This issue is exacerbated by demographic trends and the growing emphasis on making an informed career choice [1].

Modern universities face the challenge of maintaining a steady influx of talented applicants. The need to search for new forms of career guidance is recognized at the level of leading educational institutions [3]. Moreover, sociological surveys indicate a high level of professional dissatisfaction, highlighting the importance of proper initial orientation [4].

A promising solution to these problems lies in the use of gamification principles. The key mechanisms of such a system include:

- Tasks simulating real professional problems in various university faculties (e.g., journalism, applied mathematics, international relations).
- Personalized content delivery based on user activity and choices.
- Involvement of current university students to share experiences and mentor participants within the game environment.

The target audience for this approach includes school students aged 15-18, whose values are centered around self-development and success, but who also experience fear of making the wrong career choice. Gamification helps mitigate this fear by providing a safe space for experimentation and trial.

The implementation of this model requires a multi-stage promotion strategy, starting from the capital and expanding to regional areas. Monetization can be ensured through a subscription model, advertising, and sponsorship, which would guarantee the project's sustainability.

Thus, the integration of gamification into career guidance activities appears to be a viable path to addressing key ethical and pedagogical problems. It promotes a more conscious, informed, and responsible approach to adolescents' professional self-determination, aligning the interests of future students, parents, and educational institutions.

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EFFECTS OF CHRONIC STRESS ON PHYSICAL CONDITION A PERSON

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Abstract. This article discusses the features of the influence of chronic stress on a person's physical condition.

Keywords: stress, physical health, disorders, consequences

Chronic stress – is a prolonged activation of the body's adaptive reactions under the influence of unfavorable factors. It has a significant impact on both a person's mental and physical health. The main factor in a chronic stress reaction is considered to be prolonged psycho-emotional stress. There are many immediate causes, they are always individual – what is normal for one person will be a source of stress for another. The causes of chronic stress can be: disharmonious relationships, excessive loads, long-term illnesses material difficulties, insoluble problems.

Chronic stress activates the sympathetic nervous system, causing constant tension in the body. This is manifested by increased heart rate, increased blood pressure and increased levels of cortisol – stress hormone. Long-term exposure to these factors can lead to the development of cardiovascular diseases, including hypertension and coronary heart disease. Stress also suppresses the immune system, making the body more vulnerable to infections and diseases. Research shows that chronic stress reduces the activity of white blood cells, increasing the risk of developing colds, flu and even cancer. Constant nervous tension has a negative effect and to the work of the gastrointestinal tract. Stress-prone people often face problems such as gastritis, stomach ulcers, irritable bowel syndrome, and other digestive disorders. Elevated cortisol levels promote fat accumulation, especially in the abdominal area. This is due to impaired glucose metabolism and insulin resistance, which increases the risk of developing type 2 diabetes and obesity. Frequently satellites chronic stress sleep disorders are also. Insomnia, difficulty falling asleep and shallow sleep lead to fatigue, decreased concentration and even more deterioration of general well-being.

Although mental health goes beyond the physical state, it is important to note that chronic stress significantly affects mood, cognitive abilities, and overall quality of life. Depression, anxiety, decreased motivation and performance are becoming common among those who experience prolonged emotional pressure. To minimize the consequences of chronic stress, it is recommended to use a set of measures aimed at improving physical fitness, increasing the stability of the nervous system and maintaining a healthy lifestyle.

Thus, chronic stress poses a serious threat to human physical health, affecting many organs and systems of the body. Timely identification of signs of stress and the adoption of appropriate measures can prevent the development of serious diseases and maintain good health.

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RESPONSIBILITY AS A FACTOR OF ENVIRONMENTAL BEHAVIOR

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The article examines the role of personal responsibility in motivating environmental behavior, analyzes psychological factors, and proposes recommendations for forming environmental activity.

Keywords: motivation psychology, ecology, personal responsibility, environmental behavior.

Modern global challenges, including climate change and environmental pollution, highlight the need to study the behavioral aspects of their solution. The analysis of motivational mechanisms, especially the awareness of personal responsibility, takes a central place.

Personal responsibility is the awareness of one's role in ecology and the willingness to be accountable for the consequences. Theories of motivation (planned behavior, self-determination) and value theory explain the influence of attitudes, norms, control, and values on environmentally friendly behavior. The results of psychological research show that personal responsibility is an important factor in environmental behavior – from sorting waste and saving resources to participating in environmental campaigns. It is important to note that the awareness of personal responsibility can be hindered by the "diffusion of responsibility" effect, where an individual feels less responsible for a problem when they are part of a larger group. This is due to the influence on intentions, sense of control, morals, and environmental identity. At the same time, it should be taken into account that the influence of personal responsibility on environmental behavior is not direct and unconditional. It is mediated by a number of psychological factors such as environmental knowledge, environmental values, emotional involvement, social norms, self-efficacy [1]. Active highlighting of environmental issues, demonstrating the consequences of inaction, and simultaneously presenting positive examples of environmentally responsible behavior can significantly enhance awareness of individual roles in preserving the environment. To increase environmental motivation and responsibility, a comprehensive impact is important:

1. Increasing literacy: dissemination of information about environmental problems and solutions
2. Value formation: strengthening the connection with nature, ethics of interaction.
3. Emotional involvement: using visual materials, stories and experiences.
4. Support for social norms: consolidating rules of environmentally responsible behavior.
5. Strengthening self-confidence: creating opportunities for participation in environmental projects.
6. Practical activities: organizing campaigns, clean-up days, educational events.
7. Positive reinforcement: encouraging behavior through rewards, recognition.
8. Formation of ecological identity: development of eco-responsibility and values [2].

Thus, personal responsibility transforms environmental knowledge into action. It is important to consider and overcome the diffusion of responsibility effect. Its development requires support of internal motivation through values, self-efficacy and social norms. This turns environmental behavior into a sustainable life position.

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A PHILOSOPHICAL VIEW ON THE PROBLEMS OF INTERNET ADDICTION IN MODERN SOCIETY

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This work examines a pressing contemporary problem: internet addiction. Its types and causes are discussed. A philosophical perspective on internet abuse is offered, along with the importance of not losing oneself online.

Keywords: Internet, addiction, worldview, virtuality, social isolation.

In modern society, the internet is ubiquitous, and excessive use leads to internet addiction. Internet addiction is a disorder characterized by compulsive and excessive internet use, which leads to decreased self-control, the displacement of real life, and the development of behavioral problems. This addiction remains a pressing issue in the 21st century. In Belarus, according to a 2014 study, 20-25% of participants were internet addicted, while in 2019, the figure was 35% (16% of adolescents and 19% of young adults) [2].

Interesting fact! In China, internet addiction is called "electronic opium." There, it is officially recognized as a disease and included in national clinical guidelines for mental disorders [4].

Let's consider the main types of internet addiction. 1) Gaming addiction – an obsessive passion for online games, often accompanied by financial investments; 2) Addiction to virtual communication – the need to constantly communicate in chats, instant messaging apps, and social networks, replacing real-life contacts; 3) Compulsive shopping – the need to shop online (Wildberries, Ozon, etc.); 4) Addiction to video content – obsessive viewing of videos on video hosting sites and streaming services [3].

The main causes of this addiction are:

1) communication difficulties, low self-esteem, and self-doubt;

2) loneliness;

3) financial problems;

4) dissatisfaction with real life [3].

Abusive use of online resources blurs the boundaries between the "real" and "virtual" worlds, which has a detrimental effect on the development of a healthy worldview. In the virtual world, a person can create an ideal image for themselves that differs from their "true self," which can lead to a split personality and difficulties in developing a coherent identity. Despite virtual connectivity, internet addiction leads to profound loneliness and social isolation. Philosophically, this can be interpreted as a degradation of human communication, where online interactions replace the need for intimacy and emotional support, leading to a decline in registered marriages, an increase in divorce rates, and a decline in the demographics of countries [2].

Thus, from a philosophical perspective, internet addiction is not simply a behavioral disorder, but a social obstacle associated with the loss of individual agency, the blurring of the boundaries of reality, and the search for meaning in life in the information world [1].

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PSYCHOLOGICAL ASPECTS OF OVERCOMING ACADEMIC STRESS

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The relevance of this issue is due to the steady trend towards an increase in student complaints of psychoemotional disorders, which is confirmed by the statistics of the work of psychological services of universities. A conscious understanding of the impact of learning stress on the involvement of students in the educational process creates the prerequisites for adjusting pedagogical strategies.

Keywords: studying, academic stress, social support, students.

Promising areas for dealing with learning stress are justified by psychologists, considering anticipatory viability as a personal resource of students. In order for students to be aware of the difficulties of the learning process as a potential source of stress, it is important to understand the peculiarities of students' self-regulation in learning [1].

Academic stress is a persistent psycho – emotional stress that students experience in response to the demands of the educational environment, including high academic workload, the need to meet deadlines, pressure from teachers and peers, as well as fear of failure or non-compliance with expectations. In the context of modern higher education, characterized by an accelerated pace of learning, digitalization and increased demands on academic results, the stress level among students is showing steady growth. According to a number of studies, more than 60% of students report a chronic level of study-related stress, and one in five experiences symptoms of anxiety and depressive disorders.

Psychological science considers academic stress not as a pathology, but as a natural reaction to the imbalance between external demands and internal resources of the individual. In this regard, coping strategies are of particular importance, which determine the effectiveness of adaptation to stressful conditions. According to the theory of Lazarus and Folkman, coping is a cognitive and behavioral effort aimed at managing internal and external demands, assessed as exceeding the individual's resources. In the context of academic activity, there are two main types of strategies: problem-oriented (aimed at changing the situation) and emotion-oriented (aimed at regulating the emotional response).

The most effective cognitive aspects of coping with academic stress include cognitive reassessment and the formation of a growth mindset. Cognitive reassessment makes it possible to interpret stressful events not as a threat, but as a challenge or an opportunity for development, which reduces anxiety and increases motivation to achieve.

Emotional regulation plays a key role in maintaining psychological well-being. Research shows that students with advanced mindfulness, self-compassion, and emotional flexibility demonstrate lower stress levels and higher academic engagement.

At the behavioral level, the effectiveness of coping with stress is determined by such factors as time management skills, organization of the educational process, adherence to sleep and rest, physical activity and rejection of destructive strategies (for example, procrastination or abuse of psychostimulants). Empirical evidence suggests that students who adopt a structured approach to planning academic activities are less likely to experience a sense of overload and demonstrate higher academic results.

The social context is equally important. Having a supportive social network – including friends, family, mentors, and mental health professionals – acts as an important stress buffer. Social support not only reduces the subjective perception of stress, but also contributes to the formation of adaptive coping strategies.

Finally, personal resources such as self-efficacy and psychological resilience are predictors of successful coping with academic stress.

Thus, overcoming academic stress is a multicomponent process in which cognitive attitudes, emotional skills, behavioral strategies, social support, and personal characteristics interact. Understanding these aspects makes it possible to develop comprehensive psychological support programs for students aimed not only at reducing stress levels, but also at developing sustainable mechanisms for adapting to the challenges of the modern educational environment.

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TRENDS AND FACTORS AFFECTING THE NUMBER AND DISTRIBUTION OF SEAGULS IN THE CITY OF MINSK

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The ecological potential of urban landscapes is determined by the species composition, population structure, and adaptation of birds to new urban areas. In this regard, we analyze the rapidly increasing seagull population in Minsk, which is causing discontent among residents and even leading to complaints.

Keywords: gulls, gulls, numbers, biotic and anthropogenic factors.

In recent decades, the numbers of some gull species have increased significantly in Western European countries, as well as in the Republic of Belarus [2]. As a result, their status in nature and role in the national economy have changed.

The material for this work was based on our own research conducted in the floodplain zone of the Svisloch River (within the Moscow Ring Road) in Minsk. Field surveys of gull biodiversity and their spatial distribution across the capital's urban landscapes were studied in the capital in 2023-2025. The species composition of gulls was determined using standard external distinguishing features [4].

An analysis of literary data [1-3] and our own showed that 10 species of gulls have been recorded in the territory of Minsk: black-backed gull (***L. ridibundus*)**, common gull (*L. canus*), herring gull (L. argentatus), long-backed gull (L. marinus), gull (*L. cachinnas*), lesser black – backed gull (*L. fascus), little-backed gull* (*L. minutus*), Arctic gull (*L. glaucoides*), West Siberian gull (*L. heuglinis*) and spotted gull (*L. dominicanus*). The seagulls' distribution area covers the entire capital.

The capital's largest reservoirs–Drozdy, Chizhovskoye, Tsnyanskoye, and Loshitsa–are home to the greatest diversity of gull species. These reservoirs are home to key breeding grounds for black-headed gulls (82.4%) and herring gulls (17.4%). These aggregations play a significant role in maintaining the geographic populations of these species.

During the nesting season, the total gull population in the capital is 5,000-6,000 pairs. The most numerous gulls are the black-headed gull (up to 50% of the total), the common gull (25%), and the Caspian gull (10%). Gull population trends vary.

Several groups of gull species have been identified: those with dynamic population growth (black-headed gull); those with relatively stable populations (herring gull, gull); those with characteristic fluctuating populations (lesser black-backed gull, great black-backed gull); those with decreasing populations (little gull) and new species that periodically appear (West Siberian, Arctic and spotted gulls).

The timing of the reproductive cycle depends on the weather conditions of the particular season. The black-headed gull begins nesting earlier than others (april), while the herring gull is the last to breed (mid-may). Most gulls nest on sandy and pebble islands. Nesting is predominantly colonial, with colonies containing different species. Recently, in Minsk, about half of the entire black-headed gull population (more than 1,500 individuals), along with gulls and herring gulls, have been nesting on the roofs of industrial buildings (the Shabany industrial zone, the Chegladze public transport stop, BTU dormitories, etc.) and residential buildings (near the train station). For this reason, residents *complain that the birds soil cars and sidewalks, and sometimes even snatch food from passersby.*

Thus, over the past decades, the species composition and numbers of gulls in Minsk have undergone significant changes due to anthropogenic impacts. Gulls are most present in the capital's urban landscapes in the spring and fall,

during their migrations. During the nesting season, the most common species are black-headed gulls, herring gulls, and gulls, whose concentrations are confined not only to large reservoirs but also to the roofs of industrial buildings and residential buildings.

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THE ORIGIN OF THE BAROQUE ARCHITECTURE IN BELARUS

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This article analyzes the historical context and conditions of the development of Baroque architecture in Belarus, its characteristics and distinctive features, and presents the earliest and most striking monuments built in this architectural style in Belarus.

Keywords: history, architecture, history of architecture, Baroque, G. M. Bernardoni

Each era not only has its own economic and social content but also leaves an indelible mark on architecture. Architectural heritage is the most vivid trace of an era, captivating all subsequent generations, revealing all the characteristics of bygone days in stone.

The emergence of Baroque in Belarus was associated with the penetration of architectural innovations from Italy, a consequence of the activities of the Jesuits, who popularized this movement. It is known that the Jesuits appeared in Belarus after the Union of Lublin in 1569 [1]. One of the Jesuits' activities was education, which was provided through Jesuit colleges, whose instructors included not only local residents but also specialists from afar. One such figure was Giovanni Maria Bernardoni, who arrived in Belarus in 1586 as an architect. He was hired by Mikolaj Radziwill the Orphan as the Radziwill court architect. Serving in this position for 12 years, he distinguished himself not only as a secular architect but also as an architect of religious buildings, laying the foundation for the widespread adoption of Baroque in Belarus. Among the first Baroque architectural monuments are the Radziwill castle in Nesvizh, built from 1586 to 1600, and the Corpus Christi Church in Nesvizh (1587 to 1593). A characteristic feature is the transition to new architectural solutions, inherently Baroque: pretentious forms, extreme pomp, massiveness bordering on gigantism, the presence of small details, an abundance of decoration, stucco, gilding, and sculpture [2, p. 54].

One striking example of the establishment of the new style is the reconstruction of St. Sophia Cathedral in Polotsk, carried out by the architect J. Glaubitz in the mid-18th century [1]. It embodies all the characteristics of Baroque in Belarus: the plasticity of the facades, the use of original window openings and semicircular tiers. Other monuments include the Church of Sts. Peter and Paul in Berezvechye, the Trinity Church in Glubokoye, and later the church in Dyatlovo [3, p. 37].

Thus, Baroque emerged in Belarus in the late 16th and 17th centuries. Under the influence of Italian architectural traditions brought by the Jesuits, it became the mainstream in architecture for more than a century.

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THE SIGNIFICANCE OF THE 1557 "FELLING CHARTER" FOR THE INTENSIFICATION OF AGRICULTURAL PRDUCTION IN THE XVI CENTURY

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This article addresses the agrarian reform in the Grand Duchy of Lithuania in 1557 and analyzes its significance for the development of agriculture in the XVI century.

Keywords: history, economic history, agriculture, Felling Charter, felling Pomera.

Agriculture is a fundamental sector of the economy, its foundation, and the basis for social prosperity. This gives rise to a persistent desire to intensify agricultural production and find ways to achieve more efficient management in this sector. Efforts in this direction have been continuously pursued, including in Belarusian lands. However, historiography does not examine all aspects of one of the most important stages on this path: the Pomerania na Valoky (landfills) of 1557. In particular, the socioeconomic aspects of the changes brought about by this reform in the second half to the end of the 19th century are poorly analyzed.

Sigismund II Augustus, Grand Duke of the Grand Duchy of Lithuania (GDL), implemented this reform as early as 1551 on his princely lands [1; p. 693]. This innovation was part of the policy, already pursued by his mother, Bona Sforza, to strengthen the grand ducal power. The reform provided for the allocation of land plots to peasants equal to 30 morgas or 20 dessiatinas (21.36 hectares). These lands became the experimental site for the "Volochnaya Pomeraniya," which made it possible to increase the productivity of the Grand Duke's estates, paving the way for the reform's expansion throughout the Grand Duchy of Lithuania in 1557, including to the private lands of feudal lords. Legally, the Volochnaya Pomeraniya was established by the Statute of 49 Articles, which standardized the specific methods for implementing the reform locally. Tax rates (corvée and chinsha) were established, which peasant families who received the Volochnaya Pomeraniya plots had to pay. The increase in the number of plots cultivated centrally reduced strip farming, facilitating the transition to a three field system and a progressive system of falwarks (highly productive agricultural estates) for that time.

The reform created the preconditions for a powerful intensification of agricultural production and created equal conditions for peasant households, which slowed the differentiation of peasants [1; p. 694]. Uniform rules for farming were established throughout the Grand Duchy of Lithuania, lasting for over two hundred years. Overall, the significance of the "Valok Charter" of 1557 was enormous: it significantly increased food and fodder production, making the Belarusian lands one of the largest food exporters in the world, laying the foundations for a long-term stable inflow of funds from the export of these goods. Socially, it facilitated the emergence of special categories of peasants – "gardeners" – who became a new phenomenon in the villages of the Grand Duchy of Lithuania at that time. The remaining peasants were divided into those who were similar (free) and those who were not. The tax on one valok ranged from 66 to 106 groszy per year, depending on the productivity of the valok's soil [2; p. 2].

Thus, the 1557 Valok Charter marks a milestone not only in the development of agricultural production but also in the socioeconomic history of the Belarusian lands. Therefore, the changes it brought about radically altered the face of not only the agricultural sector but also greatly influenced the entire history of the XVI - XVII centuries.

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ECOLOGICAL QUEST AS A TOOL FOR RESEARCHING THE DEVELOPMENT OF ECOLOGICAL LITERACY IN OLDER PRESCHOOL CHILDREN

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The importance of environmental quests for the basic literacy of older preschool-aged children is demonstrated. It has been established that environmental quests are one of the most effective and sought-after tools for developing basic literacy in preschoolers.

Keywords: environmental literacy, environmental quest.

One of the goals of preschool education is to foster moral and aesthetic values, as well as environmental protection and nature management. The Republic of Belarus has established a legislative framework regulating environmental education for preschool-age children. This framework is reflected in the Law of the Republic of Belarus "On Environmental Protection" and the "National Action Plan for the Rational Use of Natural Resources and Environmental Protection." The documents provide for improved environmental management, stabilization of the ecological situation, and the preservation of biological and landscape diversity. In the preschool educational standard, one of the key components of the educational process is education aimed at developing in students a respectful attitude toward the environment and environmental management [1].

Environmental literacy is knowledge in areas related to maintaining a desirable environmental state and preventing undesirable phenomena. Students develop the fundamentals of environmental literacy and a caring attitude toward the natural environment through educational activities in preschools and in everyday life.

The effectiveness of developing environmental literacy depends on the age group of children and the methods used in organizing the educational process. We conducted a study on developing environmental literacy in children aged 5-6 at the state educational institution "Kindergarten No. 12 in Molodechno."

An ecological quest game, "Ecological Trail: Nature Experts," has been developed. A quest is a technology that implements educational objectives, with game elements, involving the search and discovery of places, objects, people, and information, using information resources to solve the problem. Quests are games in which players must search for various objects, find uses for them, solve puzzles, interact with various characters in the game, etc. [2].

The environmental quest for children aged 5-6 involved teamwork to complete tasks at designated sites. The participating children developed teamwork and collaborative problem-solving skills.

Based on the results of the quest game, it was found that among the pupils of the integrated education and upbringing group, 30% of children had a high level of environmental literacy, 60% had an average level, and 10% had a low level.

The results of a survey on the emotional perception of environmental game participants revealed that this form is effective for studying the level of development of environmental literacy in older preschool children.

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PRACTICAL STUDY OF BIORHYTHMOLOGICAL CHANGES IN PERFORMANCE OF STUDENTS

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The article presents the results of a practical study aimed at identifying biorhythmological changes in the physical and mental performance of students based on an analysis of their dependence on sleep and wakefulness patterns.

Keywords: chronotype, biological rhythms, students' performance.

The individual and genetically determined characteristics of the human body's circadian rhythms are called the chronotype. A person's chronotype determines the organization of the body's physiological functions and its adaptability and can be used as a universal criterion for the overall functional state of the body. It is possible to determine the following main chronobiological types, namely: morning (early, "larks"); intermediate (indifferent, "doves"); evening (late, "owls"). It should be noted that each type is characterized by its peculiar behavioral characteristics.

The aim of this work is to identify biorhythmological changes in the physical and mental performance of students based on the analysis of their dependence on the sleep and wakefulness regime.

To achieve this goal, the following objectives were set:

1. To analyze students' sleep and wake-up times, as well as their subjective levels of alertness.
2. To analyze their peak productivity and concentration times.

It should be pointed out that a questionnaire-based approach was used to analyze students' biorhythmological characteristics. A questionnaire was specifically developed and it included 11 questions to gather the proper and up-to-date information about sleep patterns, peak productivity times, concentration levels at different times of day, and overall well-being. Twenty-six 11th-grade students participated in the study. The questionnaire was administered during school hours.

Data analysis showed that the major part of students (64%) go to bed after 22.00, with 24% falling asleep after midnight. It is also important to stress that only 8% of students follow healthy sleep recommendations and go to bed before 21.00.

Most part of students being studied wake up between 6:00 and 7:30, 16% of participants of the study has to wake up before 6:00, which can have negative influence on their well-being. Sleep duration of most students accounts for 6-8 hours, but 20% of participants of the study sleep less than 6 hours, that indicates a significant sleep deficit.

Subjective feeling of alertness upon waking demonstrates that only 12% of students being studied feel alert or very alert, while 52% feel of students feel slack, and 36% of participants rate their well-being as average. This confirms that a significant proportion of students experience difficulty waking up in the morning, which may be related to a late bedtime.

The study also found that 40% of students occasionally needed a day nap (1-2 times a week), and 20% of students have a nap after school almost every day.

An analysis of the time peaks of physical and mental activity showed that 8% of students report the greatest increase in energy in the morning (before 10:00), 28% between 10:00 and 14:00, another 28% in the afternoon, and 36% feel a surge of energy only in the evening or late at night.

A similar picture is observed when assessing the time of greatest mental productivity: only 12% of students believe that they perform best on mental tasks in the morning, while 48% of students report that they reach their maximum productivity after 14.00. These data indicate that most part of students experience difficulty when having early lessons and could demonstrate better level of performance if their educational workload could happen later in the day.

When analyzing concentration of attention within different times of day, it has been revealed that in the morning (before 10:00), 36% of students reported low levels of concentration (1-2 points), while only 32% of students reported high levels of concentration (4-5 points). During the day (10:00 -14:00), scores are improving: only 12% of students experienced serious problems with having an appropriate level of concentration, while 64% of students demonstrated

high levels of focus. Thus, the major part of students experience their greatest mental performance during the day and afternoon.

An overall assessment of student well-being during the school week showed that 24% of students rated their well-being as good (4-5 points), but 60% of students had average or low levels of energy, and 16% of students rated their well-being as minimal. These obtained data confirm the presence of fatigue among a significant portion of students, which may be related to chronic sleep deprivation and a daily routine that is inconsistent with their biological rhythms.

It should be underlined that the results of the study showed that the sleep patterns of most students do not meet their physiological needs, thus resulting in decreased morning productivity and concentration. Of special importance is the fact that most students demonstrate the highest level of their productivity during the daytime and during the afternoon, while morning activities of the students are associated with low levels of alertness and concentration.

In conclusion it is considered of vital importance to stress that to improve students' level of productivity, it is recommended to consider their individual chronotypes. For example, it is best to schedule complex subjects and tests during the period of peak cognitive activity (10:00-14:00) rather than early morning. Physical education classes, on the other hand, can be shifted to the afternoon, when most students reach their peak physical activity. It is also important to conduct preventative work with students and their parents, explaining the importance of adequate sleep and the negative consequences of sleep deprivation.

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THE USE OF THE PROBLEM-BASED LEARNING METHOD IN TEACHING ENGLISH LANGUAGE FOR THE FORMATION OF PERSONAL COMPONENTS OF THE ENVIRONMENTAL CONSCIOUSNESS OF STUDENTS

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The potential of the Problem-Based Learning (PBL) method is considered in the context of teaching English as a foreign language. PBL is a highly effective pedagogical tool for the formation of not only foreign language communicative competence but also key personal components of ecological consciousness: cognitive, value-motivational, emotional-feeling, and practical-activity.

Keywords: Problem-Based Learning, environmental consciousness, personal components, sustainable development, critical thinking, ecological education.

Modern global ecological challenges require a transformation of human consciousness from an anthropocentric to an ecocentric paradigm. Higher school is called upon to prepare not only competent specialists but also responsible "ecological citizens," capable of critical comprehension of problems and active actions.

However, traditional methods aimed at the assimilation of thematic vocabulary and grammatical structures are insufficient for impacting deep personal structures. Pedagogical strategies are needed that model the complexity and ambiguity of real ecological dilemmas. Precisely such a strategy is Problem-Based Learning (PBL) – a method in which students encounter a complex, real problem before they receive ready knowledge for its solution, and the process of

searching for a solution becomes a catalyst for learning. Its key principles ideally correspond to the nature of ecological problems, which often belong to the category of "wicked problems," not having an unambiguous or final solution.

Personal components of environmental consciousness, at which PBL is aimed: Cognitive component: deep, systemic understanding of interconnections in nature and consequences of human activity. PBL requires from students independent research, analysis of information from authentic English-language sources (scientific articles, UN reports, documentary films); value-motivational component: Formation of ecocentric values and internal motivation for action. Facing a real problem and the necessity of choice, students are forced to determine and defend their position; emotional-feeling component: Development of empathy towards nature and a feeling of co-participation); practical-activity component: An attitude towards active action and readiness for pro-ecological behavior.

Let us consider the implementation of the method using the example of the problem: «The city council is deciding whether to build a new shopping mall on a greenfield site or to renovate the abandoned industrial zone in the city center. Your task as an international advisory group is to analyze the environmental and social consequences and propose a sustainable solution». Stage 1: Encounter with the problem: the teacher presents the problem in the form of a brief case, video clip, or a set of statistical data in the English language (the cognitive and emotional components are activated – students begin to analyze the situation and form a primary attitude towards it). Stage 2: Identification of the known and unknown: students in small groups compose two lists in the English language: What do we KNOW? What do we NEED TO KNOW? (an assessment of the boundaries of their own knowledge occurs; the complexity and multifaceted nature of the problem is realized). Stage 3: Independent research: based on the "Need to Know" list, students distribute topics for research and independently search for information, using English-language resources (the cognitive component deepens due to work with authentic information; information literacy develops). Stage 4: Joint solution and synthesis: students return to groups to exchange the found information, discuss it in English language and work out an agreed-upon solution or recommendations (in the process of discussion, a crystallization of values occurs and readiness for collective action is formed). Stage 5: Presentation of the solution and reflection: groups present their solutions in English language, substantiating them with the results of the research (the practical-activity component is reinforced through the presentation; the emotional-feeling and value components are integrated into personal experience through reflection).

The Problem-Based Learning method goes far beyond purely linguistic tasks. It creates in the lesson a unique educational ecosystem where foreign language communication becomes a natural tool for comprehending and solving complex ecological problems. Going through all the stages of PBL, students not only perfect their English language skills in a real, life context but also live through a deep personal experience. This experience, combining intellectual search, emotional involvement, value choice, and practical action, is the most effective path for the formation of a holistic, ecocentric consciousness, necessary for building a sustainable future.

NARCISSISTIC PERSONALITY DISORDER

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This article examines narcissistic personality disorder, its signs, causes of formation, influence on interpersonal relationships, as well as methods of diagnosis and treatment, including approaches to interacting with people suffering from this disorder.

Keywords: narcissism, idealization, self-perception, relationships.

Narcissistic personality disorder is a mental condition in which a person is convinced of their own exclusivity and superiority, is constantly preoccupied with their own significance, and needs external validation. Personality disorders in general are persistent patterns of self-perception, behavior, and relationships that form in adolescence and persist throughout life; they interfere with adequate adaptation and often require intervention by a psychologist or psychiatrist.

Previously, it was believed that narcissism was exclusively a male trait, but recent studies have shown that it is equally common in both men and women. As a rule, narcissistic traits are formed under the influence of upbringing, social conditions and trauma, but biological and hereditary factors (including neurobiological features, such as ADHD) can increase vulnerability. It is rarely expressed in childhood; the first signs usually appear in adolescence and intensify in youth and adulthood [1].

The diagnosis of narcissistic disorder relies on a consistent set of signs: an inflated sense of self-importance with the expectation of special recognition, a tendency to fantasize about exceptional success or power, and a belief in one's own "exclusivity" that requires communication only with equals in status; a constant need for admiration and the right to privileges; using others to achieve personal goals while being indifferent to their feelings; frequent envy of others and demonstration of arrogance. These traits are stable and significantly disrupt interpersonal relationships and adaptation.

Narcissism is not always noticeable: there are two types - grandiose, expressed in demonstrative self-confidence, the requirement of admiration and external assertiveness, and vulnerable, which looks withdrawn and insecure, but harbors internal fantasies of superiority and painfully perceives criticism. Both variants disrupt interpersonal relationships and interfere with adaptation.

Three key traumatic scenarios that shape the "false self" can be identified. The first is the trauma of neglect, which arises from emotionally cold or unavailable parents who ignore a child's basic needs, causing the child to stop feeling valued. The second is the trauma of adoration, where parents idealize the child, praising them for non-existent qualities while failing to see their real personality, thus making love conditional. The third is conditional love, where attention and warmth are given only for achievements, leading the child to learn that they are valued not for who they are, but only for their successes. In response to these traumas, the psyche creates a defense mechanism – the "false self." To receive love, the child hides their vulnerable, true self and forms an idealized version, which over time replaces the authentic personality.

The main method of treatment is long-term psychotherapy. The most effective are psychoanalytic therapy, dialectical behavior therapy, which develops emotional regulation skills, and schema therapy, which works with deep maladaptive beliefs. The goal is not "cure," but help in developing basic empathy, awareness of defense mechanisms, and building healthier relationships [2].

If you are dealing with a narcissist, the key strategy is to rely on their main fear of being insignificant, using the tactic of ignoring. Reinforce desired behavior with praise and deprive unwanted behavior of attention. Do not engage in excuses, firmly establish and defend your boundaries, and know how to say "no." Do not try to change a narcissist - it's useless. Maintain emotional distance, remaining calm and not getting involved in manipulation. Focus on yourself, not allowing them to consume all your time and energy. If the relationship is destroying your personality, consider a complete break.

Narcissistic personality disorder is not a sentence, but a heavy burden for both the person and their environment. Behind the mask of superiority hides someone who never learned that they can be loved not for achievements, but just as they are. Understanding NPD does not justify destructive behavior, but allows you to see the pain behind it - and stop taking it personally.

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BETWEEN WAKEFULNESS AND ANXIETY: HOW DO SLEEP, STRESS, AND COFFEE SHAPE OUR PERCEPTION OF REALITY?

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This paper explores the balance between the body's natural rhythms and artificial stimulants. It examines the impact of sleep patterns, stress levels, and caffeine consumption on physical and emotional health. Factors that influence the human body are analyzed. Parallels are drawn between these themes, and their interactions with energy levels, mental health, and overall well-being are described.

Keywords: stress level, caffeine consumption, sleep patterns, health, emotional state, purpose of normal human functioning, striving for the ideal.

Sleep is the foundation of human health, essential for overall recovery. It strengthens the immune system, normalizes hormonal levels, and supports normal functioning. However, sleep quality can be disrupted. The cause of this is the thoughts and experiences caused by stress in everyday life. This relationship between sleep and emotional state is becoming a subject of study and analysis in the fields of medicine, sociology, and psychology. Understanding these interactions can help improve people's quality of life and health [1].

Caffeine, in turn, also affects human well-being. It is a central nervous system stimulant and provides an invigorating effect, reducing the risk of depression. However, excessive coffee consumption can cause anxiety, irritability, and cardiovascular disease [2; p. 2].

Based on the knowledge of the relationship between these three factors, a social survey was conducted on the impact of sleep, stress, and caffeine on well-being. One hundred and twenty volunteers participated in the survey, of whom more than 40% were minors aged 16-17 (schoolchildren and university students). The remainder of the population was primarily represented by the older working class (18-67 years old). The majority of respondents describe stress as a negative factor, negatively impacting their overall well-being and causing symptoms such as headaches, increased blood pressure, decreased appetite, and increased heart rate. To maintain their mental health, the majority (65.8%) prefer walking in the fresh air, spending time with loved ones, exercising, and meditating. Issues related to finances, health, family, work, and studies were identified as stress-causing factors. An analysis of the responses revealed that the majority of people (53.3%) do not perceive the impact of caffeine on their mood, overall well-being, or anxiety levels. However, quite often (about 54.2%) of respondents experience a deterioration in well-being without an apparent cause. Of the total number of people surveyed, 66 are completely healthy and have no health complaints. While the rest of the respondents most frequently suffer from heart disease, gastritis, and hypertension, attributing this to poor sleep and frequent stress in everyday life.

Thus, having examined the influence of sleep, stress levels, and caffeine consumption in both theoretical and practical sections, we can conclude that in this triad, a person balances between the biological and the social, between idea and body, and between peace and aspiration. A person is a system of compromises; a biological organism living in a sociocultural universe, where every star represents a choice between body and idea. Sleep, stress, and caffeine are not simply physiological phenomena. They are indicators of the era, reflecting the tension between the natural and the social.

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THE IMPACT OF INTIMATE LIFE ON MENTAL HEALTH

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The article examines the influence of the impact of intimate life on mental health and how various aspects of sexual life can affect a person's general condition, and also considers options for maintaining mental health in the context of sexuality.

Keywords: psychotherapy, sex, intimate relationships, mental health.

Sex and mental health are two interconnected areas that have a significant influence on each other. Understanding this connection can help people improve both their sexual life and general psychological well-being.

Sexual activity can have both positive and negative effects on mental health. According to research by many psychologists, regular sexual activity promotes the production of endorphins and other hormones that improve mood and reduce stress levels. Also, sex can strengthen the emotional bond between partners, which contributes to a sense of security and satisfaction in relationships. However, sex does not always bring positive emotions. Sexual dysfunction, such as erectile dysfunction or low libido, can cause feelings of shame, anxiety, and depression. These conditions can exacerbate relationship problems and reduce quality of life [1].

Mental health plays an important role in sexual function. Depression, anxiety disorders, and other mental illnesses can negatively affect sexual desire and the ability for intimate closeness. For example, people with depression often experience decreased libido, which can cause conflicts in relationships. On the other hand, satisfaction with sexual life can act as a protective factor for mental health. Research by sexologists shows that people who are satisfied with their sexual life have higher indicators of general well-being and suffer less frequently from depression and anxiety [2].

Psychotherapy can be an effective tool for solving problems related to sex and mental health. Sexologists can help patients understand their sexual preferences and problems related to intimacy. Psychotherapy can also help in overcoming sexual trauma and improving emotional connection with a partner [3].

The impact of intimate life on mental health is a multifaceted and complex aspect of human life. Having healthy and fulfilling intimate relationships can contribute to improved self-esteem, reduced stress levels, and overall emotional well-being. Conversely, a lack of intimacy or the presence of toxic relationships can lead to feelings of loneliness, anxiety, and depression.

It is also worth noting that intimate life can involve expressing feelings and providing emotional support, which can strengthen the bond between partners. However, it is important to consider individual differences and cultural factors that may influence the perception of intimacy. Ultimately, taking care of mental health requires recognizing the importance of harmonious relationships and working on their quality, which can be a key to emotional well-being [4].

Thus, sexual life not only makes us physically healthier, but also improves mood, reduces stress levels, and helps fight depression. By receiving a sense of satisfaction, we increase the level of our internal energy. It is important to seek help from specialists if problems arise in these areas.

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ENVIRONMENTAL INEQUALITY AND "ENVIRONMENTAL RACISM"

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The article presents the results of a practical study aimed at identifying awareness of environmental inequality and "environmental racism".

Keywords: environmental inequality, environmental racism.

Environmental inequality is the unequal distribution of environmental risks and pollution, as well as unequal access to natural resources among different social groups. "Environmental racism" is a form of environmental inequality where race or ethnicity becomes a key factor increasing the likelihood of facing unfit environmental living conditions.

The aim of this work is to analyze the manifestations of and attitudes towards environmental inequality and environmental racism in the world, to identify causes and consequences, and to find possible solutions.

To achieve this goal, the following task was set:

1.Conduct a survey aimed at understanding the population's perception and attitude towards environmental inequality and racism.

The questionnaire method was used for the analysis. A questionnaire was developed, containing 15 questions to gather information on attitudes and perceptions regarding problems such as environmental inequality and environmental racism. The study involved 52 people of different ages and from different professional fields.

Data analysis showed that the majority of respondents (44%) have no idea what environmental inequality and environmental racism mean, while 33% have heard of them but do not know the exact meaning. Only 23% of respondents know what they are.

A large portion of the respondents (40%) believe that industrial enterprises and landfills are most often located in areas where low-income people live, while 22% completely disagree with this.

It should also be noted that the majority of respondents were aged 36-50. This confirms that the older generation is more informed and interested in solving these problems.

The study also revealed that only 28% of respondents aged 18-25 are aware of environmental inequality issues.

About 6% have personally encountered situations that can be classified as environmental inequality; however, 44% have never heard of such situations, and 28% have heard about such situations from acquaintances. This indicates that situations attributable to environmental inequality and environmental racism are relatively few but still present.

Over 60% believe that the main cause of environmental inequality is the economic interests of large enterprises; 56% believe the causes are weak environmental legislation and the historically established location of industrial zones. However, 38% also believe that low civic engagement is a cause. These data indicate that the majority of respondents believe the main cause is economic interests.

When analyzing the consequences of environmental inequality and environmental racism, 48% believe it can lead to increased diseases in polluted areas, and 7% believe it can lead to mental health issues due to stress caused by discrimination; 44% believe it will lead to unequal opportunities in education, as prosperous areas have a sufficient number of educational institutions with highly qualified teachers.

According to the respondents, the most effective ways to solve these problems are increasing environmental literacy among the population (over 65%) and economic incentives for businesses for environmental responsibility (55%). Supporting environmental NGOs and civil activists was considered less effective by the respondents.

The results of the study showed that people are aware of the existence of such problems and are also interested in solving them to preserve all available resources for their own comfortable lives and for the comfortable lives of future generations.

In conclusion, it should be added that a sustainable future is only possible when the right to clean air, water, and land is guaranteed to every person, regardless of their origin, income, or skin color.

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THE ROLE OF MIND MAPS IN STUDENT LEARNING

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This article explores the potential applications of the mind map method, also known as mental mapping, in teaching higher education students, as well as assessing student awareness of this learning technique. The practical significance of the study lies in the possibility of using its results to develop methodological recommendations and practical materials, implement mind maps into the educational process, and enhance the efficiency of learning material acquisition.

The essence of a mind map lies in the graphical representation of information and thought processes in a radial format. Unlike traditional linear notes (lists, tables, continuous text), a mind map has a centered structure. The main topic, idea, or problem is located at the center. Main branches radiate from this central image or keyword, representing key subtopics or aspects of the central idea. Each main branch, in turn, can branch out into smaller branches of the second, third, and subsequent levels, detailing the information. This structure visually resembles a neural network or a tree crown, reflecting the associative nature of human thinking.

D. Morales distinguishes the following types of mind maps: spider map, bubble map, bridge map, brace map, multi-flow map, and dialogue map [1].

The "spider map" allows for structuring thoughts in a web-like format: the key concept is placed in the center, with related ideas or subtopics radiating outwards in all directions. By using color coding, clear organization, and visual imagery to break down complex issues, the "spider map" offers a simplified yet comprehensive overview of essential data.

"Bubble maps" are a type of mental map whose primary task is to describe a central concept or idea in detail. Their distinctive feature is the active use of adjectives for description. Therefore, it is critically important to carefully select these descriptive words. Working with a bubble map helps to expand vocabulary and understand its various forms.

The "bridge map" is used for the visual comparison of concepts and for identifying analogies between them, helping to eliminate confusion. It effectively identifies and compares two or more ideas, demonstrating the relationships and common ground between them, including shared data or characteristics. This tool is particularly useful when working with multiple datasets, as it allows for clear visualization of connections. The "bridge map" simplifies the process of analyzing a main topic by providing opportunities for its filtering, classification, and description through comparison. This is why it is in demand among researchers.

The "brace map" is excellent for structuring and analyzing extensive conceptual information. It allows for focusing on individual data elements, analyzing them without the need to grasp the entire picture at once. To draw the necessary conclusions, it is sufficient to isolate and examine a specific aspect.

The "multi-flow map" is used to visually display the causes and effects of an event or phenomenon. The event itself occupies the central position, with its causes listed to the left and its results (effects) to the right.

The primary goal of a "dialogue map" is to find a solution to a specific problem. It is a special style of mind map designed to develop critical thinking. The primary goal of many dialogue mapping sessions is to address wicked challenges. The discourse map begins with a set of related nodes. Each node serves as a main focus for a specific step or stage. They can be connected by lines depicting flows. Subsequently, all concepts and options are recorded [2].

Mind maps help structure and systematize information, which contributes to more effective planning of tasks and projects. Visual elements and information structuring not only aid in memorizing material more effectively but also in doing so more meaningfully. This is the fundamental difference between using mind maps and rote memorization of information. Mind maps serve as repositories of information and allow for its organization in a more systematic and understandable way. Complex topics are broken down into simpler and more comprehensible parts, making the material more accessible. They help highlight main aspects and their interrelationships, which facilitates the understanding of complex concepts.

According to a student survey, the majority (63.01%) indicated that they were not familiar with mind maps. After testing, the scores of students using the described method were statistically significantly higher (≈60%, $p<0.05$) compared to students who did not use mind maps in their learning process. This confirms that this method deserves attention and should be implemented in the educational process.

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THE ROLE OF METAPHORS AND ANALOGIES IN THE FORMATION OF SCIENTIFIC CONCEPTS

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The paper examines the definition of metaphors and analogies, the role of metaphors and analogies in the formation of scientific concepts, and the philosophical aspects of the use of metaphors and analogies.

Keywords: metaphor, analogy, scientific concepts.

Scientific knowledge is traditionally perceived as a rigorous, rational, and objective study of the world. However, in reality, the process of forming scientific concepts often relies on creative thinking tools, among which metaphors and analogies occupy a special place. They not only help scientists explain complex phenomena but also facilitate the development of new theories and models. This article examines the significance of metaphors and analogies in science, their role in the discovery and communication of scientific ideas, and the philosophical aspects of their use.

Metaphor is the transfer of meaning from one concept to another based on similarity or associative connection. Analogy is a more complex cognitive technique that involves identifying structural similarities between two different objects or systems. In a scientific context, these tools are used to simplify abstract and new concepts, making them more understandable and visual.

The role of metaphors and analogies in the formation of scientific concepts

1. Brainstorming and generating new ideas. New scientific theories are often born precisely by searching for analogies with familiar objects. When scientists encounter an incomprehensible phenomenon, they look for something to which it can be compared. For example, Newton's classical mechanics was based on an analogy with the motion of everyday objects; quantum physics, by contrast, is inspired by analogies with waves and statistics.

2. Simplification and visualization of complexity. Metaphors allow complex systems to be represented in sim pler, more familiar images. This simplification does not mean distortion, but rather serves to effectively assimilate and transmit knowledge. The method of analogy facilitates the explication of new concepts and promotes scientific learning.

3. Communicative function. Scientific ideas often remain abstract and difficult to understand. The use of metaphors and analogies makes these ideas accessible not only to specialists but also to a wider audience. This contributes to the popularization of science and its dissemination to society.

4. Forming a cognitive framework for research. Metaphors influence how scientists think about a problem, what questions they ask, and what methods they prefer. They can guide scientific inquiry and limit or expand a researcher's field of vision. An example is the "machine" metaphor in cognitive psychology, which has shaped approaches to the study of thinking.

Philosophical aspects of the use of metaphors and analogies

One of the fundamental questions in the philosophy of science is the reliability and adequacy of scientific concepts. Metaphors and analogies, being figurative by nature, do not always reflect absolute truth, but serve as models. This gives rise to debate about the extent to which models and concepts built on figurative transferences can be considered true.

Nevertheless, the history of science shows that metaphorical thinking stimulates science to develop and innovate. Even if a specific metaphor is ultimately rejected, it serves as a bridge between the unknown and the known.

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THE IMPACT OF ENVIRONMENTAL CONDITIONS ON MENTAL HEALTH

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The article examines the relationship between the ecological state of the environment and human mental health.

Keywords: environmental conditions, pollutants, noise, stress, environment.

One of the characteristic features of modern society can be confidently called rapid urbanization. Under these conditions, the problem of environmental impact on human health becomes especially acute and urgent. If the physiological consequences of environmental pollution are studied deeply enough, then the relationship between the environmental situation and the mental health of people remains an area of active research. Mental well-being is closely related to the physical, and a degrading environmental environment becomes a significant risk factor affecting mental processes, emotional state, and the development of various mental disorders.

One of the most important direct impacts of environmental factors is, first of all, air pollution. A variety of atmospheric pollutants such as carbon monoxide, volatile organic substances (VOCs), oxides of nitrogen, sulfur, particulate matter, and other pollutants can enter the bloodstream and then reach the brain, causing neuroinflammation, oxidative stress, and neuronal damage. These processes can impair the function of neurotransmitter systems such as dopamine and serotonergic, which play a critical role in mood, motivation and cognitive regulation. Exposure to pollutants can affect structural and functional changes in the amygdala and prefrontal cortex. Modern studies show a connection between long-term inhalation of polluted air and an increased risk of anxiety and depressive disorders [1,2], as well as an increased risk of neurodegenerative diseases with prolonged exposure to pollutants.

Chronic exposure to anthropogenic noise and sounds of high power (transport, industry, construction), which is not uncommon in modern large cities, acts as a physiological stressor. It leads to the activation of the sympathetic nervous system and the stress axis of the hypothalamus-pituitary-adrenal glands, which, accordingly, causes an increase in cortisol levels, sleep disturbance, arterial hypertension and even pain. These physiological changes are strongly associated with a worsening mental state, increased irritability, aggressiveness and anxiety. The effects of climate change, such as natural disasters (floods, hurricanes, wildfires), can cause acute psychological trauma. Those, in turn, lead to the development of post-traumatic stress disorder (PTSD), depression, anxiety disorders and exacerbated stress responses.

One of the most dangerous factors is rightfully the increased radiation background. Its effect, as a rule, causes atrophy of the cortex of the temporal and frontal lobes, subcortical structures, and conductive pathways. Radiation is a risk factor for chronic fatigue syndrome and also accelerated aging of the central nervous system.

The indirect impact of the environmental situation is no less important. In the modern urbanized environment, the availability of green spaces, parks and natural landscapes has significantly decreased, which seriously limits human capabilities for recovery and emotional relief [3]. This problem can also contribute to chronic fatigue, a decrease in concentration, a deterioration in mood and an increased risk of depressive states. The uneven distribution of environmental risks (for example, the concentration of industrial enterprises in areas of low-income groups or ethnic minorities) creates additional stress loads and exacerbates existing mental health problems in the most vulnerable groups.

Thus, it can be concluded that the environmental situation has a significant impact on human mental health, acting both through direct physiological mechanisms and through indirect socio-economic and psychological pathways, therefore, both at the individual and state levels, it is necessary to minimize the negative consequences of environmental degradation of the environment.

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PSYCHOLOGY OF INDIVIDUAL DIFFERENCES FORMATION

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Character is an individual and stable structure of enduring, relatively constant mental properties that determine the specifics of an individual's relationships and behavior.

Keywords: character, personality formation, temperament, age.

By making each person individual, character is not a random set of traits. Heredity, upbringing, and life experience collectively determine the formation of a person's character, which is a complex process.

The formation of character is divided into several main stages:

1. Early childhood (from one to three years): the foundations of character are laid, the child becomes more independent and self-aware. The child learns about the world around them better through actions with objects, and the differentiation of the objective and social environment occurs.

2. Preschool and primary school age (from three to ten years): during primary school, children develop the foundations of achievement motivation, collectivism, and improve control over emotions and behavior.

3. Adolescence: adolescents actively search for their identity, asking questions "Who am I?", "Who do I want to be?". They begin to better understand their feelings, motives, and actions. The role of peers increases significantly.

4. Early adulthood and maturity: characterized by greater stability. The formation of close relationships requires the ability to build communication, show empathy, compromise, and take on commitments [1].

Various aspects also participate in the formation of character: Genetic predisposition, manifested in the features of the nervous system, determines the level of emotional reactivity.

Thanks to the Eysenck test, it was proven that the type of temperament and character are interconnected with the perception of gender differences. Upbringing also plays an important role in the formation of character [2].

Thus, character and temperament are the result of complex and multifaceted work, where genetic predisposition, life experience, and conscious self-development play interconnected roles.

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PLAN AND IMPLEMENTATION OF THE OPERATION "BAGRATION" – INTERACTIVE MAP

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The project is devoted to the creation of an interactive map of Operation "Bagration" using the Genially platform. Its aim is to visualize the course and importance of the operation through digital tools. The interactive map combines historical facts, schemes, and visuals, making learning more accessible and engaging. The project can be used for educational and patriotic purposes.

Keywords: Great Patriotic War, Operation "Bagration", interactive map, visualization.

The development of IT technologies has opened up great opportunities for visualizing historical events. Modern digital tools make it possible not only to present complex processes clearly but also to understand historical facts more deeply. One of the most effective visualization tools is the creation of interactive maps.

This is especially relevant for studying the events of the Great Patriotic War, as the visual format helps young people better understand the scale and significance of what happened. For this project, a free version of the Genially online platform was used to create interactive content. The project represents a dynamic map of Operation "Bagration", supported by theoretical and methodological justifications and visual clarity.

The interactive map is not just a modern digital tool but a significant step forward in the visualization of key historical events, particularly Operation "Bagration" and the liberation of Belarus. It can be used for educational purposes – in schools and universities, as well as in research – to study, analyze, and delve into historical events. In patriotic and educational projects – at lectures, excursions, and presentations – the map increases audience engagement.

The interactive map of Operation "Bagration" demonstrates how modern technologies can combine science, education, and patriotic upbringing. This approach helps not only to transmit knowledge but also to form an emotional connection with history, strengthening pride in the heroism of the Belarusian people.

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RESEARCH OF SOCIAL AND ECOLOGICAL CHALLENGES AND THE FORMATION OF ECOLOGICAL CULTURE

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The article presents the results of a study that reveals the essence and structural components of environmental culture in the context of modern social and environmental challenges, and also identifies the key pedagogical and institutional conditions for its formation.

Keywords: environmental culture, social and environmental challenges, sustainable development, environmental education, environmental awareness.

Modern society faces a complex of socio-environmental challenges, including climate change, depletion of natural resources, loss of biodiversity and environmental pollution. The answer to these challenges is the development of an environmental culture as the foundation for the transition to sustainable development. Environmental culture is a system of values, knowledge, and practices aimed at harmonizing human interaction with nature.

Ecological culture is understood as an organic part of general culture, including three interconnected components:

1. Environmental awareness is a system of knowledge, beliefs and ecological thinking oriented towards the co-evolution of man and nature.

2. Environmentall attitude are considered to be emotional and value perception of nature, responsibility for its preservation.

3. Environmental activities are practical actions aimed at preserving and restoring the environment.

The most important feature of ecological culture is the unity of social and natural principles, where nature is considered as the basis of life and social development.

The National Strategy for Sustainable Social and Economic Development of the Republic of Belarus till 2030 emphasizes the need of transition to a green economy. This requires a new way of thinking, which challenges the education system to foster an environmental culture. Among the key principles of environmental policy, the following can be highlighted:

- a combination of environmental, economic, and social interests;
- priority of preserving natural ecosystems;
- presumption of environmental hazards associated with economic activity.

Research shows that environmental education should be:

- systemic – integrated into curricula at all levels;
- consistent – ensuring the continuity of knowledge and skills;
- systematized - organized around key concepts such as sustainable development, environmental safety, quality of life.

Effective methods for developing environmental culture include: project activities, research work, practical participation in environmental campaigns, environmental games and holidays.

Social institutions play an important role in shaping environmental culture:

- educational institutions implementing environmental standards;
- government agencies developing legal and economic mechanisms for environmental protection and the rational use of natural resources;
- mass media promoting environmental education;
- social movements engaging citizens in solving environmental problems.

Developing an environmental culture is essential for overcoming socio-environmental challenges and transitioning to sustainable development. This requires a comprehensive approach, including updating educational content, developing environmental awareness, and actively engaging citizens in practical conservation efforts.

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BIOETHICAL ASPECTS OF TRANSPLANTATION

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Relevance: The transition from the 20th to the 21st century was marked by significant achievements in the field of transplantation, which turned scientific hypotheses into real medical procedures. However, this progress has raised several serious ethical issues.

Keywords: philosophy, transplantation, bioethics, organ donation, medicine, technology, achievements, social problems.

Ethical issues in resource allocation.

One of the key ethical aspects is the fairness of resource allocation in healthcare. High-cost organ transplantation surgeries help a limited number of patients, raising questions about the feasibility of large investments in this field of medicine. However, proponents argue that transplantation plays an important role in the development of innovative technologies and medical equipment [1].

The problems of organ donation.

Modern biotechnology leads to the commercialization of the human body, which is perceived as a collection of interchangeable components. This causes serious moral dilemmas, as the body becomes a subject of sale and purchase. The Church strongly opposes the sale of human organs, emphasizing the importance of voluntary donation as an act of altruism and compassion. International norms require adherence to the principle of autonomy and informed consent when using a living organism as a donor. It is important to ensure that the patient fully understands the potential risks and consequences of donation [3].

The use of deceased organs is also associated with a number of ethical issues. Historically, there have been three approaches to posthumous organ harvesting: routine harvesting, the presumption of consent, and the presumption of non-consent. Routine harvesting, characterized by a lack of control over the procedure and a violation of the right to personal autonomy, is no longer used. The presumption of consent assumes that every citizen automatically agrees to become an organ donor after death, unless they have expressed their disagreement in advance. This approach allows for an increase in the number of available organs for transplantation, as it does not require each individual to actively express their willingness to donate. In contrast, the presumption of refusal requires each potential donor to actively express their willingness to donate. This creates a barrier to increasing the number of donors, as many individuals may either forget to express their consent or choose to avoid making a decision [2].

Ethical issues in resuscitation Modern advances in resuscitation allow for the long-term support of patients with severe brain injuries. This has led to the emergence of the "extended process of dying." Medical technologies can sustain the functioning of individual organs even when the entire body is in a terminal state. This situation raises ethical concerns, as while medicine aims to prolong life, it raises questions about the quality of that life and the suffering experienced by the patient. The Russian Orthodox Church emphasizes the importance of providing patients with the opportunity to die with dignity, without the use of artificial life-support measures that may cause suffering. Instead, it suggests developing palliative care that focuses on alleviating pain and maintaining the quality of life for dying patients. Thus, the issue of organ transplantation and the understanding of death in the medical field [3].

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THE CURRENT STATE OF THE VIPER POPULATION COMMON (*VIPERA BERUS*) IN BELARUS AND MINSK REGION

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In the last decade, a number of very interesting microevolutionary studies on amphibians have been conducted in our country and abroad. The phenogeography of the common viper (*Vipera berus*) has been little studied. It is believed that research on this species will not only allow us to elucidate the specific features of the microevolutionary process but also to obtain data on the role of this reptile species in the energetics of biogeocenoses [3].

Keywords: common viper, phenes, phalidosis, apical shields, suture shapes.

The common viper (*Vipera berus*) is a species of venomous snake in the genus Viperidae, commonly found in Europe and Asia. It prefers cooler temperatures and is found as far north as the Arctic Circle and even in the Arctic Circle, or in mountains up to 2,600 m above sea level [1].

The present study was based on population samples of the common viper (*Vipera berus*) collected from various landscape provinces of Belarus by the former Institute of Zoology of the National Academy of Sciences of Belarus between 1978 and 1998. During the field research, the reptiles were studied in 20 districts representing five regions of the republic, excluding the Grodno Region.

A total of 160 specimens were processed, and a total of 30 phenes were isolated. The isolation of integument phenes and their derivatives proceeded in two directions: the isolation of scale arrangement phenes (pholidosis) and the isolation of integument color and pattern phenes [2].

It has been established that the average number of apical scutes in the common viper in Belarus is 12.2. The number of abdominal scutes is 139.6. The number of subcaudal scutes is 37. The average number of fronto-supraorbital scutes is 7. The number of upper labial scutes is 16.5. The number of lower labial scutes is 18.5.

A certain pattern in the distribution of individuals by scute number is evident across all quantitative characteristics of scutes. The greatest number of individuals is concentrated in close proximity to or coincides with the arithmetic mean, while the number of individuals with higher and lower scute numbers gradually decreases, with only a few specimens exhibiting the extreme values.

An analysis of the shape of the suture between the zigzag stripe and the dark spot on the head revealed that the most common specimens have a suture in the form of a narrow, straight stripe (36%). Individuals without a suture account for 25%. Twenty-five percent of specimens have an acute-angled suture, while 10% have an obtuse-angled suture. A notch is present in 9%. The rarest pattern is the presence of a «notch».

To further study the viper's distribution in the Minsk region, the results of field studies conducted between 2012 and 2014 in the following administrative districts were used: Volozhin, Derzhinsky, Stolbtsy, Pukhovichi, Vileika, Minsk, and Logoisk. The collection material was collected by A.V. Khandogim and M.S. Medvedeva.

It was revealed that in the modern structure of the viper population inhabiting the Minsk region (a sample of 127 specimens), medium-sized individuals (60-70 cm in length) predominate. The ratio of immature males to females is 25%, 35.0%, and 40.0%. The sex balance in the population is shifted towards a slight dominance of females (1:1.1).

The following quantitative distribution of different color forms in the population was established: gray individuals – 32.8%, brown – 42.4% and black – 24.8%.

In the central part of the country, in the Minsk region, the dominant habitat group is made up of mixed coniferous-small-leaved forests, wet pine forests, and various types of swamps. The highest abundance rates are found in wet biogeocenoses – in swamps, along riverbanks, canals, and reservoirs, in mossy pine forests, and in mixed coniferous-small-leaved forests.

Thus, the common viper population in the Minsk region is unevenly distributed, due to landscape heterogeneity and anthropogenic transformation of the territory. It totals approximately 30,600 individuals. Thus, compared to other regions, Minsk has the poorest common viper population in Belarus. The most significant populations are found in the Dzerzhinsky, Vileika, Pukhovichi, and Stolbtsy districts. The population density in the Minsk region is very low, approximately 2-2.5 times lower than in other districts of the Minsk region, and ranges from 0.9-24.6 individuals/ha, with an average of 9.3±1.2 individuals/ha.

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ETHICAL CHALLENGES OF TECHNOLOGICAL PROGRESS AND SOCIETAL DIGITALIZATION

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The report analyzes the key ethical dilemmas associated with the rapid development of technology and the comprehensive digitalization of society. Special attention is paid to issues of privacy, data security, algorithmic bias, and the impact of technological unemployment on social justice. Proposals for developing ethical frameworks and regulatory mechanisms to mitigate negative consequences are considered.

Keywords: Digitalization, Ethics, Technological Progress, Privacy, Algorithmic Bias.

The main ethical issues of digitalization

The digitalization of society and rapid technological progress, including the development of artificial intelligence and big data, bring enormous benefits, but they constantly create pressing ethical challenges for humanity. The relevance of their discussion is determined by the need to form a socio-ecological and ethical-pedagogical environment capable of adapting to new realities.

The main ethical dilemmas relate to privacy and data security. The mass collection and processing of personal information creates risks of unauthorized access and abuse. Therefore, special attention should be paid to implementing the principle of the "right to be forgotten" in the digital space.

The problem with algorithmic bias is that decisions made by AI can reflect and reinforce existing societal biases (racial, gender, social). For example, recognition systems may demonstrate less accuracy for certain population groups, leading to social injustice. Addressing this issue requires the development of transparent and explainable algorithms.

The development of new ethical and pedagogical approaches should include training citizens in digital literacy and critical thinking to assess technological risks. The implementation of ethical codes for developers and regulators is becoming critical to ensuring sustainable technological development.

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ENVIRONMENTAL DIFFERENTIATION IN MAJOR CITIES: WHO PAYS FOR EXPANSION AND DEVELOPMENT

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This paper examines the phenomenon of environmental differentiation as a critical challenge of modern urbanization. It analyzes the systemic process of socio-spatial stratification where access to environmental benefits – such as green spaces, clean air, and quality water – is distributed unevenly across different urban populations. Concurrently, environmental risks, including air and noise pollution and proximity to hazardous infrastructure, are disproportionately borne by vulnerable socio-economic groups. The study aims to uncover the mechanisms driving this inequality in the context of rapid urban growth and to identify the social strata that ultimately pay the highest price for metropolitan expansion and development.

Keywords: environmental differentiation, environmental justice, urban planning, transport poverty, green gap, gentrification, urban environment, spatial inequality, sustainability, social equity.

The research employs a comprehensive literature review and case study analysis of major cities in North America and Europe. It synthesizes findings from urban studies, environmental sociology, and spatial justice theories to construct a multifaceted understanding of the drivers and consequences of environmental differentiation.

The study reveals that environmental injustice manifests in several interconnected ways. Historically marginalized communities, including low-income and ethnic minority populations, are consistently concentrated in areas with high concentrations of environmental burdens, such as landfills, industrial zones, and major transport corridors, a practice identified as "environmental racism" [1]. A critical dimension of this is transport injustice, where proximity to highways exacerbates public health crises, increasing risks of asthma and other respiratory ailments by 20-40%, while simultaneously suffering from a lack of accessible and affordable public transport, creating a "transport poverty" trap [2, 3]. Furthermore, a significant "green gap" is documented; affluent neighborhoods possess substantially more parkland and tree canopy, which is directly correlated with better physical and mental health outcomes, while deprived areas remain devoid of these essential amenities [4].

A paradoxical outcome of urban sustainability initiatives is identified. Municipal investments in greening, public transit, and brownfield rehabilitation, while environmentally beneficial, often act as catalysts for gentrification [5]. This leads to the displacement of long-term, lower-income residents, who, after enduring poor environmental conditions, are priced out of their improved neighborhoods. This creates a double burden: first, health impacts from a neglected environment, and second, the loss of home and community due to subsequent redevelopment.

The relentless expansion of megacities exacts a heavy toll on their most vulnerable inhabitants, perpetuating cycles of social and health inequality. The inequitable distribution of environmental goods and bads deepens existing social fractures and undermines the goals of sustainable and inclusive urban development.

Addressing the chasm of environmental differentiation requires conscious and targeted policy interventions. Key recommendations include conducting rigorous equity-focused impact assessments for all urban planning decisions, establishing robust affordable housing funds in revitalizing areas, prioritizing "green" investments in environmentally

deprived districts, and fostering genuine, meaningful participation of local communities in the planning processes [6]. Without such a foundational commitment to spatial and environmental justice, the future development of cities will continue to impose an unsustainable burden on those least able to bear it.

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BIOMEDICAL EDUCATION OF BELARUSIAN YOUTH AS AN ADAPTATION FACTOR DETERMINING THE WELL-BEING OF THE REPUBLIC

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A person, like any biological object, is under the influence and impact of numerous factors that come from living conditions and places of residence.

The processes occurring in the external environment equally affect all living organisms, and only the degree of their adaptation increases the chances of survival of some and dooms others to death. A person, as an intelligent creature, is by definition obliged to foresee all risks and be prepared for most of the unfavorable moments that arise throughout his life.

The very mechanism that will subsequently allow young people to avoid most problems of social and physiological orientation is obtaining the basics of medical and biological education, which will provide the opportunity to correctly navigate in a fairly aggressive environment. This knowledge, obtained by young people at the beginning of their lives, will allow them not only to avoid the risks of disruption of the physiological and psychological state, but also to help correctly navigate in choosing a healthy lifestyle for themselves and their immediate environment.

Keywords: medical and biological education, adaptation process, healthy lifestyle, young generation, infectious pathology, preventive measures.

Historically, people with a certain amount of biological knowledge are better adapted and feel more confident in the transition to independent life. There are many reports, both scientific and trivial stories from people's lives, indicating that young people who have had experience communicating in the biological spheres of human life adapt much more easily to society.

And, on the contrary, young people who have an insignificant level of biological awareness and a minimal amount of medical and biological knowledge have a much harder time adapting to independent life and have a harder time coping with even low levels of psychological challenges (problems).

In Belarus, a sufficient number of successfully functioning educational institutions have been created, which provide young people with the opportunity to obtain knowledge of various levels of complexity and focus. Biological, medical-biological and, specifically, medical education stand separately - which truly provide a high level of bio-focus in the adaptation processes of the period of entry of young people of the Republic of Belarus into independent life [1, 2].

All educational institutions of Belarus, without exception, in the programs for training specialists in the areas not mentioned above, have included, without fail, educational subjects that provide a certain minimum of medical and

biological knowledge. This knowledge allows young people of Belarus to feel confident in any situation that they have to face not only at the beginning of their lives, but also in subsequent periods [3].

One of the key educational institutions that has included medical and biological subjects in its educational programs is the UO "International Ecological Institute named after A.D. Sakharov" of the Belarusian State University, where every year, along with specialist diplomas, a large number of young people receive a start in life, who become worthy members of Belarusian society.

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PSYCHOEMOTIONAL STRESS AND ITS EFFECT ON THE CHILD'S BODY

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The relevance of childhood stress as a global problem in the Republic of Belarus and around the world is considered.

Keywords: stress, psychoemotional stress, childhood stress.

Stress (from the English word "stress" meaning "pressure" or "tension") refers to a person's stressed state that occurs in response to extreme external factors.

Stress is one of the most pressing problems of our time. For a long time, stress has been considered a problem primarily faced by adults. But today, stress is spreading more and more to the children's world. Children, just like adults, suffer from excessive physiological and informational stress, as well as psychological pressure that they cannot cope with. [2].

Types of childhood stress:

1) Physical stress. It is manifested by the body's reactions to external factors.

2) Psychological (emotional, nervous) stress. It is manifested by behavioral and emotional reactions to stimuli.

Stress itself is very important for survival. Short-term stress in small doses helps to activate a person's reserve capabilities, promotes the development of new reactions, educates and ensures progress and evolution [2].

Prolonged exposure to stressful situations associated with constant negative experiences, on the contrary, "depletes" the body, causes impaired body functions, worsens the psycho-emotional state, and also gives rise to and progression of various diseases in adulthood: autoimmune diseases, allergies, bronchial asthma, chronic back pain, cardiovascular diseases, diabetes mellitus, migraines, obesity, depression, and personality disorders [1].

Regardless of the cause, childhood stress is a growing problem. The prevalence of psychosomatic disorders in children and adolescents ranges from 10 to 25%. In the Republic of Belarus, every third child constantly experiences psychoemotional stress [3].

Prevention and treatment of stress are based on increasing the adaptive (adaptive) capabilities of the child. To do this, it is necessary to actively identify children who cannot cope with situations in their lives [4].

Effective treatment of childhood stress is possible only with a comprehensive and long-term approach aimed at changing the lifestyle of both the child and his family members. Stress therapy is based on stress prevention measures

(diaphragmatic breathing, regular exercises that develop flexibility, relaxation that replaces a child's active activity, an appropriate sense of humor and the ability to express their emotions), parental involvement and attention, regular physical activity, and adequate sleep [4].

Thus, understanding the early signs associated with the development of psychoemotional stress in children opens up opportunities for early prevention of stress and its complications.

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PSYCHOLOGICAL INFLUENCE OF CULTURE ON SEXUALITY

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This article describes the mechanisms by which the cultural environment influences the formation of human sexuality, as well as the impact of social norms in a cultural society on sexual behavior, development, and identity.

Keywords: sexuality, cultural influence, psychology

Human sexuality is not only a biological aspect, but also a social construct deeply rooted in cultural frameworks. It is social norms that determine the acceptability of certain sexual behaviors, identities, and their expressions.

Every culture has certain patterns of behavior, and deviating from them is subject to public condemnation. This is because people who grow up in a certain society unconsciously begin to imitate their surroundings. People who do not adopt the habits of their environment are perceived as antisocial. Thus, if in a cultural society where sex is taboo, someone begins to speak openly on this topic, many will feel discomfort, shame, and embarrassment [1].

In addition, cultural customs and social structures (patriarchal or matriarchal) influence what behavior (including sexual behavior) is characteristic of a particular gender, as well as awareness and willingness to discuss details of intimate health and sexual preferences. For example, in a strictly patriarchal society, female sexuality is expressed in gentleness and submissiveness, while male sexuality is expressed in confidence and dominance. Individuals who do not conform to the gender stereotypes characteristic of a given society are subject to social condemnation. For example, a timid and shy guy is likely to be called a loser, while an overly open and confident girl is likely to be called vulgar [2].

The formation of cultural norms regarding sexuality depends on a variety of social factors surrounding the individual. Among these factors are: the influence of family and environment, the media, peers, etc. The immediate environment creates an idea of what is “right” and “beautiful,” the media broadcasts generally accepted standards of sexuality and attractiveness, which are often practically unattainable, and the community establishes unspoken rules of behavior and expectations regarding sexual behavior. The availability of information, level of education, and historical context have an equally strong influence. The combination of these factors, as well as the degree of influence of each of them, combined with personal experience and individual perception, forms a unique perception of sexuality and attitude towards it in each person [3].

Thus, it is difficult to overestimate the psychological influence of culture on the formation of sexuality. However, despite the foundations of society, this topic should not be avoided, because open discussion will allow us to expand the boundaries of the norm.

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SYSTEMATIC PATTERN OF EXCLUSION: ENVIRONMENTAL AND HUMANITARIAN ETHICS IN THREE DECADES OF THE NICARAGUA CANAL

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The Nicaragua Interoceanic Canal project, systematically reactivated between 1998 and 2018 under three consecutive governments, represents a paradigmatic case of the subordination of indigenous rights and environmental regulations. This article examines the pattern of exclusion of the Rama and Kriol communities, demonstrating how this project operates as a "state of exception" that suspends constitutional guarantees without complying with Free, Prior, and Informed Consent or conducting socio-environmental impact studies.

Keywords: Nicaragua Canal, ethics, exclusion, indigenous rights.

The Rama and Kriol peoples inhabit ancestral territories in Nicaragua's South Caribbean Coast Autonomous Region, where they have developed livelihoods based on fishing, agriculture, and sustainable use of forest resources. The interoceanic canal project would cross 52% of their titled territories, Lake Nicaragua, and the Indio Maíz Biological Reserve. The removal of millions of cubic meters of sediment poses irreversible risks, ecosystem disruption, and loss of biodiversity. For indigenous communities, forced displacement would likely mean cultural and linguistic extinction, making it imperative to examine the fundamental ethical implications of this case. [3]

Nicaragua has a formally progressive legal framework: the 1987 Constitution recognizes indigenous territorial rights; Law No. 28 establishes regional autonomy; Law No. 445 regulates communal property; ILO Convention 169 requires prior consultation; and Law No. 217 requires environmental impact assessments. However, the three canal initiatives reveal a structural contradiction between legislation and institutional practices that systematically suspend these guarantees. [1]

During the administration of Arnoldo Alemán, Presidential Order No. 68-98 of 1998 created the Multi-Sectoral Commission for the Dry Canal without prior consultation with indigenous communities, setting an institutional precedent of omission despite the fact that Nicaragua had ratified ILO Convention 169 eight years earlier. In 2002, under the government of Enrique Bolaños, Presidential Order No. 160-2002 established the Working Commission for the Interoceanic Grand Canal, maintaining the same structure of exclusion towards these communities. [3-1]

The most serious manifestation of this occurred in 2013 when the National Assembly approved Law No. 840 under the presidency of Daniel Ortega, granting Hong Kong Nicaragua Development (HKND) a 50-year concession with extraordinary faculties: accelerated expropriation, unrestricted use of natural resources, and explicit exemption from prior consultation. This continuity under governments of different political persuasions shows that the pattern transcends partisan politics and responds to institutional logic where economic development is seen as a state prerogative that doesn't need the consent of the affected populations and overrides the ordinary legal framework. [2]

Comparative analysis confirms the existence of institutional continuity in the exclusion of indigenous peoples, regardless of government ideology. The "national interest" has consistently functioned as a mechanism for legitimizing regulatory violations, creating a "state of exception" where constitutional guarantees are suspended indefinitely under economic justification. These facts expose an institutional weakness between the formal recognition of rights and the institutional capacity to enforce them in the face of economic interests.

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ETHICS OF ARTIFICIAL INTELLIGENCE IN SCIENTIFIC RESEARCH: THE BOUNDARIES OF THE SCIENTIST'S RESPONSIBILITY

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Artificial intelligence (AI) technologies are being increasingly integrated into scientific practice, transforming research methodologies, data analysis, and even the very process of knowledge generation. In the context of Belarus, where the adoption of AI in science is still in its early stages, the question of the scientist's ethical responsibility becomes especially acute. Drawing on international surveys (including Nature, 2023), national statistical data, and philosophical frameworks developed by Hans Jonas, Karl Popper, and Michel Foucault, this article demonstrates that responsibility for scientific conclusions derived with the aid of AI cannot be delegated to algorithms.

AI-based technologies are reshaping established practices across all spheres of human activity, and science is no exception. According to a 2023 survey by the journal Nature, more than a quarter of scientists already using AI in their research expect this technology to become an indispensable part of their discipline within the next decade, while an additional 47% consider it "highly useful".

The integration of AI into the scientific sphere remains at an initial stage in Belarus. Data from the National Statistical Committee of the Republic of Belarus indicate that in 2023, only about 4% of research organizations and 7% of universities officially employed AI-based solutions in their activities. However, as in other countries, these figures reflect only institutional-level adoption and do not account for the individual use of AI tools by researchers themselves – for example, for literature review, processing experimental data, or preparing manuscripts.

This gap between official statistics and actual practice creates an ethical "grey zone": when a scientist uses AI outside the framework of approved institutional protocols, uncertainty arises regarding authorship, reliability, and accountability. Under these conditions, philosophical reflection on the moral foundations of scientific activity in the age of algorithmic reasoning becomes particularly crucial.

One of the central ethical challenges is the opacity – or "black box" nature – of many AI algorithms. As Mittelstadt note, complex machine learning models often do not allow users to trace the logical pathway from input data to output conclusion. This contradicts a core requirement of the scientific method: reproducibility and justification.

Karl Popper emphasized that a scientific hypothesis must be falsifiable. If a researcher cannot explain why an AI arrived at a particular conclusion, how can that conclusion be subjected to critical scrutiny? In the context of limited resources in Belarusian scientific laboratories, the temptation to rely on "off-the-shelf" AI solutions is strong – but it is precisely here that ethical risk emerges: the substitution of understanding with blind trust in technology.

Hans Jonas, in his work The Imperative of Responsibility, argued that in the age of advanced technologies, ethics must be oriented toward future consequences. In the Belarusian scientific context – where formal AI ethics committees have not yet been established – the personal responsibility of the researcher takes on particular significance.

AI lacks moral agency; it is incapable of reflection, remorse, or repentance. Therefore, even if an error stems from an algorithmic malfunction, the human researcher remains responsible for publishing unreliable results. Attempts to claim "the AI did it" constitute ethical evasion, which is unacceptable in the scientific community.

The issue of authorship is especially pressing amid the growing number of publications involving generative AI models. The Committee on Publication Ethics (COPE) explicitly states that AI cannot be listed as a co-author, although its use must be disclosed.

Currently, Belarusian universities and research institutes lack unified methodological guidelines for handling such cases. This creates a risk of violating principles of intellectual integrity. Michel Foucault reminded us that authorship is not merely a name beneath a text but an ethical stance tied to one's willingness to be accountable for what is said. Delegating this stance to a machine undermines the very foundations of scientific communication.

AI models are trained on datasets that often reflect dominant scientific paradigms. This may lead to the marginalization of local research traditions, including Belarusian ones–for instance, in the humanities or socio-economic sciences.A researcher who employs AI without critically assessing its cultural and linguistic assumptions risks reproducing epistemic inequality. From the perspective of John Rawls' theory of justice, the scientific community should strive to develop inclusive, critically reflective approaches to AI use.

The integration of artificial intelligence into science opens new opportunities but simultaneously poses complex ethical questions for researchers. The answers cannot be purely technical – they require philosophical reflection, the updating of normative frameworks, and, above all, the strengthening of a culture of personal responsibility. While official institutions are only beginning to consider the regulation of AI, it is ultimately individual researchers who determine whether this technology becomes a tool for progress or a source of new crises of trust. As Hans Jonas wrote, "Responsibility is a duty toward the future." In the age of AI, this duty rests upon every scientist.

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THE PHENOMENON OF CONFLICT

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This paper examines the main types of conflicts, their causes and dynamics, as well as the psychological mechanisms that determine the behavior of conflict participants. Special attention is paid to methods and methods of conflict resolution, including constructive approaches such as negotiation, mediation and arbitration. Various strategies of behavior in conflict situations are analyzed, such as cooperation, compromise, avoidance, and competition.

Keywords: conflict; methods of solution; strategy; personality behavior.

Conflicts are an integral part of human interaction and can occur in various forms. The main types of conflicts include personality conflicts that arise between individuals due to differences in personality characteristics, values, or

opinions. Group conflicts occur between teams or organizations and can be caused by competition for resources or differences in goals. Social conflicts arise at the societal level and may be related to cultural, economic, or political factors. Conflicts of interest arise when two parties have opposing interests or goals.

The causes of conflicts can be diverse, including communication barriers that lead to misunderstandings and erroneous conclusions. Differences in values and beliefs can also become a source of disagreement, especially when the parties to the conflict have different views on important issues. Competition for limited resources such as time, money, or attention can cause conflicts between individuals or groups. In addition, high levels of stress and pressure can exacerbate conflicts and reduce participants' ability to engage in constructive dialogue.

The dynamics of a conflict describes its development and changes over time. There are usually several stages: the pre-conflict stage, when the prerequisites for conflict arise; the escalation of the conflict, when the parties begin to actively express their differences; the crisis stage, when the conflict reaches its peak; and conflict resolution, when the parties begin to look for ways out of the situation.

Psychological mechanisms play a key role in how participants respond to conflict. Cognitive distortions can make it difficult to objectively perceive a situation, and emotional reactions such as fear, anger, or resentment affect participants' behavior. Belonging to a certain group can increase the confrontation between the parties.

There are many conflict resolution methods, including negotiation, mediation, and arbitration. Negotiations are a process of discussing the interests of the parties in order to reach a mutually acceptable agreement. Mediation involves the involvement of a third party to help find a solution to a conflict, whereas arbitration involves a binding decision by a third party.

Constructive approaches to conflict resolution are aimed at turning conflict into an opportunity for growth and improvement of relations. These include cooperation, in which the parties work together to achieve a common goal; compromise, where each side makes concessions; avoiding conflict in situations that do not require immediate intervention; and competition, when one side tries to impose its opinion on the other.

The study of conflicts and their resolution methods is an important area of psychology and social sciences. Understanding the types of conflicts, their causes and dynamics allows us to develop effective strategies for their management. Constructive approaches not only help to resolve differences, but also contribute to improving mutual understanding and cooperation between participants.

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THEORETICAL BASIS OF NATURAL SCIENCE EDUCATION OF MODERN YOUTH IN BELARUS

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Natural science education is a term that arose as a result of the purposeful systemic unification of biological sciences. In essence, the process of forming such an educational enclave is dictated by the modern development of human society, which is interested in the well-being of its presence on Earth.

Evolutionary processes that have changed the intellectual needs of people accordingly could not but affect all areas of educational processes. This happened due to the successful development of natural sciences, as the most formed in the 19th century, and replaced "natural history" and "natural science". Natural science education is aimed at forming a

holistic picture of the world, a scientific worldview, an idea of the unity and diversity of the properties of living and inanimate nature; environmental and technical knowledge. Studying the process of forming natural science education, its improvement and practical use is extremely relevant.

Keywords: natural science education, ecology, environmental education, environmental conservation, a set of academic disciplines.

According to the interpretation in the dictionary of education and pedagogy, natural science education as a term is presented as a purposeful process of upbringing and training in the interests of a person, society and the state, aimed at forming a scientific worldview, an idea of the unity and diversity of the properties of inanimate and animate nature. It is one of the components of general education, uniting a set of academic disciplines that set out the basics of scientific knowledge about nature.

The evolution of civilization with radical transformations of thinking and intellect gave birth to the evolution of natural science and natural science educational reality. The joint development of natural science and the natural science educational system gives new spheres and laws of development, gives rise to educational problems and new ways of solving them.

The last decades have attracted attention by the change in the natural and climatic balance. All biological objects suffer from these changes. Only people with deep knowledge and who have studied the processes occurring in the world are able to analyze the processes occurring in the natural and social environment of human society.

Natural sciences ("nature" or nature) are sciences that study nature (understood in a broad sense as the material world of the Universe) [1]. Many branches of natural sciences are united in a system called natural science. Even more systems of sciences and scientific directions are united in the sphere of natural science education. It covers a set of academic disciplines that set out the foundations of scientific knowledge about nature, which provides for two main goals: a) the formation of a scientific picture of the world and an adequate understanding of the world; b) the preparation of a theoretical foundation for the successful study of specialized disciplines in the field of vocational education, preparing workers for industrial and agricultural production [2].

In the course of our research, we analyzed the process of teaching students natural sciences in the context of the modern information system of education at the UO "MGEI named after A.D. Sakharov" of BSU. For this, it was necessary to: 1) analyze the organization of the educational process and students' research work; 2) identify the level of students' natural science competence; 3) identify the main problems affecting the quality of education.

The methodology of the study was based on numerous reports from researchers, politicians, and teachers on the level of knowledge in the natural sciences. Theoretical analysis of psychological, pedagogical, and scientific and methodological literature; methodological analysis of curricula; academic performance documents; modeling method; pedagogical observation; expert assessment; methods of mathematical and statistical processing.

Our research has shown that students have a fairly high level of knowledge in biological and environmental subjects.

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ENVIRONMENTAL LITERACY OF SCHOOLCHILDREN IN ADDRESSING THE SUSTAINABLE DEVELOPMENT GOALS

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The paper assesses the environmental literacy of schoolchildren in the context of achieving the Sustainable Development Goals. The priority Sustainable Development Goals for schoolchildren in the Grodno region and Minsk have been identified.

Keywords: sustainable development goals, environmental education.

The development of students' environmental literacy is a vital component of the educational process. Environmental literacy is a key element of education for sustainable development, which encompasses the interaction between the environment and human activity to ensure the preservation of resources for future generations. Cultivating students' environmental knowledge, skills, and motivation to engage in solving ecological challenges is achieved through the formation of personal environmental culture, expressed in practical actions and awareness-raising efforts.

The goal of environmental literacy is to cultivate an educated and responsible citizen capable of making informed decisions and interacting with the environment in a sustainable and balanced manner [1].

The target groups included students from Ivye Secondary School (Ivye, Grodno Region) and School No. 165 in Minsk. The aim of the study was to explore students' perceptions of the Sustainable Development Goals (SDGs) and their willingness to contribute to their achievement. Following extracurricular activities, students completed assignments in which they identified the most relevant SDGs and wrote essays titled "I advocate for the achievement of the SDGs," proposing mechanisms for their implementation.

Students from School No. 165 in Minsk identified the following SDGs as priorities: Goal 1 – No Poverty (16%), Goal 16 – Peace, Justice and Strong Institutions, Goal 10 – Reduced Inequalities, Goal 3 – Good Health and Well-being (11%), Goal 2 – Zero Hunger, and Goal 4 – Quality Education (9%).

Students from the school in Ivye, Grodno Region, identified the following Sustainable Development Goals (SDGs) as priorities: Goal 3 – Good Health and Well-being (68%), Goal 4 – Quality Education (59%), and Goal 1 – No Poverty (50%).

In both groups, the priority Sustainable Development Goals (SDGs) were Goal 1 – No Poverty and Goal 4 – Quality Education. Students' selection of these goals reflects their perceived social relevance and importance for society.

In their essays, students demonstrated personal engagement with the challenges of achieving the Sustainable Development Goals (SDGs). The most frequently chosen goals were Goal 3 – Good Health and Well-being (14.1%–18%), Goal 4 – Quality Education, Goal 13 – Climate Action (12%), Goal 1 – No Poverty (10.7%), Goal 11 – Sustainable Cities and Communities (12.4%), and Goal 12 – Responsible Consumption and Production (9%).

It was found that the level of environmental literacy among students is relatively high, providing a solid foundation for the further effective development of students' environmental competencies in addressing the Sustainable Development Goals (SDGs).

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VULNERABILITY AS A PHENOMENON OF PSYCHOLOGICAL STRENGTH

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The article analyzes the concept of vulnerability as a phenomenon from the perspective of psychology and philosophy.

Keywords: vulnerability, psychology, philosophy.

Vulnerability is considered a fairly broad concept, and the term can be used in a variety of contexts. In its most general sense, vulnerability is a completely natural state of young children, baby animals, and other creatures who are unable to care for themselves. Typically, this type of vulnerability is easily overcome – it's a matter of time, growth, and development.

Vulnerability is a state of insecurity in which a person is especially susceptible to the influence of threats or harmful experiences, and the likelihood of a negative outcome increases significantly. Vulnerability can give rise to anxiety, worry, fear, apprehension, and foreboding associated with the possibility of experiencing harm or damage.

All people experience some vulnerability in the context of disasters and other types of traumatic events. Vulnerability can be described as a distressing feeling of being unable to avoid a threat, having difficulty coping with its impact, or being unable to recover from a traumatic incident. Some individuals recover from trauma quite quickly and effectively cope with its negative consequences, while others experience long-term effects, such as post-traumatic stress disorder and other mental health problems [2].

In the common consciousness, vulnerability is traditionally associated with weakness and an inability to self-control. However, modern philosophical and psychological concepts interpret it as a fundamental condition of human existence and an important resource for personal development.

Existential philosophy emphasizes the inevitability of human finitude and limited control over life's circumstances. Recognizing one's own limitations not only does not devalue the individual, but also fosters genuine freedom of choice: a person who accepts their vulnerability understands responsibility for the decisions they make. In this context, vulnerability is not a flaw, but an ontological given that enables one to attain existential authenticity.

From a psychological perspective, research by B. Brown and her followers shows that a willingness to acknowledge one's own weaknesses positively correlates with levels of trust in interpersonal relationships, a subjective sense of resilience to stress, and a reduction in manifestations of internal conflict. Accepting vulnerability narrows the gap between the idealized self-image and actual emotional experiences, which contributes to the development of psychological integrity.

Although the term "vulnerability" often carries negative connotations, psychology is seeing a growing appreciation for this concept in the context of human qualities – and many specialists recognize that vulnerability can be useful and beneficial. According to existentialist theory, vulnerability is an integral part of the human condition. While vulnerability indicates the likelihood of experiencing pain, it also implies a greater sensitivity to experiencing life in its fullness [1].

Thus, vulnerability can be viewed as a complex phenomenon, combining existential and psychodynamic aspects. Philosophically, it reveals the depth of human existence, and psychologically, it provides adaptive mechanisms for maintaining resilience and building trusting relationships.

Therefore, personal strength lies not in the denial of vulnerability, but in the ability to integrate it into one's experience. Consciously accepting vulnerability fosters not fragility, but inner resilience, making this phenomenon key both to the philosophical analysis of human existence and to psychological practice.

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DEVIANT BEHAVIOR

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The article discusses human deviant behavior, which refers to actions that contradict the generally accepted moral norms and rules of behavior in society. This behavior is influenced by a combination of biological, psychological, and social factors. Studying the factors that contribute to deviant behavior and the characteristics of deviant individuals is an important task in psychology, as it aims to understand and address this type of behavior.

Keywords: deviant behavior, moral norms, causes of deviant behavior, ways to prevent deviant behavior.

To prevent deviant behavior, it is important to understand the factors contributing to its development. There are many factors influencing deviant behavior, and most often they act in a complex. These factors are often divided into several groups, such as biological factors, psychological factors, and social factors.

The biological causes of deviant behavior cover a wide range of factors, including genetic predisposition, anatomical features, and the functioning of the nervous system. Thus, the Italian physician Cesare Lombroso argued in his works that "congenital criminals" can have specific physical signs, such as the shape of the skull and other anatomical features. Another important aspect is the state of the nervous system. Organic brain lesions, both congenital and acquired, and disorders in its functioning. One of the biological causes of deviant behavior can be seen in the work of hormones, or rather an imbalance (overabundance or lack) of hormones. The most striking example of this is an overabundance of the hormone testosterone, which can often lead to aggressive behavior towards others [1].

The psychological causes of deviant behavior are a complex set of factors that influence individual behavior and its deviations. One of the main characteristics influencing the manifestation of deviations from the norms of human behavior is temperament. It is noted that people with choleric traits may be more often affected by affective actions that are little or completely under the control of conscious regulation, since the formation of dominance occurs quite quickly. Melancholics are more likely than others to have communication problems, which become the foundation for problems with socialization. We emphasize that there are no pure types of temperament among people as such, but even the predominance of one of the types does not mean a direct tendency to deviation. It is also necessary to take into account the subjective experience or so-called traumatic experiences, that is, events and related experiences that negatively affect a person's mental health. These can be the loss of a loved one, natural and man-made disasters, experienced acute or chronic effects of stressors. Such traumas can consolidate deviant patterns of behavior in a person's experience, and they can cause irreparable harm that prevents a person from responding adequately to the surrounding reality [2].

Social institutions carry certain patterns of behavior in specific situations, generate social statuses and roles according to which a person should behave, as well as learn and apply various kinds of social norms. In the life of every person there are role models from which he takes an example, such people become bearers of moral and ethical standards, legal norms. These can be both close people and idols. If social institutions fail to cope with their function of socialization, reference groups for a person and other people carry negative, deviant patterns of behavior, norms and values, or do not have clearly defined norms and rules at all (it often manifests itself if a person lives in a dysfunctional family or an area with a severe criminal situation), then a person with a large It is more likely to behave in a deviant manner [3].

Thus, it should be mentioned that most people may be subject to deviant behavior. To minimize the likelihood of this phenomenon, it is extremely important to understand the full range of causes and take into account everything from genetic to socio-cultural. The ways to prevent deviant behavior include a healthy lifestyle and sports, which will reduce the susceptibility to nervous diseases. Also an important component for the formation of prosocial behavior is a high level of intellectual development. It promotes the assimilation of social norms and principles, the correct construction of activities and behavior.

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THE INFLUENCE OF EMOTIONAL STATE ON AN ATTACK OF GASTRITIS

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This article describes the mechanisms by which psychoemotional state influences the development of gastritis.

Keywords: gastritis, stomach, gastrointestinal tract, stress, psychoemotional state.

Gastritis is an inflammation of the gastric mucosa, leading to tissue degeneration and dysfunction. This condition is caused by an imbalance of protective and damaging factors in the stomach, which occurs as a result of infectious agents, aggressive chemicals, and diseases of other organs of the digestive system. However, the most underestimated factor influencing the development of this condition is an unstable emotional state.

The physiological mechanism by which emotional states influence the digestive system is explained by the close relationship between the nervous and endocrine systems. In response to stress, the adrenal cortex produces large amounts of adrenaline. This stress hormone promotes increased conductivity of smooth muscle synapses [1]. Overstimulation of the stomach wall muscles leads to spasms and impaired motility, which increases the time food remains in the stomach and, consequently, increases the exposure of the mucosa to aggressive gastric juice. Muscle spasms in the blood vessel walls reduce tissue oxygenation, leading to a decreased ability to resist alteration.

At the same time, the release of cortisol causes untimely secretion of hydrochloric acid, which increases acidity. This results in increased secretion of pepsin, which is most active at low pH values. These two factors dramatically increase the aggressiveness of gastric juice on the mucosal wall [2].

During prolonged stress, cortisol levels are constantly elevated, which leads to the activation of adaptive mechanisms. Several outcomes can occur: first, the tissue may be replaced by mucous connective tissue, which is less sensitive to hydrochloric acid (metaplasia). Extensive metaplasia can lead to gastric sclerosis, as the connective tissue is unable to perform the functions of the mucous membrane [3]. Second, with persistently elevated cortisol, the gastric glands become less sensitive to its levels and stop synthesizing hydrochloric acid in a timely manner, which can lead to digestive problems.

If the adaptive mechanisms are not activated and the inner lining of the stomach continues to be exposed to aggressive acid, there is a risk of developing a stomach ulcer or rupture.

In addition to the physiological consequences of stress, it can also affect an individual's behavior. Many people, experiencing constant psychological discomfort, tend to develop unhealthy habits to cope (smoking, drinking alcohol, stress eating), which also contribute to the development of gastritis.

For the prevention and successful treatment of gastritis, it is important not only to eliminate infectious and chemical factors but also to correct the emotional state. A combination of preventive measures, including psychotherapy, relaxation, and normalizing work and rest patterns, helps stabilize the nervous system and restore balance to the gastrointestinal tract.

Thus, emotional state is one of the determining factors in the development of gastritis. Psychoemotional overload not only creates favorable conditions for inflammation of the gastric mucosa but can also cause its recurrence, even with diet and medication.

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THE IMPACT OF THE MUNICIPAL SOLID WASTE CLASSIFICATION AND RECYCLING SYSTEM ON THE EFFICIENCY OF REGIONAL MATERIAL RECYCLING

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This paper explores the impact of municipal solid waste (MSW) classification and recycling systems on regional material recycling efficiency. By analyzing the operational logic of classification systems and their role in material recovery, it finds that standardized classification systems significantly reduce the difficulty of subsequent material sorting, increase the purity of recyclable materials, and lower recycling costs. Case studies from typical regions show that effective MSW classification can improve the recovery rate of key materials (such as paper, plastic, and metal) by 15%-30%. The research confirms that a sound MSW classification and recycling system is a core driver for enhancing regional material recycling efficiency, promoting circular economy development.

Keywords: Municipal Solid Waste; Waste Classification; Recycling System; Material Recycling Efficiency; Circular Economy

With the acceleration of urbanization, the output of MSW has increased sharply, bringing pressure on environmental governance and resource utilization. Regional material recycling, as an important part of the circular economy, relies heavily on the pretreatment of waste – among which MSW classification is the foundational link. A scientific classification and recycling system can connect waste generation and material reuse, directly affecting the efficiency of resource recovery.

Unclassified MSW contains a mixture of recyclables, hazardous waste, and kitchen waste, requiring a large amount of manual and mechanical sorting in the recycling stage. A standardized classification system (e.g., dividing waste into recyclables, kitchen waste, hazardous waste, and other waste) allows residents to complete preliminary sorting at the source. This reduces the workload of subsequent recycling facilities by 40%-60% and cuts down the time and labor costs of secondary sorting [1].

Impurities in unclassified waste (such as food residues mixed with paper) often lead to the degradation of recyclable materials or even make them unrecyclable. Source classification ensures that materials like plastic bottles and waste paper are collected separately, increasing their purity to over 90%. Higher purity not only improves the quality of recycled materials but also enhances the willingness of recycling enterprises to participate, forming a positive cycle of the recycling chain[1].

Conclusion: The MSW classification and recycling system has a direct and positive impact on regional material recycling efficiency. By optimizing the source pretreatment of waste, it reduces recycling costs, improves the quality and recovery rate of recyclable materials, and provides a reliable guarantee for the development of the regional circular economy. To further enhance efficiency, regions should strengthen the popularization of classification knowledge, improve supporting recycling facilities, and establish a supervision mechanism for the whole classification-recycling chain[2].

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SECTION 2
MEDICAL ECOLOGY

ENVIRONMENTAL IMPACT ON WOMEN'S REPRODUCTIVE HEALTH

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The paper examines the impact of environmental factors on the female body, including chemical pollution, stress, and urbanization. Special attention is given to the effects of endocrine-disrupting compounds and psycho-emotional stress on reproductive health. The mechanisms of physiological adaptation and the consequences of ecological disturbances are analyzed. The study emphasizes the need for comprehensive preventive measures aimed at preserving women’s health and improving quality of life under modern environmental conditions.Modern women live under constant exposure to a wide range of environmental factors that collectively determine their health, adaptive capacity, and reproductive potential. The female body demonstrates a high sensitivity to both external and internal influences due to its cyclical hormonal regulation and complex physiological mechanisms. Consequently, the impact of adverse ecological and social factors often manifests more strongly in women than in men.

The main external factors affecting women’s health include air and water pollution, exposure to toxic chemical Women's health, environment, endocrine dysraptors, stress, reproductive function, environmental factors, environmental pollution, women's healths, radiation and electromagnetic fields, noise, climate fluctuations, stress, and disruption of work–rest balance.

Environmental contamination with heavy metals, pesticides, phthalates, and other chemicals leads to toxin accumulation in tissues, metabolic imbalance, and dysfunction of the endocrine and detoxification systems.

Of particular concern are endocrine-disrupting chemicals (EDCs) that can mimic or block the action of natural hormones, affecting the synthesis of estrogen and progesterone. As a result, menstrual irregularities, decreased ovarian reserve, infertility, and pregnancy complications may occur.

Equally important are psychological and emotional stressors. Chronic stress, mental overload, fast-paced lifestyles, and lack of rest activate the sympathetic-adrenal system, increase cortisol levels, and disturb hormonal balance. Combined with environmental pressures, these factors contribute to immune suppression, fatigue, sleep disturbances, and emotional instability.

In recentyears, increasingattentionhasbeenpaid to the impact of socio-economic and urbanizationfactors on women’shealth. Life in largecities is accompanied by exposure to exhaustgases, a shortage of green spaces, noisepollution, and highpopulationdensity. Thesefactorscollectivelycreate a chronicstressbackground that contributes to the development of metabolicdisorders, obesity, and reducedreproductivefunction. The disruption of ecologicalbalance and the acceleratedpace of modernlife push the adaptivecapacities of the femalebody to their limits.

Minimizing the negative influence of the environment requires a systemic and interdisciplinary approach, which includes improvement of environmental conditions and control over air, water, and food quality; development of public ecological awareness and education; promotion of a healthy lifestyle and balanced daily routine; prevention and timely management of stress, as well as regular medical check-ups for women of reproductive age.

The influence of environmental factors on the female body is complex and multifactorial, affecting both physical and emotional well-being. Contemporary research clearly demonstrates that ecological and social conditions are closely linked to women’s reproductive health, hormonal balance, and quality of life. Preserving women’s health requires an integration of medical, social, and environmental measures aimed at creating safe living conditions and fostering a culture of prevention and ecological responsibility.

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LOW-MOLECULAR INHIBITORS FACTOR XII / XIIA

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The article presents a comparative analysis of physico-chemical and pharmacokinetic properties of low-molecular factor XII/XIIa inhibitors obtained using SwissADME resource. The study revealed differences in lipophilicity, solubility, ability to penetrate through biological barriers.

Keywords: factor XIIa, inhibitors, thrombosis, SwissADME, pharmacokinetics, lipophilicity.

Factor XII (FXII) is a serine protease, which plays an important role in the initiation of the internal blood clotting pathway, calliccrein-kinin system and complement system. Unlike other clotting factors, FXII deficiency in humans does not cause bleeding, making it a highly selective and safe target for anticoagulation therapy. Pathological activation of FXII on foreign surfaces (catheters, artificial valves), as well as biological polyanions (extracellular traps of neutrophils, polyphosphates of platelets) contributes to the development of venous thrombosis, ischemic stroke and inflammatory processes. In this connection, the current task is to find and characterize effective FXII/FXIIa inhibitors [1]. Currently, the main classes of inhibitors being developed are antibodies, peptides and, to a lesser extent, low-molecular compounds with potential benefits in terms of oral bioavailability and low synthesis costs.

The object of the study was four low molecular weight inhibitors of FXIIa selected from the PubChem database based on screening data ($IC_{50}<$ μmol): 1-(4-bromoenzyl)-1H-1H-1,2,3-benzenitriazole (1), 1-(4-chlorobenzyl)-1H-benzenitriazole (2), 5-amino-3-(pyridin-3-yl)-1H-1,2,4-triazol-1-ylanone (3) and 1-(4-chlorobenzoyl)-3-pyridine-3-yl 1H-1,2,4-triazole-5-amine (4). The SwissADME web resource was used for a comprehensive characterization, allowing to predict key physico-chemical descriptors (molecular mass, TPSA, Log P, number of rotational bonds, hydrogen bond donors/acceptors) and pharmacokinetic profiles (HIA permeability, CYP inhibition, P-gp substrate, synthetic availability).

Analysis of physico-chemical properties revealed significant differences between the compounds. Compound 1 had the highest molecular weight (302.13 g/mol) and the highest TPSA value (139.55 $Å^2$), indicating its high polarity and potentially low permeability through cell membranes. In contrast, compound 2 was characterized by the lowest molecular weight (257.67 g/mol) and the lowest TPSA (47.78 $Å^2$), which correlates with its predicted high capacity for passive diffusion. All compounds conform to Lipinsky's «Rule five» and have identical FABS (0.55) bioavailability assessment, assuming moderate oral bioavailability.

The evaluation of lipophilicity by consensus Log P showed that compound 2 is the most lipophilic (2.94), while compound 1 is the least (0.92). The high lipophilicity of compound 2 predicts its good absorption in digestive tract. An important pharmacokinetic difference was the ability of only compound 2 to pass through the blood-brain barrier, which may open prospects for treatment of thrombotic complications in the cerebrovascular system.

All compounds, except compound 1, are not P-gp substrates, which is a favorable sign as it prevents the active removal of the drug from the cells and helps maintain therapeutic concentration. In the context of drug interactions, compounds 2, 3 and 4 have shown potential to inhibit CYP1A2 and/or CYP2C19 isoenzymes, which requires special attention in combination therapy [2].

The study carried out allowed a comparative characterization of four promising low-molecular inhibitors of FHIIa. Based on a comprehensive analysis of the physico-chemical and pharmacokinetic parameters, 1-(4-chlorobenzoyl)-1H-benzetriazole (compound 2) has been identified as the most optimal candidate for further pre-clinical studies. It combines

a favorable lipophilicity profile, ability to penetrate through HIA and absence of substrate for P-gp. The data obtained serve as a theoretical basis for a targeted synthesis and subsequent experimental study of the efficacy and safety of these compounds as new antitumorous agents.

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QUANTUM-CHEMICAL MODELING OF (R)-2-AMINO-5-OXO-4-(5-PHENYLISOXAOL-3-YL)-4,5,6,7-TETRAHYDROCYCLOPENTA[B]PYRAN-3-CARBONITRILE

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Tetrahydrocyclopentapyrans are heterocyclic compounds with interesting structural features and exhibit a wide range of biological activities, including antiviral, antitumor, and antimicrobial activity[1,2,3]. Therefore, the study of tetrahydrocyclopentapyran derivatives is a relevant area of research in medicinal chemistry.

In this study, we aim to conduct quantum chemical modeling of tetrahydrocyclopentapyran to assess its interactions with biological life. We studied the electrical and geometric parameters of the compounds and also considered the possibility of their action on biological targets in real time.

Keywords: biological activity, FMO.

To determine the physicochemical properties and activity of the molecule, the ionization potential (1), electron affinity (2), global hardness (3), electronegativity (4), chemical softness (5), electrochemical potential (6), electrophilicity (7), and electron donor capacity (8) were calculated, electron acceptor capacity (9), total charge transfer (10)[4].

$\mathrm{IP} = -E_{HOMO}$, *(eV) (1),* $\mathrm{EA} = -E_{LUMO}$, *(eV) (2),* $\eta = \frac{IP-EA}{2}$, *(eV) (3),* $\chi = \frac{IP+EA}{2}$, *(eV) (4),* $\mathrm{S} = \frac{1}{\eta}$, *(eV) (5),* $\mu = -\frac{IP+EA}{2}$, *(eV) (6),* $\omega = \frac{\mu^2}{2\eta}$, *(eV) (7),* $\omega^- = \frac{(3*IP+EA)^2}{16*(IP-EA)}$, *(eV) (8),* $\omega^+ = \frac{(IP+3*EA)^2}{16*(IP-EA)}$, *(eV) (9),* $\Delta N_{max} = -\frac{\mu}{\eta}$, *(eV) (10)*

The results of the analysis of physico-chemical properties are shown in Table.

Table – Results of the FMO compound analysis

E_{HOMO} (eV)	E_{LUMO} (eV)	IP (eV)	EA (eV)	Eg (eV)	χ (eV)	η (eV)	S $(eV)^{-1}$	μ (eV)	ω (eV)	ω+ (eV)	ω- (eV)	ΔNmax
6.72	1.64	5.09	4.18	2.54	0.197	-4.18	3.44	1.67	5.85	1.65	6.73	1.64

DOS analysis shows that the band gap of the joint is 2.54 eV, and the total hardness (η) is -4.18 eV (table). Based on the data obtained, it can be concluded that the molecule has a very high biological activity.

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DYNAMICS OF MORBIDITY AND MORTALITY OF PATIENTS DIAGNOSED WITH BREAST CANCER IN THE REPUBLIC OF BELARUS

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There is a steady trend of increasing breast cancer incidence in Belarus from 2012 to 2021. Significant regional disparities have been noted, with higher rates in cities and certain regions. Meanwhile, the stability of the mortality rate indicates an improvement in diagnostics and treatment effectiveness.

Keywords: breast cancer, mutations, incidence dynamics.

Breast cancer is a malignant tumor of glandular tissue that develops as a result of a mutation, causing abnormally rapid cell division. These cell's form a tumor capable of invading neighboring tissues and creating secondary foci – metastases.

The purpose of this work was to analyze the morbidity and mortality of the population of the Republic of Belarus from breast cancer in 2012-2021.

There is a steady trend of increasing breast cancer incidence in Belarus. Analysis of data from 2012 to 2021 shows that the standardized incidence rate per 100,000 female population increased from 45.7 in 2012 to 52.7 in 2021.

There is a significant difference in the incidence rate between urban and rural populations, as well as between different regions of the country. The incidence rate is significantly higher in urban areas (80.7 per 100,000 female population in 2012 compared to 63.5 in rural areas), and this gap has persisted in subsequent years. Among the regions, the highest rates are observed in Gomel and Grodno regions, as well as in Minsk, while Brest and Minsk regions have relatively lower rates. This significant regional variation requires further investigation and identification of the underlying causes. This indicates the need to develop and implement specific preventive programs that are tailored to the specific needs of each region, taking into account the risk factors that are unique to each area.

Minor fluctuations in mortality rates with increasing incidence indicate improvements in diagnosis and treatment. Despite a significant increase in breast cancer incidence, the mortality rate remains relatively stable, with a slight increase from 23.7 in 2012 to 25.0 in 2021. This may indicate improvements in diagnosis, early detection, and treatment effectiveness, leading to a decrease in mortality rates.

The need for further research to identify risk factors and develop effective prevention and treatment strategies. The findings highlight the complexity of the breast cancer problem in Belarus. To develop effective prevention strategies and improve the cancer care system, further research is needed to identify risk factors, analyze the impact of socio-economic factors on disease incidence in different regions, and evaluate the effectiveness of existing prevention and treatment programs. Special attention should be given to understanding the causes of regional differences in disease incidence and developing targeted programs for areas with higher rates.

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RETROSPECTIVE ANALYSIS OF THE INCIDENCE OF DIABETES MELLITUS IN THE REPUBLIC OF BELARUS

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Abstract: A retrospective analysis of the incidence of diabetes mellitus among the population the Republic of Belarus for 2018-2023 was carried out. Throughout the entire period of the study, the average value of the proportion of diabetes mellitus in the structure of the incidence of endocrine pathology among the population of the Republic of Belarus was 77.5%. Dynamics were analyzed, growth rates were calculated and the main trends in population morbidity were identified based on available statistical data.

Keywords: diabetes mellitus, incidence, growth rates, dynamics, structure.

Diabetes mellitus is one of the global problems of our time. It ranks ninth in the ranking of the most common causes of death after cardiovascular and oncological diseases and consistently holds the first place among the causes of blindness and kidney failure [1, 2]. In the Republic of Belarus, the number of people with diabetes has increased in 3 times over the past 20 years.

Throughout the entire study period, the average proportion of diabetes mellitus in the incidence of endocrine pathology was 77.5%.

When analyzing the long-term dynamics (2017-2023) of general and primary morbidity of the population of the Republic of Belarus with diabetes mellitus in general and its individual forms a steady trend towards an increase in morbidity was noted. The only exception was the general and primary morbidity of the child population with type 2 diabetes mellitus (unclear dynamics).

The growth rates of diabetes mellitus were considered. In 2018, the growth rates in the prevalence of the disease per 100 thousand child population was 2.28%, and in 2023 – 5.30%. For the adult population, these parameters in 2018 and 2023 were 10.73% and 4.99%, respectively. The growth rate of primary morbidity per 100 thousand population was 8.53% in 2018 and -2.50% in 2023 for the child population. In the case of the adult population, this parameter was 12.47% in 2018 and 11.89% in 2023.

The average annual overall incidence rate for adults and children was 4998.43 and 164.88, respectively, per 100 thousand people. The annual trend indicator – 164.04 and 11.64 per 100 thousand adults and children, respectively. It is noted that the overall incidence of diabetes mellitus in the adult population exceeds the incidence in children by more than 30 times.

Polyneuropathies, angiopathies and preproliferative retinopathy accounted for the largest share in the structure of complications resulting from diabetes mellitus in the adult population.

In 2017 and 2023, the largest share in the structure of adult treatment methods was taken only by hypoglycemic oral medications (68.73 and 77.26 %, respectively); for the child population, combination therapy (54.6%) in 2017 and insulin therapy (97.69%) in 2023.

Among people with diabetes, group 2 people with disabilities account for the largest proportion (on average, 56.6% during the study period), group 3 people with disabilities account for an average of 33.81% and group 3 – 9.59%. More than 95% of all people with disabilities due to diabetes mellitus are adults in the republic.

Diabetes mellitus differs from all other endocrine diseases in the frequency of development and severity of complications. High damage to public health and significant economic costs for expensive treatment of complications, rehabilitation of patients and the disabled determine diabetes mellitus in many countries, including Belarus, as national priorities among the most important health problems. In the Republic of Belarus, for the treatment and prevention of diabetes mellitus, the state program "People's Health and Demographic Security" for 2021-2025 is currently being implemented, which will further reduce the number of cases.

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EFFECT OF TURMERIC EXTRACT FROM DIFFERENT MANUFACTURERS ON THE GROWTH OF COMMON BACTERIA

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As numerous studies have shown, the antibacterial activity of turmeric extracts and curcuminoids has a wide range of biological and pharmacological properties against various pathogenic and opportunistic microbes

Keywords: turmeric, curcuminoids, disco-diffusion analysis, Staphylococcus aureus, Escherichia coli.

Curcumin ((1E,6E)-1,7-bis-(4-hydroxy-3-methoxyphenyl)-hepta-1,6-diene-3,5-dione) is one of the main active ingredients of turmeric extract. Curcumin is a mixture consisting mainly of three hydrophobic curcuminoids, namely demethoxycurcumin (DMC), bisdemethoxycurcumin (BDMC), and curcumin in a ratio of 17:3:77 [1].

Curcumin's beneficial properties are significantly hampered by its color, poor water solubility, and low bioavailability. By its nature, the polyphenol is poorly absorbed when taken orally and has low bioavailability, partly due to its slow intestinal absorption rate and partly due to rapid metabolism (glucuronidation), which limits its clinical use.

Increasing bioavailability can lead to a reduction in the therapeutic dose of the main drug, decreased toxicity and side effects, as well as increased efficacy, decreased resistance, and reduced raw material requirements for drug production. Piperine is used as a well-known adjuvant to enhance the bioavailability of curcumin. Piperine enhances and supports the analgesic and anti-inflammatory effects of curcumin [2].

The test substances were aqueous and alcoholic extracts of pure Austrian, Uzbek, and Indian turmeric, as well as extracts of the previously mentioned turmeric mixed with black pepper in a 1:1 ratio.

The following antibiotics were used as control disks for the disk diffusion assay: ampicillin for E. coli and oxacillin for St. aureus. Ampicillin and oxacillin were selected based on literature data on the susceptibility of microorganisms to these antibiotics. Antibiotic activity was assessed based on the phenomenon of growth inhibition around the disk. The diameter of the growth inhibition zones around the disks was determined using a ruler, including the diameter of the disk itself.

Unlike aqueous extracts, ethanol extracts of turmeric demonstrated antibacterial activity against Staphylococcus aureus and E. coli in the overwhelming majority of cases, demonstrating the effective use of ethanol as a solvent.

The highest antibacterial activity was demonstrated by ethanol extracts of turmeric and a turmeric-pepper mixture produced in India. For Staphylococcus aureus, the inhibition zones averaged 20 and 23 mm in diameter, respectively. For E. coli, the zones were 18 and 30 mm.

Alcohol extracts of Uzbek turmeric demonstrated greater antibacterial activity against E. coli than against Staphylococcus aureus. The inhibition zones for E. coli were 17 and 14 mm in diameter, respectively. The inhibition zones for Staphylococcus aureus were 10 and 11 mm in diameter, respectively. Austrian turmeric demonstrated moderate activity against E. coli (inhibition zones of 10 and 15 mm). Staphylococcus aureus was relatively resistant to the Austrian powder (inhibition zones of 10 and 7 mm in diameter).

The use of piperine to enhance the antibacterial activity of turmeric extracts is currently inadvisable. The obtained results do not prove that the extracts increase their effectiveness against bacteria.

The study, the results of which are presented in this paper, is aimed at studying the antibacterial properties of alcoholic extracts of turmeric from various manufacturers, which in the future can be used as antibacterial substances in medicine and various industries, such as food and chemical.

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APPLICATION OF CHITOSAN-BASED BIOPOLYMERS IN MEDICAL ECOLOGY

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In modern medical ecology, special attention is given to studying the effects of biomaterials and nanostructures on human health and the state of the environment. One of the most promising areas is the use of naturally derived biopolymers. Chitosan exhibits high biocompatibility, non-toxicity, and pronounced sorption and antimicrobial properties. Thanks to these characteristics, chitosan is widely considered as a basis for the development of new medical and environmentally safe materials.

Keywords: chitosan, biopolymers, medical ecology, biosorption, nanomaterials, biosafety, biocompatibility, bioremediation.

Chitosan is obtained by partial deacetylation of chitin, a structural polysaccharide of the exoskeleton of crustaceans, arthropods, and fungal cell walls. Due to its cationic nature and ability to bind negatively charged molecules, it is actively used in medical ecology for the biosorption of toxicants, purification of biological fluids, neutralization of radionuclides, and creation of biocompatible nanomaterials.

At the molecular level, the amino groups of chitosan can undergo protonation at physiological pH values, enabling interactions with cell membranes, microbial walls, and heavy metal ions. These properties allow chitosan to be applied as a biosorbent in purification systems for biological media (blood, plasma) as well as in filtering systems for removing radionuclides and toxic compounds.

In medical practice, chitosan is used for biodegradable coatings of implants that accelerate tissue regeneration, antimicrobial dressings, hydrogels for wounds, and drug delivery carriers. At the cellular level, chitosan molecules can form thin biofilms that exhibit antiseptic and healing properties, accelerating tissue regeneration and preventing secondary infections. Thanks to its biocompatibility and degradability by lysozyme, chitosan materials do not elicit an immune response and provide accelerated tissue regeneration.

A promising direction is the development of chitosan nanocomposites with incorporated silver, copper, and zinc oxide nanoparticles, which exhibit prolonged antiseptic effects and provide localized therapeutic activity without systemic toxicity. Furthermore, chitosan is actively studied in tissue engineering, bioindication, and biomonitoring, where it serves as a carrier for biosensor systems that detect changes in internal organism parameters.

From an ecological perspective, chitosan is a safe alternative to synthetic polymers: it is biodegradable, does not form toxic metabolites, and is produced from seafood waste, making the process environmentally rational and economically advantageous. Current research focuses on optimizing chitosan’s molecular weight, degree of deacetylation, and nanostructuring, as well as chemical modification with functional molecules to expand its applications in medicine and ecology.

Thus, chitosan-based biopolymers form a scientific and technological platform for medical ecology, combining the properties of a sorbent, biomaterial, and ecological detoxifier. High chemical adaptability, antimicrobial activity, non-toxicity, and modifiability make chitosan a key component in the development of biocompatible and environmentally safe nanomaterials for medicine and sanitary biotechnology.

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PROPAEDEUTIC ASSESSMENT OF THE EFFECTS OF HOUSEHOLD TOXICANTS AND THEIR RELATIONSHIP TO THE GENERAL STATE OF HUMAN HEALTH

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The modern urbanized environment is saturated with household sources of toxic compounds that have a chronic effect on the human body. A propaedeutic assessment of their effects makes it possible to identify early functional disorders and prevent the development of intoxication.

Keywords: household toxicants, propaedeutic assessment, chronic intoxication, biomonitoring, free radical processes, endocrine disruptors, preventive medicine, chemical safety.

The modern urbanized environment is characterized by a high chemical load due to household sources of toxic compounds. The most common are organic solvents, aromatic hydrocarbons, aldehydes, phenols, phthalates, bisphenol A, synthetic surfactants, and heavy metals. They are part of paint and cleaning products, cosmetics, polymers, furniture and building materials, and are present in the air, dust, and water of residential environments [1].

Chronic exposure to toxicants causes cumulative effects, manifested by impaired metabolic, neurohumoral, and immunobiological processes. The routes of entry of toxicants into the human body include inhalation, percutaneous and oral, which contributes to their bioaccumulation. The pathogenetic mechanism of toxic effects is associated with the activation of free radical processes and an imbalance between the pro-oxidant and antioxidant systems, which causes lipid peroxidation, membrane damage and destabilization of mitochondria. The activity of xenobiotic biotransformation enzymes is inhibited and the functioning of liver cytochrome systems is disrupted. Endocrine-disrupting compounds interact with hormonal receptors, causing dysregulation of reproductive and metabolic functions, and heavy metals have a neurotoxic effect, disrupting hematopoiesis, as well as calcium and enzyme metabolism [2,3].

Epidemiological studies in recent years have indicated a significant correlation between prolonged exposure to low doses of household toxins and an increased prevalence of allergic, autoimmune, metabolic, and endocrine disorders [1].

Propaedeutic assessment of the effects of household toxicants is a system of early diagnosis of functional disorders that precede the clinical development of intoxication. It is based on the integration of laboratory, biochemical and instrumental research methods. The preventive direction of propaedeutic medicine involves minimizing contact with potential toxicants and developing a safe strategy for their use in everyday life. Effective measures are the replacement of chemically active agents with environmentally friendly analogues [3].

Thus, propaedeutic assessment of the effects of household toxicants is a key element of the preventive medicine system aimed at preventing chronic intoxication and related metabolic and neurohumoral disorders. The complex application of biomonitoring and functional diagnostic methods allows timely identification of risks and corrective measures before the formation of clinically pronounced diseases [1-3].

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EFFECT OF AIR POLLUTION ON DEVELOPMENT OF BRONCHIAL ASTHMA

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During the analysis of literature data, the influence of atmospheric air pollution on the state of human respiratory system and development of bronchial asthma was considered. The main mechanisms of influence of harmful substances on bronchi and their role in formation of inflammatory processes are disclosed. There is a need to improve the environmental situation as an important area for the prevention of respiratory diseases.

Keywords: bronchial asthma, air pollution, respiratory system, prevention.

Bronchial asthma is a chronic disease of the respiratory system, in which there is inflammation and narrowing of bronchi. The main manifestations of the disease are cough, wheezing and difficulty breathing. Among the factors contributing to the development of asthma, air pollution occupies a special place - one of the most serious environmental problems of our time [1,2].

Polluted air has an adverse effect on the respiratory organs. Harmful substances accumulate in the urban atmosphere: sulphur dioxide, nitrogen oxides, carbon monoxide, ozone, suspended particles of dust and soot. These compounds are formed during the combustion of fuel in transport and factories, as well as during operation of heating systems [1,3].

When breathing in polluted air, the smallest particles enter the respiratory tract and settle on the mucosa of the bronchi. As a result, irritation and inflammation develop, the work of the returned epithelium is disrupted, which cleans the respiratory tract from dust and microorganisms. The constant exposure of pollutants leads to an increased sensitivity of bronchi - they begin to respond with spasm even to minor irritants [4].

In addition to direct toxic action, polluted air amplifies allergic reactions. Dust particles and exhaust gases can bind to allergens, making them more active. This is especially dangerous for children and people with low immunity. Prolonged stay in a polluted environment contributes not only to the development of asthma, but also to the exacerbation of already existing forms of disease.

The problem is exacerbated in large cities, where concentrations of harmful substances in the air are well above safe levels. Residents of mega-cities more often complain of chronic cough, increased fatigue, feeling of lack of air. All this points to a direct link between the state of the environment and human health.

For prevention, it is important to reduce the amount of emissions into the atmosphere, develop environmentally friendly technologies, increase the number of green areas. It is also recommended to use personal protective equipment, monitor the quality of the air and limit outdoor exposure during periods of heavy pollution [1,2].

Thus, air pollution has a significant impact on the development of bronchial asthma. It causes inflammatory changes in the airways, exacerbates allergic reactions and increases the frequency of seizures. Improvement of the environmental situation, control of emissions and increase of ecological literacy of the population are important conditions for health preservation and prevention of bronchial diseases.

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PHYSIOLOGICAL ROLE OF HORMONES IN THE REGULATION OF METABOLISM AND PROTEIN SYNTHESIS

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Hormones serve as key regulators, integrating metabolic pathways and protein biosynthesis processes to maintain systemic homeostasis. This article reviews current understanding of the mechanisms of hormonal control over energy and protein metabolism. Particular attention is paid to the roles of insulin, glucagon, growth hormone, and thyroid hormones. Furthermore, it addresses the question of how environmental factors, such as endocrine disruptors, can disrupt these delicate mechanisms, posing new challenges for human health and ecosystems.

Keywords: hormonal regulation, metabolism, protein synthesis, insulin, glucagon, endocrine disruptors, environmental physiology.

The complex network of endocrine regulation serves as the foundation for maintaining metabolic equilibrium in the body. Hormones act as systemic coordinators, enabling adaptation to changes in nutrition, physical activity, and stress. In recent decades, it has become evident that external environmental factors can interfere with these processes, disrupting the delicate hormonal balance [1].

Current research confirms that the maintenance of energy homeostasis is achieved through the coordinated action of antagonistic hormones. Insulin, secreted by the β-cells of the pancreas, not only stimulates glucose utilization but also acts as a central regulator of anabolic processes, suppressing lipolysis and gluconeogenesis [2]. Its main antagonist, glucagon, activates the mobilization of energy substrates through cAMP-dependent signaling pathways in the liver.

Thyroid hormones (T3 and T4) regulate basal metabolic rate by affecting mitochondrial biogenesis and oxidative phosphorylation. Studies show that they activate nuclear receptors (TRα and TRβ), which act as transcription factors, modulating the expression of genes involved in metabolism [3]. Cortisol, in turn, facilitates adaptation to long-term stress by reprogramming metabolism towards catabolism and gluconeogenesis.

The anabolic effects of somatotropin (growth hormone) are mediated by insulin-like growth factors (IGF-1), whose synthesis is stimulated in the liver. The GH/IGF-1 complex activates the PI3K/Akt/mTOR signaling cascade, which is a central regulator of translation and protein synthesis in skeletal muscle and other tissues [4].

Insulin potentiates this process by enhancing amino acid uptake and initiating translation. Sex hormones contribute in a tissue-specific manner: testosterone enhances muscle protein synthesis through androgen receptors, while estrogens modulate gene expression in reproductive tissues.

In the modern environment, the classical view of hormonal regulation is now complemented by an understanding of the influence of anthropogenic factors. Chemicals known as endocrine disruptors (EDs), such as bisphenol A (BPA), phthalates, and certain pesticides, can mimic or block the action of natural hormones.

For instance, it has been shown that BPA can interact with estrogen receptors, disrupting lipid metabolism regulation and contributing to the development of insulin resistance [5]. Exposure to perfluoroalkyl substances (PFAS) is associated with impaired thyroid function, which can lead to shifts in basal metabolism and thermogenesis [1]. These environmental interferences create a constant background burden that disrupts the delicate mechanisms of hormonal regulation, potentially having long-term consequences for population health.

Thus, hormones form an integrated system that precisely calibrates metabolism and protein synthesis according to the body's needs. However, in the modern world, this system faces new challenges in the form of environmental chemical pollutants. Further research at the intersection of endocrinology and environmental medicine is necessary to develop strategies for protecting human health and the integrity of ecosystems from the consequences of hormonally-mediated disruptions induced by environmental factors.

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EFFECT OF SUGAR CONSUMPTION ON HUMAN HEALTH

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This article examines the effects of sugar on the human body, the risks associated with excess consumption, and suggests ways to reduce its intake in the diet.

Keywords: sugar, health, glucose, fructose, sucrose, metabolism

Sugar is an essential part of many people's diets. It adds flavor and pleasure to our lives, but excessive consumption can have serious health consequences.

Sugar is a general term for sweet, soluble carbohydrates, primarily simple sugars: glucose (the primary source of energy for cells), fructose (fruit, honey, corn syrup), sucrose (table sugar, glucose + fructose), and lactose (milk). It is found in both obvious sources (candy, cakes, soda, juices, sugary cereals) and hidden sources (bread, sauces, yogurts, processed foods).

Sugar has a number of negative health effects: it disrupts metabolism (glucose spikes, insulin resistance, fat accumulation, increased triglycerides/LDL), causes type 2 diabetes (insulin resistance, pancreatic dysfunction), increases the risk of cardiovascular disease (vascular inflammation, atherosclerosis, high blood pressure), leads to obesity (high calorie content, lack of satiety), causes dental problems (caries), worsens skin condition (glycation, collagen/elastin damage, acne), affects mental health (mood swings, depression, anxiety), and increases the risk of certain cancers.

To reduce sugar intake:

1. Read labels (pay attention to the sugar content of foods and drinks. Look for low-sugar or no-added-sugar alternatives)
2. Limit sugary drinks (replace with water/tea)
3. Cook at home (control ingredients)
4. Choose whole foods (fruits, vegetables, grains)
5. Use natural sweeteners (stevia, erythritol)
6. Be aware of hidden sources (sauces)
7. Increase fiber intake (slows sugar absorption)
8. Develop taste preferences (get used to less sweet things).

In conclusion, moderate sugar consumption is acceptable, but excess sugar leads to serious problems (diabetes, heart disease, obesity, tooth decay). Reducing sugar intake and switching to healthy alternatives improves health.

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ANTIBACTERIAL ACTIVITY OF BAZIRON AGAINST CUTIBACTERIUM ACNES (PROPIONIBACTERIUM ACNES) AND STAPHYLOCOCCUS EPIDERMIDIS

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The thesis presents the results of a study of literature data on the antibacterial activity of the drug for the treatment of acne Baziron AC, manufactured by Galderma laboratories, France, against Cutibacterium acnes (Propionibacterium acnes) and Staphylococcus epidermidis.The main component of baziron is benzoyl peroxide, which exhibits diverse biological activity, including bactericidal and bacteriostatic properties. The drug's antimicrobial activity, superior to that of topical antibiotics, and the absence of resistance make Baziron AC a recommended first-line treatment for papulopustular acne.

Keywords: Baziron, benzoyl peroxide, acne.

Acne (Acne vulgaris) is one of the most common chronic inflammatory skin diseases, affecting up to 90% of adolescents and young adults and a significant proportion of the adult population, primarily women. The disease negatively impacts patients' quality of life, causing psychoemotional disorders, social maladjustment, and the development of persistent cosmetic defects.[1]

Let's take a closer look at the antibacterial and anti-inflammatory properties of benzoyl peroxide.

1. Bactericidal efficacy (kills bacteria): Benzoyl peroxide is a powerful oxidizing agent. Upon contact with the skin, it breaks down, forming oxygen free radicals that literally "explode" the cell walls and membranes of Cutibacterium acnes (Propionibacterium acnes). This action leads to the rapid and immediate death of bacteria. Benzoyl peroxide acts as a non-specific antiseptic, meaning it can also kill other bacteria on the skin's surface.[2]

2. Bacteriostatic activity (inhibition of bacterial growth): The direct bacteriostatic activity of BPO is not its primary function, but its continued use creates an environment on the skin that is hostile to the growth of C. acnes. By destroying the bulk of bacteria, BPO prevents the remaining individual bacteria from actively multiplying and reaching numbers sufficient to cause inflammation. A key aspect associated with growth suppression is the lack of resistance. Unlike antibiotics, bacteria do not develop resistance to BPO, making it an exceptionally valuable agent for long-term therapy and relapse prevention.[2]

3. Keratolytic and comedolytic action: Benzoyl peroxide promotes exfoliation of dead skin cells and opens pores, preventing the formation of new comedones (blackheads and whiteheads).[3]

4. Anti-inflammatory action: Benzoyl peroxide is capable of moderately suppressing inflammatory reactions.[3]

Baziron also has side effects. All adverse reactions identified during clinical trials are associated with disorders of the skin and subcutaneous tissues. Dry skin, erythema, scaling (desquamation), and a burning sensation are very common; itching, pain, tingling, and contact dermatitis are common; Uncommon: allergic contact dermatitis. All adverse reactions are reversible with reduced frequency of use or discontinuation of treatment.

Baziron AC is a highly effective foundation drug for the treatment of moderate acne. Its antimicrobial activity, superior to that of topical antibiotics, and the absence of resistance development make it suitable for use as a primary treatment for grades II and III acne. The ACAP-glycerin system absorbs excess sebum, while the gradually released glycerin helps soften and moisturize dry and sensitive skin.

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INFLUENCE OF HEAVY METALS ON THE DEVELOPMENT OF ENDOMETRIOSIS

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The article focuses on studying the impact of heavy metals and dioxins on the development of endometriosis – a chronic condition affecting women of reproductive age. It examines ecological factors that can disrupt hormonal balance and immune function, potentially contributing to the progression of this pathology.

Keywords: endometriosis, heavy metals, dioxins, ecology, female fertility, hormonal disorders, cadmium, mercury, lead, arsenic.

Relevance of the topic: Endometriosis is one of the leading causes of female infertility, and its connection to environmental pollution requires special attention. The rise of industrialization and the accumulation of toxic substances in the body make this issue particularly significant for modern medicine and ecology.

Endometriosis is a condition in which cells from the inner lining of the uterus grow beyond its boundaries. These clusters of cells are referred to as lesions. During menstruation, endometriosis lesions become inflamed and increase in size, causing severe pain and discomfort. It is most commonly seen in women of reproductive age between 25 and 44 years. Without treatment, it can lead to infertility and the development of cancer.

Endometriosis arises from complex pathological processes occurring within the body. The disease disrupts the body's systems (endocrine, immune, etc.). The exact cause of endometriosis is unknown; however, there are several factors that may trigger this condition, one of which is environmental [2].

Heavy metals are naturally occurring and necessary for life, but they can become toxic as they accumulate in organisms [1]. The most common heavy metals include arsenic, cadmium, chromium, copper, nickel, lead, and mercury. UNEP considers mercury, lead, and cadmium to be the most dangerous heavy metals due to their ability to travel long distances through the air.

Based on known negative effects of heavy metals on female fertility, a Chinese study published in the journal Environmental Science in 2023 found that women with the highest levels of cadmium and lead in their blood were three times more likely to suffer from endometriosis compared to those with the lowest levels [3]. Similarly, endometriosis was five times more prevalent among women with the highest levels of arsenic and 13 times more common among those with the highest levels of mercury. Lead, arsenic, cadmium, and mercury are known endocrine disruptors. They have widespread effects on the reproductive system, including menstrual cycle irregularities, adverse pregnancy outcomes, DNA damage and mitochondrial dysfunction, and an increased risk of breast and endometrial cancer.

It is possible that heavy metals interact with estrogen receptors in the body, stimulating the growth of endometriosis-like cells outside the uterus and generally worsening endometriosis symptoms.

The effects of the dioxin 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) have also been studied. Experiments on primates showed that TCDD affects the reproductive system, increasing the prevalence and severity of endometriosis. Further animal studies indicated that dioxins and dioxin-like compounds could induce this disease. Research on rodents supports the likelihood that environmental pollutants may play a role in the pathophysiology of endometriosis. Dioxins can accumulate in the body over long periods and affect the immune system, hormonal balance, and other biological processes [4]. Some studies have shown that women exposed to dioxins have an increased risk of developing endometriosis.

Thus, exposure to heavy metals and dioxins may play a significant role in the pathogenesis of endometriosis. These substances disrupt hormonal balance, immune mechanisms, and reproductive function, contributing to the development and progression of the disease. Given the increasing environmental burden, it is important to consider the impact of toxicants when diagnosing and preventing endometriosis.

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ALYSIS OF DISEASE-FREE SURVIVAL IN PATIENTS WITH DIFFERENT MOLECULAR-BIOLOGICAL SUBTYPES OF BREAST CANCER

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In this study, clinical data from 124 patients with a confirmed molecular-biological subtype of breast cancer, as well as the stage and degree of tumor differentiation, were analyzed. A comparative assessment of disease-free survival among patients with different molecular-biological subtypes of breast cancer was carried out, and it was found that no statistically significant differences were observed for this parameter.

Keywords: breast cancer, disease-free survival, immunohistochemical method, luminal A, luminal B (Her-2−), luminal B (Her-2+), Her-2 positive, triple-negative, molecular-biological subtype.

Breast cancer (BC) is a heterogeneous disease and one of the major challenges of clinical oncology [1]. According to the Belarusian Cancer Registry, the annual increase in BC incidence is 1.2–1.5%, making it the most common oncological pathology among women. In modern oncology, five molecular-biological subtypes are used for diagnosis and treatment planning: luminal A is characterized by high expression of estrogen (ER) and progesterone (PR) receptors, lack of Her2/neu expression, and low Ki-67 expression (<20%); luminal B (Her-2−) is defined by the absence of Her-2/neu expression combined with either lack of PR expression or elevated Ki-67 (>20%); luminal B (Her-2+) is characterized by decreased expression of ER and PR (<20%) and overexpression of HER2 receptors; Her-2 positive (non-luminal) subtype demonstrates negative ER and PR expression, positive Her-2/neu expression, and any level of Ki-67; triple-negative subtype is defined by lack of ER, PR, and Her-2/neu expression and overexpression (>50–90%) of Ki-67 [2].

The study material consisted of clinical data and tumor tissue from 124 female patients with BC aged 27–85 years who received treatment at the N.N. Alexandrov National Cancer Centre of Belarus.

According to the results of previously conducted immunohistochemical studies, patients with breast cancer were divided into five molecular-biological subtypes. For each group, tumor stage and disease-free survival were analyzed.

In patients with the luminal A subtype (33.9% of cases), the stage distribution was as follows: stage I – 23.8%, stage II – 35.7%, stage III – 33.3%, stage IV – 7.1%. Disease-free survival for this subtype was 73.5 [51; 88]. The luminal B (Her-2−) subtype was identified in 29% of patients: stage I – 19%, stage II – 38%, stage III – 29%, with a median survival of 71 [38.5; 84.5]. The luminal B (Her-2+) subtype was detected in 9.7% of cases: stage I – 17%, stage II – 5%, stage III – 5%. Disease-free survival was 79 [76; 84]. The Her-2 positive subtype was identified in 7.3% of patients: stage I – 2%, stage II – 14%, stage III – 5%, with a median survival of 79 [70; 82]. The triple-negative breast cancer subtype accounted for 20.2% of all molecular subtypes: stage I – 7%, stage II – 33%, stage III – 19%. Disease-free survival was 70 [44; 85]. Comparative analysis revealed that disease-free survival in luminal A patients was 1.03 and 1.05 times higher than in patients with luminal B (Her-2−) and triple-negative subtypes, respectively. The median survival was 1.07 times higher in luminal B (Her-2+) and Her-2 positive subtypes compared to luminal A. Disease-free survival in luminal B (Her-2−) was 1.11 times higher than in Her-2 positive and luminal B (Her-2+) subtypes. The triple-negative subtype demonstrated 1.014 times lower disease-free survival compared to luminal B (Her-2−).

No significant differences were observed between Her-2 positive and luminal B (Her-2+) subtypes, whereas disease-free survival in these groups was 1.13 times higher than in the triple-negative subtype. Statistical analysis revealed no significant correlations (p (Mann–Whitney) > 0.05) between disease-free survival and molecular-biological subtypes of breast cancer.

Thus, the obtained data indicate that the molecular-biological subtype of the tumor does not have a statistically significant effect on disease-free survival in breast cancer patients, but may serve as an additional marker of tumor aggressiveness to be considered when choosing a treatment strategy.

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RETROSPECTIVE ANALYSIS OF THE INCIDENCE OF CIRCULATORY DISEASES IN THE GORETSKY DISTRICT

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Abstract: The work is devoted to a retrospective analysis of the incidence of cardiovascular diseases in the population of the Goretsky district for the period 2016 - 2023: extensive and intensive coefficients, growth rates of primary and general morbidity were calculated, a comparative analysis of the incidence of the working-age population of the district and the population older than working age was carried out.

Keywords: cardiovascular diseases, risk factors, morbidity.

Cardiovascular diseases remain a major health problem in most countries worldwide. In particular, 4 million people die from cardiovascular diseases in Europe each year. A key indicator of all-cause mortality is the proportion of deaths from cardiovascular diseases, which in the Republic of Belarus amounted to 55.9%, compared to 47% in Europe.

Among people of working age, who bear the brunt of the gross domestic product (GDP), the wealth of which determines the nation's well-being, circulatory diseases account for more than one-third of all deaths. Moreover, the mortality rate for men is 4.7 times higher than for women overall, from coronary heart disease (CHD) by 7.2 times, from myocardial infarction by 9.1 times, and from cerebrovascular diseases by 3.4 times. Despite the fact that mortality rates have declined in developed countries, and in recent years in Belarus as well, the situation in our country remains extremely serious, as highlighted in numerous domestic and international publications.

When analyzing the structure of morbidity of the population of the Gorki district with cardiovascular diseases, it was noted that in 2016, in the structure of the general morbidity of the population of the district with diseases of the cardiovascular system, 60.08% accounted for arterial hypertension (first place), in second place was ischemic heart disease - 22.81%, cerebrovascular diseases accounted for 9.75%, cerebral infarction - 1.17% and myocardial infarction - 0.6%.

In 2023, in the structure of the general incidence of cardiovascular diseases in the district, arterial hypertension also occupied the first place (67.56%), ischemic heart disease was in second place - 20.03%, cerebrovascular diseases accounted for 2.91%, myocardial infarction - 0.41% and cerebral infarction - 0.32%.

Thus, in the Gorki District, circulatory diseases are one of the main causes of permanent disability and mortality. The main causes are diseases characterized by high blood pressure, coronary heart disease, and cerebrovascular diseases.

Over the study period, a steady increase in the overall incidence of coronary heart disease and a moderate increase in the incidence of arterial hypertension, as well as a moderate decrease in the overall incidence of cerebrovascular diseases, were identified in the Gorki District population.

Statistically significant differences in the incidence rates of cardiovascular diseases between the working-age population of the district and the population of post-working age for the period from 2016 to 2023 with a probability of $p < 0.001$ were found for the overall incidence of circulatory diseases, arterial hypertension, coronary heart disease, and cerebrovascular diseases, as well as for the primary incidence of cerebrovascular disease, myocardial infarction, and cerebral infarction, and with a probability of $p < 0.05$ for the primary incidence of coronary heart disease.

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IMMUNOHISTOCHEMICAL DETERMINATION OF THE EXPRESSION OF INDIVIDUAL TISSUE ANTIGENS IN GASTROINTESTINAL STROMAL TUMORS

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Every year, 15 cases of GIST are diagnosed in the world per million population, of which up to 30% are malignant with the presence of metastases mainly within the abdominal cavity and liver, which is 0.1–3% of all gastrointestinal malignancies [2]. Currently, there are no reliable epidemiological data on the incidence of GIST in the Republic of Belarus, which is due to the limited level of awareness and diagnostic alertness of clinical morphologists and oncologists.

Keywords: Gastrointestinal stromal tumors, immunohistochemical study, CD117, CD34, markers, gastrointestinal tract.

Gastrointestinal stromal tumors (GIST) are mesenchymal neoplasms of the gastrointestinal tract that arise from interstitial Cajal cells or their precursors, which have a pronounced activity of the KIT protein (CD117) or mutations in the KIT or PDGFRA (CD140a) genes, which leads to uncontrolled proliferation of these cells [1]. To make a morphological diagnosis of GIST, it is mandatory to perform an immunohistochemical study. The main IHC markers used to differentiate HISO from other non-epithelial gastrointestinal tumors are KIT (CD117), DOG-1, and protein kinase C-theta (PKC-theta). GISO treatment is complex and includes a surgical approach and drug therapy [3].

The study material was tumor tissue of 25 patients suffering from mesenchymal neoplasms of the gastrointestinal tract, abdominal cavity, retroperitoneal space and small pelvis, who received special treatment in the oncogynecological department of the State Institution "Republican Scientific and Practical Center of Oncology and Medical Radiology named after N. N. Alexandrov". The study methods were immunohistochemical determination of the expression of stem cell markers (CD117) and endothelial cells (CD34). The immunohistochemical study was performed on sections of tumor tissues fixed in paraffin blocks and intended for routine morphological examination. Sample preparation included dewaxing and rehydration of sections in accordance with the standard protocol. The degree of expression intensity of the immunohistochemical marker was evaluated semi-quantitatively on a four-point scale, depending on the intensity of staining.

As a result of preliminary data obtained from an immunohistochemical study of patients suffering from GISO, we found that CD117 overexpression was detected in 48% of cases, moderate-in 32%, hypo expression-in 16%, and lack of expression was detected in 4 % of cases. Immunohistochemical determination of CD34 expression showed that hyperexpression was detected in 56% of cases, moderate-in 12%, hypo expression-in 4%, and lack of expression was detected in 28% of patients.

Thus, in the studied 96% of gastrointestinal stromal tumors, a focal or diffuse positive reaction to CD117 was detected. A positive response to the CD34 marker was observed in 72% of gastrointestinal stromal tumors. The study continues.

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EFFECTS OF THE HEAVY METAL LEAD ON THE HUMAN BODY

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Abstract: Ecological pollution with lead has a serious impact on the human nervous system, causing: a decrease in intelligence, a decrease in physical activity, hearing impairment, and disruption of the cardiovascular system. This is especially reflected in the state of health of children, who are most susceptible to lead poisoning. Therefore, the development of aspects of environmental protection requires the strengthening of fundamental research aimed at studying the mechanisms of the relationship of living organisms with lead.

Keywords: lead, organism, environment.

Lead is a toxic metal that is widely distributed in the earth's crust. Its widespread use in industry has led to widespread environmental pollution, lead exposure to the human body, and serious public health problems in many regions of the world.

The lion's share of lead consumed worldwide comes from the production of lead-acid batteries for motor vehicles. However, lead is also used in many other products (pigments, paints, solder, stained glass, stained glass, stained glass, lead crystal utensils, ammunition, ceramic glaze, jewelry, toys), as well as in some folk cosmetics or some traditional medicine in India, Mexico, Vietnam and a number of other countries. Lead can enter drinking water coming through lead pipelines or pipes welded with lead solder. Lead causes long-term damage in adults, including an increased risk of high blood pressure, cardiovascular disease, and kidney damage. Once in the body, lead is concentrated in various organs: in the brain, kidneys, liver and bone tissue. Over time, lead accumulates in the teeth and bones. High concentrations of lead in pregnant women can cause miscarriages, stillbirths, preterm birth and low birth weight. Young children are especially vulnerable to lead poisoning, since compared to adults, their body absorbs 4 to 5 times more lead that enters the gastrointestinal tract from one source or another. In high concentrations, lead leads to serious damage to the brain and central nervous system, which can be accompanied by coma, convulsions and even death. Children who have suffered severe lead poisoning may experience irreversible mental retardation and behavioral disorders. Increased lead content in the body can lead to toxicity and contribute to the development of kidney failure, neuropathy, osteoporosis, atherosclerosis, nephropathy, and dysfunctions of the gastrointestinal tract. Also, a strong excess of the element in the body causes such a dangerous disease as encephalopathy. At lower concentrations that do not cause any obvious symptoms, lead affects a number of body systems. Lead exposure causes anaemia, hypertension, kidney failure, immune toxicosis and reproductive toxicity. The neurological and behavioural effects of lead exposure are considered irreversible. Malnourished children are more exposed to lead because, due to a lack of other micronutrients, such as calcium or iron, their body absorbs more lead. There is no safe concentration of lead in the blood; Even as low blood lead as 3.5 μg/dL can cause mental decline, behavioral disorders, and learning difficulties in children [1].

Studies show that lead does not perform any biological function in the human body and affects almost all organs and systems.

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PROSPECTS FOR THE USE OF SQUALENE IN TYPE 2 DIABETES

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Abstract: The pharmacological activity of squalene as a drug for the treatment of type 2 diabetes has been analyzed. It has been proved that squalene, due to its antioxidant and membrane-stabilizing properties, is able to protect the islets of Langerhans, demonstrate antihyperglycemic and anti-inflammatory effects, improve the function of pancreatic β cells, and can be considered as a promising compound for the treatment of T2DM.

Keywords: squalene, insulin, diabetes mellitus.

Squalene, derived from shark liver, has become known as an anti-cancer drug as a drug. Further studies have also shown the presence of cardioprotective, antibacterial, antifungal, detoxifying, antioxidant and, very importantly, antidiabetic properties for this drug. Type 2 diabetes, characterized by elevated blood glucose, insulin resistance, and relative insulin dysfunction, is now showing signs of a pandemic. The antidiabetic properties of squalene were studied in comparison with metformin, which also has significant side effects. Importantly, in clinical and preclinical trials, intravenous administration of squalene emulsion has been shown to be safe and well tolerated. The effect of squalene and metformin on the state of pancreatic cells in diabetic rats caused by the administration of low doses of STD (30 mg/kg body weight) was investigated. Histopathological examination of the pancreas revealed that control rats without diabetes lacked degenerated alpha and beta cells. In contrast, diabetic rats showed a significant decrease in the volume and number of islets. In rats treated with squalene, islet cells acquired a normal appearance and size. Similar differences in histopathological sections of pancreatic tissues were found in the groups of healthy people and patients with diabetes. Administration of squalene to diabetic patients resulted in a significant improvement in β cell size.

Dipeptidyl peptidase-4 (DPPIV) is an important enzyme that regulates insulin production by deactivating GLP-1, an incretin capable of regulating insulin secretion after meals. DPPIV enzyme inhibitors are used to treat diabetic conditions. In the experiment, it was found that in a group of rats with developed insulin resistance due to HFD ((high-fat diet) feeding, the activity of the DPPIV enzyme decreased as a result of taking squalene. In patients with diabetes, a similar effect of squalene inhibiting the activity of the DPPIV enzyme was revealed. In diabetes , the administration of squalene resulted in lower levels of glucose, leptin, cholesterol and triglycerides, as well as less weight gain. This is consistent with the action of metformin and is indicative of modulation of leptin and insulin signaling. The antioxidant effect of squalene was manifested through an increase in superoxide dismutase (SOD) activity and a decrease in lipid peroxidation (MDA β). reducing the production of ROS and pro-inflammatory cytokines (IL-6, IL-1β, TNF-α, NF-κB) and increasing the levels of anti-inflammatory IL-10, IL-13, IL-14 [1]. Patients taking squalene also showed significant changes in other health-related parameters, including systolic and diastolic blood pressure, blood urea nitrogen (BUN), albumin, transforming growth factor beta 1 (TGFbeta1), and creatinine levels [2]. Discovered antiatherosclerotic effect of squalene was realized due to its ability to increase HDL cholesterol levels, regulate lipid metabolism in the liver.

Thus, squalene, due to its antioxidant and membrane-stabilizing properties, is able to protect the islets of Langerhans, demonstrate antihyperglycemic and anti-inflammatory effects, improve the function of pancreatic β cells, and can be considered as a promising compound for the treatment of T2DM.

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CHARACTERISTIC OF POLLUTANTS IN THE ATMOSPHERIC AIR OF BELARUS

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This article reviews the pollutants present in the regional cities of the Republic of Belarus based on data from the National Statistical Committee and the Ministry of Natural Resources and Environmental Protection. Indicators such as the annual mean concentration of PM10, SO_2, CO and NO_2 characterize the state of the environment in terms of air quality and the negative impact of elevated concentrations of pollutants on public health.

Keywords: pollutants, air, Belarus, sulfur dioxide, carbon monoxide, nitrogen dioxide

The health of the urban ecosystem is the foundation of a country's sustainable development. The main environmental problems facing cities include air, water, and soil pollution from industrial emissions, transport, and waste. In addition, problems include noise and heat pollution, as well as soil and biodiversity degradation due to dense development and unsustainable land use. Characteristics of air pollutants in large regional cities is crucial for assessing the impact of anthropogenic emissions on the urban ecosystem and human health.

The aim of the work was to conduct a comparative analysis of the state of atmospheric air in regional cities of the Republic of Belarus according to data from the National Statistical Committee and the Ministry of Natural Resources and Environmental Protection for 2023 and 2024. The main pollutants considered were annual mean concentrations of microscopic particles with a diameter of less than 10 micrometers (PM10), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2).

The main sources of air pollution in Belarus are transport, thermal power plants, industrial enterprises, farming, and housing and communal services. The largest contributions come from mobile sources such as vehicle exhaust gases and stationary sources associated with fuel combustion in thermal power plants and industrial plants. The total volume of pollutant emissions in Belarus in 2023 amounted to 897.9 t or 4,325 kg/km^2.

Table

Annual mean concentrations of air pollutants in Belarusian cities in 2023-2024, μg/m^3

Cities	PM10		Sulfur dioxide (SO_2)		Carbon monoxide (CO)		Nitrogen dioxide (NO_2)	
	2023	2024	2023	2024	2023	2024	2023	2024
Minsk	25	25	14	19	379	468	33	29
Brest	29	30	33	21	596	399	20	29
Vitebsk	17	15	3	4	370	439	24	21
Gomel	44	44	26	22	617	640	28	20
Mogilev	25	20	24	9	428	227	55	50
Grodno	7	-	11	17	412	455	28	27

The lowest PM10 level was recorded in Grodno, and the highest in Brest and Gomel. The similar trend was observed in both 2023 and 2024. The highest annual mean concentration of sulfur dioxide in 2023 was recorded in Brest, but in 2024 the data rate in this area decreased by 36,4%. The lowest levels of sulfur dioxide were recorded in Vitebsk. In Minsk, a slight increase in SO_2 concentration was established in 2024 (19 μg/m^3) compared to 2023 (14 μg/m^3) data. Changes in the annual mean concentration of carbon monoxide in regional cities of Belarus are quite heterogeneous. In Gomel the concentration of this air pollutant was the highest (617 μg/m^3 in 2023 and 640 μg/m^3 in 2024). In Minsk, Vitebsk and Grodno, an increase in nitrogen oxide concentrations was observed in 2024 compared to 2023 data (by 19,0%, 15,7% and 9,5%, respectively). Whereas in Mogilev and Brest a significant decrease in this indicator was noted

by 46,9 and 33,1%, respectively. The most pronounced increase in annual mean concentrations of nitrogen dioxide in the period from 2023 to 2024 was characteristic of the city of Brest (31,0%). In Mogilev, a 9,1% decrease in nitrogen dioxide concentrations was recorded: from 55 μg/m^3 in 2023 to 50 μg/m^3 in 2024.

Thus, atmospheric air quality in the largest cities of Belarus for the period 2023-2024 can be assessed as very good and good. During the study period, the highest annual mean concentrations of PM10 and carbon monoxide were observed in Gomel, and nitrogen dioxide in Mogilev.

THE ROLE OF AIR POLLUTION IN THE DEVELOPMENT AND EXACERBATION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE

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A literature review examined environmental factors that significantly influence the development and progression of chronic obstructive pulmonary disease. Understanding these factors is critical for developing effective strategies for primary and secondary prevention, as well as for optimizing treatment and comprehensive disease management, particularly by minimizing exposure to harmful pollutants.

Keywords: chronic obstructive pulmonary disease, environmental factors, respiratory infections, air, tobacco smoke, nutrition

Studying the influence of environmental factors on COPD is crucial for understanding its development and progression, as well as for effective prevention and treatment. Research into the impact of air pollution, occupational hazards, climate, and other environmental factors helps identify risks, develop preventive measures, and optimize patient management strategies [1].

Chronic obstructive pulmonary disease is a chronic, progressive lung disease characterized by irreversible airflow limitation and chronic airway inflammation caused by exposure to harmful particles or gases [2]. The main symptoms are shortness of breath, chronic cough with sputum, and chest tightness, which worsen over time.

Environmental factors play a significant role in the etiology and pathogenesis of the disease. Key environmental factors influencing the development and exacerbation of chronic obstructive pulmonary disease include:

1. Indoor air pollution and occupational hazards.

Exposure to biomass combustion products (wood, coal, straw) during cooking and heating in poorly ventilated spaces is a significant risk factor. Similarly, prolonged exposure to occupational dust (e.g., coal dust, cotton dust), chemical fumes, irritating gases, and fumes in the workplace also leads to the development of the disease.

2. Respiratory infections.

Viral and bacterial infections are a common cause of disease exacerbations, leading to worsening symptoms, hospitalizations, and increased mortality by increasing inflammation and bronchospasm.

3. Air pollution.

Inhaled pollutants such as fine particulate matter, nitrogen dioxide, ozone, sulfur dioxide, and industrial emissions are among the leading risk factors for the development of chronic obstructive pulmonary disease in nonsmokers and a powerful trigger for exacerbations in patients already diagnosed. They cause chronic inflammation, oxidative stress, and structural changes in the lungs.

4. Tobacco smoke.

Active tobacco smoking is the primary and most significant risk factor for the development of the disease, responsible for the vast majority of cases. Exposure to passive smoking (secondhand smoke) also significantly increases the risk of developing chronic disease and contributes to its progression, especially in individuals exposed from an early age. Reducing the risk of developing and progressing chronic obstructive pulmonary disease requires a multifaceted

approach. A key step is stopping smoking and avoiding secondhand smoke. Minimizing exposure to outdoor and indoor air pollution, as well as occupational hazards, is also crucial.

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FEATURES OF HAND GRIP STRENGTH IN ROWERS

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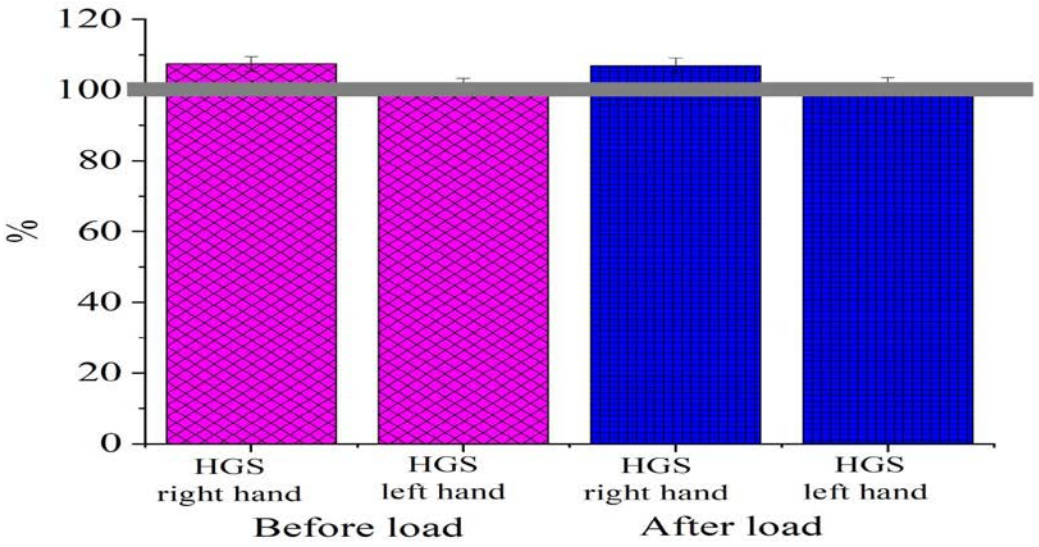
In Uzbekistan, great attention is paid to the development of sports and physical culture. This is reflected in the wide promotion of a healthy lifestyle and in practical measures aimed at raising a well-rounded younger generation. Such an approach contributes not only to the development of physical culture and sports but also to the improvement of public health, motivation, and the professional training of athletes. The state’s focus on creating favorable conditions for the growth of young sports talents allows the republic to maintain competitiveness in various international sports arenas.

*Keywords***:** rowing, grip strength, muscle fatigue, forearm muscles, athletes, training, endurance, physical performance, dynamometer, adaptation.

Purpose of the study – to compare the hand muscle strength of elite rowers and non-athletes and to evaluate the degree of fatigue that occurs after physical exertion.

Materials and methods. The study involved athletes from the national rowing team of Uzbekistan and students from the National University of Uzbekistan who did not engage in professional sports. Hand grip strength was measured before and after training sessions of approximately the same intensity. The values were determined using a hand dynamometer (Megeon-34090). All participants were male and of similar age, which minimized the influence of age-related physiological differences. The obtained data were analyzed statistically to assess the magnitude of grip strength and its reduction after exertion.

Results and discussion. Absolute Hand Strength (kg) Values of Elite Rowers Depending on Somatotype (M±m).



It was found that the right-hand grip strength of rowers averaged 68.6 ± 12.1 kg, while among non-athletes it was 52.5 ± 7.5 kg. The left-hand grip strength of rowers reached 64.7 ± 10.4 kg, whereas that of non-athletes was 55.4 ± 7.5 kg.

After physical load, the right-hand strength of rowers decreased by 6.1 kg, and the left-hand strength by 6.2 kg. In non-athletes, the reduction was greater – 9.2 kg for the right hand and 9.3 kg for the left.

These results indicate that although both groups experienced a decline in hand grip strength after exertion, the decrease was significantly smaller in trained athletes. This demonstrates that regular rowing training enhances the endurance of forearm and hand muscles and reduces the impact of fatigue. Despite the dominance of the right hand in both groups, the proportional decline in strength was similar for both hands, suggesting balanced muscular work during rowing training.

In conclusion, systematic training contributes to the development of greater initial muscle strength and a higher resistance to fatigue. The results obtained may be useful for coaches and sports physiologists when planning training loads, monitoring athletes' adaptation to stress, and optimizing recovery. Further research could include electromyographic analysis of hand muscles during rowing to better understand neuromuscular coordination and endurance mechanisms.

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THE EFFECT OF POLYPHENOL EXTRACT *HELMAR 1* ON THE PASSIVE PERMEABILITY OF LIVER MITOCHONDRIAL MEMBRANES IN RATS WITH TOXIC HEPATITIS

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In this study, the effect of the polyphenol extract helmar 1, isolated from the plant Helichrysum maracandicum, on the passive ion permeability of liver mitochondrial membranes was investigated in vivo. The experimental results revealed that the polyphenol extract increased the passive permeability of mitochondrial membranes to certain cations – particularly K^+, Na^+, and H^+ ions – in a dose-dependent manner. Consequently, a dose-dependent biphasic effect (stabilizing and inducing) of helmar 1 was identified, highlighting their importance as natural bioactive compounds capable of modulating mitochondrial membrane function.

Keywords: Helmar 1, mitochondria, passive ion permeability.

Mitochondria are the primary energy-producing organelles within the cell, responsible not only for oxidative phosphorylation (OXPHOS) but also for regulating cellular ion homeostasis [1,2]. Under conditions of hepatitis induced by CCl_4, the formation of free radicals, lipid peroxidation, and protein modification are enhanced, leading to the loss of ion selectivity of the mitochondrial membrane [3]. According to the studies by Ahmedova S. and co-authors, polyphenols from Helichrysum maracandicum restore oxidative phosphorylation processes in liver mitochondria, reduce lipid peroxidation, and enhance the activity of antioxidant enzymes (SOD, catalase, GPx) [4,5,6].

According to the obtained results, an increase in the permeability of liver mitochondria to KNO_3, $NaNO_3$, and NH_4NO_3 salts was observed in the group II rats with CCl_4-induced toxic hepatitis compared to the control group (group I) under isoosmotic conditions. Under the influence of CCl_4 induced toxic hepatitis, passive ion permeability increased by 67.6% for K^+, 72.7% for Na^+, and 32.1% for H^+ ions compared to the control. These findings indicate that in the experimental model of toxic hepatitis, the passive permeability of liver mitochondria to K^+, Na^+, and H^+ ions was significantly elevated. After 10 days of pharmacotherapy with helmar 1 (20 mg/kg injection) and silymarin (20 mg/kg injection) in animals of groups III and IV, respectively, a partial restoration of passive permeability was observed. In these groups, the passive permeability of liver mitochondria decreased compared to the CCl_4 induced group (group II): for KNO_3 by 15.8% with helmar 1 and by 26.4% with silymarin; for $NaNO_3$ by 18.1% and 36.9%; and for NH_4NO_3 by 10.8% and 21.6%, respectively.

Based on the obtained results, it can be concluded that in the model of toxic hepatitis, the increase in CCl_4 concentration in the blood of animals leads to damage of liver cells, including mitochondrial membrane systems, and enhances the passive transport of ions in mitochondria. Moreover, the contribution of glycolysis to ATP synthesis increases under these conditions. The corrective (hepatoprotective) effect of the polyphenol extract, which reduces the degree of such damage in toxic hepatitis, can be explained by its ability to restore oxidative phosphorylation processes and the antioxidant defense system in mitochondria. In the future, identifying such hepatoprotective compounds and studying their mechanisms of action may provide opportunities for the development of effective therapeutic agents for the treatment of toxic hepatitis.

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EFFECT OF IMMUNOSTIMULATORS ON THE IMMUNE SYSTEM IN EXPERIMENTAL HEPATITIS

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Keywords: tissue solutions, immunostimulants, anemia, immune response, antibody-forming cells, and antigen.

Toxic substances can cause liver damage with prolonged exposure. This condition is mainly characterized by intermittent liver pain, diarrhea, fatigue, low body temperature, a bitter taste in the mouth, flatulence, loss of appetite, hepatomegaly, splenomegaly, and skin itching. These symptoms appear periodically and may resolve spontaneously after some time. The symptoms and clinical presentation of toxic hepatitis vary slightly. In acute hepatitis, the first signs appear 2–4 days after the administration of a toxic substance, but this period may shorten to 12–24 hours. Patients may experience pain in the right hypochondrium, fever, weakness, decreased appetite, headache, nausea, vomiting, and associated pain. The toxic effects on blood vessel walls can lead to hemorrhages, increased bleeding, and jaundice.

The aim of this work is to evaluate the effectiveness of immunostimulants derived from tissue compounds in experimental hepatitis.

Materials and methods.

Experiments were performed on non-inbred white mice. Hepatitis was induced by intraperitoneal injection of an oil solution of carbon tetrachloride (CCl_4) at a dose of 0.2 mg/kg for three consecutive days. To detect deep infection in animals with secondary immunodeficiency, assess the effect on antibody-forming cells in the spleen, and evaluate the hematopoietic system, five groups of ten animals each were formed. The animals were immunized with sheep erythrocytes at a dose of 2×10^8. After seven days, the spleens were removed for analysis. To correct the immunodeficiency state, mice were injected intraperitoneally with tissue-derived immunostimulants at concentrations of 0.1%, 0.3%, and 0.5%.

Conclusions: Experiments were conducted to determine the effects of tissue-based immunostimulating solutions. Toxic hepatitis was successfully induced in experimental animals. In mice with induced hepatitis, the number of antibody-producing cells in the spleen decreased by approximately 3.3 times. Similar results were obtained when assessing the number of antibody-producing cells per 1 million splenocytes. The immunodeficiency state was

manifested by a decrease in antibody-forming cells, while treatment with tissue-based immunostimulating solutions demonstrated a pronounced immunostimulatory effect.

BIOELEMENT STATUS OF YOUNG PEOPLE IN TURKMENISTAN

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Data on the elemental composition (Ca, Cu, Fe, Pb, Zn) of the hair of young people in Turkmenistan were obtained. The mean and median concentrations of Ca, Fe, Zn, and Cu were within reference limits. There were some cases of elevated Pb levels.

Keywords: bioelement status, chemical elements, heavy metals, microelementoses, hair, youth, environmental pollution.

Microelements are required by all organisms only in optimal quantities. Two zones of microelement action have been established: biotic action and toxicopharmacological action. The zone of biotic action is revealed when microelements are used in concentrations close to those in which they are found in the body under normal environmental conditions. In this case, microelements, without stimulating the body's physiological barriers and without encountering resistance from them, exhibit biological activity. The zone of toxicopharmacological action is revealed when microelements are used in quantities significantly exceeding biotic concentrations. In this case, microelements overcome the resistance of physiological barriers by their "functional breakdown" and, penetrating in large quantities, cause not a biotic, but a toxic effect [1]. Long-term deficiency or, conversely, excess of any element leads to metabolic disorders and disease, therefore, a balanced diet in terms of mineral composition is of particular importance.

The aim of our work was to assess the levels of accumulation of chemical elements in the hair of young people of Turkmenistan. In this regard, the following tasks were solved: 1. To collect samples of biomaterial (hair). 2. To determine the concentrations of chemical elements in the hair of young people. 3. To evaluate the compliance of the content of chemical elements in hair with reference values. The object of the study was the hair of young people (11 young men) aged 22 years. Dashoguz city and Dashoguz region (Turkmenistan). The subject of the study is the concentration of Cu (copper), Zn (zinc), Ca (calcium), Fe (iron), Pb (lead). Research methods: review and analytical, statistical, X-ray fluorescence analysis [2]. Hair sampling, sample preparation and measurements were carried out according to established methods based on the laboratory of environmental monitoring and management of *International Sakharov Environmental Institute of Belarusian State University*. Table 1 presents data on the concentrations of chemical elements in the hair of young people living in the city of Dashoguz and the Dashoguz region, in comparison with reference values.

Table 1

Content of chemical elements in young men's hair (n=11; p=0.05), mg/kg

Element	Mean ± error (p=0,05)	Minimum	Maximum	Median	P=25%	P=75%	Reference values	
							Minimum	Maximum
Ca	348 ± 131	130	719	311	212	402	300	1000
Cu	9 ± 1	7	12	10	8	10	9	30
Fe	18 ± 3	13	28	15	14	22	13	35
Pb	4 ± 2	1	7	3	2	6	0	5
Zn	185 ± 8	165	203	187	177	196	114	320

Pb concentrations were outside the reference range (>5 mg/kg) in 36% of cases, although the median was within the reference range. The mean and median values of Ca, Fe, Zn, and Cu concentrations were within the reference range.

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EFFECTIVENESS OF ZOLEDRONIC ACID IN IMPROVING BONE MINERAL DENSITY IN PROSTATE CANCER PATIENTS RECEIVING ANDROGEN DEPRIVATION THERAPY: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Prostate cancer is one of the most prevalent malignancies affecting men worldwide, with notable geographical differences in incidence. In China, it ranks sixth among male cancers, whereas in the United States, it is the most commonly diagnosed malignancy in men[1]. In advanced stages, prostate cancer is highly prone to bone metastases, with up to 80% of patients developing skeletal involvement[2]. Androgen deprivation therapy (ADT) is widely used as first-line or adjuvant treatment for prostate cancer; however, it leads to significant bone mineral loss and an increased risk of osteoporosis and skeletal-related events (SREs)[3-4].

Osteoporosis and related complications such as fractures and spinal cord compression can drastically impact patients' quality of life and prognosis. Therefore, effective strategies to prevent or mitigate ADT-induced bone loss are urgently needed in clinical practice.

Zoledronic acid, a third-generation nitrogen-containing bisphosphonate, exhibits strong antiresorptive properties by inhibiting osteoclast activity. It has been widely used in managing cancer-associated bone loss[5]. Although several studies have suggested its efficacy, comprehensive evaluation of zoledronic acid in the specific context of ADT for prostate cancer is still limited. This meta-analysis aims to consolidate current evidence and assess the efficacy and safety of zoledronic acid in improving bone mineral density (BMD) among prostate cancer patients undergoing ADT.

Study Objective: To evaluate the clinical efficacy of zoledronic acid in improving bone mineral density among prostate cancer patients receiving androgen deprivation therapy.

Databases Searched: PubMed, Embase, Web of Science, CNKI, and Wanfang up to July 11, 2025.

Inclusion Criteria: Randomized or non-randomized controlled trials involving prostate cancer patients aged ≥18 receiving ADT; intervention group treated with zoledronic acid; outcome measures included lumbar spine, femoral neck, and total hip BMD.

Data Extraction & Quality Assessment: Two reviewers independently extracted data and assessed study quality using the RoB 2.0 tool for RCTs and MINORS scale for non-RCTs.

Statistical Analysis: Meta-analysis conducted using Stata 15.0. Fixed or random-effects models were applied based on heterogeneity (I^2), along with subgroup, sensitivity, and publication bias analyses (Egger's and Begg's tests).

Results：A total of 10 studies (n=678 patients) were included.

Lumbar Spine BMD: Zoledronic acid significantly increased BMD compared to control (WMD=0.07; 95% CI: 0.04–0.10), with low heterogeneity (I^2=30.8%).

Femoral Neck and Total Hip BMD: No statistically significant difference was observed (WMD=-0.002 and -0.003, respectively; P>0.05).

Sensitivity and funnel plot analyses indicated robust results with no significant publication bias.

Conclusion

Current evidence suggests that zoledronic acid significantly improves lumbar spine bone mineral density in prostate cancer patients undergoing ADT, though its effect on femoral neck and total hip BMD is not statistically significant. Zoledronic acid appears to be a safe and potentially long-term effective adjunct in managing ADT-related bone loss. However, further high-quality studies are needed to confirm these findings.

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INTERACTION OF THE INTESTINAL MICROBIOTA AND THE CNS THROUGH THE "GUT-BRAIN" AXIS: MECHANISMS AND THERAPEUTIC PERSPECTIVES

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This review examines the gut-brain axis through key interaction mechanisms and the microbiota's role in producing neuroactive substances, its epigenetic influence during early development, and therapeutic potential for CNS disorders.

Keywords: "gut-brain" axis, intestinal microbiota, neurotransmitters, dysbiosis, probiotics.

The intestinal microbiota is a complex community of microorganisms that plays a key role in the physiology of the host. Of particular importance is the bidirectional communication axis "gut-brain", linking the intestinal microbiota with the central nervous system (CNS). From the gut side, this interaction is carried out, in particular, through the microbiota's production of neurotransmitters (GABA, glutamate) and the neurotrophic factor BDNF, which affect cognitive functions and neuroplasticity. The reverse influence of the CNS on the microbiota is mediated mainly by stress-induced changes, such as the activation of the hypothalamic-pituitary-adrenal axis and the autonomic nervous system.

The study of the intestinal microbiota, initiated by the discoveries of A. van Leeuwenhoek about 300 years ago, received a qualitative leap with the development of molecular genetic methods, initiated in part by the "Human Microbiome Project" (2007). The scale of this community underscores its potential influence on host physiology: the number of microorganisms inhabiting the intestine is orders of magnitude greater than the size of the human population. In this regard, a key task of modern science is not only to determine the composition of the microbiome but also to decipher its specific role in maintaining homeostasis and the pathogenesis of diseases [1].

One of the key mechanisms of the intestinal microbiota's influence on the CNS is the synthesis of neuroactive metabolites. These include the brain-derived neurotrophic factor (BDNF), which is critical for neurogenesis, synaptic plasticity, and neuroprotection, as well as neurotransmitters – GABA (inhibitory) and glutamate (excitatory). A decrease in BDNF levels is associated with an increased risk of developing dementia, Alzheimer's disease, and depression. Intestinal microbiota dysbiosis, especially against the background of increased intestinal permeability, disrupts the production of these compounds, which contributes to systemic inflammation and is involved in the pathogenesis of neurological and psychiatric disorders [2].

The reverse influence of the CNS on the composition and function of the intestinal microbiota is realized mainly during stress. The resulting dysbiosis, often against the background of increased intestinal barrier permeability, maintains chronic inflammation and dysfunction of the "gut-brain" axis, which is associated with the pathogenesis of autism spectrum disorders and other neurological diseases. Of particular importance is the epigenetic programming of

CNS functions during critical periods of development (the first 1000 days of life), when interventions such as cesarean section or antibiotic use can lead to persistent disturbances in the formation of the intestinal microbiota and increase the risk of neurodevelopmental pathology [3].

Thus, gut microbiota dysbiosis is a significant risk factor for neurological disorders. Correcting the balance using probiotics (Lactobacillus, Bifidobacterium) is a promising approach for the prevention and therapy of CNS disorders. Personalized microbiota modulation strategies require further research.

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MODERN APPROACHES TO SUSTAINABLE PHYSIOLOGICAL NUTRITION IN ENSURING FOOD SECURITY

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Sustainable physiological nutrition is a multidimensional approach that integrates human nutritional needs, food security, environmental sustainability, and socio-economic factors. This article analyzes the principles of sustainable nutrition using locusts (Orthoptera) as an example and highlights their significance as a promising protein source for global food security. The nutritional value, physiological compatibility, safety aspects, ecological advantages, and socio-cultural acceptance of locusts are discussed.

Keywords: sustainable nutrition, food security, locusts, edible insects, physiology, protein

In the 21st century, ensuring sustainable food security and healthy nutrition is among humanity's greatest challenges. Population growth, climate change, and the depletion of natural resources demand the exploration of new protein sources. Edible insects, including locusts (*Locusta migratoria*, *Schistocerca gregaria*, *Dociostaurus maroccanus*), are considered a promising alternative due to their high nutritional value and low environmental impact.

Dried locusts contain about 55–65% protein and 8–15% fat. Their amino acid profile partially meets the requirements recommended by the World Health Organization (WHO/FAO). Locusts are rich in iron, zinc, magnesium, and B-group vitamins. The high bioavailability of iron makes them particularly beneficial for preventing anemia. Incorporating locust meal into animal and human diets enhances protein digestibility, growth performance, and metabolic efficiency. Additionally, chitin positively influences gut microflora and helps reduce cholesterol levels. In Africa, Asia, and Latin America, the consumption of locusts is an ancient tradition. In Europe and the United States, however, widespread adoption requires raising consumer awareness, developing new dishes, and offering the products in familiar forms (such as protein powder or bakery ingredients). For farmers, locust farming can help diversify income sources and create new employment opportunities. Locusts represent a food source that fully aligns with the principles of sustainable physiological nutrition. Their high protein and micronutrient content, environmental efficiency, and economic benefits position them as a valuable component in ensuring global food security. With proper safety measures, social acceptance, and political support, locusts can play a significant role in building a sustainable future food system.

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PARENTS AND OFFSPRING UNDER EXPERIMENTAL HYPOTHYROIDISM WITH PROPHYLACTIC POLYPHENOL THERAPY

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The study investigates the effects of prophylactic polyphenol therapy on blood biochemical indicators – liver enzymes (ALT, AST, ALP) and glucose levels – in parents and their offspring under experimental hypothyroidism. The relevance lies in the impact of thyroid hormone deficiency on liver and carbohydrate metabolism. Polyphenols, due to their antioxidant and hepatoprotective properties, may help normalize cellular metabolism and reduce oxidative stress.

Keywords: hypothyroidism, polyphenols, ALT, AST, ALP, glucose.

Thyroid hormones (T3 and T4) are central regulators of energy metabolism, and their deficiency causes disturbances in protein, lipid, and carbohydrate metabolism [1]. Hypothyroidism has a significant effect on liver function, leading to alterations in ALT, AST, ALP, and glucose levels [2]. Therefore, studying the potential of polyphenols – natural antioxidants – to mitigate these biochemical changes is of scientific importance [3].

The experiment was carried out on healthy adult male and female Wistar rats (6 per group). The animals were divided into three groups: (1) healthy control, (2) hypothyroid group, and (3) polyphenol-pretreated group followed by hypothyroidism induction. Experimental hypothyroidism was induced according to the method of Sabanov et al. (2018) by administering methimazole at a dose of 1.2 mg/100 g body weight for 21 days [4]. At the end of the experiment, serum ALT, AST, ALP enzyme activities and glucose levels were measured using a biochemical analyzer.

It is expected that prophylactic polyphenol therapy will bring liver enzyme activities in parents and offspring under hypothyroid conditions closer to physiological norms, stabilize glucose levels, and reduce oxidative stress. Furthermore, administration of polyphenols to parent rats may contribute to maintaining metabolic stability in their offspring.

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THE EFFECT OF PROPHYLACTIC POLYPHENOL THERAPY ON PANCREATIC, HEMATOLOGICAL, INTESTINAL ENZYMATIC, COGNITIVE AND GROWTH PARAMETERS IN PARENTS AND OFFSPRING UNDER EXPERIMENTAL HYPOTHYROIDISM

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The study investigates the effects of prophylactic polyphenol therapy on the histological condition of the pancreas, hematological parameters (erythrocytes, leukocytes, thrombocytes), intestinal enzyme activity (sucrase, lactase, maltase, amylase, lipase), cognitive function, and growth development in parents and their offspring under experimental hypothyroidism. The relevance of this research is determined by the systemic impact of thyroid hormone deficiency on various organs, particularly the digestive and central nervous systems.

Keywords: hypothyroidism, polyphenols, pancreas, intestinal enzymes, cognitive function.

Thyroid hormones (T3 and T4) are crucial regulators of metabolic processes in the body. Their deficiency leads to a decrease in energy metabolism, disruption of protein and lipid metabolism, and weakening of nervous system activity [1]. In experimental hypothyroidism, exocrine pancreatic activity decreases, and intestinal enzyme secretion and absorption processes become impaired [2]. Therefore, it is important to explore the potential of natural antioxidants such as polyphenols in correcting these disorders.

Polyphenols reduce oxidative stress, stabilize cell membranes, and normalize the functional activity of the endocrine and digestive systems [3]. According to Sabanov's method, hypothyroidism was induced by administering methimazole at a dose of 1.2 mg/100g for 21 days [4]. Each experimental group consisted of 6 male and 6 female rats, divided into the following groups: Healthy control group; Hypothyroidism group

Polyphenol pretreated + hypothyroid group.

The experiment was carried out on white laboratory Wistar rats (Rattus norvegicus, Wistar line), both males and females, maintained under standard laboratory conditions. After hypothyroidism induction, blood samples were collected to determine erythrocyte, leukocyte, and thrombocyte counts using a hematological analyzer. The activities of intestinal enzymes – sucrase, lactase, maltase, amylase, and lipase – were assessed using biochemical analysis.

Histological examination of the pancreas was performed to evaluate the proliferation rate of alpha, beta, and acinar cells using hematoxylin-eosin staining.

Cognitive function was assessed through the open-field maze and color maze tests. Growth dynamics were monitored by regularly measuring body weight and length.

Prophylactic polyphenol therapy is expected to normalize blood parameters toward physiological levels, restore pancreatic cell proliferation, and enhance intestinal enzyme activity in hypothyroid rats. Furthermore, administering polyphenols to parents is expected to improve cognitive performance and growth development in their offspring. These findings could provide a scientific basis for the protective potential of polyphenols against hypothyroidism.

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LABORATORY DIAGNOSIS OF ALZHEIMER'S DISEASE

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Alzheimer's disease is a progressive neurogenerative disease based on the accumulation of toxic proteins in the brain, leading to the death of neurons. This is a pathology that is becoming one of the main medical and social problems of modern society. Laboratory diagnosis of this disease is beginning to play a key role.

Keywords: Alzheimer's disease, Aß42 peptide, p-tau protein, laboratory diagnostics.

The diagnosis of Alzheimer's disease has long been clinical and could only be confirmed posthumously. PET scanning of amyloid plaques is expensive and inaccessible. It is necessary to find an available biomarker.

Currently, the key biomarkers are amyloid-β (Aß), especially the Aß42 peptide and the Aß42/Aß40 ratio, as well as tau protein (t-tau) and phosphorylated tau (p-tau). In Alzheimer's disease, Aß42 accumulates in the brain, which forms plaques. Its level in the cerebrospinal fluid decreases, as it "gets stuck" in the brain. The Aß42/Aß40 ratio is a more

accurate indicator. And when neurons die, the level of total tau (t-tau) in the cerebrospinal fluid increases as a marker of damage to the nervous tissue [1].

In a healthy neuron, tau protein stabilizes microtubules. Microtubules carry nutrients and other important molecules. To perform its function, the tau protein can be chemically modified - phosphorylated. Normally, this process is reversible and regulated. In Alzheimer's disease, tau protein is hyperphosphorylated. This causes tau protein molecules to lose contact with microtubules, stick together, and form insoluble neurofibrillary tangles inside neurons. These tangles destroy the internal structure of the cell, leading to its death [2]. p-tau is the hyperphosphorylated tau protein, which is a direct marker of this pathological process.

P-tau analysis solves several key tasks in the diagnosis of Alzheimer's disease. It allows us to distinguish Alzheimer's disease from other causes of dementia (for example, frontotemporal dementia, dementia with Lewy bodies), where the pathology of tau protein is less pronounced or has a different nature. Previously, the diagnosis could only be confirmed postmortem. Now, the presence of p-tau in the cerebrospinal fluid or blood objectively indicates a disease-specific process in the brain.

Studies have shown that different phosphorylation sites have different diagnostic value. For example, p-tau181, which is the first biomarker to be mass-measured in blood. He distinguishes Alzheimer's disease from healthy aging and from many other dementias. If we talk about p-tau217, which is considered the most promising and specific, then it increases earlier and more strongly compared to p-tau181, and also correlates better with the accumulation of amyloid plaques in the brain. The P-tau217 has high accuracy for detecting even the earliest stages. P-tau231 is also a promising marker. It increases at very early stages, perhaps even earlier than p-tau217 [3].

Today, the "gold" standard of lifetime diagnostics is cerebrospinal fluid analysis. The analysis makes it possible to measure the combination of Aß42, p-tau and t-tau. The characteristic pattern for Alzheimer's disease is low Aß42, high p-tau and high t-tau. This makes it possible to distinguish the disease from other dementias with high accuracy. But the breakthrough of recent years has been blood tests. Their goal is to achieve accuracy close to the analysis of cerebrospinal fluid, but in a non-invasive and cheap way. The analysis can be performed at any clinic and is suitable for screening. Now the analysis is being actively introduced into clinical research and is beginning to appear in specialized clinics. Successes are associated with the advent of hypersensitive methods (immunoprecipitation with mass spectrometry) [4].

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USING PLANTS TO REDUCE THE SYMPTOMS OF SICK BUILDING SYNDROME

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Providing environmentally safe housing is the most important aspect of human ecology, which today attracts the close attention of specialists in the field of ecology, hygiene, architecture and construction. This is due to the fact that the modern living environment often contains factors that pose a real threat to health. One of the ways to improve the air quality in residential areas is the use of tropical and subtropical plants, the range of which is constantly expanding, which requires studying the features of their adaptation and maintenance in indoor conditions [1].

Keywords: plant, "sick building syndrome", vertical landscaping.

The modern term "sick building syndrome" describes situations when people, while in a building, experience various symptoms such as headache, irritation of mucous membranes, cough, dizziness, nausea, dry skin, sensitivity to odors, difficulty concentrating and fatigue, the cause of which cannot be determined. The causes of this syndrome are often associated with inefficient operation or breakdowns of ventilation, heating and air conditioning systems. Toxins from mold and fungi that develop in damp, poorly ventilated areas can also be a cause. In addition, pollutants released by some building materials, volatile organic compounds and high concentrations of ozone (which can be released as a byproduct of office equipment) also contribute to its development [2].

The solution may be to use vertical landscaping in the design of premises, including a variety of plants with high biofiltration and phytoncidal activity. During biofiltration, carbon dioxide and harmful compounds are effectively absorbed by plants and the substrate. Phytoncides and medicinal properties of tropical and subtropical plants have a healing effect in residential and public spaces.

Blum's coleus, which is a popular species, has an amazing variety of leaf shapes and colors. Low-growing, compactly deciduous varieties can be recommended for vertical landscaping in interiors: Ferry, Tammy, White Line and many others. It releases oxygen and absorbs carbon dioxide at night, making it ideal for the bedroom.

Chlorophytum ("Spider") is an excellent fighter against formaldehyde, benzene and carbon monoxide. It is especially effective in the kitchen, where formaldehyde can form during the combustion of gas. It forms "babies", which reproduce very easily.

Golden pipremnum is the leader in the rate of absorption of formaldehyde and carbon monoxide (CO). It effectively combats exhaust fumes that can enter from the street.

Dracaena (especially Dracaena marginate) effectively removes benzene, formaldehyde, trichloroethylene and xylene from the air. These compounds are isolated from varnishes, solvents, and synthetic materials [2].

Pelargonium has a powerful phytoncidal effect and is able to purify the air from pathogenic microorganisms, which helps reduce the risk of allergic reactions.

Spathiphyllum is a powerful multifunctional filter. Removes a wide range of pollutants: ammonia (found in cleaning products), formaldehyde, benzene, xylene and toluene.

An important step in prevention is the introduction of comprehensive measures aimed at improving the microclimate. In turn, the use of phytofiltering plants is an integral part of it. The implementation of such solutions will help reduce the level of pollutants, thereby increasing the comfort and health of people in the premises. Monitoring of the microclimate and regular maintenance are an important contribution to preventing the manifestations of sick building syndrome.

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RESEARCH ADVANCES IN GREEN EXTRACTION TECHNOLOGIES FOR PLANT-DERIVED MEDICINES

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This article reviews three novel green extraction technologies which offer a greener alternative to conventional methods, addressing key environmental and scientific challenges.

Keywords: Plant-derived medicines, Extraction techniques, Green technology

Plant-derived medicines, comprising single or complex mixtures of active ingredients from botanicals, are used for disease prevention and treatment. Traditionally used herbal medicines have garnered global interest due to their natural origins and health potential [1], particularly in chronic disease management. However, their complex composition makes extraction challenging. Traditional methods often involve lengthy processes or hazardous solvents like chloroform, raising environmental concerns. Consequently, various green extraction techniques are being implemented. Ultrasound-Assisted Extraction (UAE).

UAE utilizes ultrasonic cavitation and mechanical effects to disrupt cell walls, enhancing the release and dissolution of intracellular compounds, thereby improving extraction yield [2]. This method is straightforward and applicable to compounds regardless of polarity or molecular weight, generally preserving the structural integrity of extracts. A key limitation is the temperature rise during processing, which may degrade thermolabile components, and its scalability for industrial production remains challenging.

Flash extraction employs high-speed mechanical shear force to pulverize plant material into fine particles within seconds, enabling rapid equilibrium of active components for efficient extraction [3]. It is a high-efficiency technique for extracting bioactive constituents from herbs, offering advantages in processing time, and efficiency.

Supercritical Fluid Extraction (SFE). SFE uses supercritical fluids as solvents to isolate specific components, earning its reputation as a "green technology" [4]. Carbon dioxide (CO_2) is the most widely used solvent due to its chemical inertness, cost-effectiveness, non-toxicity, and status as a food-grade solvent.

In recent years, modern green extraction methods have gained significant attention to reduce energy and solvent consumption. The three technologies reviewed here represent viable, environmentally sustainable options. Their continued development is expected to contribute significantly to sustainable practices and reduce the reliance on organic chemicals.

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MITOCHONDRIAL MECHANISMS REGULATING APOPTOSIS, AUTOPHAGY, AND THE INFLAMMATORY RESPONSE

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Mitochondria act as integrative regulatory hubs, coordinating apoptosis, mitophagy, and innate immune inflammatory responses. In mitochondria-mediated apoptosis, BCL-2 family proteins control the permeability of the outer membrane: pro-apoptotic BAX/BAK form channels, leading to the release of cytochrome c and co-factors, assembly of the APAF-1 apoptosome, and sequential activation of CASP9→CASP3. Key accompanying events include opening of the mitochondrial permeability transition pore (mPTP) and loss of membrane potential ($\Delta\psi m$), which reinforce the irreversibility of the process under stress conditions [1].

Keywords: mitochondria; apoptosis; mitophagy; cGAS–STING; BAX/BAK; PINK1–PRKN.

Selective removal of dysfunctional mitochondria is ensured by mitophagy: PINK1 stabilizes on the outer membrane of damaged organelles and recruits the E3 ubiquitin ligase PRKN, initiating ubiquitination of outer membrane proteins; subsequently, adaptor receptors OPTN, NDP52, and others bind LC3, enabling autophagosome formation and lysosomal degradation. Receptor pathways BNIP3, NIX, and FUNDC1 operate as PRKN-independent and complementary mechanisms, expanding the spectrum of damage detection[2].

At the level of inflammation, damaged mitochondria release reactive oxygen species and mitochondrial DNA (mtDNA) as danger signals. This activates the NLRP3 inflammasome and maturation of IL-1β/IL-18; moreover, oxidized mtDNA exiting through BAX/BAK channels engages the cGAS–STING pathway with induction of type I interferons, while TLR9 recognizes unmethylated CpG motifs of mtDNA in endosomes.

These circuits are tightly interconnected. Effective mitophagy, by removing sources of ROS and mtDNA, restrains apoptosis and inflammation, maintaining homeostasis; conversely, under severe or prolonged stress, caspase-dependent apoptosis and inflammatory cascades exacerbate mitochondrial dysfunction and bias cellular fate toward death. Thus, by integrating the initiation of apoptosis, selective autophagic clearance, and activation of innate immunity, mitochondria determine the trajectory of the cellular response depending on the degree of damage and tissue context.

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ONCOLOGICAL SITUATION AND CANCER CARE SYSTEM IN THE REPUBLIC OF BELARUS: A TEN-YEAR ANALYTICAL REVIEW (2010-2019)

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As a result of the analysis, key trends in the dynamics of cancer incidence and mortality in the Republic of Belarus from 2010 to 2019 were identified. There is a noted increase in the number of diagnosed malignant neoplasms. In 2019, the most frequently diagnosed cancers were: among men – prostate, lung, colorectal, stomach, oral cavity and pharynx, and kidney cancers; among women – breast, colorectal, uterine body, thyroid, stomach, kidney, and ovarian cancers.

Keywords: cancer epidemiology, Belarus, incidence, mortality, screening, rural population.

Cancer is one of the most significant medical and social problems in modern society, greatly affecting life expectancy and quality of life. Globally, there is an increasing trend in both cancer incidence and mortality. This is attributed to natural demographic changes (e.g., population aging), environmental factors, lifestyle, and advances in diagnostic technologies that enable early disease detection. The Republic of Belarus, with a developed healthcare system, faces similar challenges that necessitate a comprehensive analysis of the epidemiological situation and the effectiveness of existing oncological care mechanisms.

The objective of this study was to analyze the levels of incidence and mortality from malignant neoplasms, as well as to assess the current state of the cancer care system in Belarus from 2010 to 2019.

Based on statistical data from 2010–2019, there has been a steady increase in cancer incidence in the country. The total number of new malignant neoplasm cases increased by 24.7%. Among the working-age population, the increase was 29.0%, indicating growing epidemiological pressure from oncological pathologies.

In terms of gender, the incidence among working-age men rose from 237.7 to 317.8 per 100,000 population (an increase of 33.7%), while among women it rose from 211.3 to 259.4 (an increase of 22.8%). This may be due to later medical consultations among men and occupational hazards. Analyzing the disease structure shows that in men, lung, prostate, and digestive system cancers predominate, while in women, breast, thyroid, and uterine cancers are most

common. Cancer incidence is increasing in both urban and rural areas, with a 10-year rise of 25.5% in urban areas and 23.8% in rural areas.

In the mortality structure, the leading causes of cancer death among men were lung, stomach, prostate, oral cavity and pharynx, colorectal, and pancreatic cancers. For women, the leading causes were breast, stomach, colorectal, pancreatic, and ovarian cancers. The crude mortality rate increased from 187.5 per 100,000 in 2010 to 198.6 in 2019; however, the standardized mortality rate declined from 110.3 in 2010 to 105.9 in 2019.

The analysis highlights the necessity for further development of the cancer care system in Belarus. In particular, there is a need to strengthen preventive measures, expand screening programs, improve oncological awareness at the primary care level, and ensure equitable access to medical services regardless of location. A comprehensive approach will help identify the most critical areas for improvement, enhance prevention and treatment efforts, and develop strategies aimed at reducing cancer mortality and improving patients' quality of life [1].

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EPIDEMIOLOGICAL ANALYSIS OF POTENTIALLY MALIGNANT DISEASES OF THE ORAL CAVITY IN THE REPUBLIC OF BELARUS

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This article examines the epidemiological situation in the Republic of Belarus regarding the incidence of potentially malignant diseases of the oral cavity.

Keywords: potentially malignant diseases, oral cavity, oncology.

According to the Belarusian Cancer Registry, over a 10-year period, the incidence of malignant neoplasms (MN) of the head and neck (C01-C14) increased by 1.3 times among the entire population of the country: from 14.0 per 100,000 population in 2014 to 18.4 in 2023 (growth rate of +31.4%); among people of working age: from 12.9 to 17.4 per 100,000 working-age population (growth rate +34.9%). Moreover, cancer of the lip, oral cavity (OC) and oropharynx (C01-C06, C10) accounts for an average of 53.4% of all cases of cancer of the head and neck [1].

Malignant tumors of the oral cavity and pharynx account for approximately 3% of the total number of oncological diseases in Belarus. This figure is higher among men (5.5% of the total number of oncological diseases in men) compared to women (1.0%) [2].

One of the priority tasks of modern dentistry and maxillofacial surgery remains the timely diagnosis and treatment of oral diseases that precede the development of the most common histological variant of oral cancer - squamous cell carcinoma.

In the initial stage, painless nodules, lumps, superficial ulcers, or fissures are observed that do not respond to conservative treatment. Patients may also complain of discomfort when eating, such as a burning or tingling sensation. In the advanced stage, pain is observed in almost 100% of cases. Despite the oral cavity being easily accessible for medical examination, only approximately 34% of oral cancers worldwide are diagnosed at an early stage. Mortality rates from cancers of the lip, oral cavity, and oropharynx also remain high, reaching 57.1%, and 59% among the working-age population.

Most biological tests for potentially malignant diseases turn out to be false negatives. This can usually be explained by technical errors made by doctors when collecting biopsy material. Furthermore, pathologists lack sufficient knowledge, their assessments are subjective, and they are limited by traditional examination methods. The difficulty of diagnosing potentially malignant oral diseases in the early stages is compounded by their similarity to benign lesions.

Oral cancers can develop at the site of established dysplasia, which can be formed due to constant mechanical damage to the tissues of the oral cavity.

Mortality rates from oral cancer have increased by 32% over 20 years. Comparatively higher mortality rates were found in the Minsk and Grodno regions (8.1 per 100,000 population). Men are more often affected (15.3 per 100,000 population), while women are more often affected (2.4 per 100,000 population, according to data for 2018-2022 [2].

The number of detected cases is increasing due to improved laboratory diagnostics and the introduction of new testing methods for detecting oral cancer.

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EPIDEMIOLOGICAL ASSESSMENT OF THE INCIDENCE OF PNEUMONIA AMONG CHILDREN'S POPULATION

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The study analyzes the dynamics of the overall incidence of pneumonia among the child population in the Republic of Belarus for the period from 2019 to 2023. Pneumonia is an acute inflammatory disease of the lung tissue of infectious origin. The study shows that during the investigated period, a decrease in the incidence of pneumonia among the child population was observed. At the same time, the highest level of pneumonia incidence among the child population was recorded in 2019. The reduction in pneumonia incidence in the Republic of Belarus in subsequent years was achieved through the implementation of a series of sanitary and epidemiological measures. Timely diagnosis and treatment of pneumonia allow for the prevention of complications and improvement of the disease prognosis.

Keywords: pneumonia, morbidity, diagnosis, mortality, treatment, population.

Pneumonia is a pressing issue in pediatric pathology and the leading single infectious cause of child mortality worldwide. Pneumonia is among the most common acute illnesses, affecting 10-15 people per 1000 population annually, and in older age groups (over 60 years), it occurs in 25-44 cases per 1000 people per year. The mortality rate for community-acquired pneumonia is lowest (13%) in young and middle-aged individuals, while in older age groups, this figure reaches 15-30%. Mortality from hospital-acquired pneumonia can be as high as 50%. The significance of the problem is determined by high morbidity, substantial labor losses, and financial costs associated with the diagnosis, treatment, and rehabilitation of pneumonia. Due to changes in the etiological structure of pneumonia and the immunological background of the population, early clinical, radiological, and laboratory signs of pneumonia are increasingly losing their classic manifestations and are presenting with atypical courses and more diverse clinical pictures.

The study showed that during the investigated period from 2019 to 2023, the Republic of Belarus has observed a decrease in pneumonia incidence among the pediatric population, with a negative growth rate. The highest level of infectious morbidity was recorded in 2019. At the same time, the lowest pneumonia incidence was observed in the

Mogilev region (4.8-11.8 cases per 1000 pediatric population), and the highest in the Grodno region (9.7-18.9 cases per 1000 pediatric population).

In 2022, the overall incidence of pneumonia decreased by 1.7 times compared to the previous year. However, in 2022, the highest incidence was observed among children under 1 year of age and children aged 1-4 years (15.36 and 15.35 cases per 1000 pediatric population, respectively), while the lowest incidence was among children aged 14 years (2.45 cases per 1000 pediatric population).

Thus, the highest level of pneumonia incidence during the investigated period was noted in 2019, followed by a pronounced and stable trend of decreasing incidence. The reduction in pneumonia incidence in the Republic of Belarus was achieved through the implementation of sanitary and epidemiological measures. Timely diagnosis and treatment of pneumonia allow for the prevention of complications and improvement of the disease prognosis.

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MOLECULAR DIAGNOSTICS OF HIGH-GRADE GLIAL BRAIN TUMORS

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In the present study, the expression levels of the *EGFR* and *TP53* genes were determined. Preliminary results showed positive *EGFR* gene expression in 7 patients with glioblastomas and in 2 patients with astrocytomas. Expression of the *TP53* gene was observed in 10 patients with glioblastomas and in 5 patients with astrocytomas.

Keywords: glioblastomas, astrocytomas, EGFR, p53, immunohistochemistry

Brain tumors represent a heterogeneous group of malignant neoplasms with an incidence rate of 4-15 cases per 100,000 population. About 400 cases of primary brain tumors are registered annually in the Republic of Belarus. More than half of them are glial tumors. In recent decades, there has been a tendency toward an increase the incidence of malignant gliomas by 1% across all age groups [1].

Glial tumors can be either primary, forming in the brain tissues and its membranes, or secondary, representing metastases of tumors from other organs. Depending on the degree of differentiation, gliomas are divided into highly differentiated and poorly differentiated tumors. The group of high-grade gliomas includes glioblastomas that occur in 80% of patients, as well as anaplastic astrocytomas, anaplastic oligodendrogliomas, and anaplastic gangliogliomas [2].

At the present stage, priority in the diagnosis and monitoring of CNS tumors is given to molecular genetic methods. Determination of target gene expression levels and identification of chromosomal aberrations are carried out using immunohistochemistry and fluorescence in situ hybridization (FISH) [3].

Genetic markers of glial tumors include such genes as ATRX, BRAF, EGFR, IDH, MGMT, PI3K, PTEN, TP53 [4].The epidermal growth factor receptor (EGFR) belongs to the family of epidermal growth factor receptors and possesses tyrosine kinase activity. Mutations in the EGFR gene lead to uncontrolled tumor cell division. The tumor suppressor and transcription factor p53 plays a critical role in preventing tumor growth, which is associated with the activation of various cellular responses, including apoptosis, inhibition of angiogenesis, maintenance of genomic stability, and regulation of cell metabolism. Abnormalities in the p53 signaling pathway are observed in 30% of primary and 70% of secondary glioblastomas [5].

The present molecular biological study was performed using biomaterial from 24 patients of the N. N. Alexandrov National Medical Research Center of Oncology in order to determine the expression levels of the tumor markers EGFR and p53. The study material consisted of tumor tissue from 16 patients with glioblastoma and 8 patients with

astrocytoma. The analysis was performed by immunohistochemical determination of the expression levels of EGFR receptor and the tumor suppressor protein p53. The study was conducted according to the standard avidin-biotin peroxidase immunohistochemical method.

The tumor was considered EGFR-negative in the absence of membrane staining or when the number of stained cells was less than 10%, and p53-negative in the absence of nuclear immunoreactivity.

The expression levels of genetic markers were tested for normality using the Shapiro-Wilk test. Correlation analysis was performed using Spearman's rank correlation coefficient (R), the differences were considered statistically significant at $p < 0.05$.

Immunohistochemical analysis of EGFR expression revealed a positive reaction in 43.75 % of glioblastoma cases (7 patients) and 25% of astrocytoma cases (2 patients). Expression of the apoptosis-related marker p53 was observed in 62.5 % of patients with glioblastoma and 62.5 % patients with astrocytoma.

The results of comparative analysis showed co-expression of *EGFR* and *TP53* in 43.75% of glioblastoma cases ($r=0.26$; $p < 0.05$). In astrocytomas, combined expression of these markers was detected in a single case (12.5%).

Based on the previously obtained data, pathological expression of the *EGFR* and *TP53* genes was confirmed by immunohistochemistry in patients with glioblastoma and astrocytoma. The study is ongoing.

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QUANTITATIVE ASSESSMENT OF RESPIRATORY DISTORTIONS OF TUMOR VOLUME DURING PET/CT IMAGING

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A mathematical model was developed to quantitatively assess the impact of respiratory motility on the visualization of pathological lesions during PET/CT scanning of malignant tumors. Experimental verification demonstrated high reproducibility and reliability of the method.

Keywords: mathematical model, intervention, PET/CT, phantom, size uncertainty, respiratory movements.

The use of PET/CT in oncological imaging presents a number of technological challenges, one of which is the impact of patient breathing on tumor contours, increasing their size, and reducing the accuracy of numerical measurements, which negatively impacts patient examination and treatment. The relevance of studying flow monitoring methods in PET/CT scanning has driven the need to improve visualization quality and, from a theoretical perspective, to ensure diagnostic accuracy.

Modern imaging techniques, particularly combined PET/CT tomography, are key tools for diagnosis, staging of malignant processes, and planned radiation therapy [1]. When performing 4D scanning using gating, one of the pressing

problems is that the volume of space actually traversed by the tumor during respiration does not correspond to the volume reconstructed in healthy images [2]. This is a consequence of systematic assumptions, and the theory leads to errors in numerous estimates of the volume of the pathological lesion.

To quantitatively analyze and correct for these effects, a mathematical model of respiratory effects in PET/CT imaging was developed, the operating principle of which is shown in Figure 1.

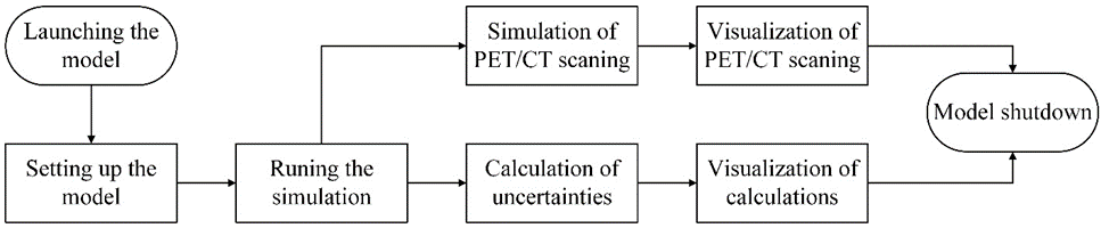

Fig. 1. – Simulation block operation diagram

The model is based on data obtained using a physical PET/CT phantom created at the N. N. Alexandrov Republican Scientific and Practical Center of Oncology and Medical Radiology (Republic of Belarus) and is implemented as an algorithm for predicting absolute and relative uncertainties in assessing the size of a fall based on the dependence of the relative uncertainty on the diameter of the pathological lesion and the absolute uncertainty on the diameter of the pathological lesion. Furthermore, the model provides visualization of a conventional PET/CT scan, i.e., a cable free of any movement caused by respiratory motion.

Verification was performed based on the analysis of PET/CT images contoured using Ellipse v.16.1 software. Data analysis revealed that for CT scanning, the relative error of absolute and relative uncertainty was 2.07% ± 1.01% and 2.10% ± 0.99%, respectively. For PET scanning, the same figures were 1.99% ± 0.87% and 2.69% ± 0.77%. A comparison of the study results with experimental data confirmed the reliability of the proposed method and a high degree of measurement reproducibility.

Along with its positive results, the model has a number of limitations, namely the need for detailed tuning of the modeling parameters and the model's applicability only to spherical or nearly spherical lesions. These limitations make it difficult to apply the model to a wide range of clinical scenarios with varying lesion morphologies and complex trajectories. Further development of the model could be aimed at expanding its clinical applicability, i.e., introducing the ability to define arbitrary shapes and sizes of lesion.

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EPIDEMIOLOGIC FEATURES OF KIDNEY CANCER INCIDENCE IN URBAN AND RURAL POPULATIONS OF THE REPUBLIC OF BELARUS

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Keywords: malignant neoplasms, kidney cancer, epidemiological assessment, morbidity, rural population, urban population, regions of the Republic of Belarus.

The work examines the dynamics of kidney cancer incidence among the population of the Republic of Belarus for 2014-2023. During the study, it was established that over the period 2014-2023, there is a steady trend of increasing kidney cancer incidence in the Republic of Belarus among the entire population, as well as among men and women. The highest incidence rate of kidney cancer during this period is noted in the older age group, as well as among men compared to women. Regional differences are observed, with the greatest increase in the Grodno region and a decrease or unclear trend in certain regions, such as the Gomel region.

Kidney cancer (KC) is one of the leading malignant neoplasms in oncourology, accounting for about 5% of cases among men and 3% among women. Annually, more than 400 thousand new cases and 175 thousand deaths from KC are registered worldwide. The risk increases from 40 years, reaching a peak at 70 years, with a predominance among men 3 times more often than among women. Incidence varies geographically: high in North America, Europe, Australia; low in Africa and Asia. [1-3]. In Belarus, the problem is relevant due to risk factors such as smoking and obesity. Early symptoms are often imperceptible, leading to late diagnosis and metastases in 30-40% of cases. Based on the above, the aim of our work was to assess the incidence of kidney cancer among the male and female population of the Republic of Belarus.

The data obtained by us show that the incidence of kidney cancer in the population of the Republic of Belarus in 2023 was 4.75% of all localizations. Since 2014, it has grown by 0.55%. The highest incidence rate in 2023 was observed in the age range of 60-79 years. It was 59.16% among the male population, and 62.74% among the female population. The lowest incidence of kidney cancer was observed among men (1.54%) and women (2.02%) aged 20-39 years. The morbidity rate of the population of the Republic of Belarus increased by 44.23% among the urban population and by 56.47% among the rural population from 2014 to 2023. The most noticeable increase was observed among urban residents in the Grodno and Minsk regions – by 1.8 – 2.1 times compared to other regions. In Gomel region, there was also an increase in morbidity among men and women in urban areas, and in Mogilev region – mainly in rural areas. In contrast, in the Grodno, Brest and Vitebsk regions, the incidence was higher among the rural population. In the Vitebsk region, this difference reached 12.37%, mainly due to a twofold increase in morbidity rates among women. Among all regions of Belarus, the highest incidence of kidney cancer in 2023 was recorded in the Grodno region among both urban and rural residents. Urban residents in the Gomel region have the lowest, while rural residents in Mogilev region have the lowest.

Thus, based on all the data presented in the study, it is shown that kidney cancer incidence has a steady increase in Belarus, especially among men and in older ages, with regional differences between urban and rural populations. KC remains a significant problem requiring improved prevention, early diagnosis, and consideration of risk factors.

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THE IMPACT OF ENVIRONMENTAL POLLUTION ON THE DEVELOPMENT OF PERINATAL PATHOLOGY

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This article examines the influence of environmental pollution on the development of perinatal pathology in the population of the Republic of Belarus.

Keywords: perinatal pathology, pollution, perinatal period, ecology

Perinatal pathology refers to pathological conditions and diseases that arise from the moment of germ cell maturation, conception, and throughout the perinatal period. The perinatal period includes the time from the 22nd week of gestation until birth, the period of birth itself, and the early neonatal period, ending 7 days after birth. Perinatal pathology includes congenital anomalies, asphyxia, birth trauma, intrauterine infections, central nervous system lesions, and other disorders affecting the viability and health of the child [5].

The problem of perinatal pathology remains one of the most pressing issues in modern medicine. Adverse environmental factors are increasingly cited among its leading causes. Air, water, and soil pollution, as well as exposure to chemical substances of anthropogenic origin, create risks for the health of pregnant women and fetuses, contributing to the development of pregnancy complications and intrauterine developmental disorders. Issues related to the impact of ecology on perinatal health are particularly important for urban regions with high levels of pollution, where pregnant women and newborns are at greater risk [1].

Environmental toxicants can affect the mother and fetus through various routes: inhalation (via air), orally (via food and water), and transdermally (via skin). These substances are capable of penetrating the placental barrier, accumulating in fetal tissues, and causing congenital anomalies [3].

The main components of anthropogenic pollution include fine particulate matter (PM2.5 and PM10), nitrogen oxides, carbon monoxide, heavy metals, as well as persistent organic compounds – phthalates, pesticides, and bisphenol-A. Under their influence, processes of oxidative stress are activated, endothelial functions of placental vessels are disrupted, and hormonal regulation of pregnancy is altered. As a result, preconditions are created for the development of chronic fetal hypoxia, placental insufficiency, and premature birth. Some compounds possess mutagenic and epigenetic effects, which can affect the child's health [2].

Reducing the negative impact is possible only through the integration of medical and environmental approaches. Key aspects include: monitoring the state of the environment and assessing individual ecological risk for pregnant women, informing women about ways to reduce household toxic exposure, and efforts aimed at reducing emissions and improving air quality [4].

Thus, environmental pollution is an important determinant of perinatal morbidity, influencing pregnancy outcomes and the subsequent health of the child. Awareness of the role of ecological factors and the implementation of preventive measures can significantly reduce the prevalence of perinatal pathology and improve the demographic indicators of society.

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MAIN FACTORS CONTRIBUTING TO THE DEVELOPMENT OF A DEFICIENCY OR EXCESS OF SELENIUM IN THE HUMAN BODY

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The relevance of selenium research in biology stems from its specific, vital functions, including reducing the risk of certain cardiovascular diseases; preventing heavy metal accumulation in animals; the use of certain organic selenium compounds for the prevention and treatment of cancer; and its high antioxidant activity, which is 500-1000 times greater than that of alpha-tocopherol (vitamin E).

Keywords: selenium excess and deficiency, pathologies, Se doses, toxicity.

Pathologies associated with Se deficiency are rare, particularly due to the widespread use of Se-containing dietary supplements in regions with low Se soil levels (Tibet, some regions of China). Se deficiency leads to decreased appetite, stunted growth, and decreased overall muscle mass. It also affects the thyroid, cardiovascular, and immune systems and can cause infertility, among other things. Severe selenium deficiency in the food chain leads to the development of specific endemic diseases, such as Keshan disease (cardiomyopathy) and Kashin-Beck disease (osteochondropathy) in humans, as well as myopathy and general muscular dystrophy in animals.

The important role of Se in maintaining human health has been demonstrated in patients with muscular dystrophy. Specifically, symptoms of this disease disappeared in patients receiving Se through parenteral nutrition (intravenous injections). Currently, dietary supplements containing Se are considered an integral part of parenteral nutrition [3].

The pathological effects associated with Se deficiency in vivo are due to a decrease in the production of vital selenoproteins. Animal studies have shown that inhibition of the biosynthesis of certain selenoproteins or Se-specific transporters leads to a significant increase in intracellular free radical levels, leading to cell death and, therefore, is incompatible with life [1].

The symptoms of Se poisoning (selenosis) are well studied in humans and animals. An extremely high dose of Se ingested in the diet over a short period of time causes acute toxicity, rapidly leading to death. However, moderately elevated Se intake over a longer period causes chronic selenosis, characterized by weight loss, hair loss, changes in nail structure, dermatitis, gastrointestinal disturbances, decreased fertility, and abnormalities in offspring.

Se toxicity can be caused by the nonspecific substitution of sulfur for Se in sulfur-containing amino acids and subsequent changes in the tertiary structure of proteins. According to another hypothesis, an increased concentration of Se disrupts the oxidation-reduction balance in the body with all the ensuing consequences [2].

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USE OF PLATELET-RICH PLASMA IN THE TREATMENT OF EXPERIMENTAL ANIMALS (RATS) WITH ACUTE NECROTIZING PANCREATITIS

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The management of acute necrotizing pancreatitis (ANP) remains a challenging problem in abdominal surgery, with persistently high patient mortality rates reaching 15-40%. This study explores the possibility of using a plasma-derived biologic product, platelet-rich plasma (PRP), for local adjuvant therapy of ANP, aimed at reducing the inflammatory process and enhancing the regeneration of pancreatic tissue.

Keywords: platelet-rich plasma, acute necrotizing pancreatitis, rats.

Acute pancreatitis is a polyetiological disease characterized by the development of aseptic demarcation-type inflammation. The pathogenesis of this condition is based on pancreatocyte necrobiosis and enzymatic autoaggression, followed by necrosis and dystrophy of the pancreatic parenchyma. The severity of the disease is determined by the intensity of three pathogenetic mechanisms: intracellular activation of pancreatic enzymes via the trypsin-dependent pathway, direct damage to the organ's tissue structures with the development of coagulative necrosis, and intensification of the systemic inflammatory response with the release of pro-inflammatory cytokines.

Among the new directions in the biotherapy of ANP, the use of PRP is of interest. PRP is a biological product obtained by centrifuging whole blood, containing a 3-5 fold concentration of platelets. PRP is a lysate of concentrated platelets, enriched with growth factors (PDGF, TGF-β, VEGF, EGF), cytokines, and chemokines, which provide suppression of inflammation, stimulation of angiogenesis, and remodeling of damaged tissue and organs. The supraphysiological concentration of bioactive substances in PRP allows it to suppress inflammatory reactions, stimulate angiogenesis, and remodel damaged tissues, thereby potentiating natural reparative mechanisms.

Preclinical studies in animals allow for the evaluation of the biological activity, safety, and efficacy of new biological products. Modeling ANP in rats using detergents corresponds to the pathogenesis of acute pancreatitis in humans. The histological picture of ANP is characterized by foci of necrosis in the pancreas, as well as lung and liver damage, and changes in peripheral blood characteristic of sterile inflammation.

The application of PRP via local injection into the affected area of the pancreas demonstrates a complex therapeutic effect, including local stimulation of regeneration and a pronounced systemic anti-inflammatory response. Available literature data indicate both local and systemic effects of PRP: local administration leads to improved histological architecture and function not only of the pancreas but also of distant organs (e.g., lungs, liver), along with a significant decrease in the level of pro-inflammatory cytokines in the systemic circulation. These positive changes correlate with increased survival and improved integral indicators of the quality of life in animals with an ANP model.

The results of preclinical studies on PRP indicate the promise of its local application in ANP. Clinical studies are required to determine the treatment regimen for its use to achieve a favorable clinical effect.

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INFLUENCE OF SLEEP ON HUMAN HEALTH

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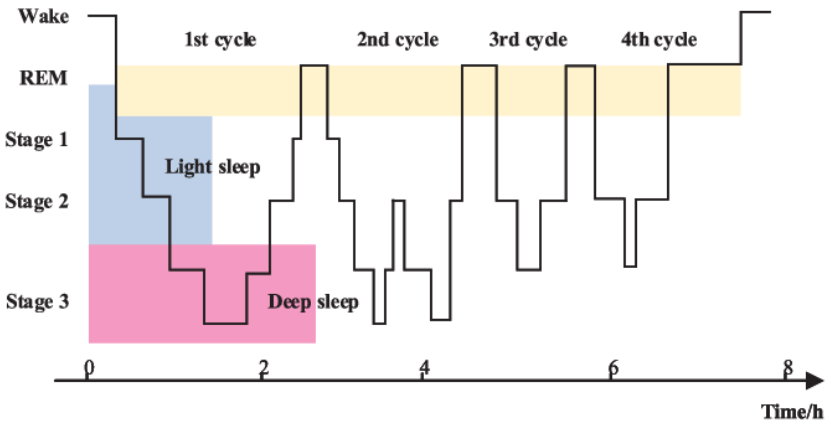
This article examines the influence of sleep quality and duration on a person's physical and mental health.

Keywords: sleep, health, physiology, cognitive functions, chronic diseases.

Sleep is a complex and vital biological process that has a profound impact on all aspects of human health. Sleep quality is directly linked to the functioning of the immune, endocrine, cardiovascular, and nervous systems. Chronic sleep deprivation is a risk factor for the development of numerous diseases, including obesity, type 2 diabetes, depression, and cardiovascular pathologies [1].

Key physiological processes such as tissue repair, memory consolidation, and the production of key hormones (e.g., growth hormone and melatonin) occur primarily during sleep. The slow-wave sleep stage is critical for physical restoration, while the REM sleep stage is closely associated with emotional processing and cognitive functions [2].



Ris. 1 – Cyclic alternation of slow and rapid sleep stages in humans

Sleep disorders, such as insomnia or obstructive sleep apnea syndrome, lead to sleep fragmentation and a reduction in its restorative function. This manifests as daytime fatigue, decreased concentration, impaired memory, and increased irritability. Long-term sleep restriction (less than 7 hours per night for an adult) causes metabolic disturbances, increasing cortisol levels and reducing insulin sensitivity.Optimizing sleep patterns and sleep hygiene is the key to maintaining health, improving productivity, and enhancing quality of life. Adhering to a regular schedule, creating comfortable sleep conditions, and managing stress are effective measures for preventing sleep disorders [2].

The study of sleep mechanisms and its influence on the body continues to reveal new opportunities for the prevention and therapy of a wide range of diseases, making somnology one of the most promising fields in modern medicine.

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METHODS OF ISOLATION OF DENDRITIC CELLS

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This article describes methods for isolating dendritic cells: monocyte cultivation, use of immunoregulatory drugs and biological agents, immunomagnetic separation.

Keywords: dendritic cells, cultivation, biological agents, immunomagnetic separation.

Dendritic cell isolation is used to study their functions, interactions with other cells, and the development of therapeutic vaccines.

There are several methods that allow you to obtain dendritic cells of varying degrees of purity and maturity. The choice of method depends on the purpose of the experiment, the availability of equipment, and the required number of cells. The aim of the study was to investigate methods for isolating dendritic cells.

Monocyte culture. This process allows for the isolation of monocytes from human or animal blood, followed by their differentiation into dendritic cells, which play a crucial role in activating the immune response. The main steps involved in monocyte culture include cell isolation (using centrifugation to separate monocytes from peripheral blood), culture, dendritic cell activation, and cell collection and analysis [1].

Application of immunoregulatory drugs and biological agents. Immunoregulatory drugs and biological agents that can induce immunological tolerance in dendritic cells include IL-10, TGF-B, G-CSF, PGE2, histamine, vitamin D, and its analogues, glucosamine, HLA-G, and cobalt protoporphyrin, which induces the expression of heme oxygenase-1 (HO-1). In addition, different immunosuppressive drugs, such as corticosteroids, cyclosporine, tacrolimus, rapamycin, aspirin, deoxynergualin, and mycophenolate mofetil, have been used to modulate the differentiation and functional activity of tolerogenic dendritic cells. Typically, these molecules can prevent the maturation and/or activation of dendritic cells, as well as reduce the production of IL-12 by dendritic cells [2].

Immunomagnetic separation of cells – method allows for the isolation of cells, proteins, and nucleic acids by specifically capturing biomolecules using small magnetized particles, beads containing antibodies and lectins, attached to them. These beads are coated with a substance that binds to the target biomolecules, which are then carefully separated and subjected to multiple washing cycles to obtain the target molecules bound to these superparamagnetic beads, which can be differentiated based on the strength of the magnetic field and the target molecules. They are then eluted to collect insufficient liquid, and the concentration of the target biomolecules can be determined. Immunomagnetic separation allows for the specific concentration of target molecules in target bacteria.

Thus, the study, use, and isolation of dendritic cells opens up new horizons for the development of vaccines and immunotherapies, including cancer and infectious disease therapies. They can also be used in research to model immune diseases and test new medications [3].

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EPIDEMIOLOGICAL ANALYSIS OF THE INCIDENCE OF MALIGNANT NEOPLASMS OF THE UPPER JAW

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The work shows that the risk of developing malignant neoplasms of the upper jaw is higher among the male population than the female population. High rates of detection of malignant neoplasms in stage IV in 2023 were revealed. Nationwide (for all forms and stages of neoplasms), the five-year adjusted patient survival rate increased from 22.7% in 2014 to 32.7% in 2023. Survival rates depend on the stage at which the disease was detected.

Keywords: oncoepidemiology, upper jaw, morbidity, five-year survival rate.

The problems of timely diagnosis and radical treatment of malignant tumors of the head and neck are becoming relevant all over the world due to the increasing incidence in the last decade. Due to the rapid increase in the incidence, the Republic of Belarus is included in the group of countries with a high risk of developing malignant neoplasms of the head and neck [1].

It should be noted that the nasal cavity and paranasal sinuses are in a complex anatomical and topographic relationship with the oral cavity, which is why the malignant tumor is rapidly spreading to neighboring structures and several areas are already infiltrating by the time of recognition, in addition, the early symptoms of a malignant disease are often identical to those of chronic inflammatory processes, or there is an asymptomatic course of the initial stage diseases [2].

The epidemiological situation in malignant neoplasms involving the maxilla in the pathological process in the Republic of Belarus has been characterized by a slight decrease in morbidity over the last more than ten years (a rough intensive indicator, a standardized World indicator). This incidence rate is noted among both the male and female populations. Given the tendency to increase life expectancy, as well as the phenomenon of aging, an increase in the number of cancer cases in the study area should be expected. This is evidenced by the dynamics of the registered incidence.

The aim of the work is to analyze the main statistical indicators of the incidence of malignant neoplasms of the upper jaw in the Republic of Belarus for the period from 2014 to 2023.

In general, for the entire group of malignant neoplasms (C03.0, C05.0, C31.0), the risk of the disease is higher among the male population than the female.

High rates of detection of malignant neoplasms in stage IV have been revealed. In 2023, 64.3% of neoplasms of the hard palate were diagnosed in stage IV of the disease, 71.9% of the maxillary sinus and 81.3% of the upper jaw gum. Thus, the frequency of diagnosis of malignant neoplasms in stages III-IV increased from 58.9% in 2014 to 78.3% in 2023 (an increase rate of +19.4%). At the same time, it should be noted that the use of modern diagnostic capabilities (CT, MRI, PET-CT) leads to the detection of small distant metastases, clarification of the local spread of the tumor, and, accordingly, to an increase in the proportion of cases of late diagnosis.

Nationwide (for all forms and stages of neoplasms), the five-year adjusted patient survival rate increased from 22.7% in 2014 to 32.7% in 2023. Survival rates depend on the stage at which the disease was detected. High survival rates are detected in the group of patients treated under the radical program, the 5-year adjusted survival rate among those treated under the radical program increased from 35.1% in 2014 to 40.9% in 2023. Surgical removal of a neoplasm in the upper jaw area with the formation of an oronasal and orosinous communication leads to the need for prosthetics of the resulting defect, which requires the provision of qualified and timely dental and orthopedic care.

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EFFECT OF REGULAR PHYSICAL ACTIVITY OF VARYING INTENSITY ON LIFE EXPECTANCY

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The aging process is a complex biological process associated with deterioration of physiological functions and increased susceptibility to diseases. Physical activity is a key factor that can slow down aging and increase life expectancy. Studies show that even moderate physical activity significantly improves overall health and slows down the aging process, emphasizing the importance of an active lifestyle [1, 3].

Keywords: aging; physical activity; markers; life expectancy.

The World Health Organization emphasizes the importance of physical activity for maintaining health and preventing diseases, recommending that adults engage in physical activity for at least 150 minutes per week [2].

The study, which involved 40 people, whose age group ranged from 18-61 years, collected data on the frequency of physical activity, preferred types of physical activity and their opinion on the impact of physical activity on overall health and aging processes.

The effect of regular physical activity of varying intensity on markers of aging and life expectancy has been analyzed. The majority of respondents (56.1%) were under the age of 20, reflecting the younger generation's interest in physical health, while 19.5% belong to the 31-40 age group, which broadens the understanding of the impact of activity on different age categories.

The frequency of classes showed that 53.7% rarely practice (1-2 times a month), while 24.4% train 3-4 times a week, indicating a group actively leading a healthy lifestyle. Cardio was the most popular (58.5%), strength training was the most popular among 13 participants.

The majority (80.5%) positively assess the impact of physical activity on overall health, while 78% believe that sport slows down aging. At the same time, 78.1% rate their health higher than that of sedentary people, confirming the importance of an active lifestyle for health and well-being.

Thus, the majority of respondents of different ages recognize the benefits of physical activity for improving well-being and consider their health to be better than those who lead a sedentary lifestyle. These data indicate that regular physical activity of varying intensity is perceived by people as a significant factor in maintaining health and slowing down aging, which is important for improving the quality and longevity of life [4, 5].

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ANALYSIS OF HUMORAL IMMUNE RESPONSE IN HEALTHY DONORS

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This article discusses the definitions of standard and additional indicators of the humoral immune response in a group of conditionally healthy donors.

Keywords: B-lymphocytes, immunoglobulins, humoral immune response.

Studies have shown that antibody levels in healthy donors vary depending on age, gender, and other factors. On average, IgG levels are the highest among all classes of antibodies, which indicates the presence of immune memory and previous contact with antigens. IgM levels tend to be higher in young people, which may indicate a more active humoral response to new infections. It was also noted that in donors with chronic diseases, the level of antibodies may be reduced, indicating possible abnormalities in the humoral immune response. This highlights the importance of regular monitoring of immune response parameters in donors, especially before transfusions or transplants [2].

A comparative analysis of the results obtained with the literature data showed that the reference intervals for most indicators correspond to the results of other studies. However, there was some difference in the concentration of serum IgG in donors permanently residing in Minsk, compared with the literature data.

The number of B lymphocytes and their subpopulations in the peripheral blood of healthy donors was determined by flow cytometry using monoclonal antibodies to CD19 and CD5 membrane antigens [1].

The percentage of B-lymphocytes in peripheral blood varies from 4.8 to 18.7%. In this case, the predominant population in the bloodstream are B2 lymphocytes expressing CD19 glycoprotein. B1 lymphocytes, along with the presence of CD19 on the cell surface, express the T-cell antigen CD5 and, accordingly, are characterized by the CD19+5+ phenotype. The number of B1-lymphocytes in peripheral blood is very low and does not exceed 2.5% of all circulating lymphocytes.

The results obtained in the study of healthy donors in Minsk are fully consistent with the data presented in the literature. According to the data of S.V. Khaidukov and co-authors for 2009, the normal number of CD19+ B-lymphocytes is 7-17%, B2–lymphocytes - 6.5-14.9%, B1–lymphocytes - 0.5–2.1%.

Immunoglobulins are globular proteins that are contained in blood serum and other body fluids, and have the ability to specifically interact with an antigen.

Immunoglobulins exist in the form of circulating antibodies, receptors on immunocompetent cells. There are five classes of immunoglobulins: IgG, IgA, IgM, IgD, and IgE. Despite the variety of classes of immunoglobulins, they all have the same structure. Each class differs in structure, antigenic composition, and function. Each class has a unique specificity, but they are involved in different immunological reactions to varying degrees [2].

It was found that the reference range for serum IgG concentration in donors permanently residing in Minsk does not match the literature data, while the reference ranges for other indicators correspond to the results of other studies described in the literature.

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NEURODEGENERATION: EFFECT OF EXOGENOUS TOXINS AND CHRONIC STRESS

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Neurodegenerative diseases (NDDs) are a group of central nervous system (CNS) pathologies characterized by the progressive loss of neuronal structure and function. Their etiology is multifactorial and includes genetic predisposition and environmental factors. This article examines the contribution of exogenous neurotoxins and chronic stress as modifiable risk factors, and the mechanisms through which a beneficial external and internal ecology provide neuroprotection. [1].

Keywords: Neurodegeneration, neurotoxins, chronic stress, neuroprotection

The progressive aging of the population is increasing the prevalence of NDDs, such as Alzheimer's disease (AD), Parkinson's disease (PD), and amyotrophic lateral sclerosis (ALS), posing a serious challenge to modern healthcare.

Exogenous Neurotoxins and their Impact on the Brain. Exposure to various chemical agents from the environment is an established risk factor for the development of several NDDs. Their mechanisms of action include the induction of oxidative stress, neuroinflammation, mitochondrial dysfunction, and direct damage to neurons.

• Atmospheric Air Pollution (AAP): Components of AAP (particulate matter PM2.5, NO2, polycyclic aromatic hydrocarbons) can penetrate the CNS through the olfactory tract and the blood-brain barrier (BBB). Epidemiological studies link prolonged exposure to AAP with an increased risk of AD and PD. [1]

• Heavy Metals: Lead (Pb), mercury (Hg), and potentially aluminum (Al) are neurotoxic elements. They cause oxidative stress, mitochondrial dysfunction, disrupt calcium homeostasis, and promote the aggregation of toxic proteins, which is associated with the pathogenesis of various NDDs.

• Pesticides and Herbicides: Certain classes of agrochemicals, particularly organophosphates, paraquat, and rotenone, demonstrate neurotoxicity. They cause mitochondrial dysfunction and oxidative stress, selectively damaging dopaminergic neurons, which serves as a model for studying PD.

• Industrial Chemicals and Endocrine Disruptors: Bisphenol A (BPA), phthalates, polychlorinated biphenyls (PCBs) can disrupt neurodevelopment, synaptic plasticity, and contribute to neuroinflammation by affecting hormonal balance and signaling pathways in the brain.

• Mycotoxins: Toxins produced by certain types of mold can cause chronic inflammation and neurological dysfunction, including cognitive impairment

Chronic psychoemotional stress represents a potent modifiable risk factor for the development of NDDs, affecting the brain through activation of the hypothalamic-pituitary-adrenal (HPA) axis and associated neuroendocrine and immune changes.

The way we live directly impacts brain health. Neurodegenerative processes develop slowly, and over a long period, we can actively influence them, resisting the development of diseases. Simple yet regular actions in daily life help to delay the manifestation of hereditary predisposition [2].

Lifestyle and the environment significantly influence how quickly the brain will lose its functions. The concept of "ecology" in the context of neuroprotection encompasses both minimizing exposure to adverse external factors and optimizing the internal physiological environment of the body through lifestyle.

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ANALYSIS OF THE PREVALENCE OF UROGENITAL DISEASES AMONG THE POPULATION OF THE REPUBLIC OF BELARUS

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The study shows that circulatory diseases rank first in the morbidity structure of the population of the Republic of Belarus (25.8%), respiratory diseases rank second (17.6%), and genitourinary diseases rank third (7.4%). Furthermore, it has been established that genitourinary diseases are most common in the 65-69 age group among both men and women, while the lowest incidence rate is observed among those aged 15-19.

Keywords: prevalence of genitourinary diseases, incidence, status, incidence dynamics, population, growth rate.

Genitourinary diseases are common conditions affecting people of all ages and, according to medical statistics, rank fourth, behind heart disease, respiratory disease, and cancer. Due to their anatomical and physiological characteristics, the genitourinary system is susceptible to a number of factors, both endogenous and exogenous.

The urinary system consists of the organs that produce and excrete urine. They are responsible for filtering the blood and removing excess fluid and metabolic waste from the body. The organs that make up the urinary system are identical in men and women: two kidneys, two ureters, a bladder, and the urethra. The kidneys constantly filter the blood, removing excess water, waste, and toxic substances. Electrolytes (sodium, potassium, calcium, and chloride) and nutrients are returned to the bloodstream. On average, the kidneys clear the entire circulating blood volume of the body in 5 minutes. Each kidney is connected to the bladder through a special tubular structure called the ureter. The ureter transports urine to the bladder, where it is stored until the brain signals the bladder muscles to contract and the muscles of the urethra, which exits the bladder, to relax. This allows urine to flow forcefully from the urethra.

General incidence of genitourinary diseases in the Republic for 2019-2023 amounted to 2019- 68.3%; 2020 - 61.05%; 2021 - 61.65%; 2022 - 65.99%; 2023 - 66.33%, which is 64.7% per 100,000 population. Among urological diseases, the prevalence of urolithiasis (33.9%), chronic pyelonephritis (15%), onco-urological diseases (19%) is noted, the prevalence of renal dysfunction reaches (5%), cystitis (27.1%). There is an increase in the number of patients with prostate diseases. In the structure of morbidity of the population of the Republic of Belarus, the 1st place is occupied by diseases of the circulatory system 25.8%, 2nd place - respiratory diseases 17.6%, 3rd place - diseases of the genitourinary system - 7.4%. Urogenital diseases are most common in the 65-69 age group among both men and women, with the lowest incidence rates observed among those aged 15-19. The increase in incidence is most pronounced among men. In urban areas, the incidence rate is lower than in rural areas, due to more accessible and high-quality diagnostics. The incidence of malignant tumors of the genitourinary system has also increased significantly among the population of the Republic of Belarus. Based on the analysis of the obtained results, it can be seen that the problem of urolithiasis remains extremely pressing today. Over the study period from 2019 to 2023, the incidence rate in the Republic of Belarus decreased slightly.

Similarly, global medical statistics indicate that genitourinary diseases have been steadily increasing in recent years. These diseases affect people of all ages, genders, and social statuses, indicating that the phenomenon is widespread.

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ANALYSIS OF MORBIDITY IN THE CHILDREN'S POPULATION SERVED BY THE BOBRUISK CITY CHILDREN'S POLYCLINIC

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A retrospective analysis of morbidity rates among children served by the Bobruisk City Children's Polyclinic No. 2 from 2019 to 2023 was conducted. A steady increase in morbidity was revealed. Among all cases, the most frequent cases are recorded in children aged 5-9 and 10-14 years. Overall morbidity rates in children aged 1-4 and under one year are significantly higher than in older children. The overall morbidity patterns of the child population served are determined by respiratory diseases, endocrine diseases, nutritional and metabolic disorders, and diseases of the eye and adnexa.

Keywords: morbidity, child population, structure, dynamics, trends, growth rates.

Analyzing the level, structure, and dynamics of childhood morbidity is a crucial tool for assessing public health and the effectiveness of the healthcare system. Systematic research into childhood morbidity, including assessing its level, long-term dynamics, and structure, is driven by the need to identify key risk factors specific to a given region. The data obtained can serve as a scientific basis for substantiating management decisions and planning interventions to preserve and improve the health of the younger generation.

Based on official data on the incidence of children served by the Bobruisk City Children's Polyclinic No. 2 in 2019-2023, a retrospective analysis of primary morbidity was conducted, dynamics were analyzed, and key trends were identified.

When analyzing the dynamics of overall morbidity, a steady increase was revealed (R^2=0.7013) of overall morbidity. In 2019, the overall morbidity rate was 1746.4 cases per 1000 children, while in 2023, the rate increased to 1988.9 cases per 1000 children. The average annual overall morbidity rate (A0) was 1798.74 per 1000 children. The trend coefficient (A1) was 66.43 per 1000 children. The analysis shows that the most vulnerable age group is school-age children: those aged 5-9 and 10-14. At the beginning of the study period (2019), the proportion of total incidence in the 10-14 age group was 26.93%. It is worth noting that the proportion of children aged 5-9 had a proportion of 28.30%. At the end of the study period (2023), the proportion of total incidence among children aged 10-14 was 30.21%, and among children aged 5-9 – 28.84%. The smallest proportion of cases occurred in children under one year of age.

A comparative analysis of the average annual age-specific indicators of general morbidity in children served by the Bobruisk City Polyclinic No. 2 showed that the levels of general morbidity in children aged 1-4 years and up to one year are significantly higher than in older children.

In the structure of the general morbidity of the child population served by the Health Institution “Bobruisk City Children’s Polyclinic No. 2”, the first places in the ranking are occupied by diseases of the respiratory system (60-63%), diseases of the endocrine system, nutritional disorders and metabolic disorders (11-12%), diseases of the eye and its adnexa (5%).There is a tendency towards an increase in the dynamics of incidence rates for all of the above-mentioned nosologies.

Thus, the conducted analysis demonstrates the need for a prompt response to existing trends. Identifying priority disease classes will facilitate further targeted interventions and formation of priority vectors for the development of programs to improve the health of this age group.

EFFECT OF PROLONGED Γ-IRRADIATION ON THE STRUCTURAL AND FUNCTIONAL CHARACTERISTICS OF HEMOGLOBIN IN EXPERIMENTAL ANIMALS

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Hemoglobin (Hb) is the main component of red blood cells and performs specific functions: it performs gas exchange, participates in maintaining blood pH, and performs antioxidant functions. The structural and functional characteristics of Hb are important for performing these functions. In the post-radiation period, the intrinsic fluorescence Hb, the energy of the excited state, changes in waves (from decrease to increase). In the nearest time after training, the efficiency of extinguishing the energy of tryptophanils of hydrophobic hemoglobin zones with the 1,8-ANS acceptor decreased, indicating a denser packaging of these areas. Studies on day 30 showed that conformational rearrangements of hemoglobin are reversible.

Keywords: Prolonged γ - irradiation, red blood cells, hemoglobin.

The object of the study was the hemoglobin of rats exposed to prolonged radiation for 42 days. The age of the subjects at the beginning of the experiment was 120 days. Animals were tested on days 3, 10.30 of the affected period. Animals of appropriate age were used as controls. Prolonged irradiation was carried out at the GAMMARID-192/120 installation from a cesium source with a dose rate of $2.8 \cdot 10^{-7}$ Gy/s to a total absorbed dose of 1 Gy.

The conformational state of hemoglobin was evaluated by its intrinsic protein fluorescence, as well as by the kinetic characteristics of the interaction of hemoglobin molecules with the fluorescent probe 1-anilino-8-naphthalene sulfonate (1,8-ANS). Hemoglobin molecules have the property of radiative deactivation of an externally stimulated singlet electron-excited state (fluorescence), which is due to the presence of aromatic amino acids in the molecule, among which tryptophan makes the greatest contribution to this phenomenon. Changes in the structural characteristics of the protein, which determine the violation of the microenvironment of chromoform amino acids, are reflected in a change in the parameters of the protein's own fluorescence. As follows from the presented data, the intensity of the intrinsic fluorescence of Hb on the 3rd day after irradiation drops by 20%, but increases on the 30th day. Post-radiation changes are noted not only for the energies of the main, but also the excited state of hemoglobin. The pattern of structural post-radiation changes in hemoglobin can be analyzed using a 1,8-ANS fluorescent probe capable of quenching tryptophan fluorescence when bound to positively charged regions of the protein. The efficiency of fluorescence quenching by the acceptor is determined by the type of tryptophan amino acids involved in energy transfer. Type 1 - sedentary forms of tryptophanils, located mainly in hydrophobic zones, λ_{vials} = 330-332 nm. Type 2 - tryptophanils oriented in the polar regions, their mobility is limited by interaction with water dipoles λ_{vial} = 340-342 nm. Type 3 - polar mobile tryptophanils, weakly interacting with water λ_{vial}. = 350-352 nm. An ANS fluorescent probe capable of interacting with positively charged protein regions of both hydrophilic and hydrophobic zones preferably penetrates and binds at the hydrophobic regions. In this regard, the compared values of tryptophanyl fluorescence quenching with the 1,8-ANS acceptor (Fo - fluorescence in the absence of 1,8-ANS and F - in the presence) were evaluated at λ_{vials} = 330-335 nm. It was revealed that on days 3 and 10 after training, the effectiveness of extinguishing the energy of tryptophanils of the hydrophobic zones of hemoglobin with the 1,8-ANS acceptor decreased, indicating a denser packaging of these areas. Studies on day 30 showed that these conformational rearrangements of hemoglobin are reversible.

The most common cause of post-radiation effects in biological molecules is peroxidation activation. It is known that certain ratios of various forms of hemoglobin, including the representation of its oxidized forms (methemoglobin, hemichrome) are necessary for the successful operation of adaptation mechanisms. Naturally, various forms of hemoglobin have certain structural features. Are there changes after irradiation in the ratio of hemoglobin forms, in particular, an increase in the representation of its oxidized forms and, therefore, the presence of post-radiation structural rearrangements at their expense? The data obtained indicate that the amount of methemoglobin after irradiation does not change, while, as previously shown, the concentration of Hb in the red blood cell increased significantly. Based on this, it can be assumed that the post-radiation attenuation of the interaction of 1,8-ANS with positively charged regions

in the region of heme pockets Hb may be due to changes in the availability of positive charges and sign modification in the surface regions of hemoglobin molecules.

SELECTION OF CULTURE MEDIA AND DISHES AS A TOOL FOR OPTIMIZING CULTIVATION CONDITIONS AND IMPROVING THE QUALITY OF PREIMPLANTATION EMBRYOS IN IVF

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Achievements in the field of in vitro fertilization (IVF) are due to deep knowledge in the field of embryonic physiology and metabolism, which makes it possible to develop improved conditions for the cultivation of preimplantation embryos. The relevance of medical environmental at the embryological stage of embryo cultivation increases in artificially created conditions.

Keywords: Infertility, IVF, OPU, in vitro fertilization, IVF laboratory, embryo toxicity, environmental factors, oocyte quality, embryo quality, MEA testing, embryo culture media, plastic toxicity.

Introduction

In the field of assisted reproductive technologies (ART), the most important issue in the study of embryonic development remains the influence of anthropogenic factors (chemical, physical, biological) on the preimplantation human embryo and the development of preventive methods, such as the creation and implementation of preventive measures to prevent the negative impact of the environment on the development of the embryo. Nutrient media play a crucial role in optimizing embryo cultivation in the early days of development, but a number of other factors are equally important: the purity of the air in the embryological laboratory, the plastic used, pH, temperature, osmolality, and the concentration of gases that create the necessary conditions to prevent stress and ensure optimal development and implantation [1-5].

The aim of the study was to create a healthy environment by optimizing the interaction with the environment of gametes and embryos during the preimplantation period of development in the light of the use of various cultural media.

Research materials and methods: a prospective cohort study was conducted, which included 43 pairs of patients undergoing infertility treatment at the Doctor D-IVF clinic between August 2024 and September 2024. The patients were treated with IVF/ ICSI with controlled stimulation of the ovaries with gonadotropins, aged from 20 to 45 years, the average age was 32.5 years (± 12.5 years). Ejaculated or microsurgically obtained spermatozoa of the spouses were used to fertilize the oocytes. In 36 cases, the programs resulted in the development of embryos to the blastocyst stage. The embryos were cultured in a Vitrolife EmbryoScope+ multigas time-lapse incubator at a temperature of 37^0C, with a CO_2 level of 6.2% and an O_2 level of 5.0%.

The separation of patients' gametes and embryos for cultivation in two different commercial media ("VV" and "VL") was carried out randomly. Of the 36 programs, the "VV" group includes 19 programs, and the "VL" group includes 17.

The composition of the media and the quality controls carried out were studied. All media underwent an osmolality test, pH control, bacterial endotoxins (LAL test), 1-cell analysis of mouse embryos (MEA test) and were filtered using an aseptic technique. Due to trade secrets, a full examination of the ingredients is not possible. The results of the study: a comparison of the cultivation results showed that in the "VV" group (N=19) fertilization rate was 57.0%, blastocyst rate was 58.9%, the utilization rate was 60.8%, and in the "VL" group (N=17) fertilization rate was 73.1%, blastocyst rate - 68.0%, utilization rate – 46.6% (Table 1). The differences are statistically significant ($p<0.05$)

According to the Vienna Consensus, the recommended values of efficiency indicators for fertilization rate are: competent - 65% and reference 80%, blastocyst rate - 40% and 60%.

Table

№	Groups	M2	2pN		Blastocyst		Utilization	
1	“VV” (n=19)	128	73	57.0%	43	58.9%	34	46.6%
2	“VL” (n=17)	171	125	73.1%	85	68.0%	76	60.8%

Conclusion: it was revealed that embryo cultivation in the "VL" medium showed better results in terms of fertilization rate, blastocyst rate and utilization rate than in the "VV" medium. The difference in indicators is statistically significant ($p<0.05$).

The study has a number of limitations, as it was conducted on a small sample of patients. Further research is needed.

Conclusions: achievements in the field of ART are due to in-depth knowledge in the field of embryonic physiology and metabolism, which makes it possible to develop improved conditions for the cultivation of preimplantation embryos in in vitro fertilization (IVF) procedures. Ovarian stimulation, egg production, sperm fertilization, embryo cultivation and transfer into the uterus affect normal embryonic development and are responsible for the outcomes of IVF programs.

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DEMOGRAPHIC AND BMI CHARACTERISTICS OF HEMODIALYSIS PATIENTS IN IRAQI PATIENTS INFECTED WITH HEPATITIS B VIRUS

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This study focuses on assessing demographic characteristics and body mass index (BMI) of patients infected with the hepatitis B virus (HBV) who are undergoing hemodialysis. The research aims to analyze their relationship with patient age, gender, and body composition.

Keywords: Hepatitis B virus, hemodialysis, demographic characteristics, BMI.

As of 2019, the World Health Organization (WHO) estimated that 296 million people were infected with the hepatitis B virus (HBV), making it a persistent global health issue [1]. Both acute and chronic forms of the infection are possible. The chronic stage, which is often asymptomatic at onset, can lead to severe complications such as cirrhosis, hepatocellular carcinoma, and ultimately liver failure.

This study was conducted to evaluate the demographic and BMI characteristics of patients undergoing hemodialysis at the City of Medicine Hospital (Iraq). The study included 20 patients (12 males and 8 females) selected based on eligibility criteria, including age, gender, and clinical condition. Participants were divided into three age groups: 50-59 years (5 patients), 60-69 years (7 patients), and 70-79 years (4 patients).

Data were analyzed using IBM SPSS 22 software with both descriptive and analytical statistical methods.

The mean demographic and anthropometric characteristics of the patients revealed an average age of 48.9 ± 16.5 years, indicating that the sample primarily consisted of middle-aged and older adults. The mean height was 176.5 ± 12.5 cm, and the average body weight was 91.6 ± 17.4 kg, suggesting that most individuals maintained a relatively high

nutritional status. The calculated BMI averaged 29.96 ± 8.0, placing a significant proportion of participants within the overweight category according to WHO classification. These findings indicate that, in addition to HBV infection and renal impairment, excess body weight may contribute as an additional risk factor influencing disease progression and metabolic stability.

The mean age of the total cohort was 65.0 ± 7.6 years, confirming that the majority belonged to an older age group - a known risk factor for renal complications and HBV progression. A slight male predominance (12 males vs. 8 females) was observed, consistent with broader epidemiological patterns of HBV-related disorders.

The obtained results suggest that older age and elevated BMI may exacerbate the metabolic burden in HBV-infected individuals undergoing hemodialysis. These parameters are likely to affect not only renal function but also the overall course of hepatic injury and recovery potential. Moreover, the predominance of overweight and elderly patients supports existing evidence linking obesity and age with increased vulnerability to both hepatic and renal dysfunction. Continuous monitoring of BMI and demographic indicators may therefore enhance risk stratification and facilitate personalized therapeutic approaches for HBV-positive patients on dialysis. Further research involving larger patient cohorts is needed to confirm these associations and explore the underlying biochemical mechanisms.

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CIGARETTE SMOKE EXTRACT AS MODEL FOR STUDYUNG OF TOBACCO ADDICTION

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This article describes a procedure for obtaining an aqueous extract of cigarette smoke by passing cigarette smoke through RPMI-1640 culture medium. Cigarette smoke extract can be used for preclinical studies on tissue and cell cultures to study the mechanisms of influence of smoking on cellular, biochemical and molecular genetic processes.

Keywords: smoking, experimental model *in vitro*, cigarette smoke extract

Smoking is a significant social problem in the Republic of Belarus, and its prevalence has increased over the past decade. According to the National Statistical Committee, in 2023, the number of smokers amounted to 22.1% of the total population. Animal models are used to study many human diseases, including the mechanisms of tobacco addiction. A limitation of such preclinical models is their incomplete coverage of cigarette smoke exposure, as they use only nicotine, even though tobacco smoke contains approximately 7000 other components. Furthermore, non-nicotine components of cigarette smoke have also been shown to play an important role, including enhancing the effects of nicotine. Consequently, experiments using nicotine alone do not allow for a full assessment of health risks. Preclinical models used to study tobacco addiction include inhalation of cigarette smoke, the use of smokeless tobacco extracts and cigarette smoke extracts [1, 2].

The aim of the study was to develop a method for obtaining an aqueous cigarette smoke extract.

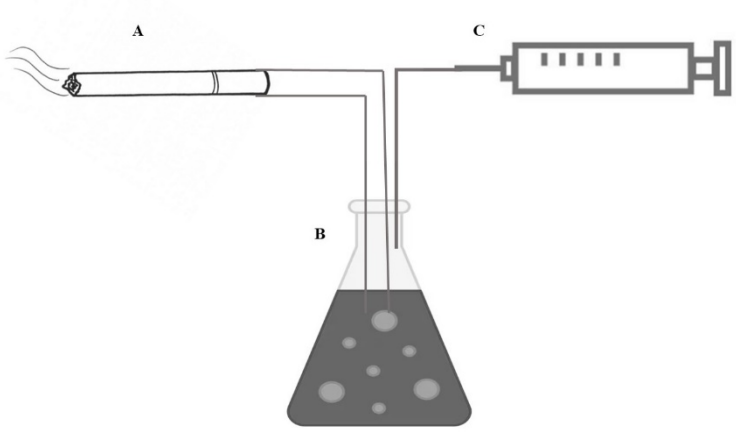

Fig. 1. Schematic representation of aqueous cigarette smoke extract generation

The scheme for preparing cigarette smoke extract is shown in figure 1. A cigarette (A) was inserted into one end of a polymer tube, and the other end was placed in a flask (B) containing 20 ml of sterile RPMI-1640 medium. Air was pumped out of the flask through another polymer tube using a 50 ml syringe (C). A roller clamp on the polymer tube was used to change the position of the syringe plunger. The extract was obtained from five cigarettes, filtered through a 0.22-μm filter, supplemented with 100 IU/ml penicillin and 100 μg/ml streptomycin. Aliquots of the resulting extract were stored at -80°C for further analysis. The described method for preparing cigarette smoke extract is cost-effective and highly reproducible in laboratory conditions. The resulting extract can be used to model the effects of cigarette smoke on cell cultures and tissues, as well as on experimental laboratory animals. The proposed model can be used to study the effects of cigarette smoke on oxidative stress, the functional activity of immune cells and respiratory system cells, the ability of cells to undergo tumor transformation, the effectiveness of the development of antibacterial and antiviral responses, etc.

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RETROSPECTIVE ANALYSIS OF THE INCIDENCE OF DIGESTIVE DISEASES IN THE ADULT POPULATION OF BOBRUISK (2019-2023)

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Abstract: The paper presents a retrospective analysis of the incidence of digestive diseases in the adult population of Bobruisk from 2019 to 2023 in terms of primary and general morbidity over time, and identifies the main trends.

Keywords: digestive diseases, general and primary morbidity, growth rates, prevention.

When analyzing the structure of the primary morbidity of digestive system diseases in the adult population of Bobruisk at the beginning of the study period (2019), it was revealed that the first rank was occupied by diseases of the esophagus, stomach, and duodenum (38.4%), the second place – by diseases of the gallbladder and biliary tract (25.6%), and the third place – by hernias (17.6%). By the end of the study period (2023), the rank distribution of digestive system diseases remained the same as in 2019. However, it is worth noting that the contribution of diseases of the esophagus, stomach, and duodenum to the structure of primary morbidity increased by 16.7% and amounted to 55.12%, while the contribution of diseases of the gallbladder and biliary tract and hernias decreased by 5.14% and 7.04%, respectively.

When analyzing the dynamics of the primary morbidity of diseases of the esophagus, stomach, and duodenum in the adult population, a trend towards an increase in incidence is observed. The average annual incidence rate was 28.15 per 10,000 adults, with an annual trend indicator of 8.67.

When analyzing the structure of the general morbidity of digestive system diseases in the adult population of Bobruisk at the beginning of the study period (2019), it was revealed that the first rank was occupied by diseases of the esophagus, stomach, and duodenum (65.51%), the second place was taken by diseases of the gallbladder and biliary tract (14.14%), and the third place was occupied by diseases of the pancreas (7.76%). By the end of the study period (2023), the rank distribution of the general morbidity of digestive system diseases remained unchanged. In first place were diseases of the esophagus, stomach, and duodenum (66.75%), in second - diseases of the gallbladder and biliary tract (14.78%), and third place was occupied by diseases of the pancreas (6.72%).

Thus, the greatest contribution to the structure of the morbidity of digestive system diseases in the adult population of Bobruisk is made by diseases of the esophagus, stomach, and duodenum.

During the analysis of the dynamics of the general morbidity of diseases of the esophagus, stomach, and duodenum in the adult population, a steady decrease in incidence was noted. However, from 2019 to 2023, the primary morbidity of diseases of the esophagus, stomach, and duodenum in the adult population increased 3.5 times.

It was noted that the general morbidity of diseases of the esophagus, stomach, and duodenum in the adult population exceeded the primary morbidity by an average of more than 15 times during the study period, and the general morbidity of hernias exceeded the primary morbidity by an average of more than 3.5 times during the study period.

During a quantitative assessment of the morbidity of digestive diseases in the population of Bobruisk from 2019 to 2023, it was noted that during the study period, the primary morbidity of digestive diseases in the adult population of Bobruisk was characterized by a steady increase; the general morbidity of liver diseases in the population had a tendency to a steady increase, while the morbidity of diseases of the esophagus, stomach, and duodenum and the pancreas had a steady tendency to decrease.

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THE INFLUENCE OF THE CHEMICAL STRUCTURE OF DEXTRAN- AND POLY-N-ISOPROPYLACRYLAMIDE-BASED STAR COPOLYMERS ON THE ADSORPTION OF TETRAPYRROLE COMPOUNDS

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Using fluorescence spectroscopy methods, the dependence of the sorption capacity of thermosensitive copolymers based on dextrans of various molecular weights and poly-N-isopropylacrylamide to Temoporfin on their phase state (coil/globule), regulated by temperature changes, was shown. Differences in the complexes stability of Temoporfin molecules with copolymers were established. It is assumed that differences in the interaction mechanism of copolymers with Temoporfin are determined by the structural characteristics of copolymers intermolecular aggregates.

Keywords: Temoporfin, thermosensitive copolymers, poly-N-isopropylacryliamide, dextran.

Thermosensitive polymers are high-molecular compounds capable of step nonlinear changes in their physical properties in response to variations in ambient temperatures. The most studied of their representative is poly-N-isopropylacrylamide, which undergoes a coil-globule phase transition in the region of the lower critical solution temperature (LCST). Materials based on it are used in industry to remove contaminants from water, to manufacture sensor materials, to create gel electrolytes and in other areas.

The aim of this work was to study the interaction processes features of copolymers based on dextrans of different molecular weights (M_w = 6 10^3 and M_w = 7 10^4 g/mol) and poly-N-isopropylacrylamide (D6P and D70P) and the photosensitizer (PS) Temoporfin.

Previously, a method for assessing the complexes stability and the PS release rate constant was developed, based on the analysis of the Temoporfin spectral characteristics associated with copolymers of dextran and poly-N-isopropylacrylamide [1]. It was established that in an aqueous solution at temperatures below the LCST, no adsorption of Temoporfin by D70P and D6P macromolecules is observed (the copolymers are in a statistical coil conformation), while the PS molecules in the solution are in an aggregated state. It was established that in an aqueous solution at temperatures below the LCST, no adsorption of Temoporfin by D70P and D6P macromolecules is observed (the copolymers are in a statistical coil conformation), while the PS molecules in the solution are in an aggregated state. At the same time, a sharp increase in the D70P and D6P affinity to Temoporfin is observed, as a result of which the PS is completely bound by the polymer globule. It takes less than a minute for the PS molecules to be incorporated into the copolymer globules. It was found that the spectral-fluorescent characteristics of Temoporfin (relative fluorescence quantum yield, shape and position of the fluorescence excitation and emission spectra, etc.) in the composition of complexes, D70P and D6P are practically identical.

The Temoporfin rate release upon dilution of PS complexes with copolymers was assessed. It has been shown that almost all Temoporfin molecules remain in the D70P copolymer globule for 24 hours, while complete Temoporfin dissociation from D6P is observed within 4 hours. The observed differences are probably due to the rheology of the copolymer globules. A poly-N-isopropylacrylamide molecules denser grafting in the D6P copolymer prevents the implementation of a complete coil-globule phase transition, which leads to a reduction in steric hinderance [2].

The obtained data indicate that thermosensitive copolymers based on dextran and poly-N-isopropylacrylamide can be used as adsorbents in water purification.

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LACK OF SLEEP AND ITS IMPACT ON THE HUMAN BODY

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The article examines the problem of sleep deprivation and its impact on the human body. Despite extensive research on the issue of insufficient sleep, the number of people with chronic sleep deprivation is increasing. It is estimated that approximately 35% of the global population suffers from chronic sleep deprivation.

Keywords: sleep, performance, and lifestyle.

About 34% of our lives are spent sleeping, a physiological process that is essential for our survival. Sleep is a period of active rest and recovery, during which our metabolism slows down, our muscle tone weakens, our nervous system slows down, and the formation of new neural connections in our brains slows down. Lack of sleep increases our risk of death and cardiovascular diseases, as well as diabetes. If you sleep less than 6 hours per day and suffer from insomnia, your risk of dying from cardiovascular diseases increases by 48%, and your risk of dying from a stroke increases by 15% [1].

Insufficient sleep is a condition in which a person consistently sleeps less than what is necessary for proper rest and recovery. The recommended sleep duration varies depending on age, individual characteristics, and other factors, but it typically ranges from 7 to 9 hours for adults. Chronic sleep deprivation can manifest in various forms, such as reduced sleep time, interrupted sleep, and disrupted circadian rhythms (e.g., shift work). Insufficient sleep has significant implications for various aspects of human health, including physiological, cognitive, and emotional consequences.

The physiological consequences of sleep deprivation include a weakened immune system. People who suffer from sleep deprivation are more likely to develop colds, flu, and other infections. Additionally, there is an increased risk of inflammatory bowel diseases due to the disruption of the gut microbiome caused by insufficient sleep. There may also be hormonal imbalances, as sleep deprivation affects the secretion of hormones such as cortisol (a stress hormone), leptin (a satiety hormone), and ghrelin (a hunger hormone), which can lead to increased appetite, weight gain, and metabolic disorders. Lack of sleep leads to increased activity in the sympathetic nervous system and impaired regulation of blood pressure, which increases the risk of hypertension and cardiovascular diseases.

Decreased cognitive functions manifest themselves in the form of impaired attention and concentration, memory disorders. Lack of sleep disrupts the processes of memory consolidation, which leads to a deterioration in the memorization of new information and the reproduction of old. It has been established that lack of sleep makes people more irritable and hot-tempered, worsens mood and increases the likelihood of conflicts, increases the risk of depression and anxiety disorders.

A professor from California, M. Karimi, studied the relationship between circadian rhythm disorders and the development of cancer. The study found that reducing sleep duration, especially to less than six hours per day, can increase the risk of developing polyps in the colon, which can develop into colon cancer. A later population-based case-control study found that the risk of developing colorectal cancer was significantly higher in patients with sleep disorders, especially those who also suffered from sleep disorders and depression. It was also found that reducing sleep increases the risk of developing breast cancer [2].

In today's world, people face a multitude of stress factors that need to be managed through proper rest and sleep. To reduce the impact of sleep deprivation, it is important to establish a consistent sleep schedule, avoid using smartphones, tablets, and computers 1-2 hours before bedtime, and limit caffeine and alcohol consumption before bed. Additionally, creating a comfortable sleep environment is crucial, with a dark, quiet, and cool bedroom. Regular exercise can improve sleep, but it is important to avoid intense exercise right before bedtime. Relaxation techniques such as meditation, yoga, or deep breathing can be used to reduce stress and improve sleep. If you have chronic insomnia or other sleep disorders, it is important to consult a healthcare professional for diagnosis and treatment. [3].

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ASSESSMENT OF THE DYNAMICS OF CELLULAR REACTIVITY IN PATIENTS WITH CIRRHOSIS OF THE LIVER DURING TREATMENT

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The study evaluated the cellular homeostasis system of peripheral blood in 15 patients with cirrhosis of the liver during combined treatment, in which the content of hemoglobin, erythrocytes, leukocytes, and platelets in peripheral blood was studied before and after therapy. The results of the study showed that in patients suffering from cirrhosis of

the liver, the cellular reactivity of the body to the treatment was characterized by a statistically significant ($p<0.05$) increase in the total hemoglobin content by 1,35 times, erythrocytes by 1,53 times, leukocytes by 1,31 times, platelets by 1,8 times.

Keywords: liver cirrhosis, homeostasis, peripheral blood, hemoglobin, erythrocytes, platelets, leukocytes.

The liver is one of the most important organs of the human body, purifying the blood from toxins. The organ also takes an active part in digestion, carbohydrate, lipid and protein metabolism. Any malfunction of the liver negatively affects the entire body and the patient's quality of life [1]. Cirrhosis of the liver is a chronic progressive disease characterized by impaired liver structure and function due to fibrosis and death of hepatocytes. Cirrhosis is one of the most common causes of morbidity and mortality worldwide, which makes it an urgent topic for medical research [2].

Studying the dynamics of cellular and biochemical parameters of peripheral blood allows an objective assessment of the effectiveness of therapy and the reactivity of the body [3].

The object of the study was the clinical data of 15 patients with cirrhosis of the liver. The subject of the study is the indicators of a general blood test.

The study included data from 15 patients diagnosed with cirrhosis of the liver who were treated at the Doctor Light Diagnostic clinic (Tashkent, Republic of Uzbekistan). In the course of the work, the dynamics of cellular reactivity of homeostasis during treatment was studied in terms of peripheral blood parameters: hemoglobin, erythrocytes, leukocytes, and platelets. Laboratory tests were performed using hematological analyzers Hemacomp 10 (Italy) and Sysmex XN-350 (Japan). Statistical data processing was carried out in the STATISTICA 13 program using the Wilcoxon criterion.

When analyzing the total hemoglobin level in patients suffering from cirrhosis of the liver, it was found that hemoglobinemia was observed before the start of treatment, this indicator was 90 g/l [90; 101], which indicates the presence of anemia characteristic of cirrhosis of the liver. After therapeutic intervention, the hemoglobin level increased statistically significantly ($p_{(Wilkinson)} = 0,0065$) by 1,35 times to 130 g/l [127; 133] and tended to reference values (120-155 g/l). When analyzing the total content of erythrocytes in the peripheral blood of patients, it was found that before the start of treatment, this indicator was $3,0\times10^{12}$/l [2,8; 3,3], which indicates erythrocytopenia. After treatment, the red blood cell count tended to the reference values (4,0–5.1×1012/l) and statistically significantly increased by 1,53 times ($p_{(Wilcoxon)} = 0,00056$), and amounted to $4,6\times10^{12}$/g [4,4; 4,8]. The total content of leukocytes in the peripheral blood of patients before the start of treatment was $3,9\times10^{9}$/l [3,6; 4,3], which was below the reference values ($4\text{-}9\times10^{9}$/l), this may indicate the development of severe pathological processes associated with complications of liver cirrhosis. After treatment, the leukocyte level increased statistically significantly to $5,1\times10^{9}$/l [4,9; 5,4] by 1,31 times ($p_{(Wilcoxon)} = 0,03349$). Analysis of the platelet count in this group of patients during treatment showed a statically significant ($p_{(Wilcoxon)} = 0,007689$) increase in the studied parameter and a 1,80-fold tendency to reference values (180-320) from 83×10^{9}/l [70; 95], which is typical for severe thrombocytopenia up to 150×10^{9}/l [145; 160].

Thus, the study showed that combination therapy of liver cirrhosis contributes to a statistically significant improvement in peripheral blood parameters. The results obtained confirm the effectiveness of the treatment and its positive effect on the restoration of the homeostasis system in patients with cirrhosis of the liver.

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RATIONAL NUTRITION WITH LOW PHYSICAL ACTIVITY: MODERN SCIENTIFIC APPROACHES

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This article presents modern approaches to balanced nutrition during periods of reduced physical activity. It examines mechanisms for correcting energy balance and optimizing nutrients during periods of reduced physical activity. The focus is on evidence-based nutrition principles for preventing nutrition-related diseases and maintaining metabolic health.

Keywords: physical inactivity, energy balance, balanced nutrition.

Physical inactivity reduces energy expenditure and disrupts metabolism, increasing the risk of obesity, metabolic syndrome, and type 2 diabetes. It is recommended to reduce calories by 15–20%, reduce simple carbohydrates and saturated fats, and increase protein and dietary fiber to maintain metabolic health.

The main principle is to match the caloric intake of the diet to the reduced energy expenditure. According to the WHO, in cases of hypokinesia, it is recommended to reduce caloric intake by 15–20% of the norm while maintaining adequate intake of essential micronutrients [1].

Diet correction includes optimization of macronutrients: plant proteins (legumes, nuts, seeds) – 50–55% of total protein, limiting saturated fats and added sugars with replacement with ω–3 and ω–6 (fish, flaxseed oil, nuts), complex carbohydrates with a low glycemic index (whole grains, vegetables) for stable glucose levels and long-lasting satiety.

Eating small, balanced meals 4–5 times a day with evenly distributed calories maintains a stable metabolism and reduces the risk of overeating. Ideally, the last meal should be 3–4 hours before bedtime, which aligns with circadian rhythms and improves nutrient absorption.

Dietary fiber (25–30 g/day) is recommended from whole grains, vegetables, fruits, bran, and seeds. It normalizes gastrointestinal function and supports intestinal microbiome, which is especially important for people with low mobility.

Fluid requirements vary with body weight, age, and metabolism. According to the EFSA, adequate intake is 2.0 L/day for women and 2.5 L/day for men (including all sources). The primary source is clean drinking water [2].

Thus, following the principles of a balanced diet while experiencing low physical activity is a scientifically proven method for preventing metabolic disorders. Dietary modification – managing energy balance, optimizing nutrients, and maintaining a healthy eating pattern – supports health and quality of life in individuals with low physical activity.

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THE INFLUENCE OF POLLUTED AIR ON ALLERGIC RHINITIS

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Polluted air is a significant factor that increases the prevalence, severity, and chronicity of allergic rhinitis. Inhalation of aerosols and gaseous pollutants (PM2.5, PM10, NO2, O3, SO2, volatile organic compounds) causes direct damage to the respiratory epithelium of the nasal cavity, disrupting the epithelial barrier and increasing transepithelial permeability to allergens [1].

*Keywords***:** allergic rhinitis, air pollution, inflammation, exposure.

At the cellular level, exposure to pollutants initiates oxidative stress and induces the formation of reactive oxygen species, leading to activation of epithelial cells and the release of alterative cytokines and allergen-alarm signals (IL-33, TSLP, IL-25). These mediators contribute to the polarization of the immune response towards Th2/Type 2: activation of ILC2 and Th2-lymphocytes with subsequent increased production of IL-4, IL-5, and IL-13, which causes eosinophilic infiltration of the mucosa, mucus hypersecretion, tissue remodeling, and increased neuro-reflex sensitivity. Particles and chemical substances adsorbed on them modify the physicochemical properties of pollen aerosols and other allergens, increasing their allergenicity and retention on the mucous membrane; simultaneously, the ability of antigen-presenting cells to stimulate allogeneic sensitization increases [2].

Exposure to polluted air in early childhood is associated with an increased risk of primary sensitization and the formation of an atopic phenotype; in adults, constant exposure contributes to the chronicity of the inflammatory process and frequent exacerbations, requiring more intensive pharmacotherapy. Epidemiological data demonstrate a reliable correlation between the concentration of PM2.5 and NO2 and the frequency of exacerbations of allergic rhinitis is also exacerbated by the interaction of pollution with respiratory infections: damage to the epithelium and a decrease in local antimicrobial mechanisms increase susceptibility to viral and bacterial superinfections, which is accompanied by a more severe and prolonged course of rhinitis [1].

From a therapeutic point of view, constant exposure to pollution can reduce the effectiveness of topical anti-inflammatory therapy, increase the need for combined therapeutic approaches, and increase the likelihood of prescribing systemic corticosteroids and antibacterial agents in case of complications. Prevention requires a multi-level approach: from policies to reduce emissions from transport and industry, air quality monitoring and public awareness, to targeted optimization of allergy control, early diagnosis and treatment of concomitant infections, as well as limiting outdoor activities during periods of high pollution, using air filtration systems in premises and masks with high particle filtration efficiency [3].

For further progress in understanding and controlling the impact of polluted air on allergic rhinitis, prospective cohort studies with accurate individual exposure assessment (personal monitors), molecular stratification of patients (inflammation biotopes, cytokine profile), as well as interventional studies evaluating the clinical effectiveness of measures to reduce pollution and individual protection are needed. The introduction of multidisciplinary protocols combining epidemiology, molecular immunology and environmental medicine will allow the formation of evidence-based recommendations for the prevention and treatment of allergic rhinitis in the context of persistent anthropogenic air pollution [3].

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EFFECT OF PROLONGED Γ-IRRADIATION ON THE STRUCTURAL AND FUNCTIONAL CHARACTERISTICS OF HEMOGLOBIN IN EXPERIMENTAL ANIMALS

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Hemoglobin (Hb) is the main component of red blood cells and performs specific functions: it performs gas exchange, participates in maintaining blood pH, and performs antioxidant functions. The structural and functional characteristics of Hb are important for performing these functions. In the post-radiation period, the intrinsic fluorescence Hb, the energy of the excited state, changes in waves (from decrease to increase). In the nearest time after training, the

efficiency of extinguishing the energy of tryptophanils of hydrophobic hemoglobin zones with the 1,8-ANS acceptor decreased, indicating a denser packaging of these areas. Studies on day 30 showed that conformational rearrangements of hemoglobin are reversible.

Keywords: Prolonged γ - irradiation, red blood cells, hemoglobin.

The object of the study was the hemoglobin of rats exposed to prolonged radiation for 42 days. The age of the subjects at the beginning of the experiment was 120 days. Animals were tested on days 3, 10.30 of the affected period. Animals of appropriate age were used as controls. Prolonged irradiation was carried out at the GAMMARID-192/120 installation from a cesium source with a dose rate of $2.8 \cdot 10^{-7}$ Gy/s to a total absorbed dose of 1 Gy.

The conformational state of hemoglobin was evaluated by its intrinsic protein fluorescence, as well as by the kinetic characteristics of the interaction of hemoglobin molecules with the fluorescent probe 1-anilino-8-naphthalene sulfonate (1,8-ANS). Hemoglobin molecules have the property of radiative deactivation of an externally stimulated singlet electron-excited state (fluorescence), which is due to the presence of aromatic amino acids in the molecule, among which tryptophan makes the greatest contribution to this phenomenon. Changes in the structural characteristics of the protein, which determine the violation of the microenvironment of chromoform amino acids, are reflected in a change in the parameters of the protein's own fluorescence. As follows from the presented data, the intensity of the intrinsic fluorescence of Hb on the 3rd day after irradiation drops by 20%, but increases on the 30th day. Post-radiation changes are noted not only for the energies of the main, but also the excited state of hemoglobin. The pattern of structural post-radiation changes in hemoglobin can be analyzed using a 1,8-ANS fluorescent probe capable of quenching tryptophan fluorescence when bound to positively charged regions of the protein. The efficiency of fluorescence quenching by the acceptor is determined by the type of tryptophan amino acids involved in energy transfer. Type 1 - sedentary forms of tryptophanils, located mainly in hydrophobic zones, λ_{vials} = 330-332 nm. Type 2 - tryptophanils oriented in the polar regions, their mobility is limited by interaction with water dipoles λ_{vial} = 340-342 nm. Type 3 - polar mobile tryptophanils, weakly interacting with water λ_{vial}. = 350-352 nm. An ANS fluorescent probe capable of interacting with positively charged protein regions of both hydrophilic and hydrophobic zones preferably penetrates and binds at the hydrophobic regions. In this regard, the compared values of tryptophanyl fluorescence quenching with the 1,8-ANS acceptor (Fo - fluorescence in the absence of 1,8-ANS and F - in the presence) were evaluated at λ_{vials} = 330-335 nm. It was revealed that on days 3 and 10 after training, the effectiveness of extinguishing the energy of tryptophanils of the hydrophobic zones of hemoglobin with the 1,8-ANS acceptor decreased, indicating a denser packaging of these areas. Studies on day 30 showed that these conformational rearrangements of hemoglobin are reversible.

The most common cause of post-radiation effects in biological molecules is peroxidation activation. It is known that certain ratios of various forms of hemoglobin, including the representation of its oxidized forms (methemoglobin, hemichrome) are necessary for the successful operation of adaptation mechanisms. Naturally, various forms of hemoglobin have certain structural features. Are there changes after irradiation in the ratio of hemoglobin forms, in particular, an increase in the representation of its oxidized forms and, therefore, the presence of post-radiation structural rearrangements at their expense? The data obtained indicate that the amount of methemoglobin after irradiation does not change, while, as previously shown, the concentration of Hb in the red blood cell increased significantly. Based on this, it can be assumed that the post-radiation attenuation of the interaction of 1,8-ANS with positively charged regions in the region of heme pockets Hb may be due to changes in the availability of positive charges and sign modification in the surface regions of hemoglobin molecules.

THE IMPACT OF SOLAR RADIATION ON HUMAN SKIN COVERINGS

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This article examines the beneficial and negative effects of UV radiation on humans, as well as methods of protection from solar radiation and recommendations for the prevention of skin diseases.

Keywords: olar radiation, UV rays, infrared radiation, visible light, photoaging, melanoma, burns, dermis.

The spectrum of solar radiation reaching the Earth's surface and affecting humans includes UV rays, visible light, and infrared radiation. UV rays are divided into UVA, UVB, and UVC. The most harmful to all living things are UVC rays (200-280 nm); however, the ozone layer of the atmosphere surrounding our Earth absorbs them, protecting flora and fauna from their effects.

For a long time, the main focus was on UVB rays. The action of UVB rays is primarily directed at the dilation of dermal vessels, but the main changes caused by these rays are observed in the epidermis. UVB radiation causes inflammatory reactions in the skin, leading to redness, pain, and swelling. Repeated burns increase the risk of developing melanoma.

UVA rays can penetrate deeply into the skin. By penetrating into the papillary and reticular layers of the dermis, these rays can cause destruction of collagen and elastin, which leads to a decrease in skin elasticity and firmness, resulting in the appearance of wrinkles, folds, pigmented, and keratotic lesions due to premature skin aging (photoaging). It is important to note that photoaging can be observed long before the symptoms of chronological aging of the skin appear (chronoaging).

UV radiation undoubtedly also has positive effects on humans. Sunbathing provides excellent strengthening effects: metabolism increases, the function of endocrine glands improves, hemoglobin levels rise, and vitamin D is synthesized (which is especially important during pregnancy to prevent rickets in the fetus, as well as for the prevention of osteoporosis in the elderly). Sunlight has a pronounced antidepressant effect and contributes to positive dynamics in the treatment of psoriasis, atopic dermatitis, and various forms of ichthyosis.

Sensitivity to UV radiation directly depends on skin type. People of European descent are considered more susceptible to the sun–protection is required for them already at an index of 3, while an index of 6 is considered dangerous. For Indonesians and African Americans, an index of 6 indicates that protection is necessary, while an index of 8 is unfavorable for health.

The use of high-SPF sunscreens, wearing protective clothing, and avoiding sunlight during peak hours (from 10 AM to 4 PM) help reduce the risk of skin damage; regular check-ups with a dermatologist, especially for individuals at high risk, are an important part of skin disease prevention.

Thus, under the influence of UV light, the skin undergoes certain changes to provide protection against damage. The longer one stays in the sun, the higher the risk of developing precancerous skin formations and skin cancer, including malignant melanoma. Increasing awareness about the harms of solar radiation and methods of protection is a key factor in preventing skin diseases.

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EVALUATION OF THE EFFECTIVENESS OF COMMERCIAL HAND ANTISEPTICS AGAINST TEST BACTERIAL CULTURES

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A comparative evaluation of the efficacy of four commercial hand antiseptics against *Staphylococcus aureus* and *Escherichia coli* was conducted using the disk diffusion method. The study revealed that alcohol-based formulations (96% ethanol and 70% isopropanol) demonstrated high antibacterial activity. The triclosan-based product showed limited effectiveness, while the lotion with declared 70% alcohols exhibited no significant antimicrobial activity. *E. coli*

was less susceptible to alcohol-based antiseptics compared to *S. aureus*. The results highlight the importance of selecting antiseptics with proven efficacy for effective hand hygiene.

Keywords: hand antiseptics, Staphylococcus aureus, Escherichia coli, disk diffusion method, antimicrobial efficacy, alcohol-based sanitizers.

The growing emphasis on public health and personal hygiene has led to the widespread use of hand antiseptics as a primary measure for preventing the transmission of pathogenic microorganisms. This study focuses on evaluating the efficacy of various commercially available hand sanitizers against common bacterial contaminants, a subject of significant practical importance for consumer awareness and infection control. The research employs a standardized disk diffusion assay to quantitatively assess and compare the antimicrobial activity of selected antiseptics against reference strains of Staphylococcus aureus and Escherichia coli, representing Gram-positive and Gram-negative bacteria, respectively. The findings aim to provide an objective comparison of the products' effectiveness and contribute to a better understanding of bacterial susceptibility to different antimicrobial agents [1-3].

The aim of the study: To evaluate the in vitro antimicrobial efficacy of commercially available household hand antiseptics against reference strains of Staphylococcus aureus and Escherichia coli using the disk diffusion method.

The investigation utilized reference strains Staphylococcus aureus ATCC 6538 and Escherichia coli ATCC 25922. Five test samples were evaluated: 1) "Septocide-Synergy" (96% ethanol), 2) "Viksan" (70% isopropanol), 3) "CLERK" (triclosan-based), 4) "STOP" lotion (declared 70% alcohols), 5) distilled water as negative control. Antimicrobial activity was assessed using the standard disk diffusion method on Mueller-Hinton Agar. Bacterial suspensions standardized to 0.5 McFarland were lawn-inoculated onto agar plates. Sterile paper disks (6 mm) were impregnated with 10 µL of each test substance, applied to inoculated plates, and incubated at 37°C for 24 hours. Inhibition zone diameters were measured with 1 mm accuracy; all tests were performed in duplicate.

The results of the disk diffusion assay demonstrated significant variation in the antimicrobial efficacy of the tested antiseptics against both Staphylococcus aureus and Escherichia coli. The data, including the average diameter of the growth inhibition zones and standard deviation, are summarized in Table 1.

Table 1

Antibacterial activity of commercial hand antiseptics

Antiseptic Sample (Active Agent)	Avg. Zone of growth inhibition ± SD for S. aureus, mm	Avg. Zone of growth inhibition ± SD for E. coli, mm
Septocide-Synergy (96% Ethanol)	26.0 ± 1.0	17.5 ± 1.5
Viksan (70% Isopropanol)	33.5 ± 1.5	24.0 ± 1.0
CLERK (Triclosan)	7.0 ± 0.0	11.0 ± 1.0
Lotion "STOP" (Unknown 70% Alcohols)	7.0 ± 1.0	7.0 ± 0.0
Control (Distilled Water)	6.0 ± 0.0	6.0 ± 0.0

Against both test strains, the most effective antiseptics were alcohol-based. Viksan (70% Isopropanol) showed the largest zones of inhibition (33.5 mm for S. aureus and 24.0 mm for E. coli), followed by Septocide-Synergy (96% Ethanol) (26.0 mm and 17.5 mm, respectively). The antiseptic based on Triclosan (CLERK) showed negligible activity against S. aureus (zone equal to control) and very weak activity against E. coli. Lotion "STOP", despite containing declared 70% alcohols, demonstrated no significant antibacterial effect on either bacterium, with inhibition zones virtually identical to the negative control. The negative control (Distilled Water) confirmed the absence of antimicrobial activity, as the zone diameter was equal to the disk itself (6 mm). A notable difference in susceptibility was observed: E. coli was less susceptible to alcohol-based antiseptics than S. aureus. The low standard deviation values across replicates indicate high reproducibility of the results.

In conclusion, the study demonstrated a significant disparity in the efficacy of commercially available hand antiseptics. Alcohol-based formulations, particularly Viksan (70% isopropanol), proved to be the most effective against

both test cultures. In contrast, the triclosan-based product and the lotion with unknown 70% alcohols showed little to no reliable antibacterial activity. The results clearly indicate that the specific composition of an antiseptic, rather than the mere presence of alcohols, is the critical determinant of its antimicrobial effectiveness. Furthermore, the observed higher resistance of E. coli compared to S. aureus underscores the importance of considering the spectrum of activity when selecting a hand sanitizer for effective hygiene.

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THE INFLUENCE OF TUMOR CELLS ON THE IMMUNOPHENOTYPE OF LYMPHOCYTES FROM HEALTHY DONORS IN VITRO

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The study presents an analysis of changes in the immunophenotype of peripheral blood lymphocytes from healthy donors under the influence of tumor cells under *in vitro* conditions.

Keywords: lymphocytes, tumor cells, immunophenotype, flow cytometry, immunosuppression, apoptosis, T-regulatory cells.

The ability of malignant neoplasms to evade immune surveillance remains one of the central problems of modern oncological immunology. Despite the existence of a complex immune control system, tumor cells demonstrate a remarkable ability to avoid recognition and destruction by the immune system [1]. This phenomenon is explained by the development of numerous immune suppression mechanisms, among which the direct modulating effect of tumor cells on lymphoid cells of the immune system holds a special place [2].

Studying the interaction between tumor and immune cells is of significant theoretical and practical interest. Experimental *in vitro* models are becoming particularly valuable, as they allow investigating these processes under controlled conditions, minimizing the influence of the organism's systemic factors [3]. Such research contributes to a better understanding of the fundamental mechanisms of immunosuppressive tumor microenvironment formation and may form the basis for developing new approaches in immunotherapy of malignant neoplasms.

The aim of the study was to assess the influence of tumor cells on the immunophenotype of peripheral blood lymphocytes from healthy donors under *in vitro* co-cultivation conditions.

The research material consisted of peripheral blood lymphocytes from healthy donors (n=10) and a culture of tumor cells from the MCF-7 line (breast cancer). Lymphocytes were isolated by density gradient centrifugation using Ficoll-Verografin. Cultivation was carried out for 72 hours under co-culture conditions of lymphocytes with tumor cells (at a 10:1 ratio). For immunophenotyping, monoclonal antibodies to CD3, CD4, CD8, CD25, CD69, CD95 were used. Analysis was performed on a flow cytofluorimeter (CytoFlex, Beckman Coulter). Statistical data processing was performed using STATISTICA 10.0 software.

As a result of the study, statistically significant changes in the lymphocyte immunophenotype after co-cultivation with tumor cells were revealed. A significant decrease in the relative number of CD3+ lymphocytes from 72.15% to 65.30% ($p < 0.05$) and CD3+CD4+ T-helpers from 45.60% to 38.25% ($p < 0.01$) was noted. A parallel increase in the proportion of CD3+CD8+ cytotoxic lymphocytes from 28.40% to 32.80% ($p < 0.05$) was detected. Of particular note is the significant increase in the number of CD4+CD25+ T-regulatory cells from 5.20% to 8.90% ($p < 0.005$), which may indicate the development of an active immunosuppressive state.

An important aspect of the study was the detection of a significant increase in the number of CD3+CD95+ apoptotic cells from 8.50% to 15.30% ($p < 0.005$). This result convincingly demonstrates the ability of tumor cells to induce programmed cell death of lymphocytes. Simultaneously, a decrease in the number of activated CD8+CD69+ cytotoxic lymphocytes from 12.30% to 7.80% ($p < 0.01$) was found, indicating suppression of their functional activity.

The increase in the number of T-regulatory cells and the simultaneous induction of lymphocyte apoptosis can be considered as key mechanisms of tumor evasion from the immune response. The revealed redistribution of subpopulations towards an increase in cytotoxic lymphocytes with a simultaneous decrease in their activation potential reflects the complex nature of the interaction between tumor and immune cells.

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LACK OF SLEEP AND ITS IMPACT ON THE HUMAN BODY

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The article examines the problem of sleep deprivation and its impact on the human body. Despite extensive research on the issue of insufficient sleep, the number of people with chronic sleep deprivation is increasing. It is estimated that approximately 35% of the global population suffers from chronic sleep deprivation.

Keywords: sleep, performance, and lifestyle.

About 34% of our lives are spent sleeping, a physiological process that is essential for our survival. Sleep is a period of active rest and recovery, during which our metabolism slows down, our muscle tone weakens, our nervous system slows down, and the formation of new neural connections in our brains slows down. Lack of sleep increases our risk of death and cardiovascular diseases, as well as diabetes. If you sleep less than 6 hours per day and suffer from insomnia, your risk of dying from cardiovascular diseases increases by 48%, and your risk of dying from a stroke increases by 15% [1].

Insufficient sleep is a condition in which a person consistently sleeps less than what is necessary for proper rest and recovery. The recommended sleep duration varies depending on age, individual characteristics, and other factors, but it typically ranges from 7 to 9 hours for adults. Chronic sleep deprivation can manifest in various forms, such as reduced sleep time, interrupted sleep, and disrupted circadian rhythms (e.g., shift work). Insufficient sleep has significant implications for various aspects of human health, including physiological, cognitive, and emotional consequences.

The physiological consequences of sleep deprivation include a weakened immune system. People who suffer from sleep deprivation are more likely to develop colds, flu, and other infections. Additionally, there is an increased risk of inflammatory bowel diseases due to the disruption of the gut microbiome caused by insufficient sleep. There may also be hormonal imbalances, as sleep deprivation affects the secretion of hormones such as cortisol (a stress hormone), leptin (a satiety hormone), and ghrelin (a hunger hormone), which can lead to increased appetite, weight gain, and metabolic disorders. Lack of sleep leads to increased activity in the sympathetic nervous system and impaired regulation of blood pressure, which increases the risk of hypertension and cardiovascular diseases.

Decreased cognitive functions manifest themselves in the form of impaired attention and concentration, memory disorders. Lack of sleep disrupts the processes of memory consolidation, which leads to a deterioration in the memorization of new information and the reproduction of old. It has been established that lack of sleep makes people

more irritable and hot-tempered, worsens mood and increases the likelihood of conflicts, increases the risk of depression and anxiety disorders.

A professor from California, M. Karimi, studied the relationship between circadian rhythm disorders and the development of cancer. The study found that reducing sleep duration, especially to less than six hours per day, can increase the risk of developing polyps in the colon, which can develop into colon cancer. A later population-based case-control study found that the risk of developing colorectal cancer was significantly higher in patients with sleep disorders, especially those who also suffered from sleep disorders and depression. It was also found that reducing sleep increases the risk of developing breast cancer [2].

In today's world, people face a multitude of stress factors that need to be managed through proper rest and sleep. To reduce the impact of sleep deprivation, it is important to establish a consistent sleep schedule, avoid using smartphones, tablets, and computers 1-2 hours before bedtime, and limit caffeine and alcohol consumption before bed. Additionally, creating a comfortable sleep environment is crucial, with a dark, quiet, and cool bedroom. Regular exercise can improve sleep, but it is important to avoid intense exercise right before bedtime. Relaxation techniques such as meditation, yoga, or deep breathing can be used to reduce stress and improve sleep. If you have chronic insomnia or other sleep disorders, it is important to consult a healthcare professional for diagnosis and treatment. [3].

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"USELESS" MUSHROOMS WITH VALUABLE PROPERTIES: USING PARASITIC AND SAPROTROPHIC FUNGI IN THE SEARCH FOR NEW ANTITUMOR AGENTS

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The search for new antitumor agents of natural origin remains a priority in modern oncology. This review examines the potential for using basidiomycetes, a group of parasites and saprotrophs considered "useless," as a promising resource for the discovery of new drugs thanks to their unique metabolic capabilities and ecological adaptations.

Keywords: basidiomycetes, parasitic fungi, saprotrophic fungi, antitumor activity, cytotoxic activity.

The study of basidiomycetes, which belong to the ecological groups of parasites and saprotrophs, is of significant scientific interest. A systematic analysis was conducted of 45 fungal species collected from various forest ecosystems in Belarus between 2020 and 2023. Methanol and aqueous extracts were prepared from the samples and screened for cytotoxic activity against human tumor cell lines (MCF-7, A549, HeLa) using the MTT assay. The results revealed significant differences in biological activity among the species studied. The highest cytotoxicity was demonstrated by extracts of the following species: *Fomitopsis pinicola* (IC50 = 32.5 μg/ml against MCF-7), *Ganoderma applanatum* (IC50 = 28.7 μg/ml against A549) and *Trametes versicolor* (IC50 = 35.2 μg/ml against HeLa). Chemical analysis allowed us to identify several groups of biologically active compounds: β-glucans with immunomodulatory properties, triterpenoids inducing apoptosis via the mitochondrial pathway, steroids suppressing angiogenesis, and phenolic compounds with antioxidant activity.

Studies conducted within the framework of the research project «Assessment of the biological activity of basidiomycetes as potential substances with antitumor activity in vitro model conditions», task 3.03.02 "Develop methods for enhancing the body's adaptive capacity and reducing the negative impacts of anthropogenic and natural

factors" of the State Program of Scientific Research «Natural Resources and Environmen» (2021-2025), showed that mushroom extracts are capable of modulating the secretion of immunoactive molecules (cytokines) by normal (lymphoid) human cells in vitro. The studied substances: PI-1 and PI-2 - ethanol extracts of stinkhorn fruiting bodies, GL-1 - an aqueous extract of reishi fruiting bodies, LE-1 - an aqueous extract of shiitake fruiting bodies. Adding mushroom extracts to PHA-induced cell cultures resulted in a statistically significant increase in IL-2 and IFN-γ concentrations compared to the control. Immunocompetent cells were shown to respond to polysaccharide-containing mushroom extracts with increased production of IL-2 and IFN-γ cytokines in the supernatants of the activated K562 tumor cell line, indicating activation of natural immune response mechanisms. The potential for using mushroom extracts in oncology stems from their multicomponent effects on the mechanisms of carcinogenesis. The ability of this complex of biologically active substances to modulate immune responses and inhibit malignant cell proliferation opens up new therapeutic possibilities. However, the introduction of such substances into clinical practice requires standardization of cultivation and extraction methods, as well as preclinical studies to assess efficacy and safety.

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MODERN PERSPECTIVES ON FUNGOTHERAPY: FROM TRADITIONAL USE TO MOLECULAR ONCOLOGY

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Fungotherapy – the therapeutic use of medicinal mushrooms is undergoing a paradigm shift from ethnopharmacological tradition to evidence-based integrative oncology. Contemporary research confirms that basidiomycetes produce a diverse array of bioactive metabolites with multimodal antitumor mechanisms, including immunomodulation, apoptosis induction, cell cycle arrest, antiangiogenesis, and epigenetic regulation.

Keywords: fungotherapy, medicinal mushrooms, β-glucans, triterpenoids, integrative oncology, tumor microenvironment.

Recent advances highlight that the efficacy of fungal preparations depends not only on isolated compounds but also on synergistic interactions within whole extracts. For instance, *Ganoderma lucidum* polysaccharides enhance dendritic cell maturation via Dectin-1 and TLR4, while its triterpenes (e.g., ganoderic acid T) suppress NF-κB and STAT3 signaling in breast and lung cancer models (Wu et al., 2023). Similarly, *Trametes versicolor* PSP and PSK fractions are now clinically used as adjuvants in gastric and colorectal cancer therapy in Asia, improving survival and reducing chemotherapy-induced immunosuppression (Standish et al., 2022). Importantly, ecological and cultivation factors significantly influence metabolite profiles. Wild strains from pristine ecosystems show 2–3-fold higher cytotoxic activity than cultivated counterparts, likely due to stress-induced secondary metabolism (Mikhailova et al., 2023). Submerged fermentation now enables standardized production of biomass with consistent β-glucan (15–22%) and triterpenoid (1.8–3.5%) content, meeting pharmaceutical requirements (Zhang et al., 2024). Emerging data also reveal that fungal compounds modulate the tumor microenvironment: β-glucans reprogram tumor-associated macrophages toward an M1 phenotype, while phenolic antioxidants mitigate oxidative stress that drives mutagenesis (Li et al., 2023). Moreover, mycochemicals exhibit low systemic toxicity and high biocompatibility, making them ideal candidates for combination regimens with checkpoint inhibitors or targeted kinase inhibitors. Despite promising results, challenges remain in standardization, pharmacokinetic profiling, and regulatory approval. Future directions include nano-

encapsulation for improved bioavailability, CRISPR-based strain engineering for enhanced metabolite yield, and large-scale randomized trials to validate clinical efficacy in Western oncology protocols.

The studies conducted within the framework of the research project «Assessment of the biological activity of basidiomycetes as potential substances with antitumor activity under in vitro model conditions», task 3.03.02 "Develop methods for increasing the adaptive capacity of the body and reducing the negative impacts of anthropogenic and natural factors" of the State Program of Scientific Research «Natural Resources and the Environment» 2021-2025, are consistent with the above-mentioned data from other researchers.

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ECO-BIOTECHNOLOGICAL ASPECTS OF OBTAINING ANTITUMOR SUBSTANCES FROM BASIDIOMYCETES

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The integration of ecological principles with advanced biotechnological approaches represents a promising strategy for sustainable production of antitumor compounds from basidiomycetes. This study presents a comprehensive eco-biotechnological platform for the selection, cultivation, and extraction of bioactive metabolites with demonstrated cytotoxicity against human cancer cell lines.

Keywords: basidiomycetes, eco-biotechnology, antitumor substances, sustainable production, submerged cultivation, metabolic engineering

The growing demand for novel antitumor agents necessitates the development of sustainable production methods that minimize ecological impact while maximizing yield and efficiency. Basidiomycetes, with their diverse metabolic capabilities, offer immense potential as sources of anticancer compounds. However, traditional collection methods threaten natural populations and lack standardization. Our research addresses these challenges through an integrated eco-biotechnological approach that combines ecological understanding with advanced cultivation technologies. The study encompassed 35 basidiomycete species collected from various ecological niches in Belarusian forests (2021-2024). We implemented a multi-stage selection process: ecological profiling of natural habitats, in vitro cytotoxicity screening against MCF-7, A549, and HT-29 cell lines, metabolic fingerprinting using UPLC-MS/MS, and optimization of submerged cultivation parameters. Innovative cultivation strategies included development of agro-industrial waste-based media, implementation of two-stage fermentation processes, application of elicitors for metabolic pathway activation, and optimization of oxygenation and mixing parameters. Our eco-biotechnological approach yielded significant improvements in both biomass production and metabolite yield. Cultivation optimization resulted in biomass

production increased to 18-23 g/L, representing a 2.5-fold improvement over conventional methods, reduction in production costs by 40% through utilization of agricultural by-products, and decreased energy consumption by 35% via optimized process parameters.

The studies conducted within the framework of the research project «Assessment of the biological activity of basidiomycetes as potential substances with antitumor activity under in vitro model conditions», task 3.03.02 "Develop methods for increasing the adaptive capacity of the body and reducing the negative impacts of anthropogenic and natural factors" of the State Program of Scientific Research «Natural Resources and the Environment» 2021-2025, are consistent with the above-mentioned data from other researchers.

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PHENOTYPIC CHARACTERISTICS OF T-LYMPHOCYTES IN NEOPLASMS

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The study presents the phenotypic characteristics of T-lymphocyte subpopulations in neoplasms.

Keywords: T-lymphocytes, antibodies, flow cytometry, neoplasms, tumor cells.

The study of the functioning of the immune system in the occurrence and development of malignant neoplasms (MN) is of great interest because, despite significant advances in the study of molecular and genetic aspects of oncogenesis, there is currently no sufficiently clear understanding of the role of antitumor immunity, the relationship that develops between the host immune system and developing tumors. The special relevance of such research for oncology is due to the growing number of diseases associated with neoplasms. The lack of available knowledge about the various mechanisms of tumor effects on the body, in particular, on the functions of the immune system, makes it difficult to develop new methods of early diagnosis and effective immunotherapy. The study of T-lymphocyte subpopulations in MN plays a key role in understanding the mechanisms of the antitumor immune response, predicting the course of the disease, and developing new diagnostic methods [1, 2].

The aim of the study was to evaluate the phenotype of T-lymphocyte subpopulations in neoplasms.

The study material was peripheral blood from patients with squamous cell carcinoma of the head and neck (n=8) and inverted papilloma (IP) (n=7). Monoclonal antibodies (CD45-FITC, CD4-PE, CD8-ECD, CD3-PC7) were used for phenotyping isolated peripheral blood T-lymphocytes. Statistical data processing was carried out in the STATISTICA 10.0 program.

Using flow cytometry analysis, five T-lymphocyte subpopulations were identified: $CD3^+$T-lymphocytes, $CD3^+CD4^+$T-helper (Th), cytotoxic $CD3^+CD8^+$T-lymphocytes (CTL), double positive $CD4^+CD8^+$T-lymphocytes (DP)

and double negative $CD4^-CD8^-$T-lymphocytes (DN). The subpopulation composition of T-lymphocytes of the studied groups is presented in the table.

The number of T-lymphocytes in peripheral blood in patients with malignant neoplasms and inverted papilloma median (25-75 percentile)

Subpopulations	Patients with MN	Patients with IP	p
$CD3^+$, %	67,00 (65,05÷74,85)	70,63 (64,70÷79,70)	0,73
$CD3^+CD4^+$Th, %	58,51 (52,89÷67,15)	59,60 (54,80÷68,30)	0,95
$CD3^+CD8^+$CTL, %	40,20 (30,50÷43,45)	38,34 (31,30÷43,10)	0,90
$CD4^+CD8^+$DP, %	0,24 (0,13÷0,73)	0,31 (0,12÷1,34)	0,73
$CD4^-CD8^-$DN, %	2,48 (2,31÷5,14)	1,99 (1,11÷4,13)	0,14

A study of the subpopulation composition of T-lymphocytes in patients with MN and IP revealed no statistically significant differences in the content of $CD3^+$T-lymphocytes, $CD3^+CD4^+$ T-helper cells, $CD3^+CD8^+$ T-lymphocytes, $CD3^+CD4^+CD8^+$T-cells, $CD3^+CD4^-CD8^-$T-cells, this indicates the involvement of immune cells, both in the case of squamous cell carcinoma of the neck and head, and in inverted papilloma to the same extent. Cytotoxic $CD8^+$ T-cells are able to recognize and destroy tumor cells expressing foreign or altered antigens, release perforins and granzymes, triggering apoptosis (programmed death) of cancer cells. In addition, $CD4^+$ T-lymphocytes regulate the immune response by enhancing the activity of other immune cells, including macrophages and B-lymphocytes, which is important for the formation of long-term antitumor immunity. A high level of tumor infiltration by $CD8^+$ T-cells is associated with a better response to therapy and a more favorable prognosis in many types of cancer (for example, melanoma, colorectal cancer). On the contrary, a decrease in the number of T-lymphocytes may indicate the immune escape of the tumor when it suppresses the immune response, which worsens the prognosis.

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DIAGNOSTIC MARKERS OF LYMPHOMAS IN THE ADULT POPULATION

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Diagnosis of lymphomas requires detailed knowledge of morphology, clinical data, and is often impossible without immunohistochemical examination. The use of a wide differential diagnostic panel of antibodies makes it possible to make a correct diagnosis in a timely manner, to identify variants of an extensive family of lymphomas. The need for differential diagnosis of lymphomas is due to differences in therapeutic tactics and prognosis of the disease. The study presents diagnostic parameters of lymphomas in the adult population in an oncological dispensary.

Keywords: non-Hodgkin's lymphoma, Hodgkin's lymphoma antibodies, immunohistochemistry, tumor cells.

Lymphoproliferative disease can develop in any organ or tissue where there are lymphoid cells (lymphoblasts, lymphocytes, cells of the follicular center – centrocytes and centroblasts). Lymphoid cells are usually found in the lymph nodes, in the lymphatic pharyngeal ring (palatine tonsils, tonsils of the tongue, adenoids), thymus, aggregated lymphatic follicles (Peyer's plaques) of the small intestine, spleen, and extra-lymphatic organs. From a practical point of view, timely identification of a lymphoproliferative disease and the corresponding division of lymphoma variants according to the degree of malignancy is of great importance.

It is important to emphasize that with the variety of different diagnostic methods for lymphoproliferative diseases, the main method for making a diagnosis is morphological with immunohistochemical (IHC) examination of biopsy material or tissue obtained during surgery. In some cases, bone marrow aspirate or peripheral blood cells may also be used for immunophenotyping. But in any case, the immunological characteristics of tumor cells obtained by methods of flow immunofluorometry or IHC are necessary for the subsequent adequate appointment of immunochemotherapy. Verification of the lymphoma variant is possible with immunohistochemical examination using a well-formed panel of poly- and monoclonal antibodies, which makes it possible to identify a "diagnostic" complex of positive reactions or a "marker" antigen [1]

The aim of the study was to analyze the immunohistochemical markers of lymphomas in the adult population.

The study material included lymph nodes of patients with large cell (follicular) non-Hodgkin's lymphoma (n=6), large cell (diffuse) non-Hodgkin's lymphoma (n=10), small cell (diffuse) non-Hodgkin's lymphoma (n=8) and Hodgkin's disease (n=10). The following markers were used for immunohistochemical analysis: CD3, CD5, CD10, CD15, CD20, CD23, CD79a, bcl6, bcl2, Ki67. Statistical data processing was carried out in the STATISTICA 10.0 program.

Using immunohistochemical analysis, the most common markers in various forms of lymphomas were determined (table).

Frequency of occurrence of diagnostic markers in various forms of lymphomas, %

	Large cell follicular non-Hodgkin's lymphoma	Large-cell diffuse non-Hodgkin's lymphoma	Small cell diffuse non-Hodgkin's lymphoma	Hodgkin's disease
CD3	0	10	0	0
CD5	0	0	50	0
CD10	100	20	25	0
CD15	0	0	0	100
CD20	100	90	75	0
CD23	66,7	0	50	0
CD79a	100	90	75	0
bcl6	66,7	60	25	0
bcl2	100	90	100	0

In patients with large cell (follicular) non-Hodgkin's lymphoma, high expression (in 100% of cases) of key markers CD10, CD20, CD79a, and bcl2 was detected, with Ki67 expression level of 16.6%. While CD20, CD79a, and bcl2 expression was detected in 90% of cases in patients with large-cell (diffuse) non-Hodgkin's lymphoma, however, the CD10 marker was detected in 20% of cases and the Ki67 expression level was 57.9%. Patients with small cell (diffuse) non-Hodgkin's lymphoma were characterized by high expression of bcl2 in 100% of cases and low incidence of bcl6 in 25% of cases, Ki67 expression was 14.3%. A distinctive feature of patients with Hodgkin's disease was CD15 expression in 100% of cases and high Ki67 expression in 73.5%.

Thus, it is important to study immunohistochemical markers of lymphomas in the adult population to determine the prognosis and aggressiveness of the disease, select targeted therapy, evaluate the response to therapy and identify minimal residual disease.

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ANALYSIS OF ATMOSPHERIC AIR POLLUTION IN MINSK

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An analysis of atmospheric air pollution in 2010-2022 was carried out. There is a favorable tendency to decrease the total amount of polluting emissions into the atmospheric air in the period 2010-2022. Mobile sources account for about 80% of all emissions. In general, during the study period, the annual average concentrations of major and specific pollutants remained at a consistently low level and were below hygienic standards. The amount of emissions per capita and per unit of territory is steadily decreasing.

Keywords: Atmospheric air pollution, sources, maximum permissible concentrations, dynamics

More than two hundred large and medium-sized industrial enterprises are located on the territory of Minsk. The main sources of atmospheric air pollution in Minsk and its region are enterprises producing building materials, chemical products, energy, motor transport, etc. Despite the continuing trend of reducing harmful emissions and a general decrease in the content of major pollutants in the atmospheric air (nitrogen oxides, sulfur dioxide, carbon oxides, and others), monitoring the level of atmospheric air pollution by major and, especially, specific substances continues to be relevant.

The work carried out an analysis of atmospheric air pollution in 2010-2022. The dynamics of the share of emissions into the atmospheric air of Minsk from stationary and mobile sources was considered. Emissions of pollutants into the atmosphere of Minsk from mobile sources are significantly higher than from stationary ones. Mobile sources account for about 80% of all emissions. However, we can note a downward trend in this proportion.

In 2010-2022, there is a favorable trend towards a decrease in the total amount of polluting emissions into the atmospheric air. Thus, the dynamics of the total amount of pollutants in the atmospheric air of Minsk in the period from 2010 to 2022 showed a moderate decrease (R2 =0.61). The average value of the indicator for the study period was 22.1 thousand tons.

A comparative analysis of the annual emissions of each substance into the atmospheric air with the maximum permissible concentration was carried out. Thus, the average annual emissions of particulate matter were below the maximum permissible concentration (40 micrograms/m3), except for 2010 (44.3 micrograms/m3) and 2022 (46.9 micrograms/m3). Moreover, it can be noted that since 2011, a decrease in emissions has been recorded that does not exceed the maximum permissible concentration of this substance per year. The maximum permissible concentration for average annual emissions of carbon monoxide and methane into the atmospheric air has been exceeded throughout the entire period. With a maximum permissible concentration for carbon monoxide of 50 micrograms/m3, the average annual emissions into the atmospheric air of Minsk in the period from 2010 to 2022. They were 72 micrograms/m3 and higher. The average annual emissions of methane into the atmospheric air of Minsk have exceeded the maximum permissible concentration (50 micrograms/m3) three times since 2015. During the study period, annual average concentrations of nitrogen oxide and sulfur dioxide remained at a consistently low level and were below hygienic standards.

In addition, the dynamics of indicators of total emissions of pollutants into atmospheric air per capita and per unit of territory for the period from 2010 to 2023 was analyzed. The dynamics of emissions of harmful substances per capita repeats the dynamics of emissions of harmful substances per unit of territory and has a steady downward trend, which may indicate systematic work to protect atmospheric air.

EPIDEMIOLOGICAL ASSESSMENT OF THE INCIDENCE OF ENDEMIC GOITER IN THE REPUBLIC OF BELARUS

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In the work, an assessment of the level of incidence of the population of the Republic of Belarus with endemic goiter in 2008-2023 was carried out. Endemic goiter ranks 2-3 in the structure of thyroid diseases. During the studied period, there is a tendency to decrease, both in the general and in the primary incidence of the population of the Republic of Belarus in all age groups. The highest incidence rates of endemic goiter are noted in the Gomel and Mogilev regions. In 2008, the relative epidemiological risk of getting sick with endemic goiter in all regions belonged to the range of increased risk, with the exception of the Minsk and Gomel regions, and in 2023, risk levels decreased in all regions of the Republic of Belarus to acceptable.

Keywords: thyroid gland, endemic goiter, incidence, dynamics, trend, epidemiological risk.

The problem of thyroid diseases does not lose its relevance for the population of Belarus, determining the relevance of the issue and the need for research in this area. This problem is a priority for the country's healthcare system and is due to a combination of two factors: the consequences of the accident at the Chernobyl nuclear power plant and the persistent natural iodine deficiency. Constant monitoring of this pathology is not only a medical necessity, but also an important element of state policy aimed at preserving the health of the nation, preventing disability and ensuring the demographic security of the country [1,2]. In this regard, the purpose of this work is to assess the level of incidence of the population of the Republic of Belarus with endemic goiter in 2008-2023.

In the work, a retrospective analysis of the indicators of the incidence of the population of the Republic of Belarus with endemic goiter for the period 2008-2023 was carried out, the dynamics were analyzed and the main trends were determined. In addition, relative epidemiological territorial risks were calculated. In the Republic of Belarus, endemic goiter occupies a leading position in the structure of thyroid diseases, but it is possible to note a decrease in its share in 2023 (9%) compared to 2008 (28%).

During the studied period, there is a tendency to decrease, both general and primary incidence of the population of the Republic of Belarus by more than 60%. The average annual indicator of the general incidence (A0) was 427.87 0/0000, the annual indicator of the trend A1 = -26.6 0/0000. For the primary incidence, the average annual indicator (A0) was 56.53 0/0000, the annual indicator of the trend A1 = -3.6 0/0000. It is necessary to note that the incidence rates of the child population exceed the similar indicators of the incidence of the adult population by approximately 6 times.

In addition, an assessment of the territorial features of the incidence of the population by regions of the Republic of Belarus was carried out. During the analysis, it was revealed that the distribution of the general incidence of the population across the country is uneven. In 2008-2023, the highest average annual indicators of the general incidence were noted in the Gomel and Mogilev regions, and they are approximately 5 times higher than the indicators in the other regions (respectively, 1149.43 and 699.13 0/0000). In 2008, the relative epidemiological risk of getting sick with endemic goiter in all regions belonged to the range of increased risk, with the exception of the Minsk and Gomel regions, and in 2023, risk levels decreased in all regions of the Republic of Belarus to acceptable.

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ANALYSIS OF THE INCIDENCE OF BRAIN AND CENTRAL NERVOUS SYSTEM CANCER IN THE POPULATION OF BELARUS

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The article presents the results of an epidemiological analysis of statistical data on the incidence of primary brain tumors in the population of the Republic of Belarus. From 2003 to 2022, an upward trend in the incidence of brain and CNS cancer was observed among the population of the Republic of Belarus. During the observed period, the incidence of brain and CNS cancer in the rural population was higher than in the urban population. High incidence rates were recorded primarily in the 50-54 age group.

Keywords: oncology, incidence, growth rates, dynamics, structure.

Currently, there is a worldwide trend toward an increase in the number of patients with neoplasms. The proportion of brain tumors among neoplasms is low (1-2%), but the high mortality and disability rates of patients, as well as the significant social, economic, and moral damage this pathology inflicts on society, have generated well-founded interest in this aspect of oncology.

Based on data on the incidence of cancer in the population of the Republic of Belarus, an analysis of the incidence of malignant neoplasms of the brain and central nervous system from 2003 to 2022 was conducted. During the study period, the incidence of brain and central nervous system cancer remained virtually unchanged, amounting to 1.1-1.5% across all localizations.

As a result of a retrospective analysis of the incidence of malignant neoplasms of the brain and central nervous system in the population of the Republic of Belarus from 2003 to 2022, A pronounced upward trend in incidence was identified. The overall incidence rate increased by 1.4 times. The average annual incidence rate of malignant neoplasms of the brain and central nervous system in the republic (A0) was 5.7 cases per 100,000 population, while the annual trend rate (A1) was 0.122 per 100,000 population. The average annual growth rate was 2.26% for males, 4.01% for females, and 2.81% for both sexes. This overall increase in incidence may be due to a combination of factors, including improved diagnostic methods that increase detection; a real increase in the impact of potential risk factors (environmental, occupational, and lifestyle); and the aging of the population, given the pronounced age-related dependence of malignant neoplasms of the brain and central nervous system.

During the observed period, the incidence of brain and central nervous system cancer in males was higher than the incidence in females.

The key finding of the analysis is the identification of higher incidence rates of malignant neoplasms of the brain and central nervous system in rural areas compared to urban areas for most of the observed period. However, a trend toward a narrowing of this difference was identified, driven by a more pronounced rate of incidence growth among the urban population. High incidence rates are recorded primarily in the 50-54 age group.

The highest incidence rates are recorded in older age groups. The peak consistently occurred in the 60-64 age group (2003, 2022) or 75-79 age group (2012).

The analysis revealed that the highest incidence rate in 2022 was recorded in the Minsk Region (315.7 cases per 100,000 residents), in 2022 in the Vitebsk Region (301, 2.6 cases per 100,000 residents), and in 2022 in the Gomel Region (344.9 cases per 100,000 residents). The lowest incidence rate in 2012 was recorded in the Brest Region (202.3 cases per 100,000), the Vitebsk Region (214.2 cases per 100,000), and the city of Brest and Minsk (228.7 cases per 100,000).

Analysis of the level, structure, and dynamics of cancer incidence is a crucial tool for assessing public health and the effectiveness of the healthcare system. Therefore, studying this problem highlights the need to develop targeted prevention programs and plan measures to maintain and improve public health.

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ANALYSIS OF CHILD MORBIDITY IN THE CITY OF FANIPOL IN 2019-2023

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retrospective analysis of the morbidity rates of the children's population in the city of Fanipol was conducted in 2019-2023. When analyzing the dynamics of the overall morbidity rate among children, a steady decrease in morbidity was observed. The morbidity rate among children of different ages remains approximately the same. In the structure of morbidity, the first rank is occupied by diseases of the respiratory system, diseases of the ear and mastoid process, as well as diseases of the skin and subcutaneous tissue, injuries, poisoning, and some other consequences of external causes. There is a tendency towards a decrease in the dynamics of morbidity rates for all of the above-mentioned nosologies.

Keywords: morbidity, child population, structure, dynamics, trends, growth rates.

The study of morbidity in individual age groups occupies a special place in the assessment of children's health. The morbidity rate allows us to assess the resistance of the child's body to adverse environmental factors, the functional state of the child's body at different age periods, and the quality of medical care. The study of this level, as well as the structure and dynamics of children's morbidity, serves as the basis for developing and implementing effective measures to promote health.

The purpose of the study is to analyze the morbidity of the children's population in the city of Fanipol in 2019-2023.

Based on official data on the incidence of childhood diseases in the city of Fanipol in 2019-2023, a retrospective analysis of primary morbidity was conducted, the dynamics were analyzed, and the main trends were identified.

The analysis of the dynamics of the overall morbidity of children revealed a steady decrease (R^2=0,8317) in morbidity. In 2019 it amounted to 756,5 cases per 1000 population, whereas in 2023 the indicator decreased to 634,7 cases per 1000 population. The average annual incidence rate (A_0) was 681,7 per 1000 children. The annual trend indicator A_1 =-34,09 per 1000 children. The average annual rate of decline is -2,5%. The most vulnerable age group is children aged 5-9 and 10-14. During the study period, the proportion of children aged 5-9 who fell ill was about 21%, and the proportion of children aged 10-14 was 24-26%. Children under the age of one and 15-17 years old make up the smallest proportion of patients. The incidence of children of different ages is approximately the same. The lowest average long-term incidence rates are observed in the 5-9 years old age group. In the structure of the incidence of the child population of the city of Fanipol, the first rank is occupied by diseases of the respiratory system, diseases of the ear and mastoid process, as well as diseases of the skin and subcutaneous tissue (2019), injuries, poisoning, and some other consequences of external causes (2023). The percentage distribution is as follows: respiratory diseases – 76-77%, ear and mastoid diseases – 6-7%, skin and subcutaneous tissue diseases – 4%, injuries, poisoning and some other consequences of external causes – 4%. The average annual incidence of respiratory diseases among children was 536,5 cases per 1000 children. The average annual incidence rate of ear and mastoid diseases among children was 48,65 cases per 1000 population, of skin and subcutaneous tissue diseases – 23,6 cases per 1000, and of injuries – 24,6 cases per 1000. There is a downward trend in the incidence rates of all the above-mentioned diseases.

The study and analysis of the morbidity of the child population are of great importance, as knowing the level and structure of morbidity allows not only to assess the degree of health loss, but also to determine the amount of medical, social, and economic damage, and to develop priority areas for improving the health of the analyzed population group.

RETROSPECTIVE ANALYSIS OF THE INCIDENCE OF BRONCHIAL ASTHMA IN THE POPULATION OF THE REPUBLIC OF BELARUS FOR 2013-2022

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Bronchial asthma is a disease that significantly reduces the quality of life, disrupts social relationships, requires significant state financial expenditures, and represents a global medical and social problem. In the Republic of Belarus, bronchial asthma accounts for about 1.5% of all respiratory diseases. It can be noted that the proportion of bronchial asthma cases is increasing. During the study period (2013-2022), an increase in the incidence of bronchial asthma in the population was observed both in the Republic of Belarus as a whole and in all its regions.

Keywords: bronchial asthma, incidence, dynamics, trend.

Bronchial asthma is one of the most common human respiratory diseases, based on chronic inflammation of the airways. Asthma is a heterogeneous disease and manifests itself with respiratory symptoms such as wheezing, shortness of breath, chest tightness, and cough, which vary in time and intensity, accompanied by variable airway obstruction.

The aim of the work is to analyze the incidence of bronchial asthma in the population of the Republic of Belarus for 2013-2022.

Intensive incidence rates were calculated. At the beginning of the observation period in 2013, the intensive incidence rates for bronchial asthma were 619.2 cases per 100,000 population. Throughout the studied period, the dynamics of intensive incidence rates are characterized by a pronounced upward trend. The incidence rate among the population in 2022 increased 1.2 times compared to 2013 and amounted to 749.2 cases per 100,000 population. Peak rates in the studied time segment were recorded in 2020 and amounted to 854.7 cases per 100,000 population; compared to the initial observation period, the incidence increased 1.4 times. The average annual incidence rate of bronchial asthma (A_0) was 747.4 cases per 100,000 population, the annual trend indicator ($A_{1)}$ was 17 cases per 100,000 population.

A comparative analysis of the long-term average level of bronchial asthma incidence in the population of the Republic of Belarus by regions of Belarus was conducted. The highest average annual incidence rate was noted in the Vitebsk region – 991.5 cases per 100,000 population, which is 32% higher than the average national incidence rate (991.5 per 100,000 population). The Gomel region ranked second, where the average incidence rate was 910.2 per 100,000 population, which also exceeds the average incidence rate for the Republic of Belarus. The incidence rate of bronchial asthma in the Minsk region population (774.3 per 100,000 population) also exceeds the national average. This is followed by the city of Minsk – 682.4 per 100,000 population, which is below the national average, Brest region – 641.8 per 100,000 population, Mogilev region – 595.9 per 100,000 population, and Grodno region – 583.8 per 100,000 population.

An analysis of the year-on-year growth/decline rates of bronchial asthma incidence in the population of the Republic of Belarus by region showed that during the period 2014-2022, there were annual fluctuations in population incidence with periods of growth and decline. During the period from 2014 to 2022, the largest decline was recorded in the Mogilev region in 2022, amounting to -14.2%. The largest increase in incidence rates was also recorded in the Mogilev region and amounted to 22.1%. It is worth noting simultaneous growth/decline in all regions of the Republic of Belarus. Thus, in 2014, 2015, 2017, 2019, and 2020, an increase in incidence was observed in all regions, while in 2016, 2021, and 2022 – a decline. The only exception was 2018, when a decline in incidence was registered in all regions except the Grodno region.

The average annual growth rates were: 1.9% for Brest region; 3.3% for Vitebsk region; 1.3% for Gomel region; 3.5% for Grodno region; 2.8% for Minsk region; 2.7% for Mogilev region and 2.2% for the city of Minsk.

Thus, it must be acknowledged that bronchial asthma represents a global medical and social problem, the solution of which requires the mobilization of resources from the scientific and medical community and healthcare authorities worldwide, as well as constant improvement of diagnostic criteria to detect bronchial asthma at early stages.

SECTION 3

PROBLEMS OF MODERN ENVIRONMENTAL SAFETY (BIOMONITORING, BIOINDICATION, BIOREMEDIATION, RADIOECOLOGY AND RADIATION SAFETY, ENVIRONMENTAL MONITORING, MANAGEMENT AND AUDIT. INFORMATION SYSTEMS AND TECHNOLOGIES IN ECOLOGY)

ENERGY EFFICIENCY OF A SMALL HYDROPOWER PLANT ON THE COLD WATER RETURN CHANNEL OF A NATURAL-DRAFT EVAPORATIVE COOLING TOWER AT THE NUCLEAR POWER PLANT

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This article discusses the potential for improving the energy efficiency of nuclear power plants by utilizing the hydraulic potential of the outlet channel of a tower cooling tower. A concept is proposed for integrating a small hydroelectric power station (SHPS) into the existing water circuit of the thermal balance, which can help reduce emissions of steam gases.

Keywords: small hydroelectric power station, nuclear power plant, cooling tower, energy efficiency, reduction of steam gas emissions.

Modern nuclear power plants (NPPs) consume significant amounts of electricity for their own needs – in particular, for operating circulating pumps, ventilation fans, and auxiliary systems. Typically, up to 10% of the electricity generated by the NPP itself is directed toward meeting these internal demands [1]. In situations where the generation structure within the power system includes coal or gas-fired power stations, such significant consumption of electricity for internal needs leads to increased emissions of carbon dioxide (CO_2) and other pollutants.

The outlet channel for cold water from a tower cooling tower is characterized by stable flow rates (approximately 40 m^3/s for modern VVER-1200 reactor units) and a considerable hydraulic head formed by the height difference between the tower and the discharge point. At present, this hydraulic potential is not utilized; installing a small hydroelectric power station at a non-critical section of the channel would allow conversion of this energy into electricity. The operation of the SHPS does not require regulation of the water flow and does not affect the cooling regime of the main equipment, ensuring full compliance with ecological and technological safety requirements.

The environmental and energy effects of implementing an SHPS include reduced electricity consumption for internal needs during normal plant operation. As a result, overall emissions of greenhouse gases into the power system are reduced. Moreover, this effect is especially pronounced in regions with a high share of fossil fuels in the energy mix [2]. Additionally, the presence of an independent local energy source does not impact the reliability of power supply to auxiliary systems or the overall operational stability of the plant.

Implementing this concept aligns with global trends toward decarbonization and transitioning to integrated systems with low emission levels. For nuclear energy – already one of the lowest-carbon energy sources – this allows further strengthening its “ecological footprint,” not only during the generation process but also throughout the entire chain of auxiliary operations. Such solutions may be incorporated into programs aimed at improving energy efficiency and ecological management in the nuclear industry, as well as applied to other energy facilities such as thermal power plants (TPPs) and combined heat and power plants (CHPPs), where similar water flows with hydropower potential exist.

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ANALYSIS OF ESTIMATES OF THE ECONOMIC VALUE OF ECOSISTEM SERVISES

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The article provides average estimates of the economic value of providing (biotic/biophysical) ecosystem services, showing, among other things, the possible priority that can be applied in scientific activities. Recommendations are given on how to increase the market value of the most valuable of them, and options for working in the field of increasing the economic value of ecosystem services are presented, depending on the actors and the degree of influence of the owner. The compliance of Russian data with international standards has been verified.

Keywords: Ecosystem services, economic value, cost, state.

The General International Classification of Ecosystem Services (CICES) was used as the basis for the classification of ecosystem services. The Ecosystem Services Assessment Database (ESVD) was used to calculate the economic value. The Russian data for comparison was taken from the Ecosystem Services of Russia report.: Prototype of the national report. Vol. 1 Terrestrial ecosystem services. The number of values received from the database was entered in Table 1 (link: https://disk.yandex.ru/i/ivbj-Y_hkuHPrQ). The largest number of values were obtained for services: "Wild animals (terrestrial and aquatic) used for food purposes", "Fibers and other materials from wild plants for direct use or processing (except for genetic materials)", "Cultivated terrestrial plants (including fungi, algae) grown for food purposes", "Wild plants (terrestrial and aquatic, including fungi, algae) used for food," which can be presented as the researchers' response to assessing the true value of the most commonly used ecosystem services, which presumably can be considered rational in terms of prioritizing scientific research. There are also several more studies in the database, while not all have data on the economic value of services.

The cost of the service "Cultivated plants (including fungi, algae) grown as an energy source" is the maximum and amounted to $ 65,742/ha/year, "Fibers and other materials obtained from cultivated plants, fungi, algae and bacteria for direct use or processing (excluding genetic materials)" is estimated at 47 507 $/ha/year. The service "Cultivated terrestrial plants (including fungi, algae) grown for food purposes" is estimated at $20,229/ha/year. The service "Wild animals (terrestrial and aquatic) for obtaining food, materials or energy" is estimated at $20,999/ha/year. In some cases, estimates of economic value from the perspective of ecosystem services turned out to be higher than the market value, which indicates the need to increase the importance of ecosystem services in the market.

The state as an actor has an obvious benefit in preserving the country's natural wealth. Educational campaigns and the development of a culture of doing responsible business can eventually be reflected in the ESG strategies of enterprises and ultimately in the consumer's choice of a sustainable alternative, that is, perhaps a little more expensive, but maintaining the economic value of ecosystem services. Companies as recipients can contribute to increasing the economic value of ecosystem services by incorporating principles of responsible supply chains and procurement, thereby extending these measures to counterparties. In most cases, the defining role of the owner is noted in the description, since in most cases the owner determines the existence or absence of an ecosystem service as such, as in the case of the generalized case of agriculture. If the state is the owner, then its activity as an actor is also decisive, however, in fact, the state does not always conduct active activities throughout the territory, therefore, the presence of influence is noted.

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GEOECOLOGICAL ASSESSMENT OF SOIL POLLUNION ON TEMPORARY SNOW STORAGE SITIES IN MINSK

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This article presents the results of a comprehensive geoecological study aimed at assessing the degree and nature of soil pollution on temporary snow storage sites within Minsk city. The results revealed significant spatial differentiation in pollution levels. The obtained results are of practical importance and can serve as a basis for developing more effective winter waste management to reduce the technogenic load on the territory of Minsk.

Keywords: temporary snow storage sites, ecological-geochemical assessment, soil pollution, heavy metals, petroleum products, urban environment, urban ecosystems.

The issue of snow disposal in large cities remains relevant due to the substantial volumes of snow accumulated during winter and its high contamination levels. The snow cover in urban areas accumulates a wide range of emissions from motor vehicles, industrial facilities, and de-icing agents [1]. Temporary snow storage sites (TSSS), while being a necessary element of urban environmental infrastructure, themselves become a source of secondary environmental pollution, primarily of the soil cover at their locations. During snowmelt, a concentrated release of accumulated substances into the soils and subsoils occurs, leading to the formation of localized technogenic geochemical anomalies. Previous research indicates that meltwater from snow dumps is characterized by abnormally high mineralization and significant concentrations of heavy metals [2, 3].

To assess soil contamination in the city areas influenced by TSSS, the following analyses were conducted: the specifics of the sites' spatial distribution were examined, the concentration levels of pollutants (petroleum products and heavy metals) in the soils were determined, and the spatial patterns of soil-geochemical anomaly formation were identified. The assessments were based on field survey data and laboratory analyses performed by the author in 2022 and 2024. Site inspections and sampling were carried out at seven TSSS located in seven administrative districts of Minsk (Leninsky, Moskovsky, Oktyabrsky, Partizansky, Sovetsky, Frunzensky, Tsentralny). The obtained data were interpreted by comparing them with current hygienic standards (Maximum Permissible Concentration - MPC, Approximate Permissible Concentration - APC) [4].

Analysis of heavy metal content in the soils revealed that lead and copper are the most environmentally problematic elements. The total lead content exceeded the critical APC standard (40 mg/kg) in the soils of two sites: in the Leninsky district (51.6 mg/kg) and the Partizansky district (87.5 mg/kg). Regarding copper, an abnormally high total content of the element was recorded at the TSSS in the Frunzensky district (192 mg/kg), significantly exceeding the APC (132 mg/kg). Furthermore, a dangerously high content of the mobile form of copper was identified at the site in the Moskovsky district (16.1 mg/kg against an APC of 10 mg/kg), indicating its high bioavailability and potential hazard to

ecosystems. In contrast to lead and copper, the content of zinc – both total and mobile forms – in all tested soil samples was within the established hygienic standards.

The spatial distribution of pollutants in the soils shows a clear correlation with the type of functional land use in the urban areas from which the snow was collected and is closely related to the intensity of the anthropogenic load. The highest levels of soil contamination with petroleum products, lead, and copper are associated with TSSS serving districts with developed industrial infrastructure and high traffic density (Leninsky, Moskovsky, Frunzensky). The identified consistent exceedances of APC standards for petroleum products and heavy metals in the soils indicate a significant environmental risk due to the accumulation of persistent pollutants in soils.

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ECOLOGICAL REHABILITATION OF POST-INDUSTRIAL TERRITORIES: FROM MAN-MADE LANDSCAPES TO SUSTAINABLE URBAN ECOSYSTEMS

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Human industrial activity has left behind man-made landscapes - vast disturbed territories. In Russia, there are millions of hectares of such lands destroyed by mining, construction, waste storage and other activities [1]. These territories are characterized by degraded soils, heavy metal pollution and other toxic substances, and the loss of vegetation and soil cover leads to a deterioration of the local climate and living conditions of the population. Ecological rehabilitation of post-industrial zones is aimed at overcoming this man-made heritage and turning it into sustainable urban ecosystems - new green spaces of the city with restored ecological functions and value for society.

Keywords: ecological rehabilitation, ecological safety, urban ecosystems.

In Russian practice, restoration of disturbed lands is traditionally referred to by the term "reclamation" – a set of measures to restore productivity and environmental value of degraded territories. The technical and biological stages of reclamation are distinguished [1]. At the technical stage, engineering works are carried out, such as terrain planning, removal or isolation of contaminated soils, application of a fertile layer, creation of drainage and anti-erosion systems. The biological stage includes the improvement of the properties of the substrate (application of organic matter, fertilizers, liming to neutralize acidity) and subsequent biological reclamation – planting, restoration of soil biota and fauna. Without these measures, man-made soil is often unsuitable for growth, as seeds do not germinate or seedlings die from environmental toxicity. Therefore, the key task is to form a favorable soil substrate that supports vegetation.

Environmental rehabilitation is a lengthy process that requires careful planning. It is necessary to take into account the peculiarities of each object: geography, geology, climate of the region, properties of polluted soils. A comprehensive survey of the territory helps to optimize the project and achieve maximum effect at minimum cost [2]. In some cases, innovative nature-like technologies are used. For example, phytoremediation – the use of plants to extract and neutralize pollutants – is considered as a sustainable alternative to expensive methods of soil purification [3]. The experience in Amsterdam has shown that the integration of phytoremediation into the renovation project of an industrial zone allows for the simultaneous purification of soils and the creation of a new green space. This combination of soil purification with landscaping and biomass cultivation has given the territory new ecological, economic and social functions [3].

Thus, biotechnological methods (phytoremediation, bioremediation, etc.) are increasingly being included in rehabilitation programs, complementing traditional engineering work.

Successful rehabilitation of man-made landscapes opens up the possibility to include them in the "green framework" of the city - a system of parks, squares and other natural objects. All over the world, projects for the revitalization of former industrial zones are aimed at improving the environmental situation and expanding the network of urban green spaces. Abandoned industrial sites (brownfields) are increasingly turning into public spaces that bring environmental, social and economic benefits to the city [4]. The inclusion of elements of green infrastructure (parks, water-green and other green spaces) returns natural ecosystems and their services to the city.

Ecological rehabilitation of post–industrial territories is an important condition for sustainable urban development. By turning degraded man-made landscapes into functioning urban ecosystems, cities not only eliminate the environmental damage of the past, but also receive new green spaces that improve the quality of life of citizens and the ecological situation. Experience shows that with the support of science, community participation and the use of modern eco-technologies, such territories can be successfully returned to the urban environment. This contributes to the formation of more sustainable, healthy and attractive cities, where former "industrial wastelands" are transformed into green oases and an important part of urban ecosystems.

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MOLECULAR GENETIC METHODS FOR SEX DETERMINATION IN POPULATION OF THE EURASIAN BEAVER

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This study describes two methods for determining the gender of Eurasian beavers using molecular genetic analysis. We successfully tested two approaches on samples such as bone powder, wool, and muscle tissue. Primer pairs that amplify shorter DNA fragments are the most effective. The analysis confirms that a comprehensive approach using various detection methods is necessary to ensure maximum reliability in sex determination using molecular genetic methods.

Keywords: Eurasian beaver, sex determination, molecular genetic methods.

Studying the demographic structure of populations is a fundamental task of modern ecology and population biology [1]. A key parameter determining the dynamics, stability, and reproductive potential of any population is its sex structure. Assessing this parameter is critically important for developing effective strategies for the conservation, management and monitoring of species, especially those that are resource-based or recovering from a period of decline

The Eurasian beaver is an integral species of Belarusian natural ecosystems. Determining sex in the field is difficult due to the absence of sexual dimorphism, so molecular genetic analysis is used for reliable identification [2-3].

Molecular genetic studies to determine the sexual structure of the Eurasian beaver population were conducted on 60 samples of biomaterial, including 20 samples of bone material from Eurasian beavers from 1960-1980, wool and muscle

tissue from beavers obtained in 2024-2025. DNA was extracted from bone material of historical Eurasian beaver samples using the ammonium acetate method. DNA was extracted from wool using the «ArtSpinExpert kit» (ArtBioTech, Belarus) according to the protocol. DNA was extracted from muscle tissue samples using the Jena Bioscience «Animal and Fungi DNA Preparation Kit».

The first method involves electrophoretic identification of amplification products. Two primer sets were tested: the SRY gene was amplified using SRY F and SRY R primers, and primers L14841 and H15149 of the *cybB* fragment of the mitochondrial genome were used as a positive control for a successful PCR reaction [3]. The next set focused on zinc finger nuclease (ZFN) genes on the X and Y-chromosomes [4]. The second method is based on the double-stranded DNA-binding ability of the SYBR Green I fluorescent dye. The amount of PCR products was determined in real time by measuring the fluorescence that accumulates with each cycle. Amplification was performed with two pairs of primers, 12SO and 12SA, for positive control [5], as well as SRY F and SRY R primers, which determine sex.

During the research, primer sets targeting the amplification of sex-linked (SRY, ZFN) and mitochondrial (*cytB*/12s) markers were successfully tested. A key finding is that primer pairs amplifying shorter DNA fragments, in particular *cytB*/SRY, demonstrate maximum efficiency and reliability when working with muscle tissue, bone material, and wool. Moreover, the method based on the amplification of target DNA using primers and an intercalating fluorescent dye allowed the sex of all samples studied to be detected. To ensure maximum reliability in sex determination using molecular genetic methods, a comprehensive approach based on the application of the two detection methods described above is necessary.

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SPECIES DIVERSITY OF ANURAN AMPHIBIANS IN THE LOYEV DISTRICT

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The paper presents results of a field study on the species composition of anuran amphibians in the Loyev District (Gomel Region, Belarus). During the 2025 season, five species belonging to two families were recorded across three main habitat types: pond, mixed forest, and swamp. Differences in species occurrence were linked to habitat moisture, vegetation density, and anthropogenic influence. The study emphasizes the importance of habitat heterogeneity for maintaining amphibian biodiversity in southeastern Belarus.

Keywords: amphibians, *Anura*, species diversity, Belarus.

Amphibians represent one of the most sensitive bioindicators of environmental health due to their complex life cycles and dependence on both terrestrial and aquatic ecosystems [1]. The present study aimed to assess the species diversity of anuran amphibians in the Loyev District [2].

The study was conducted from May to August 2025 at three representative habitats located within the southern part of the Loyev District:

1) Pond site near the village of Peredelka – shallow standing water with emergent vegetation and silty substrate; a total of 47 individuals of *Bombina bombina* (fire-bellied toad) were recorded here.

2) Mixed forest near the settlement of Loyev – shaded, humid environment with temporary pools formed during rainfall. This site was inhabited by *Rana terrestris* (moor frog, 28 individuals) and *Rana temporaria* (common frog, 31 individuals).

3) Swamp area near the Sozh River floodplain – open, permanently waterlogged habitat dominated by sedges and reeds. Here *Rana esculenta* (edible frog, 22 individuals) and *Rana ridibunda* (lake frog, 19 individuals) were observed.

In total, five species of anurans were identified: *Bombina bombina*, *Rana terrestris*, *Rana temporaria*, *Rana esculenta*, and *Rana ridibunda*. These species represent two families *Ranidae* and *Discoglossidae* and two ecological groups: aquatic (*R. esculenta*, *R. ridibunda*, *B. bombina*) and semi-terrestrial (*R. terrestris*, *R. temporaria*).

Species abundance and distribution varied among habitats. The pond site supported the largest population of Bombina bombina, a species preferring calm shallow waters with abundant vegetation cover, serving as both breeding and feeding grounds. The mixed forest was dominated by *Rana terrestris* and *Rana temporaria*, which were frequently observed near small pools and damp leaf litter. The swamp habitat hosted *Rana esculenta* and *Rana ridibunda*, which exhibited strong association with open sunlit wetlands and slow-flowing channels.

Environmental parameters such as soil humidity, vegetation structure, water depth, and human disturbance strongly affected species distribution. Amphibian activity peaked during evening and night hours, with calling males most often recorded in June and early July. No invasive or non-native species were detected, indicating a stable, naturally formed local amphibian community [3].

The results confirm that habitat diversity within the Loyev District supports relatively high amphibian species richness compared to other parts of the Gomel Region. Maintaining the ecological integrity of wetlands and forest edges is crucial for the long-term conservation of amphibian populations. The collected data can be used for regional biodiversity monitoring, ecological education, and conservation planning.

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DETERMINATION OF THE ACTIVITY OF NATURAL RADIONUCLIDES BY GAMMA SPECTROMETRY

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Natural ionizing radiation primarily comes from primordial radionuclides that make up the Earth's crust. These primordial radionuclides include K-40 and the decay products of U-238, Th-232, and U-235. Soil radioactivity is determined primarily by the content of these radionuclides in the parent rock and varies among soils in different parts of the world. This results in areas with varying levels of natural background radiation.

The Canary Islands are a volcanic archipelago located in the Atlantic Ocean. They have unique geological characteristics that determine the level of natural background radiation. The level of natural radioactivity on these islands is determined by the radionuclide content of volcanic rocks and coastal sediments [1].

Keywords: natural radioactivity, radionuclides, specific activity, gamma spectrometry.

For gamma spectrometric analysis, samples of black and white sand from Tenerife, weighing 432 g and 187.5 g, respectively, and a soil sample from Gran Canaria, weighing 594.7 g, were collected.

Spectrometric measurements were conducted using a GCD-100220 semiconductor gamma spectrometer with a coaxial high-purity germanium detector. The acquisition and processing of gamma spectra, identification of

radionuclides in the samples, and determination of specific activity were performed using the specialized SpectraLineGP software package.

Measurement results:

1) Soil sample (Gran Canaria) – $^{232}Th = 5{,}2 \pm 1{,}3$ Бк/кг, $^{226}Ra = 5{,}9 \pm 1{,}5$ Бк/кг, $^{40}K = 233{,}7 \pm 37{,}4$ Бк/кг.
2) Black sand sample (Tenerife Island) – $^{232}Th = 3{,}7 \pm 1$ Бк/кг.
3) White sand sample (Tenerife Island) – $^{232}Th = 9{,}1 \pm 0{,}3$ Бк/кг, $^{226}Ra = 22{,}4 \pm 4{,}5$ Бк/кг, $^{40}K = 618 \pm 111{,}4$ Бк/кг.

Sedimentary rocks such as sandstone typically have higher levels of potassium-containing minerals (e.g., feldspars), resulting in higher activity of the radionuclide ^{40}K. On average, the ^{40}K activity of sandstone is approximately 680 Bq/kg, the ^{226}Ra activity is approximately 17 Bq/kg, and the ^{232}Th activity is approximately 20 Bq/kg.

In contrast, volcanic (igneous) rocks have significantly lower activity values. For basalt, the average ^{40}K activity ranges from 150 to 400 Bq/kg, the ^{226}Ra activity ranges from 10 to 20 Bq/kg, and the ^{232}Thactivity ranges from 5 to 15 Bq/kg [2].

It should be noted that the calculated activity values for the soil and sand samples correspond to the activity values inherent in these rock types. Thus, the higher potassium-40 activity in the white sand in Tenerife, which was imported from the Sahara and is a sedimentary rock (sandstone), is explained by its geochemical origin.

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IRON AVAILABILITY OF YOUNG PEOPLE IN MINSK

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Data on hair iron levels in young people in Minsk were obtained (11–60.5 mg/kg). The median was within reference limits. There were no statistically significant differences (p=0.05) in hair iron levels between boys and girls. There were some cases of hair iron levels outside the reference limits, which is concerning and requires attention and further study.

Keywords: iron, deficiency, excess, bioelements, minerals, bioelement status, chemical elements, heavy metals, trace element deficiency, hair, young people, environmental pollution.

Iron is a key component involved in various biochemical processes, such as hemoglobin synthesis, maintenance of normal immune system function, and cellular metabolism. Iron deficiency or excess can lead to serious health consequences, including anemia, metabolic disorders, and weakened immune defenses. In today's world, where the environment, lifestyle, and nutrition of young people are undergoing significant changes, it is important to monitor iron levels in the body. Minsk, as the capital and a major metropolis, represents a unique research environment, as it is home to a variety of factors influencing public health.

The aim of our study was to assess iron accumulation levels in the hair of young people in Minsk. The following objectives were addressed: 1. Collect biomaterial (hair) samples. 2. Determine iron concentrations in the hair of young people and assess its compliance with reference values. The study sampled 24 young people: 18 girls and 6 boys aged 18–22, students at the International Sakharov Environmental Institute of Belarusian State University and who had been living in Minsk for more than 1 year. The study focused on Fe (iron) concentrations in hair. Research methods included

survey analysis, statistical analysis, and X-ray fluorescence analysis [1]. Hair sampling, sample preparation, and measurements were performed according to established methods at the Environmental Monitoring and Management Laboratory of the International Sakharov Environmental Institute. Table 1 presents data on the concentrations of chemical elements in the hair of the young people studied, compared to reference values.

Table

Iron content in the hair of girls and boys in Minsk (p=0.05), mg/kg

Groups	Mean ± error (p=0,05) Minimum-maximum median, percentiles25-75%	Reference values	
		minimum	maximum
Girls, n=18	19,86±3,95 11 – 44 17,75; 15,6 – 22,3	13	35
Young men, n=6	23,92±18,98 14 – 60,5 16,5; 15,25 – 20	13	35

Hair iron levels in young people in Minsk ranged from 11 to 60.5 mg/kg, with the median within the reference range. The study results showed no statistically significant differences (p=0.05) in hair iron levels between boys and girls. However, cases of low and high iron levels were identified. Among girls, 11.1% were in the deficient range, 83.3% were within the normal range, and 5.6% had excess levels. Among boys, 83.3% were within the normal range, and 16.7% were above the reference range.

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DECISION-MAKING IN ECOLOGY: HOW GIS TECHNOLOGIES HELP MANAGE ENVIRONMENTAL QUALITY

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The article reveals the key role of geographic information systems in modern environmental monitoring. It discusses the main tasks of monitoring, with a particular focus on the functions of GIS aimed at supporting the optimization of environmental protection activities.

Keywords: geoinformation systems, environmental monitoring, data.

A Geographic Information System (GIS) is a hardware-software complex designed to work with spatial data. It allows for the collection, storage, analysis, and visualization of geographic information in the form of maps and models. The essence of GIS technology is based on the principle of multi-layering: distinct layers containing information about individual elements of the territory are overlaid on the primary layer of the geographic map.

The essence of environmental monitoring lies in the comprehensive collection of data from various components of the environment, followed by analysis, forecasting, and identification of change dynamics. This information serves as the foundation for evidence-based environmental regulation, with geographic information systems playing a crucial role as an essential analytical tool in this process.

GIS tools are used to perform spatial modeling that allows assessment and prediction of pollutant dispersion in the atmosphere and water systems – for example, concentration fields are generated from emissions and meteorological data, helping to estimate the potential scale of impact.

Assessment of habitat degradation: based on GIS data, maps of key environmental parameters are created. By comparing these with current information about the state of ecosystems, one can evaluate the scale and speed of degradation, as well as track anthropogenic impacts over time.

For cadastral purposes, GIS is used to create digital registries and maps of property owners: this ensures the integration of parcel geometry with attribute information and simplifies the management and analysis of land resources.

An equally important role is assigned to the monitoring of protected areas, where GIS is used to systematize information about nature reserves and other valuable zones, helping to plan conservation activities, track the status of rare biological species, regulate anthropogenic loads, and analyze land productivity. The systems also provide invaluable assistance in habitat restoration – from identifying optimal areas for species reintroduction to monitoring organism adaptation.

Additionally, GIS performs a critically important function of retrospective analysis, allowing for the evaluation of the effectiveness of undertaken conservation measures at various territorial levels.

Besides standard GIS functions, the software complex used provides: the formation and maintenance of ecological data bases for territories, enterprises, and environments (air, water, soil); a database of regulatory legal documents in the field of ecology; a database of standards for pollutant content in various environmental components and food products; and a database of ecological monitoring instruments.

In conclusion, it can be stated that GIS technologies play a critically important role in ecological monitoring and related fields. Their implementation allows for the automation of labor-intensive processes, reduces dependence on human factors, and minimizes the number of errors.

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ASSESSMENT OF THE OCCURRENCE OF AUXOTROPHIC FORMS OF SANITARY-INDECENT MICROORGANISMS IN SOILS OF RECREATIONAL AREAS OF MINSK

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During the study, bacteria of the genus Escherichia and genus Staphylococcus were isolated and identified from soil samples. The highest numbers of auxotrophic variants of coliform bacteria, particularly *E. coli* and *S. aureus*, were found in samples from beach №2 and the lowest in beach №3. These results may indicate a potential high organic matter content in the soil. Coli titer values ranged from 0,008 to 0,1, and the coli index was 10^4, suggesting severe beach pollution.

Keywords: microorganisms, auxotrophy, total microbial count, recreational areas, soil, culture method.

Currently, due to rapid technological progress, much attention is being paid to the study of the widespread phenomenon of auxotrophy, which refers to the inability to independently synthesize certain growth factors. The fact that some epidemiologically and ecologically significant microorganisms require amino acids, nitrogenous bases, and vitamins for growth is widely used in research on prokaryotic taxonomy and genetics.

Regarding the presence of sanitary indicator microorganisms, particularly *E. coli* and *S. aureus*, in soil, their concentrations should not exceed the regulated sanitary and epidemiological indicators. For soil, such indicators include the total microbial count, the coliform titer, the *C. perfringens* titer, the nitrifying bacteria titer, the coliform index, and the thermophilic microorganism index.

During the study, bacteria of the genus Escherichia and genus Staphylococcus were isolated and identified from soil samples. Sampling was carried out from Beach №1, Beach №2 on the Drozdy Reservoir, and Beach №3 on Lake Komsomolskoye. The total microbial count from the Drozdy Reservoir samples was $3{,}57 \times 10^5 \pm 2 \times 10^4$ and $0{,}296 \times$

$10^5 \pm 2 \times 10^3$ CFU/g, respectively, and from the Lake Komsomolskoye samples it was $6{,}08 \times 10^5 \pm 5 \times 10^4$ CFU/g, which corresponds to the standard values.

During the study, the coli index and coli titer values were calculated for soil samples from beaches №1 and №2 of the Drozdy Reservoir and beach №3 of Komsomolskoye Lake. Soil was assessed as clean if its coli titer was equal to 1 or higher; contaminated if the coli titer was from 0,9 to 0,01; and heavily contaminated if the coli titer was equal to 0,009 or lower. Coli titer values ranged from 0,008 to 0,1, and the coli index was 10^4. Based on the coli titer and coli index results, it can be concluded that regular sanitary and microbiological monitoring of the soils in these areas is necessary.

The amount of auxotrophic variants of coliform bacteria, in particular *E. coli* and *S. aureus* in soil samples from beach №1 was 47 ± 4.03% and 26 ± 2.2%, beach №2 – 59.2 ± 5.1% and 4 ± 0.4%, beach № 3 – 17 ± 1.3% and 3 ± 0.2% for these bacteria, respectively. Such results may indicate a possible high content of organic matter in the soil.

Thus, according to the obtained results, the presence of auxotrophic variants of *E. coli* and *S. aureus* in the soil samples can be explained by the possible high concentration of organic matter. The coli titer and coli index values exceed sanitary and hygienic standards, making recreation in these areas inadvisable, as excess coliform bacteria in beach soils can lead to increased intestinal infections among the population. This constitutes the basis for sanitary and epidemiological monitoring of the beaches.

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RESEARCH OF PHYSICAL AND CHEMICAL PROPERTIES OF SOIL IN AREAS OF POTASH PRODUCTION

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Soil salinization occurs due to clay-salt sludge and gallite waste. The formation of liquid and solid gallite waste in the Republic of Belarus is associated with the development of new potassium salt deposits. One of the possible measures for land restoration is biological reclamation. Biological reclamation is a set of measures aimed at restoring disturbed lands with the help of halophyte plants.

Keywords: clay-salt sludge, gallite waste, biological reclamation

The purpose of this work is to study the physico-chemical properties of soil in areas of potash production to justify the choice of plants for biological reclamation. To achieve it, the following tasks have been solved: 1) studies of the granulometric composition, humidity, acidity, and salinity of soil samples taken at a distance of 100 m, 200 m, and 300 m from the terricon were carried out; 2) the germination of halophyte plant seeds selected for biological reclamation of saline soils was analyzed.

The granulometric analysis of the soil was carried out using the sieve method, which is based on the mechanical separation of soil particles into different size fractions using sieves with different hole diameters. The following soil samples were used as the analyzed samples:

- Sample No. 1 (100 m from the spoil heaps);
- Sample No. 2 (200 m from the spoil heaps);
- Sample No. 3 (300 m from the spoil heaps).

The analysis of the results of the granulometric composition of the soil taken at a distance of 100, 200 and 300 meters from the spoil heaps showed that the studied samples according to the classification of N.A. Kachinsky belong to the cohesive-sandy composition.

Determination of soil moisture was carried out by drying the studied samples in an electric heating oven at a temperature of 105ºC-110ºC and subsequent determination of the loss of mass fraction of moisture. After that, the hygroscopicity coefficient was calculated to convert the analysis results to an absolutely dry soil.

The soils near the spoil heaps are quite dry, with a moisture content of no more than 8% according to the results of the studies.

The acidity of the analyzed soil samples was determined using a universal indicator paper. The pH of the analyzed soil samples is 7.5-8 (alkaline reaction).

The degree of salinity of the analyzed soil samples was determined by measuring the amount of dry and calcined residue. The mass of dry and calcined residue was determined by calculation, taking into account the hygroscopicity coefficient. The obtained data on the amount of dry residue in the water extract shows the total content of water-soluble organic mineral compounds in the soil, while the amount of calcined residue provides information on the total amount of water-soluble mineral salts. Based on the amount of dry and calcined residue, all the samples are classified as saline. Sample No. 1 (100 m from the spoil heap) showed the highest level of salinity. The results of the analysis speak of the horizontal migration of salts.

To determine the possibility of growing halophyte plants, an experiment was conducted to determine the content of the natural radionuclide potassium 40 and the radionuclide of the Chernobyl release - cesium 137 in soils on the ALIOT device. The surface activity of the soil samples was calculated. Since it is less than one Curie per square kilometer, it was concluded that it is possible to grow plants.

The following halophyte plants were selected for biological reclamation: meadow bluegrass, phacelia tanacetifolia, sugar beet, and barley.

The highest percentage of germination on all studied soil samples (100 m, 200 m, 300 m from the terricon, control sample) is observed in barley – 70.0%, 76.7%, 83.3% and 93.3%, respectively. The germination rate of seeds of all selected crops is 10-20% higher in the control soil sample, which allows us to conclude that the initial seeding rate should be increased by 20-30% during biological reclamation on saline soils.

The results of laboratory studies showed that halophyte plants such as bluegrass, phacelia, beetroot, and barley can be used for biological reclamation of saline, sandy, dry, and alkaline soils. Barley showed the highest tolerance to saline soils, and the seeding rate for saline soils should be increased by 20-30%.

ANALYSIS OF ENVIRONMENTAL IMPACT OF PHOSPHORUS FERTILIZER PRODUCTION WASTE STORAGE FACILITIES ON SOIL COVER

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The environmental impact of storage facilities for phosphorus fertilizer production waste on the soil cover has been analyzed. Long-term, large-scale accumulation of phosphorus fertilizer production waste has led to the formation of a technogenic geochemical province in the area of phosphogypsum dumps of OJSC "Gomel Chemical Plant" and its nearby periphery. The dominant elements in this province are phosphorus, sulfur, and fluorine. Local contamination of the soil cover within the enterprise's territory by heavy metals has been observed.

Keywords: environmental protection activities, industrial waste management, phosphogypsum, soil monitoring, heavy metals, local monitoring, environmental management.

OJSC "Gomel Chemical Plant" is one of the leading enterprises in the petrochemical industry and the only company in the republic with a full production cycle for phosphorus-containing fertilizers. The raw materials used for fertilizer

production are enriched natural phosphate ores - apatite concentrate from the Russian Federation and phosphorites from North African countries.

Acid decomposition of natural phosphate ores generates significant volumes of liquid and solid waste, the latter represented by phosphogypsum. Phosphogypsum is a white, loose, greasy-to-the-touch material. Its removal is carried out by freight transport to long-term waste storage sites - phosphogypsum dumps designed in the form of spoil heaps. The area allocated for these dumps exceeds 90 hectares. The height of individual spoil heaps reaches up to 90 meters, with a total length of approximately 400 meters.

An analysis of statistical data on the phosphorus fertilizer production waste management in the Republic of Belarus revealed that the accumulated volume of phosphogypsum as of early 2025 exceeded 26.4 million tons. The annual increase ranges from 700 to 900 thousand tons. The phosphogypsum recycle rate declined from 0.8% (6.43 thousand tons) in 2019 to 0.18% (1.50 thousand tons) in 2024 of the total amounts generated [1]. At the same time, the total design capacity of phosphogypsum processing facilities registered in Belarus exceeds 1.9 million tons per year [2].

The surface of phosphogypsum dumps is subject to intense water erosion due to raindrop splash dispersal of soil particles and washouts caused by temporary surface runoff streams. This leads to the formation of an erosion-accumulation cycle and contamination, primarily of the soil cover in the dump placement zone and its nearby periphery. Long-term accumulation of phosphorus fertilizer production waste has resulted in the technogenic geochemical province formation, whose dominant elements are the main waste components - phosphorus, sulfur, and fluorine.

The average phosphorus content in the form of superphosphate in the soils of the enterprise's territory is 3.0 g/kg in the surface layer (0-5 cm) and 1.9 g/kg at a depth of 5-20 cm. A decrease in the concentration of this element with depth is observed, ranging from 1.5 to 11 times.

Total sulfur concentrations in the soils of the phosphogypsum dump zone and its nearby periphery range from 1.5 to 2.5 g/kg.

No fluoride contamination of the enterprise's soils has been detected: the average content of water-soluble forms of this element is 4.87 mg/kg in the surface horizon (0-5 cm) and 6.06 mg/kg at a depth of 5–20 cm.

Heavy metal content is within acceptable limits, with the average cadmium concentration not exceeding 0.1 MAC (Maximum Allowable Concentration). Local exceedances of MAC for heavy metals have been recorded, which are attributed to the close proximity of other industrial facilities.

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ENVIRONMENTAL DEVELOPMENT RATING DYNAMICS OF THE REGIONS OF THE REPUBLIC OF BELARUS FOR 2020–2023

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Environmental development rating dynamics of the regions of the Republic of Belarus from 2020 to 2023 have been analyzed. The rating is based on three categories of indicators, each assigned a specific weight (in %): current state and use of environmental components (30%), impact of major types of economic activity on the environment (30%), and environmental impact management and environmental policy effectiveness (40%). Analyzing the set of indicators in each category allows for ranking the regional centers and districts of the Republic of Belarus from best to worst.

Keywords: environmental protection activities, environmental rating, environment current state, environmental policy, environmental management.

Work on compiling, maintaining, and updating the environmental development rating of the regions of the Republic of Belarus has been conducted since 2020. The goal is to provide a comprehensive assessment of the environmental condition of the republic's regions as part of the implementation of the state policy of the Republic of Belarus in the field of sustainable development and improving environmental quality [1].

The rating indicators for administrative-territorial units are grouped into indicator groups, which are then combined into categories. Each category includes 4 to 6 indicator groups (3 to 5 groups for cities). Based on statistical data, a linear scaling operation is performed to calculate scores for each administrative-territorial unit. Final category scores are determined by summing the scores of each group within the category. Based on the total scores among cities and/or districts, the absolute leader and outsider are identified [1].

In 2023, among the regional centers of the Republic of Belarus, Vitebsk ranked first in the category "Current state and use of environmental components" with 207 points, while Minsk was the lowest with 60 points. The cities were ranked from best to worst in this category as follows: Vitebsk, Brest, Gomel, Mogilev, Grodno, Minsk.

In the category "Impact of major types of economic activity on the environment," Brest took the leading position in 2023 with 277 points, indicating the lowest environmental impact, while Gomel ranked last with 145 points. The ranking in this category is: Brest, Vitebsk, Minsk, Grodno, Mogilev, Gomel.

In the category "Management of environmental impact and environmental policy effectiveness" Minsk retained the leading position in 2023 with 404 points, while Gomel was again the lowest with 135 points. The cities were ranked in this category as follows: Minsk, Vitebsk, Grodno, Mogilev, Brest, Gomel.

Thus, the final results of the environmental development rating of regional centers across all three categories in 2023 are as follows: first place – Minsk, second – Vitebsk, third – Brest; Grodno, Mogilev, and Gomel ranked fourth to sixth, respectively. The results of the environmental development rating of regional centers for 2020–2023 are presented in Table 1.

Table

Environmental development rating of regional centers for 2020-2023

Name of the administrative-territorial unit	Position			
	2020 г.	2021 г.	2022 г.	2023 г.
Brest	2	1	1	3
Vitebsk	6	5	5	2
Gomel	5	6	4	6
Grodno	1	4	2	4
Minsk	4	3	3	1
Mogilev	3	2	6	5

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ANALYZING ENVIRONMENTAL POLLUTANTS, AFFECTING FERROPTOSIS, THEIR POSSIBLE CONSEQUENCES AND PREVENTION STRATEGIES

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Environmental pollutants suppress ferroptosis, impacting cellular bioenergetics and aging rate. A multifaceted approach combining natural compounds, pharmacology, and biotechnology is crucial to preserve mitochondrial health.

Keywords: Ferroptosis, G-quadruplexes, mitochondrial DNA, environmental pollutants, heavy metals, radiation, bioenergetics, aging

Ferroptosis was identified in 2012, and it was termed as a regulated cell death pathway associated with an iron-dependent lipid peroxidation. Now it considered to be a vital mechanism for eliminating compromised cells, preventing their accumulation, also supporting normal iron metabolism [1]. Some key cellular defense mechanisms, such as the glutathione peroxidase 4 (GPX4) and glutathione (GSH), are important in the antiferroptotic process. But under the environmental stress this protective action can be abnormal.

Iron metabolism and ferroptosis can be influenced by numerous environmental pollutants and ionizing radiation. A possible mechanism for this effect may be an impact on G-quadruplex (G4) structures in the genome, particularly in mitochondrial DNA (mtDNA) [3,4]. G4 is a guanine-rich DNA region that is particularly vulnerable to oxidative damage. Thus, some environmental toxicants can disrupt mtDNA replication and transcription, cause damage to the electron transport chain (ETC), excessive formation of reactive oxygen species (ROS), and impaired cellular energy production. These events may explain the development of age-related pathologies and accelerated aging [4]. First, several elements deserve attention: selenium, often present in agricultural waste, can increase the expression of the selenoprotein GPX4 and thus disrupt iron metabolism, potentially enhancing G4 stabilization in mtDNA genes such as ND5 [1]. Second, two other metals, zinc and cadmium, can also stabilize G4 structures in other regions (CYTB and COX1). This may lead to similar impairments in mitochondrial function and suppression of ferroptosis [2,3]. Third, it is worth noting that radioactive elements such as cesium-137 (137Cs) can affect mtDNA G4, causing damage that disrupts the replication process and may lead to bioenergetic disturbances [4].

Regarding counteracting the impact of environmental factors on ferroptosis, a number of researchers place hope in innovative approaches. For example, the use of a number of plant metabolites, such as flavonoids and polyphenols, especially from the flora of the Russian Far East, which are capable of binding to G4 and influencing iron availability, may be very promising [2,5]. Specific ligands (e.g., TMPyP4) have a similar effect, based on the ability to bind to G4 and prevent its stabilization. Some drugs (erastin, RSL3) can directly influence the ferroptosis pathway. In the long term, the integration of new advanced technologies is expected: bioinformatics tools, including AI-based methods for the analysis of genetic variants associated with G4, and CRISPR base editing tools, which will allow for more precise manipulation of genetic material, reduce the effects of radiation mutagenesis, and promote the restoration of mitochondrial function [1,4].

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IMPROVING THE ENERGY EFFICIENCY OF LASER CUTTING STEEL MATERIALS USING HYDROABRASIVE PRETREATMENT

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Keywords: laser cutting, jet, bentonite clay, metal, machinery, mechanisms, technology, mechanical engineering, mechanics, corrosion, coating, speed, cleaning, material.

The high efficiency of modern methods for manufacturing machine parts and mechanisms is closely related to the quality of preliminary cleaning of metal surfaces from corrosion. The required level of processing is achieved through the use of jet technological solutions, especially in the context of laser cutting used at engineering enterprises of the Republic of Belarus [1-4]. One of the key indicators determining the effectiveness of laser metal processing is the speed of laser cutting (Figure 1). Let's consider an innovative approach to jet cleaning of metal materials from corrosion, with subsequent application in the laser cutting process. The distinctive feature of the proposed hydroabrasive treatment method is the introduction of special components into the high-pressure water jet – bentonite clay, soda ash, and soot. This not only ensures effective corrosion removal but also creates a surface optimal for laser cutting. At the Department of "Energy-Efficient Technologies" of the International Sakharov Environmental Institute in cooperation with the Department of "Hydraulic Engineering and Energy Construction, Water Transport and Hydraulics" of the Belarusian National Technical University, research was conducted on a new method for cleaning metal materials from corrosion with subsequent use for laser cutting. To analyze the influence of hydroabrasive treatment parameters on the laser cutting speed, industrial tests were conducted on three groups of samples made from St3, St20, and St45 steels. The sample dimensions were 200 × 200 mm with a sheet thickness range of S = 2-12 mm. Based on the results of experimental studies, a modernized technology for hydroabrasive cleaning of metal materials was developed, intended for corrosion removal with their subsequent processing by laser cutting. The proposed technology uses a working fluid containing the following components [3]: bentonite clay (K_b = 1.5-2.5 %), soda ash ($K_{s.a.}$ = 1.8-2.2 %), soot (K_s = 11-13 %), and water. The use of this working fluid allowed for an increase in laser cutting speed by 8-12 % compared to the results obtained using a similar fluid containing polyacrylamide instead of soot – and without the need for introducing additional technological operations.

Fig:1 External appearance of the HYPER-GEAR-510 laser cutting complex:
1 - laser machine module; 2 - pallets; 3 - the door closing the work area

Conclusions. Based on the conducted experimental studies, as well as the patent source [3], an improved hydroabrasive cleaning (HAC) technology was developed, intended for removing corrosion from metal materials with their further use in laser cutting processes. This technology involves the use of a working fluid prepared based on

bentonite clay (K_b=1.5-2.5 %), soda ash ($K_{s.a.}$=1.8-2.2 %), *soot* (K_s=11-13 %), and water, which allowed for an increase in laser cutting speed of up to 8-12 % (compared to data [5]) without performing additional technological operations.

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AIR POLLUTION CHARACTERISTICS AND THEIR RELATIONSHIP WITH METEOROLOGICAL FACTORS IN SHANXI PROVINCE

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Base on the daily mass concentrations of 6 air pollutants (SO_2, NO_2, PM_{10}, $PM_{2,5}$, CO and O_3), air quality index (AQI), meteorological observations and Modern Era Retrospective-analysis for Research and Applications (MERRA-2) reanalysis product the characteristics of air pollution and its correlations with meteorological factors in 11 cities of Shanxi Province during 2015 - 2019 will be analyzed and presented in this study.

Keywords: air pollution, meteorological factors, Shanxi province.

China’s rapid economic growth has been accompanied by massive consumption of fossil fuels such as coal. The resulting emissions of various polluting gases and particulate matter have led to an overall decline in air quality over the past decade, with frequent occurrences of heavy pollution events. Air pollution not only harms human health and affects atmospheric visibility, urban transportation, radiation balance, and cloud-precipitation processes but also further induces climate change, damaging industrial and agricultural production as well as economic development. Therefore, air pollution has become a major concern for both the government and the public. Currently, particulate matter and ozone pollution represent the most significant air quality issues in China.

The Beijing-Tianjin-Hebei region and its surrounding areas are key zones for air pollution in northern China. Extensive and in-depth research has already been conducted on air pollution in the Beijing-Tianjin-Hebei region. Shanxi Province, adjacent to the Beijing-Tianjin-Hebei region, is an important coal reserve and production base in China. At the same time, its unique “valley between two mountains” topography hinders the dispersion of air pollutants, leading to prominent air pollution issues in recent years. Current research on air pollution in Shanxi Province has primarily focused on key cities such as Taiyuan, Changzhi, and Linfen. Studies have indicated that surface-level ozone in Taiyuan showed an increasing trend from 2013 to 2017, with its precursor volatile organic compounds (VOC) mainly originating from industrial emissions and transportation sources. Observational and modeling studies suggest that regional transport significantly impacts air quality in Shanxi and its surrounding areas. Some research has pointed out a certain correlation between haze events in Shanxi Province and anomalies in East Asian atmospheric circulation. Moreover, the effective implementation of air pollution control policies has significantly improved air quality in Shanxi. Overall, comprehensive analytical studies on the long-term variation characteristics of multiple air pollutants in Shanxi Province still need to be strengthened.

The air quality data in this study consist of daily average mass concentrations of 6 atmospheric pollutants (SO_2, NO_2, PM_{10}, $PM_{2,5}$, CO and O_3) and the Air quality index (AQI) for 11 cities in Shanxi Province from 2015 to 2019. Monthly, seasonal, and annual averages will be calculated based on these data. The meteorological data employed in this study include daily average observations from conventional weather stations and monthly average products from

The Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) reanalysis dataset. The weather station data were obtained from the China Meteorological Data Center (CMDC) (http://data.cma.cn/). MERRA-2 is a next-generation reanalysis dataset developed by NASA in the United States. It focuses on weather and climate time scales as well as fields related to the water cycle. The dataset assimilates satellite-based hyperspectral infrared radiance, microwave observations, and GPS radio occultation data. The spatial resolution of the MERRA-2 product is 0.5° × 0.625°.

Thus, this study will comprehensively utilize daily average data on the mass concentrations of 6 air pollutants and the AQI from 11 cities in Shanxi Province from 2015 to 2019 along with meteorological station observations and MERRA-2 reanalysis products to analyze the characteristics of air pollution changes in Shanxi Province and their relationship with meteorological factors [1 - 3].

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ANALYSIS OF THE DEVELOPMENT OF THE GREEN ECONOMY IN CHINA

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The article shows that the "green economy" is a new economic structure that is being widely implemented in agriculture, the industrial sector and other economic services. It represents a growth model that is more efficient, harmonious, and sustainable. The "green economy", "green new deal" and "green society" are recognized worldwide as a common consensus and direction for the development of human civilization in the 21st century.

Keywords: digital economy; green economy; Development effect

Green development is an important strategic direction for our country's economic and social development, and it is also an important path for our country to achieve the "double carbon" goal. In recent years, our country's digital economy has developed rapidly, but it has also brought about problems such as resource consumption and environmental pollution. Explore its effect on empowering green economic development. At the theoretical level, it is mainly analyzed from the aspects of digital economy empowering green technology innovation, upgrading of green industrial structure, and release of green consumer demand. At the practical level, taking the development and utilization of data resources as an example, this paper analyzes its role in the transformation and upgrading of traditional industries and promoting consumption upgrading. At the same time, we will work together from both sides of supply and demand to give full play to the enabling effect of the digital economy in the development of the green economy and help our country achieve the "double carbon" goal.

The green economy is an economic structure, growth model, and social form that aims for efficiency, harmony, and sustainability, with ecological agriculture, circular industry, and sustainable service industries as its core components. The green economy represents a brand-new trinity of theoretical ideas and development systems. This includes a trinity of objectives - "efficiency, harmony, and sustainability"; a trinity of structures-"ecological agriculture, circular industry, and sustainable service industries"; and a trinity of development systems-"green economy, green new deal, and green society." History has shown that the green economy constitutes a new economic structure following agricultural, industrial, and service economies. It represents a growth model that is more efficient, harmonious, and sustainable, and a social form that surpasses agricultural, industrial, and service society. The green economy, green new deal, and green society are recognized globally as the shared consensus and developmental direction of human civilization in the 21st century.

The British economist Pearce first proposed the concept of a green economy in his 1989 publication, *The Green Economy Blue Paper*. In the 1990s, Jacobs, Postel, and others advocated in their version of green economics that, in addition to the three traditional factors of production in classical economics-labor, land, and man-made capital-there must be an inclusion of social and organizational capital (SOC). They also made slight modifications to the definitions of the other three types of capital: 1. Human capital: emphasizing the health, knowledge, skills, and motivation of the workforce. 2. Expanding land costs into ecological capital, or natural capital. 3. Man-made capital remains unchanged, also referred to as manufactured capital.

NEURAL NETWORKS ARCHITECTURES FOR PREDICTING POLLUTANT MIGRATION IN SOIL

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The main types of neural networks (NN) architectures for predicting pollutant migration in natural dispersed media are discussed. A description of the architecture of physically-informed neural networks for solving forecasting problems is provided.

Keywords: neural networks, physics-informed neural networks, architectures neural networks.

Forecasting the migration of pollutants in soil is a multifaceted task that involves the interaction of hydrological, geochemical, and biological processes. Traditional numerical methods, such as the finite difference method and the finite element method, offer high modeling accuracy but require significant computational resources and are sensitive to the quality of input data. In recent years, increasing attention has been paid to the use of neural networks, including physics-informed neural networks (PINNs), which allow physical laws to be incorporated into the training process [1].

The application of neural networks to pollutant migration forecasting is based on their ability to approximate complex nonlinear relationships between environmental input parameters and pollution output characteristics. The most commonly used architectures include multilayer perceptrons (MLPs) [2], convolutional neural networks (CNNs) [3], and recurrent neural networks (RNNs) [4], each offering unique advantages depending on the input data structure and nature of the task.

A multilayer perceptron (MLP) is a basic form of neural network consisting of an input layer, one or more hidden layers, and an output layer. In pollutant migration modeling, MLPs are used to predict the concentration of a substance at a given point in space and time based on environmental parameters such as porosity, moisture content, hydraulic conductivity, initial concentration, and others. MLPs perform well in regression tasks [2], especially when large volumes of training data are available, but may struggle with modeling spatiotemporal dependencies.

Convolutional neural networks (CNNs), originally developed for image processing, are useful in tasks where data have spatial structure. For example, when modeling the spread of pollutants in two- or three-dimensional soil domains, CNNs can effectively extract local patterns related to medium heterogeneity. Convolutions help identify migration patterns associated with terrain features, porosity distribution, and localized sources of contamination.

RNNs, including their variants such as Long Short-term Memory (LSTM) and Gated Recurrent Unit (GRU) neural networks, are applied for modeling the temporal dynamics of pollutants migration. These networks can capture sequences of events, such as changes in pollutant concentration over time at a single location. This is particularly important for modeling processes influenced by weather conditions, seasonal fluctuations, or cyclical anthropogenic impacts. However, RNNs can be sensitive to the vanishing gradient problem, which limits their effectiveness over long time intervals.

Hybrid architectures such as Convolutional LSTM or Convolutional GRU combine the strengths of CNNs and RNNs, providing opportunities of simultaneous modeling of spatial and temporal dependencies. These models are

especially promising for tasks that require predicting pollutant dispersion across space and time using multidimensional input data.

PINNs as a hybrid architecture deserve special attention. Unlike classical neural network architectures, PINNs allow pollutant transport equations to be incorporated directly into the loss function, enabling the model to learn not only from laboratory or field data but also from physical constraints. It enhances the model's robustness to input data noise and improves its generalization capability.

PINNs are trained so that their output satisfies the governing equations at every point in space and time, allowing for physically based predictions even with limited input data. Recent studies [1,3,5] have demonstrated the successful application of PINNs to modeling transport processes in porous media, such as advection and diffusion.

Thus, integrating PINNs into pollutant migration forecasting tasks opens new avenues for environmental modeling compared to more traditional NN architectures. So it makes PINNs attractive to use for predicting pollutants migration in soil because of their robust and physically grounded predictions which has already been proven in practice.

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ELEMENTAL COMPOSITION OF GERMAN CHAMOMILE *(MATRICARIA RECUTITA L.)*

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The elemental composition (Ca, Cu, Fe, Hg, Mn, Pb, Sr, Zn) was determined in pharmaceutical raw material of German chamomile (*Matricaria recutita L.*) sold in pharmacy networks of the Republic of Belarus and produced in Vitebsk and Grodno regions. The content of all determined elements was within sanitary and hygienic standards.

Keywords: German chamomile, *Matricaria recutita L.*, elemental composition, heavy metals, macro- and microelements

German chamomile (*Matricaria recutita L.*) is an annual herbaceous plant; species of the genus *Matricaria*, family *Asteraceae (Compositae)*, the type species of this genus. The root is taproot, weakly branched. The stem is erect, 15-60 cm high. Leaves are alternate, sessile, broadly lanceolate or ovate. Inflorescences are conical baskets, numerous, located on pedicels. Fruits are achenes. The plant is widely distributed in Eurasia and North America; actively cultivated; as an introduced species occurs in almost all extratropical regions of both hemispheres. German chamomile is a popular pharmaceutical remedy in folk medicine; however, plants are capable of absorbing almost all elements of D.I. Mendeleev's periodic system from the environment, the content of some of which is important to control, which determines the relevance of this study.

The aim of our work was to evaluate the elemental composition of German chamomile. Therefore, the following tasks were solved: 1. Provide botanical description of German chamomile. 2. Investigate the elemental composition of German chamomile. 3. Compare the elemental composition of German chamomile with sanitary and hygienic standards.

For this study, we purchased the following chamomile samples from one of Minsk pharmacies: 1. Chamomile flowers Meditea "MPC Biotest" (manufacturer Grodno, Republic of Belarus), 20 filter bags of 1.5 g. 2. Chamomile flowers Meditea "MPC Biotest" (manufacturer Grodno, Republic of Belarus), loose. 3. Chamomile flowers coarse

powder LLC "Kalina" (manufacturer Vitebsk region, Orsha district, Pishchalovo village, Republic of Belarus), 20 filter bags.

In German chamomile samples purchased in Minsk pharmacies, the following elements were determined by X-ray fluorescence method: Ca, Cu, Fe, Hg, Mn, Pb, Sr, Zn. The highest Ca content was found in sample No. 2 – 2624 mg, which is 1.5 times higher than in sample No. 1, where calcium content was 1721 mg. The highest Cu content was in sample No. 2 – 5.1 mg, which is 1.1 times higher than in sample No. 3, where the content of this element was 4.6 mg. Fe content: the highest value was in sample No. 3 – 159 mg, which is 2.7 times higher than in sample No. 2, where the element content was 58.6 mg. The content of Hg and Pb was the same in all samples – 0.1 mg and 1.7 mg respectively. The highest Mn content was in sample No. 3 – 28.9 mg, which is 1.19 times higher than in sample No. 2 – 24.1 mg. The highest Sr content was in sample No. 2 – 21.8 mg, which is 2.5 times higher than the content of this element in sample No. 3 – 8.7 mg. The highest Zn content was in sample No. 2 – 26.2 mg, which is 1.37 times higher than in sample No. 1 – 19.1 mg.

The obtained elemental composition and element concentrations in German chamomile samples were compared with sanitary and hygienic standards. The concentrations of Cu (in samples within 4.6–5.1 mg), Hg (in all samples 0.1 mg), Mn (in samples within 24.1–28.9 mg), Pb (in all samples 1.7 mg), Zn (in samples within 19.1–26.2 mg) were within normal limits.

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CRITERIA FOR SELECTING THE REFERENCE PERSON AND REPRESENTATIVE PERSON FOR ASSESSING RADIATION DOSES FROM TRITIUM IN VARIOUS EXPOSURE SITUATIONS

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The modern system of radiation protection is based on a differentiated approach to dose assessment, including from tritium, which involves the use of two key concepts – the reference person and the representative person. These concepts find different applications depending on the exposure situation: planned, emergency, or existing. The assessment of radiation doses from tritium is particularly relevant for the Republic of Belarus in connection with the commissioning of the Belarusian NPP. The development of criteria for the reference person and representative person adapted to national conditions is crucial for improving the country's radiation safety system.

Keywords: tritium, representative person, reference person, exposure situations, radiation safety

The reference person is a standardized biokinetic and dosimetric model with a fixed set of anatomical and physiological parameters. For tritium, the key characteristics of this model are total body water content and water turnover rate, lung ventilation rates for different activity levels, skin absorption parameters for tritiated water (HTO), and daily consumption of water and foodstuffs. In planned exposure situations, the reference person model is used for dose assessment using dose coefficients, establishing authorized discharge limits, and subsequently planning protective measures. In emergency situations, this model is applied for dose prediction in the early phase of an accident and for developing criteria for protective measures [1].

The representative person is a hypothetical individual whose characteristics reflect the conditions of the most exposed part of the population in a specific exposure situation. The criteria for selecting the representative person in planned exposure situations include the principle of reasonableness, which involves using real data on the consumption of local food and water; the principle of sustainability, requiring that consumption habits are maintained over a long period; and the principle of homogeneity, meaning the representation of a population group with similar characteristics [1, 2]. In emergency situations, the approach to defining the representative person shifts towards using scenarios of maximum plausible exposure, accounting for short-term changes in population behavior, and applying more conservative parameters. In existing exposure situations, priority is given to using environmental monitoring data, accounting for actual dietary habits of the population, and analyzing the actual use of local resources [2].

Of particular importance in assessing radiation doses from tritium is accounting for its specific characteristics. Critical aspects are the dominance of oral intake with water, the significance of percutaneous intake for HTO, age-dependent metabolic features, and the rapid achievement of equilibrium in the body. According to [2, 3], three age categories are used for dose assessment: infants (0-5 years) with parameters of a 1-year-old child, children (6-15 years) with parameters of a 10-year-old child, and adults (16-70 years) with adult parameters. For tritium, the infant group is often critical due to high specific water consumption, intensive water turnover, and specific distribution characteristics in the body.

Thus, the criteria for defining the reference person and representative person for tritium must account for the specifics of various exposure situations. In planned exposure situations, priority is given to sustainable and justified scenarios; in emergency situations – to conservative estimates; in existing situations – to real monitoring data. For Belarusian conditions, particular importance is placed on accounting for regional features of water consumption and dietary structure when determining the parameters of the reference person. The development of national criteria for assessing radiation doses from tritium will optimize the radiation monitoring system and enhance the effectiveness of protective measures in the area of the Belarusian NPP location.

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ENVIRONMENTAL RISKS ASSOCIATED WITH NUCLEAR POWER

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Annotation: This article examines nuclear power engineering and analyzes the risks associated with the production of a nuclear cycle. The ways of minimizing such risks are considered.

Keywords: nuclear power, environmental impact, uranium production, radiation.

Nuclear power occupies a strategic place in the global energy mix, offering low-carbon electricity generation on an industrial scale. Its uniqueness lies in the fact that environmental risks and obligations that arise throughout the entire life cycle extend over an unprecedentedly long period of time, covering centuries. All environmental threats associated with nuclear energy must be considered in the context of the Nuclear Fuel Cycle (NFC), which includes three main stages: the front end (extraction, conversion, enrichment), operation and the back end (nuclear fuel waste management, reprocessing, disposal of radioactive waste and decommissioning).

It is advisable to divide the environmental threats associated with NFC into two large groups: radiation and non-radiation. Radiation risks are directly related to exposure to ionizing radiation (alpha, beta, gamma) and the spread of

radionuclides. These risks require specialized radiation monitoring and isolation throughout the entire cycle. Non-radiation risks include thermal pollution, chemical exposure, landscape degradation and occupational risks, which, although not directly related to the atom, are an integral part of the environmental responsibility of the nuclear industry [1].

Uranium mining, both open-pit and underground, inevitably leads to large-scale degradation of the landscape and changes in the hydrological regime in the regions of development. A key long-term environmental problem is the formation of huge volumes of waste rock dumps and tailings dumps. The empty rock that remains after ore extraction can serve as a permanent source of gamma radiation. Such circumstances require that uranium tailings dumps be functionally considered as objects of low-level radioactive waste. Consequently, the cessation of mining does not relieve the environmental burden, but transfers it to the stage of centuries-old environmental control, obliging operators to carry out not only physical remediation of the landscape, but also to ensure centuries-old physical and hydrological isolation of these wastes from the environment.

Numerous studies confirm the critical importance of thermal pollution of water bodies: issues of thermal pollution are a mandatory and important part of environmental expertise in the regions of operating nuclear power plants. This requirement underlines that the choice of a site for a nuclear power plant is a long-term environmental commitment that is rigidly linked to the ability of a water body to withstand a constant thermal load.

After analyzing the production process of the fuel, it can be seen that uranium production is associated with a high level of occupational risks to the health of personnel. The development of occupational lung diseases is mainly associated with inhaled exposure to radon (an inert gas) and its short-lived daughter products, as well as uranium dust. Radon migrates easily and concentrates in confined spaces of mines. Its daughter solid radionuclides settle in the respiratory tract, causing localized alpha radiation, which is directly related to serious diseases such as lung cancer, pneumoconiosis, tuberculosis and emphysema, and blood diseases. Based on this, the risks of uranium mining require the implementation of not only radiation, but also specialized dust protection, as well as the creation of a highly developed medical infrastructure to reduce social, demographic and economic damage.

A detailed study based on the technical documentation for VVER-1200 type reactors demonstrates that environmental obligations do not cease with the final shutdown of the power unit, but require monitoring for periods significantly exceeding the operational life.

The predicted mass distribution of activated materials shows that long-term exposure is critically important for reducing the category of waste activity. For example, a decrease in the activity category of a significant mass of highly radioactive waste (HW) (from 236 tons to 106 tons) occurs after a long half-life, up to 100 years.

A promising direction in solving the problem of long-term management of highly active nuclear waste is the transition to a closed NFC. Transmutation technologies can reduce the long-term radiotoxicity of waste by "burning" long-lived actinides. Repeated fuel recycling also helps to reduce the amount of waste sent to the final geological disposal, thereby minimizing the environmental burden on the geological layer.

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ECOLOGY AS AN AREA OF APPLICATION OF NEUROMODELING

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The analysis shows that ecology should be considered one of the most promising and priority areas for the application of neuromodeling.

Keywords: artificial intelligence, neuromodeling, artificial neural networks, ecology, environmental forecasting.

Neuromodeling as a technology of the so-called artificial intelligence today penetrates into a variety of spheres of life. Moreover, according to experts, it can be useful and successfully applied in almost all areas of human knowledge and practice [1, etc.]. As the amount of data and information that needs to be processed, analyzed and evaluated is growing everywhere. And the increasing capabilities of modern computer tools and technologies allow them to cope with increasingly large-scale and complex tasks.

One of the most promising areas of application of neuromodeling, in our opinion, should be considered the field of ecology [2, 3, etc.]. It is no coincidence that in recent years a lot of work has appeared on its application to analyze and solve some environmental problems and problems. However, it can be noted that the authors of many review publications still do not attribute ecology to a number of the main areas of modern use of neuromodeling. Therefore, we tried to make some own assessment of the possibilities of its application in the ecology.

Artificial neural networks, being a key element of neuromodeling, are capable of searching for and finding patterns in large arrays of diverse data. In doing so, they can uncover patterns that are difficult or almost impossible to detect using traditional methods. This provides grounds for concluding that neuromodeling can significantly increase the quality of forecasts for changes that are occurring or may occur in the natural environment, and enhance the accuracy of assessing the prospects for the development of natural processes under the influence of both natural and anthropogenic factors. As a result, ecological forecasting can become more operational and, in many cases, more timely. This applies not only to the prediction of slow and gradually developing processes and changes, but also to environmental emergencies. Numerous specific examples of the importance of accuracy and timeliness in environmental forecasting can be provided. At the same time, the development of open artificial intelligence platforms can allow specialists and interested parties from various countries, including those with limited resources, to have access to neural modeling tools and the results obtained through them in near real-time. What can facilitate the timely adoption of essential management decisions in extreme environmental situations, such of a large-scale natural disaster, including those affecting neighboring countries and regions.

Therefore, the use of neural modeling in ecology is relevant and can be highly beneficial. Therefore, we believe that the field of ecology should be considered one of the priority areas for its future application.

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PROSPECTS FOR USING CHEMICAL NICKEL PLATING WASTE AS MODIFIERS FOR SILUMINS

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An analysis of existing issues in the practical application of silumins has been conducted. Current approaches to modifying the structure and properties of silumins by alloying and by increasing the melt cooling rate were studied. The idea of modifying the structure of hypereutectic silumins using a fine-dispersed NiP powder a by-product of chemical nickel plating was proposed and investigated.

Keywords: silumins, nickel, phosphorus, modification, waste.

To date, the main unresolved problem for both wrought silumins (hypoeutectic and eutectic compositions) and cast silumins (hypereutectic compositions) produced by conventional methods without additional alloying is their high

brittleness, because they are characterized by heterogeneous microstructures and coarse phase dispersions primarily of silicon, and of iron in secondary phases [1-2].

Aluminum-based alloys occupy a special position among structural materials. By consumption volume they rank third after steel and cast iron. Therefore, research aimed at improving the microstructure and enhancing the functional properties of silumins is timely and is being actively pursued along two main lines. The first approach involves selecting effective master alloys and modifiers. The second approach focuses on increasing the solidification rate. One commonly used modifier for silumins is phosphorus.

Meanwhile, during electroless nickel plating a fine NiP powder is generated as a result of spontaneous decomposition of spent plating baths. The chemical deposition of nickel-phosphorus coatings on parts made from aluminum alloys is employed in the manufacture of aerospace and specialized equipment [3].

Studies of the microstructure of hypereutectic silumins obtained at a cooling rate of 100 K/s have shown that alloying with Ni-P powder leads to splitting and branching of eutectic silicon plates. This may be associated both with a local retardation of the solidification of the silicon plates and with changes in their growth directions due to the presence of AlP clusters and P atoms at the growing silicon surface. A comparison of rapidly solidified foils synthesized at a melt cooling rate of 10^7 K/s also demonstrated a beneficial effect of NiP particle modification on the structure – namely, refinement and changes in the morphology of the silicon phase [4].

Thus, the use of these powders to modify the structure and properties of silumins would not only make it possible to create new materials with improved characteristics, but also promote the rational reuse of NiP powders recovered from spent solutions, thereby solving the environmental problem of treating spent solutions.

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DEVELOPMENT OF AQUACULTURE EFFLUENT TREATMENT IN WATER ENVIRONMENT PREVENTION AND CONTROL

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China is the country with the largest scale of aquatic production in the world. The environmental pollution caused by aquaculture effluent has become a core factor restricting Chinas aquatic ecological environment.The recirculating water farming system that utilizes tailwater circulation is a new type of ecological farming model that has emerged in response to the concepts of circular economy and environmental protection.

Keywords: aquaculture; circulating water treatment; water environment; environmental management

Background: By 2015, Chinas aquaculture output had exceeded 40 million tons. Against the backdrop of limited aquaculture space, how to maximize breeding efficiency while reducing wastewater discharge or even achieving zero discharge and minimizing environmental pollution has become a core concern in the industry, leading to the rise of industrial recirculating aquaculture technology. Industrial recirculating aquaculture systems offer significant

advantages, not only drastically reducing required space and enabling intensive, efficient water resource utilization, but also significantly decreasing wastewater discharge, yielding substantial economic and environmental benefits [1].

Development: Chinas industrial recirculating aquaculture began in the mid-1980s. In the early stages, due to the disconnect between management concepts and practical applications, the operational efficiency of related equipment was poor. In the early 1990s, China initiated research and technological development in the field of industrial recirculating aquaculture. After nearly 30 years of continuous R&D, a breakthrough was ultimately achieved, transitioning from technical exploration to industrial promotion. From 2015 to the present, China has independently developed a series of technical equipment, including multifunctional protein separators, multifunctional solid-liquid separation devices, modular disinfection equipment, high-speed aerators, and elastic brush-type biological purification media. The water purification processes required for recirculating aquaculture have also been significantly optimized and upgraded.

Currently, the water recycling efficiency of this system has surpassed 90%. Aquaculture is increasingly adopting standardized, mechanized, intelligent, and intensive practices that better align with environmental protection and circular ecological requirements. By organically integrating the recirculating aquaculture model with comprehensive ecological wastewater purification technologies, the industry has successfully achieved zero-waste production and "zero-discharge" standards. Future development of the aquaculture sector will be driven by core factors including automation upgrades, intelligent empowerment, economic value enhancement, and strengthened environmental protection.

Conclusion: As the only safe and environmentally friendly aquaculture method currently available that ensures chemical-free products and prevents heavy metal contamination, the recirculating aquaculture system not only plays a pivotal role in the industry but also aligns with Chinas national strategies for green transformation, circular economy development, and environmental emission reduction in aquaculture [2]. This system significantly enhances the efficiency of aquaculture-related treatment processes, effectively reduces environmental pollution, promotes efficient water recycling, and advances sustainable development of aquatic ecosystems.

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EFFECTS OF HEAVY METAL EXPOSURE ON OXIDATIVE STRESS IN HEPG2 CELLS

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This study examined cadmium and lead induced oxidative stress in HepG2 cells. Both metals decreased cell viability, increased ROS and MDA, and reduced SOD and GSH in a dose-dependent manner. Cadmium showed stronger toxicity, confirming oxidative stress as a key mechanism of heavy metal liver damage.

Keywords: Heavy metals, Oxidative stress, HepG2 cells, Reactive oxygen species, Lipid peroxidation, Antioxidant system

Heavy metal pollution constitutes a global ecological and health concern. As the primary metabolic and detoxification organ, the liver represents a critical target for heavy metal toxicity. Previous studies have indicated that heavy metals can disrupt cellular redox homeostasis by promoting ROS generation and inhibiting antioxidant enzyme activity, thereby inducing lipid peroxidation and DNA damage [1].

This study treated HepG2 cells with $CdCl_2$ and $Pb(NO_3)_2$ at 0, 10, 20, and 50 μM for 24 hours. Cell viability (CCK-8 assay), ROS levels (DCF-DA probe), MDA content, SOD activity, and GSH levels were measured.

Results showed dose-dependent decreases in cell viability, with 50% survival at 50 μM ($p < 0.001$). ROS levels increased 1.5-1.8 times in 10 and 20 μM groups ($p < 0.001$), with Cd^{2+} inducing stronger fluorescence than Pb^{2+} (Figures

1 and 2). These findings align with Li Y. et al. (2019), who showed lead induces lipid hydroperoxides in HepG2 cells [1].

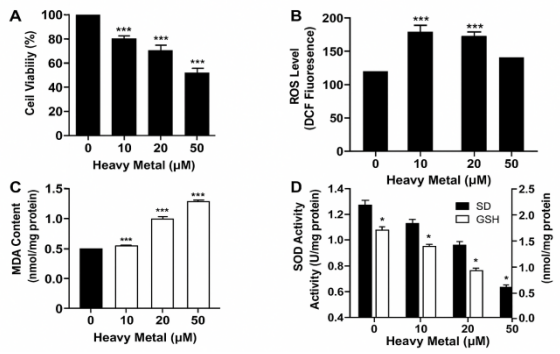

Fig.1. Effects of Heavy Metal Exposure on Oxidative Stress Indicators in HepG2 Cells

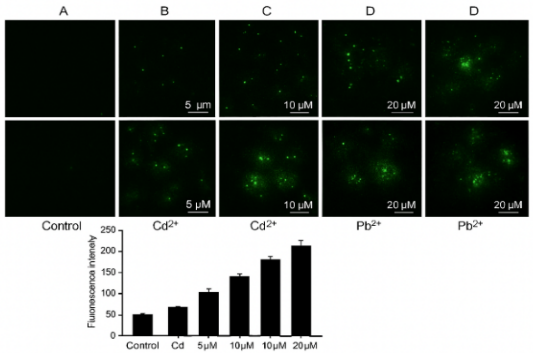

Fig.2. Changes in ROS Levels in HepG2 Cells Following Cd^{2+} and Pb^{2+} Exposure

MDA content reached 2.5 times control levels at 50 μM ($p < 0.001$), while SOD and GSH decreased to 0.6 U/mg protein and 0.8 nmol/mg protein respectively ($p < 0.05$), indicating antioxidant system disruption. These results support Yedjou C.G. and Tchounwou P.B. (2007), who confirmed N-acetyl-L-cysteine mitigates lead-induced oxidative stress [2, p. 135].

Both cadmium and lead induced oxidative stress in HepG2 cells through decreased viability, increased ROS and MDA, and reduced SOD and GSH, with cadmium showing greater toxicity. These findings confirm the pathway: heavy metal exposure → ROS accumulation → antioxidant inhibition → lipid peroxidation → cellular damage.

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COMPREHENSIVE MORPHO-ANATOMICAL ANALYSIS OF HARDWOOD AS A PROMISING METHOD FOR BIOINDICATION OF URBAN ECOSYSTEM STATE

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The article discusses the possibilities of applying a comprehensive morpho-anatomical analysis of wood to assess the state of urban plantations under anthropogenic load.

Keywords: morpho-anatomical analysis, wood, bioindication, urban ecosystems, dendrochronology, environmental monitoring.

Woody plantations form the structural and functional basis of urban ecosystems, playing a key role in maintaining their ecological balance [1]. Under intensive anthropogenic load, traditional methods for the assessment of a tree state can only detect significant disorders, failing to identify preclinical stages of stress impact [2]. A comprehensive analysis of the morpho-anatomical parameters of wood provides a unique opportunity for retrospective assessment and forecasting of the state of woody plants, since wood accumulates information on the impact of stress factors throughout the entire growth period [3].

The most informative research objects are species with clear annual ring differentiation and distinct anatomical structure demonstrating high sensitivity to anthropogenic stress [4]. A comprehensive assessment includes the analysis

of dendrochronological parameters, anatomical characteristics, and structural anomalies that allows to obtain an integrated assessment of plant state [5].

Modern methods of computer image analysis combined with multivariate statistical methods are used for data processing (figure 1). This approach makes it possible to identify hidden patterns and establish cause-and-effect relationships between specific anatomical changes and stress factors of the urbanized environment [4].

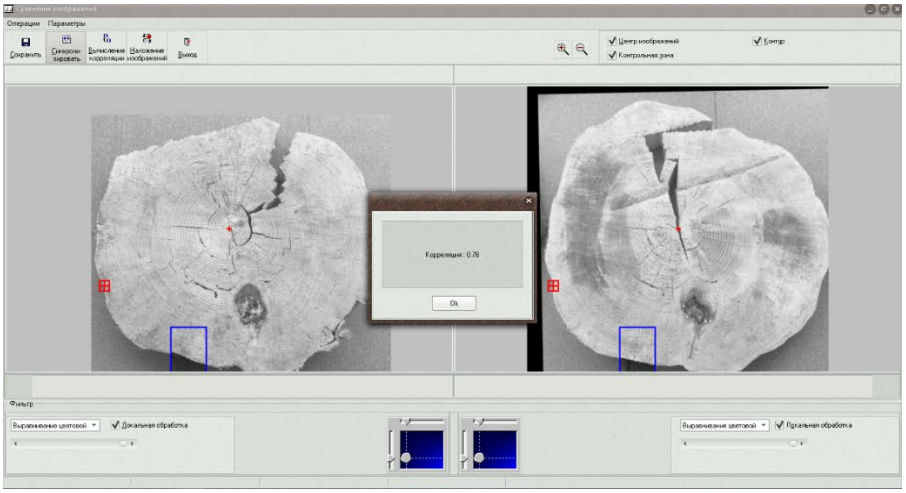

Fig. 1 – The software interface for matching wood cross-sections

The prospects for the practical application of comprehensive morpho-anatomical analysis are associated with the development of early diagnostic systems, improvement of urban green space monitoring, and optimization of the selection of tree species for landscaping. The development of non-destructive control methods and automated analysis of wood tissues creates the basis for the development of standardized protocols for assessing the state of urban plantations.

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INFLUENCE OF SALINITY AND IONIZING RADIATION FACTORS ON AGRICULTURAL PLANTS: WINTER RAPESEED

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Considering that most plants are sensitive to salt stress, high salinity can be considered one of the most severe abiotic environmental factors. Given that drought conditions and high levels of radiation are common in the Republic of Belarus, the combined effects of ionizing radiation and soil salinity on plant growth and development are of interest. Therefore, efforts are being made to mitigate these negative impacts.

Keywords: factor; salinity; ionizing radiation; winter rape.

Despite the fact that to date, most attempts and studies conducted to increase plant salt tolerance, improve their morphogenetic capabilities, and physiological characteristics have concluded that the combination of salinity and ionizing radiation has both stimulating and inhibiting effects.

A dependence on radiation dose and salinity concentration has been observed in the winter rapeseed variety «Zenit»

The response of winter rapeseed of the «Zenit» variety, grown under the same salinity conditions, varied depending on the irradiation dose of 10, 50, and 100 Gy. With increasing irradiation dose, within the same salinity level, germination energy was inhibited. These results indicate that the studied plant has a more stable sensitivity to ionizing radiation: the half-lethal dose of winter rapeseed is LD50 = 1200-1400 Gy.

Results on the effect of salt stress on winter rapeseed plant development show that a salt concentration of 0.5% stimulates seed germination.

It can be concluded that the combined effects of ionizing radiation and salinity lead to changes in germination energy and seed viability.

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DIVERSITY OF MITOCHONDRIAL DNA IN THE NOBLE CRAYFISH (*ASTACUS ASTACUS*) IN BELARUS

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This study presents the first comprehensive analysis of mitochondrial DNA in noble crayfish (*Astacus astacus*) from Belarus. We identified two European lineages and seven haplotypes, also revealing the Neman River as a unique diversity hotspot and a key postglacial corridor, which is crucial for conservation planning.

Keywords: noble crayfish, *Astacus astacus*, mitochondrial DNA, genetic diversity, conservation.

Introduction. The noble crayfish (*Astacus astacus*) is a species threatened with extinction throughout Europe. Populations of this species are experiencing significant decline due to multiple factors, including habitat loss, spread of invasive species, and infectious diseases [1, 2]. The study of the species genetic diversity is particularly relevant as it determines its adaptive potential and long-term viability [3]. Despite substantial phylogeographic research on *A. astacus* in Europe, populations in the eastern part of its range, particularly in Belarus, have remained understudied. The aim of this study was to conduct a comprehensive analysis of mitochondrial DNA to determine the phylogeographic structure and assess genetic diversity of noble crayfish populations in Belarus.

Materials and methods. The study included 103 *A. astacus* specimens collected from 26 locations between 2014 and 2024. Two mitochondrial markers were used for genetic analysis: cytochrome c oxidase I gene (COI) 620 bp long and 16S rRNA gene 496 bp long. DNA amplification was performed using standard primers in a C1000 Touch thermal cycler. PCR products were sequenced on an ABI 3500 automated sequencer. The obtained sequences were aligned and analyzed using MEGA X and DnaSP v6 software. Median-joining haplotype network construction was performed in PopArt v1.7. Statistical analysis of population differentiation was conducted in ARLEQUIN.

Results. Mitochondrial DNA analysis revealed seven haplotypes, five of which are unique. Belarusian populations belong to two main phylogeographic lineages (1 and 2) previously described for Europe [4]. Haplotype distribution shows clear geographical structure: 5 haplotypes with maximum haplotype diversity (Hd = 0.337) were found in the

Neman River basin, 3 haplotypes (Hd = 0.169) in the Western Dvina basin, while only 2 haplotypes (Hd = 0.083) were identified in the Dnieper River basin. A unique feature of the Neman River basin is the simultaneous presence of both phylogeographic lineages, indicating its historical role as an important migration corridor during the postglacial period [5]. Statistical analysis confirmed significant differentiation between populations from different river basins ($p < 0.001$).

Conclusion. The obtained results indicate a high level of genetic diversity in *A. astacus* populations in Belarus, particularly in the Neman River basin. The revealed phylogeographic patterns emphasize the need for developing differentiated conservation strategies that consider river basin boundaries. The Neman River basin requires special attention as a unique reservoir of the species genetic diversity on the scale of the entire Baltic Sea catchment area.

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ALUMINUM IN SOILS. BIOECOLOGICAL ASPECT

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Aluminum compounds in soils are very diverse. These are aluminosilicates, aluminum oxides and hydroxides, minerals containing aluminum salts; simple and complex Al compounds with organic substances. The mobility and bioavailability of this element depends on the forms of its presence in soils. The most mobile forms of aluminum in the soil are the ionic form, hydroxide complexes, and exchangeable aluminum. The toxicity of this element in the soil is manifested mainly in conditions of soil acidification.

Keywords: forms of aluminum in soil, mobility, bioavailability, toxicity, acidity.

Aluminum is the third most abundant element in the Earth's crust, with a mass fraction of 8,8%. Aluminum is characterized by a pronounced concentration differentiation depending on the rock. Ultrabasic rocks contain on average about 0,45% A1, and sedimentary rocks (clays, shales) it increases to 10-11%. Acidic, medium and basic rocks (granites, diorites, basalts, etc.) occupy an intermediate position – 7-9%.

The total aluminum content in soils is usually 5-15% by weight, mainly in the form of minerals. These include:

- clay minerals (the most common group): These minerals are formed from rock weathering and account for up to 20-60% of soils (kaolinite ($Al_2Si_2O_5(OH)_4$), illite ($KAl_2(Si,Al)_4O_{10}(OH)_2$), montmorillonite ($Al_2Si_4O_{10}(OH)_2 \cdot nH_2O$), chlorite ($(Mg,Fe,Al)_6(Si,Al)_4O_{10}(OH)_8$) and others;
- aluminum oxides and hydroxides: These minerals are formed under acidic conditions (gibbsite ($Al(OH)_3$), Bemite (AlOOH), diaspore;
- aluminum silicates: include primary minerals from rocks that are weathered (feldspars - for example, orthoclase $KAlSi_3O_8$); micas (muscovite $KAl_2(AlSi_3O_{10})(OH)_2$);
- other minerals: corundum (Al_2O_3), spinel ($MgAl_2O_4$), and alumophosphates are found in smaller quantities.

Aluminum in the composition of minerals is inert and practically does not participate in its circulation and other processes of soil formation. Its behavior is highly dependent on environmental conditions. The key environmental problem of this element is the mobilization of toxic forms of aluminum in conditions of acidification of the soil environment, which leads to negative consequences for agrocenoses and natural ecosystems.

The reason for aluminum's transition to a dangerous state is an increase in soil acidity below pH 5,0–5,5. With a significant decrease in pH, aluminum passes into the soil solution in the form of toxic cations. The Al^{3+} ion is the most toxic and bioavailable form, dominating in highly acidic soils (pH < 4,5); hydroxide complexes ($AlOH^{2+}$, $Al(OH)_2^{+}$); exchangeable aluminum is a form displaced from the soil absorbing complex, which has a direct toxic effect. These forms of aluminum become factors that harm living organisms and the environment. The toxicity of aluminum manifests itself already at a concentration of 1-2 mg/l in a soil solution and has a complex character. In this case, a vicious circle is formed – the acidity increases the solubility of aluminum, and the products of its hydrolysis generate additional H^{+} ions, further acidifying the medium.

The toxic effect of aluminum on living organisms and, in particular, on plants is expressed in the destruction of the root system – Al^{3+} ions block cell division in the root meristem. There is a violation of mineral nutrition – aluminum forms insoluble compounds with phosphates, causing phosphorus starvation. It also inhibits the absorption and transport of potassium, calcium, magnesium and sulfur. Cellular and metabolic stress is manifested – aluminum ions destroy cell membranes, inhibit enzyme activity and can cause damage at the genetic level. All these effects are visually expressed in chlorosis, leaf necrosis, dwarfism and a sharp decrease in plant productivity.

For soils, the negative effect of mobile forms of aluminum is expressed in the deterioration of physico-chemical properties – aluminum causes dispersion (spraying) of colloidal particles, which leads to the destruction of the soil structure, compaction, deterioration of aeration and water permeability. Aluminum controls the hydrolytic acidity of soils – the more this element is in ionic form (Al^{3+}) in the soil solution, the higher the hydrolytic acidity.

The presence of a large number of mobile forms of this element in the soil solution disrupts biochemical cycles – by binding to soil organic matter, aluminum impairs its quality and accessibility to microorganisms. The activity of the soil microflora and fauna responsible for the processes of mineralization and humification is suppressed.

In natural conditions, aluminum migration is an agent of podzolization, a process that leads to depletion of the upper horizons and the formation of infertile podzolic soils.

The mobile forms of aluminum migrate with the downward currents of moisture, are washed out into the groundwater and end up in rivers and lakes. Aluminum is no less dangerous for aquatic ecosystems: its maximum permissible concentration for aquatic organisms is 0,04 mg/l. Once in water bodies, it causes toxicosis in fish and other aquatic organisms.

Thus, the bioecological status of aluminum in the soil and adjacent ecosystems depends on the forms of its presence in soils.

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USE OF GIS FOR MODELING THE BIOENERGETIC POTENTIAL OF TERRITORY

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The article examines modern approaches to assessing the bioenergetic potential of territories using geographic information systems (GIS). An analysis of the advantages of GIS technologies in accounting for spatially distributed factors such as biomass type and productivity, transport accessibility, terrain relief, and environmental constraints is conducted. The conclusion is drawn about the high effectiveness of GIS as a tool for supporting strategic decision-making in sustainable energy.

Keywords: bioenergy, bioenergetic potential, geographic information systems (GIS), spatial analysis, biomass, sustainable development.

In the context of global energy transition and economic decarbonization, bioenergy occupies one of the key positions among renewable energy sources (RES). However, the effective use of biomass resources requires accurate assessment of their volume, spatial distribution, and economic feasibility of operation. Traditional accounting methods based on statistical data do not consider territorial spatial heterogeneity, which leads to significant errors in calculations.

Geographic information systems (GIS) represent a powerful tool for solving this problem, allowing the integration, analysis, and visualization of heterogeneous spatial data. The purpose of this article is to demonstrate the methodology and advantages of using GIS systems for comprehensive modeling and assessment of bioenergetic potential.

The bioenergetic potential of territory is traditionally classified into several types:

Gross (theoretical) potential - total amount of energy contained in the region's biomass.

Technical potential - part of gross potential that can be used considering existing technical limitations.

Economic potential - part of technical potential whose use is economically feasible under current prices and tariffs.

Modeling in the GIS environment is based on sequential "screening" of potential through overlaying spatial constraints.

The research methodology must include the following stages:

1. Formation of a geo-information database. At this stage, spatial data is collected and prepared:
- Land use data (types of vegetation cover, agricultural land, forest areas).
- Climate data (precipitation, temperature, insolation).
- Digital elevation model.
- Infrastructure data (roads, settlements, location of existing power facilities).
- Data on environmental and nature protection restrictions (protected natural areas, water protection zones).

2. Calculation of gross biomass potential. For each land use type (for example, arable land, meadow, forest), based on statistical or expert data, biomass productivity coefficients (t/ha/year) are assigned. In GIS, raster calculations are performed, resulting in a map of theoretical energy potential.

3. Spatial analysis and constraint overlay. To transition to technical and economic potential, overlay operations are performed:
- Exclusion of protected areas and lands of other purposes.
- Accounting for transport accessibility (creation of buffer zones around roads and calculation of logistical costs).
- Accounting for relief (excluding territories with excessive slope unsuitable for mechanized biomass harvesting).
- Determining zones of economic efficiency based on analysis of distance to energy consumers and processing facilities.

The main advantages of this approach are visibility (results are presented in map form), systematicity (many interconnected factors are considered simultaneously), and relevance (databases and models can be updated promptly).

The application of geographic information systems for modeling the bioenergetic potential of territory transforms the planning process from the realm of abstract calculations into the practical plane of substantiated spatial analysis. The presented methodology allows not only to assess the volume of available resources but also to determine optimal locations for their processing, which is critically important for reducing bioenergy costs.

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AGRICULTURAL CROPS AND THEIR TROPHIC IMPORTANCE FOR THE CONSERVATION OF WILD ANIMALS AND BIRDS POPULATIONS IN BELARUS

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Abstract. This publication presents the results of research to establish the role of Belarusian agricultural lands in preserving and increasing wild animal and bird populations. It characterizes agricultural crops and determines the trophic significance of crops and the technological losses of the main species for wild animals. An assessment is made of the use of agricultural plants by wild representatives of Belarusian fauna within the seasonal patterns of the year, as well as seasonal bird migration.

Keywords: agricultural crops, technological losses of agricultural crops, wild animals and birds, feeding stations, migration period.

Belarus's natural resources have always provided ideal habitats for wild animals and birds. Belarus has over 9.7 million hectares of forested land, accounting for almost half of its total territory. The forest cover ratio increases annually; in the last 30 years alone, forest area has increased by almost 1 million hectares. (The forest cover ratio is the degree of forest coverage in an area, determined by the ratio of forested area to the total area of the country, district, forestry enterprise, etc., expressed as a percentage.)

Belarus's river network includes 20,800 rivers and streams with a total length of 90,600 kilometers. The total surface area of lakes in Belarus is 1,600 square kilometers, with a total water volume of approximately 7 cubic kilometers. There are also 85 reservoirs (with a water surface area of at least 100 hectares). All of this points to ideal habitats for wild animals and birds in Belarus.

However, the food supply provided by agricultural crop production in the Republic of Belarus contributes significantly to their population growth. The total area of agricultural land is approximately 8,283,900 hectares (5,660,000 hectares of arable land and 2,520,800 hectares of meadow land). Wild animals, in one way or another, use all of these territories as habitats. Regularly visiting these areas, wild representatives of Belarusian fauna utilize agricultural crops to supplement their primary diet. During the autumn-winter and winter-spring periods, agricultural lands and fields with crop residues become the main feeding grounds for some animal and bird species.

In our research, we conducted field studies of the agricultural lands they frequent to determine the role of agricultural crops and their trophic significance in preserving wild animal and bird populations. Research conducted on the hunting grounds of the Volozhin and Molodechno districts of the Minsk region to determine the trophic role of agricultural crop losses for wild animals and birds suggests their great importance for animal [1, 2]. Remaining legume and root crop crops allow resource-rich animal species to maintain high population levels (Fig. 1).

Fig. 1 – Roe deer feeding on agricultural land. *(Photo by Yu.G. Liakh, April 9, 2025, Volozhin District, Minsk Region)*

The increase in wild animal density observed in recent years prevents a reduction in the forage capacity of hunting grounds. Agricultural crops and the portion of the harvest remaining in the fields after harvest provide an additional

source of food for forest inhabitants. Despite constantly improving harvesting techniques, a certain amount of the harvest remains on the ground. Grain losses range from 0.1-0.8% to 3-5% or more [3, 4].

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KISSPEPTIN-10 INHIBITS PAPILLARY THYROID CANCER PROGRESSION BY REGULATING P38 MAPK/P53 AND VEGF SIGNALING PATHWAYS

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Papillary thyroid cancer (PTC) is the most common malignant tumor of the endocrine system, with an increasing incidence worldwide [1]. Despite a favorable prognosis, diagnosis and treatment of both invasive and metastatic PTC remains challenging. The kisspeptin (KPs)/GPR54 system plays a complex regulatory role in various tumors, and its specific function and molecular mechanism in PTC remain unclear [2].

The aim of this study was to investigate the effects of kisspeptin-10 (Kp-10) on the biological behavior of human PTC cells (TPC-1) and the signaling pathways regulating RET/PTC1 expression.

Methods: The Cell Counting Kit-8 (CCK-8) was used to detect changes in cell proliferation and viability; cell invasion was assessed using the Transwell Matrigel invasion assay. Fluorescence quantitative real-time PCR (qRT-PCR) was used to determine vascular endothelial growth factor (VEGF) mRNA expression levels. The expression of p53, P21, Sirt1, and VEGF proteins, as well as the phosphorylation level of p38 mitogen-activated protein kinase (MAPK), were determined using Western blot. To confirm the role of the p38 MAPK signaling pathway, the selective p38 inhibitor SB203580 [3] was used.

Results: Kp-10 inhibited TPC-1 cell proliferation in a dose- and time-dependent manner. Using a four-parameter nonlinear regression model (4PL), it was calculated that the half-maximal inhibitory concentration (IC50) value decreased sharply over time: from 0.030 nM after 24 hours to 5.69×10^{-4} nM after 48 hours. Furthermore, Kp-10 inhibited the invasive ability of TPC-1 cells by 86% compared to the control group ($p < 0.01$), and at a concentration of 0.1 nM, treatment of cells with Kp-10 (10 nM) for 24 hours resulted in an 88% decrease in VEGF mRNA expression ($p < 0.01$). Western blotting showed that Kp-10 increased p53 expression and decreased VEGF, P21, and Sirt1 expression at the protein level. Crucially, pretreatment with the p38 inhibitor SB203580 significantly attenuated the increase in p53 expression and the decrease in VEGF expression induced by Kp-10 ($p < 0.01$), confirming the involvement of the p38 MAPK signaling pathway in the effect of Kp-10.

Conclusion: The results of this study demonstrate the potent antiproliferative and antiinvasive effects of Kp-10 on PTC cells in vitro. These biological effects are mediated by its significant suppression of the expression of the key proangiogenic and prometastatic factor VEGF. We propose a molecular model according to which Kp-10 increases p53 expression and decreases VEGF expression through activation of the p38 MAPK signaling pathway. The results of this

study not only deepen our understanding of PTC pathogenesis but also provide an important experimental and theoretical basis for the development of new therapeutic strategies for the treatment of PTC using the kisspeptin signaling pathway.

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APPLICATION OF BRACKET FUNGUS IN ECO-LEATHER PRODUCTION

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Nowadays finding natural and eco-friendly materials became one of priority goals for bio economy and circular economy development because it can help to get lower the ecological footprint: pollution, the emission of greenhouse gases, the waste of water and energy. One of eco-friendly materials we can use as an analogue of eco-leather- Mushroom skin, which is made from tinder mushrooms. This article provides the research about such materials, manufacturing technology and evaluation for biodegradability.

Keywords: tinder mushrooms, eco-leather, Mushroom skin, biogradable materials, bio economy.

Despite the versatility and popularity of genuine leather, its production has significant environmental harm. Tanning processes that rely on aggressive chemical compounds lead to pollution and pose health risks to workers when safety regulations are not followed. Therefore, the implementation of green technologies and the development of sustainable, safe materials have become priority tasks for science and industry. Modern requirements dictate the need to create materials that combine versatility, energy efficiency, and environmental safety at all stages of the life cycle.

Modern leather alternatives available on the market have several advantages, including visual similarity to natural material, satisfactory functional characteristics, and relatively low cost. However, many of them have a synthetic base and are not biodegradable. Producing eco-leather from the mycelium of tinder mushrooms allows for minimizing environmental impact and creating functional products with a sustainable, closed-loop life cycle. At present, companies in the Russian Federation that are developing such products are unpresented, which opens up significant opportunities for research in this area.

The goal of the project is to develop and test a method for producing eco-friendly leather "Mushroom skin" from the bodies of tinder mushrooms, followed by creating a prototype for practical application.

The bodies of tinder mushrooms were used as raw material for producing the eco-friendly leather "Mushroom skin." An original methodology was developed for its processing, which includes several steps: cleaning from contaminants, boiling for 15–20 minutes in a 1% NaOH solution, forming a preparation from mushroom pulp, mechanical processing, and drying at a temperature of 150°C for 1.5 hours. The samples obtained in this way were stitched, dyed with natural inks, and treated with wax to enhance consumer properties.

To preliminarily assess the environmental friendliness of the material, a biodegradability test was conducted. A sample weighing 57.2 g was placed in soil. After 30 days, the sample was reweighed, showing a 2% reduction in weight (to 56.0 g), confirming the material's ability to biodegrade under natural conditions.

The research successfully developed and tested the technology for producing eco-leather "Mushroom skin" from tinder mushrooms. Several prototypes suitable for practical use were created. The biodegradability test demonstrated the high potential of the material as an environmentally sustainable alternative to traditional materials.

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DUST-FILTERING CAPACITY OF WOODY PLANTS USING THE EXAMPLE OF THE LOSHITSKY ESTATE AND PARK COMPLEX IN MINSK

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This study analyzes the effectiveness of tree leaves as dust filters in urban environments. Results indicate that Tilia cordata Mill. and Acer platanoides L. possess the highest dust retention capacity, confirming their importance in improving ecological conditions in landscape-recreational zones of Minsk.

Keywords: dust retention capacity, green plantings, dust filter, Lositsa Park-Estate complex, woody plants.

In modern cities, green spaces serve many functions. The sanitary and hygienic qualities of green spaces are based on the high gas-absorbing and accumulative properties of vegetation. Trees act as a constantly active filter through processes of adsorption, absorption, filtration, and infiltration. The role of plants as dust filters has been studied by many authors, including O. Chernyshenko, N. Podzorov, M. Doncheva-Boneva, Ya. Supuka, G. Ilkun, D. Kiseleva, and others. Tree leaves play an important role in filtering dust from the air. The level of dust accumulation partially reflects the ability of plants to sequester dust and assesses the environment-purifying role of vegetation throughout the growing season. Thus, trees growing in urban environments are regularly "buried" in a layer of harmful substances. Constant exposure to emissions leads to dust accumulation on leaves and bark, a decrease in photosynthetic activity, and other negative consequences.

The aim of the study was to examine the condition of leaves and their role as a dust filter in condominant woody plant species (downy birch (*Betula pubescens* Ehrh.), norway maple (*Acer platanoides* L.), small-leaved linden (*Tilia cordata* Mill.), brittle willow (*Salix fragilis* L.) and weeping willow (*Salix babylonica* L.)) in landscape and recreational areas.

To assess the dust-filtering capacity of woody plants, the Loshitsky estate and park complex was selected. The sites were located no more than 400 m from the highway. The Loshitsky estate and park complex is located in the Leninsky district of Minsk, between the Loshitsa and Serebryanka microdistricts, and covers an area of 102.3 hectares. Loshitsky Park borders only the highway of Mayakovsky Street (880 m). The roadway runs 15-20 meters from the nearest trees. The internal area is designated for pedestrian and bicycle traffic, creating favorable conditions for maintaining clean air and healthy vegetation.

For this study, leaf samples were collected at a height of 1.5-2 meters, with 100 leaves from trees of the above-mentioned species. To determine the amount of adsorbed dust, the leaves were washed in 100 ml of distilled water, and the amount of solid sediment was then determined gravimetrically on a filter after drying [1]. Leaf blade area was determined in cm^2 using the Petiole.LeafArea app. The data obtained are presented in the table.

Table

Dust-retention capacity of tree leaves (using the Loshitsky estate and park complex as an example)

Name of the species	Leaf area, cm^2	Dust-holding capacity of leaves, mg/m^2
Tilia cordata Mill.	40,39±9,89	935,31
Acer platanoides L.	118,44±50,91	548,68

Betula pubescens Ehrh.	19,77±5,61	151,73
Salix fragilis L.	15,52±4,03	96,62
Salix babylonica L.	11,00±2,84	90,92

According to the data obtained, *Tilia cordata* Mill. and *Acer platanoides* L. have the highest dust-retaining capacity, while *Salix fragilis* L. and *Salix babylonica* L. have the lowest.

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ASSESSING THE ECOLOGICAL CONDITION OF FORESTS AND METHODS OF THEIR RESTORATION USING ARTIFICIAL INTELLIGENCE

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The assessment of the state of forest ecosystems and their restoration using data from various sources and artificial intelligence technologies is considered. It is shown that digital methods – satellite and drone sensing, neural network analysis – increase the accuracy of monitoring, predict risks and optimize recovery measures. The importance of precision forestry is emphasized as a tool for sustainable forest management in the context of climate change.

Keywords: ecosystem restoration, forests, monitoring, remote sensing, artificial intelligence.

The current degradation of forest ecosystems is complex and is caused by multiple negative factors, including climate change, forest fires, illegal logging, pests and diseases, which leads to disruption of the structure and functions of forest communities. Traditional forest monitoring methods based on ground control and visual patrolling are experiencing practical difficulties in implementation due to a shortage of workers, the inability to automate the processes of detecting changes and limited spatial and temporal coverage of territories. Given the scale of Russian forests and the increasing negative impacts, the traditional monitoring approach is becoming insufficient to identify and prevent degradation processes in a timely manner. The use of digital technologies and artificial intelligence in forestry demonstrates significant advantages: neural network algorithms work 62% faster than humans and 12% more accurately, which makes it possible to automate the processing of large amounts of remote sensing data, predict changes in forest conditions and ensure accurate ecosystem restoration based on a comprehensive analysis of multi-source information.

The current state of forest ecosystems is characterized by ongoing degradation under the influence of several interrelated factors. Deforestation and capital reforestation erase natural landscape structures, reducing the volume of old-growth forests and the diversity of ecotypes. Fires, including extreme and recurring ones, deplete forest resources and disrupt succession cycles, leading to lengthy rehabilitation of some areas. Climate change is exacerbating stressful conditions: rising temperatures, changing precipitation, and the frequency of extreme weather events lead to the weakening of trees, the spread of diseases, and the invasion of pests. Diseases associated with pathogens and pests spread faster due to warmer conditions and reduce the viability of forest ecosystems, especially in young stands and individual age groups. These factors not only reduce biodiversity, reducing the number and diversity of plant, animal and fungal species, but also enhance the greenhouse effect: reducing the area of biodiversity forests reduces the ability of forests to capture carbon and stabilize the climate, as well as the consequences of influencing the water regime, soil erosion and local microclimates. As a result, there is a growing need for a systematic assessment of the state of forests

in large areas, which requires the integration of remote sensing data, field observations and forecast models in order to form objective indicators of forest health, identify risk areas and plan strategic restoration measures across regions and countries.

The main data sources for forest assessment include satellite imagery, drone data, and ground-based observations. Satellites such as Landsat and Sentinel provide a global overview and long-term monitoring of forest areas. Drones allow you to take detailed pictures of local areas, and ground-based sensors and field studies provide additional data on the state of the soil, tree and microclimate. Modern systems combine this data into a single analytical platform for comprehensive analysis and decision support for forest restoration.

Artificial intelligence (AI) plays an important role in forest analysis and restoration. It allows you to automatically detect changes in vegetation by processing satellite and drone images, quickly detecting deforestation, desiccation and regeneration. AI also predicts the risks of fires, droughts, and diseases by analyzing climate and environmental data, which helps to take timely preventive measures. Automation of mapping and modeling of restoration using AI allows you to create accurate maps of restoration zones, choose optimal planting patterns and tree species, taking into account genetic diversity and climatic conditions. These technologies combine data from different sources and provide decision support at the regional and national levels, contributing to the sustainable restoration of forest ecosystems in a changing climate.

Precision forestry is based on the use of modern technologies for optimal management of forest resources. Artificial intelligence and remote sensing make it possible to accurately plan plantings and allocate funds, taking into account the characteristics of specific sites, such as soil type, topography and climatic conditions. This approach reduces costs, increases crop survival, and minimizes negative impacts on the ecosystem. Successful projects in Russia, China and Brazil demonstrate the effectiveness of these technologies: they contribute to the sustainable restoration of forests and the rational use of natural resources. The application of precision forestry will increase the productivity of forestry and preserve biodiversity in a changing climate.

Thus, digital technologies play a key role in the restoration of forest ecosystems, providing accurate and timely monitoring, risk forecasting and optimization of resource management. Modern platforms, such as ForestCloud, integrate satellite, drone, and ground-based sensor data to effectively coordinate restoration projects and prevent wildfires. The prospects for the development of monitoring systems are related to the expansion of the scale of digital solutions and their increased accessibility for various countries and regions. For sustainable forest management, it is necessary to combine the capabilities of artificial intelligence, scientific research and environmental policy, creating conditions for the conservation of biodiversity and the adaptation of ecosystems to a changing climate. Such an integrated approach will improve the efficiency of reforestation and ensure the long-term sustainability of natural resources.[1,2]

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A COMPARATIVE ANALYSIS OF IMAGE GENERATION PLATFORM: CAPABILITITES, WORKFLOWS, AND ECONOMIC EFFICIENCY

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This paper presents a practical comparative analysis of several leading platforms – Midjourney (via BotHub), Grok (xAI), Canva (Magic Media), Microsoft's Image Generator – evaluating their operational workflows, output quality, generation speed, and economic models. Using a standardized, complex prompt, we benchmark these services to provide

insights for content creators, designers, and researchers seeking to integrate AI-generated imagery into their workflows efficiently.

Keywords: AI Image Generation, Generative Artificial Intelligence, Comparative Analysis, Visual Content Creation, AI Models Benchmarking.

The traditional process of sourcing visual assets – ranging from digital editing to extensive stock photo searches – is often time-consuming and can stifle creative momentum. The advent of generative artificial intelligence (AI) offers a paradigm shift, enabling the near-instantaneous translation of conceptual ideas into visual representations. This technology holds significant potential for accelerating content creation for social media, marketing, presentations, and design prototypes.

Comparative Analysis of Platforms

1.1. Midjourney via BotHub

Midjourney is renowned for its high-quality, artistic outputs but is primarily accessible through third-party aggregators like BotHub for users outside its native Discord environment. Workflow & Economics: BotHub operates on an internal currency system ("caps"). The test prompt consumed 40,000 caps from an initial grant of 100,000 caps provided upon referral-based registration. This model abstracts direct pricing but functions on a de facto pay-per-query basis. Performance: Generation time was approximately 40 seconds, yielding four distinct, high-detail images. The results demonstrated strong compositional understanding and artistic rendering.

1.2. Grok (xAI) with Flux Backend

Grok integrates seamlessly into the X social media platform, offering a highly accessible user experience. Workflow & Economics: The service is currently free to use, providing four images per prompt without an explicit daily or monthly limit at the time of testing. Performance: Generation was rapid, completing in under 30 seconds. The output from the Flux model was of high quality, accurately interpreting all elements of the complex prompt with a realistic leaning.

1.3. Canva Magic Media

Canva integrates its AI generator directly into its comprehensive design suite, positioning it as a feature for rapid asset creation within a workflow. A notable limitation of the tool is its tendency to generate images in a cartoonish style. This makes it well-suited for specific applications like children's content or illustrations but less ideal for projects demanding realism. Upon generation, four images are produced, which can be instantly downloaded or edited further within the Canva editor.

1.4. Microsoft Image Generator

This service offers a streamlined, minimalist interface for image generation, powered by a robust underlying model. A significant functional advantage is the ability to pre-define the output's aspect ratio, which obviates the need for subsequent resizing and streamlines the post-production workflow. However, its free tier is limited to 15 boosts (generations) per month, after which service speed or access may be restricted. Paid plans start at approximately $10 for 100 images. Performance: Generation speed is fast (a few seconds per image), producing four images per prompt. The quality is generally high, though the restrictive free tier is a considerable limitation for frequent users.

The results indicate a clear trade-off between accessibility, cost, output quality, and control. Platforms like Grok and Freepik AI offer compelling value, combining high-quality outputs with economically viable models (free and freemium, respectively). Canva's strength lies not in its standalone generator but in its deep integration into a broader design ecosystem, despite its slower speed and stylistic limitations.

The significant language barrier observed with DeepAI underscores the ongoing challenge of multilingual processing in some AI models, highlighting the need for users to utilize English prompts for optimal results across most services. Furthermore, the economic models range from subscription-based (Microsoft, implied by BotHub's "caps") to ad-supported (DeepAI) and credit-based freemium (Freepik), requiring users to align their choice with their expected generation volume.

This comparative analysis demonstrates that the landscape of AI image generation is diverse, with no single platform dominating all criteria. The "best" choice is highly contextual, dependent on the user's specific needs regarding style, integration, budget, and required volume.

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TOXIC SUBSTANCES IN THE ENVIRONMENT AND THEIR RELATIONSHIP WITH CANCER

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Environmental toxicants are chemical, physical, or biological agents capable of harming human health. They enter the ecosystem from industrial emissions, agriculture, transportation, and household waste. According to the World Health Organization (WHO), many of these substances are classified as carcinogens – factors that trigger the development of cancer. Cancer occurs due to damage to cellular DNA, leading to uncontrolled cell division and tumor formation. The link between toxins and cancer has been confirmed.

*Keywords***:** toxic substances, carcinogens, cancer.

Toxic substances affect the body through various pathways: inhalation, ingestion (absorption through food or water) and skin contact. They can accumulate in tissues (bioaccumulation) and cause mutations, inflammation, or suppression of the immune system. Key examples:

- Asbestos: A fibrous mineral used in construction. Causes mesothelioma (pleural cancer) and lung cancer. Mechanism: Fibers penetrate lung tissue, causing chronic inflammation and mutations.

- Heavy metals (arsenic, cadmium, lead): Leak into water and soil from mines and industry. Arsenic is linked to skin, lung, and bladder cancer; cadmium is linked to lung and kidney cancer. Mechanism: DNA binding, cell cycle disruption, and oxidative stress.

- Organic Compounds (Benzene, Polycyclic Aromatic Hydrocarbons - PAHs): Benzene - from gasoline and smoke; PAHs - from fuel combustion. Benzene causes leukemia; PAHs - lung and skin cancer. Mechanism: Metabolism in the body forms epoxides, which damage DNA.

- Pesticides and Herbicides (DDT, Glyphosate): Used in agriculture. Linked to breast, prostate, and lymphoma cancer. Mechanism: Endocrine disruption and genotoxicity.

- Radiation (ionizing, such as radon): Radon is a gas from the soil; causes lung cancer. Mechanism: Ionization of DNA, leading to mutations.

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Risk factors are aggravated by combined exposure (cumulative effect) and vulnerable groups (children, elderly, low socioeconomic status).

Risk mitigation includes strict emission controls (EPA and EU standards), environmental monitoring, and personal measures such as using water filters and avoiding contaminated areas. The WHO recommends limiting exposure through legislation and education. Research shows that early detection and detoxification (antioxidants, diet) can mitigate the effects.

Environmental toxicants are a significant factor in cancer, as scientifically proven. Understanding these links is important for prevention and policy. Further research is needed to assess emerging threats, such as microplastics.

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BIOMONITORING OF URBANIZED TERRITORIES AS A TOOL FOR ASSESSING THE ECOLOGICAL SAFETY OF MAN-MADE ECOSYSTEMS

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Urbanized territories are man-made ecosystems where natural components experience intense anthropogenic effects, such as industrial emissions, vehicle exhaust, man-made accidents, etc. Ensuring the ecological safety of such ecosystems requires reliable methods of monitoring the state of the environment. Biomonitoring is an important tool based on the use of living organisms to assess the quality of the habitat. In contrast to purely physico-chemical monitoring, biomonitoring reflects the combined impact of many factors on biota and makes it possible to identify hidden effects of pollution that are difficult to detect by direct measurements of concentrations.

Keywords: biomonitoring, urbanized territories, ecological safety.

Biomonitoring of urban ecosystems is based on bioindication methods – registration of changes in indicator organisms under the influence of anthropogenic factors. Approaches to the organization of monitoring of various components of biota and criteria for assessing changes in biogeocenoses under the influence of man-made objects have been developed [1]. The main methods include:

1) Air lichenoindication is an assessment of atmospheric purity based on the composition and condition of epiphytic lichens. Lichens are extremely sensitive to air pollution (especially sulfur dioxide and heavy metals) and are widely used to map urban air quality.

2) Phytoremediation indicators – analysis of pollutants in plant tissues. Thus, the leaves, bark and annual rings of trees accumulate heavy metals and toxins, serving as indicators of the level of pollution of the atmosphere and soils. For example, a comparison of the accumulation of metals in the foliage and bark of poplars and linden trees in Moscow revealed higher concentrations of Pb, Fe, Sr, and Zn in the industrially loaded Southeastern District compared with the relatively clean Southwestern District [1]. The data confirm the different levels of anthropogenic load in the areas of the megacity.

3) Bioindication of soils and aquatic ecosystems – assessment of the state of the environment by communities of living organisms. In urbanized landscapes, changes in the structure of the microflora and mesofauna of the soil are indicative (for example, a decrease in the number of earthworms due to toxic pollution) and the composition of aquatic organisms in reservoirs. Studies show that the degree of water pollution is most clearly reflected by the communities of zoobenthos [2].

4) Cytogenetic monitoring – detection of genotoxic environmental effects using tests for damage to the genetic apparatus of bioindicators. Thus, the analysis of chromosomal aberrations in the meristem of tree buds is used to assess the total mutagenicity of the urban environment [3]. A ten-year study in an industrial city showed a significantly increased level of chromosomal rearrangements in the rudimentary leaves of poplars and elms near a chemical plant [3].

5) Biotesting – rapid laboratory methods using live test objects (algae, daphnia, bacterial cultures, etc.) to assess the toxicity of air, water, and soil samples. In recent years, instrument biotests have been introduced into the practice of environmental monitoring, which make it possible to determine the total toxicity of the environment in a short time [2].

Thus, biomonitoring of urbanized territories is complex. It combines different trophic levels and groups of organisms, giving a holistic picture of the ecosystem. Biomonitoring of urbanized territories has proven to be an effective tool for assessing the environmental safety of man-made ecosystems. Using living organisms as "sensors", it integrates the effects of a variety of pollutants and factors, identifying even mild and chronic effects. This makes it possible to detect threats to ecosystems and human health in a timely manner and take measures to neutralize them. In the context of urban growth and the technosphere, biomonitoring complements traditional control methods, providing a scientifically sound basis for managing the quality of the urban environment and maintaining its safety.

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REAL TIME AIR QUALITY MONITORING SYSTEM BASED ON IOT-SENSORS

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Urban air pollution (CO_2, $PM_{2,5}$, NO_2 and O_3) poses serious health risks and requires continuous monitoring. Traditional stationary monitoring stations are sparse and expensive. A distributed IoT-based solution can provide granular, real-time data at lower cost.

Keywords: air quality, monitoring system, IoT-sensors.

Air quality monitoring stations (AQMS) are critical tools for tracking atmospheric pollutants and assessing environmental health. These systems represent integrated hardware-software complexes designed to measure, record, and transmit key air quality parameters. The deployment of AQMS is essential for urban planning, public health management, industrial compliance, and climate research.

With the growing demand for automated environmental monitoring, modern AQMS increasingly rely on embedded technologies – microcontroller-based systems optimized for low power consumption, compact size and robust field operation. Such systems enable the creation of geographically distributed sensor networks capable of continuous, real-time air quality assessment. The development of AQMS starts with the careful selection and integration of core hardware components. The sensing layer includes gas sensors (CO_2, $PM_{2,5}$ / PM_{10}, NO_2, O_3 etc. (SCD4x, SDS011, ZE07, ME3 etc.), meteorological sensors (temperature / humidity, pressure, wind speed / direction etc. (BME280 etc.) and optional high-accuracy calibration references. This is paired with a processing unit (microcontroller such as ESP32 or STM32, data logger with non-volatile memory and RTC module), a communication module (supporting Wi-Fi, LoRa, or NB-IoT along with protocols like MQTT, HTTP(S), or CoAP), a power system (solar panel + rechargeable battery with power management IC), and a weather-resistant, ventilated enclosure (IP65 + rated) with mounting hardware.

The deployment process spans hardware integration – ensuring sensor specifications match monitoring goals and electrical compatibility – followed by firmware development (in C / C++ or MicroPython), calibration and validation (laboratory calibration, field validation against reference stations and drift compensation), and network configuration (MQTT broker / HTTP server setup, data payload structure in JSON / CBOR, security via TLS and device

authentication). Once deployed, routine maintenance ensures long-term accuracy: sensor cleaning every 1 - 3 months, battery checks, firmware OTA updates, monthly accuracy verification, and recalibration every 6 - 12 months. Collected data feeds real-time dashboards (with AQI), historical analysis, alert systems, and smart city platforms, using formats like JSON / MQTT streams, CSV / Parquet files, and geospatial databases (PostGIS). The technological stack often includes ESP32 / STM32F4 microcontrollers, Sensirion / Alphasense / Plantower sensors, MQTT over TLS, Node.js / Python Flask backends, PostgreSQL / InfluxDB, and visualization tools like Grafana and Leaflet. This approach delivers cost efficiency, scalability, real-time responsiveness, public accessibility, and regulatory compliance.

Thus, the development of air quality monitoring stations using embedded technologies represents a powerful approach to environmental management. By combining low-cost sensors, efficient microcontrollers, and cloud connectivity, these systems deliver actionable air quality data for public health, urban planning, and industrial applications. Proper design, calibration, and maintenance ensure reliable operation, making embedded AQMS a cornerstone of modern environmental monitoring infrastructure [1].

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CONSIDERATION OF THE INFLUENCE OF NATURAL AND CLIMATIC FACTORS AS PART OF ENVIRONMENTAL MONITORING OF EMISSIONS FROM TANKS

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The aim of the paper is to consider the influence of climatic and meteorological factors on the emissions of pollutants into the atmospheric air from oil and petroleum products storage tanks. The study provides a brief description of the types of tanks, the main influencing factors, as well as an example of comparing indicators using the calculation method. The significance of the differences between the factors under consideration and the relevance of the topic are clearly shown.

Keywords: tank, climatic factor, meteorological factor, emissions monitoring.

Oil and petroleum products storage tanks are an integral part of every oil refinery, tank farm, thermal power plant, gas station and other production facilities. There are many types of reservoirs, but the main classification is by location in space (horizontal and vertical). Vertical tanks, in turn, are divided into: vertical steel tank (RVS with a fixed roof), vertical steel tank with a pontoon (RVSP), vertical steel tank with a floating roof (RVSPK).

Emissions of pollutants into the atmospheric air from reservoirs are called "breathing" of the reservoir, which occurs as a result of the evaporation process of the contents. There are 2 main types of emissions: "big breaths" occur when the tank is filled with petroleum products, "small breaths" – due to daily fluctuations in air temperature in the tank [2]. Emissions are subject to environmental monitoring to control the state of the environment.

All types of "breathing" of reservoirs are influenced by a number of factors: climatic (landform, climatic zone, which in the long term determines the factors mentioned below), meteorological (air temperature, atmospheric pressure, humidity, wind speed, precipitation, as well as special phenomena, such as fog). The temperature and air pressure are directly related: as the temperature rises, the pressure increases, which leads to increased evaporation and the release of the contents of the tank into the atmosphere; as the temperature decreases, the opposite effect is observed.

Increased humidity can lead to condensation of moisture and flooding of the tank contents, while in the atmosphere it (as well as calm) can keep emissions in the surface air layer. Strong wind and fog contribute to the active circulation of air masses, and along with this, the distribution of released vapors. The climate significantly affects not only the temperature, but also its daily amplitudes. For example, in a severely continental climate, the amplitude will be greater

than in a moderately continental climate, which will affect the "breathing" of the reservoir. To carry out environmental monitoring, all factors must be taken into account [2].

To evaluate the "small respiration" of the reservoir and compare different meteorological and climatic conditions, a calculation was performed, which is currently performed according to the formula of Professor N.N. Konstantinov [1]:

$$G_{МД} = \sigma \cdot V_Г \cdot \ln\left[\frac{(Pa - P_{КВ} - Pmin) \cdot Trmax}{(Pa + P_{КД} - Pmax) \cdot Trmin}\right],$$

где: σ - average mass content of oil vapors in PVS; $V_Г$ - the volume of the gas tank space; $Pmin$ и $Pmax$ - accordingly, the minimum and maximum partial pressures of oil vapor in the gas tank during the day; $Trmin$ и $Trmax$ - minimum and maximum temperatures of the GP tank during the day.

The initial data was taken as an abstract RVS with a volume of 5,000 m3 with light oil (p = 820 kg/m3) at two points different in terms of the factors described above – Perm and Chita. As a result of the calculations, the following results were obtained: oil losses from the "small breathing" of the RVS in Perm in July 2025 amounted to 1128.71 kg; in Chita – 1177.07 kg. Thus, the loss of RVS in Chita is 48.36 kg more than the loss of RVS in Perm, due to differences in climatic and meteorological conditions.

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STUDY OF ECOLOGICAL BENEFITS OF URBAN FOOD SYSTEM TRANSFORMATION

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This article introduces the dietary structure transformation of replacing traditional beef with alternative proteins to alleviate the current ecological and environmental pressure. Measures such as the transformation of urban food and dietary systems provide a key path to achieving the dual carbon goals. Under different shared socio-economic pathways (SSPs), alternative proteins have the greatest potential for ecological benefits under the Sustainable Development Pathway (SSP1).

Keywords: ecological benefits, urban food system, transformation.

With the continuous growth of the world's population, it is one of the main factors causing large food consumption, resource shortage and environmental crisis. Cities have become key hotspots in terms of resource consumption and environmental impact, and their dietary structure plays a decisive guiding role in global agricultural production. Traditional beef production is widely regarded as one of the most resource-intensive food production methods. Its environmental costs are reflected in greenhouse gas emissions, land occupation and water resource consumption. In recent years, the replacement of beef with alternative protein, due to its resource-efficient and environmentally friendly characteristics, has reshaped urban food consumption habits and generated good ecological benefits.

Research shows that replacing beef with alternative protein is sufficient to have a significant impact on the total net greenhouse gas emissions. The dynamic changes in land caused by alternative proteins: The land area required for the production process of alternative proteins is significantly reduced, thereby alleviating deforestation and ecological degradation caused by the expansion of pastures, creating conditions for the maintenance and restoration of biodiversity. At the same time, the production of alternative proteins consumes less water, which helps to relieve regional water resource pressure. It also provides higher protein production efficiency under the same land resource conditions, which has a positive impact on the sustainability of water resources. Meanwhile, the scenario analysis of the ecological benefits of alternative proteins under different development paths can more intuitively feel the degree of realization of their ecological benefits. Through the analysis of ecological benefits in different scenarios, it is demonstrated that the

transformation of urban food consumption plays a positive role in the sustainable development of the future ecological environment.

This paper systematically and comprehensively demonstrates the crucial and indispensable role of alternative proteins in the transformation and evolution of urban food systems. The strategic application and extensive integration of alternative proteins have great potential to fundamentally alleviate and reduce the huge ecological and environmental pressures currently faced by our planet. In the complex structure of urban food systems, the large-scale adoption and practical application of alternative proteins are supported by clear, well-defined and operational implementation approaches, as well as solid and continuously growing empirical evidence and real-world practical foundations.

It is not merely an abstract or idealized concept confined to the theoretical level, but a practical and feasible reality. Through rigorous analysis, comprehensive assessment and multi-faceted evaluation, this study clearly reveals the intrinsic feasibility, realistic relatability and overall feasibility of this important goal. The ultimate goal and significant contribution of this work is to provide a powerful, sustainable and forward-looking approach for achieving the “dual carbon” goals. To effectively alleviate the increasing pressure on the ecological environment and ensure and safeguard national ecological security and the long-term sustainability of resources.

Thus, this study aims to provide a scientific, reasonable, evidence-based and reliable basis for the formulation, development and improvement of relevant policies, strategic guidelines and regulatory frameworks, thereby supporting informed decision-making and proactive governance to achieve a more sustainable and resilient future [1, 2].

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ASSESSMENT OF THE TREE STANDS CONDITION IN PAVLOV PARK

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The article shows the dynamics of the assessment of the tree condition in Mikhail Pavlov Park. The changes in the tree condition coefficient of the urban park have been identified.

Keywords: ecological condition of parks, anthropogenic impact, tree stand condition coefficient.

In contemporary urban ecosystems, green infrastructure plays a critical role, fulfilling not only recreational functions for the populace but also contributing significantly to environmental health enhancement, augmentation of the aesthetic value of urban areas, and the formation of a rational and harmonious spatial structure of the urban environment. Consequently, the maintenance, rehabilitation, and conservation of woody vegetation across various urban territories present a pressing ecological challenge. Urban parks, as key elements of green infrastructure, often exhibit a condition that fails to comply with established normative requirements [1].

Minsk, being one of the largest industrial hubs in Belarus, is subject to substantial anthropogenic pressure on its ecological systems, particularly its phytocenoses. Within urban ecosystems, parks serve essential recreational functions, facilitating comfortable leisure activities [2]. The presence of arboreal vegetation directly influences urban air quality by partially mitigating pollutants from vehicular and industrial emissions; additionally, plants act as acoustic barriers and modify adverse wind patterns.

Mikhail Pavlov Park, located in the Moskovsky District of Minsk between the Malinovka, Yugo-Zapad, and Brilevichi residential areas, covers an area of 41 hectares. An assessment of the ecological status of the park's dendroflora was conducted on sample plots characterized by varying degrees of anthropogenic load. The evaluation of

tree vitality was performed based on visual morphological traits (using a 1 to 5-point scale), enabling the calculation of the tree stand condition index for each species and respective plot.

The dendrological composition of the park is represented by seventeen taxa, among which introduced species constitute over 50%. The most common species are: Silver Birch (*Betula pendula*), Large-leaved Linden (*Tilia platyphyllos*), Common Ash (*Fraxinus excelsior*), Manitoba Maple (*Acer negundo*), and White Willow (*Salix alba*).

We conducted an analysis of the state of tree vegetation from 2021 to 2025. The tree stand condition coefficient in Pavlov Park on the selected plots did not change significantly. For the plots with the highest anthropogenic impact, the tree stand condition coefficient (K) indicated that these plots have a weakened tree stand (from K=1.74 in 2021 to K=1.81 in 2025). For the plots with the lowest degree of anthropogenic impact, the values of the tree stand coefficient changed more significantly (from K=1.13 in 2021 to K=1.36 in 2025).

The overall tree stand condition coefficient for Mikhail Pavlov Park in 2021 was K=1.86, which classified it as a "weakened" category. In 2025, the value of the park's overall tree stand condition coefficient was K=1.61, indicating a more favorable situation in the park; however, the obtained value still corresponds to the "weakened" tree stand category. The results of the conducted research indicate the implementation of a range of park improvement measures by the district administration.

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USING ARTIFICIAL INTELLIGENCE TO MONITOR QUALITY AND RESTORATION OF SURFACE WATER RESOURCES

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The rapid degradation of water bodies due to pollution, global warming, and anthropogenic activities necessitates newer methods of restoration. The current research presents the application of artificial intelligence (AI) for real-time monitoring of water quality, management, and parameter analysis for accelerating ecosystem recovery. AI makes anticipatory interventions such as automatic pollutant monitoring and efficient resource allocation possible through machine learning algorithms, IoT sensors, and predictive analytics.

Keywords: artificial intelligence, aquatic ecosystems, water quality monitoring, real-time management, ecosystem restoration.

An aquatic ecosystem is an ecosystem found in and around a body of water, in contrast to land-based terrestrial ecosystems. Aquatic ecosystems contain communities of organisms – aquatic life – that are dependent on each other and on their environment. The two main types of aquatic ecosystems are marine ecosystems and freshwater ecosystems. Aquatic ecosystems like rivers, lakes, and oceans are vital to climate, water supply, and biodiversity. Yet they face threats in the form of eutrophication, chemical pollution, and habitat destruction that can take years to recover on their own. Traditional monitoring is labor-intensive and late, limiting immediate response. Artificial intelligence can provide a paradigm shift by enabling smart real-time ecosystem management systems.

AI applications in water quality monitoring include machine learning algorithms to predict parameters like pH, dissolved oxygen, turbidity, and nutrients. As a point of illustration, convolutional neural networks (CNNs) and recurrent neural networks (RNNs) work on the sensor values of IoT sensors to detect anomalies in real-time. In aquatic restoration, AI platforms integrate satellite images, drone patrol, and underwater sensors for integrative analysis.

Predictive models forecast the ecosystem response to interventions such as bio-remediation or flow adjust-ments to optimize restoration strategy.

Real-time management is maximized by AI algorithms that are capable of automating management systems. As an example, reinforcement learning is able to dynamically adjust water treatment procedures based on incoming data, reducing pollutant loads and supporting biodiversity restoration. Research demonstrates that AI-fused systems can shorten restoration timelines by 30-50% through the capability of early threat detection of algal blooms.

Empirical evidence from global applications bring forth the practical benefits of AI in aquatic restoration. In aquaculture, IoT-driven AI systems have been successfully utilized to monitor key parameters in real time, preventing outbreaks of disease and ensuring yield sustainability through precise regulation of the environment. Similarly, in marine conservation efforts, AI-based automated tools have facilitated monitoring of large-scale habitats, resulting in site-specific interventions that enhance the resilience of ecosystems against climate stressors.

Therefore, the evidence strongly supports AI as a cornerstone for the future of aquatic conservation. While challenges in implementation remain, its capacity to enable precise, predictive, and adaptive management underscores its indispensable role in safeguarding these critical ecosystems for generations to come.

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SOIL QUALITY IN ORGANIC AND CONVENTIONAL AGRICULTURAL SYSTEMS

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Organic agriculture significantly improves soil structure, carbon sink function and nutrient cycling resilience by increasing soil aggregate content, enhancing carbon sequestration capacity and optimizing microbial communities. Despite the low initial yield, it stabilizes after five years and outperforms conventional agriculture, demonstrating superior soil health and long-term sustainability.

Keywords: soil quality, organic agriculture, soil organic carbon, microbial diversity, carbon sequestration, agroecosystem resilience

Organic agriculture is defined as a production system that relies on natural processes rather than synthetic chemicals, genetically modified organisms, or artificial additives. It represents a paradigm shift toward renewable food production, grounded in agroecological principles that prioritize soil health, biodiversity conservation, and resource efficiency, with the aim of mitigating climate change impacts while ensuring long-term food security. This study conducts a systematic comparison of soil quality between organic and conventional farming systems, addressing critical knowledge gaps regarding their differential effects on soil integrity and sustainability.

Drawing on data from long-term field trials, this research evaluates soil quality through physical, chemical, and biological indicators. Key findings indicate that organic systems significantly enhance soil structure: large aggregate content (>2 mm) increases by 47.3% compared to conventional farmland, and soil erosion is reduced by 38% under heavy rainfall conditions. Soil organic matter (SOM) accumulates in organic systems at a rate of 0.35 t C/ha per year, doubling the carbon sequestration capacity relative to conventional agriculture. Microbiologically, organic management increases microbial biomass carbon by 35.2% and arbuscular mycorrhizal colonization by 28.7%, thereby enhancing the diversity and functionality of the soil food web. These improvements are associated with enhanced nutrient cycling

nitrogen mineralization rates increase by 19% during drought periods, contributing to greater resilience under climatic stress.

From an economic perspective, although initial yields in organic systems are 12–18% lower than those of conventional systems, they stabilize at 82% of conventional yields after five years due to progressive improvements in soil health. Carbon footprint analysis reveals that organic systems reduce CO_2 emissions per unit of output by 32%, though the productivity gap must be assessed contextually. From a social standpoint, organic farming reduces externalized costs by 103 euros per hectare annually compared to conventional practices, particularly in areas such as water pollution mitigation.

Thus, the introduction of elements of organic agriculture shows some positive aspects compared to the traditional way of farming, which are expressed in a more favorable effect on soil cover, carbon uptake and long-term sustainability, despite the existing yield compromises and socio-economic problems. Future research should prioritize regional specifics of adaptation strategies and interdisciplinary collaboration to fully realize the potential of sustainable food systems using organic farming systems.

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REDUCING ENVIRONMENTAL RISKS IN THE WATER TREATMENT SYSTEM OF ENERGY PLANTS

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The study presents the results of the possible use of clarified water purification methods in closed hydraulic ash removal systems of thermal power plants, without the use of chemical reagents. A dangerous rise in the water level in the sections can lead to a breach of the enclosing dams and a spill of clarified water into nearby territories. The use of excess water in the technological needs of enterprises is also difficult due to the discrepancy in quality requirements for process water. For these reasons, there is an urgent need to develop and implement non-traditional methods of industrial wastewater treatment based on the principles of waste-free production. One of the possible methods may be the thermodynamic treatment of wastewater and the possibility of their use for the technical needs of the enterprise.

Keywords: cavitation, wastewater treatment, ash removal system, clarified water, environmental risks.

In modern conditions of growing interest in environmental issues and stricter environmental legislation in both the Russian Federation and other countries, strict requirements are imposed on the methods of industrial wastewater treatment. These restrictions serve to increase the environmental safety of industrial enterprises and are an incentive to create closed water use systems. The electric power sector is the key to stable economic growth and industrial development in the country. In the context of growing cities, there is an increase in the strategic importance of energy complex enterprises, because the life and health of a large number of people depend on their uninterrupted operation.

Water is one of the most demanded natural resources consumed by industrial enterprises, while thermal power plants are no exception. This natural resource is cheap, universally available, and suitable for various technological needs of power plants. Water is used to recharge the cycle of the plant and the heating network, for condensation and cooling of spent steam, cooling of mechanisms, hydraulic cleaning, chemical flushing of equipment, and so on. These methods of using natural water inevitably lead to the formation of polluted industrial wastewater. The concentration and composition of pollutants in this wastewater depends on the type of power plant, the fuel it uses, the composition of natural water, and the culture of operation. During the operation of thermal power plants, cooling waters, as a rule, are not polluted if no foreign effluents enter them. In this case, thermal pollution of the reservoir may occur, because the

temperature of the waste water is higher than the natural one. In this regard, many thermal power plants use closed cooling systems.

Coal-fired power plants traditionally use a closed hydro ash removal system. In this regard, there is a problem of purification and further use of clarified water effluents, because the emergence of a positive balance in the system is almost inevitable. The method of water purification used in settling ponds at the ash dump does not ensure the environmental safety of handling such types of wastewater. Another potentially applicable way to use wastewater is to use it as process water. However, quality requirements are also imposed on process water, which are not achieved by filtration in ash dump areas.

The aim of this research is to study changes in water properties under the influence of cavitation and to consider the possibility of using these technologies as a non-reagent method of purification of clarified water of a thermal power plant.

The object of laboratory research is on the physico-chemical parameters of clarified water resulting from the transportation of ash and slag waste generated by the combustion of brown coal in the Kansk-Achinsk fuel basin. The studied clarified water samples were taken at the ash and slag dump, which is used for the operational storage of ash formed as a result of burning brown coal in the Kansk-Achinsk basin. The physico-chemical properties of the selected clarified water samples were determined.

The object of the study is clarified water obtained as a result of purification in settling ponds, used to transport ash and slag obtained by burning brown coal grade B2. Table 1 shows the initial concentrations of pollutants determined as a result of quantitative chemical analysis.

A Silverson L5M high-speed laboratory mixer was used to process clarified water. During processing in three modes, a chemical analysis of the sample of each mode was performed. The data from these analyses are also shown in Table 1.When analyzing the data obtained, it can be concluded that the efficiency of wastewater treatment is quite high.

Table

Concentrations of impurities in the source and treated water

Indicator, units	Initial sample	Processed sample		
		1 mode *	2 mode **	3 mode ***
Dry residue, mg/dm^3	912,00	1044,00	1002,00	1112,00
Sulphate ion, mg/dm^3	80,50	83,50	77,20	62,50
Hydrogencarbonate ion, mg/dm^3	less than 6,1	less than 6,1	less than 6,1	less than 6,1
Carbonate ion, mg/dm^3	1206,00	768,00	864,00	730,10
Hydrogen index, units, pH	12,12	12,02	10,21	8,55
Overall stiffness, mg-eq/dm^3	17,84	12,72	13,04	9,92

The proposed technical solutions ensure the necessary water quality for reuse. The main advantages of the reagentless method based on hydrothermodynamic cavitation include: a wide range of purification, the possibility of implementation into existing systems, reducing environmental risks, reduction of operating costs, system autonomy.

Hydro-ash removal systems are one of the most important elements of a coal-fired thermal power plant. The reliability of the ash-collecting and ash-removing equipment depends on their effective operation. Now, when the problem of environmental efficiency is acute, it is important to develop and implement new technologies in existing outdated systems. These technologies should be based on waste-free and agent-free methods, which will keep pace with progress and meet modern international requirements for waste-free production.

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RARE EARTH MATERIALS, THEIR PROPERTIES AND APPLICATIONS

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Rare earth materials are a group of 17 elements, including scandium, yttrium, and the lanthanides. In this article, we will focus on elements such as scandium, terbium, ytterbium, dysprosium, yttrium, and neodymium. All these elements are in the third group and share the common name – lanthanides.

Keywords: rare earth materials, scandium, terbium, ytterbium, dysprosium, yttrium, neodymium.

Rare earth materials are a group of 17 elements that received their name due to the fact that they are relatively rare in the Earth's crust and form refractory, practically insoluble in water oxides. This key property, which historically justified the inclusion of the word "earth" in their name, is directly related to their chemical nature and determines the wide range of practical applications of these elements in modern technologies, from electronics to heavy industry.[1]

The chemical element lanthanum (density ρ=6.16 g/cm³, melting point τ=920 °C, abundance in the Earth's crust about 0.0034%) occurs in nature as a mixture of two isotopes: stable lanthanum-139 and radioactive lanthanum-138. Lanthanum is widely used in medicine and various industries (production of optical glasses, hydrogen storage alloys, high-temperature ceramics) due to its high catalytic activity and ability to form superconductors.[2-3]

The chemical element scandium (ρ=2.99 g/cm³, τ=1540.85 °C, abundance in the Earth's crust about 0.001%) is a mono-isotopic element; only one stable isotope, scandium-45, is found in nature. It exists in two crystalline modifications: α-scandium with a hexagonal close-packed lattice and β-scandium with a body-centered cubic lattice. Scandium is widely used in metallurgy, microelectronics, nuclear energy, and medicine due to its light weight, high strength, and high melting point.[4]

The chemical element terbium (ρ=8.229 g/cm³, τ=1356 °C, abundance in the Earth's crust about 0.00034%) has a single stable isotope, terbium-159. The longest-lived radioactive isotope is terbium-158 with a half-life of 180 years. Terbium is used in the production of magnetostrictive alloys, magnetic materials, and optical materials.

The chemical element ytterbium (ρ=6.9654 g/cm³, τ=823.85 °C, abundance in the Earth's crust about 0.000033%) occurs in nature as seven stable isotopes. Ytterbium is widely used in the creation of laser materials, thermoelectric materials, magnetic materials, as well as in nuclear energy due to its ability to emit light in the infrared range and its capacity to improve the mechanical properties of metals in alloys.

The chemical element dysprosium (ρ=8.55 g/cm³, τ=1411 °C, abundance in the Earth's crust about 0.0005%) occurs in nature as seven main natural isotopes; among these, the most common is dysprosium-164, which constitutes 26.26%

of all natural dysprosium. Dysprosium is widely used in metallurgy and nuclear energy due to its magnetic and nuclear properties.

The chemical element yttrium (ρ=4.47 g/cm³, τ=1521.85 °C, abundance in the Earth's crust about 0.0026%) is a mono-isotopic element; in nature, it is represented by one stable isotope, yttrium-89. Yttrium is widely used in the creation of yttrium ceramics because it transmits infrared radiation very well.[5]

The chemical element neodymium (ρ=7.007 g/cm³, τ=1020.85 °C, abundance in the Earth's crust about 0.0025%) occurs in nature as seven isotopes, five of which are stable and two are weakly radioactive: neodymium-144 undergoes alpha decay with a half-life of 2.29*10^15 years, and neodymium-150 undergoes double beta decay with a half-life of 9.3*10^18 years. The atomic mass of neodymium is 144.24 g/mol. Neodymium is widely used in the creation of powerful permanent magnets, neodymium glass, and is also extensively used in electronics due to its magnetic and strength properties.[6]

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THE RELATIONSHIP BETWEEN THE LEVEL OF HEAVY METAL CONTAMINATION IN DRINKING WATER AND THE PREVALENCE OF URINARY TRACT DISEASES

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This article reveals the problems of drinking water contamination with heavy metals and describes the mechanism of the impact of such contamination on the urinary system.

Keywords: water quality, heavy metals, morbidity.

Heavy metals are components of the Earth’s crust, but their concentration in the environment can increase significantly as a result of human activity. As industrial waste products, they end up in water that is then used for drinking. These substances are highly toxic and can have a negative impact on the human body.

The urinary system is a kind of “filter” for our body, so it is the first to be affected by drinking water contaminants. The condition of this organ system affects the condition of the body as a whole, so it is important to monitor its health and prevent damage [1].

The assessment of the risk of heavy metal exposure to the body depends on the type of pollutant. Heavy metals such as cadmium, lead, and mercury are nephrotoxic, i.e., they can destroy kidney tissue. Accumulating in kidney cells, they cause oxidative stress, inflammation, and DNA damage, which subsequently leads to the development of chronic kidney diseases (glomerulonephritis, urolithiasis, chronic kidney disease). Other metals, such as arsenic, are carcinogenic. Once inside the body, they can disrupt DNA repair processes in bladder cells, which contributes to the accumulation of mutations and, as a result, increases the risk of cancer. In addition, virtually all pollutants of this type are immunotoxins. They cause immune dysfunction, which leads to increased susceptibility to urinary tract infections [2].

To prevent the consequences of heavy metal contamination of drinking water, there is a list of measures that includes: monitoring the quality of drinking water, improving water treatment technologies, timely replacement of water pipes, protecting drinking water sources from industrial waste, and raising public awareness of this issue. These actions

minimize the risks associated with the impact of pollutants on human health and reduce the number of patients with urinary system pathologies [3].

Thus, the presence of heavy metals in water has a negative effect on the health of the human urinary system. Chronic exposure to this type of pollutant significantly increases the risk of developing chronic kidney disease, bladder cancer, and other pathologies. To prevent this, there is a set of measures for monitoring water quality and purifying it, which is one of the priority tasks for maintaining public health.

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POCKET PARKS EMPOWER SUSTAINABLE URBAN DEVELOPMENT

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This paper explores the role of pocket parks in sustainable urban development. Based on the case of Minsk, China and Belarus, it points out their functions, maintenance, and ecological challenges, proposes optimization paths such as planning, design, and policy, and looks forward to the green cooperation between China and Belarus. The "15-minute city" concept promotes sustainable urban development by integrating pocket parks into community life circles.

Keywords: Pocket park,sustainable urban development,15-minute city,urban renewal, ecological sustainability, China-Belarus cooperation.

Pocket park is miniature public gree spaces created using idle corner spaces in the city for residents to relax nearby. Pocket park and the theoretical basis of sustainable urban development.Pocket parks should be multifunctional composite spaces with rest, play, viewing, earthquake prevention and disaster reduction, education, etc., and public green space with human activities as the main body[1]. They have become an important carrier for realizing the "15-minute city" concept. The design principles of pocket parks[2] provide residents with ecological services and social places, and promote urban sustainable development in the three dimensions of environment, society and economy. From the Paris community green network to Singapore's high-density greening practice, global cases have confirmed the value of pocket parks in building livable cities. Current status of pocket parks in Minsk, China and Belarus.

A survey of pocket parks in Minsk, Suzhou and Shanghai, China, found that both faced common problems in urban renewal, such as difficulty in facility maintenance[3], unscientific planning and layout, and insufficient ecological sustainability. Effective maintenance mechanisms and improved community participation models need to be established.

Innovative development and future prospects.Systematic innovative strategies are needed to improve the benefits of pocket parks. A functional composite model should be implemented at the planning and design level to create age-friendly spaces. A cross-departmental coordination mechanism should be established at the policy level to explore sustainable models that combine parks with commerce and improve the community co-construction and co-governance system. Under the framework of the Belt and Road Initiative, China and Belarus can cooperate in multiple fields, explore development models that adapt to different cultural backgrounds, and provide new ideas for the sustainable development of global cities.

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OPTIMIZATION RESEARCH ON LOW-CARBON AND HIGH-EFFICIENCY WATER TREATMENT SYSTEMS INTEGRATING AI AND MEMBRANE TREATMENT TECHNOLOGY

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Wastewater treatment is a major energy consumer. Under the 'Dual Carbon' goals, energy conservation and consumption reduction have become one of the most urgent needs in the industry. Currently, the vast majority of wastewater treatment plants still rely on manual experience or simple PID controls, resulting in extensive operation, weak resistance to shock loads, and significant fluctuations in effluent quality. 'Intelligentization' is the inevitable path for industry upgrading.

Keywords: Wastewater, energy saving, membrane technology, AI

With the advancement of the "Dual Carbon" goals, the water treatment industry faces dual challenges of energy saving, consumption reduction, quality improvement, and efficiency enhancement. Membrane technology, as a core separation method, has energy consumption and operational stability that are key to determining the carbon footprint of water treatment systems. In recent years, the rise of artificial intelligence technology has provided a revolutionary new path for achieving the low-carbon and high-efficiency optimization of membrane treatment systems.

Traditional membrane system optimization primarily relies on physical models and expert experience, struggling to cope with the dynamic complexity of water quality fluctuations and membrane fouling. The integration of AI and membrane technology is profoundly changing this situation across three levels. Firstly, in terms of intelligent control and predictive maintenance, machine learning models can accurately predict membrane fouling trends based on historical and real-time data, dynamically optimize backwashing and chemical cleaning cycles, and adjust operating pressure. This significantly reduces energy and chemical consumption while ensuring water production flux, achieving "targeted low-carbon" operations. Secondly, in energy consumption and carbon footprint modeling, AI algorithms can integrate energy consumption data from all system units to build global energy efficiency models, identify energy flow bottlenecks, and couple with the variable output of renewable energy sources (like solar and wind power). This enables the coordinated optimal dispatch of membrane systems and green energy, reducing carbon emissions at the source. Finally, in digital twins and global optimization, by constructing a digital twin of the membrane system, AI can simulate and deduce the performance of the entire process under different working conditions, providing optimal decision-making support for adjusting process parameters and selecting/configuring membrane modules. This maximizes system energy efficiency from individual equipment to the entire water treatment plant.

In summary, the deep integration of AI and membrane technology is an inevitable trend for driving the water treatment industry towards low-carbon and intelligent transformation. Future research should focus on constructing high-quality datasets, developing cross-media (water-energy-carbon) collaborative optimization models, and the embedded integration of edge computing and AI algorithms, aiming to ultimately achieve the "unmanned" low-carbon and high-efficiency operation of water treatment systems.

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MECHANISM ANALYSIS OF MULTI-OMICS INTEGRATION IN SOIL MICROPLASTIC-HEAVY METAL COMBINED POLLUTION MONITORING

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Soil microplastic-heavy metal combined pollution threatens farmland ecosystems, but integration of multi-media mechanisms and accurate monitoring is lacking [1]. This study integrated literature data and applied multi-omics to reveal that microplastics regulate soil pH to affect heavy metal mobility [4]; the plastisphere enriches functional microorganisms and modulates synergistic gene expression. A three-tier "physicochemical-microbial-functional" monitoring system, superior to traditional indicators, provides theoretical and practical support for pollution monitoring [1,5].

Keywords: Microplastic-heavy metal combined pollution; Multi-omics integration; Plastisphere; Soil monitoring system

Combined pollution alters soil properties and exacerbates risks via plastisphere microbial community reconstruction [1]. Existing studies focus on single pollutants, lack integrated analysis of the "microplastic type-dose-heavy metal form-microbial response" chain, and rely on single-dimensional indicators [3]. This study integrates multi-omics literature to clarify regulatory mechanisms and support a sensitive, accurate monitoring system, breaking single-research fragmentation and guiding farmland surveys.Core literatures (pot experiments/metagenomics) were selected by strict criteria: farmland combined pollution focus, ≥2 omics technologies, complete data, and publication in high-impact journals (past 8 years). Data were standardized and integrated from three dimensions: physicochemical (pH, heavy metal bioavailability) [5], microbial (plastisphere core genus abundance, functional gene expression) [2], and functional (enzyme activity, metabolite concentration) [1].

There are three points :First,pH and heavy metal mobility: Traditional microplastics reduce pH to promote mobility; biodegradable ones inhibit mobility via late-stage alkalization (verified by multiple studies) [5].Second Plastisphere microorganisms: Microbial communities differ from bulk soil; traditional microplastics enrich heavy metal-resistant bacteria, biodegradable ones enrich degrading bacteria. Synergistic expression of degradation/resistance genes aids adaptation to combined pollution [2].Third Enzymes and metabolites: Biodegradable microplastics enhance key enzyme activity via carbon release; traditional ones inhibit specific enzymes. Specific metabolites act as pollution/degradation markers, some linked to heavy metal toxicity [1].

A verifiable three-tier system with literature-supported, quantifiable, high-response indicators [3]: Physicochemical layer: Early warning via soil pH safety range and heavy metal bioavailability risk value [4]; Microbial marker layer: Risk signal when indicator genus abundance or resistance gene expression hits thresholds;Function verification layer [2]: Judge via key enzyme activity thresholds; use metabolites to indicate pollution/degradation [1].

Verified in contaminated farmland, this system is more accurate, faster, and sensitive than single indicators, meeting on-site monitoring needs. Microplastics affect contaminated soil ecology via "pH regulation-microbial enrichment-gene expression" chain (literature-verified); Plastisphere-specific microorganisms/metabolites serve as combined pollution markers; A feasible framework for the three-tier monitoring system is provided.

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IMPACT AND PREDICTION OF CLIMATE CHANGE ON BIODIVERSITY AND ECOLOGICAL PROCESSES IN MOUNTAIN GLACIER ECOSYSTEMS

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Mountain glacier ecosystems, renowned as "white treasures" and "solid reservoirs", play irreplaceable roles in regulating regional climate, maintaining downstream freshwater supplies, and supporting unique biodiversity. As sentinels of global climate change, these ecosystems are among the most vulnerable to warming temperatures – with even subtle glacial retreat triggering cascading effects on ecological processes and species survival. This paper explores the multifaceted impacts of climate warming-induced glacier ablation on biodiversity and key ecological processes (e.g., biogeochemical cycling, vegetation succession) in mountain glacier ecosystems. It also predicts their evolution under different future shared socio-economic pathways (SSPs) and proposes targeted conservation strategies. Studies indicate that accelerating glacier retreat not only reduces habitat availability but also profoundly restructures biological communities, disrupts nutrient cycling, and alters species interactions. Specifically, under shared socio-economic pathways (SSPs), Rimeier et al. (2025) found that the loss of specialized taxa (e.g., cold-adapted invertebrates) and functional transition of microbial communities will be more pronounced in high-emission scenarios (e.g., SSP5-8.5), while sustainable development pathways (e.g., SSP1-1.9) may mitigate such degradation by slowing glacial loss [1]. This research provides a scientific basis for understanding, monitoring, and responding to ecological changes in mountain glacier ecosystems, which is critical for safeguarding global ecological security.

Keywords: Climate change; Mountain glacier ecosystems; Biodiversity loss; Ecological processes; SSP scenarios; Conservation strategies

Mountain glacier ecosystems are complex, interconnected systems that encompass three core habitats: supraglacial (on-glacier) environments, subglacial (beneath-glacier) zones, and proglacial (post-glacial) areas. These habitats are defined by extreme environmental conditions – near-freezing temperatures year-round, high ultraviolet (UV) radiation at high altitudes, and oligotrophy (low nutrient availability) – which have driven the evolution of highly specialized biological communities. For example, supraglacial communities often include cold-tolerant cyanobacteria and algae that form "glacier algae" (visible as red or green patches on ice), while subglacial environments support chemoautotrophic bacteria that rely on mineral-rich meltwater for energy [2].

Liu et al. (2024) further clarified that supraglacial and subglacial ecosystems contribute differentially to proglacial system function: supraglacial organic matter (e.g., from algae and wind-blown debris) fuels proglacial soil fertility, while subglacial meltwater delivers essential minerals (e.g., phosphorus, nitrogen) that support downstream plant growth [2]. This functional differentiation highlights the fragility of glacier ecosystems – disturbance to one habitat can disrupt the entire system. Since 2000, global glaciers have lost approximately 5% of their total mass, with even greater losses in high-mountain regions: Chinese glaciers, for instance, shrank by 6% between 2008 and 2020, primarily driven by anthropogenic warming (e.g., greenhouse gas emissions) and black carbon deposition (which reduces ice albedo and accelerates melting). These changes are already triggering cascading ecological effects, from reduced meltwater supply to the loss of specialized species, threatening both ecosystem integrity and downstream human livelihoods.

Climate change drives profound and interconnected changes in mountain glacier ecosystems, manifested as specialized biodiversity loss, accelerated vegetation succession, and disrupted biogeochemical cycles. Future trajectories are closely tied to emission pathways: high emissions will exacerbate ecological degradation, while sustainable pathways offer a chance to mitigate loss [1]. Protecting these ecosystems requires urgent global action to reduce emissions, enhanced monitoring, and integrated management – measures that are not only critical for safeguarding glacial biodiversity but also for ensuring downstream freshwater security and global ecological balance. As Liu et al. (2024) emphasized, preserving the functional integrity of supraglacial and subglacial habitats is key to maintaining the resilience of entire glacier ecosystems [2]. Only through coordinated, science-based efforts can we ensure the long-term survival of these "white treasures".

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ECHINOCYSTIS *(ECHINOCÝSTIS LOBÁTA)* AND ITS DISTRIBUTION IN BELARUS

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The abstracts provide data on the spread of alien fauna in Belarus, which are considered one of the main threats not only to the biodiversity of plants and animals, but also leading to more serious consequences. In particular, to economic, environmental and social ones.

Belarus is no exception in the issue of the appearance of introduced species of plant origin on its territory. Measures to clear territories of these species are carried out as tangible negative consequences of their presence arise. One of the main representatives of alien plant species actively spreading across the territory of Belarus is Echinocystis lobata. Its presence poses a threat to the extinction of local plant and animal species in the places where it grows.

Keywords: интродукция, эхиноцистис колючеплодный, чужеродные виды, экономический ущерб, экология и защита окружающей среды.

In accordance with the legislation of the Republic of Belarus "On the Protection and Use of Fauna and Flora", invasive and alien species of wild plants are wild plants that are outside their natural range, forming viable populations in a state of natural freedom, the distribution and number of which pose a threat to biological diversity. Currently, on the territory of the Republic of Belarus there are more than 50 species of invasive plant species that have appeared on the territory of modern Belarus [1].

An alien or invasive species is a species whose introduction threatens ecosystems, other biological species, and causes (ecological) economic damage [2].

Echinocystis lobata or thornberry is a plant that has enormous growth energy and, in a short period of time, if no measures are taken to destroy it, it takes over the floodplains of Belarusian rivers, land plots of abandoned buildings, and agricultural lands. The thornberry is capable of destroying entire sections of young forest plantations, entwining trees and depriving them of sunlight. The unpretentiousness of this plant to the soil, the huge number of seeds with almost 100% germination and, as mentioned earlier, the enormous starting energy of growth allowed this plant to spread across the territory of Belarus, causing enormous economic damage to the national economy.

Seedlings of *Echinocystis lobata* in early spring on the edge of a corn field *(Molodechno district, Minsk region. Photo by Yu.G. Liakh, S.A. Klimkova, April 23, 2025)*

The territories occupied by power lines are the best places for the formation of Echinocystis plantations. It is in such places where this alien species has settled that the aboriginal species of plants and animals experience the greatest oppressive pressure.

Long-term growth of Echinocystis in the same area completely changes the species composition of plants that have grown there for centuries. Under the shade of Echinocystis, there is practically no possibility of vegetation of other plants. Only in early spring, when the seeds of native species of local flora have the opportunity to germinate, they eventually die, since they are not able to compete with Echinocystis for the reasons given above.

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STUDY OF CHARACTERISTICS AND SOURCE TRACING OF HEAVY METAL POLLUTION IN GROUNDWATER OF TYPICAL INDUSTRIAL CITIES

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This study focused on heavy metal contamination of groundwater in industrial cities, analyzing its characteristics, distribution, sources, and mechanisms, identifying heavily polluted areas associated with industrial activities. By integrating multiple methods, the study quantified the sources of pollution and assessed its ecological and health risks.

Keywords: characteristics and source tracing, heavy metal pollution, groundwater

This study presents a systematic investigation of heavy metal pollution in the groundwater systems of a representative industrial city in China, with extensive mineral resource exploitation and diversified industrial activities. Through an extensive monitoring network and comprehensive laboratory analysis, researchers identified lead (Pb), cadmium (Cd), mercury (Hg), and chromium (Cr) as the predominant contaminants, with concentrations in ~68 % of wells exceeding national drinking water standards by 2 - 15 times, especially near industrial parks. Spatial distribution showed substantial heterogeneity, strongly correlating with proximity to non-ferrous metal smelting, electroplating, and chemical plants. Notably, these heavy metals pose potential health risks to human organs.

The methodology combined conventional hydrogeochemical analysis with spatial interpolation modeling and multivariate statistics, including Principal Component Analysis and Hierarchical Cluster Analysis. This enabled precise source apportionment, distinguishing three major contamination sources: industrial wastewater discharges (45 - 60% of heavy metals), traffic-related emissions (15 - 25%), and natural geological background (20 - 30%). Supplementary isotopic tracing of lead and chromium further validated that historical industrial waste in unlined landfills, atmospheric deposition, and leakage from corroded pipelines are primary contamination pathways.

Critical to understanding contaminant behavior was the detailed examination of hydrogeological factors governing heavy metal transport. The study showed that specific geological characteristics – such as soil permeability (10^{-3} - 10^{-5} cm / s), aquifer porosity (15 - 35 %), and complex groundwater flow – significantly influence contaminant migration and accumulation. Areas with karst fractured formations and shallow aquifers (water table less than 5 meters) were especially vulnerable, facilitating contaminant mobility and increasing exposure risks to nearby residents.

The health risk assessment quantified carcinogenic and non-carcinogenic risks for approximately 250 000 residents relying on groundwater as their primary drinking source. Cadmium and lead were the most critical contaminants, with the total hazard index (HI) reaching 3,8 and carcinogenic risk (CR) exceeding acceptable limits by 10 - 45 times in

severely affected zones. The model incorporated multiple exposure routes – direct ingestion, dermal contact, and inhalation – providing a comprehensive public health evaluation across demographic groups.

This study aims to establish a preliminary scientific framework for groundwater quality management in a typical industrial area, providing practical guidance and reference value for local environmental protection and urban planning authorities. This integrated approach, combining traditional hydrogeochemical analysis with multivariate statistical techniques, can serve as a reference model for assessing groundwater contamination in similar industrial settings, but its broader application requires further validation in diverse geological settings. Within the limited scope of this study, the results provide foundational data for developing targeted remediation strategies for heavily polluted areas and establishing a basic monitoring system for vulnerable water resources. The identification of major pollutants and their spatial distribution patterns provides a technical basis for prioritizing intervention measures.

Thus, furthermore, this study recommends the implementation of cost-effective monitoring programs and the adoption of an integrated watershed management approach to address real-world environmental issues and future research should expand the sampling network and incorporate long-term monitoring data to validate and refine the proposed framework [1, 2].

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REVIEW OF CHERNOBYL CONTAMINATION REMEDIATION AND ENVIRONMENTAL MONITORING IN BELARUS

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This review examines Belarus' remediation strategies – physical, chemical, and biological methods – and advanced monitoring technologies, including remote sensing and bioindicators. Despite progress, challenges such as low-level contamination and land-use conflicts persist, underscoring the need for sustainable solutions. The paper synthesizes current efforts and future directions to inform global nuclear pollution management.

Keywords: climate change, ecosystems, biodiversity, adaptation, mitigation

This paper reviews Belarus's main approaches to mitigating the long-term consequences of the Chernobyl accident. About 23% of the country's territory remains contaminated with cesium-137 and strontium-90, primarily in the Gomel and Mogilev regions [1]. Remediation efforts combine physical, chemical, and biological measures to reduce radionuclide mobility and ecological risk. Physical methods include removal or isolation of polluted soil, while chemical stabilization uses potassium and phosphate amendments to decrease bioavailability[2].

Modern monitoring integrates remote sensing, Geographic Information System (GIS), and bioindicators. Satellite and drone data enable mapping of radiation hotspots, while biological indicators such as moss and lichens provide low-cost, high-sensitivity monitoring. National databases and GIS-based decision systems now combine environmental and agricultural data to guide land-use planning and assess remediation efficiency.

To enhance decision-making in contaminated land management, several computational models have been developed in Belarus to simulate radionuclide behavior and assess ecological risks. Table 1 summarizes representative examples, including models based on radionuclide migration equations, machine learning prediction, and GIS-integrated ecological risk assessment.

Table

Overview of Nuclear Pollution Monitoring and Prediction Models

Model name	Application areas	Core methods/techniques	References
Dynamic migration model of cesium-137	Simulating the long-term migration of Cs-137 in soil-plant systems and predicting the spread of contamination	Migration equations based on physical and chemical processes, combined with soil type, precipitation, and vegetation parameters	[3]
Machine learning pollution prediction model	Using satellite and ground data to predict Cs-137 concentrations in farmland to support agricultural land planning	By studying random forest algorithm data, remote sensing and monitoring data are integrated	[4]
GIS integrated ecological risk model	Quantify the ecological risks of polluted areas	GIS spatial analysis, combining radioactivity levels, population density and land use data	[5]

On April 30, 2021 Belarus mandates daily CBM (contamination background monitoring) measurements using dosimeters or equivalent methods, with a static error margin ≤20%. If CBM levels exceed the three-month regional average by 0.20 μSv/h, hourly monitoring is enforced – a critical protocol for maintaining stability.

Future efforts could leverage artificial intelligence for big-data analysis and deploy robots for high-risk zone sampling, minimizing human exposure. Integrating technological innovation, interdisciplinary collaboration, and global resources is essential to unraveling Chernobyl's enduring legacy.

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SPATIAL STRUCTURE OF THE *APROCEROS LEUCOPODA (HYMENOPTERA: ARGIDAE)* POPULATION IN THE REPUBLIC OF BELARUS AND EUROPE (INVASIVE SPECIES), AND IN CHINA (NATURAL ECOSYSTEM)

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Keywords: Aproceros leucopoda; invasive species; spatial structure; parthenogenesis; mapping; Belarus; Europe; China; forest ecosystems.

The spread of invasive species is one of the pressing environmental issues of our time, significantly affecting biodiversity and ecosystem functioning. This study focuses on the sawfly Aproceros leucopoda (Hymenoptera: Argidae), which has spread from its natural range in East Asia (China) to Europe, including the Republic of Belarus, where it has been intensively exhibiting invasive properties and causing damage to elm plantations. Studying the spatial structure of populations of this species in various geographical and ecological conditions contributes to understanding

the mechanisms of invasion and developing measures to control its spread. Analysis of data from mapping the distribution areas of the above-mentioned representative of the Hymenoptera family was the main task of the study.

The main routes of A. leucopoda's spread to Europe, and in particular to Belarus, are international trade in plant material, transport corridors, and climate change. The import of elm seedlings from East Asia and the movement of insects along railways and motorways have contributed to the catastrophic spread of the species throughout Europe (Fig. 1). Modern geographic information systems allow us to track both the spatial and temporal dynamics of species distribution, including invasive species such as the elm sawfly within the European part of the continent.

Fig. 1. Distribution of A. leucopoda in Europe (4)

Climate warming has created favorable conditions for reproduction and survival, as evidenced by the expansion of the range northward. In invasive regions, unlike in China, A. leucopoda causes massive defoliation of elm trees, weakening them and reducing their resistance to disease, which leads to disruption of ecosystem functions and economic losses in forestry.

A. leucopoda is characterized by a short life cycle (25–40 days) with the possibility of forming 2–3 generations per season, which ensures rapid population growth. A unique feature is parthenogenesis – reproduction without males, which significantly increases its invasive potential. In China's natural ecosystem, the species' population is controlled by parasitic wasps and predators, the sawfly's natural enemies in the environment, which maintains a stable and low population density. In addition, the population is regulated by diseases of various etiologies. In Europe and Belarus, the absence of natural enemies and the widespread availability of food sources (Ulmus spp.) lead to sharp and massive outbreaks and serious damage to elm plantations.

In invasive regions (Europe and Belarus in particular), populations of A. Leucopoda are clustered, with pockets of high density, mainly near transport routes, urbanized areas, and forests with elm trees. In the Minsk region, the density of larvae reaches 50–100 individuals per tree, leading to complete defoliation. In China, on the contrary, the distribution is more uniform and the density is significantly lower (5–10 individuals per tree) due to natural regulators and climatic constraints.

The use of geographic information systems (GIS) has made it possible to visualize the range and distribution of A. leucopoda in different regions. In China, detection points are evenly distributed across the forest areas of Hebei, Shandong, and Liaoning provinces. In Europe as a whole and in Belarus in particular, clusters with high density have been identified along major rivers and transport corridors (e.g., the M1 highway in Belarus, the Tisza and Vistula rivers in Europe). This confirms the significant leading role of anthropogenic factors in invasive spread.

In conclusion, a comparative analysis of the spatial structure of Aproceros leucopoda populations in the natural ecosystem of China and invasive European regions, including Belarus, has revealed the key factors for the species' success: parthenogenesis, adaptability, absence of natural enemies, and the influence of anthropogenic pathways of spread. Invasiveness manifests itself in a clustered distribution with high densities and significant damage to elm plantations. The results of the study emphasize the need for comprehensive monitoring using GIS, strengthening quarantine measures, and studying biological control using natural enemies from the area of origin. This will allow for effective management of the spread of A. leucopoda and preservation of the biodiversity of forest ecosystems in the context of global environmental change.

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CARBON AEROGEL FROM COTTON AS EFFICIENT AND RECYCLABLE SORBENT FOR OIL WASTE

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This study presents the synthesis and characterization of a cotton-based carbon aerogel that can be used as a reusable absorbent for oil cleanup. The developed material exhibits high oil absorption capacity (~30 times more than its own weight) and can be regenerated by simple combustion. Although the absorption capacity gradually decreases over several cycles due to thermal degradation, the aerogel represents a promising, cost-effective, and environmentally friendly alternative to traditional disposable sorbents.

Keywords: carbon aerogel, cotton, recyclable sorbent, pyrolysis, oil waste.

To address environmental issues caused by oil and oil-containing product spills, the development of effective and reusable sorbents is essential. Natural organic materials such as straw and wool, as well as synthetic polymers, are used as sorbents. However, these materials often have significant limitations, including low absorption capacity, low selectivity for oil-water separation, lack of reuse, and the generation of secondary waste.

An ideal sorbent should not only possess high absorption capacity and hydrophobicity but also sufficient mechanical strength to allow repeated regeneration and reuse, which increases cost effectiveness and minimizes environmental impact. Carbon aerogels have attracted considerable attention due to their exceptional properties, such as ultra-low density, high specific surface area, and hydrophobicity. However, traditional production of carbon aerogels often requires expensive or toxic precursors and complex synthesis methods, hindering their large-scale practical application. To address these issues, the development of sustainable biomass-based aerogels is being explored. Cotton, one of the

world's most abundant natural cellulose fibers, is a promising, readily available precursor for the production of carbon materials. The aim of this study is to synthesize, characterize, and utilize a cotton-derived carbon aerogel for oil absorption.

Pieces of cotton were soaked with deionized water and pressed into cylindrical shape and then dried at 30 °C for 24 h. The residual water was removed under high vacuum at the pressure of 10^{-6} mbar for 3 h. Under evacuation the height of cylindrical sample was increased ~2 times. On the next step, cotton cylinders were pyrolized in tubular furnace. In order to prevent the oxidation, the furnace was evacuated, and then purged with argon flow. Then, the furnace was heated up to 800 °C at a heating rate of 5 °C/min for pyrolysis and held at 800 °C for 2 h with 300 sccm argon flow. Finally, the furnace was cooled down to room temperature.

After the pyrolysis, the weight and diameter of carbon aerogel cylinders sufficiently decrease compared to the raw cotton. The product of pyrolysis lost up to 93-96 % of the initial weight. According to the results of scanning electron microscopy, the raw cotton fibers form an interconnected 3D network, with most fibers extending to several centimeters in length, while the carbon aerogel fibers display a reduced diameter and more furcate morphology that corresponds to the increase of specific surface area after pyrolysis. A layered structure of thermally exfoliated carbon was also observed.

For an oil absorption test, 0.048 g of carbon aerogel was soaked with a highest possible amount mineral oil waste. Then the aerogel with oil was combusted in an atmospheric air. The strong sorption capability of carbon aerogel was demonstrated: the sample absorbed about ~1.4 g (i.e. ~30 times more than its own weight) on the first cycle of soaking in an oil waste. After the first combustion the weight of dry carbon aerogel decreases to ~0.023 g and remained constant during 5 subsequent cycles. However, the oil absorption capacity gradually decreases to ~0.67 g after 5 cycles, due to the thermal destruction of aerogel fibers and deposition of residues on their surface of fibers leading to the decrease of specific surface area.

To sum it up, this study introduces a superior sorbent made from upcycled cotton, offering exceptional absorption capacity, as well as the ability of reuse after a simple combustion. Carbon aerogel from cotton could be a sustainable and cost-effective alternative to conventional oil sorbents, which are often single-use and non-biodegradable.

SECTION 4
BIOINFORMATICS

DEPENDENCE OF THE STANDARD DEVIATION AND COEFFICIENT OF VARIATION ON MEAN HEIGHT

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Statistical analysis of anthropometric data from 12 population groups revealed a positive correlation between mean height and its standard deviation within each group, while no such relationship was observed with the coefficient of variation.

Keywords: Standard deviation, coefficient of variation, mean height.

Article [1] presents the results of a study based on UK Biobank data, demonstrating the appropriateness of applying the classical model of normal distribution and additive effects in analyzing adult growth. The authors showed that when analyzing hundreds of thousands of individuals, the assumption of normality of residuals and the purely additive nature of the influence of gender, genes and environment is no longer sufficient. Analyzing data from 50 countries, the authors found that as the average height of the population increases, its standard deviation increases. At the same time, the coefficient of variation remains unchanged, which is typical for a lognormal rather than a normal distribution. This indicates that the variability of average height is proportional to its magnitude, rather than constant, as assumed by the normal additive model.

This paper presents the results of calculations of the standard deviation (SD) and coefficient of variation (CV) of average height in 12 groups formed taking into account the gender, region of origin and age of participants (table). The sample included families from Belarus and China, including data on fathers, mothers, and their adult daughters and sons. The data were obtained in the course of research conducted at the Belarusian State University of Physical Culture. The main characteristic studied in all groups was height, which made it possible to assess the variability of this indicator in different populations and generations. Data processing and calculations were performed using MS Excel spreadsheets and statistical packages of the R programming language.

Table

Average height in population groups, its standard deviation and coefficient of variation

Mean height	169.14	180.99	166.44	182.19	179.05	168.40	168.5	174.67	161.17	178.92	172.87	163.87
SD	6.73	6.97	6.75	7.87	7.34	6.38	3.83	5.92	4.92	7.54	4.41	5.29
CV	0.04	0.038	0.041	0.043	0.041	0.038	0.023	0.034	0.031	0.042	0.025	0.032

Standard deviation serves as a measure of the dispersion of individual growth values around the arithmetic mean. Based on standard deviation, the coefficient of variation is calculated – a dimensionless measure of relative variability that allows comparing the degree of dispersion between groups with different mean growth values.

The Shapiro – Wilk tests revealed that the distribution of the analyzed data is approximately normal. For average height, p-value = 0.5393 was obtained, for its standard deviation – 0.564, for the coefficient of variation – 0.1679. In all three cases, the Wilk coefficients are less than the critical value, and the p-value exceeds the standard significance level of 0.05, indicating no statistically significant deviations from the normal distribution.

The correlation between standard deviation and average height was studied using linear regression. The model showed a statistically significant positive correlation: the regression coefficient is 0.1179 (p-value = 0.0261). The coefficient of determination R^2 was 0.4051, and Pearson's correlation coefficient was 0.664, which means that about

44% of the variation in standard deviation is explained by the variation in average height. This indicates that groups with higher average height also have greater absolute dispersion of height values.

At the same time, there is no dependence of the coefficient of variation on average height: for a regression coefficient equal to 0.0004, p-value = 0.104, i.e., the coefficient is not significant at the 0.05 level, which confirms the validity of the null hypothesis of no dependence.

Thus, the relative variability of average height, which is characterized by the coefficient of variation CV, unlike the absolute variability (standard deviation SD), does not show a reliable linear relationship with the average height in the study groups. This is consistent with expectations for biological traits that are subject to proportional variability.

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AUTOMATED SCHEDULE PARSING AND NOTIFICATION THROUGH TELEGRAM BOT

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This article describes a Python project implementing a schedule parser and a Telegram bot that provide students and teachers with instant access to schedule data. The system automatically updates the schedule information and sends the new schedule to users if any changes occur.

Keywords: Schedule parser, Telegram bot, python.

The idea for this project arose when the schedule website periodically went down due to a large number of users. The initial concept did not include a Telegram bot; the first version featured a minimal TUI interface for retrieving schedules based on pre-saved parser data.

At the design stage, it was necessary to determine the technologies to be used. The project was initially conceived as asynchronous so that users would not have to wait long periods to receive up-to-date schedule information. The first step was to choose a storage method for the schedule data. Since the project was non-commercial and subject to frequent server migrations, Firebase and PostgreSQL were unsuitable. SQLite was selected for its open-source nature, cross-platform compatibility, and ease of use. Python was chosen as the main programming language because it efficiently handles I/O-bound tasks and provides a rich ecosystem of libraries.

An analysis of the schedule website revealed that it did not expose any hidden APIs, making it necessary to parse the HTML content directly. It also became clear that the website was built using ASP.NET.

The following libraries were used in the implementation:

1. aiohttp – for handling asynchronous HTTP requests;
2. BeautifulSoup4 – for parsing HTML and XML pages;
3. aiosqlite – for performing asynchronous queries to the SQLite database.
4. Aiogram – Telegram API

During the analysis of the site’s request flow, it became evident that reproducing a valid user session without including special keys such as __EVENTTARGET, __VIEWSTATEGENERATOR, and __EVENTVALIDATION was impossible. To retrieve the schedule, the client must follow the entire request sequence step by step, with each stage corresponding to a separate HTTP request. All special keys are embedded within the form body of the HTML page.

To determine how the data would be stored and transmitted, JSON lists were selected, where the index represents the week number. Each element of this list contains an HTML-formatted message generated by the parser from the corresponding table data.

Because the parser is resource-intensive, it operates concurrently with the Telegram bot but in a separate thread. The event loop is executed in a dedicated thread to run the parser independently, while the main thread runs the bot and manages the schedule change notification coroutine.

Source code: https://github.com/Koalko99/isei-schedule

Bot: https://t.me/isei_schedule_bot

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INVESTIGATION OF ELECTRICAL PROPERTIES AND ANTIOXIDANT ACTIVITY OF TENTOXIN

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In the present study, the electrical properties and antioxidant activity of the tetrapeptide tentoxin, derived from the phytopathogenic fungus Alternaria alternata, were investigated. Key electronic parameters of the molecule, including E_{HOMO}, E_{LUMO}, and the energy gap between the HOMO and LUMO orbitals, were analyzed. A non-empirical computational approach employing extended basis sets in an aqueous solvent environment (CAM-B3LYP/TZVP) was applied.

Keywords: electrical properties; antioxidant; *Alternaria alternata*; tentoxin.

Tentoxin, a phytotoxin produced by Alternaria species fungi, inhibits ATP hydrolysis in specific F_1 (CF_1) chloroplasts and induces chlorosis in susceptible plants. To calculate the initial geometry of the molecule, a non-empirical method employing extended basis sets (CAM-B3LYP/TZVP) within the Gaussian 09W software package was selected. The CAM-B3LYP functional-a long-range corrected hybrid functional-was chosen for its accuracy in modeling properties such as UV spectra. The TZVP basis set, a triple-zeta valence polarized atomic orbital set, was used to represent electron distribution within the molecule. To identify the global energy minimum and the most stable conformers, all stationary points on the molecule's potential energy surface were analyzed. Frontier molecular orbitals, including the highest occupied molecular orbital (HOMO) and the lowest unoccupied molecular orbital (LUMO), are key parameters in chemical reactivity. The HOMO and LUMO energy levels reflect the molecule's ability to donate and accept electrons, respectively.

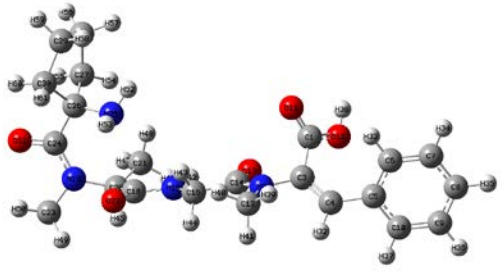

Fig.1 – 3D structure of the tentoxin

Results: Total Energy of the molecule tentoxin E (TD-HF/TD-DFT) = -1451.22.

E_{LUMO} = -0.023 eV; E_{HOMO} = -0.294 eV; E_{gap} = 0.271 eV.

Thus, the tentoxin compound exhibits notable antioxidant activity. The findings of this study highlight the potential of tetrapeptide-based compounds derived from fungal sources as promising antioxidants. Furthermore, previous investigations have reported that tentoxin also demonstrates antibiotic activity against various antibiotic-resistant strains of microorganisms.

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IN SILICO STRUCTURAL ANALYSIS OF ABC TRANSPORTERS FROM *BREVICORYNE BRASSICAE*

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We report high-quality structural models of cabbage aphid ABC transporters, generated using AlphaFold 3. These models serve as a valuable resource for future studies aimed at elucidating resistance mechanisms, discovering new insecticide targets, and designing innovative plant protection solutions.

Keywords: Bioinformatics, structural biology, phytopathogens, resistance mechanisms.

The cabbage aphid (*Brevicoryne brassicae*) is a typical pest in Belarus, which causes damage in rapeseed and cabbage crops through direct feeding, honeydew secretion, and the transmission of plant viruses. The management of these pests relies heavily on chemical insecticides; however, their efficacy is increasingly compromised by the development of robust resistance mechanisms in aphid populations. The overexpression and polymorphism of ABC transporters, which facilitate the active efflux of toxins, is a substantial part of it. Moreover, some of their specific functional and structural characteristics remain unexamined. Therefore, studying these proteins can provide the foundation for designing new control methods [1].

Computational methods have become firmly established in biology due to their frequently high, experimentally validated predictive power, coupled with significant savings in time and resources, and often a reduced environmental footprint. Structural modeling is valuable not only in its own right by providing fundamental insights into molecular features, but also serves as a critical prerequisite for molecular docking. In such docking studies, ligands can include potential insecticides or plant metabolites, aiming to identify the most effective compounds. However, the use of computational methods requires the careful selection of tools with proven effectiveness, also the results obtained must have strong statistical support and other plausibility assessments. Therefore, for our modeling, we chose AlphaFold 3, a recently developed and already proven technology from DeepMind [2].

A structural model was generated for the consensus sequence of ABC transporters involved in Phase III insecticide detoxification in the cabbage aphid. During model construction, standard settings were used with the "auto seed" option enabled. Reliability of the obtained results was assessed using several parameters: plDDT (predicted local-distance difference test), a local confidence score for the positioning of each residue; pTM (predicted template modeling score),

a global confidence score for the overall structure; and PAE (Predicted Aligned Error), a matrix representing the expected positional error (in angstroms) for each residue pair in the model..

We obtained a structural model characterized by the following high-quality parameters: The plDDT scores are distributed primarily between 70 and 90 for approximately half of the amino acid residues, indicating a confident level of support, and above 90 for the other half, reflecting a very high degree of confidence. The pTM score of 0.82 is considered excellent. The predicted aligned error (PAE) matrix is predominantly dark green, signifying low expected positional error in those regions. The distinct squares along the diagonal can be interpreted as individual domains, with the lighter areas between them likely corresponding to flexible linkers or hinges. Visually, architecture of the model displays a cylindrical shape, consistent with the canonical structure of ABC transporters as a class of integral membrane proteins.

Overall, this high-confidence model is suitable for detailed structural analysis, characterization of protein features, and subsequent molecular docking studies.

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MOLECULAR DOCKING STUDY OF MENIN

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This study employed molecular modeling to establish theoretical models of complexes formed between DA-63788, Revumenib, Emilumenib and the protein binding structure of Menin [1](PDB ID: 6BY8).

Keywords: Molecular Docking, Menin, DA-63788, Revumenib, Emilumenib.

The structure of Menin was obtained from the RCSB Protein Data Bank (PDB ID: 6BY8). Protein structure preparation was performed using the Discovery Studio software package, involving removing the native ligand and water molecules, addition of hydrogen atoms and optimization of hydrogen bonding networks and side-chain conformations.

The three-dimensional structures of the ligands (DA-63788, Revumenib, Emilumenib) were retrieved from the PubChem database. Molecular docking simulations and visualization of results were conducted using Prankweb, Molegro Molecular Viewer and PyMOL software.

To identify the active site of the protein, we used the PrankWeb server to perform an active site prediction search. Among all the predicted pockets output by PrankWeb, the top-ranked pocket was selected as the most likely active site. This pocket is located at coordinates (x, y, z): 13.2775, 7.4366, 11.5393. This site has the highest prediction score (PrankWeb score: 5.45), ranking first among all predicted sites. Inspection of this pocket showed that it contains 14 residues . Given its highest algorithm ranking and good fit with known functional regions, this pocket was used for all subsequent ligand docking studies.

After molecular docking simulation , three stable complexes with significantly different binding properties were obtained, varying in affinity, interaction networks, and key residues involved. All detailed energy and interaction data summarized in Table.

Table

Quantitative Comparison of Molecular Docking Results of 3 Ligands with Menin complex

Ligand	DA-63788	Revumenib	Emilumenib
Energy (kcal/mol)	-8.236	-7.516	-7.450
MolDock Score	-144.433	-128.489	-142.530
H-Bond Count	2	4	4
H-Bond Residues	SER 178 , TYR 276	ASN 282, SER 155, HIS 181, GLN 260	TYR 323, TYR 323, TYR 276, SER 155
Steric interactions	SER 155, LEU 177, MET 278, LEU 177	ALA 242	TYR 323, TYR 319, CYS 241, TYR 323, ASN 282, TYR 276

Molecular docking results showed that all three ligands formed stable complexes with the Menin protein, but their binding modes and interaction characteristics differed significantly. In terms of overall binding stability, DA-63788 exhibited the best predicted binding affinity, with the highest MolDock Score (-144.433) and binding energy (-8.236 kcal/mol) among the three, suggesting it may be the most thermodynamically favorable binder. Emilumenib's MolDock Score (-142.530) was similar, but its binding energy (-7.450 kcal/mol) was slightly lower than that of DA-63788. Revumenib was the weakest in both energetic metrics.

Regarding key interactions, Revumenib and Emilumenib each formed four hydrogen bonds, surpassing DA-63788, which formed only two hydrogen bonds. However, DA-63788 likely achieves its high stability through more extensive hydrophobic interactions and steric complementarity, as evidenced by its steric interactions with multiple residues (SER 155, LEU 177, and MET 278). Notably, emilumenib forms a double hydrogen bond with residue TYR 323 and makes dense steric contacts with multiple residues, including TYR 323 and TYR 319, demonstrating a highly localized binding mode.

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IN SILICO AND DFT INVESTIGATION OF MOLECULES PREVENTING INSULIN AGGREGATION IN TYPE II DIABETES

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The purpose of this paper is to describe the results of coupling phorbol with target insulin receptor proteins.

Keywords: Diabetes, docking, natural antioxidant, bioactivity, Michaelis – Menten constant.

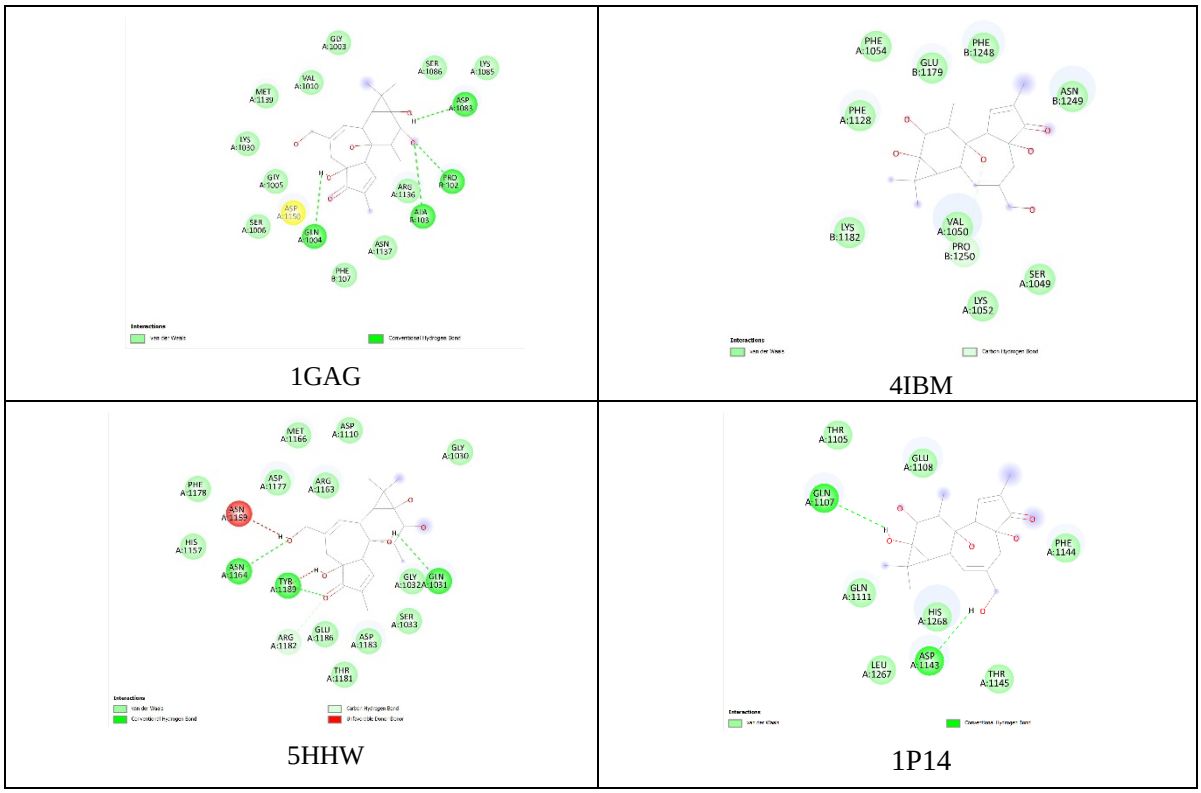
The accumulation of insulin in amyloid fibrils poses a serious problem in the treatment of type II diabetes, reducing the effectiveness of insulin therapy. During the study, a molecular coupling of 23 prospective compounds was carried out. Important aspects were good permeability through the membrane, comparison of six physicochemical parameters for peroral bioavailability - size, polarity, lipophilicity, solubility, saturation and flexibility for structures with equivalent deviations from Lipinsky's rules [1]. The only substance that does not destroy and interact with cytochromes is phorbol.

Molecular coupling of phorbol with target proteins (ID PDB: 1GAG, 4IBM, 5HHW, 1P14,) indicates that the chosen structure forms with targets thermodynamically stable complexes with Δg -8.0, -8.6, -9.0 and -9.6 kcal/mol. Constantine

of Michaelis – Menten (Km), reflecting the affinity of the enzyme to the substrate for complexes equal to 1.37, 0.50, 0.25 and 9.16 10^{-5} mkM (table).

Table

Molecular docking interactions of phorbol displaying amino acid residues with target proteins



Since phorbol also does not interact with any cytochrome isoform P450, we can conclude that phorbol prevents the breakdown of insulin protein and thus combat the problem of type II diabetes.

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SYNTHESIS OF 8-BROMO DERIVATIVES OF PURINE NUCLEOSIDES

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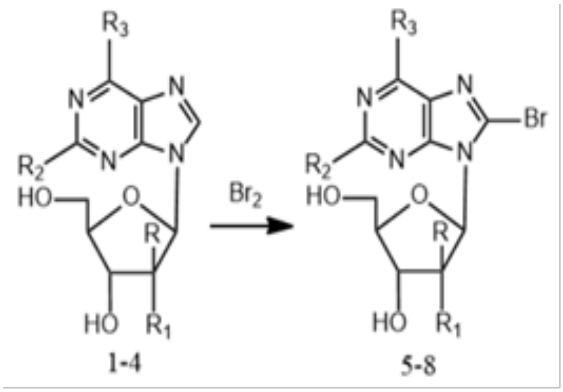
8-Bromo derivatives of purine nucleosides are used to obtain 8-substituted derivatives with diverse biological activity [1]. The most common reagents for obtaining such compounds include a solution of bromine in various solvents [2]. The aim of this research is to investigate the influence of the medium on the efficiency of the bromination reaction of adenosine **1**, guanosine **2**, arabinofuranosylguanine **3** and fludarabine **4** with a bromine solution in water using a 0.1 M solution of KH2PO4 pH 4.5 and a 0.1 M solution of H3BO3 pH 5.3 as the medium.

Keywords: Purine nucleosides, bromination reaction.

The synthesis of 8-bromo derivatives of purine nucleosides **5–8** was carried out according to the scheme shown in the figure



№	R	R_1	R_2	R_3
1, 5	H	OH	H	NH_2
2, 6	H	OH	NH_2	OH
3, 7	OH	H	NH_2	OH
4, 8	OH	H	F	NH_2

Fig. - Scheme of synthesis of 8-bromo derivatives of purine nucleosides

The progress of reactions and the content of the initial compounds **1–4** and reaction products **5–6** in the reaction medium were monitored using thin-layer chromatography on Kieselgel 60 F254 plates from Merck (Germany) in a solvent system of chloroform/methanol (4:1 v/v). Compounds on the plates were visualized by viewing them under ultraviolet light and by wetting the plate with a 0.2% solution of nafluoresorcinol in alcohol with the addition of a 20% sulfuric acid solution in a 1:1 ratio, followed by heating the plate at 80–90°C. Spots representing the reaction products and the starting compounds were colored differently.

The general technique of the bromination reaction was to obtain a suspension of 1 g of the starting compound in an appropriate solvent. During intensive stirring with a magnetic stirrer in a fume hood, a pre-obtained bromine solution in water in an amount of 1.2 equivalent to the initial nucleoside was added to the resulting suspension in portions. Each new portion of the bromine solution was added to the suspension after discoloration of the previously added bromine solution. After adding the last portion of the reagent, the resulting reaction mixture was stirred for 8 hours at room temperature in the case of guanine derivatives **2** and **3**, and for 48 hours in the case of adenine nucleosides **1** and **4**. During this period, the color of the suspension became lighter. A saturated solution of sodium bisulfite was added to the suspension to restore the excess bromine and to discolor the solvent. The precipitate from the reaction mixture was filtered in a vacuum of a water jet pump on a glass Schott filter and washed with a sodium bisulfite solution diluted and cooled in an ice bath, then cooled to 0–4°C with distilled water and acetone. The resulting precipitate was dried in air at room temperature to a constant weight. The yield of the reaction products was 30–70% based on the initial nucleoside. Preliminary results indicate a multidirectional effect of the solvent type on the yield of 8-bromine derivatives of purine nucleosides. To increase the purity of the products, they were recrystallized from a hot mixture of ethyl alcohol and water in a ratio of 1:1.

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HUMO AND LUMO ZONES OF CHALCON DERIVATIVE ANALYSIS

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Annotation. This article presents the results of quantum-chemical modeling of HOMO and LUMO zones of a chalcone derivative.

Keywords: HOMO and LUMO zones, chalcone derivatives, quantum-chemical modeling, antioxidant activity.

Chalcone derivatives and their heterocyclic analogs, such as dihydropyrimidines, are of significant interest due to their broad spectrum of biological activity, including antioxidant, anti-inflammatory, and antitumor properties [1]. The electronic structure of a molecule, particularly the energy of the highest occupied (HOMO) and lowest unoccupied (LUMO) molecular orbitals and band gap (Eg), is a key parameter determining reactivity and the mechanism of interaction with biological targets [2].

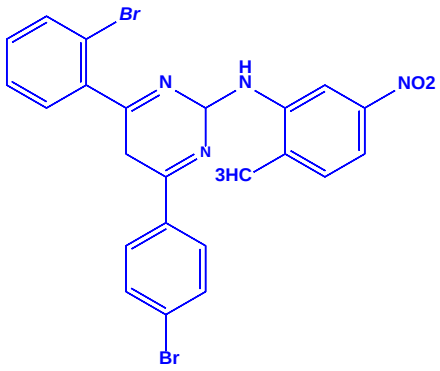

Fig. ~~1~~ - 4-(2-bromophenyl)-6-(4-bromophenyl)-N-(2-methyl-5-nitrophenyl)-2,5-dihydromeperidine-2-amine

For the initial investigation of the electronic properties of the derivative, the molecular modeling ChemOfficeBio 2016 software was used (Fig). The molecular geometry was optimized, after which the molecular orbital energies were calculated (Table).

Table

Structure and physical-chemical properties of the derivative

E_T, kcal/mol	E_{HOMO}, eV	E_{LUMO}, eV	E_g, eV
22.0790	-7.498	-5.178	2.320

The data obtained in the Table indicate that the band gap of the molecule is 2.320 eV, which suggests its high antioxidant activity.

Thus, the conducted study demonstrates that the synthesized chalcone derivative is a promising compound with pronounced antioxidant activity, which opens up possibilities for its further, more detailed study as a potential drug.

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MOLECULAR DOCKING OF PHE-GLY-GLY TRIPEPTIDE WITH HUMAN NICOTINIC A4B2 RECEPTOR ID:5KXI

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In this study, the interaction of the tripeptide Phe-Gly-Gly with the human nicotinic α4β2 receptor (PDB ID: 5KXI) was investigated using molecular docking. The binding energy was calculated and the main interactions in the receptor's active site were characterized. The obtained data define the studied peptide as a promising object for further research aimed at creating new pharmacological approaches to the treatment of nicotine addiction.

Key words: molecular docking, nicotine addiction, tripeptide, α4β2-nAChR.

Developing new, effective treatments for nicotine addiction is a key challenge in modern pharmacology. Current medications, such as varenicline, have limited efficacy and are associated with side effects. In this regard, the search for new peptide ligands targeting α4β2-nicotinic acetylcholine receptors (nAChRs) is relevant.

Molecular docking was performed with the tripeptide Phe-Gly-Gly (figure) and the crystal structure of human α4β2-nAChR (PDB ID: 5KXI) [1].

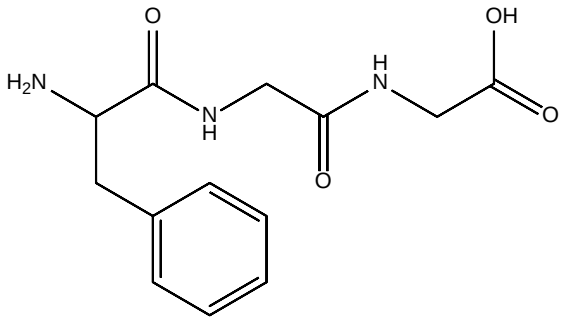

Fig. – 2D-Structural formula of a tripeptide Phe-Gly-Gly

The Score value for the tripeptide was -7.3, which is lower than that of nicotine (-5.7) and indicates the likelihood of forming a thermodynamically stable complex [2]. The total energy of the peptide-receptor complex is -79.302 kcal/mol. The tripeptide forms stable interactions with amino acid residues Ser 272, Lys 53, Thr 273, Gln 55, and Tyr 212 of the receptor's active site, including the key residue Glu 1770, which ensures selectivity and binding strength.

The tripeptide Phe-Gly-Gly exhibits high affinity for α4β2-nAChR, with a binding energy superior to that of nicotine. These results suggest this peptide may be a promising candidate for developing a new, effective treatment for nicotine addiction.

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COMPARATIVE ANALYSIS OF PHASE II GENES OF THE PROCESS OF BIOTRANSFORMATION OF XENOBIOTICS IN THE GENOMES OF APHIDS WITH DIFFERENT FOOD SPECIALIZATION

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In this study, a comparative analysis of phase II detoxification system genes in monophagous, oligophagous, and polyphagous aphids. The analysis of the total number of detoxification genes did not show a statistically significant increase in the number of UGT and GST genes in polyphagous species compared to oligophagous ones. The positive correlation for UGT2B33 and high intragroup variability suggest that resistance to xenobiotics is determined by the functional differentiation of gene families.

Keywords: aphids, detoxification systems, UGT genes, GST genes, monophages, oligophages, polyphages

Aphids (Aphididae) are agricultural pests and vectors of plant viral infections. The primary method for their control is the use of insecticides; however, aphids rapidly develop resistance. A key mechanism of this resistance is associated with UDP-glucuronosyltransferase (UGT) and glutathione S-transferase (GST) enzymes, which are involved in the phase II detoxification of xenobiotics. According to one model, aphid resistance to insecticides is explained by gene

copy number variation: polyphagous species have a higher number of detoxification gene copies than monophagous species.

For the comparative analysis, genomic data on the number of UGT and GST genes from 6 aphid species, obtained by the staff of the Student Research Laboratory of Animal Bioinformatics and Molecular Evolution, were used. Additionally, data for 6 aphid species were extracted from the NCBI RefSeq database. The aphids were then classified into three trophic groups: polyphages (*Aphis gossypii* (GCF_020184175.1), *Myzus persica*e, *A. craccivora*), oligophages (*Acyrthosiphon pisum* (GCF_005508785.1), *Diuraphis noxia* (GCF_001186385.1), *Melanaphis sacchari* (GCF_002803265.2), *Macrosiphum rosae*, *Brevicoryne brassicae*, *A. glycines*, *Sipha flava* (GCF_003268045.1), *Rhopalosiphum maidis* (GCF_003676215.2)), and monophages (*M. albifrons*).

Due to the presence of outliers, asymmetric data distribution, and the limited sample size (n = 3 for polyphages, n = 8 for oligophages, n = 1 for monophages), non-parametric tests were used: the Kruskal – Wallis test and the Mann – Whitney U test. For UGT genes, the distribution across subfamilies was analyzed; for GST genes, the total number of genes was analyzed since the data from the genetic database were not annotated at the subfamily level. The presence of a correlation was tested using Spearman's coefficient (ρ). The level of statistical significance for all tests was set at $p < 0,05$.

Statistical analysis did not reveal significant differences in the total number of UGT genes between polyphages and oligophages (H = 0,129; p = 0,719). Polyphages had on average (M ± SD) 64,0 ± 2,65 UGT genes, while oligophages had 58,63 ± 14,11. At the level of individual subfamilies, a significant difference and a strong positive correlation were found only for UGT2B33 (ρ = 0,8091; p = 0,0014). For GST genes, no significant differences (M ± SD) were found between polyphages (13,00 ± 7,26) and oligophages (11,50 ± 5,10) (H = 0,011; p = 0,918). Quantitative analysis of the single monophagous representative (*M. albifrons*) showed values of 79 UGT genes and 14 GST genes, which exceed the average values for both polyphages and oligophages.

Thus, there are no differences in the total number of UGT and GST genes between polyphages and oligophages, which may indicate more universal functions of the UGT and GST gene families. However, a significant positive correlation was identified between feeding specialization and the number of genes in the UGT2B33 subfamily, which may indicate a potential role of this family in adaptation to a wide range of host plants and insecticides through an increase in gene copy number. It can be assumed that the key role in the adaptation of aphids to a wide range of host plants and the detoxification of xenobiotics is played by the functional specialization of specific subfamilies, rather than the total number of genes.

REGULATORY REGIONS MAPPING IN THE GENOME OF PRIMARY ENDOSYMBIONT OF *MACROSIPHUM ROSAE – BUCHNERA APHIDICOLA*

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The upstream regions in the genome of *Buchnera aphidicola*, an obligate intracellular symbiont of aphids, were analysed. The results for two loci (*mdlB, yheI*) include a list of operators with their coordinates and localisation on DNA strands, which allows us to form a sample of potential binding sites for transcription factors in the genome of *B. aphidicola*.

Keywords: transcription factor binding sites, Buchnera aphidicola, Escherichia coli

Buchnera aphidicola is an obligate intracellular symbiont that may contribute to more efficient transformation of substances in the aphid organism, which entails increased resistance to currently used insecticides. The proteins *mdlB* and *yheI* belong to the ABC-transporter superfamily and are potentially involved in the detoxification of xenobiotics by aphid endosymbionts [1].

The previously assembled *B. aphidicola* genome of the *M. rosae* lineage was annotated for the present study. Operator sites of transcription factors known in Enterobacteriaceae to be key regulators of stress response and multidrug resistance were searched. The study included the operator sites *ArcA, BaeR, CpxR, FNR, LexA, MarA, Rob and SoxS*, which provide within *E. coli* regulatory networks a link between metabolic status, stress signalling and activation of genes that play a key role in the formation of multidrug resistance. Ready-made position-weighted matrices from the RegulonDB database, constructed for E. coli as the closest of the detailed characterised relatives of *B. aphidicola*, were used to search for operator sites. A script was written in the Python programming language, using Biopython modules and the pandas library, to extract fixed upstream regions by coordinates from the annotation file (the reverse complementary sequence was obtained for the minus chain). Upstream sequences were scanned using the FIMO utility. For each motif, a single position with minimal q-value was retained, since prioritisation by q-value reduces redundancy and generates a reliable set of candidates for subsequent experimental validation. The final list of unique operators was generated for each gene under study (Table).

Table

Regulatory sites of analyzed genes

Gene	Motif identifier	Start	End	Strand	Q-value	Matched sequence
mdlB	*ArcA*	29370	29385	+	0.00107	TTAAAAAATTTATTAC
yheI	*ArcA*	31156	31171	-	0.00257	TTAGCATTTTTTTTAC
	BaeR	31178	31195	+	0.0219	TTTTTTTTTCCATGGTAT
	FNR	30994	31010	+	0.00324	TTTGAAAATAATTAAAA
	LexA	31013	31032	+	0.00926	AACTGCTAATATTTGCAGCA
	Rob	31194	31210	+	0.0311	ATTGCATAAATTATTAA

During the analysis of the upstream regions of the *mdlB* and *yheI* genes in the *B. aphidicola* lineage of *M. rosae*, unique operator regions were identified that correspond to potential binding sites for transcription factors of stress response regulatory genes and multidrug resistance genes. The obtained results indicate the presence of conservative elements of the regulatory system in *B. aphidicola*, potentially involved in the control of the expression of the genes under study. This suggests that *B. aphidicola* may contribute to the development of aphid resistance to insecticides by regulating active transport systems. This approach demonstrates the effectiveness of using positional weight matrices of transcription factors from model bacterial species for annotating regulatory elements in endosymbiont

PHYSICOCHEMICAL AND BIOLOGICAL PROPERTIES OF METFORMIN

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In this study quantum-chemical modeling of metformin, electronic properties of molecules such as E_{HOMO}, E_{LUMO} and energy gap between LUMO and HOMO have been investigated. A preliminary quantum-chemical simulation of a drug of the biguanide class was carried out using the MM^+ method of molecular mechanics.

Keywords: metformin, molecular modeling, antioxidant activity, diabetes mellitus.

Metformin [Fig.] is a synthetic analogue of guanidine due to its ability to reduce glucose levels by reducing gluconeogenesis and insulin resistance [1]. Metformin is a first-line therapy for type 2 diabetes mellitus. In addition to its antihyperglycemic properties, metformin has many health benefits. For example, the benefits of metformin therapy for weight loss have been proven. This mechanism helps protect cells from damage caused by oxidative stress and improves endothelial function, reducing the risk of vascular complications in diabetes mellitus.

When calculating the initial geometry of a molecule, the method of molecular mechanics (MM^+) of the ChemOffice 2016 software package was chosen. The choice of the MM^+ method is justified by the fact that it was developed for

organic molecules, takes into account the potential fields formed by all atoms of the calculation system, and allows you to flexibly change the calculation parameters depending on the specific task. To find the global minimum energy and the most stable conformers, all fixed points on the surface of the potential energy of the molecules were analyzed. Boundary molecular orbitals, including HOMO and LUMO orbitals are important parameters in chemical reactions. The energies of HOMO and LUMO illustrate the ability to give an electron and receive an electron, respectively [2].

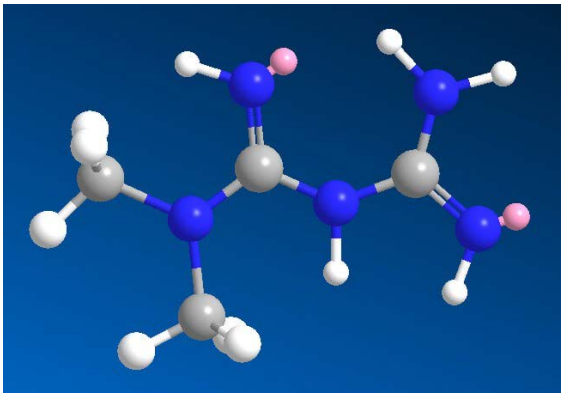

Fig. – Computer model of metformin

Results: total energy of the compound 6.8208 kcal/mol; E_{LUMO} = 8,000 eV; E_{HOMO} = -9,963 eV.

The data obtained as a result of the study opens up wide opportunities for improving metformin treatment methods.

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VIRTUAL SCREENING OF MURA INHIBITORS BY MOLECULAR DOCKING

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This article describes the discovery of novel inhibitors targeting MurA through molecular docking-based virtual screening.

Keywords: MurA, Virtual screening, Molecular Docking.

In recent years, the widespread emergence of drug-resistant bacterial strains due to antibiotic abuse has become a major threat to human health, making the development of antibacterial drugs with novel mechanisms of action urgently needed. MurA enzyme is indispensable for bacterial cell wall synthesis, serving as a promising target for new antibiotic discovery. Fosfomycin, an inhibitor of MurA enzyme, exerts targeted inhibition by forming an interaction with the active site of MurA [1]. We conducted virtual screening of fosfomycin analogs for MurA inhibition to identify molecules with potential enhanced inhibitory activity.

The 100-molecules with structures similar to fosfomycin were collected from the ZINC database and processed using the Prepare or Filter Ligand module in Discovery Studio 2019 (DS). MurA (PDB ID: 1UAE) was downloaded from the PDB Bank and subsequently processed using the Prepare Protein module in DS. After processing, a spherical active pocket was generated at Cys115 using the Define Binding Site function in the Receptor-Ligand Interactions module. Molecular docking was performed using the LibDock module in DS. The results are presented in Table and Figure. Compound 33 (SMILE: CC1[NH]C(=O)C(NCC2NC3CCCCC3O2)CC1[C@@H](C)O), with the highest LibDock score, was selected for comparison with fosfomycin.

Table

Molecular docking results

Compound	Absolute energy / (kJ · mol⁻¹)	Relative energy / (kJ · mol⁻¹)	LibDock score
Compound 33	65.6	9.6	112.2
Fosfomycin	1.59	1.72	63.3

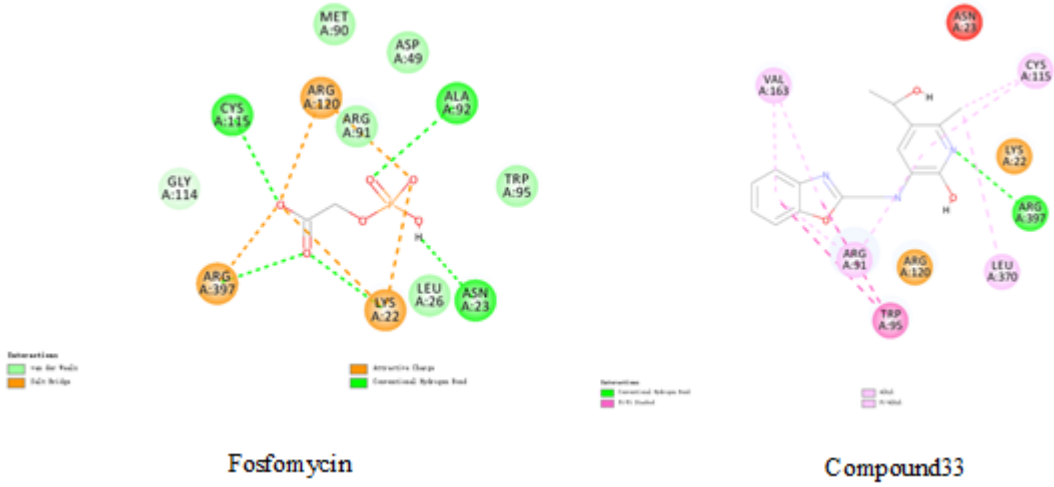

Fig. 1 - Molecular Docking 2D Image

Molecular docking results showed that Compound 33 formed hydrogen bonds with ARG397 and hydrophobic interactions with TRP95, VAL163, and CYS115. In contrast, fosfomycin formed hydrogen bonds with CYS115 and ASN23, van der Waals forces with MET90 and TRP95, and salt bridges with ARG (120, 397) and LYS 22. Although Compound 33 exhibited higher absolute and relative free energies (indicating lower stability) compared to fosfomycin, it formed more binding interactions and achieved a higher score, which is beneficial for binding.

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APPLICATIONS AND ADVANCES OF DEEP LEARNING IN DRUG DISCOVERY

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This article discusses the research progress of deep learning in drug discovery, mainly covering molecular generation, conformation prediction, and binding affinity evaluation.

Keywords: Deep Learning, Drug Discovery, Artificial Intelligence

Artificial intelligence(AI) is profoundly transforming the field of drug discovery, serving as a key solution to the high cost and long cycle of traditional small-molecule targeted drug discovery. As a subset of AI, deep learning(DL) is a technology that analyzes and learns from large volumes of data through multi-layer processing units. It exhibits remarkable advantages in molecular generation, conformation prediction, binding affinity evaluation, paving new paths for drug design[1].

In the field of molecular generation, the chemical space of organic molecules is enormous, making traditional methods inefficient. Generative DL models (RNNs and GANs) generate new structures by learning the distribution of molecular data; early models were trained with SMILES strings as input, but their applicability is limited due to the lack

of permutation invariance and 3D information. Molecular graph representation is more advantageous models,like Pocket2Mol and LiGAN can generate molecules within protein binding pockets, intuitively demonstrating interactions, though their performance relies on high-quality training data[2].

3D molecular conformation is one of the crucial features determining many physical, chemical, and biological properties of molecules. Traditional methods exhibit poor performance in terms of accuracy and computational efficiency. DL have been introduced into conformation generation to address this issue . ClofNet can directly manipulate molecular conformations and has been applied in AlphaFold. In the prediction of complex conformations, models such as DeepDock and EquiBind achieve rapid and accurate generation of protein-ligand binding conformations through geometric learning and other approaches, thereby improving the efficiency of virtual screening[3-5].

Binding affinity prediction is a crucial step in drug research and development. Traditional methods such as molecular docking and pharmacokinetic simulation have high computational costs, which limit the efficiency and speed of drug discovery. DL have been applied in the field of drug-target binding affinity prediction. Initially, AtomNet predicted molecular binding using Convolutional Neural Networks (CNNs)[6]. Pafnucy, another CNN model, predicted the binding affinity between proteins and ligands through 3D CNNs, but it had problems such as high computational cost and direction sensitivity. Graph convolutional networks proposed by Gomes and Lim have achieved better performance in prediction[7].

Nowadays, DL has become an indispensable tool in drug discovery, with significantly improved speed and efficiency that enhance the accuracy of drug-related predictions, optimize virtual screening, and expand applications to aid in discovering new drug targets.

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STRUCTURAL MODELING OF AN ABC TRANSPORTER IN *MYZUS PERSICAE*

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Here we report the structural modeling of an ABC transporter protein based on a consensus amino acid sequence from the aphid Myzus persicae.

Keywords: detoxification system, aphids, protein modeling.

The green peach aphid, Myzus persicae, is a widespread pest that feeds on numerous plants, including fruit trees and agricultural crops. It is known that M. persicae possesses high adaptability to environmental changes and chemical exposure.

One method of controlling insect pests relies on the use of pesticides; however, as a result of evolutionary adaptations, insects have developed resistance to chemical compounds. One mechanism of adaptation to insecticides is the altered expression of ABC transporter proteins, which are responsible for expelling toxins from cells during the third phase of xenobiotic detoxification.

A dataset of 49 amino acid sequences of ABC transporters from a Belarusian M. persicae population was compiled from whole-genome sequencing data generated by the Laboratory of Bioinformatics and Molecular Evolution of Animals. A consensus protein sequence was then constructed. Three-dimensional structural modeling of this consensus ABC transporter was performed using AlphaFold v2.3.2 on the Google Colab Pro platform with GPU acceleration. Multiple sequence alignments were generated with the UniRef90 and BFD databases. Modeling was carried out in the standard AlphaFold mode with three relaxation cycles and the high-accuracy option enabled. Model quality was evaluated using the built-in metrics pLDDT (predicted Local Distance Difference Test) and PAE (predicted Aligned Error). The pLDDT color scale indicates prediction confidence: blue and cyan regions correspond to high and very high confidence, whereas yellow, orange, and red regions indicate lower reliability.

The resulting structural model exhibits a cylindrical architecture typical of the ABC transporter family. The nucleotide-binding domains, composed of small β-sheets and conserved motifs (Walker-A, Walker-B, LSGGQ), are predominantly blue, reflecting high confidence in their spatial organization. The transmembrane domains consist of two types of α-helices: the first form a cylindrical channel and are colored blue and cyan, while the second group, rendered in yellow and red, suggests structural variability and reduced confidence. The pLDDT profile shows a decline in confidence after residue 250, likely corresponding to a flexible linker region that acts as a hinge, undergoing conformational changes during ATP binding or hydrolysis. Overall, the consensus M. persicae ABC transporter model demonstrates strong statistical support and offers a reliable structural framework for downstream applications, including molecular docking and functional analyses.

QUANTUM-CHEMICAL MODELING OF THUJOL FROM *ARTEMISIA ABSINTHIUM* L. ESSENTIAL OIL BY THE SEMI-EMERIC METHOD PM6

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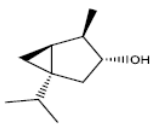
Artemisia Absinthium L. essential oil contains 15–25% thujol. Thujol is a monoterpene alcohol with antiseptic activity.

The aim of this study was to optimize the structure of thujol and obtain its thermodynamic parameters and UV spectral characteristics [1].

Keywords: Artemisia absinthium, tuyol, quantum chemical modeling, PM6 method.

Table

Structural formula and thermodynamic parameters of thujol calculated by the PM6 method

Structural formula of thujol	$E_{(THERMAL)}$ kcal/mol	CV Cal/Mol-kelvin	S Cal/Mol-kelvin
	158,539	48,496	110,209

The PM6 method was used to optimize and determine the thermodynamic parameters of thujol. The following results were obtained: thermal energy = 158.539 kcal/mol, heat capacity at constant volume = 48.496 cal/mol-Kelvin, and entropy = 110.209 cal/mol-Kelvin (table).

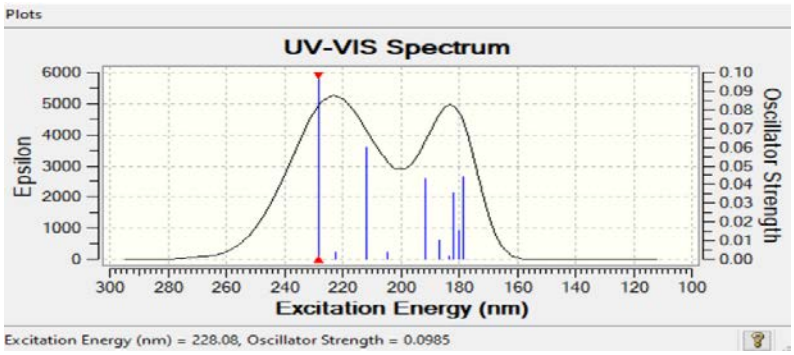


Fig. – Visualization of the UV spectrum of thujol

Gaussian View 15 was also used to visualize the UV spectrum of thujol. In this case, the most strength excitation energy of the molecule was 228.08 nm, and the oscillator strength = 0.0985 (Figure).

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PHYSICOCHEMICAL PARAMETERS AND ANTIOXIDANT ACTIVITY STUDY OF ARTEMETIN FROM THE MEDICINAL PLANT ARTEMISIA ABSINTHIUM L. BY IN SILICO METHOD

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The search for plants with a large number of secondary metabolites and a broad spectrum of pharmacological properties is a pressing issue. One such plant is *Artemisia absinthium* L., which synthesizes biologically active substances that are of great interest for experimental and clinical research.

The aim of this work was to study the physicochemical parameters and antioxidant activity of the flavonoid artemetin in *Arhemisia absinthium* L. using the *in silico* method [1].

Key words: Artemisia absinthium, antioxidant properties, artemetin, chemical modeling, MM2.

During the study, we created a 3D model of the chemical compound artemetin, and used the Compute Properties method and the MM2 method (Figure).

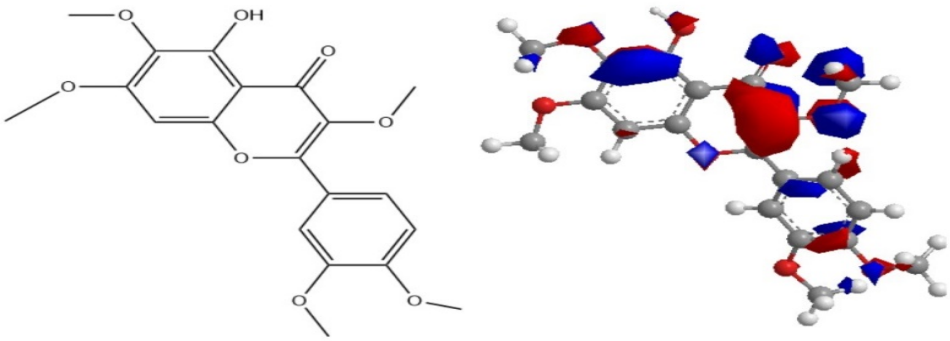

Fig. – Structural formula of artemetin (A) and 3D model with visualization of electron clouds (B)

The Compute Properties method showed the following values for artemetin: molecular formula C20H20O8, molecular weight = 388.37 Da, boiling point = 785.132 K, melting point = 792.22 K, critical temperature = 970.85 K, critical pressure = 196.458 bar, Gibbs free energy = -527.08 kJ/mol, number of single bonds 6.

Using the MM2 method, we found that the total energy (ETOTAL) = 55.7830 kcal/mol, the energy of the highest occupied molecular orbital (EHOMO) = 9.990 eV, the energy of the lowest unoccupied molecular orbital (ELUMO) = 3.989 eV, and the band gap width of artemetin was 6.052 eV, which allows it to be classified as a strong antioxidant.

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DOCKING OF C-MET PROTEIN WITH CABOZANTINIB ZGWATINIB AND TIVANTINIB

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This study employed molecular modeling to establish theoretical models of complexes formed between Cabozantinib, Zgwatinib,Tivantinib and the crystal structure of c-Met (PDB: 3CD8).

Keywords: Molecular Docking, c-Met,Cabozantinib, Zgwatinib,Tivantinib

The structure of c-Met was obtained from the RCSB Protein Data Bank. Protein structure preparation was performed using the Discovery Studio software package, involving removing the native ligand and water molecules, addition of hydrogen atoms and optimization of hydrogen bonding networks and side-chain conformations.

We used the PrankWeb server to perform an active site prediction search. Among all the predicted pockets output by PrankWeb, the top-ranked pocket was selected as the most likely active site. This pocket is located at coordinates x, y, z = 20.9361, 11.3708, 57.0817. This site has the highest prediction score (PrankWeb score: 12.29), ranking first among all predicted sites. Inspection of this pocket showed that it contains 18 residues.

To identify the probable ligands that can be docking to c-Met we used the Prankweb and PubChem server to search for the structure of inhibitor or inducer ligands (Cabozantinib, Zgwatinib [1], Tivantinib), then perform molecular docking and display the results the table below.

Table

Quantitative Comparison of Molecular Docking Results of Ligands with c-Met

Ligand	Cabozantinib	Zgwatinib	Tivantinib
ΔG (kcal/mol)	-8.803	-10.593	-10.927
MolDock Score	-132.495	-142.971	-137.920
H-Bond Count	1	0	1
H-Bond Residues	Asp1222		Arg1086
Steric Contacts	Gly1163, Tyr1230, Ang1208	IIe1084, Tyr1230, Arg1208 Met1211, Asp1222, Asn1209, Cys1210	Arg1208, Asp1164, Asn1167

The docking results demonstrate that all three ligands form stable complexes within the ATP-binding pocket of c-Met, yet exhibit significant differences in their binding modes. Tivantinib displayed the strongest predicted binding affinity (-10.927 kcal/mol) but the stability of the combination (-137.920) is not as strong as Zgwatinnib, followed by Zgeatinib (-10.593 kcal/mol) and the most favorable MolDock Score (-142.971). Also it doesn't have H-Bonds. This

indicates that it is the thermodynamically most unstable adhesive among the three ligands. This was followed by the natural inhibitor Cabozantinib (-8.803 kcal/mol), MolDock Score (-132.495) is also the lowest.

In MolDock Score Zgwatinib has the highest value and is the ligand with the most stable contact points with c-Met, but in has only 7 steric contacts with the protein. Tivantinib is the ligand with the strongest binding affinity. Cabozantinib also has hydrogen bonding networks that can bind to protein, but their strength is relatively weaker than Tivantinib.

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BIOLOGICAL ACTIVITY OF THE OF DEHYDROCOSTUS LACTONE COMPOUND

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In this work, the biological activity of the compound of Dehydrocostus lactone (DL) was investigated using the semi-empirical method PM6 of Gaussian 09 W software package [1]. DL is a sesquiterpene lactone found in plants of the genus *Saussurea* and has various biological activities, including antibacterial and antioxidant properties. The electrical properties of a molecule in a vacuum environment have been calculated.

Ключевые слова: дегидрокостус лактон, биологическая активность, полуэмпирический метод PM6.

Dehydrocostus lactone (DL) is an organic compound belonging to the class of Guaiane-type sesquiterpene lactones and found in *Saussurea Costus*, which is the most well-known species of the genus *Saussurea* [2]. The 2D image and optimized molecular structure of MM2 DL are presented in Figure 1 and 2, respectively.

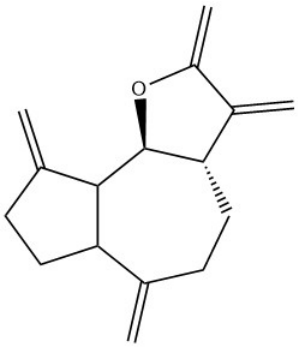

Fig. 1. 2D DL image

Fig. 2. Optimized DL structure

The molecule was further optimized using the semi-empirical PM6 method of the Gaussian 09W software package until the global minimum of the total energy of the system under study was reached. To study the biological activity, the energies of the highest occupied (HOMO) and lowest unoccupied (LUMO) molecular orbitals were calculated, as well as the forbidden gap width (E_g=E_{LUMO}-E_{HOMO}) to assess the presence or absence of biological activity.

Table

Electrical properties of DL molecule

E_T, kcal/mol	E_{LUMO}, eV	E_{HOMO}, eV	E_g, eV
197,843	0,00975	- 0,33176	0,34151

The forbidden band width of the compound, 0.34714 eV, indicates that the DL compound has high biological activity, including antioxidant activity (table).

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COMPARATIVE ANALYSIS OF THE NUCLEOTIDE COMPOSITION IN THE MITOCHONDRIAL GENOMES OF *ACYRTHOSIPHON CARAGANAE* AND *BREVICORYNE BRASSICAE*

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This article presents the results of calculating the nucleotide composition of the mitochondrial genomes of *Acyrthosiphon caraganae* and *Brevicoryne brassicae*.

Keywords: mitochondrial genome, nucleotide composition, aphids.

Representatives of the Aphid superfamily (Aphidoidea) are widespread pests of agricultural and ornamental crops on the territory of the Republic of Belarus [1]. Mitochondrial genomes are important objects in evolutionary research, which can potentially be a source of information for developing measures for quick identification and prevention of pest invasions.

The mitochondrial genomes of *Acyrthosiphon* caraganae [MW724715] and *Brevicoryne brassicae* [MW267824] were extracted, assembled, and annotated by the authors and collaborators of the SSRL of Bioinformatics and Molecular Evolution of Animals. The nucleotide composition was calculated using the MEGAX program [2].

The nucleotide composition in the mitochondrial genomes of *A. caraganae* and *B. brassicae* is typical for the mitochondrial genomes of aphids. This is expressed in the ratio (A + T)/(G + C) > 80/20, and the richest with A+T bases are considered to be non-coding regions – the repeat region and the D-loop formation region.

Calculation of the nucleotide composition showed that the content of adenine-thymine bases in the complete mitochondrial DNA of *A. caraganae* reaches 83.6 %. The repeat region in the mitochondrial genome of *A. caraganae* is quite long for this region – 1002 bp. Analysis of the nucleotide composition also confirms that the repeat region is the most saturated with adenine-thymine bases in the mitochondrial genome (86.8 %). The D-loop formation region in the mitochondrial genome of *A. caraganae* is slightly shorter than the typical size of aphids and consists of 447 bp, but the A+T composition in this region is characteristically high (85.2 %). The results of the analysis of the nucleotide composition of the mitochondrial genome of *B.brassicae* showed that the content of adenine-thymine bases in this mitochondrial genome reaches 84.0 %. In the mitochondrial genome of *B. brassicae*, the length of the repeat region was 578 bp, and it consists of 3 large pairs (195, 195, and 123 bp) of tandem repeats. The region is saturated with adenine-thymine bases (86.5 %). The D-loop formation region in the mitochondrial genome of *B. brassicae* consists of 675 bp, the content of adenine-thymine bases was 86.7 %.

The A+T content of individual protein-coding and tRNA genes was also calculated. It was found that the content of A+T in all mitochondrial genomes varies significantly depending on the functional region. Among the protein-coding regions, the *Cox1* gene has the least amount of A and T – 76.24 % in *A. caraganae* and 76.99 % in *B. brassicae*. On average, all subunits of mitochondrial cytochromes had a lower level of A+T content than in the genes encoding the

ATP synthase and NADH subunits. The highest number of A+T nucleotides was found in the protein-coding gene *Atp8* in both mitochondrial genomes of aphids (88.05 % in *A. caraganae* and 92.67 % in *B. brassicae*). Generally, the control region (D-loop) and especially the repeat region in insect mitochondrial genomes are generally considered to be the richest in A+T. However, the content of A+T in these functional parts in mtDNA was lower than the average content in the *Atp8* gene and several tRNA genes, such as *tRNA*, *trnC*, *trnE*, *trnG*, *trnH*, *trnL* (past NADH1), *trnP*, *tRNS* (past trnN), *trnT*, *trnW*, *trnV* and *trnF*. The mitochondrial genomes *of A. caraganae* and *B. brassicae* have a negative GC deviation in almost all regions, except for the region of protein-coding genes from the minor chain, which indicates a significant content of C compared to G in the main mtDNA chain of these species.

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COMPARATIVE ANALYSIS OF THE GEOMETRIC PARAMETERS OF THEOBROMINE AND CAFFEINE MOLECULES

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This article presents the results of a comparative analysis of the geometric parameters of theobromine and caffeine molecules, performed using the ChemOffice 2015 software package.

Keywords: quantum chemical modeling, theobromine, caffeine, molecular geometry

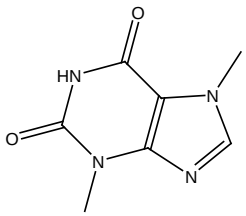
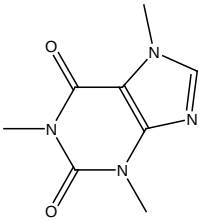
Theobromine (C7H8N4O2) and caffeine ($C_8H_{10}N_4O_2$) are natural alkaloids that are purine derivatives. The substances are structurally similar and both are methylxanthines from a pharmacological point of view, which makes it appropriate to compare the geometry of the molecules in order to evaluate their properties [1].

Analysis of the geometric parameters of a molecule can provide information about its reactivity, thermodynamic stability, polarity, and biological activity, which is important for assessing the prospects for using the substance in a particular direction [2].

Table 1 shows the information obtained during the study on the geometry of theobromine and caffeine molecules.

Table

Results of analysis

Parameter	Theobromine	Coffeein
Structure	E_T=25.7101 kcal/mol 	E_T=26.4446 kcal/mol 
Number of methyl groups	2	3
C-N1 bond length	1.343	1.450

C=O bond length	1.208	1.208
N-C-N angle (degrees)	126.000	126.000

Based on the analysis results, it can be suggested that the presence of a methyl group in the caffeine molecule, distinguishing it from the theobromine molecule, only slightly alters its geometric structure. However, in certain cases, the methyl group may hinder caffeine's binding with substances that theobromine can interact with, as it "overlaps" the reactive center located at the nitrogen atom.

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THE EFFECT OF VITAMIN B12 DEFICIENCY ON THE HUMAN BODY

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This article reviews current scientific understanding of vitamin B12 deficiency – a condition often unrecognized in its early stages yet capable of causing severe hematological and neurological consequences. Vitamin B12, or cobalamin, plays a pivotal role in DNA synthesis, homocysteine metabolism, and the maintenance of myelin sheath integrity in nerve fibers. Deficiency may result from inadequate dietary intake (e.g., strict vegan diets) or impaired absorption due to autoimmune gastritis, gastric resection, or medication use [1].

Keywords: vitamin B12, deficiency, megaloblastic anemia, neurological disorders

The most well-known clinical manifestation of vitamin B12 deficiency is megaloblastic anemia. Vitamin B12 and folate act as interdependent partners in several biochemical reactions and jointly participate in erythropoiesis. Together, they ensure proper nuclear maturation and division of erythroid precursor cells in hematopoietic tissue, a process characterized by decreased hemoglobin levels, increased mean corpuscular volume of erythrocytes, and the presence of megaloblasts in the bone marrow.

Beyond megaloblastic anemia, cobalamin deficiency leads to nervous system involvement in approximately one-third of patients. Primary neurological manifestations include spinal cord lesions (subacute combined degeneration of the lateral and posterior columns, or funicular myelosis), cerebral dysfunction (dementia), optic nerve damage, and peripheral nerve involvement resulting in distal sensory polyneuropathy. Combined central and peripheral nervous system impairment is also possible [2].

The immediate pathophysiological mechanisms underlying these neurological disturbances include impaired methionine synthesis, reduced oxidation of odd-chain fatty acids, and accumulation of methylmalonate – a neurotoxic metabolite that induces neuronal lipid degeneration and demyelination of nerve fibers.

Current evidence confirms the role of B-group vitamins, particularly vitamin B12, in human cognitive function. A 10-year longitudinal study at the University of Oxford (UK) evaluated cognitive performance in 1,648 participants across various age groups. Low serum vitamin B12 levels, coupled with elevated methylmalonic acid concentrations, were associated with accelerated cognitive decline [3].

Recent studies indicate that serum vitamin B12 levels do not always reflect true body stores. More sensitive markers – elevated methylmalonic acid (MMA) and homocysteine – can detect functional deficiency even when serum B12 concentrations appear normal. This is especially critical in elderly patients, in whom deficiency is frequently misattributed to age-related cognitive changes [4].

Thus, vitamin B12 deficiency remains a significant issue in clinical practice, demanding heightened awareness among physicians across specialties. Timely diagnosis and appropriate replacement therapy – via intramuscular injections or high-dose oral cobalamin formulations – can prevent not only anemia but also irreversible neurological damage. Future research should focus on standardizing diagnostic criteria and identifying at-risk populations for targeted screening.

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BIOLOGICAL ACTIVITY OF PHENAZINE-1-CARBOXYLIC ACID

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A promising compound considered as an active component in potential anticancer drugs is a phenazine isolated from the bacterium *Pseudomonas chlororaphis* subsp. *aurantiaca* strain B-162 [1]. The main active component of this compound is phenazine-1-carboxylic acid (Figure). To investigate its biological activity, theoretical calculations of electronic parameters were performed using the B3LYP/STO-3G method.

Keywords: phenazine-1-carboxylic acid, biological activity, B3LYP/STO-3G method.

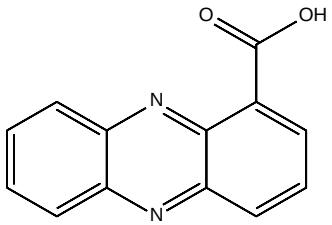

Fig. – phenazine-1-carboxylic acid

The chemical properties of phenazine-1-carboxylic acid were determined using the ChemDraw 2.0 software package and are summarized in Table 1. Preliminary quantum-chemical modeling was performed using the molecular mechanics (MM2) method as implemented in the Chem3D suite.

Table 1

Chemical properties of phenazine-1-carboxylic acid

Compound	Boiling point, K	Melting point, K	Gibbs free energy, kJ/mol
phenazine-1-carboxylic acid	824,55	656,31	175,22

The electronic properties of the molecule were determined using the Gaussian 09W software package. The non-empirical method B3LYP/STO-3G was chosen for the calculations. Visualization and analysis of the results were carried out using GaussView 6.0.

As a result, the following molecular parameters were obtained: E_{HOMO}, E_{LUMO}, band gap (E_g), ionization potential (IP), electron affinity (EA), global hardness (η), electronegativity (μ) and chemical softness (S). The calculated data are summarized in Table 2.

Table 2

Electronic properties of phenazine-1-carboxylic acid

Compound	E_{HOMO}, eV	E_{LUMO}, eV	E_g, eV	IP, eV	EA, eV	η, eV	μ, eV	S, eV^{-1}
phenazine-1-carboxylic acid	-0,15070	-0,02350	0,1272	0,15070	0,02350	0,0636	-0,0636	7,862

Based on the obtained data, phenazine-1-carboxylic acid was found to exhibit high antioxidant activity, which is associated with its low band gap value ($E_g < 7$) [2].

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NEGATIVE EFFECTS OF SILVER NANOPARTICLES ON HUMAN HEALTH

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Silver nanoparticles (AgNPs) are widely used in the development of pharmaceuticals and cosmetics due to their enhanced antimicrobial and virucidal properties. However, alongside their beneficial effects, AgNPs also exhibit significant toxicological risks.

Keywords: Silver nanoparticles, nanotechnology.

Due to its potent bactericidal, fungicidal, and virucidal properties, silver has become a convenient and effective agent in medicine-serving as a natural alternative to antibiotics-and in cosmetology, where it is used as a therapeutic and preventive additive in various cosmetic formulations.

Upon transitioning to the nanoscale, silver particles acquire the ability to penetrate cellular membranes more efficiently and disseminate throughout the organism via systemic circulation. Beyond their intrinsic cytotoxicity, silver nanoparticles (AgNPs) can disrupt key cellular processes and have been shown to induce apoptosis through oxidative and molecular stress pathways [1].

Common side effects associated with prolonged consumption of nanosilver colloids (NCS) include conditions such as argyria-characterized by near-irreversible skin pigmentation-argyrosis, involving silver deposition in ocular tissues, and both acute and chronic nephropathy. Some researchers hypothesize that these manifestations may represent a physiological detoxification mechanism, whereby silver is sequestered in tissues in the form of relatively inert protein complexes or silver sulfides.

Researchers Seung-Heon et al. [2] and Shin et al. [3] demonstrated that nanosilver colloids (NCS) exert significant cytotoxic effects by impairing cell division and altering cytokine expression in peripheral blood mononuclear cells.

In his study, Senjin demonstrated that the consumption of colloidal silver-a suspension containing silver in micro- or nanoparticulate form-may lead to a range of adverse effects, including neurological and gastrointestinal disorders, renal dysfunction, sleep disturbances, headaches, and hyperpigmentation. In certain cases, a decline in night vision was also observed [4].

It is well established [1] that nanosilver colloids (NCS) can induce oxidative stress, a process that damages key cellular components-including lipids, proteins, and DNA-and may contribute to the onset of various pathologies, including carcinogenesis. Therefore, it can be concluded that despite the widespread use of NCS-based products, their excessive or uncontrolled application poses serious health risks. Moreover, given the tendency of silver to accumulate

in renal and osseous tissues, individuals with kidney or skeletal disorders are strongly advised to avoid the use of nano-silver-containing medications and personal care products.

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ANALYSIS OF THE STRUCTURE OF CYTOCHROME P450 GENES OF APHIDS *MACROSIPHUM ROSAE*

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Cytochrome P450s constitute a large superfamily of enzymes that play a key role in the insect detoxification system, participating in the oxidation and biotransformation of a wide range of insecticides and other xenobiotics. This study presents the results of an analysis of the exon–intron structure of the obtained cytochrome P450 models in the aphid *Macrosiphum rosae*.

Keywords: aphid; detoxification system; exon–intron structure; cytochrome P450.

The rose aphid, *Macrosiphum rosae* (Linnaeus, 1758), is a cosmopolitan species widely distributed due to rose cultivation. *M. rosae* is one of the most important pests of plants in the genus *Rosa* worldwide and causes significant economic damage. The rose aphid spoils the aesthetic appearance of rose bushes by deforming flowers and foliage. In addition, it contributes to the formation of sticky honeydew, which provides a surface for the development of sooty molds.

Cytochrome P450 enzymes are the first to interact with toxic secondary plant metabolites and insecticides within the detoxification system. It is known that due to their genetic diversity and broad substrate specificity, P450s play a crucial role both in the metabolism of endogenous compounds and in the detoxification of xenobiotics, leading to the development of resistance to synthetic insecticides and facilitating insect adaptation to phytochemicals.

The structural analysis of the studied genes was performed using the online tool Gene Structure Display Server. Previously annotated sequences were uploaded to the website in *.gff* format, which enabled the visualization of their exon–intron organization. Information on the total gene length as well as exon and intron sizes was obtained using a custom script written in the Bash programming language.

The average gene length was 3059 base pairs. It was found that genes of the CYP6 family contain from 1 to 7 exons, with most comprising approximately 3–4 exons. Cytochromes of the CYP4 and CYP380 families show greater diversity, containing from 3 to 12 exons (on average, 3–7). Some genes, such as *CYP6CZ1*, *CYP6DD1*, and *CYP6DA1*, exhibit relatively simple structures with few exons and long introns, while others, such as *CYP4CJ2* and *CYP4CJ14*, are characterized by more complex organizations including numerous short exons. The length of exons and introns varies significantly, which may be related to regulatory features and the evolutionary origin of these genes. The mosaic nature of the exon–intron structure is a characteristic feature of cytochrome P450 genes in insects, reflecting their functional diversity and important role in detoxification mechanisms.

The exon–intron structure of *M. rosae* cytochrome P450 genes demonstrates substantial structural variability, reflecting the functional and evolutionary diversity of this superfamily. Differences in exon number may be associated with specific regulatory mechanisms of gene expression and adaptive responses contributing to insect resistance to

xenobiotics. Such structural mosaicism indicates the key role of P450 genes in providing flexibility in detoxification metabolic pathways and in adaptation to changing environmental conditions. The data obtained serve as a foundation for further functional studies aimed at understanding the mechanisms of *M. rosae* resistance to insecticides.

ANALYSIS OF ORTHOLOGOUS AND PARALOGOUS CYTOCHROME P450 GENES IN DIFFERENT APHID SPECIES

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Cytochrome P450s constitute a large and diverse superfamily of enzymes that play a key role in the detoxification system of insects. They participate in the oxidation and transformation of a wide range of xenobiotics, facilitating their elimination from the organism. This study presents the results of evolutionary analysis of the dN/dS and dS parameters for cytochrome P450 genes in various aphid species.

Keywords: aphids; detoxification system; evolutionary analysis; cytochrome P450.

The analysis utilized cytochrome P450 gene sequences from seven currently available aphid genomes in RefSeq – *Acyrtosiphon pisum* (GCF_005508785.1), *Aphis gossypii* (GCF_020184175.1), *Diuraphis noxia* (GCF_001186385.1), *Myzus persicae* (GCF_001856785.1), *Melanaphis sacchari* (GCF_002803265.2), *Rhopalosiphum maidis* (GCF_003676215.2), and *Sipha flava* (GCF_003268045.1) – as well as the genomes of *Aphis craccivora* and *Macrosiphum rosae*, which were assembled and annotated by the Bioinformatics and Molecular Evolution of Animals Research Group.

Based on phylogenetic data, 38 orthogroups of cytochrome P450 genes belonging to the CYP4 and CYP6 families, known to be actively involved in detoxification processes, were selected for evolutionary analysis. A Python script was employed to identify paralogs within these orthogroups. The script performed multiple sequence alignment using MAFFT, calculated pairwise evolutionary distances, and visualized them in two-dimensional space via multidimensional scaling (MDS). Paralogs were defined as sequences that were most distant from the cluster center.

For each orthologous and paralogous sequence, two evolutionary parameters were calculated – dN/dS (the ratio of nonsynonymous to synonymous substitutions) and dS (the number of synonymous substitutions per site) – using the *yn00* program from the PAML package, which implements the Yang and Nielsen method. For orthologs, the calculations were performed relative to an outgroup species (*Bemisia tabaci*, GenBank: GCF_001854935.1), while for paralogs they were performed relative to the putative ortholog.

To assess differences between groups, the normality of data distributions was tested using the Shapiro–Wilk test, which showed that the datasets deviated from normality ($p < 0.05$). Therefore, the non-parametric Mann–Whitney U test was applied for subsequent analysis. The statistical results demonstrated significant differences between orthologs and paralogs for both parameters – dN/dS and dS ($p < 0.05$).

A comparison of the obtained values revealed that paralogs exhibited lower dS values, indicating fewer accumulated synonymous substitutions and thus a more recent evolutionary origin, most likely associated with recent gene duplication events. Orthologs, in contrast, showed higher dS values, reflecting longer evolutionary divergence times. Moreover, the dN/dS ratios were higher in paralogs than in orthologs, suggesting differences in selective pressure between these gene groups. This indicates that paralogs undergo adaptive changes following duplication, whereas orthologs tend to retain their ancestral functions.

The most conserved orthogroup was identified as *CYP4G51*, which exhibited minimal dN/dS values (0.0146–0.0151). This points to strong purifying selection and high functional importance of this gene. Such evolutionary stability can be explained by the critical role of *CYP4G51* in aphid desiccation resistance through its participation in the biosynthesis of cuticular hydrocarbons. The low level of evolutionary change maintained in this gene over long evolutionary timescales suggests that even minor amino acid substitutions could negatively affect insect viability.

In contrast, two paralogs – *CYP380C35* and *CYP6CY6* – demonstrated the highest dN/dS values (0.5228 and 0.5055, respectively) combined with low dS values (0.0174 and 0.0285). This indicates a recent duplication origin of these genes and their potential involvement in adaptive processes related to xenobiotic metabolism. Elevated dN/dS ratios imply accelerated evolution, possibly linked to the development of insecticide resistance mechanisms.

STUDY OF ANTIOXIDANT PROPERTIES OF QUERCETIN IN THE MEDICINAL PLANT *CATHARANTHUS ROSEUS* (L.) G. DON BY THE *IN SILICO* METHOD

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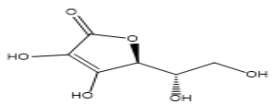
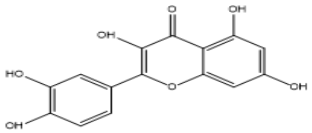
Catharanthus roseus (L.) G. Don is a valuable medicinal plant due to its content of secondary metabolites: alkaloids, phenols, anthocyanins. These biologically active compounds have anticancer, anti-inflammatory, antiviral and hepatoprotective properties which makes it possible to use them for therapeutic purposes [1].

The aim of this work was to study the antioxidant activity of quercetin contained in the plant *Catharantus roseus* (L.) G. Don using the *in silico* method and to compare its antioxidant activity with ascorbic acid [2].

Keywords: *Catharantus roseus*, antioxidant properties, quercetin, chemical modeling.

Table

Structure and physicochemical properties of ascorbic acid and quercetin calculated by the MM2 method

Name of biologically active substance	Structure	E_T, kcal/mol	E_{HOMO}, eV	E_{LUMO}, eV	Eg, eV
Ascorbic acid		5,3921	-10,585	-1,404	9,181
Quercetin		15,0487	-10,086	-3,902	6,184

During the study, calculations were made using the MM2 molecular modeling method, namely the total energy (E_{TOTAL}), the energy of the highest occupied molecular orbital (E_{HOMO}) and the lowest unoccupied molecular orbital (E_{LUMO}), as well as the width of the forbidden zone of the studied biologically active substances to confirm the antioxidant activity of quercetin in the medicinal plant *Catharanthus roseus* (L.) G. Don.

The data obtained in the table indicate that the band gap of the quercetin molecule is 6,184 eV while that of the ascorbic acid molecule is 9,181 eV.

Thus, our results indeed confirm that quercetin found in the secondary metabolites of the medicinal plant *Catharanthus roseus* (L.) G. Don, is a more powerful antioxidant than ascorbic acid.

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Совет ботанических садов стран СНГ при МААН; редкол.: В. Н. Решетников [и др.]. – Минск : ИВЦ Минфина, 2023. – 144 с.

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MOLECULAR DOCKING STUDY OF AZALOMYCIN, GELDANAMYCIN AND SNX-2112 WITH HSP90A

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This study employed molecular modeling to establish theoretical models of complexes formed between Azalomycin, Geldanamycin, SNX-2112 and the crystal structure of HSP90α (PDB: 4EGK).

Keywords: Molecular Docking, HSP90α, Azalomycin, Geldanamycin, SNX-2112.

The structure of HSP90α was obtained from the RCSB Protein Data Bank [1]. Protein structure preparation was performed using the Discovery Studio software package, involving removing the native ligand and water molecules, addition of hydrogen atoms and optimization of hydrogen bonding networks and side-chain conformations.

The three-dimensional structures of the ligands (Azalomycin, Geldanamycin, SNX-2112) were retrieved from the PubChem database. Molecular docking simulations and visualization of results were conducted using PrankWeb, Molegro Molecular Viewer and PyMOL software.

PrankWeb analysis identified one main binding site with a score of 43.93 and a probability of 0.968. The pocket centered on x, y, z = 8.5994, -6.7430, 18.2885 and formed by 34 amino acids residues includes key interaction residues confirmed by docking (e.g. Asn51, Asp93).

Three stable complexes with significantly different binding properties were obtained, varying in affinity, interaction networks, and key residues involved. All detailed energy and interaction data summarized in Table.

Table

Quantitative Comparison of Molecular Docking Results of Ligands with HSP90α

Ligand	SNX-2112	Geldanamycin	Azalomycin
ΔG (kcal/mol)	-8.87	-7.84	-7.17
MolDock Score	-135.967	-108.707	-111.662
H-Bond Count	5	3	6
H-Bond Residues	Thr 184, Asn 106, Lys 112, Asp 54, Asn 51	Asn 106, Lys 112, Asn 51	Asn 51, Thr 184, Asp 93, Ser 52, Asn 106, Lys 112
Steric Contacts	Asp 93, Ile 96, Gly 97	Asn 106, Gly 97, Asp 102	Thr 184, Asn 106, Phe 138, Val1 86

The docking results demonstrate that all three ligands form stable complexes within the ATP-binding pocket of HSP90α, yet exhibit significant differences in their binding modes. The synthetic inhibitor SNX-2112 displayed the strongest predicted binding affinity (-8.87 kcal/mol) and the most favorable MolDock Score (-135.967), indicating it is the most thermodynamically favorable binder. This was followed by the natural inhibitor Geldanamycin (-7.84 kcal/mol), while Azalomycin had the relatively least favorable binding energy (-7.17 kcal/mol), though its MolDock Score (-111.662) was comparable to Geldanamycin, suggesting considerable binding stability.

Azalomycin formed the most extensive hydrogen-bonding network (interacting with 6 key residues), featuring bonds of notable quality, such as Asn51 (strength: -2.46 kcal/mol) and Thr184 (strength: -2.0 kcal/mol). Although SNX-2112 formed fewer hydrogen bonds (5), it possessed the strongest set of interactions, including two high-strength bonds

(-2.5 kcal/mol each), explaining its superior binding affinity. Geldanamycin exhibited fewer (3) and generally weaker hydrogen bonds, suggesting its stability may rely more heavily on steric complementarity within the pocket.

Conclusions: Quantitative docking results indicate that SNX-2112 possesses the optimal binding affinity, while Azalomycin, despite a slightly weaker binding energy, forms the most extensive and qualitatively significant hydrogen-bonding network. The three ligands achieve stable binding through distinct interaction strategies: SNX-2112 relies on high-strength hydrogen bonds, Geldanamycin on classical shape complementarity, and Azalomycin exhibits a broad-spectrum interaction profile (hydrogen bons and steric interactions). The unique interaction spectrum of the natural product Azalomycin identifies it as a valuable novel scaffold for HSP90 inhibition.

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STUDY OF ANTIOXIDANT PROPERTIES OF QUERCETIN IN THE MEDICINAL PLANT CATHARANTHUS ROSEUS (L.) G. DON BY THE IN SILICO METHOD

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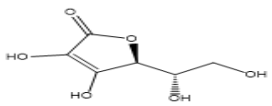
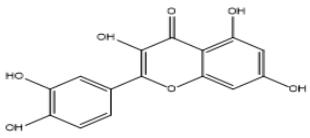
Ascorbic acid		5,3921	-10,585	-1,404	9,181
Quercetin		15,0487	-10,086	-3,902	6,184

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NEGATIVE EFFECTS OF SILVER NANOPARTICLES ON HUMAN HEALTH

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Silver nanoparticles (AgNPs) are widely used in the development of pharmaceuticals and cosmetics due to their enhanced antimicrobial and virucidal properties. However, alongside their beneficial effects, AgNPs also exhibit significant toxicological risks.

Keywords: Silver nanoparticles, nanotechnology.

Due to its potent bactericidal, fungicidal, and virucidal properties, silver has become a convenient and effective agent in medicine-serving as a natural alternative to antibiotics-and in cosmetology, where it is used as a therapeutic and preventive additive in various cosmetic formulations.

Upon transitioning to the nanoscale, silver particles acquire the ability to penetrate cellular membranes more efficiently and disseminate throughout the organism via systemic circulation. Beyond their intrinsic cytotoxicity, silver nanoparticles (AgNPs) can disrupt key cellular processes and have been shown to induce apoptosis through oxidative and molecular stress pathways [1].

Common side effects associated with prolonged consumption of nanosilver colloids (NCS) include conditions such as argyria-characterized by near-irreversible skin pigmentation-argyrosis, involving silver deposition in ocular tissues, and both acute and chronic nephropathy. Some researchers hypothesize that these manifestations may represent a physiological detoxification mechanism, whereby silver is sequestered in tissues in the form of relatively inert protein complexes or silver sulfides.

Researchers Seung-Heon et al. [2] and Shin et al. [3] demonstrated that nanosilver colloids (NCS) exert significant cytotoxic effects by impairing cell division and altering cytokine expression in peripheral blood mononuclear cells.

In his study, Senjin demonstrated that the consumption of colloidal silver-a suspension containing silver in micro- or nanoparticulate form-may lead to a range of adverse effects, including neurological and gastrointestinal disorders, renal dysfunction, sleep disturbances, headaches, and hyperpigmentation. In certain cases, a decline in night vision was also observed [4].

It is well established [1] that nanosilver colloids (NCS) can induce oxidative stress, a process that damages key cellular components-including lipids, proteins, and DNA-and may contribute to the onset of various pathologies, including carcinogenesis. Therefore, it can be concluded that despite the widespread use of NCS-based products, their excessive or uncontrolled application poses serious health risks. Moreover, given the tendency of silver to accumulate in renal and osseous tissues, individuals with kidney or skeletal disorders are strongly advised to avoid the use of nano-silver-containing medications and personal care products.

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