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FORMATION OF THE SCIENTIFIC WORLDVIEW OF STUDENTS IN THE PROCESS OF LEARNING BIOLOGICAL KNOWLEDGE ABOUT THE LEVELS OF ORGANIZATION OF LIVING MATTER

The purpose of the study is to theoretically substantiate and experimentally verify the effectiveness of methodological approaches to the formation of students' scientific worldview in the process of studying biology based on mastering knowledge about the levels of organization of living matter.

The study used a complex of complementary methods: analysis, generalization, and systematization of scientific and psychological and pedagogical sources on the problem of forming a scientific worldview.

The experimental results confirmed that systematic study of the levels of organization of living matter (molecular, cellular, tissue, organ, organismal, population-species, ecosystem, and biosphere) ensures the formation of a holistic understanding of the interrelationships between biological systems and promotes the development of scientific thinking. It was established that the use of research tasks, laboratory work, interactive methods, digital educational resources, and interdisciplinary connections

increases the level of scientific concept formation, the ability to analyze natural phenomena, and the development of ecological thinking. The pedagogical experiment demonstrated positive dynamics in the formation of a scientific worldview, increased cognitive activity, independence, and students' readiness for research activities.

It has been proven that the formation of a scientific worldview in the process of studying biology is effective under the conditions of systematic use of innovative pedagogical technologies, integration of theoretical knowledge with practical activities, and organization of inquiry-based learning. The study of the levels of organization of living matter serves as a methodological basis for forming a holistic scientific worldview and developing a responsible attitude toward the environment.

Keywords: *scientific worldview, biological education, levels of organization of living matter, systems thinking, research activity, knowledge integration, educational process.*

(статтю подано мовою оригіналу)

In today's society, the development of a scientific worldview among students is of particular importance, as it fosters an informed understanding of the phenomena of the surrounding world, the development of critical thinking, and the capacity for scientific inquiry. One of the key means of fostering a scientific worldview is biological education, as it is biology that reveals the fundamental patterns of the development of living nature, the interrelationships between organisms and the environment, and humanity's place within the biosphere. The study of the levels of organisation of living matter plays a special role in forming a holistic scientific picture of the world, enabling learners to understand the hierarchical structure of living systems – from the molecular level to the biospheric level. This approach fosters the development of systems thinking and an understanding of the unity and interconnection of all forms of life. An analysis of scientific and pedagogical literature indicates that the issue of fostering a scientific worldview in students has been explored by many domestic and international researchers. However, the question of the effective use of knowledge about the levels of organisation of living matter as a means of forming a scientific worldview in learners requires further theoretical consideration and methodological justification. In this regard, the search for effective pedagogical conditions, methods and techniques for teaching biology, aimed at forming a scientific worldview in learners, is of particular relevance

The aim of the study is to provide a theoretical justification for the effectiveness of the methods and pedagogical conditions involved in shaping students' scientific worldview during the process of acquiring biological knowledge about the levels of organisation of living matter.

Research objectives: to analyse scientific and pedagogical literature on the issue of forming a scientific worldview in pupils; to reveal the role of biological education in shaping a scientific picture of the world; to substantiate the importance of knowledge about the levels of organisation of living matter for the formation of a scientific worldview; to develop methodological approaches to forming a scientific worldview in pupils during biology lessons.

The study employed a комплекс of complementary methods: theoretical methods (analysis, generalization, and systematization of scientific and psychological-pedagogical literature); empirical methods (pedagogical observation,

questionnaires, testing, analysis of students' learning outcomes); pedagogical experiment aimed at determining the effectiveness of implementing inquiry-based, problem-based, integrative, and activity-based approaches in biology education.

The issue of developing an individual's scientific worldview occupies a central place in philosophy, psychology and pedagogy, as it determines a person's ability to perceive the world holistically, to understand the laws governing the development of nature and society, and to recognise their own role within the system of natural and social interrelationships. In the modern educational context, a scientific worldview is regarded as the outcome of the learning process, which fosters the development of critical thinking, a scientific mode of thinking, and the capacity for rational understanding of reality [1]. It is formed on the basis of systematised scientific knowledge, evidence-based facts and objective laws, is characterised by logic, systematicity and the ability to explain phenomena of reality through scientific theories and laws, and involves a critical approach to information, analysis of facts and the formation of well-founded conclusions. Psychological and pedagogical literature emphasises that a scientific worldview encompasses not only a system of knowledge but also established values, beliefs and attitudes towards the world, grounded in a scientific understanding of reality [2]. In the pedagogical context, its development is achieved through teaching, upbringing and cognitive activity, where the content of education, integration across subjects, the application of research methods, problem-based tasks and interactive forms of work play a key role in stimulating pupils' cognitive activity. Psychological research shows that the development of a scientific worldview is a complex, long-term process that depends on pupils' age and individual characteristics, their level of cognitive development and their educational environment; during this process, fragmented ideas are gradually transformed into a systematic and generalised understanding of natural phenomena [1]. A scientific worldview involves an awareness of the interrelationships between natural phenomena, the unity of living and non-living matter, and the laws governing the development of biological systems. Biological education takes on particular significance in this process, as it ensures a holistic understanding of the structure, functioning and multi-level organisation of living systems, the interrelationship between organisms and the environment, and the role of humans in preserving the biosphere [3]. Thus, a scientific worldview emerges as a complex integrative construct that unites knowledge, values, beliefs and ways of thinking, forming an objective, systematic and critically grounded understanding of the world, the development of scientific thinking, cognitive activity and a responsible attitude towards nature and society. Within the context of biological education, this ensures an awareness of the laws governing the development of living matter, the interrelationships between its levels and humanity's place in natural processes, which forms the foundation for the formation of a holistic scientific picture of the world and an environmentally responsible worldview. In the modern education system, it is becoming increasingly important to foster in learners a holistic understanding of the patterns governing the development of nature, society and humanity's place in the world. One of the key components of this understanding is a

scientific worldview, which is formed through the acquisition of knowledge across various scientific disciplines. Biological education plays a special role in this process, as it reveals the patterns of the functioning and development of living nature, the interrelationships between organisms and the environment, and the importance of biodiversity for the existence of life on Earth.

In the scientific literature, the scientific worldview is regarded as an integrated system of knowledge about the structure and development of nature and society, which reflects the objective laws of reality [1]. It is formed on the basis of achievements in various fields of science, such as physics, chemistry, biology, geography and others, providing a systematic and holistic view of the world. In this context, biology occupies a special place, as it studies living matter, its structure, functioning and evolutionary development. Biological education contributes to the formation of a scientific worldview through the acquisition of fundamental knowledge about the multi-level organisation of living systems and their interrelationships with the non-living world, including the laws governing the exchange of matter and energy, heredity, variability, adaptation and evolution [3]. An awareness of these patterns fosters systematic thinking and an understanding of the unity of living nature. A significant role is played by the study of the levels of organisation of living matter, from the molecular to the biospheric, which allows living systems to be viewed as complex hierarchical systems and enables an understanding of the interaction of all their components with the environment. Furthermore, biological education stimulates the development of ecological thinking, fostering in learners a responsible attitude towards natural resources, biodiversity and the principles of sustainable development. Another important aspect is the development of a scientific way of thinking, which involves the ability to analyse phenomena, establish cause-and-effect relationships, formulate hypotheses and draw well-founded conclusions, achieved through observation, experiments, laboratory work and practical activities. It is important to make use of interdisciplinary links, as explaining biochemical processes within a cell requires knowledge of chemistry, whilst explaining energy processes in living organisms requires knowledge of physics; this ensures a holistic understanding of natural phenomena and the integration of knowledge. Thus, biological education is a key factor in shaping a scientific worldview, as it provides a systematic understanding of the laws of living nature, the development of scientific thinking, environmental awareness and an understanding of humanity's place within the system of natural interrelationships, which forms the basis for the development of a scientific worldview [4]. In modern biological science, one of the fundamental principles of understanding living nature is the concept of the levels of organisation of living matter, which allows living systems to be viewed as a hierarchically ordered structure, where each level is characterised by specific properties of structure, functioning and interaction with the environment. This approach is a key component of biological education and serves as an important tool for shaping the scientific worldview of students, as it provides a systematic understanding of the complexity of living systems and the patterns of their development. The concept of levels of organisation is based on the understanding

that life manifests itself at various structural and functional levels – from the molecular to the biospheric – which allows us to explain the interrelationships between different forms of life and the multi-level organisation of biological phenomena. Traditionally, the following levels are distinguished: molecular, cellular, tissue, organ, organism, population-species, ecosystem and biosphere levels, each of which has its own patterns of functioning whilst being integrated into a single system. The molecular level provides the basic biochemical processes – protein synthesis, metabolism and energy exchange, and the transmission of genetic information – which form the chemical basis of life. The cellular level, being the fundamental structural and functional unit of life, sustains the vital functions of organisms through metabolism, growth, cell division and development. The tissue and organ levels demonstrate the organisational principles of multicellular organisms, where tissues unite similar cells, and organs form complex systems of interconnected structures to perform specific functions. At the organismal level, adaptive mechanisms and the fundamental characteristics of life manifest, ensuring self-regulation, growth, development and reproduction. The population-species level reveals the patterns of evolutionary processes, the interaction of individuals of the same species, natural selection and the formation of new species. The ecosystem level unites living organisms and components of the non-living world into a single functional system with energy flows and material cycles, which shapes ecological thinking and an understanding of humanity's role in maintaining the natural balance. The highest, biospheric level encompasses the global community of living organisms and their environment, illustrating their interaction with the atmosphere, hydrosphere and lithosphere, and emphasising the importance of maintaining ecological stability at a planetary level. As a result of mastering these levels, learners acquire a systematic understanding of living nature, recognise the interdependence of its components and form a coherent scientific picture of the world. From a pedagogical point of view, the study of the levels of organisation of living matter is of great importance for the development of systematic and holistic thinking in learners. This approach allows students not only to learn individual biological facts, but also to understand the interrelationship between various phenomena of living nature. Students gradually realise that all living systems are interconnected and function as a single system. Furthermore, knowledge of the levels of organisation of living matter contributes to the development of a scientific way of thinking, which involves the ability to analyse natural phenomena, establish cause-and-effect relationships, and generalise the knowledge gained. This, in turn, is an important prerequisite for the formation of a scientific worldview among students. Thus, the study of the levels of organisation of living matter in the biology curriculum is a key means of fostering a scientific worldview among students. It contributes to the formation of a holistic view of living nature, an understanding of the interrelationships between different levels of organisation of life, and an awareness of the role of humans in the system of natural interactions. This is precisely why this content component of biological education is of great importance for the formation of a scientific worldview and the development of students' cognitive

activity [5]. The formation of a scientific worldview among students is one of the key tasks of modern biological education. It involves not only the acquisition of a body of scientific knowledge about living nature, but also the development of students' capacity for scientific thinking, an awareness of the patterns of development in living systems, and the formation of a holistic view of the world. The effectiveness of this process depends to a large extent on the creation of appropriate pedagogical conditions that ensure the active cognitive activity of students and contribute to the formation of their scientific worldview.

In educational science, pedagogical conditions are regarded as a set of factors, methods, forms and means of organising the educational process that ensure the achievement of specific educational goals. In the context of shaping pupils' scientific worldview, pedagogical conditions are aimed at creating an educational environment free of barriers that fosters pupils' understanding of the laws governing the development of nature, the formation of systematic thinking, and the capacity for scientific inquiry [4]. An analysis of scientific and pedagogical literature and contemporary biology teaching practices allows us to identify a number of key pedagogical conditions that determine the effectiveness of the formation of a scientific worldview among learners. Among these, the first pedagogical condition is ensuring the systematic nature and integrity of biological knowledge, since the formation of a scientific worldview requires students to understand the interrelationships between various phenomena of living nature. Presenting the teaching material as an integrated system of knowledge, particularly through the study of the levels of organisation of living matter from the molecular to the biospheric, allows living nature to be viewed as a complex hierarchical system in which all components are interconnected and interact. The acquisition of knowledge about the molecular, cellular, organismal, population-species, ecosystem and biospheric levels contributes to the formation of a systematic understanding of the structure and functioning of living systems

The second pedagogical requirement is the development of a scientific way of thinking among learners, which involves the ability to analyse natural phenomena, identify cause-and-effect relationships, and draw well-founded conclusions. This is achieved through the use of problem-based tasks, research exercises, laboratory and practical work, which develop scientific thinking skills and stimulate students' active cognitive activity [5]. The third pedagogical condition is the application of interdisciplinary links, as the formation of a holistic scientific picture of the world involves the integration of knowledge from physics, chemistry, geography and ecology, enabling students to understand the interdependence of natural phenomena and the complex nature of biological processes.

The fourth pedagogical condition is the active involvement of students in research and cognitive activities, including observations, experiments and project work, which contributes to a deeper understanding of biological patterns and the development of an interest in scientific inquiry. The fifth pedagogical condition is the development of ecological thinking and a responsible attitude towards nature, as the study of the ecosystemic and biospheric levels of organisation of living matter

enables learners to understand the interrelationship between living organisms and the environment, the importance of biodiversity conservation and the sustainable use of natural resources.

Consequently, the implementation of these pedagogical conditions in the process of teaching biology – which involves ensuring the systematic nature of knowledge, developing a scientific way of thinking, utilising interdisciplinary links, organising research activities and fostering an ecological mindset – is a key prerequisite for the development of a holistic scientific worldview among learners. Of particular importance in this process is the study of the levels of organisation of living matter, which enables students to understand the interrelationship between different levels of life and to form a comprehensive scientific picture of the world. Thus, the pedagogical conditions for the formation of students' scientific worldview are closely linked to the content of biological education and the organisation of the educational process, in which knowledge of the levels of organisation of living matter serves as an important methodological foundation for the formation of a holistic scientific worldview among students [2]. The formation of a scientific worldview in students during the study of biology depends to a large extent on the effective use of various methods, techniques and interactive teaching technologies. It is these that stimulate students' cognitive activity, promote the development of critical and systematic thinking, and contribute to the formation of a holistic understanding of living nature. An important foundation for the development of a scientific worldview is pupils' understanding of the levels of organisation of living matter and the interrelationships between them. Therefore, methods and techniques for teaching biology should be aimed not only at the acquisition of individual biological facts, but also at fostering a systematic understanding of living nature as a complex hierarchical system. In this context, the use of active and interactive teaching methods takes on particular significance. One of the key methods for teaching biology is the problem-based approach, which involves creating problem situations during the learning process and engaging students in solving them. For example, when studying the cellular level of organisation of living matter, the teacher may pose a problem-based question to the pupils: why is the cell considered the basic structural and functional unit of life? Discussing such questions stimulates the pupils' cognitive activity and contributes to the development of scientific thinking. The research method plays a key role in the teaching of biology, as it involves students carrying out a variety of investigations, observations and experiments. During laboratory and practical work, students have the opportunity to directly observe biological objects and processes, which contributes to a deeper understanding of the laws of living nature. For example, studying cell structure using a microscope or observing plant development allows students to better understand the functioning of living systems at different levels of their organisation. Another effective means of fostering a scientific worldview is the project-based approach, which involves students carrying out research or creative tasks aimed at solving a specific problem. While working on projects, students learn to independently gather information, analyse it and draw conclusions. For example, pupils can undertake

projects related to researching the biodiversity of the local ecosystem or studying the impact of human activity on the environment. Such activities help pupils to understand the interrelationships between different levels of organisation of living matter – from individual organisms to ecosystems and the biosphere.

Modern biology education is impossible without digital technologies, including multimedia presentations, virtual laboratories, educational videos and interactive platforms, which clearly demonstrate complex processes, such as molecular phenomena within a cell or global ecological processes in the biosphere. Thus, the use of a variety of methods, techniques and interactive technologies in biology teaching stimulates learners' cognitive activity and fosters a scientific worldview. Particularly effective is the combination of problem-based, inquiry-based and project-based approaches with interactive forms of teaching, which allows students not only to acquire biological knowledge but also to understand the interrelationships between different levels of organisation of living matter. Thus, the systematic use of modern methods and technologies ensures that students develop a holistic understanding of living nature, promotes the development of scientific thinking and the creation of a comprehensive scientific picture of the world, which is an important prerequisite for the formation of an individual's scientific worldview.

The development of a scientific worldview in students is a key task of modern biological education, which is achieved through the application of methodological approaches capable of ensuring a holistic acquisition of knowledge, the development of scientific thinking, and an understanding of the patterns of development in living nature. The basis for such development lies in the study of the levels of organisation of living matter, which reflect the hierarchical structure of living systems and the interrelationships between different forms of life; consequently, teaching methods must ensure a systematic understanding of these interrelationships and the formation of a comprehensive scientific picture of the world. A systems approach to teaching biology involves viewing the natural world as an interconnected, holistic system, where the systematic study of levels of organisation – from the molecular to the biospheric – enables an understanding of the functional interactions between all living systems. The activity-based approach encourages pupils' active participation in acquiring knowledge through laboratory and practical work, observation and research; for example, studying cell structure under a microscope develops practical skills and investigative thinking. The problem-based approach, which involves creating learning situations that require the search for solutions, promotes the development of logical thinking and the ability to draw well-founded conclusions; an example is a discussion of the impact of human activity on ecosystems and possible ways of preserving them. The integrative approach ensures the use of interdisciplinary connections, where biological phenomena are explained using knowledge from chemistry, physics and geography, which helps to form a holistic scientific worldview. The inquiry-based approach involves engaging pupils in independent cognitive activity, formulating hypotheses, conducting observations and analysing results; for example, investigating the impact of environmental factors on plant growth or studying the

biodiversity of local ecosystems. Interactive methods, such as group work, discussions, role-play, project work and brainstorming, ensure active student engagement, the development of communication skills and the ability to solve problems collectively. The ecological approach fosters a conscious attitude towards nature and an understanding of humanity's role in maintaining ecological balance, particularly when studying the ecosystemic and biospheric levels of organisation of living matter, enabling students to grasp the interdependence of all components of natural systems. Thus, the combination of systemic, activity-based, problem-based, integrative, research-based and ecological approaches with interactive teaching methods ensures the formation of a holistic scientific worldview, the development of scientific thinking and a systemic understanding of living nature. Consequently, the implementation of systemic, activity-based, problem-based, integrative, research-based and ecological approaches in the teaching of biology creates favourable conditions for the formation of a scientific worldview among students. The use of these approaches not only ensures the acquisition of biological knowledge but also helps students develop a holistic understanding of living nature and its multi-level organisation. Consequently, methodological approaches to the formation of pupils' scientific worldview in biology lessons should be based on a combination of modern pedagogical technologies, active teaching methods and a systematic examination of biological phenomena. Of particular importance in this process is the study of the levels of organisation of living matter, which ensures the formation of a holistic scientific picture of the world in students and contributes to the development of scientific thinking.

Conclusions. Consequently, the issue of the formation of an individual's scientific worldview occupies a prominent place in philosophical, psychological and pedagogical research, as it is directly linked to the development of a person's holistic understanding of the world, the laws governing the development of nature and society, and an awareness of humanity's place within the system of natural and social interrelationships. An analysis of scientific sources has shown that a scientific worldview should be regarded as a complex, integrative formation of the individual, comprising a system of scientific knowledge, beliefs, value orientations and ways of thinking, which are based on an objective understanding of reality and reflect a generalised understanding of the laws governing the development of the world. From a psychological and pedagogical perspective, a scientific worldview is an important outcome of the educational process, which ensures the development of critical and systematic thinking, the ability to scientifically analyse phenomena and processes of the surrounding reality, as well as the formation of a responsible attitude towards nature and society. Biological education plays a significant role in shaping a scientific worldview, as it facilitates the acquisition of knowledge about the fundamental laws governing the existence and development of living nature. Biology, as a natural science, reveals the diversity of life forms, their structure, functioning and evolutionary development, as well as the interrelationship between living organisms and the environment. Of particular importance in the context of developing a scientific worldview is the study of the levels of organisation of living

matter, which reflect the hierarchical structure of living systems and enable living nature to be viewed as a complex, multi-level system. It has been established that systematically introducing students to the molecular, cellular, tissue, organ, organism, population-species, ecosystem and biospheric levels of organisation of life contributes to the formation of a holistic understanding of the structure and functioning of living systems. An awareness of the interrelationships between these levels enables students to understand the patterns of development in living nature, as well as the interactions of organisms with one another and with the environment, which is an important prerequisite for the formation of a scientific worldview. Thus, the concept of the levels of organisation of living matter serves as an important methodological foundation for the formation of a systematic view of natural processes and contributes to the development of a scientific style of thinking among students.

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Хатунцева С. М., Пиєнична Н. С., Гнатюк В. В., Расторгуєва І. С., Черневич В. В.
Формування наукового світогляду здобувачів освіти у процесі засвоєння біологічних знань про рівні організації живої матерії.

Метою дослідження є теоретичне обґрунтування та експериментальна перевірка ефективності методичних підходів до формування наукового світогляду здобувачів освіти у процесі вивчення біології на основі засвоєння знань про рівні організації живої матерії.

У дослідженні використано комплекс взаємодоповнювальних методів: аналіз, узагальнення та систематизація наукових і психолого-педагогічних джерел з проблеми формування наукового світогляду.

Підтверджено, що системне вивчення рівнів організації живої матерії (молекулярного, клітинного, тканинного, органного, організмового, популяційно-видового, екосистемного та біосферного) забезпечує формування цілісного уявлення про взаємозв'язок біологічних систем та сприяє розвитку наукового стилю мислення. Встановлено, що використання дослідницьких завдань, лабораторних робіт, інтерактивних методів, цифрових освітніх ресурсів і міжпредметних зв'язків підвищує рівень сформованості наукових понять, здатність до аналізу

природних явищ і розвиток екологічного мислення. У процесі педагогічного експерименту зафіксовано позитивну динаміку сформованості наукового світогляду, підвищення пізнавальної активності, самостійності та готовності здобувачів освіти до дослідницької діяльності.

Доведено, що формування наукового світогляду здобувачів освіти у процесі вивчення біології є ефективним за умови системного використання інноваційних педагогічних технологій, інтеграції теоретичних знань і практичної діяльності, а також організації дослідницького навчання. Вивчення рівнів організації живої матерії виступає методологічною основою формування цілісної природничо-наукової картини світу та розвитку відповідального ставлення до довкілля.

Ключові слова: *науковий світогляд, біологічна освіта, рівні організації живої матерії, системне мислення, дослідницька діяльність, інтеграція знань, освітній процес.*

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