Philosophical aspects of biological information, in the course of organic regeneration

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Философские аспекты биологической информации, в процессах органической регенерации

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Abstract. The fundamental element of developmental processes is the category of information, which gives the dynamic character to the existence of an organic whole. The manifestations of its causal action were noticed already in antiquity by Aristotle, while observing the development of organisms. Today, it manifests itself clearly in the field of experimental research on organic regeneration. Still, however, information as a causal developmental parameter requires an unequivocal definition in the context of its "controlling action" in relation to matter and energy.

Keywords: information, matter, energy, thermodynamics, biocybernetics, embryology.

Резюме. Фундаментальным элементом процессов развития является категория информации, придающая динамический характер существованию органического целого. Проявления ее причинного действия были замечены еще в древности Аристотелем при наблюдении за развитием организмов. Сегодня оно отчетливо проявляется в области экспериментальных исследований по органической регенерации. Однако информация как параметр причинно-следственного развития требует однозначного определения в контексте ее «управляющего действия» по отношению к материи и энергии.

Ключевые слова: информация, материя, энергия, термодинамика, биокибернетика, эмбриология.

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Introduction

Universe is a complexity which includes static and dynamic organic processes running in living organisms. Reality as a whole, it gives the impression of a material-energetic-informative order. However, information is its most important element because it gives it the purpose of existence as a perfect whole. The above dependencies can be symbolically expressed using an equation $\mathbf{E=^{i}mc^{2}}$ [Klimek, 2014].

The main task that scientists and philosophers have set for themselves is the final understanding of the mechanism on the basis of which complex causal processes take place within the formation and functioning of living structures. In Antiquity – Aristotle – postulated the existence of a substantial form, which gave the appropriate causal content to matter [Aristotle, *De Anima*, II, 413b 22; 414a 13; 414a 14; 414b 10].

Aristotle wrote:

> Now the soul is cause and origin of the living body. But cause and origin are terms used in various senses: accordingly, soul is cause in the three senses of the word already determined. For the soul is the cause of animate bodies as being in itself the origin of motion, as final cause and as substance. Clearly it is so as substance, substance being the cause of all existence. And for living things existence means life, and it is the soul which is the cause and origin of life. Furthermore, actuality is the notion or form of that which has potential existence. Manifestly, too, the soul is final cause. For nature, like intelligence, acts for a purpose, and this purpose is for it an end. Such an end the soul is in animals, and this in the order of nature, for all the natural bodies are instruments of soul : and this is as true of the bodies of plants as of those of animals, shewing that all are means to the soul as end; where end has two senses, the purpose for which and the person for whom. Moreover, the soul is also the origin of motion from place to place, but not all living things have this power of locomotion. Qualitative change, also, and growth are due to soul. For sensation is supposed to be a sort of qualitative change, and nothing devoid of soul has sensation. The same holds of growth and decay. For nothing undergoes natural decay or growth except it be nourished, and nothing is nourished unless it shares in life [Aristotle, *De Anima*, II, 415b 3; 416a 6].

Aristotle's substantial form had (in itself) integrating abilities of a dynamic character. Beside other conceptual categories coined by Stagirite, i.e. entelecheia, *dunamis*, *energeia*, *hyle*, *morphe*, *topos*, *telos*, *organon*, it constituted a fundamental element of his conceptual matrix which systematically included dynamic organic specificities. Today, it is often forgotten and the specificity of dynamic processes is reduced to the simple form of static-machine phenomena. Consistent systemic thinking of Aristotle (the conceptual aspect and the causal aspect of mutual relations and connections) should be an example for modern scholars and the basis for research in general [Khroutski & Klimek, 2018].

In general, it can be said that information as a causative factor of nature is omnipresent. In certain cases, it is expressed by a dynamic norm of action, integrating the physical and chemical material foundations. Its abilities and manifestations of action should be discovered through a "dynamic causal scheme" founded by Aristotle. Additionally, the mathematical description – despite its shortcomings – should be used as a tool for quantitative expression of the material-energetic-informational properties. In the longer term, should be used to constructing cybernetic models and predict organic events. Although, it will take into account only static quantitative dependences, but it can be experimentally applied on real dynamic development. In this sense, it will provide a static explanatory foundation for the overall measurement of development, especially dynamic exchange of matter, energy and information. With such a research assumption, the static description itself becomes only a tool for formalizing certain

aspects of dynamic development. The specific regenerative effect becomes a specific informative purpose, which requires the examining from side of qualitative dynamic dependences (using formal static tools, i.e. mathematics, physics, biocybernetics).

Despite the fact that today information is considered as a control parameter all physico-chemical processes, its essence of working is not sufficiently understood. The most important issue that needs to be solved is the final explanation relationship between matter energy and information in the area of organic regeneration. The main task of the present work is an attempt to methodological capture the possible way of working of information and its relationship with the material and energetically basis of the regenerated structures of the organism.

1. On the types of internal information in living systems

At this point, I'm only showing on general division of the categories of internal information which is adopted in biology as a science. However, in this paper I will refer to a certain aspect of information in the field of organic regeneration. I also insist, along with other scholars[2], that information (as a working causal factor) can not be divided on individual subcategories. Information is a kind of unity and constitutes unity, which is seen in the various classes of the physical and organic order. Experimental research shows, that it always enters into the system whenever it is activated[3] by the structures of the material body (temporarily suspending the action of these material structures). I will discuss the methodological issues related to the "suspending" action of information in further parts of the text. The living organism manifest a certain way of interconnection and interaction of elements and the possibility of maintaining a perfect order through the exchange of matter and energy with the environment in static and dynamic structures. In other words, living systems to their creation (also regulation) require the exchange of matter, energy and information. The dynamic complexity in a certain class of organic phenomena Weiss described as follows:

> Small molecules go in and out, macromolecules break down and are replaced, particles lose and gain macromolecular constituents, divide and merge, and all parts move at one time or another, unpredictably, so that it is safe to state that at no time in the history of a given cell, much less in comparable stages of different cells, will precisely the same constellation of parts ever recur (…). Although the individual members of the molecular and particulate population have a large number of degrees of freedom of behavior in random directions, the population as a whole is a system which restrains those degrees of freedom in such a manner that their joint

[2] Professors: R. Klimek. R. Tadeusiewicz, K. Khroutski.
[3] Professor Tadeusiewicz claims, that the information work where there is demand for it.

> behavior converges upon a nonrandom resultant, keeping the state of the population as a whole relatively invariant". [Weiss, 1962]

While matter and energy itself are used to "power" the developmental processes, information is already a fundamental parameter that controlling this power in the course of morphogenesis. Living organisms, at a certain stage of their development, maintain the quantum equivalence of matter, energy and information. The whole organization in a living system runs on basis controlling role of information. Usually, the information (as a cause) responsible for the course of the dynamics of life is divided as follows:

> – Genetic information contained in nucleic acids and preserved in reproducible macromolecular structures, stored in the genetic code, carrying information about the type and time of synthesizing specific proteins. It is claimed that it is present in the simplest living organisms. Its deficiency causes the process of protein synthesis and, consequently, the cessation of all life processes.
> – On the molecular level, the immune information is indicated, which is carried by antigens and antibodies in serological reactions. It is considered a type of information which is present only in certain living beings. It also states that it is not essential information. However, where the organism is adapted to receive it, it is indispensable there. This means that adapting to receiving immunological information is tantamount to the lack of other safeguards, "alarm systems" warning against the threat leading to the damage or destruction of the organism.
> – The cellular level reveals information that is related to the construction and regeneration of damaged parts of the body of plants and animals. Some scholars point out that this is a much "deeper" level.

It is worth noting that, for example, Ewa Jabłonka considers the following "dimensions of evolution": genetic, epigenetic, behavioral and symbolic. That is 4 channels of hereditary information, which include the possibility of a further, smaller divisions. Hereditary information precisely determines the structure of the organism. The form of this information changes in the process of ontogenesis until the target form of the phenotype is "established". It is a very complicated process, best described by a network of mutual dependencies [Gecow, 2010, 34–37].

2. Information as a dynamism integrating organic development

Information is closely related with phenomenon of totipotency, in both plants and animals. In antiquity, Aristotle observed the development of plants and knew that they could be divided and thus reproduced, releasing the prospective potency, contained in the individual parts of a divided organism.

> … even many animals that are not insects … can also live … after dividing their into numerous parts ... Plants live separately after dividing into parts – from one primordial tree many trees are born ... some plants reproduce by means of scions [Aristotle, *De Juventute et Senectute*, II, 468 a 26-468 b 3].

The phenomenon of totipotency is not as well visible in the case of animal organisms as in plant organisms. Rather, this is the issue that requires intensive research and definitive solution to the problem is: How (in special cases) information, as a dynamic parameter of the universe, can *de novo* trigger regenerative processes in living systems?

The above issue has been attempted to be solved on the basis of various methodological strategies. There's been such scholars who began their studies starting from the experimental data, moving into areas metaphysical generalizations, i.e. they started from the physico-chemical causes of development and came to a metaphysical concept (entelechy) [Driesch 1921]. Other researchers explained the complexity of the natural world on the basis of metaphysical foundations, e.g. soul as the cause of becoming [Aristotle, *De anima*, II, 412 i 20-22]. Today, the reality of the organic world is often studied solely on the basis of physico-chemical causes, taking into account the developmental "response" of the organism itself[4]. In each of the above methodology can be found an attempt to explain the complexity of the regenerative processes on the basis of postulated causes explaining that conceptually can be replaced by general category of information. However, metaphysics itself has more causal inspiring value in scientific research and less in terms of causal explanation of biological development[5]. Metaphysical positions, although not falsifiable, can be the subject of rational criticism and argument. They can also express the metaphysical belief in the existence of certain regularities occurring in our universe, without which practical scientific investigation is impossible [Popper, 1997, p. 209]. The frontier of metaphysics is constantly changing. Often, the scientific discoveries derived from metaphysical ideas take a strictly scientific form. The road leading to scientific discovery is often difficult and complicated. It can only be described by someone who has been through it at least once. Koenigsberg writes:

> I am fain to compare myself with a wanderer on the mountains who, not knowing the path, climbs slowly and painfully upwards and often has to retrace his steps because he can go no further-then, whether by taking thought or from luck, discovers a new track that leads him on a little till at length when he reaches the summit he finds to his shame that there is a

[4] The comprehensive historical view of various research positions in the field of experimental methods, and the searching of physico-chemical causes of development, can be found in the works of Joseph Needham [see: A *history of embryology*, New York 1959, *Chemical embryology*, vol. I, New York 1931.

[5] It's here mainly about experimental research.

> royal road, by which he might have ascended, had he only had the wits to find the right approach to it. In my works, I naturally said nothing about my mistakes to the reader, but only described the made track by which he may now reach the same heights without difficulty [Koenigsberg, 1906].

3. On the possibility of "temporary action" of information, in the course of organic regeneration

Based on the experimental data, it can be assumed that information is capable to "controlling" the material and energetic reality of every living organism. During the biological experiments with the use of various types of chemical substances or whole tissues introduced into organisms, observed a change in the course of development of the organism [Spemann, Mangold, 1924, pp. 99–638]. In this research approach, we can say that substances introduced into an experimentally damaged system interact in such a way that they "induce" information dynamics, which in turn activates their potential and developmental possibilities. In every living organism, take place specific physical and chemical relationships between cells. Every cell interacts with every other cell in holistic dynamic development. Therefore, information "control" developmental processes, not only during undisturbed experimentally development, but also during the repair of damaged body structures. In these phenomena occur gradually reducing the physical growth of entropy. If it is assumed that the introduced chemical substance (during experimental research) causes changes in a living system, it can be treated as one of many components of matter that is triggered by information – as an integrating factor *in actu*. On this basis, we can conclude that information is the causal essence of the material-energetic system, and is a specific parameter responsible for the course of the dynamics of life.

In this way, it overcomes material and energetic passivity, reducing the increase of entropy in studied thermodynamic system. Information is activated to action when only the normal state of the organism has been changed by the development of external events. This fact is confirmed by embryological experiments carried out on living animal organisms[6]. Information considered in this research context is a "constant carrier" of the changing material-energetic properties of the organism, and its gradual decrease of intensity determines the dysregulation of processes taking a place in living systems. In this sense, it can be said that the decrease of information activity, as shown by experimental studies, is equivalent to an increase of thermodynamic entropy.

[6] The experiments carried out by T. J. King's and R. Brig's show that not only the first sixteen cells of the embryo, as in the experimental research of H. Spemann's, but also thousands of cells of the later stages have a "totipotent" nucleus inside, which is informatively open to later structural changes in organisms, see King, Brigss 1956: 271-279 T. J. King, R. Brigss, *Serial transplantation of embryonic nuclei*, „Symposia on Quantitative Biology"1956, 21, pp. 271-279.

Therefore, information = negentropy. In general, information, as a fundamental factor of development of living organisms, but also in the functioning of the entire universe, strives to maintain quantum material, energetic and informative equivalence through its laws $\mathbf{E=^{i}mc^{2}}$ [Khroutski & Klimek, 2018, p. 210].

An open question is when and how does information begins its parametric control over individual parts of physical matter? Information, generally speaking, as the most important parameter of the universe is something operating in relation to what is inorganic.

> Information as the elementary part of nature has its own fundamental laws which are based on its own primary parameters by analogy to physical ones. Information acts on matter and energy by means of determination of the range of their possible reactions to develop into functionally complete being which embraces the future potency of the each and every cosmic system. It is a medium that functions to organize, accommodate, and affect all of the elements and forces of nature, formed prior to matter and energy as antecedent estate. [Challenging Integralism, 2017][7]

There must exist something in this type of relationship that is comparable to the principle of interaction in its general logical sense, but beyond the scope of "inorganic causation". Not only the "inorganic causation" but the whole development of events should be understood in relation to the interaction of the components of the organism on the basis of the exchange of matter, energy and information and the quantum equivalence of these elements. In simple words, if factor ***A*** affects on ***B***, then not only factor ***B*** is under his influence, but also ***A***.

The resource of information, as a peculiar parameter of the organic world, is on purpose directed towards a specific organic system. Therefore, in this methodological context, information is conceptually identical with the information purposeful. It is able to adapt to material and energetic actuality as a result of the specific abilities of controlling action. One can speak of a dynamic interaction of information and a specific material and energetic system. Information entering the system (as a living organism) is able to direct its functioning, without continuous impacts[8]. An example would be the physical increase in entropy in living organisms, which is reduced by the temporal

[7] Bremer, Josef; Khroutski, Konstantin S.; Klimek, Rudolf and Tadeusiewicz Ryszard (2017). "Challenging integralism, Aristotelian entelechy, hyle and morphe (form), and contemporary concepts of information, touching upon the etiological issues of carcinogenesis (with reflecting feedbacks of Paul Beaulieu, Ana Bazac, Anna Makolkin, Leonardo Chiatti, Milan Tasic and Dariusz Szkutnik)," *Biocosmology – Neo-Aristotelism* Vol. 7, No 1 (Winter 2017), pp. 8–111.

[8] The concept of the "temporal action" of the integrating factor was developed by Hans Driesch. It was a speculative-metaphysical approach, trying to reconcile the action of the extra-spatial factor (entelechy) with the general principle of conservation of energy in living organisms.

entering of information[9]. Data on medical imaging techniques using Shannon's theory show that information is the opposite of entropy. Each increase in the amount of information is associated with an increase in the degree of ordering of a given structure and a decrease in the entropy of the system under consideration. Conversely, where entropy increases, order decreases [Hodorowicz, Jasiczek, Klimek, Tadeusiewicz 2011, pp. 117-118].

In the course of organic regeneration, each cell configuration follows a specific developmental principle. The point is that the cells after reaching a certain population density, suspend their further division. It is therefore necessary, not only to establish information links between them, but also to establish the controlling effect of the information-parameter that has a "limiting" effect, i.e. by informatively "selecting" individual chemical components of the regenerated organic material. The assumption that the inhibition of cell division occurs solely through the accumulation of metabolic end products should be excluded. Experiments clearly show that a starving yeast cell, after adding a glucose solution to its structure, does not undergo (immediately) the process of biochemical changes. At first, it checks the concentration of the solution and the current density of the cell population. If the amount of solution in relation to the cells density is too low, it results in little or no metabolic efficiency. The same applies to the process where the cell density is very low with sufficient glucose solution loading. If these two input variables are in the optimal range, metabolism begins with energy production and cell division, while keeping information pathways active. Thus, even with a continuous supply of chemical substances and removal of metabolic products, the specified cells density is not exceeded [Klitzing, 2000, pp. 215-216]. Therefore, the essence of working information is based on a specific "suspending" mechanism, involving the physico-chemical material foundations, together with the material-energetic potentials of a living organism[10].

It can be added that information is directed at its object of action on purpose, because its causal "influencing" produces a specific effect. In this sense, a causal metaphysical idea can be refined, ultimately formalized and expressed as a specific cybernetic model.

4. On the need to conduct further system research in verifying the essence of information

A systemic approach to the studied phenomena should take into account all possible causal factors, which may affect on a developing organism in a combination

[9] An example is the process of morphogenesis.

[10] Information, from Latin *informatio* – image; informare – formation. In the presented approach, information means – "limiting", through suspension, the processes taking place on the material-energetic foundation.

way. A comprehensive research approach to the considered physico-chemical processes may contribute to increasing the experimental effectiveness in determining the scope of information activity. Consequently, such a methodological approach during the conducted experimental research will not lose the fundamental relationships taking place on the material-energetic-informative level of the organism. On the foundations of systemic thinking, Bertalanffy wrote:

> Since the fundamental character of the living thing is its organization, the customary investigation of the single parts and processes cannot provide a complete explanation of the vital phenomena. This investigation gives us no information about the coordination of parts and processes. Thus the chief task of biology must be to discover the laws of biological systems (at all levels of organization). We believe that the attempts to find a foundation for theoretical biology point at a fundamental change in the world picture. This view, considered as a method of investigation, we shall call "organismic biology" and, as an attempt at an explanation, "the system theory of the organism". [Bertalanffy, 1934, pp. 46, 64, 190]

Considering individual processes in a relational statement may also, to a large extent, contribute to the establishment of the fundamental task of the controlling parameter, influencing the development of events in the living system, primarily affecting the course of organic regeneration. It is additionally, this type of methodology could finally confirm that information, as a fundamental parameter controlling the potentiality of individual organism structures, has a comprehensive effect on them, based on a specific suspending capacity. This type of interaction of information is aimed at creating a quantum material-energetic balance in the organism, which serves life and biological organization. Such a research methodology should focus on mutual morphogenetic relations in the field of multifaceted causal interactions. It should also include comprehensive models of the phenomena and changes taking place in the organism, and not only concern individual organic processes[11]. The complex system cannot be treated as something that exists structurally independently, but it should be understood as something that remains in a special type of dynamic relationship with many causal factors, including information as a controlling parameter. The basic components of reality are not only material particles, but complex structures and causal relationships within it. Therefore, when explaining and describing this type of relationship, the key concept, information, should be taken into account, expressing its overall dynamism in relation to individual organic processes and the universe in general [Campbell, 1974, pp.179–186].

[11]The study of individual structures of biological phenomena is valuable insofar as they are included in a comprehensive relational juxtaposition, where individual elements exert mutual influences and dynamic interactions.

5. Biocybernetic look at the category of information

As mentioned above, information is purposely directed towards a given system because its causal action produces a specific effect. The manifestations of its action (within certain limits) can be modeled, explained and formalized.

Life phenomena can be considered at the level of atomic structures, molecular structures, macromolecular structures, multi-molecular complexes, cell organelles, etc. One can strive to capture the informational regularities occurring in intra-atomic structures, i.e. somewhat "lower", or in multicellular structures, i.e. "higher". Man is not able to observe the world of phenomena at all "depths" of its structure and dynamics simultaneously. Our basic tools of observation, i.e. the senses, record information phenomena only in layers. By observing the details, we lose sight of the whole. When we observe the whole, we stop noticing the details. By observing the inside of a cell through a microscope, only thanks to the ability to remember, we are able to combine certain facts with the category of information in a dynamic aspect and then we can relate the results of our observations to the right point of the whole organism. Further, by observing the whole organism, we lose the ability to perceive what is happening on the molecular level. Only thanks to memory, we then combine two different layers of phenomena into one multi-layer image. The same problem applies to time dimensions. By registering "fast" dynamisms, we stop registering the dynamics of "slow" phenomena and vice versa. Only thanks to the ability to remember, the elements of our observations can be combined into a multidimensional conceptual matrix[12], reflecting the real, full structure and dynamics of life phenomena.

Selye expressed the human ability to combine certain organic phenomena as follows:

> In order to learn something about the human kidney we must first recognize its subunits (cells, chemicals) and the role the principal unit (kidney) plays in relation to the other units (organs) in man. Then comparative studies will show as that, in most of these respects, the human kidney resembles that of other animals. Therefore, by determining how the animal kidney react to remedies against certain experimental diseases, we will be able to formulate theories that can forecast, with reasonable probability, what remedies have a chance to cure similar diseases in man. [Selye, 1964, p. 270]

Although in biocybernetics the category of information may be an element enabling the modeling of events and processes occurring inside a living organism, such a

[12] K. Khroutski, R. Klimek (2018), "Biocosmological definition of Information and its Naturalist causative significance, approaching to evolve the World Information University (WIU)," *Biocosmology – neo-Aristotelism* Vol. 8, No. 2, (Spring 2018); pp. 203–261.

reconstruction of the specific regenerative process is only a fragment of "complete" organic development. The reconstruction of the dynamics of reality in the model always leads to simplification. Considering information in this sense leads to a specific reduction of the wealth of unknown physico-chemical processes to the requirements limited by the needs of biocybernetic control. This type of research approach generates another problem, according to the assumptions of systemic thinking: that it is impossible to precisely define a system as a specific set of elements and feedback between these elements that define the properties of the whole [Tadeusiewicz, 2014, pp. 103–107]. Through such a reductionist approach, it is only possible a general determination of the steering role of information (in quantitative character) during feedback between elements in the course of the emergence of new system properties. However, despite some shortcomings of this methodological approach to the studied phenomena, if tries to give a scientific idea of the facts relating to the regulation of organic processes.

6. Biocybernetic model – as an auxiliary tool in discovering the essence of information

Biocybernetic systems are often considered along with their certain dynamic properties, their behavior over time, and the type of signal they can process. Input signals (operands), reaching the system, are transformed into output signals (transforms). Due to the nature of the information precision, is necessary in such a system, whose input will be a specific set of arguments and also systems capable of processing continuous quantities. In order to describe such a system related to a specific regeneration process, the following should be specified:

- The number of causal inputs and outputs over the course of a specific regeneration process.
- The principle operation of the system, describing the causal relationship of the state of the outputs to the state of the inputs during regeneration.
- The system response time, reflecting the real regeneration process, which determines how long a change of state at the input, will cause a corresponding change at the output.
- The maximum rate of change of output state, describing the maximum rate at which the state of the output signal can rise or fall [see. Warchoł, Świdziński, Jaroszyk 2008, pp.266–269].

The importance of the individual factors describing the system is as follows:

- The inputs should describe the physical state of the causal factors (acting on the system) in a complex combination approach (temperature, pressure, the concentration of chemical substances, time).
- The outputs should describe the physical state of the factors directly affected

by the system; their form, like the inputs, need not be the same.

- The principle operation of the system should describe the mutual combinational relations of outputs and inputs states; for systems processing continuous values. It is usually presented as a function (system of equations of many functions) whose arguments are states at the input of the system, and the result is the state of the output or the state of outputs (if there are many). In the case of biological systems, the functions that describe them are complex and non-linear, therefore, various degrees of simplification are used to describe them.
- The system response time is the delay time between the input state and the appearance of the output reaction; it is generally not constant and can be described by a complex relationship.
- The maximum output state change rate determines how quickly the system output state can change; its meaning is revealed when the state at the input quickly changes – then the state at the output will not immediately (after the reaction time) assume the value resulting from the function describing the system, but will achieve it by changing the speed of which depends on the described parameter. [Warchoł, Świdziński, Jaroszyk 2008, pp. 266–269].

The advantage of this methodological approach is the possibility of combining a determination of probable causal relationships on the material-energetic-informative area in the course of organic regeneration[13]. In turn, in the case of the human body, such a methodological approach increases the chance of discovering the foundations of the morphogenetic mechanism (within a specified regeneration process) explaining the essence of the control in the process of restoration of damaged structures within a living organism. The difficulty of this approach is the subsequent description of the established phenomena. In the case of biological systems, description in the form of a function is postulated. They usually have a rather complicated form and non-linear character, therefore, in order to describe them various degrees of simplification are used, which depend on the accuracy of the required approximation [see Karch, Marciniak-Czochra 2014, pp. 3–20]. In the longer term, however, simplifications may lead to cognitive discrepancies in predicting and describing experimental results.

For example, in a constructed cell model it can be assumed that the signals x, at all inputs and the signal y at the output of the cell, are digital signals[14] with

[13] I mean the course of organic regeneration in organisms that are naturally programmed to reproduce copies of their parts. (e. g. the tail of a Zebrafish).

[14] The main difference between analog and digital signals is that in analog technology, information is translated into electrical waveforms of different amplitude. In digital technology, information is translated into a binary signal – it takes values conventionally called “0” and “1”, which correspond to two different voltage ranges (usually extreme voltage – mass and power level), and usually the forbidden area separating the ranges for “0” and “1 “. It can also be added that the digital signal, with appropriate coding, can have more than two values, e.g. coding on 4 voltage intervals will make it possible to store 2 bits in one state.

appropriately determined measurement values. In this sense, the presence of a causal pulse is determined signal value of 1, and its absence is expressed as 0. In this situation, the description of the functioning of the cell containing developmental potential may be given by a logical function with arguments *x*, (i = 1, ..., u) and the value of *y*. The most important task is to determine the form of the function that binds all *x* with *y*, and it is obvious that this function must depend on certain parameters characterizing a given cell, because each cell at each development stage performs a different function and takes over from other cells different tasks in the holistic development of the living organism.

Such a research assumption leads to taking into account the relevant dependencies between the input and output signals of the cell in the network.[15] The causal impulse, transmitted from one cell to the other, can have different effects on the behavior of the recipient cell. These differences can be of two kinds. Some signals coming through certain links have an excitatory effect on the cell, i.e. they cause it to generate a new causal impulse, while others, introduced through different connections, inhibit the process of generating impulses and make it difficult to send them. In this context – as mentioned above – we can talk about the temporal working of information as an integrating factor *in actu*. On whether the cell will eventually generate the impulse or not is determined by the resultant of stimulations and inhibitions between the positive and negative interactions of individual inputs. Each interaction can be related with a sign – positive for stimulating inputs and negative for inhibitory inputs. Individual inputs differ not only a sign, but the so-called weight. It is a hypothetical concept introduced to describe the fact of the uneven influence of individual inputs on the process of stimulating or inhibiting a given particular cell. Signals from certain specific inputs, corresponding to certain fixed signal sources, have a greater influence than analogous interactions from other inputs and other signals.

Biocybernetics itself can be used in experimental research only as an auxiliary tool. On its foundation, statistical models can be constructed and transferred to the empirical level, improving experimental research.

> In this type of problem, the solution is found not in the development of ever more cunning statistical calculations but in improving the experimental technique to a point where the results are self-evident. In the case of an inhibition, for example, all animals of the control group should show

[15] Stuart Kauffman constructed an abstract regulatory network of connections for the description of biological phenomena, which is based on a dynamic working. The nodes of this network have inputs to which input signals are given and outputs to which an output signal appears, the so-called node state as a result of a function whose arguments are input signals. See. S. A. Kauffman (1971), *Gene regulation networks: a theory for their global structure and behavior*, „Current Topics in Developmental Biology" 1971, 6, p. 145.

> maximal or near maximal lesions, while the treated group remains unaffected. In other words, such semi-quantitative scales of estimation exclude the possibility of using moderate changes as a basis for conclusions; the laboratory procedure itself must be improved until it is essentially perfect. [Selye, 1964, p. 261]

Statistical science, like biocybernetics, does not fully describe living organisms as a dynamic organic whole, but rather perceives them as summative arrangements, composed of independent elements. Admittedly, they take into account information as an important component responsible for controlling the basics of material-energetic; however, these views are only partially useful for capturing statistical and mechanical of biological phenomena. Only on them are "overbuild" dynamic biological phenomena, often observed during biological experiments. Therefore, it is not possible to fully understand the individual parts of the organism (systems) if they are treated as isolated structural mechanisms. Following Ernst Nagel, two features distinguish biology from the physical sciences in a fundamental way (this canon also includes biocybernetics). Firstly, biology assumes the dominant role of teleological explanation in experimental research. Secondly, it uses the conceptual apparatus necessary to study dynamical systems, whose behavior of which is not a result of the behavior of independent components.

Conclusions

It is known that at the organ level, each cell senses its position and interacts accordingly in relation to the whole organism. At the tissue and cellular level, each cell exchanges information with other neighboring cells. However, in order to fully explain and describe the issues of organic regeneration the searching causal mechanism should aim to explaining the genesis of the informational resource of the cell in relation to the organism as multicellular complexity. A mechanism of this type should capture the way in which the information expresses a dynamic control form. In the above research framework, it should be carefully checked to what extent information working temporarily, "directionally" suspending the development of events in a specific system, and how its "temporary encroachment" releases the potentiality of matter according to the general principles of energy conservation. In this sense, an important task for scientists is to construct cybernetic models, recreate and discover their role in the course of regeneration. At this point, undoubtedly, biocybernetics plays an important epistemological role. Transferring it to real development is the foundation for discovering dynamic relationships, then captured with the help of dynamic concepts and principles. In this spirit, one should work on determining over the way of triggering and transfer information between individual cells. This is exactly, how the impulse of one cell is introduced as an input signal to another cell in a particular regeneration

network. Unambiguous determination of connections between individual cells along with their mutual interactions may significantly contribute to the understanding of information processes taking place in individual cells and in the entire network – as an organism.

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