

Evolution and Development of the Information Concept in Biological Systems: From Empirical Description to Informational Modeling of the Living Structures

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With the purpose to smooth the way of a correct understanding of information concepts and their evolution, in this paper, is discussed the evolution and development of the concept of information in biological systems, showing that this concept was intuitively perceived even since ancient times by our predecessors, and described according to their language level of that times, but the crystallization of the real meaning of information is an achievement of our nowadays, by successive contribution of various scientific branches and personalities of the scientific community of the world, leading to a modern description/modeling of reality, in which information plays a fundamental role. It is shown that our reality can be understood as a contribution of matter/energy/information and represented/discussed as the model of the Universal Triangle of Reality (UTR), where various previous models can be suggestively inserted, as a function of their basic concern. The modern concepts on information starting from a theoretic experiment which would infringe the thermodynamics laws and reaching the theory of information and modern philosophic concepts on the world structuration allow us to show that information is a fundamental component of the material world and of the biological structures, in correlation with the structuration/destructuration processes of matter, involving absorption/release of information. Based on these concepts, is discussed the functionality of the biologic structures and is presented the informational model of the human body and living structures, as a general model of info-organization on the entire biological scale, showing that a rudimentary proto-consciousness should be operative even at the low-scale biological systems, because they work on the same principles, like the most developed bio-systems. The operability of biologic structures as informational devices is also pointed out.

Keywords: empirical models on material/energy/ideas world, structuration/destructuration, absorption/release of information, information in biological systems, matter/energy/information, UTR, informational system of human body and living structures, informational devices

Introduction

The essence/origin of life and functionality of the biological systems, specifically of the human organism, is a very old theme of reflection and intriguing issue for human/humanity (Gaiseanu, 2019a; 2019b). The remarkable advances in various scientific domains still seem to be not sufficient nowadays to firmly answer to the question “What is life?”, launched in the first half of the last century by the famous physicist Erwin

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Schrödinger (1944) in his book. Biology, the first indicated discipline required to decipher this still unrevealed mystery, is deeply involved in such an investigation, and although our knowledge on some detailed processes in the biologic organisms was highly increased, especially concerning the description of specific mechanisms at microscopic level, it is difficult to depict/crystallize a global definition of life only in terms of biological concepts. However, as it was recently shown, the implication of physics (Gaiseanu, 2018a) and more recently of the science of information (Gaiseanu, 2019c) may and can bring an essential contribution to this issue, by the introduction of new concepts, which are able to open new perspectives to correctly approach this complex subject.

Nevertheless, the introduction of concepts of information is still not yet coherently considered. Although it seems to be easy in the common language to use the concept of information, it has been not at all easy to understand this concept, and this difficulty still remains to be overpassed. That is because, although in the common meaning, information is perceived as a novelty to be communicated, something which is somehow correct, when the information involvement in matter structuration and especially in the operability of the biological systems is concerned, this is already difficult to be understood. As information is immaterial, but can operate with matter, how information intervenes in solid matter or in any other type of matter is really far away from our perception.

Since immemorial times, human ask himself what is mind, an immaterial form of reality, and how surrounding reality can be perceived with the common senses by the biological systems (Gaiseanu, 2021a). In the 16th century, Descartes defined the mind as something distinct from the material body, distinct not only as functionality, but also as physiological constitution, the two entities being considered as two different parts of the whole (Brook, 2008). Such a classification indicates, on the one side, the recognition that the mind works on the basis of distinct principles in comparison with the material body, but, on the other hand, expresses the limitations in the understanding of information as a contributable constituent of reality, specifically of the living organisms. Such a perception still dominates nowadays the sciences, particularly the philosophic view and even the neurosciences. By using the concept of information, it was shown recently that such a concept can be successfully used to solve the mind-body problem (Gaiseanu, 2021b) and even to decipher the informational activity and functional properties of the living cell (Gaiseanu, 2020a), showing that actually the human is a bipolar info-matter/energy structure (Gaiseanu, 2020b), connected to information and to matter support.

With the aim to smooth furthermore the way of a correct understanding of information concept and its evolution, in this paper is presented an analysis of the evolution/development of concept of information since the antiques times of empirical models and philosophical views on nature and human, particularly concerning the primordality of ideas/forms or that of matter in material/living world and universe, and is revealed the contribution of outstanding philosophic/scientific personalities to such a development. Such a discussion is a contribution and, in the same time, an invitation to all interested sciences to participate in the analysis of life from the informational perspective, opening not only new directions of interpretation of the existent data, but also of a deeper investigation of the life phenomena and of the intimate involved processes. This analysis allows us to develop the informational model of the human and living structures, as a general informational model explaining the informational structure, organization and functionality of biological systems.

Evolution and Development of the Concept of Information in the Material World and Biological Systems

Looking back to the ancient times from the perspective of our actual knowledge, we have to reconsider the evolution of the concept of information, starting with the first proposed empirical models of the world and of human (Gaiseanu, 2021a).

According to an old Chinese philosophy, Yin/Yang represents a binomial of two contrary principles: Yin is the receptive and Yang is the active principle initiating the change (the specific symbol is shown in the 1st position of the left column in Figure 1). Based on these principles, between the fifth century BCE and the first century CE, it was initiated and developed the traditional Chinese philosophy and medicine, raised especially from Confucius ideas (2nd position of the left side column in Figure 1). Historically, 500s BCE saw Lao Tzu and Confucius about the same time with Buddha (3rd position of the left column in Figure 1), initiating the reincarnation and “channel-wheels” (chakras) philosophy in India (4th position in Figure 1) and a little before Socrates in Greece (Gaiseanu, 2019a). Yin/Yang practitioners and Five-Agents Buddhist thinkers promoted a philosophy based on distinct flowing energies referring to positive/negative (Yin/Yang) energy (Raphals, 2020; Gaiseanu, 2019a) and material, feelings, perception, volition, and sensory forms respectively (Raphals, 2020; Karunamuni, 2015). The Yin/Yang binomial represents in the Chinese conception the two opposite but complementary alternatives of the same unit, explaining the order/disorder and dynamic cycles in the universe, derived from the *qi* fundamental energy. In human body, Yin/Yang energies support the living flows along meridians and nodes in organs and the entire organism. The Yin/Yang symbol of this negative/positive energy represents a black/white-(bright) passive/active unit, suggesting the properties both of the universe and of the human body, interconnected and interdependent with each other permanently. Such a symbology is a primary form to characterize the interdependency of the parts in the natural world, particularly referring to a female/male-type unit and its expression in nature and human. Nowadays, the existence of such a mysterious energy is still a controversial topic, and captivates the attention of specialists taking into account the positive results obtained in the practice of naturist therapies (Liu, 2018). On the other hand, as it was recently shown (Gaiseanu, 2016), the Yin/Yang binomial can be interpreted as a Yes/No informational (Bit) unit, participating in the structuring/destructuring processes not only in universe, but also in any surrounding part of reality, including the biologic structures, as it will be discussed below.

The archaic Buddhist conception within the so-called Five-Aggregate Model showed that the several body functions which determine the mind, entering/passing continuously through mind as a changing mind-stream energy are: material form, feelings, perception, volition, and sensory consciousness (Karunamuni, 2015; Gaiseanu, 2021b). Of Hinduism origin in India, the chakras system (Figure 1 left side, 4th position), visible by trained initiates who developed later the experimental and theoretical knowledge, is regarded in Buddhist conception as hierarchical centers, driving the flowing of energies in the human body. In a most developed Buddhist version, the chakras are detected as “wheels” centers distributed along the central axis of the body, corresponding with the spinal cord as following (Jain & Hauswirth-Jain, 2017): root chakra (red color) located at the bust/spine base and associated with the earth, sacral chakra (orange color) located at the lower abdomen, solar plexus chakra (yellow color), hearth chakra (green color), throat chakra (bright blue color), the third eye chakra (indigo color) between eyes, crown chakra (violet color), associated with spirituality and enlightenment. Buddha initiated and developed the “reincarnation” and “karma” belief, carrying the “karma” charge of

unsolved soul problems (Siderits, 2016). In our present view, such a conception is based actually on the statement that the soul and physical body are distinct entities and should suppose moreover that the soul is actually a conservative entity, able to maintain its coherent consistency and “enter”/reincarnate in a new distinct individual. This theme was approached recently from a scientific/informational perspective (Gaiseanu, 2017b; 2017c; 2018a; 2018b), explaining the separation of consciousness from body and associated phenomena during the near-death experiences (NDEs) and the after-death “life”/immortality.

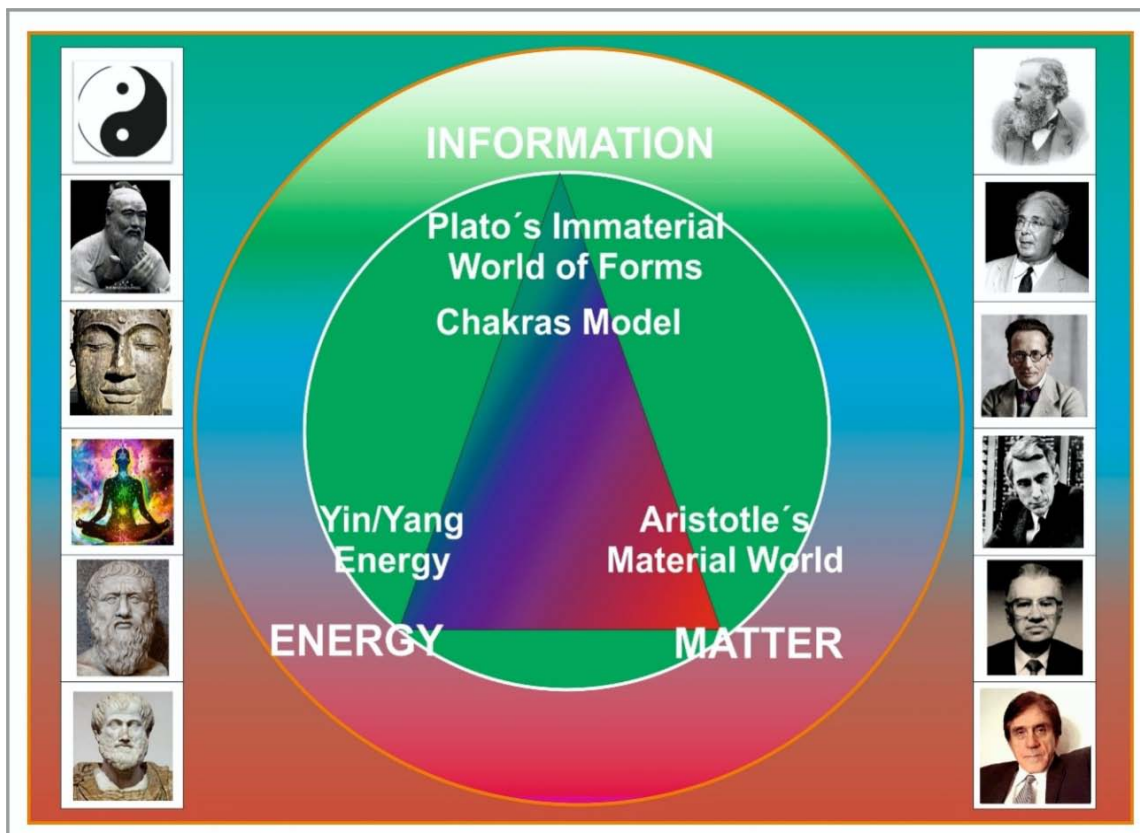


Figure 1. Diagram of the evolution of information concept in biological systems, represented by the Universal Triangle of Reality (UTR) formed by Information/Energy/Matter shown on the green circle (living world)—as a part of the material world (larger circle). In the left side column are represented consecutively: Chinese symbol Yin/Yang, Confucius, Buddha, chakras system, Plato, and Aristotle. In the right side column are represented in the following order: James Clark Maxwell, Leo Szilard, Erwin Schrödinger, Claude Shannon, Mihai Draganescu, and Florin Gaiseanu, as contributing authors to the development of information concepts and modeling in biological systems.

Plato (429?-347 BCE) (shown in the 5th position of the left side column in Figure 1), inspired by Socrates—his mentor, Pythagoras and by the Egyptian hermetic philosophy, had initiated and developed the theory of “forms/ideas”, which are eternal and changeless and which actually determine in an authentic way the primary geometrical “sacred” structures of matter, which finally determine reality (Kraut, 2016; Gaiseanu, 2019a). Aristotle (384-322 BCE) (shown in the 6th position of left column in Figure 1) was one of the greatest philosophers of all time, together with Plato (Shields, 2020). His works cover a large span of disciplines, from logic, philosophy of mind to empirical biology, referring to detailed descriptions of plants and animals. Aristotle approached and developed the study of logic (practiced today in mathematics and computer systems), highlighting its role in human inquiry and explanation. In his view, the world is built on material “substances”,

which generate the objects of surrounding reality consisting of matter and forms, which cannot be separated. Even the soul is regarded as a special form of matter, so the so-called “forms” are actually properties of matter.

A real discussion about information was initiated many centuries later, after the physicist James Clark Maxwell (1st position of the right column in Figure 1) proposed in 1867 an imaginary experiment in a thermodynamic system, composed of two containers with an ideal gas under equilibrium conditions, separated by a thin wall provided with a small door. According to this experiment, an “intelligent” demon (Maxwell’s demon) could open the door exactly when the molecules with higher velocity (temperature) would attain the door, allowing the passing of these molecules to the second container. In this way, the pressure and temperature in the second container would increase, violating the thermodynamic laws (Gaiseanu, 2020a). In other words, this would be equivalent to accepting that heat can flow from lower to a higher temperature, which would be impossible from a thermodynamic point of view. Many decades later (in 1929), the physicist Leo Szilard (2nd position of the right column in Figure 1) demonstrated, however, that this intelligent demon should spend “intelligence” (so information) to know/measure exactly the molecule velocity and to synchronize the door opening process with the movement of the high energy molecules (Szilard, 1929). Some years later (in 1944), the physicist Erwin Schrödinger (3rd position of the right column in Figure 1) observed that the entropy of the living organisms evolves from higher to smaller entropy, the difference between the final and initial entropy getting a negative value, contrary to the general evolution of our material world determining the entropy increase (Schrödinger, 1944). Few years later (in 1948), Claude Shannon (4th position of the left side column in Figure 1) developed a theory of information in communication systems, composed by an emitting/coder of information, a channel (noisily) line and a receiver/decoder of information, on the basis of statistical theory operating in binary (Bit) type mode (Shannon, 1948). According to this theory, the quantity of information can be obtained/regarded as a certainty vs. uncertainty that an event to occur in a system of states with equal (or not) probabilities, calculable by the elimination of uncertainty, measurable in terms of informational entropy.

The philosopher and scientist Mihai Draganescu (5th position of the right column in Figure 1) stipulated later that the so-called “deep matter” would be the ultimate layer of reality, indestructible and eternal matter “source”, which generates universes and time (Draganescu, 1990), formed by passive “orthomatter”, structured by the intervention of “informatter”, uniquely able to structure it. In Draganescu’s view, “informatter” would be a fluctuation/active component, regarded as a tendency to configure the matter in a certain way. The living structuration is further a result of structured matter and “informatter”. Recently, the physicist Florin Gaiseanu (6th position of the right column in Figure 1), showed that “informatter” is actually information, and the structuration process is actually a result of the interaction between information I and matter, according to a relation of the form: $(A + B) + I \Leftrightarrow AB(I)$, where A and B would be interacting components and (I) the hidden information absorbed into the new complex structure (Gaiseanu, 2021b; 2021c). As this relation is reversible, the structuration is therefore an information-absorbing process, while the destructuration is an information-releasing process. Information, according to this conception, is the result of an operation, independently of the nature of this operation—physical, mathematical, chemical or mental process, including the operation of a computer or other forms of artificial operability. The functions of a mechanism or living organism are actually expressible in an informational way, as performed in a multi-component operational system driven by certain rules and laws. The natural laws which lead to universe structuration, involve actually the participation of information, the operational “forms” of changes and configuration/reconfiguration of matter.

The universe itself at the basic level is an informational fabric of laws, forming/determining actually a matrix of matter structuration (Gaiseanu, 2016; 2020c).

From the perspective of physics, matter can be converted into energy by Einstein's relation $E = mc^2$, where m is a quantity of matter (mass) and c is the light velocity. In vacuum, pairs of particles of matter/antimatter, with opposed (Yes/No-type) properties (Gaiseanu, 2016) are generated due to fluctuation of energy (Hajdukovic, 2011; 2012), showing that energy can be converted into matter. Moreover, according to a recent model, the universe seems to follow successive matter/antimatter conversion cycles (Hajdukovic, 2011). In compliance with the Maxwell's demon experiment, information can be converted into energy, possibility demonstrated recently within a suitable experiment (Toyabe, Sagawa, Ueda, Muneyuki, & Sano, 2010). In accordance also with the above discussion, a mass contains a quantity of hidden information absorbed by structuration, and this can be released during the destructuration process. A suggestive example is the release of information during the destructuration of the deoxyribonucleic acid (DNA) molecule during the transcription process in the living cells, absorbed then in various types of proteins during the translation processes (Gaiseanu, 2020a; 2020d). Using a mass-energy-information principle, it was recently shown that the mass of a bit of information in digital (binary) devices could be expressed by the relation: $m = kT \times \ln 2 / c^2 = 3.19 \times 10^{-38}$ kg at room temperature, where k is the Boltzmann's constant, T the temperature in Kelvin (Vopson, 2019) and $\ln 2$ comes from Bit-unit information theory (Shannon, 1948). The quantitative interchange (mass \Leftrightarrow energy) can be expressed by the relation $m = E/c^2$, the interchange between mass and information (mass \Leftrightarrow information) by the relation $m = kT \ln 2 / c^2$, and the interchange between information and mass (information \Leftrightarrow energy) by the relation $kT \ln 2 = E (= mc^2)$.

Mass-energy-information composes the Universal Triangle of Reality (UTR), as it is defined and represented in Figure 1. The material/living structures are configured in our world/biological reality in a binary Yes/No (Bit)-type digital/informational way. According therefore to the above discussion, the older empirical models could be represented in the UTR model as follows: The left side of this triangle is representative for the Yin/Yang model of energies, the right side of this triangle is specific for Aristotle's material (matter) world, and the top side of this triangle is representative for Plato's ideas/forms model. The special activity in the hierarchical chakras model is also informational, coincident with structural informational organization of human body, as it presented below. According to the UTR model as defined above, showing the continuous correlation/interaction/conversion and inter-dependence between the three fundamental components of universe—information, energy, and matter, the origin of information is correlated with the origin of our world, perceived at our limited biological level as our reality of which we are only a part, as an infinite universe of three components, with indefinable time and space limits.

From Empirical/Philosophic Concepts to Informational Model of Human Body and Living Structures

A static system includes hidden information, while a dynamic system, like the biological structures, absorbs and releases information dynamically, according to the intimate local/macro-level operability, so that the whole system is under homeostatic (dynamic) equilibrium. As the quantity of information is expressible by the entropy (associated with disorder or uncertainty), which must be eliminated to obtain order or certainty, the negentropy discussed by Schrödinger is actually traduced as information. The Yin/Yang bipolar unit could be regarded as an informational Yes/No (Bit) unit, composing the material and living world (Gaiseanu, 2016). In

our universe, the contrary principles operate at various levels as a Yes/No unit, represented by action/reaction, positive/negative, active/inactive, donor/acceptor (Gaiseanu, 2013), higher/lower level of a balancing process, increasing/decreasing, emitter/receptor, accepted/rejected, structuration/destructuration, generation/recombination or Yes/No binomial decision, like in the informational devices or in the living organisms.

The function/functionality of a multicomponent system is expressed actually as information (Gaiseanu, 2021c). Particularly, the biological organisms are multicomponent systems in a continuous dynamic state. In Figure 2 central zone, is schematically represented the informational system of the human body and living structures (ISHBLS). The nature of human mind and of the sub-human beings is informational, because this operates with information (Gaiseanu, 2021a; 2021c; 2021d). Because the existence and functionality of the living organisms depend on the external foods, they are provided with an informational system, able to communicate with the surrounding environment and to their material bodies. The structure of ISHBLS is composed by seven typical informational centers as presented below.

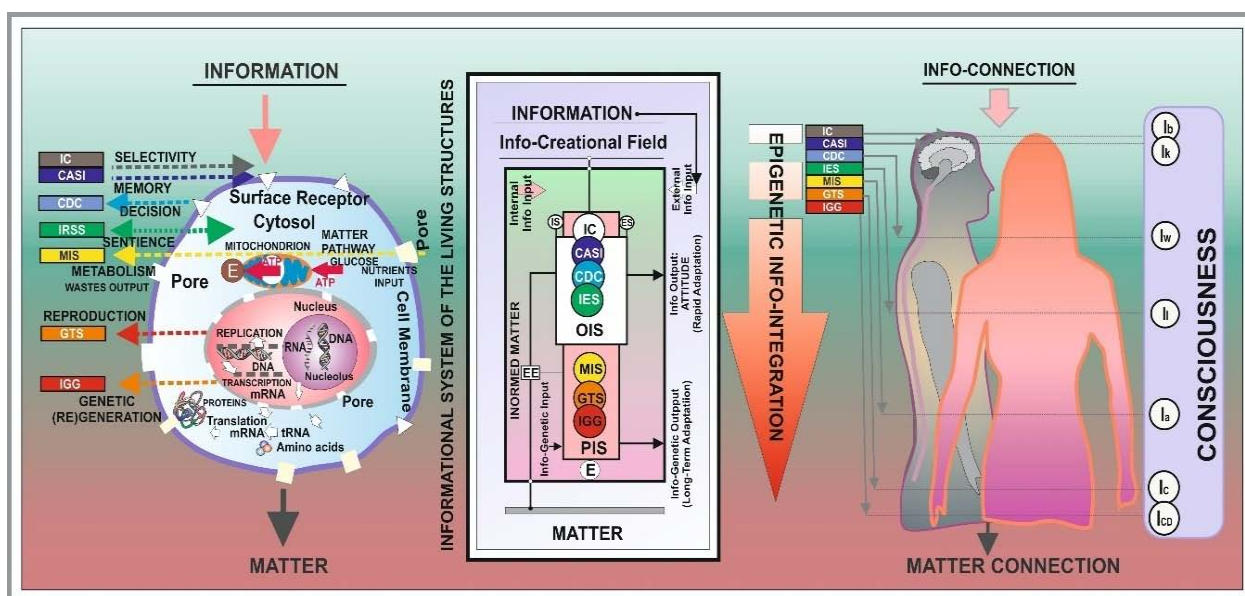


Figure 2. Schematic representation of the informational system of the human body and living structures in eukaryotic cell (left side) and human (right side), and consciousness expressed by corresponding cognitive centers (right side). The integration of information by epigenetic processes is represented in the central zone by the big arrow.

1. The Center of Acquirement and Storing of Information (CASI) is schematically shown in the left and right side of Figure 2, supported at human and sub-human animals by memory zone of the brain and the network of sensors which receive external (from common senses) and inner information (hunger, thirst, pain, sexual impulses, etc.). At the unicellular and inferior living organisms, particularly in eukaryotic cell (typical for plants and animals, schematically shown in the left side of Figure 2), the first form of memory is represented by the activity of the surface receptors on the cell membrane, which are formed as a function of the type of information predominantly received from the surrounding environment (Gaiseanu, 2020a). Such a primary form of memory allows the short/medium-term adaptation, because the cell organism is able to construct/deconstruct its own components, on the basis of DNA/RNA/Protein machinery. The deoxyribonucleic acid (DNA) in genes and ribonucleic acid (RNA), predominantly exist in the cell nucleolus and nucleon at eukaryotic cell (provided with distinct organelles, Figure 2 left side) and in the cytoplasm/cytosol at the most

inferior unicellular organisms—the prokaryotic cells (typical for bacteria). DNA molecule represents the permanent, stable memory of the cell, so there is written the species configuration and behavior. As it was recently shown (Gaiseanu, 2021b), memory is a fundamental property of the biological organisms, serving as a comparison reference for further adaptation under the changeable external conditions, and as a basis for the species' survival by reproduction.

2. The Center of Decision and Command (CDC) of human and sub-human organisms (right side of Figure 2) and of biologic cells (left side of Figure 2) assures the further processing of information from memory and sensors. The info-processing in human and sub-human organisms is supported by the centralized system in brain (specifically in cortex or similar, depending on the evolutionary level of development (Gaiseanu, 2020e; 2021c)), and in cells by specific reactive pathways of chain-type chemical reactions in the cytoplasm/cytosol (Gaiseanu, 2020a; 2020d). CDC is connected with the info-motor/transducer systems defined as execution elements (EE) (Figure 2, central zone). The interpretation of the world reality is specific for each individual, either human or different other species, according to own life experience and species availabilities/abilities. The act of decision is therefore personified according to circumstances and own decision criteria (as stable informational references). At human/sub-human organisms, the info-creational field of mind (schematically indicated in the central zone of Figure 2) is the total amount of data registered in memory and available to be operated by the decisional operative system, permanently submitted to improvement with new information.

3. The Info-Emotional System (IES) at human/sub-human categories and Info-Reactive Sentience System (IRSS) at cells, transfer the interpretation of the external/internal informational signal in terms of emotion/sentience to the body, as a reactive consequence. A priority circumstantial emotional/sentience state in the biologic organisms is induced by the alarm/fear signals, supported at human/sub-human by amygdala and limbic system and specific sensitive/sentient sensors in cells. An opposite emo-state is love/associative sentience in a favorable/friendly/protective surrounding. From the living point of view, love/favorable state is fundamental for survival and proliferation.

4. The Maintenance Informational System (MIS) is a fundamental operational system assuring the management of the metabolic (matter) processes both in human/sub-human and cellular organisms. This system manages the processing of food, air, water, as matter-type basic components of the material body and assures the elimination of uric acid and wastes. MIS is coordinated mainly by the brain stem in human/sub-human organisms and by the typical metabolic pathways in cell, assuring both the power generation (Energy—E) and the material components (mainly the proteins) for the body structuring/(re)structuring/(re)configuration elements, specifically achieved by the replication/translation processes in cell (shown in the left side of Figure 2). From the total of 20 amino acids necessary to construct the proteins in the human body, only 11 are produced by own organism, the rest must be obtained from the external nutrients. Although MIS is an automatic/autonomic informational system, this communicates with the central informational system of human/sub-human organisms (brain), to advise it about body necessities (hunger, thirst, pain, sexual impulses). In the inferior living structures, this communication is maintained by informational balance between the concentrations of adenosine triphosphate/adenosine diphosphate (ATP/ADP) inducing the “hunger” sensation. This process acts as a Yes/No-type bistable information switcher. ATP is the molecule of intracellular energy transfer, obtained from glucose and nutrients by oxidative in mitochondrion or non-oxidative (anaerobic) reactions (Gaiseanu, 2020d). MIS manages material processes in body and therefore is connected to matter.

Because the body of biologic organisms is sensitive and able to sentient and operate with information, we can define the biologic body as informed matter.

5. The Genetic Transmission System (GTS) manages the fabrication and transmission of the genetic material in human/sub-human organisms and the replication process in cells for reproduction. The replication process in cell (shown in left side of Figure 2) is based on the splitting of DNA structure in two strands (destruction process) and on the re-composition of each strand (restructuring process) in two DNA molecular structures of identical forms. This process initiates the cell division/multiplication and is assisted by specific enzymes. The replication process is the most critical during the cell lifespan.

6. The Info-Genetic Generator (IGG) manages the development of organism according to the age, by the structuration/restructuring of the cells in concordance with the body necessities. The specific structuring information is gotten from the stable genetic memory contained in the DNA molecular structure. At human/sub-human organisms, this system manages the species development and behavior and is supported mainly by hypophysis activity. The restructuring in cells is an informational process, according to the following transcription mechanism: a sequence of DNA molecule, containing a particular distribution of various “letters” from the total of four possible, i.e., adenine (A), guanine (G), cytosine (C), and thymine (T), is copied by messenger RNA (mRNA), so DNA→ mRNA. During the subsequent translation process, the information contained in mRNA is transported in ribosomes/cytosol and combined with amino acids with participation of transfer RNA (tRNA) and ribosomal rRNA for the synthesis of a specific protein. In this way, the informational segments from DNA are converted into informational building bricks with specific properties and functions, typical for the individual and for own species. Such processes are typical for unicellular and multicellular organisms. The body/tissues growth is supported by replication/multiplication processes. Specific for structuration/destruction of DNA is that the combination of the four letters is complementary, so A is paired only with T and C only with G, in dual-type elements. In proteins, the informational “alphabet” is completed by the participation of combinations of some of the twenty basic amino acids in the human body.

7. The Info-Connection (IC) manages the Yes/No selection of information and the distribution to CASI/CDC according to automatic criteria, and explains the extra-corporal experiences (ECEs) (separation of consciousness from body) and other associated phenomena during the near-death experiences (NDEs) (Gaiseanu, 2017a), religious and mystic experiences (RMEs) (Gaiseanu, 2019b) and extra-sensorial experiences (ESEs) (Gaiseanu, 2017b). At human, IC is connected with anterior and posterior cingulate cortex (Gaiseanu, 2020f). At the level of cells, the selective process of information is performed by the surface receptors, which are configured to receive only a specific type of informational (chemical) agent, with complementary/puzzle-like structure. Such a configuration highlights again the dual/digital mode of inter and intra-cell communication. The informational activity of IC is evident, for instance, during the inter-cell communication to synchronize the organization of an entire colony of bacteria in geometric forms, and in the extra-sensorial detection of natural dangerous phenomena by some sensitive animals. In the same category can be included the extra-sensorial detection of the correct geographical orientation by the migrating birds (Gaiseanu, 2020a).

The connection of the ISHBLS with the body is achieved by means of informational circuits, revealed within the human body as represented in the right side of Figure 2 by broken lines: CASI is connected with prefrontal cortex during the current (short-term memory) operation, CDC with the throat as specific organ of

decision verbal expression, IES with heart as sensitive/emotional motor system for blood alimentation according to circumstances, MIS with metabolic zone of the body, specifically the solar plexus, GTS with reproduction organs, and IGG with inferior part of the reproductive organ. Within cell, these circuits consist in pathways of typical chain/cascade reactions triggered by specific initiator info-agents (Gaiseanu, 2020d), similarly with epigenetic mechanisms (Gaiseanu, 2021c). Consciousness at human and sub-human organisms is the result of the projection of the informational activities of the informational systems in mind, expressible by the relation (ISHBLS = CASI + CDC + IRSS/IES + MIS + GTS + IGG + IC) => (I = Iknow(Ik) + Iwant(Iw) + Ilove(II) + Iam(Ia) + Icreate(Ic) + Icreated(Icd) + Ibelieve(Ib)), where the symbols in associated parentheses represent the abbreviated name of the cognitive centers of consciousness (shown in the right side of Figure 2). The connections of the informational systems with the body is achieved by nervous connections in the spinal cord (Gaiseanu, 2019d; 2019e; 2019f), showing specific nerves bundles located/coincident with the described chakra “wheels” centers, suggesting that these centers can become visible due to the electrical activity of the nervous bundles distributed along the spinal cord. Particularly, the frontal/prefrontal cortex (between eyes) is the central zone of awareness (CASI/Ik + CDC/Iw), and this together with the posterior/anterior cingulate cortex (IC/Ib) spend a lot of energy in comparison with the rest, as balancing between interior and exterior perception of reality, so these are distinct zones of brain of intensive (“observable”) activity (Gaiseanu, 2021e; 2020f; 2020g). The “aura” observed by initiated trained persons around the head, can also be a consequence of the electrical activity of the brain. Moreover, the properties assigned to informational centers, i.e., memory (Ik), decision (Is), emotion (II), power/vitality (Ia), procreation (Ic), (genetic) stability (Icd), beliefs (Ib) are justified actually by organic/brain-informational activity.

The results suggestively presented in Figure 2 show that informational activity and organization are practically the same on the entire scale of the biologic structures, from inferior to developed organisms. As the simplest biological structures have a similar informational structure, like the developed organisms and the same necessities, we can also think about a proto-consciousness form associated with such minuscule beings, even if their structure is unicellular. The difference consists in the complexity degree of such organization on the evolutionary scale.

The informational work of biological structures is based on info-operability in informational circuits. The visual bio-informational circuit for instance, can be expressed in terms of information theory (Shannon, 1948) as follows: The eyes sensors are the information source, the optic nerves would be the informational coders, the nervous cells to the brain play the role of the informational channel, the specific brain zone interpreting the signals would be the informational decoder, and the mental “screen”—the prefrontal cortex—is the final receiver, allowing the visualization like in a TV informational device. The memory/recall processes are supported by cascades of chemical reactions, as it was discussed above. Similar circuits could be revealed for the other common senses, like hearing, smell, taste and touch, showing that the so called Chalmers’s “hard” philosophical problem of qualia (Chalmers, 1995) is not so hard, if the functionality of biological organisms is approached from informational perspective (Gaiseanu, 2021b).

From this analysis, it is evident that the biologic organisms are bipolar structures, nourishing with matter (air, water, and food) and information, as it is suggestively shown in Figure 1 and 2, marking the information-connection and matter-connection. These organisms are able to integrate the surrounding information acting as stimuli, if they are sufficiently insistent/intensive for longer period of time, by means of

epigenetic processes for adaptation (big arrow in the central part of Figure 2). This information is integrated by a restructuration process into the genetic (DNA) system, but without the modification of the species characteristics, and can be transmitted to the next generation (Gaiseanu, 2019h; 2019i). The info-integration is a gradual process, starting with the reception/processing of information in CASI/CDC, passing through IES (emotional reactive amplification), MIS (automatic acquirement by insistent/repetitive practice) and included finally in GTS, retrieved then in IGG of the new generation.

The informational structure of the biological systems is suggestively represented in Figure 3 left side by the info-energy-matter diagram. As it can be seen in this figure, the composition of biological structures consists of all these components.

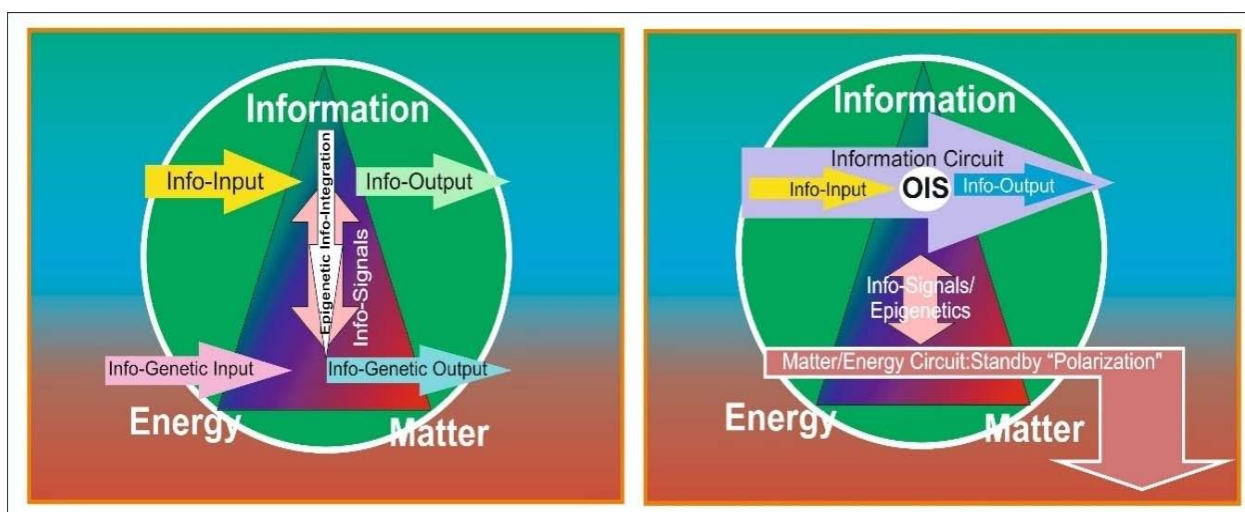


Figure 3. Diagrams of information/energy/matter universal triangle representing the informational structure/activity of the biological systems (left side) and the information (matter/energy) flowing circuits in the same systems, regarded as informational “devices” (right side). OIS is the Operative Informational System for quick/operative adaptation.

According to above analysis/modeling and from the diagram from Figure 3 left side, it can be deduced that biological structures dispose of two info-inputs and two info-outputs of information: The informational input is perceived by sensors connected with CASI/Ik, and the informational output is represented by CDC/Iw, as a reaction to the received input information. The Operative Informational System (OIS) defined as CASI + CDC + IES/IRSS assures the momentary/short-term/medium-term adaptation, while the Programmed Informational System (PIS), defined as MIS + GTS + IGG assures the body maintenance and long-term adaptation of species. IES/IRSS was included in OIS because of the emotional/affective importance for the decisional Yes/No process. The Info-Genetic Input is represented by the inherited genetic feminine/masculine (bipolar “Yin/Yang”-type) information/energy/matter managed by IGG, and the Info-Genetic Output by GTS, as it can be seen in the diagram shown in the left side of Figure 3. OIS works with virtual/mental information, as connected to informational pole of the organism, while PIS—specifically the MIS, connected to the matter pole, with matter-related information, as it was presented above and suggestively shown on the universal biological triangle in the diagram of the left side of Figure 3. OIS perceives signals from PIS and operates gradually for info-integration process by epigenetic mechanisms, as it also can be seen on the central part of this diagram. The two systems communicate by flowing streams of information in both senses, from virtual to matter-related information and reversely.

The biological structures work like an informational device, as it can be seen in the right side diagram of Figure 3. A typical transistor, for instance, as an artificial informational device, should be provided with energy to operate, by the application of a suitable biasing voltage to polarize the internal junctions (active zones of the device). In a biological structure, the biasing is obtained from the metabolic stream processes managed by MIS, as it shown by the base angular arrow oriented to matter in the universal matter/energy/information triangle in the right side of Figure 3. On this “polarized” stand-by matter-related substrate, it is applied information in the Info-Input, which modulates the functionality of this bio-“device” like in the base of the transistors, and a response is obtained in the operative informational circuit (OIS), with an informational output defined as reactive attitude (Gaiseanu, 2020h; 2021f; 2021g). However, as a differentiated characteristic from the artificial informational devices, the matter-related (“hardware”) metabolic circuit communicates in biological devices with (“software”) OIS by internal informational signals and epigenetic processes, able to reconfigure the genetic “machinery” of the entire structure. Moreover, the biologic “devices” are able to feel and to reproduce/organize themselves.

Nowadays, we assist to an increasing implication of the information science and technology (Gaiseanu, 2017c) in biological domain, specifically in human and biological structure functionality (Gaiseanu, 2021a; 2021d; 2021h), in agriculture, zotechnics and veterinary medicine (Filip, 2021). The revolutionary contribution to the understanding/modeling of life and its mechanisms in terms of information as presented above, as well as the contribution to the understanding of the basic structuration of universe/biological systems on the basis of the universal matter/energy/information triangle, allow us to solve some millenary or more recent philosophic matter-information relation problem, particularly the mind-body functionality and the origin of mind and consciousness, and to observe the universality of such concepts. On the applicative scale, such results contribute to the approaching between the investigation lines on artificial intelligence and that of biologic natural systems, particularly concerning the “big data” methods of analysis/prediction in various management activities (Filip, 2020) and medicine (Gaiseanu, 2021h), for the development of biocompatible complex structures, like silicon capacitive sensors (Gaiseanu et al., 1998; Gaiseanu, 2021h), memories (Stefan, 1998), bio-transistors and bio-computers with DNA/RNA, molecular imaging DNA-based crypto-systems, bi-dimensional DNA nanostructures, FET bio-transistors with carbon nanotubes, genetic neuronal relays (Gaiseanu, 2020c), allowing a close inter-correlation for the stimulation of mutual development with relevant results in the field of health diagnostic and treatment (Gaiseanu, 2021c). The philosophic culture starts already to enter deeper in the study of learning practice assisted by artificial intelligence/media means/games as “computational” thinking form (Tsoukalas, 2021), for which the informational analysis/modeling of cognitive architecture became a basic reference.

Conclusions

Looking back to the conceptual view of our predecessors on the material/living world and on the organizational structure of human, it was concluded that the relevant empirical models can be classified in three sorts of composing elements of reality, i.e., ideas/forms, energy, and material structuration, so these can be inserted in a Universal Triangle of Reality, representing the basic components of reality, consisting in information, energy and matter.

A highlighting of relevant scientific contributions during the previous and modern periods, leading to the present understanding of meaning attributed to information, revealed that even nowadays it is necessary to

define and understand the deep meaning of information concept when the structuration/destructuration of the material systems is concerned, processes assisted by absorption and release of information. Specifically, this binomial Yes/No process is fundamental to explain the functions and functionality of human/sub-human structures and of the biological structures in general, from the simplest unicellular structures of prokaryotic and eukaryotic cells to the most developed ones.

In such terms of information, there were discussed comparatively the functions and functionality of the biological structures of human/sub-human and of the eukaryotic cells, concluding that the functional/informational organization is the same on the entire biological scale, which can be described by the informational model of human body and living structures. As the informational architecture is the same on the entire scale, it is concluded that consciousness is a general property of the biological systems, varying from rudimentary proto-consciousness at unicellular organisms to most developed at human, as a function of the development and complexity degree of the informational system of species.

It was shown that the internal functionality of the biological systems could be described in terms of informational circuits as defined in the informational theory, and that their communication with external reality is supported by an operative circuit for adaptation, whereas an info-genetic circuit for reproduction is operational for long-time survival of species. Each of these two informational circuits is provided with specific input and output of information.

It was shown finally that the biological structures work like an informational device, taking into account that the metabolic circuit supports the device “polarization”, while the operative informational system modulates the operability of this device. The contribution to the convergent development of artificial intelligent/mimic informational models/systems and to that of the biologic structures is of beneficial interest both for biomedical applications and for their mutual simulative inter-relation.

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