

ШКОЛА ЛІКАРЯ

DOI 10.64108/imh.2026.1.5.34

UDC 577.352.5+612.013+616-056.2

THE QUANTUM ROLE OF CELL MEMBRANES AS THE BASIS OF THE PHENOMENON OF BIOLOGICAL LIFE, HEALTH, AND DISEASE IN THE HUMAN BODYG. V. Nevoit^{1*}, K. Poderiene², M. M. Potyazhenko³, O. P. Mintser⁴, G. Jarusevicius⁵, A. Vainoras^{6*}¹Laboratory for Automatization of Cardiovascular Investigations, Cardiology Institute, Lithuanian University of Health Sciences, Kaunas, Lithuania²Department of Health and Rehabilitation, Lithuanian Sports University Institute of Sports Science and Innovation, Kaunas, Lithuania 3³Department of Internal Medicine and Emergency Medicine, Poltava State Medical University, Poltava, Ukraine⁴Department of Fundamental Disciplines and Informatics, Shupyk National Healthcare University of Ukraine, Kyiv, Ukraine⁵Laboratory for Automatization of Cardiovascular Investigations, Cardiology Institute, Lithuanian University of Health Sciences, Kaunas, Lithuania⁶Laboratory for Automatization of Cardiovascular Investigations, Cardiology Institute, Lithuanian University of Health Sciences, Kaunas, LithuaniaORCID: 0000-0002-1055-7844, e-mail: ganna.nevoit@lsmu.ltORCID: 0009-0000-4151-0742, e-mail: kristina.poderiene@lsu.ltORCID: 0000-0001-9398-1378, e-mail: m.potiazhenko@pdmu.edu.uaORCID: 0000-0002-7224-4886, e-mail: omintser@gmail.comORCID: 0000-0001-9205-1902, e-mail: gediminas.jarusevicius@lsmu.ltORCID: 0000-0002-5732-8520, e-mail: alfonsas.vainoras@lsmu.lt***Correspondence:** ganna.nevoit@lsmu.lt (G.V.Nevoit); alfonsas.vainoras@lsmu.lt (A.Vainoras)

Abstract. This is a review of the second lecture in the “Bioelectronic Medicine or Look at Medicine Differently” series, which presents and substantiates its key concepts, meanings, and relevance. New perspectives on the role of biological membranes in cells are presented. It is substantiated that the ability to generate electromagnetic fields/currents is a key function of membranes and the biophysical basis of the phenomenon of life in vivo.

Albert Szent-Györgyi (1893-1986, Hungary-USA), a 1937 Nobel laureate for his series of works on biological oxidation, published his fundamental work “Bioelectronics” in 1969. The appearance of this publication can be considered the date of the beginning of the study of the role of electromagnetic processes in molecular biology. A. Szent-Györgyi was the first to offer calling this branch of knowledge bioelectronics and outlined the tasks and directions for future research

Materials and methods. Biophysical models and scientific data theorized by physicists and published in the specialized literature were analyzed. General scientific methods (dismemberment and integration of elements of the studied system, imaginary experiment, logical and historical research, analysis, induction, deduction, and synthesis of knowledge) and theoretical methods (method of constructing theory, logical methods, and rules of normative nature) were used in this theoretical study.

Results. It is important to understand that the emergence of pathology in the functioning of a biological cell/tissue/organ will be associated with a primary change in the course of electromagnetic processes. This is objectively manifested in changes to the parameters of their electromagnetic fields and their frequency-wave characteristics. These are important, promising parameters for an objective assessment of the functions of human organs during the development of internal diseases. This is a promising direction for further research into the magnetic fields of internal organs in health and disease.

Conclusions.

1. The latest layer of fundamental knowledge in quantum physics, as applied to the quantum role of cellular membranes in the phenomenon of biological life, must be integrated into the educational process of training specialists in the biological and medical fields.

2. This knowledge possesses significant paradigm-transforming potential, significantly deepening and changing scientific understanding of the etiopathogenesis of internal organ diseases.

3. Modern scientists must recognize that the phenomenology of life has a purely electromagnetic basis. However, the role of biological membranes is not purely mechanistic. Due to their liquid-crystalline state, biological membranes are unique generators and conductors of electromagnetic signals.


Keywords: medicine, bioelectronic medicine, quantum medicine, biological oxidation, magnetoelectrochemical theory of metabolism and life, biological membranes, new paradigm, biophysics.

Introduction. Albert Szent-Györgyi (1893-1986, Hungary-USA), a 1937 Nobel laureate for his series of works on biological oxidation, published his fundamental work "Bioelectronics" in 1969 [1]. The appearance of this publication can be considered the date of the beginning of the study of the role of electromagnetic processes in molecular biology. A. Szent-Györgyi was the first to offer calling this branch of knowledge bioelectronics and outlined the tasks and directions for future research [1]. A. Szent-Györgyi wrote that "without a doubt, molecular biology has achieved remarkable successes and created a powerful basis for biology. However, there are indications that it has left aside the main problems, if not entire layers, since some of the basic questions remained undiscovered and even unposed. The mechanism of energy conversion, chemical energy into mechanical, electrical or osmotic work, has also not been explained. "These transformations are closely linked to the very basis of life" [1]. Currently, the research directions described by A. Szent-Györgyi remain highly relevant for two opposing reasons. The first reason is that scientific consensus on the mechanisms of biological life has not yet been achieved, and the existing paradigm for describing the bioelectromagnetism of life is limited primarily to the chemical aspects of these processes. A classic example of this is the description of

the mechanism for the generation of action potentials in membranes, based primarily on the movement of ions [2]. Various scientists have repeatedly pointed out the model's imperfections and shortcomings. One of the most substantiated proofs is Ling's calculations of the inconsistency in the energy supply model for ATPase functioning as a pump [3, 4]. According to the calculations presented, the functioning of pumps for the transport of ions across biological membranes requires such a large expenditure of energy that does not exist in a biological cell, and so on. Therefore, there continues to be a theoretical demand for a scientific explanation of this fact and/or for the creation of a new, improved model of such concepts. The second reason is that the progressive development of fundamental science has led to the emergence of a large amount of fundamentally new knowledge [5-10]. Their accumulation, along with the simultaneous emergence and development of quantum physics [11-13], quantum chemistry [14, 15], and quantum biology [16, 17], requires a rethinking of the concepts of the paradigm. These new, fundamentally different approaches and views are already capable of partially answering the questions posed in 1969 by A. Szent-Györgyi [1] and of explaining the mechanisms underlying the life of the human body (Figure 1).

?

QUESTIONS THAT REMAINED UNANSWERED FOR A LONG TIME



LSMU, PDMU,
SNHUU
2023-2026

- What makes molecules alive in the human body and dead in vitro?
- What are the mechanisms of protein folding?
- How do stem cells and other cells know the path of their differentiation?
They have the same DNA...
- Due to which mechanisms in the human body is the coordination of such a large number of metabolic reactions?
- How are 30 trillion cells of the human body combined into one organism?
etc.

THE ANSWERS ARE ALREADY...

Figure 1. An example of current biological questions about the mechanisms of life phenomena that, until recently, remained unanswered.

This scientific review is devoted to presenting these ideas by describing the quantum role of biological cell membranes as the basis for the phenomenon of biological life. The scientific goal of the review is to present a modern concept of scientific views on the functions and role of biological cell membranes *in vivo* from the perspective of modern biophysical knowledge and the Magnetochemical Theory of Metabolism and Life [4, 18-28].

Materials and methods. This scientific material is a fragment of a research paper from the Department of Internal Medicine and Emergency Medicine of Poltava State Medical University (23 Shevchenko St., 36011, Poltava, Ukraine) on “Development of algorithms and technologies for implementing a healthy lifestyle in patients with non-communicable diseases based on the study of functional status” (state registration number 0121U108237: UDC 613 616-056-06: 616.1/9-03; the execution period is from 2021 to 2025). Now these studies are continuing within the framework of the research topic of Poltava State Medical University “Clinical and pathogenetic features of cardiovascular diseases in conditions of comorbidity, taking into account gender and age aspects and ways of correcting their disorders” (state registration number 0124U003397; the execution period is from 2024 to 2028). It is the result of a systematic analysis of literature data.

Biophysical models and scientific data theorized by physicists and published in the specialized literature were analyzed. General scientific methods (dismemberment and integration of elements of the studied system, imaginary experiment, logical and historical research, analysis, induction, deduction, and synthesis of knowledge) and theoretical methods (method of constructing theory, logical methods, and rules of normative nature) were used in this theoretical study. Scientific work is carried out in conjunction with the following scientific institutions: 1) Lithuanian University of Health Sciences (9, A. Mickev-

ičius St., LT-44307, Kaunas, Lithuania), the cooperation coordinator is Prof., DM A. Vainoras; 2) Shupyk National Healthcare University of Ukraine (9, Dorogozhytska St., 04112, Kiev, Ukraine), the cooperation coordinator is Prof., DM O.P.Mintser; 3) Kherson State University (14, Shevchenka St, Ivano-Frankivsk, 76000, Ivano-Frankivsk region, Ukraine), the cooperation coordinator is As. Prof., PhD S. Danylchenko; 4) Lithuanian Sports University Institute of Sports Science and Innovation (6, Sporto St, LT-44221 Kaunas, Lithuania), the cooperation coordinator is As. Prof., PhD K. Poderiene.

The practical application of the obtained results in medical science is carried out through a series of lectures within the educational-scientific initiative “Bioelectronic Medicine or Look at Medicine Differently” [28].

Results.

Biological membranes and electromagnetic energy generation

Systematization, analysis of existing fundamental knowledge, and its extrapolation to biological concepts of human body functioning [4, 21-28] have allowed us to draw a basic conclusion about the essence of the mechanisms underlying biological life. It has now been established that the life of a biological cell is determined by the generation of electromagnetic energy by the molecules of the biopolymers of its membrane structures, followed by its subsequent transport to other molecules within the cell and beyond. This energy serves as a “nutritional” substrate for biological molecules, transmitting information and enabling the simultaneous, non-chemical coordination of all biochemical reactions *in vivo*. Cessation of electromagnetic energy generation by cell membranes leads to cell death. In other words, the life of a biological cell is determined by the occurrence of electromagnetic processes in its molecules (Figure 2).

THE ANSWERS ARE ALREADY

LSMU, PDMU,
SNHUU
2023-2026

THE PHENOMENON OF BIOLOGICAL LIFE IS COMPLETELY DETERMINED BY MAGNETOELECTROCHEMICAL PROCESSES AT THE MOLECULAR LEVEL.

ABSENT ENERGY PROCESSES -
ABSENT LIFE


LET'S CONSIDER HOW IT HAPPENS IN SIMPLIFIED MODELS...

Figure 2. The phenomenon of biological life arises from electromagnetic processes that occur at the quantum level *in vivo*.

It is important to emphasize the fact that the electromagnetic processes that support the biological cell's life include all processes of electromagnetic current generation and circulation, as well as all metabolic biochemical reactions within cells. The biochemistry of molecules is a secondary derivative of biomagnetism. This is because chemical interactions between atoms are based on their quantum-mechanical properties and energy states, which

determine the biochemical reaction [4, 27].


Thus, as established, the fundamental structural component supporting the biological life of a cell is its membranes: both external and intracellular. Membranes are the main structural elements at the subcellular level, playing a key role in the life support of cells by generating the cell's specific electromagnetic energy (Figure 3) [4, 27].

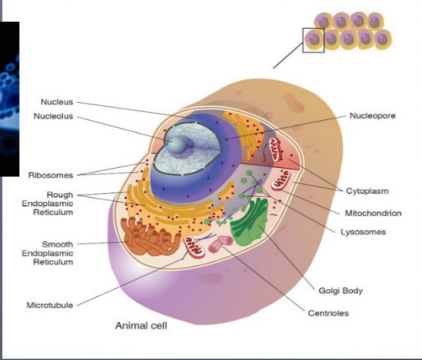


TO UNDERSTAND THE ESSENCE OF THE PHENOMENON OF LIFE IS THE KEY TASK OF SCIENCE

LSMU, PDMU,
SNHUU
2023-2026

o Membranes are the main structural element of the subcellular level, which play a key role in the life support of cells






The total mass of intracellular membranes is 2/3 of the mass of a dehydrated cell

Cell = it's membranes + other

Figure 3. Biological membranes are the basic structural components of cells, which enable the phenomenon of biological life to occur in them.

The functions of biological membranes have been studied (Figure 4). However, according to modern views, the emphasis should now be shifted when it comes to cell life support. The most important function of biological membranes was considered to be the barrier function. In light of modern concepts regarding the dominant role of electromagnetic processes in the emergence of cellular life and the fact that biological membranes generate electro-

magnetic energy [29], this issue should be reconsidered. If a cell's biological membrane ceases to generate electromagnetic currents, the cell dies, even if the membrane is intact and its barrier function is not impaired. The implementation of the barrier and transport functions of membranes also depends directly on their energy function, that is, their ability to generate and conduct electromagnetic energy.

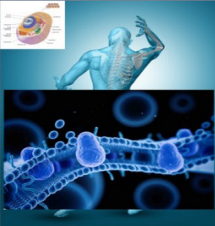


FUNCTIONS OF CELL MEMBRANES

LSMU, PDMU,
SNHUU
2023-2026

THE MAIN FUNCTIONS OF CELL MEMBRANES:

1. BARRIER FUNCTION (exchange and transport)
2. MATRIX FUNCTION (mutual reproduction and orientation of proteins determines the interaction of enzymes, etc.)
3. MECHANICAL FUNCTION (strength and autonomy of cells and organelles)



THE ADDITIONAL FUNCTIONS OF CELL MEMBRANES:

1. RECEPTOR FUNCTION
2. GENERATION AND CONDUCTION OF BIOPOTENTIALS
3. ENERGETIC (described as the ability to synthesize adenosine triphosphate on the inner membranes of mitochondria and synthesis of carbohydrates in the chloroplasts of plant cells (photosynthesis))

YOU CAN DISAGREE WITH THIS - IT IS NECESSARY TO PLACE ACCENTS DIFFERENTLY...

Figure 4. Functions of biological membranes according to the existing paradigm.

General aspects of bioelectromagnetism of biological membranes

Why do electromagnetic currents generate specifically in biological membranes? The answer lies in their structural features.

First, all biological membranes have a liquid-crystalline structure in vivo (Figure 5). The bimolecular layer of phospholipids that forms biomembranes, under physiological conditions (at body temperature, normal pH, and the ionic composition of the interstitium and cytosol), is a liquid crystal. The liquid-crystalline state of membranes results in a high degree of order and high mobility of their molecular components. This ensures the stability of the structures they form in an open system under chang-

ing conditions, as evidenced by the significant mobility of their molecular components and high recovery rates. For example, the half-life of membrane structures in the plasma membrane and endoplasmic reticulum membranes is 50 hours, in mitochondrial membranes it is 110 hours, in the nuclear membrane it is 120 hours, the half-life of membrane lipids is 15-80 hours, membrane cholesterol is 24-140 hours, and so on. Liquid crystals are capable of phase transitions, that is, transforming into solid crystals and returning to their original state, which in vivo can occur under physiological conditions in response to several agents/stimuli and not in the entire membrane volume, but in its individual areas [4, 29].

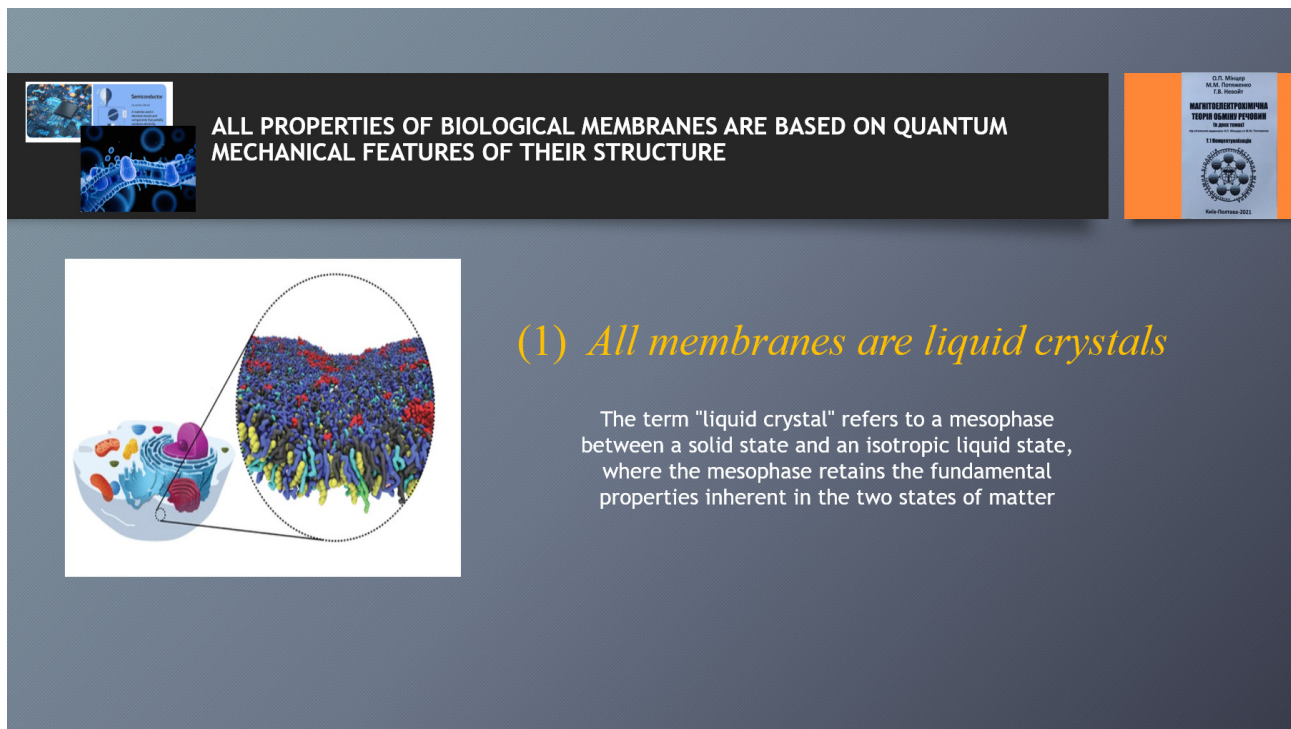


Figure 5. The main feature of the quantum-mechanical structure of biological membranes.

Other important structural features include asymmetry in the composition of membrane proteins, carbohydrates, and lipid layers, with these layers being highly dynamic. In the plasma membrane of all mammalian cells, the outer surface is rich in choline phosphatides (phosphatidylcholine, sphingomyelin), while the inner surface is rich in aminophosphatides (phosphatidylethanolamine, phosphatidylserine). Due to lipid asymmetry, the outer and inner surfaces of biological membranes undergo deformations in response to temperature changes and chemical exposure. Lipid asymmetry can determine the curvature of the cell membrane and its semiconductor properties. The inner surface of biological membranes is free of carbohydrates, whereas glycoproteins are concentrated primarily on the outer surface of the plasma membrane and serve as receptors. The majority of the plasma membrane enzymes in most cells are embedded in the inner half of the lipid bilayer. The symmetrical orientation of proteins and lipids

determines the vectorial properties of a biomembrane, i.e., the ability to transport substances unidirectionally across it, and also influences the membrane's semiconducting properties. Data on the variability of the physical and chemical properties of cell membranes indicate that they are highly dynamic structures: biological membranes can move, disappear, and reappear. Membrane changes occur continuously within the cell. An important aspect is that, due to their structural features, biological membranes can generate an electric current. They are characterized by electrostriction and flexoelectric effects (Figures 6 and 7) [4, 29].

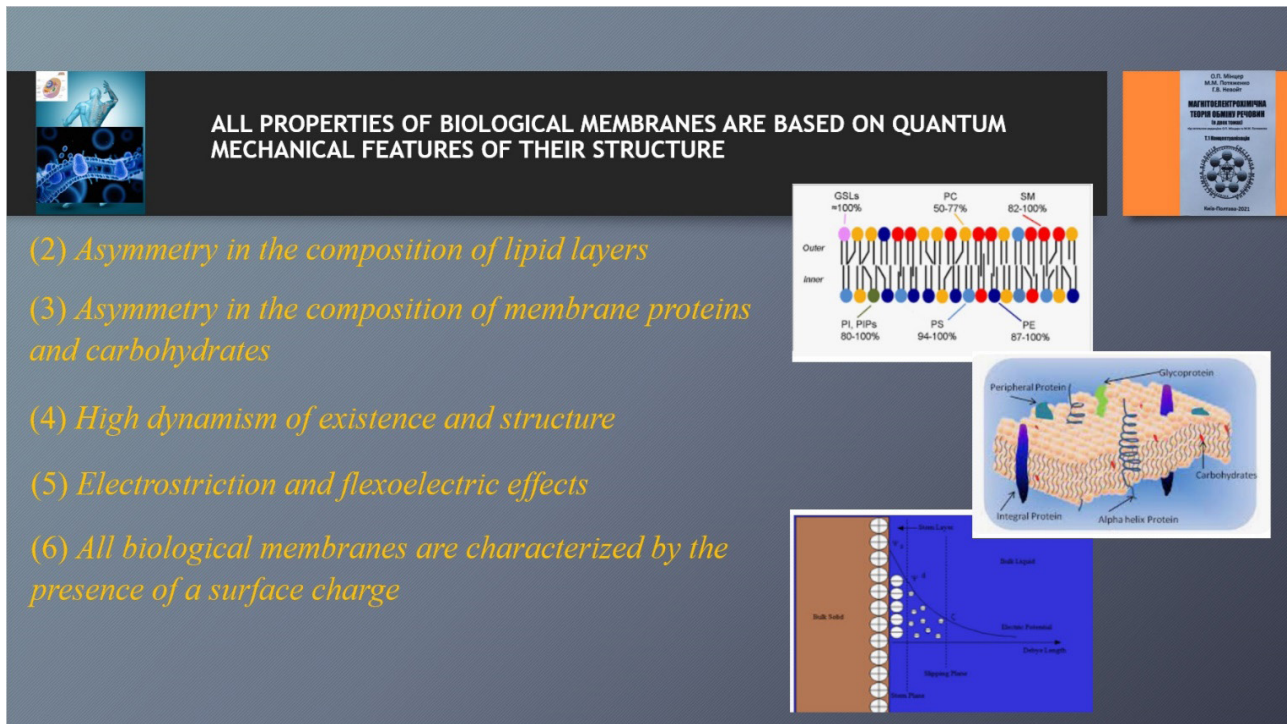


Figure 6. Features of the quantum-mechanical structure and function of biological membranes.


Therefore, all biological membranes are characterized by the presence of a surface charge. The polar heads of phospholipids create the surface charge, glycoproteins (mainly the carboxyl groups of sialic acid and amino acid residues), and glycolipids, which generate a negative charge on the surface of biological membranes. The presence of charged groups on biological membranes leads to the formation of a diffuse electrical double layer, in which the negative charge of the cell surface is fixed and balanced by the positive charge of ions in the interstitial medium. The potential difference between parts of the electrical double layer (the potential difference between the outer surface and the interstitium) is the electrokinetic potential/zeta potential. The zeta potential depends on the electrolyte type and ion concentration. With a 200-fold decrease in the sodium chloride concentration in the interstitial medium, the double layer thickness increases by a factor of 5. The zeta potential is related to the bilayer thickness by an exponential relationship: at high electrolyte concentrations, the zeta potential decreases to zero. In the presence of divalent cations in the intercellular space, the excess positive charges can become so significant that the zeta potential changes sign. A decrease in the zeta potential, and especially a reversal of its sign, is accompanied by adhesion of the plasma membranes of adjacent cells (for example, a change in the zeta potential occurs with excess Ca^{2+} in the intercellular space, as well as with cell membrane restructuring). In blood cells (e.g., erythrocytes), the zeta potential can decrease due to disturbances in the salt and protein composition of the blood plasma, which underlies the principle of changes in the erythrocyte sedimentation rate. Due to the zeta potential, electrolysis of cells occurs: in an electric field, they move toward the anode. The zeta



potential at the surface of different cell membranes varies from -10 to -30 mV [4, 29].

Thus, it is the quantum-mechanical structural features of membranes that determine their electrical properties. Furthermore, the plasma membrane's surface charge plays a significant role in intercellular interactions, contributing to the stability of membrane structures and the binding of ions in the intercellular environment. The ionic composition of the perimembrane layers of the intercellular environment depends on the plasma membrane's surface charge, thereby influencing a significant number of intracellular metabolic processes. The unique magneto-electrochemical properties of biological membranes are undoubtedly explained by the fact that, according to the quantum-mechanical structural parameters, they are semiconductor heterostructures and exhibit semiconductor properties (Figure 7) [4].

?

WHY IS THAT SO?




=


Semiconductor

(an ml-kar-104-04)

A material used in electrical circuits and components that partially conducts electricity.

ALL MEMBRANES ARE LIQUID COSTAL SEMICONDUCTOR HETEROSTRUCTURES THAT PLAY A KEY ROLE IN THE MECHANISMS OF MAGNETO-ELECTROCHEMICAL GENERATION OF ELECTRIC CURRENT AND ELECTROMAGNETIC FIELD

THAT IS, NOW THE MECHANISTIC SCIENTIFIC VIEW SHOULD BE CHANGED TO A MAGNETO-ELECTROCHEMICAL ONE...


Figure 7. Biological membranes are semiconductors.

Therefore, modern membranology should be the result of the convergence of biology and electronics. Allegorically speaking, biomembranes are essentially similar to capacitors (Figure 8): 1) they are semiconductor heterostructures; 2) they have a three-layer structure (a bi-molecular liquid crystal layer of lipids is at the edges and a protein layer is in the middle) with an asymmetry of

the three-layer organization depending on the type of cell and membrane; 3) they have an external positive charge formed by the heads of phospholipids; 4) they have an electric surface potential of 75-200 mV; 5) they have an increased concentration of Na⁺ ions outside the membrane, K⁺ – inside the cell (the property of selective permeability for Na⁺ and K⁺ ions) [4].

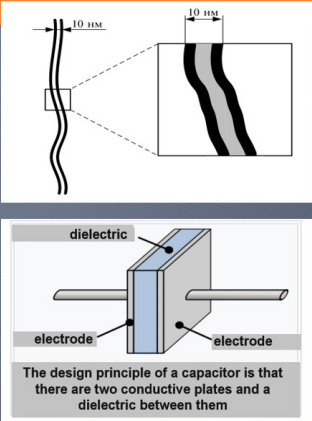
?

WHY IS THAT SO?



MODERN MEMBRANE SCIENCE IS THE RESULT OF THE CONVERGENCE OF BIOLOGY AND ELECTRONICS.....

BIOMEMBRANES guess CAPACITORS



The design principle of a capacitor is that there are two conductive plates and a dielectric between them

THAT IS, MEMBRANES GENERATE AND ACCUMULATE CHARGE...

Figure 8. Biological membranes are capacitors.

Biological membranes, like technical capacitors, can accumulate electrical charge. When a capacitor is connected to a power source, an electric current begins

to flow through it. At the beginning of the current's passage through the capacitor, its strength is maximum, and its voltage is minimum. As the device accumulates charge,

the current decreases until it vanishes, and the voltage increases. During charge accumulation, electrons accumulate on one plate, and positive ions on the other. No charge flows between the plates due to the presence of a dielectric. This is how the device accumulates charge. This is called electrical charge accumulation, and the capacitor is called an electric field accumulator. Similar processes occur in biological cell membranes [4].

Moreover, the membranes of all cells in the human body [including tissue, bone, fat, liquids, and the like] are semiconductors of varying types. Depending on their structure and corresponding quantum-mechanical characteristics, membranes can be classified as [4]: 1) narrow-band semiconductors, which conduct current well like semimetals (for example, these are biological membranes of nerve and muscle cells); 2) wide-band semiconductors and insulators, including those with ionic (usually proton) conductivity (for example, these are membranes of cells of adipose and bone tissue); 3) semiconductors with mixed conductivity (for example, different aqueous environments of the body have such parameters).

A biological representation of the biophysical mechanism of the occurrence of electromagnetic currents in biological membranes

The biophysical mechanism underlying the generation of electromagnetic currents in biological membranes is that membrane biopolymers convert the chemical energy of adenosine triphosphate (ATP) molecules into their own specific electromagnetic energy, which is coherent and in the form of a standing wave—a soliton. When phosphate residues are cleaved from an ATP molecule, the energy of these chemical bonds is released. This energy enters the biopolymer molecules and is transformed, during their movements/oscillations, into cell-specific coherent elec-

tromagnetic energy. This energy transformation occurs due to the quantum-mechanical properties of the structure of their primary molecular chains with amide groups, which formed during the stage of chemical evolution [4]. This is essentially the key biological moment in the generation of electromagnetic energy in the membrane. Questions regarding the generation and movement of energy along biopolymer chains were theorized by the Soviet biophysicist A.S. Davydov [30-32]. He found a solution to the nonlinear problem of energy conversion and its movement along biopolymer chains, as one of the most important stages of self-organization in a living system [30-32]. This resolved the crisis of biophysics of the 1970s [4]: at that time, experiments established the fact that the movement of energy along a biopolymer chain occurs at such a high speed that this effect could not be explained by the generally accepted model of energy transfer by π -electrons, which passed to biopolymers from ATP [33-38].

A significant contribution to the understanding of the biophysical processes of electromagnetic energy propagation through biological membranes and in the cytoplasm of cells was made by the work of the Soviet biophysicist N. Gall [4] on collective processes in biopolymers. She also made a significant contribution to the generalization and extrapolation of biophysical concepts of these mechanisms to biological models of processes [39,40]. Thanks to the generalization of these scientific concepts with the results of studies of the properties of water in vivo [41-43], it became possible to understand that electromagnetic energy is formed in membrane biopolymers, circulates through them, is transferred from one biopolymer to another, and is transferred without loss to liquid crystals of structured water (Figure 9).

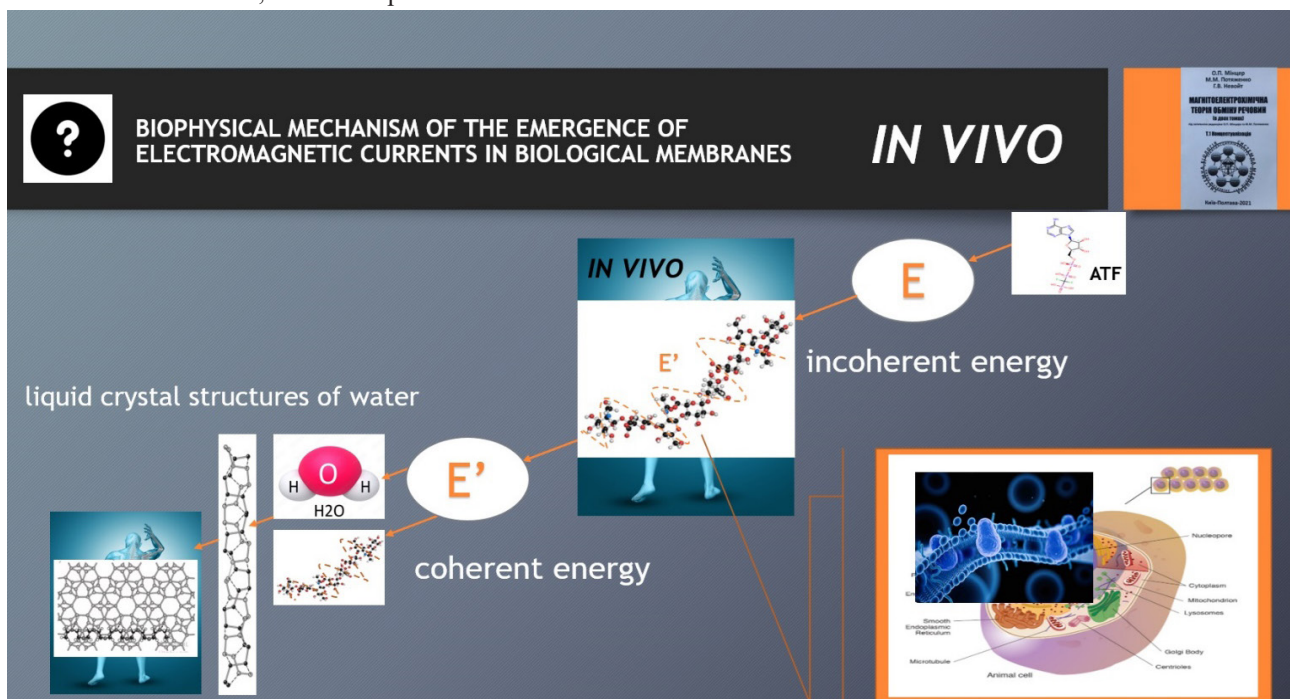


Figure 9. The principle of generation and transmission of electromagnetic energy in the membranes of biological cells.

Thus, the liquid crystal structures of membranes, formed by biopolymers, and the liquid crystal structures of water in the cell cytoplasm and intercellular fluid are

components in the formation of a single circuit for transmitting the flow of electromagnetic energy/current inside biological cells and beyond them (Figure 10).

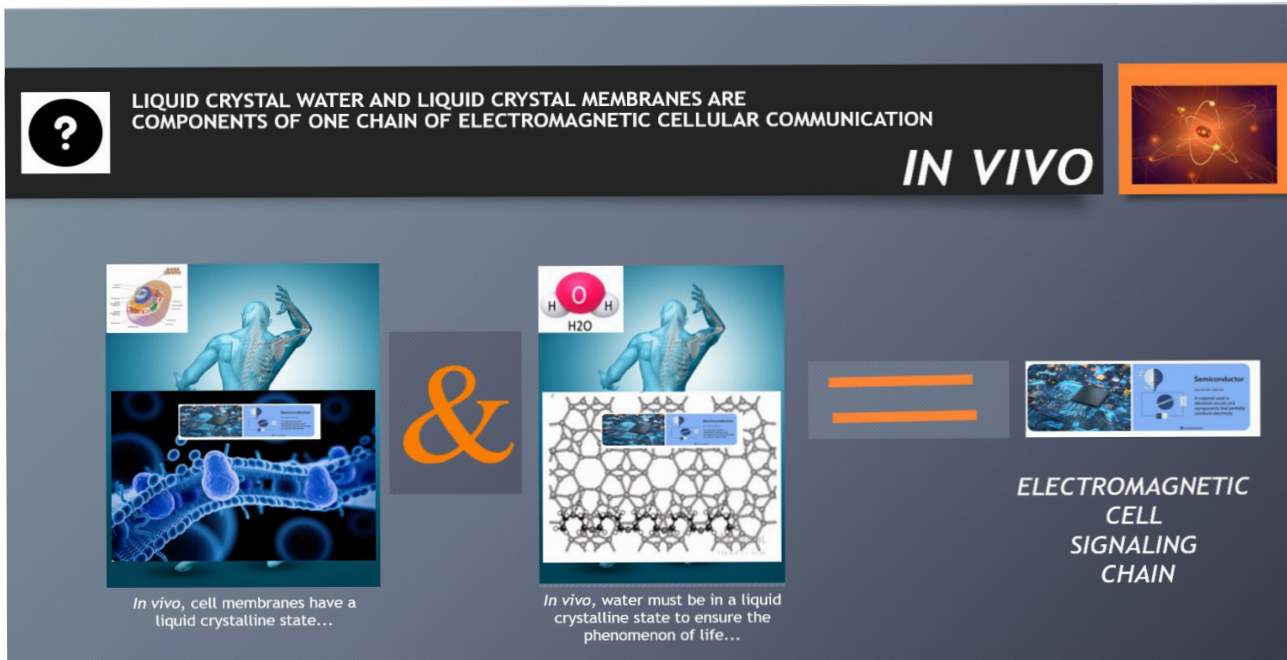


Figure 10. The principle of generation and transmission of electromagnetic energy in the membranes of biological cells (continued).

Due to the constant circulation of electromagnetic energy along this electromagnetic communication chain, all molecules of biological cells/tissues are non-chemically unified into a single functional whole. As a result, each biological molecule receives an instantaneous coordinating electromagnetic signal that controls its biochemical be-

havior. In vitro, biological molecules/biopolymers cease to receive this electromagnetic energy and information from other biopolymers in the cell. For this reason, they cease to coordinate their metabolism outside the biological cell (Figure 11) [4, 44].

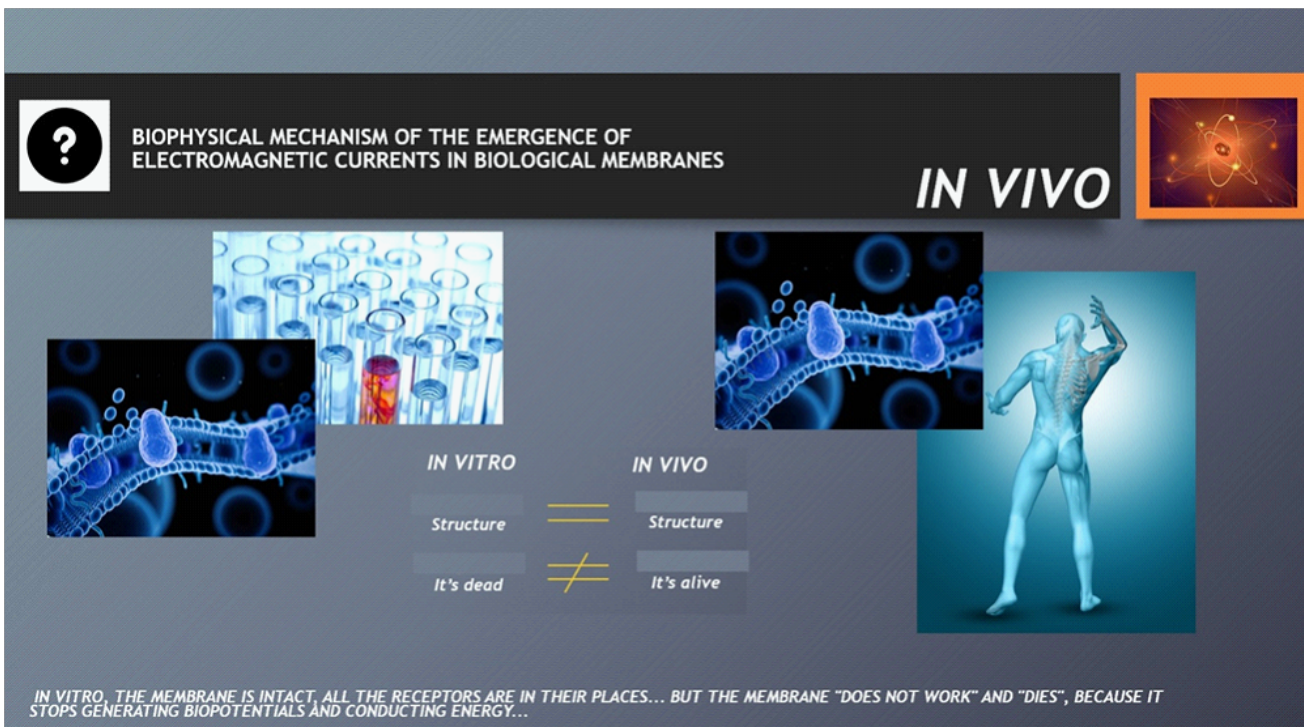


Figure 11. The principle of generation and transmission of electromagnetic energy in the membranes of biological cells (continued).

The evolution of knowledge in the physicochemical approach has generated criticism of the classical membrane theory of cell structure. A weakness of the membrane theory has proven to be the calculated energy consumption of membrane ion pumps, which is incompatible with common sense: it has been calculated that maintaining Na^+ and K^+ gradients through the membrane's Na^+/K^+ -ATPase requires 3600 times more energy than the cell can actually store [3,4], and so on. The electrochemical paradigm of metabolism cannot adequately describe the mechanism by which cells generate alternating current using environmental resources, cannot definitively explain how rhythmicity and an adaptive energy response to stimuli are ensured, and cannot explain how, and by what mechanisms, cells are organized into a single morphoenergetic structure. This information has prompted consideration of the existence of as-yet-undiscovered methods of regulating and supplying energy to cellular metabolism, as well as the need to continue the search for truth. The membrane magnetochemical biocurrent generation circuit model addresses a problematic issue. It describes a universal mechanism for explaining the phenomenon of electromagnetism in living biological systems as a consequence of the generation and flow of alternating current within their membranes. This model is simple and universal. Its creation resulted from a combination of knowledge from modern electrochemistry and cybernetics. The membrane magnetochemical biocurrent generation circuit model (authored by Soviet physicist Oshe) represents a universal algorithm for explaining the mechanism for the emergence of electromagnetism in living biological systems as a result of the generation and flow of alternating current within their membranes [4].

The essence of the idea [4]: the energy supply of living biological systems is provided by electrochemical processes on their membranes through reactions of anodic oxidation of digestive products (fuel) and cathodic reduction of oxygen (oxidizer). These reactions occur specifically on biological membranes due to the membranes' semiconductor properties. Magnetochemical reactions occur directly in cell membranes because the phosphate portion of the membrane mediates all electronic processes, while the lipid portion delivers the protons that control them. The processes of anodic oxidation and cathodic reduction are interconnected through their reaction products—the acid-base balance, which is controlled in a living organism by the laws of cybernetics. The design principle of the biological circuit for membrane magnetochemical generation is similar to that of the technical one. The only fundamental difference between the biological circuit for magnetochemical biocurrent generation and its technical counterparts is that in technical equipment, the anodic and cathodic reactions occur on different electrodes separated by an electrolyte. In the membranes of living biological systems, both processes occur on a common membrane through a single electron and ion-conductivity channel. Since biological membranes are semiconductors, they typically exhibit a nonspecific electrochemical response to any actions that alter the electronic conductivity of liv-

ing tissue. The well-known magnetochemical patterns of receiving and transmitting nerve impulses from receptors to target tissues can also be explained by the mechanism of biocurrent generation, as described by the model of a biological magnetochemical membrane generator. The difference is that neurons produce a greater quantity of biocurrent under the same qualitative conditions as a result of a different biological purpose of cells, respectively, (the ability to collect and transmit information in the form of high-frequency electrical impulses over a distance and, accordingly, an elongated shape with dendrites at the end, strengthening of protective lipid electrical insulation with nodes of Ranvier for feeding the energy of the signal transmitted over a distance and transmitting data on its strength via the frequency in the pulse packet/solitons). The biological magnetochemical membrane generator has energetic advantages over an artificial technical generator: - in a normally functioning cell, all the necessary reaction components are always available in sufficient quantities; their delivery to the “electrodes” (specific sections of the membrane) and the removal of products occur alternately and involuntarily. Technical generators for all these processes use additional “devices”, which reduce their efficiency. The stability of the rhythms of the biological magnetochemical membrane generator serves as an indicator of the performance (resistance and adaptability) of the living cell to external influences, since it depends not so much on the power of the electrochemical reactions occurring on the membranes, but on the action of low-energy factors connecting these processes - catalytic; this is integrally reflected by the generated frequency of alternating current (for example, from the effect of homeopathic doses of electroactive substances on the catalytic action and proton transfer in the biomembrane and on any other external influences, and the like). The processes of biological current generation by membranes can be accelerated or decelerated within the limits of homeostasis: theoretically, if the biological membrane of a cell is exposed to a factor requiring a change in energy conditions, then the magnetochemical membrane generator, being essentially a complex of reaction flows in certain areas of the membrane, can be reconstructed. Self-organized, stable, and compliant with new conditions, the model of a biological magnetochemical membrane generator adequately explains the mechanism of energy supply for cellular metabolism. The membrane magnetochemical biocurrent generation circuit model is a solution to a problematic issue. The model describes a universal mechanism for explaining the emergence of electromagnetic phenomena in living biological systems as a result of the generation and flow of alternating current in their membranes. This model is simple and universal. It was created by combining knowledge of the modern laws of electrochemistry and cybernetics. The model of a membrane magnetochemical biocurrent generation circuit (the author is the Soviet physicist Oshe) represents a universal algorithm for explaining the mechanism of the emergence of electromagnetism in living biological systems as a result of the generation and flow of alternating current in

their membranes [4].

Frequency-wave model of the human body structure

According to universal physical laws, the electromagnetic energy generated by biological membranes merges into a single entity, forming the electromagnetic field of a cell. Tissue cells form organs, and the electromagnetic fields of these cells form the electromagnetic fields of the corresponding organs. Therefore, the human body can also be represented using a frequency-wave model (Figure 12). For each tissue and organ, there are objective parameters of their electromagnetic fields and a frequency in Hertz for normal functioning [25, 45-48].

It is important to understand that the emergence of pathology in the functioning of a biological cell/tissue/organ will be associated with a primary change in the course of electromagnetic processes. This is objectively manifested in changes to the parameters of their electromagnetic fields and their frequency-wave characteristics. These are important, promising parameters for an objective assessment of the functions of human organs during the development of internal diseases. This is a promising direction for further research into the magnetic fields of internal organs in health and disease [28, 44].

Conclusions.

1. The latest layer of fundamental knowledge in quantum physics, as applied to the quantum role of cellular

membranes in the phenomenon of biological life, must be integrated into the educational process of training specialists in the biological and medical fields.

2. This knowledge possesses significant paradigm-transforming potential, significantly deepening and changing scientific understanding of the etiopathogenesis of internal organ diseases.

3. Modern scientists must recognize that the phenomenology of life has a purely electromagnetic basis. However, the role of biological membranes is not purely mechanistic. Due to their liquid-crystalline state, biological membranes are unique generators and conductors of electromagnetic signals.

Author Contributions: G.N., K.P., S.D., G.J., M.P., O.M., and A.V.; Data curation, G.J. and A.V.; Formal analysis, O.M. and A.V.; Investigation, G.N., K.P. and S.D.; Methodology, M.P. and O.M.; Project administration, A.V.; Resources, G.J.; Supervision, A.V. and G.J.; Validation, G.J., O.M. and A.V.; Visualization, G.N.; Writing—original draft, G.N.; Writing—review & editing, G.J., O.M., M.P. and A.V.

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

Funding: This research received no external funding.

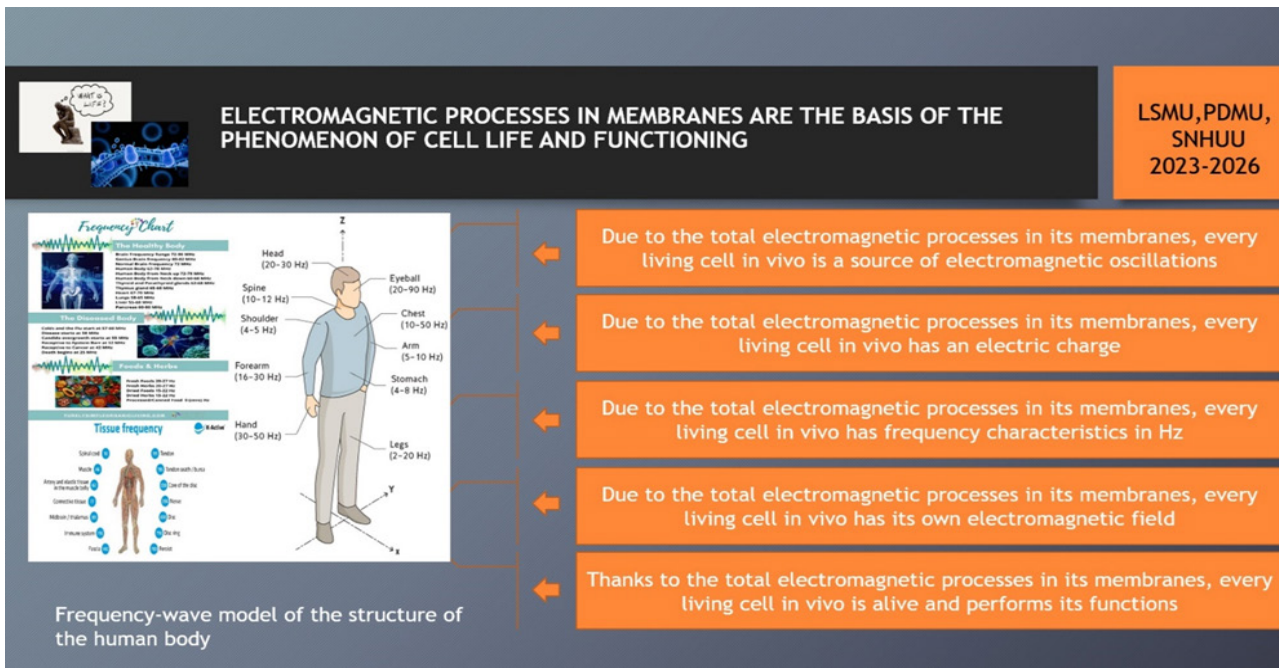


Figure 12. Frequency-wave model of the human body structure.

References:

- Szent-Gyorgyi A. (1969). Bioelectronics. Hardcover, Academic Press Inc., U.S.
- Grider MH, Jessu R, Kabir R. Physiology, Action Potential. [Updated 2023 May 8]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK538143/>
- Ling G.N. (2014). Can We See Living Structure In A Cell? *Physiol. Chem. Phys. & Med. NMR*, 43, 1–71.
- Mintser, O.P., Potyazhenko, M.M., Nevoit, G.V. (2021). Magneto-electrochemical Theory of Metabolism. Conceptualization., Kyiv-Poltava: Interservice. (Ukrainian)
- Taschetto, D. (2025). Rewriting the quantum “revolution”. *Studies in History and Philosophy of Science*, 109, 72–88. <https://doi.org/10.1016/j.shpsa.2024.12.006>
- Wells, J.D. (2020). Discovery Beyond the Standard Model of Elementary Particle Physics. In Springerbriefs in Physics Ser. Springer: Nature Switzerland AG.
- Paganini, P. (2023). Fundamentals of Particle Physics: Understanding the Standard Model. Cambridge: Cambridge University Press.
- Hübsch, T. (2023). Advanced Concepts in Particle and Field Theory. Cambridge: Cambridge University Press.
- Mintser, O. P., Semenets, V. V., Potyazhenko, M. M., Podpruzhnykov, P. M., & Nevoit, G. V. (2020). The study of the electromagnetic component of the human body as a diagnostic indicator in the examination of patients with non-communicable diseases: Problem statement. *Wiadomości Lekarskie*, 73(6), 1279–1283. <https://doi.org/10.36740/wlek202006139>
- Potyazhenko, M.M., Nevoit, G.V. (2018). Innovative methods of objective examination with computer testing in the evolution of registration of physical phenomena by a doctor of a therapeutic profile: history, reality, prospects. *Medical Informatics and Engineering*, 4, 58-65.
- Rae, A. (2004). Quantum Physics: Illusion or Reality? Cambridge: Cambridge University Press.
- Davies, P. C. W. (2010). The Ghost in the Atom: A Discussion of the Mysteries of Quantum Physics. Cambridge: Cambridge University Press.
- Schrödinger E. (1992). What is Life?: With Mind and Matter and Autobiographical Sketches. Cambridge: Cambridge University Press.
- Cao, Y., Romero, J., Olson, J.P., Degroote, M., Johnson, P.D., Kieferová, M., Kivlichan, I.D., Menke, T., Peropadre, B., Sawaya, N.P.D., Sim, S., Veis, L., and Aspuru-Guzik, A. (2019). Quantum Chemistry in the Age of Quantum Computing. *Chem Rev.* 119(19), 10856-10915. doi: 10.1021/acs.chemrev.8b00803.
- Gupta, V.P. (2016). Principles and Applications of Quantum Chemistry. V.P. Gupta -Academic Press. doi.org:10.1016/C2014-0-05143-X.
- Marais, A., Adams, B., Ringsmuth, A.K., Ferretti, M., Gruber, J.M., Hendriks, R., Schuld, M., Smith, S.L., Sinayskiy, I., Krüger, T.P.J., Petruccione, F., and van Grondelle, R. (2018). The future of quantum biology. *J R Soc Interface* 15(148), 20180640. doi: 10.1098/rsif.2018.0640
- Graham, R.F., Gregory, D.S., and Yuan-Chung, C. (2011). Quantum effects in biology. *Procedia Chemistry* 3, 38-57. doi:10.1016/j.proche.2011.08.011
- Boyko, V.V. (2022). Vidguk na monografiyu kolektivu avtoriv O.P. Mintsera, M.M. Potyazhenko, G.V. Nevoit «MagnitoelektrohImIchna teoriya obminu rechovin» u dvoh tomah [Review of the monograph of the collective of authors O.P. Mintsera, M.M. Potyazhenko, G.V. Nevoit “Magneto-electrochemical theory of metabolism” in two volumes]. *Ukrainian medical journal*, 4(150), 111. [in Ukrainian]
- Gulyar, S.O. (2022). Vidguk na monografiyu kolektivu avtoriv O.P. Mintsera, M.M. Potyazhenko, G.V. Nevoit «MagnitoelektrohImIchna teoriya obminu rechovin. Kontseptualizatsiya [Review of the monograph of the collective of authors O.P. Mintsera, M.M. Potyazhenko, G.V. Nevoit «Magneto-electrochemical theory of metabolism. Conceptualization»]. *Bukovinian Medical Bulletin.* 3, 103. [in Ukrainian]
- Kolbun, M.D. (2022). Vidguk na monografiyu kolektivu avtoriv O.P. Mintser, M.M. Potyazhenko, G.V. Nevoit «MagnitoelektrohImIchna teoriya obminu rechovin. Kontseptualizatsiya», Tom 1 [Review of the monograph of the collective of authors O.P. Mintsera, M.M. Potyazhenko, G.V. Nevoit “Magneto-electrochemical theory of metabolism. Conceptualization” Volume 1]. *Actual Problems of the Modern Medicine: Bulletin of Ukrainian Medical Stomatological Academy.* 2(22). 134-135. [in Ukrainian]
- Mintser, O., Potyazhenko, M., and Nevoit, G. (2023). Informational analytical representations of the magneto-electrochemical theory of life and health. *Journal of Applied Interdisciplinary Research* 2, 91–98. doi:10.26693/jmbs07.05.232
- Nevoit, G.V. (2021). Magneto-electrochemical concept of metabolism: postulates and main conclusions. Part 1. Current problems of modern medicine: *Bulletin of the Ukrainian Medical Stomatological Academy*, 1(21), 203-209. <https://doi.org/10.31718/2077-1096.21.1.203>
- Nevoit, G.V. (2021). Magneto-electrochemical concept of metabolism: postulates and main conclusions. Part 2. Current problems of modern medicine: *Bulletin of the Ukrainian Medical Stomatological Academy*, 2(21), 229-233. <https://doi.org/10.31718/2077-1096.21.2.229>
- Mintser, O.P., Potyazhenko, M.M., Vainoras, A., Bumblyte, I.A., Nevoit, G.V. (2022). Informational analytical representations of the Magneto-electrochemical Theory of metabolism, life and health. *Ukrainian Journal of Medicine, Biology and Sports*, 6(7), 232-

246. <https://doi.org/10.26693/jmbs07.05.232>
25. Filyunova, O., Nevoit G., Potyazenko, M., Vainoras, A. (2023). Bioelectronic Medicine for sports: justification of biophysical mechanisms and clinical feasibility of use. *Fitoterapiia. Chasopys – Phytotherapy. Journal*, 3, 63–72 doi:10.32782/2522-9680-2023-3-63
 26. Nevoit, G., Vlasova, O., Ryabushko, M., Moisieieva, N., Zviagolska, I., & Potyazhenko, M. (2024). Magneto-electrochemical theory of metabolism and life: what is it, when is it needed and what to expect from it for medicine and reflexology (literature review). *Fitoterapiia. Chasopys*. 2, 47-62. <https://doi.org/10.32782/2522-9680-2024-2-47>
 27. Nevoit, G.; Potyazhenko, M.; Mintser, O.; Jarusevicius, G.; Vainoras, A. Magneto-electrochemical theory of metabolism and life. In Book *Advances in Bioelectromagnetism: Innovations and Applications in Healthcare*. Editor: Tuan Anh Nguyen, 1st Edition. Elsevier, Academic Press - December 1, 2025 - Print Paperback ISBN: 9780443416248 eBook ISBN: 9780443416255 <https://shop.elsevier.com/books/advances-in-bioelectromagnetism/nguyen/978-0-443-41624-8>
 28. Nevoit, G.V., Poderiene, K.S., Danilchenko, I., Kitura, O.E., Lyulka, N.O., Golovchenko, I.V., Potyazhenko, M.M., Mintser, O.P., Yarushavičius, G., Vainoras A. (2025). Educational and scientific project “Bioelectronic medicine or look at medicine differently”: the path to a paradigm shift. *Ukrainian Medical Journal*, 4 (170), IV/V, 121-127. doi: 10.32471/umj.1680-3051.266174
 29. Nevoit, G., Bumblyte, I. A., Potyazhenko, M., & Mintser, O. (2022). Modern biophysical view of electromagnetic processes of the phenomenon of life of living biological systems as a promising basis for the development of complex medicine: The role of cell membranes. *Journal of Complexity in Health Sciences*, 5(1), 22–34. <https://doi.org/10.21595/chs.2022.22787>
 30. Davydov, A.S. (1982). *Biology and Quantum Mechanics*. Oxford: Pergamon Press.
 31. Davydov, A.S. (1977). Solitons and energy transfer along protein molecules. *Journal of Theoretical Biology* 66 (2), 379–387.
 32. Davydov, A.S. The theory of contraction of proteins under their excitation. *Journal of Theoretical Biology*. 1973, 38(3), 559–569.
 33. Bolterauer, H. (1990). Quantum Effects on the Davydov Soliton. In: Christiansen, P.L., Scott, A.C. (eds) *Davydov’s Soliton Revisited*. NATO ASI Series, Springer, Boston, MA. 243. doi: 10.1007/978-1-4757-9948-4_7
 34. Christiansen, P.L., Scott, A.C. (2013) *Davydov’s Soliton Revisited: Self-Trapping of Vibrational Energy in Protein* (NATO Science Series B:) Softcover reprint of the original 1st ed. 1990. Springer, 544 pages.
 35. Dauxois, T., Peyrard M. (2006). *Physics of Solitons*. Cambridge University Press, 422 pages
 36. Levin, M. (2014). Endogenous bioelectrical networks store non-genetic patterning information during development and regeneration. *The Journal of Physiology*, 592(11), 2295–2305. <https://doi.org/10.1113/jphysiol.2014.271940>
 37. Levin, M. (2021). Bioelectric signaling: Reprogrammable circuits underlying embryogenesis, regeneration, and cancer. *Cell*, 184(8), 1971–1989. <https://doi.org/10.1016/j.cell.2021.02.034>
 38. Stonis, J. R., Diškus, A., Remeikis, A., Orlovskytė, S., & Katinas, L. (2025). First documentation of Nepticulidae feeding on Gondwanan relict Nothofagus from Andean Patagonia and the unexpected discovery of morphologically similar pygmy moth species from distant Central America. *Biologija*, 71(1). <https://doi.org/10.6001/biologija.2025.71.1.1>
 39. Potyazenko, M.M., Nevoit, A.V. (2019). The human energy system as a part of natural energy exchange: Significance for fundamental science and medicine. Part I. *Ukrainian Medical Journal*. 5 (1), 24-29. doi 10.32471/umj.1680-3051.133.163161
 40. Potyazhenko, M.M., Nevoit, A.V. (2019). The human energy system as a part of natural energy exchange: Significance for fundamental science and medicine. Part II. *Ukrainian Medical Journal*. 6 (1), 41-44. doi:10.32471/umj.1680-3051.134.164365.
 41. Del Giudice E., Spinetti P.R., Tedeschi A. (2010). *Water*. 2, 566-586. URL: www.mdpi.com/journal/water
 42. Bulienkov, N. A., & Zheligovskaya, E. A. (2006). Functional modular dynamic model of the surface layer of water. *Russian Journal of Physical Chemistry*, 80(10), 1584–1604. <https://doi.org/10.1134/s0036024406100086>
 43. Bulienkov, N. A., & Zheligovskaya, E. A. (2013). System-forming functions of bound water in the mechanism of topochemical reactions of formation of ultrathin layers on water surface. *Biophysics*, 58(1), 1–18. <https://doi.org/10.1134/s0006350913010041>
 44. Nevoit, G., Filyunova, O., Potyazhenko, M., Mintser, O., Bumblyte, I. A., & Vainoras, A. (2023). Modern biophysical view of electromagnetic processes of the phenomenon of life of living biological systems as a promising basis for the development of complex medicine: Towards the concept of Bioelectronic Medicine. *Journal of Complexity in Health Sciences*. <https://doi.org/10.21595/chs.2023.23867>
 45. Nevoit, G., Filyunova, O., Danylchenko, S., Potyazhenko, M., Mintser, O., Bumblyte, I.A., Vainoras, A. (2025). Vega test method and diagnosis of Non-communicable Diseases: problems, biophysical diagnostic mechanisms and prospects. *Journal of complexity in health sciences*, 1:1-17. <https://doi.org/10.21595/chs.2024.24727>
 46. Schimmel, H. W; Schimmel, Helmut W.; Penzer, Victor. *Functional medicine*. Karl F. Haug Verlag, 1996
 47. Sylver N. (2011). *The Rife Handbook of Frequency Therapy and Holistic Health* Hardcover, Desert Gate. 768 pages.; Vértesi, C. (2004). *Infectious Disease Treatment with Radio Frequency Resonance* Washington: Alterra. 316 pages.; Vertesi, C. (2010). *The Use of Radiofrequency in the Medicine*. Revised by

Dr. K Eszto. Budapest. 655 pages. URL: [https://zap-
perotechnology.eu/Vertesi%20_The%20use%20of%20
Frequency%20V1.pdf](https://zap-
perotechnology.eu/Vertesi%20_The%20use%20of%20
Frequency%20V1.pdf)

48. Nevoit, G., Poderiene, K., Potyazhenko, M., Mintser, O., Jarusevicius, G., Vainoras A. (2025). The Con-

cept of Biophotonic Signaling in the human body and brain: Rationale, Problems and Directions. *Front. Syst. Neurosci.*, 19, 1-23. [https://doi.org/10.3389/fn-
sys.2025.1597329](https://doi.org/10.3389/fn-
sys.2025.1597329)

УДК 577.352.5+612.013+616-056.2

КВАНТОВА РОЛЬ КЛІТИННИХ МЕМБРАН ЯК ОСНОВА ФЕНОМЕНУ БІОЛОГІЧНОГО ЖИТТЯ, ЗДОРОВ'Я ТА ХВОРОБ В ОРГАНІЗМІ ЛЮДИНИ

Г. В. Невоїт^{1,*}, К. Подерєне², М. М. Потяженко³, О. П. Мінцер⁴, Г. Ярушевичус⁵, А. Вайнорас^{6*}

¹Лабораторія автоматизації серцево-судинних досліджень Інституту кардіології Литовського університету наук про здоров'я, Каунас, Литва

²Кафедра здоров'я та реабілітації Інституту спортивної науки та інновацій Литовського спортивного університету, Каунас, Литва

³Кафедра внутрішньої медицини та невідкладної медичної допомоги Полтавського державного медичного університету, Полтава, Україна

⁴Кафедра фундаментальних дисциплін та інформатики Національного університету охорони здоров'я України імені Шупика, Київ, Україна

⁵Лабораторія автоматизації серцево-судинних досліджень Інституту кардіології Литовського університету наук про здоров'я, Каунас, Литва

⁶Лабораторія автоматизації серцево-судинних досліджень Інституту кардіології Литовського університету наук про здоров'я, Каунас, Литва

ORCID: 0000-0002-1055-7844, e-mail: ganna.nevoit@lsmu.lt

ORCID: 0009-0000-4151-0742, e-mail: kristina.poderiene@lsu.lt

ORCID: 0000-0001-9398-1378, e-mail: m.potiazhenko@pdmu.edu.ua

ORCID: 0000-0002-7224-4886, e-mail: omintser@gmail.com

ORCID: 0000-0001-9205-1902, e-mail: gediminas.jarusevicius@lsmu.lt

ORCID: 0000-0002-5732-8520, e-mail: alfonsas.vainoras@lsmu.lt

*Correspondence: ganna.nevoit@lsmu.lt (Г.В. Невоїт); alfonsas.vainoras@lsmu.lt (А.Вайнорас)

Резюме. У науковому дослідженні представлено матеріалами другої лекції з циклу «Біоелектронна-медицина або поглянь на медицину інакше», яка презентує огляд новітніх поглядів на роль біологічних мембран у клітинах. Обґрунтовується той факт, що здатність до генерації електромагнітного поля/струмів є ключовою функцією мембран та біофізичною основою феномена життя *in vivo*.

Альберт Сент-Дьордь (1893-1986, Угорщина-США) — лауреат Нобелівської премії 1937 року за серію робіт з біологічного окислення, також відомий своєю фундаментальною працею «Біоелектроніка», яку опублікував у 1969 році. Появу цієї публікації можна вважати датою початку вивчення ролі електромагнітних процесів у молекулярній біології. А. Сент-Дьордь першим запропонував назвати цю галузь знань біоелектронікою та окреслив завдання і напрямки майбутніх досліджень

Матеріали і методи. Було проаналізовано біофізичні моделі та наукові дані, теоретизовані фізиками та опубліковані у спеціальній літературі. У цьому теоретичному дослідженні використовувалися загальнонаукові методи (розчленування та інтеграція елементів досліджуваної системи, уявний експеримент, логіко-історичне дослідження, аналіз, індукція, дедукція та синтез знань) та теоретичні (метод побудови теорії, логічні методи та правила нормативного характеру).

Результат. Важливо розуміти, що виникнення патології у функціонуванні біологічної клітини/тканини/органу буде пов'язане з первинною зміною перебігу електромагнітних процесів. Це об'єктивно проявляється у змінах параметрів їхніх електромагнітних полів та частотно-хвильових характеристик. Такі параметри відіграють важливу роль для об'єктивної оцінки функцій органів людини під час розвитку внутрішніх захворювань, що є перспективним напрямком подальших досліджень магнітних полів внутрішніх органів у нормі та при захворюваннях.

Висновки.

1. Новий пласт фундаментальних знань з квантової фізики щодо квантової ролі клітинних мембран у феномені біологічного життя необхідно інтегрувати в освітній процес підготовки фахівців біологічного та медичного напрямів.

2. Ці знання мають істотний парадигмально трансформуючий потенціал, істотно поглиблюють і змінюють наукове уявлення про етіопатогенез захворювань внутрішніх органів.

3. Вчені сучасності мають усвідомити, що феноменологія життя має тільки електромагнітну основу. При цьому роль біологічних мембран не є суто механістичною. Завдяки рідкокристалічному стану біологічні мембрани є унікальним генератором і провідником електромагнітного сигналу.

Ключові слова: медицина, біоелектронна медицина, біологічне окислення, квантова медицина, магнітоелектрохімічна теорія метаболізму та життя, біологічні мембрани, нова парадигма, біофізика.

Стаття надійшла в редакцію 23.02.2026 р.

Стаття прийнята до видання 25.03.2026 р.