



New Perspectives in Biomedical Engineering and Biotechnology: Information in Human and Biological Structures

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Editorial

Information is a largely used concept in our informational era, mostly by communications in written papers, TV, radio, internet and inter-personal or group communication via computers/laptops and especially through our portable intelligent devices - the smartphones. Understood as “news”, information and the connection to information became already a new form of consumption during our daily professional and private activities, as much as the foods consumption. Little is known however about information in human and biological structures, despite of the deep penetration of the artificial intelligent devices and analysis/prediction methods [1] in pathology and radiology for fast exploration, diagnostic and treatment in psychiatric disorders, and even in the investigation of the molecular behavior; structure, and mechanisms in the so called “omics” (genomic, proteomic, epigenomic, metabolomic or organimics) branches [2,3]. Although slowly, information is recognized however more and more as a fundamental concept, usefully intervening in the biomedical engineering and biotechnology, from the perspective both of the involved informational devices in the healthcare domain and of the functionality of human body, according to some recent studies [2], which describe human in terms of information, even as an informational device.

Actually, consistent with these studies [2,4], the concept of information becomes indispensable for the description of the functionality of the biological structures, from the most simples creatures-unicellular organisms (prokaryotic and eukaryotic cell),

to the most intelligent and sophisticated organism - the human. If matter is the prominent and readily detectable form of existence, which constitutes the body of the biological structures, composing actually with energy our reality, a most subtle form - information, is demonstrated now to be an active/essential part of living [4,5], as an operational contributor [5,6]. Actually, our environment on the entire scale of non-living and living structures, is a result of the contribution of three basic constituents, i.e., matter, energy and information, forming the so-called universal triangle of reality [6].

To reveal these concepts, in Figure 1 is shown a basic structural scheme of human and biologic organisms, according to the recently elaborated Informational Model of the Human Body and Living Structures (IMHBLS) [2,7,8], which allows to understand the informational structure and operability of human as an informational device [2] and to extend these concepts to any other living organism, as shown below.

The biologic structures need an appropriate environment to sustain their existence, rich in nutrients, air and water, as basic matter-related “foods”, which enter into the metabolic circuit of the body (shown schematically by the vertical brown line in the center of Figure 1), to furnish energy (E) for motor (M) activities, temperature control, and for all the chemical/physical reactions/operations [8] necessary for body maintenance, under automatic/programmed management of the maintenance informational system (MIS) (Figure 1).

The information from environment is perceived by means of the sensors (sensing “devices” [2]) at the medium/body info-perception interface (indicated schematically in the left side of Figure 1 by the blue region), as physical signals (light/electromagnetic radiation), chemical stimuli (smell, taste, internal sensing) and mechanical pressure/vibrations (touch, hearing) [9], transduced (converted) into appropriate electrical signals in the nervous system of human and sub-human organisms, adequately processed by the brain, which is the central processor of information. Two basic/defining info-systems are fundamental for the operability of the biological structures, i.e. the memory, defined as the Center of Acquisition and Storing of Information (CASI), and the decisional processor - the Center of Decision and Command (CDC), managing the info-output reactive response (Figure 1 right upside) to the input information (Figure 1 left upside). This is expressed as attitude/info-reaction by means of the info-output “terminal”, including the corporal/facial posture/motor mobility (M) and “vocalization” at human, animals, birds, and other species, measurable in Bits. CASI/CDC is the info-operational unit of any organism, including the mono-cellular structures, because the memory is the reference knowledge/experience accumulating the informational baggage/decision criteria for further decisional processes. The interface memory/decision (illustrated schematically in Figure 1 by the white zone), allows the info-interpretation of each element of reality by means of the internal specific informational “dictionary/language” acquired by every species during its own evolution, similarly with the human communication tool which is the language [10], developed, transmitted and learned by successive generations. This is significance/communicating information, attributed to the mind, or to the rudimentary proto-cognition forms supported by automatic perception/decision informational pathways, even at the inferior/primitive organisms.

The flowing stream of internal signals like digestion-related information (hunger, thirst among others), thermoception - ability to perceive temperatures, proprioception (distinctive perception of various parts of own body), tension of muscles, nociception (pain), spatial-temporal equilibrium, transmitted and perceived/interpreted by CASI/CDC, is schematically represented in the left side of Figure 1 by the interrupted brown up arrow. Hunger/thirst and danger/pain are probable some of the ancient stimuli interpreted as such. The informational carriers in the nervous system of the human and sub-human species are the cell-polarizing ionic (K^+/Na^+) and chemical (neurotransmitter) agents for the intra and inter-cell communication processes respectively. The info-interpretation (info-decoding) process depends rather on the frequency of the electrical signals than on their amplitude (the same for all fired nervous cells of the involved network [10]), and on the sorts and competition between the stimulating/inhibiting neurotransmitters, assuring binary (Bit)-type (YES/NO) signals, like in our computers. The inter-cell chemical communication is

typically carried by a selective mechanism, based on the protein structure complementarity between the communicating chemical agent and the surface receptor of the cell, so that only certain info-agent may be received by a surface receptor, acting like a key in the corresponding lock. The neurotransmitters generate mood states, as a reactive response to certain information, which are a part of the info-emotional system (IES) at human, managing the internal info-sensitivity/sentience interpreted as emotion, correlated dynamically with the blood (local nutrient fluid) distribution by the heart to the body cells in need. In sub-human organisms this is defined, according to its specific functionality, as info-reactive sentience system (IRSS).

The info-connection (IC) pole of the organism is specialized for selective orientation/ “navigation” among the multiple informational data during the exploration of reality, on the basis of beliefs criteria at human. At the inferior organisms on the evolutionary scale, this is relevant by synchronized geometrical disposition of the bacteria colonies, magneto-reception/orientation of the migratory birds or echolocation (“radar” effect detection of ultrasonic frequencies at bats), electroreception (perception and orientation by an electric field) at some species of fish and sharks, sensing of infrared thermal radiation by some snakes, the premonitory perception of bad weather or earth events by some animals and fishes. Plants are sensitive to external and internal signals like light (energy supplier and stimulating/driving factor of specific processes like sun-orientation), temperature, humidity, chemical substances and their gradients, magnetic fields, tissue damage/mechanical pressure. The internal communication in plants is achieved by means of some species of hormones and by direct cell-cell contact pathways.

The info-genetic generator (IGG) manages the processes of growth and development/evolution of the body according to the age, from the matter-related (genetic) input information (Figure 1 bottom left side) inherited from parents (by primary egg). The fundamental role in the cell is played by the deoxyribonucleic (DNA) molecule, which is the storing “library” of the species data, releasing the necessary information in a specific matter-related “language” of four letters (nucleotides) “alphabet” (adenine - A, thymine - T, guanine - G and cytosine - C), during the replication (multiplication) process and sequential transcription (copying of a DNA sequence by messenger ribonucleic acid (mRNA)) and translation for protein formation, with the participation of amino acids “bricks”. A key property for a communication mechanism is that A can be paired only with T, and G only with C. These info-communication processes build/rebuild the body, transferring the general physiology/behavior of species and the specific properties of the parents to the new generation. The genetic transmission system (GTS) manages the transference info-communication process to/through the matter-related (genetic) info-output (Figure 1 bottom right side).

The biological structures are self-organized adaptable informational “devices”, able to learn by (re)configuration of their structure, and to integrate the repetitive information (I) by successive unilateral (\Rightarrow) and bilateral (\Leftarrow) epigenetic information communication from the environment to the informational components of the informational system of the organism as:

(environmental I) \Rightarrow CASI \Leftarrow CDC \Leftarrow IES \Rightarrow MIS, finally entering into the stable genetic “library” (DNA molecules) managed by GTS, transmissible to the IGG of the offspring, without modification of the basic species characteristics, as it suggestively shown by the blue down arrow in the right side of Figure 1.

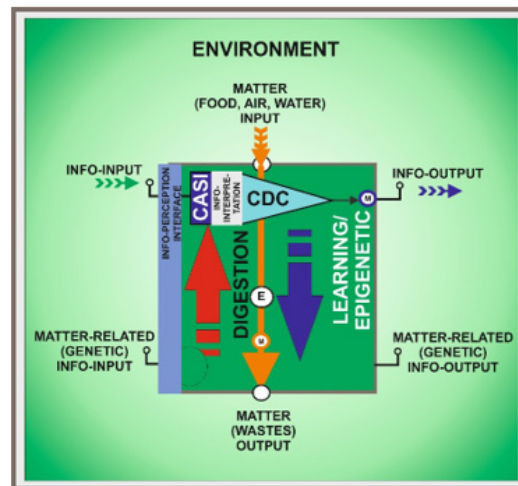


Figure 1: Schematic representation of the human and biological structures as informational devices.

According to these findings, the structure of the informational system is practically the same on the entire scale of the biologic organisms. The informational model applied in neurosciences, neurology, psychiatry, behavioral sciences, geriatrics, psychology, allowed successful results, clarifying the info-operability of various brain zones and involved specific functional mechanisms [5,6]. This informational model extended to biological organisms is a solid basis to better understand the functionality of the biological structures in terms of information, to approach from the biomedical engineering perspective (design and technology) the compatibility of the biomedical devices with the biological structures, and even the mimic research to find suitable artificial substitutes of injured/non-functional parts/tissues of the organism. The notable advances in bio-computers and bio-transistors with DNA and RNA, biological memories, genetic neuronal relays, bi-dimensional DNA nanostructures, FET bio-transistors with carbon nanotubes, sensitive bio-systems based on optic and magnetic phenomena and medical nanorobotics, allow a close inter-correlation for the stimulating mutual development in the field of health diagnostic and treatment [7].

Conflict of Interest

No financial or conflict of interests.

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