Dissipative regulation.

A new approaches to understanding the regulatory mechanisms in the human body.

Dr. Igor Orzhelskyi[1], Dr. Andrey Kuznetsov[2]

Abstract

The functioning of a living body, maintaining the dynamic stability of its homeostasis, is provided by regulatory systems. Traditionally, such systems include the nervous and humoral systems of regulation. The third regulatory system of the body, which provides communication in the body, distance interactions according to the "informational" principle, is not considered. For this reason, the understanding of the law of nature – "substance-energy-information", uniting the foundations of any matter, is very limited in biology. Therefore, the rules and postulates of Synergetics, as a science of the self-organization of matter, in the understanding of modern scientists are far from real processes occurring in matter "here and now." This article provides a summary of the basic rules and principles of the interaction of Matter, Energy and Information, which is the basis of the third regulation mechanism in the human body.

Introduction

The functioning of a living body, maintaining the dynamic stability of its homeostasis, is provided by regulatory systems. Traditionally, such systems include the nervous and humoral systems of regulation. These systems are deeply integrated. Therefore, they are often even combined into a common name for neurohumoral regulation. Regulatory signals that play a communication role directly in these systems include: in the humoral system - signal molecules (biochemicals), and in the nervous system - nerve impulses (electrical signals). The nervous system provides a reasonably quick regulation. The humoral system is more inert than the nervous system.

Regulation mechanisms in the human body

A review of existing understandings of regulation

Many scientific studies and the results obtained indicate that the regulatory principles and mechanisms of these two systems do not adequately describe the properties and processes that occur in living organisms.[1,2]

In the historical context, the description of the dynamic features and methods of the matter reduced to the determination of hierarchical structural interacting units and the result of their structural transformations with the participation of energy.[3, 4] The third, not the only, but an essential participant in such changes, providing interaction, "information," as a rule, is not considered. In the best case, the role of "information" is attributed exclusively to the structural components of matter itself, for exemple, such as various hormones, enzymes and others.

It is at this stage that there is a substitution, and perhaps misunderstanding, of the actual in-depth content and role of "information" in such interactions and transformations. In this regard, the part and significance of the trinity of "substance-energy-information," which together determine the law of conservation of energy, remain blurred and limited in biology.[5] Therefore, the rules and postulates of Synergetics, as the sciences of the self-organization of matter, are perceived as something abstract, not directly related to the real processes taking place in the matter "here and now".[6] Nevertheless, the structural and functional conditioning of the transformation, the changed properties of matter, are considered apparent.

The effects of "information" as a regulatory mechanisms

The lack of understanding in biology and medicine of the "object of information reception" and the role from the impact of the material "subject" (factor) of information, does not allow to define the very concept of "Information". The current situation also does not allow us to accept the fact that "Information" is an indispensable and an obligatory participant in any interaction and transformation in the matter. This state of affairs in the natural sciences (biology, medicine and others), has existed for a long time, and does not find not only an appropriate solution, but even the need to pose a question to resolve it. At the same time, in other areas of science, which are far from biology and medicine (such as hydrodynamics, chemical transformations and reactions of complex molecules, and even social phenomena, etc.), all these processes of self-organization and, “information” associated with them, is one of the critical factors for for analysis and research of complex processes in thease scientific areas.

Here, self-organization processes are considered as processes of transition from a less ordered state to a more ordered one based on the “principle of collectivity”. The number of participants in the system (process), their collective, coordinated behavior and interaction are reflected in the formation of new (acquired) connections, and the properties of the whole system. Moreover, the processes themselves, the action of the collective participants (subjects) of the process, obey mathematical patterns. Cooperative participants in the new dynamic state, with minimal energy costs, show increased consistency (synchronism) and sensitivity (sensitization) as a reaction to external influences.

Synergetics is a science that explores the self-organization of complex systems and processes, combining different interdisciplinary areas of science. Moreover, these complex systems and processes are dissipative, i.e., exchange with the environment substance, energy, information. They are in a state of dynamic chaos, and for the most part, the processes in them are stochastic (random), non-deterministic. However, these systems in their behavior reveal correlation relationships and patterns that obey the well-known both physical and mathematical laws.

An essential components of the dynamic state and processes in dissipative systems, is the medium, which not only combines the elements of the system, but also, to a large extent, determines the properties and evolution of this dissipative system.

Dissipative systems in the regulatory processes of the body

The most important feature of the medium at the dissipative systems is its constant fluctuation (oscillation, vibration). Processes, system elements in which vibrations and fluctuations (variability) are present - have self-synchronization and self-organization. Without a unifying framework (medium) uniting these processes, synchronization would be impossible.

At the same time, all together these factors: a change in the properties of the medium; the energy and information, introduced into the dissipative system, can disrupt the current synchronization and self-organization existing in it. Accordingly, the dissipative system may lose the properties that were inherent in it, as a single coordinated dynamic object.

The modern challenge of synergy is set to clarify of the patterns of behavior of dissipative systems across microcosm.

An essential stage in this direction was the study and discovery of the properties of supramolecular systems that are part of complex dissipative systems of the living matter.[7] Such systems include genome molecules, organelles, tissue cells, where the medium that unites them is an indispensable participant.

It is well-known that these supramolecular systems have highly specific properties and, in particular, can recognize each other, move, and carry out various transformations in interaction with other molecules. The belief is that supramolecular systems are a bridge between the living and nonliving matter.[8] A group of scientists - Donald James Crum, Jean Marie Len and Charles Pedersen were awarded the Nobel Prize in 1987 for the “Development and use of molecules with structurally specific interactions of high selectivity.” Nature used supramolecular systems to create biological systems.

The question arises: what (!) in these complex molecular systems, with specific properties, is the “force point”, thereby the “receptor”, that can respond to fluctuating medium conditions and interaction of similar molecules (system elements)?

When representing a molecule as a dynamic, spatially organized chemical structure, attention should also be addressed to its internal conformational molecular components, such as ionic bonds between atoms and the angles at which these atoms are located relative to each other. It is known that with the same chemical composition of molecules with various properties of the environment and external influences, these ionic bonds and angles can vary.[9,10,11,12] Moreover, with a change in the conformation of the molecule, the properties of this molecule also change. An indispensable participant in such changes in living media is various derivatives of water molecules involved in the hydration of many molecules, including proteins. However, it is equally crucial that ionic bonds and angles in a molecule can not only change their sizes but also, through the medium of their location, distantly synchronize with similar ionic bonds and angles in other similar molecules.[13] With such synchronization, a dissipative system arises, as a new "collective - unified" system, but with newly acquired properties that are inherent to this entire self-organized system.

Among these acquired properties it is necessary to single out the minimum energy costs for interaction, reaction, stabilizing the system, which is manifested in increased consistency (synchronism) and sensitivity, as a reaction to external influences.

The formed new state of the system co-occurs with the participation of all participants in the system, its components. Such a new state of the system carries a new regulatory (informational) signal that is complementary meaningful already for other levels of cascade (hierarchical) interaction and regulation. Moreover, the dissipative properties of the regulatory signal formed equally for the entire dissipative system, with minimal external influences on it. Furthermore, the dissipative system itself performs the functions of a "Receiver," a "Converter" (carrying out a change in the information density of the regulatory signal) and a "Repeater."

Consider an example of intracellular regulation. At this level, regulation is not only based on the principle of "receptor-ligand" interaction, but also by the principle of simultaneous relay of the ligand signal (for example, any hormone) to all the same type of cell receptors. And this "Repeater" is a dissipative medium "receptor-ligand" and extracellular matrix (ECM). Moreover, in this process, humoral and dissipative regulation act together. Violation of dissipative regulation inevitably leads to a change in humoral regulation on the principle of positive or negative feedback.

Moreover, in the same medium (EMC) at the same time can operate without interfering with each other, a large number of dissipative systems. Diversity, or in other words, the principle of "no intervention" is based on the difference of the polarization properties of dissipative systems.

It is essential to answer the question: what is the basis for the perception, reading, dissemination, and destruction of regulatory information continually coming from the outside?

The extracellular matrix, however, like the protoplasmic (intracellular matrix), is a complexly organized anisotropic molecular structure. The matrix can stay in its two primary states - sol or gel.[14]

Sol is a minimally ordered matrix phase. It is in this phase that the maximum entropy in the system is observed (maximum chaos, disconnected bonds). In this phase, the mechanisms of diffusion transfer and interactions are realized.[14]

The gel is formed by the binding of protein molecules or other colloidal structures to large quantities of ionic derivatives of water molecules. The gel phase is a highly structurally organized phase. It is in this phase that the ECM has minimal entropy (minimal chaos, high consistency, or, in other words, synchronization of connections). The system responds to minimal, in terms of energy, external fluctuations. It is in the gel phase that the mechanism of dissipative regulation and interaction is realized. This means that in the gel phase, the dissipative system converts and transmits a regulatory information signal to all receptors, complementary to this signal. Thus, the perception, reading, distribution, and, in general, relaying of the regulatory signal occurs in the gel phase. In the sol phase, the information state of the dissipative system is reset. The self-oscillatory nature of the "sol-gel transition" rhythm ensures the cascading nature of informational regulatory interactions.

The ratio of the sol-gel transition rhythms changes under the influence of various factors, including pathological processes affecting the ECM of a particular tissue. This circumstance makes a significant contribution to the dynamics and nature of the development of diseases.

It is important to note that the transfer of regulatory information, according to the cascade principle, is also carried out between complementary dissipative systems. Dissipative ECM-information is translated into interconnected dissipative system receptors of cells. If the ECM, as a "Transmitter" and a "Repeater", functions as efficiently as possible, it means then "Receiver effective antenna area" is required less. This role of "Antenna" on the cell membrane is collectively performed by the same type of cell-receptors. Moreover, their synchronization ensures maximum efficiency of the "receiving antenna". If the receptors, for whatever reason, are not synchronized, to guarantee the sufficiency of the received signal, need a more significant number of such receptors and (or) a stronger (in terms of information density) external signal from the EMC is necessary.

Concluding remarks

Inter-organic and functional synchronization and dissipative regulation are carried out through humoral structures (blood, lymph). Neuronal structures also function with the participation of dissipative regulation. So, a neuronal electrical impulse overcomes the synaptic gap in the "sol-phase" and the "gel-phase" for its electrical impulse, an "insulator". The state of "sol-gel transitions" in neuronal processes is significantly reflected in a variety of conditions and operations of a living organism.

Thus, the system of dissipative regulation is essential, along with the neuronal and humoral systems of regulation. Moreover, a violation of the physiological mechanisms of dissipative regulation is necessarily reflected in the other two, the neuronal and humoral systems of regulation.

A reasonable question arises the consideration of approaches and principles, the creation and implementation of specific means for physiological normalization and restoration of dissipative regulation, along with the humoral and neuronal systems. We will continue to consider this issue in future publications.

Acknowledgements.

This work is carried out as part of a private scientific development of the authors under the guidance of Dr. Igor Orzhelsky, CME Swiss AG, Switzerland.

Author details.

Dr. Igor Orzhelskyi[1], Scientific director CME Swiss AG, Dorfstrasse 28, 9248 Bichwil, Switzerland, e-mail: orzhelskyi@cmeswiss.com;

Dr. Andrey Kuznetsov[2], academician of the Russian Academy of Medical and Technical Sciences, st. Krupskaya 4, 119311 Moscow, Russian Federation, e-mail: kuznecovandr@yandex.ru;

Only Corresponding Author: Mrs. Elena van Dijk, Private Clinic of Elena van DIJK, Gogolova 1056/14, 90201 Pezinok, Slovakia, tel.: +421 905 955 444, e-mail: elena@evd.sk

Conflict of interest.

The authors declare that they have no conflict of interest.

Publisher's note.

The article is published for the first time.

Received:

References:

1. E.M. Trukhan and V.N. Anosov, “Vector potential as a channel of informational impact on living objects” // Biophysics 52 (2) **376**, Moscow, (2007) ISSN: 0006-3029.
2. A.I. Poletaev Meridians of the body in terms of biophysics. // Fields and informational interactions - 2012: Materials of the III International Scientific and Practical Conference. Moscow, September 15-16, 2012, **81,** Moscow, (2012)
3. Varfolomeev S.D., Gurevich K.G. Biokinetics - Fair-press, Moscow, (1999). ISBN: 5-8183-0050-1
4. Physical chemistry of bioprocesses. Edited by S.D. Varfolomeev, Moscow: KRASAND, (2014). 800 pages. ISBN: 978-5-396-00585-3
5. Igor Orzhelskyi, Andrey Kuznetsov. “Theoretical foundations of physical and mathematical medicine” UDC 577.3, LLC “Media M”, Moscow, (2016). IBSN: 978-5-9908918-4-5
6. Hermann Haken. Information and Self-Organization: A Macroscopic Approach to Complex Systems., 2006 edition (November 23, 2010), 276 pages - ISBN: 978-3642069574
7. Jean-Marie Lehn. Supramolecular chemistry. Concepts and perspectives. – (1995), 281 Pages. – ISBN: 978-3-527-29311
8. Konovalov A. I. Supramolecular systems - a bridge between inanimate and living matter / A. I. Konovalov // XIV Youth Conference on Organic Chemistry, **4**, Yekaterinburg, (2011)
9. Dmitry Knyazev, Inorganic Chemistry, Moscow: Publishing House Yurayt, (2012). – **160** p.- 591 p. – ISBN: 978-5-9916-1632-4.
10. Dmitry Knyazev, Inorganic Chemistry, Moscow: Publishing House Yurayt, (2012). – **392** p.- 591 p. – ISBN: 978-5-9916-1632-4.
11. V. N. Binghy. Interference of ion quantum states within a protein explains weak magnetic field’s effect on biosystems. - Electromagnetic Biology and Medicine 16 (3):203-214 - July 2009 doi.org/10.3109/15368379709015653
12. Karasev V.A., Luchinin V.V. Introduction to the design of bionic nanosystems. - Moscow: FIZMATLIT, (2011). ISBN: 978-5-9221-1047-1.
13. Blekhman I.I. Synchronization in nature and technology. Ed. 2, (2015). ISBN: 978-5-9710-1456-0.
14. S. L. Zaguskin “Rhythms of the cell and human health”. Southern Federal University, Rostov-on-Don, (2010). ISBN: 978-5-9275-0777-1