

The Eukaryotic Cell as an Informational Device

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ABSTRACT

On the basis of a new concept defined as matter-related information by structuration/destructuration processes, in this paper it is shown that the eukaryotic cell – the basic composing unit of the human organism, plants and animals, is actually an informational device, connected to two main informational sources: one internal/implicit for own structuration and functioning, and others external/occasional sources, for connection with the external environmental reality. This allows to understand that the cell body is automatically structured from the intrinsic informational genes/genome resources of the nucleus, which acts as an info-structuration device, and the connection with external environment is assured by an operative informational system, which processes the information and provides a response for adaptation. All these processes are powered by the connection to matter (nutrients), which provide the necessary energy and micro structuration constituents for structuration/destructuration processes.

The following main results are obtained from this analysis:

1. The cell informational behavior is similar with that of an informational device, in a standby state “polarization”, powered by the energy provided by “digestive” system, similar with that of the human, and is able to process the input signals to provide an output response;
2. The info-conduction in the cell is supported by structuration/destructuration processes, so no strictly necessary conduction by electrical agents;
3. The primary mechanisms contributing to consciousness at human are supported by the successive structuration/destructuration processes, which transduce the received information like in informational “mass-media” devices, toward the prefrontal “screen” area of the brain.

Keywords: Eukaryotic Cell; Information and Informational Sources; Matter-Related Information; Successive Structuration/Destructuration Processes; Transduction; Informational Systems; Informational Device; Mind and Consciousness

Abbreviations: ATP: Adenosine Triphosphate; IRSS: Info-Reactive Sentience System; IC: Info-Connection; IGG: Info-Genetic Input; ADP: Adenosine Diphosphate; MIS: Maintenance Informational System

Introduction

The microelectronic devices and systems have been changed our life forever, allowing the facile communication between people from various geographical areas of our planet [1,2], and the deep improvement of analysis and decision making [3,4] practically in all areas of science [5,6], education, healthcare [7,8] and industry [9]. In neuroscience, important advances were made by the introduction of a new concept of matter-related information [6], which allows a coherent approach of info-activity of human and living organisms [10]. As it was however recently recognized in a prestigious symposium [11],

neuroscience needs a revolution to understand consciousness, which actually is still regarded as a different entity from the body at human [12], and other living structures [13], and not as a product of the info-activity of the body itself [14]. Therefore, in this paper it is shown that even the most elementary unit component of the human body, animals and plants [15] – eukaryotic cell, is itself an informational system, operating like an informational device. Such a behavior indicates that the living matter is able to organize itself by informational processes, and to operate with external and internal information for reactive adaptive response, even whether this matter is or not en-

dowed with a nervous system, so with electrical conduction of information.

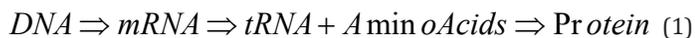
Informational Operability of the Eukaryotic Cell

In Figure 1 it is schematically shown an eukaryotic cell, its composing organelles and the main operational processes, as described by the molecular biology [16]. To understand how operates the eukaryotic cell from informational point of view, let observe that this is connected at two kind of sources (S1, S2) as follows:

1. (S1) - An internal/implicit (intrinsic) source of information, which is the genes/genome in nucleus (composed mainly by deoxyribonucleic and ribonucleic acids DNA and RNA respectively) and:
2. (S2) - External/extrinsic sources of information received by means of the surface receptors of the semitransparent membrane, which can detect only specific information (ligands), with complementary structure, acting as a YES/NO Bit-type signal.

All eukaryotic cells in a certain living organism – in human, plants or animals, have the same genome, but the cells are differentiated by functions. Regarding the info-communication by (S1), the nucleus itself is an informational device, which contains the entire structural information of the cell, shared to the cell body mainly by two fundamental processes:

- (i) The transcription – translation process, and:
- (ii) The replication process. Within the first type of processing, various sequences of the molecule of the deoxyribonucleic acid (DNA) are copied by the messenger ribonucleic acid (mRNA) in a four letter “alphabet” of the elemental components adenine (A), cytosine (C), guanine (G) and thymine (T), and transmitted as “messages” (\Rightarrow) to ribosomes, some specific informational micro-devices, which convert them in messages with the new “language” of the transport tRNA, which combines with amino acids (11 produced and 9 imported by the human organism) in the cytoplasm, in a binary YES/NO Bit-type complementary fashion, to form proteins – the bricks of the body (Figure 1a), according to the schematic info-reactions chain:



According to the dogma of molecular biology, these reactions follow only a forward sense [17], like the current stream into a micro-electronic diode. The series of these processes can be defined as the info-genetic generator (IGG), supported by nucleus, ribosomes and cytoplasm.

Information transmitted by such structuration/destructuration processes (SDPs), with absorption/release of information respectively, is defined as matter-related information I [6,18], synthetically expressed by the schematic general informational relation during the

interaction between (micro) components A and B as:

$$(A + B) + I \Leftrightarrow (AB)(I) \quad (2)$$

where (I) is a hidden (absorbed) information. Due to the dogma rule, the reverse relation in (2) should be understood as be applicable to other sequential components, different of A and B, within a successive cascade of reactive transduction events in the cytoplasm body of the cell, like that which is typical during the connection to the external environment, according to the schematic informational relations:

$$INFO \Rightarrow (A+B) + info1 \Rightarrow C \Rightarrow (D+E) + info2 \Rightarrow F \Rightarrow (G+H) + info3... \quad (3)$$

where info1, info2, info3 represent information after the interaction with INFO input and subsequent respective steps of transduction by successive SDPs toward a final terminal, represented by intervention in the genetic system (activation (YES)/deactivation (NO) of genes, or epigenetic info-integration [18,19]). In multicellular organism like human and subhuman living systems, the terminal of the series of info-transductions could be the mind and consciousness, by the release of virtual information, like in an informational device [11,14,20].

Replication is also an info SDP, which initiates the cell division in a mother-daughter pair, consisting in the splitting of the DNA molecule in its two strands and the completion with the missing nucleotides and two DNA backbones (so two DNA new strands) by an enzyme-assisted process to reconstruct two new entire identical molecules, according to the schematic informational relation:



Taking into account such typical informational processes, it is possible to define a genetic transmission system (GTS), supported also by the cell nucleus, as shown in Figure 1a.

The metabolic processes on the metabolic pathway/circuits shown also in Figure 1a, allow the production of energy and micro-nutrients for body maintenance from foods, air, water, eliminating wastes through membrane pores. Mitochondrion is an info-device driven also by own DNA, providing energy E to the cell – adenosine diphosphate (ADP) converted into adenosine triphosphate (ATP), by an oxygen-assisted process continued by an anaerobic process in cytoplasm [16], controlled by a critical value of the concentration ratio (ADP/ATP) for the production (YES) or not (NO) of energy. Such automatic SDPs allow to define the maintenance informational system (MIS), supported by a “digestive” system of the cell, composed mainly by mitochondria with similar function like the lungs in human, by vacuoles, which act like a “stomach” to accumulate the nutrients, the Golgi apparatus operating like a human “heart” and vessels for fluids distributions in the cell, the endoplasmic reticulum and lysosomes for lipid and insulin metabolism like a “pancreas” and “spleen” in human [18].

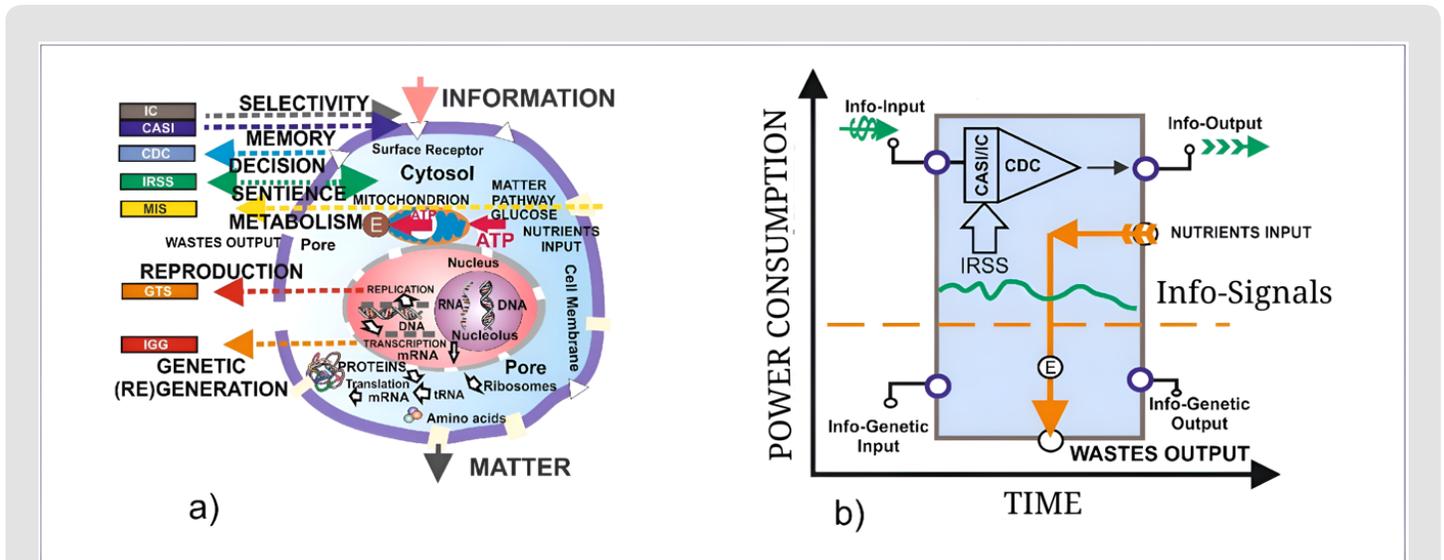


Figure 1: Schematic representation of an eukaryotic cell, showing the main composing organelles, the associate operative processing and informational components of the informational system (Figure 1a), compared with the operability of an informational device (Figure 1b).

The info-relations described above are strictly obeyed and are very precise [21], typical and always the same for eukaryotic cells, so a programmed informational system $PIS = MIS + GTS + IGG$ can be defined, acting in any eukaryotic cell, which assures its maintenance, development and reproduction. These processes show that even at a level of cell, the living matter may “know”, i.e. this disposes of knowledge, because from various many possibilities, this acts only in a certain way to drive automatically each processing step to another in a well defined manner, by means of informational messages, so this can be defined as informed matter. The info-activity of PIS allows to develop and maintain the cell body, including the info-circuitry for info-communication between the body components.

Regarding the info-communication (S2) (Figure 1a), the cell membrane plays a determinant role, because this contains surface receptors, which detect the external sources of information. While PIS assumes the existence and functioning of the cell body, as a “hardware” support of the cell informational system, the cell response to the external signals is operated by other distinct components, consisting in:

- (i) CASI – the center of the acquisition and storing of information, supported by the network of surface and internal sensors of information, specialized to detect and memorize only certain type of signals (ligands), working also in a YES/NO Bit-type selective complementarity, continued with:
- (ii) CDC – center of decision and command, represented by the reactive chain cascade circuits in cytoplasm, reaching the genes for their YES/activation or NO/inhibition, or for information integration/memorization in DNA by epigenetic mechanisms, in:

- (iii) The info-reactive sentence system (IRSS), which represents the sentence (“emotion/feeling”-like) sensitivity of cell, related with a specific information, but:

- (iv) Only within the limits of its “competence” (permitted informational range) of info-connection (IC), according to the inherited/acquired experience.

This is determined for instance in the multicellular organisms by the info-selective properties, depending on its specialized tasks in the organs where the cell is located. In other words, the functionality of IC is evident by the distinct/different info-connection properties of differentiated cells belonging to different body organs, according with their functional duties.

Therefore, an operative information system for adaptation can be defined as: $OIS = CASI + CDC + IRSS + IC$, which is the “software” of each living cell for info-communication with external environment and with its own needs and status. The right differentiation between various communication circuits are well maintained by the scaffolding proteins [22], which form together with other proteins stable configurations in the cell cytoplasm [16]. The skeleton of the cell is analogue with the bone system in human, as mechanical support, and the semi-transparent membrane with the skin, a separation but also an info and matter- connection interface with external environment.

Eukaryotic Cell as an Informational Device

According to the above analysis, an informational system of the living cell (ISLC) can be defined as follows:

$$ISLC = PIS + OIS = (MIS + GTS + IGG) + (CASI + CDC + IRSS + IC) \quad (5)$$

where PIS and OIS have distinct functions: PIS is reduced to MIS and IGG during the current functioning (without reproduction), which means the maintenance of the body with the energy source (powered/"polarized" similarly with an informational device) and necessary microelements for body ("hardware") integrity, while OIS responds to momentary contact with external and inner sources (info-signals).

This situation is represented in Figure 1b, where the functioning of the eukaryotic cell is compared with that of an informational device. In this figure, it can be seen that the eukaryotic cell disposes of an info-genetic input (IGG), transmitted during its born (mother's GTS), of an info-genetic output (own GTS), corresponding to the PIS' activity, and disposes also of an info-input of signals and an info-output reactivity/response corresponding to OIS' activity. The state of the cell disconnected from the external informational sources (i.e. from the S2-type communication) and no reproduction (no info-genetic activated output), corresponds with a regular, minimal consume of power, schematically shown by the horizontal broken line in Figure 1b, similarly with a power-connected informational device in a standby state. The application of a signal at the info-input (CASI) connection, involves a corresponding response at the info-output terminal (CDC) and a variable power consumption in the body circuits.

A suggestive experimental evidence of such a behavior can be observed at the immune cells of the human organism, driven by informational signals from the immune axis of the brain (hypophysis and hypothalamus), and which is able to communicate also with the other neighbor cells and even modify plastically their body (macrophage behavior), in order to destroy the pathogens in various local zones of the body [23]. As it was shown recently, the mini-representation at the cell scale is respected in the same informational terms at the macroscale of the body, where IRSS is an info-emotional system which at human macroscale is interpreted as info-emotional system (IES) [18].

Continuing to observe the similarity with the behavior of informational devices, it can be highlighted that on the basis of the activity of the S1-type source, PIS "knows" to drive the building of the body, starting from the "zipped"-like fertilized egg-cell (zygote), by automatic structuration/"blue-printing" of "informed" matter (body) following informational YES/NO Bit-type processes of replication (reproduction) and transcription-translation. Moreover, the specialized components "know" how to detect/acquire interest information (CASI/IC), to process information (CDC) and "feel"/"live" it (IRSS/IES) for adaptation. Formally, the interaction of the neurotransmitters with the ionic layer near the internal interface, which determines an ionic pulse discharge along the axon of the nervous cell and the triggering of new neurotransmitters to the next neuron at the end of axon, can be also described by informational relations of the type (2) and (3). The mechanisms of mixt chemical/ionic conduction near the external/interface of the semitransparent membrane of a nervous cell [24], are actually driven by this local specific informational sys-

tem, acting as an informational micro-device for info-transmission. The info-codification/informational "language" in this case is based on the frequency and number of pulses, than on the pulses amplitude, because this is practically the same, determined by the firing threshold, as a difference between the resting and action potential, when Na⁺ ions flow suddenly in and K⁺ ions flow out of the cell membrane, due to difference of permeability [23].

The access to the memorized information by means of such informational system at human is allowed by the intervention of the mind, which acts as an informational device with thought as an informational operator on the data "field" of memory for activate certain information (CDC/CASI) at a required address, consciousness resulting from the momentary representation of the external/memorized/"recorded" reality of the "mass-media" - like virtual (transduced) information, projected on the prefrontal brain "screen" [14]. The successive transductions of the primary detected information by means of structuration/destructuration processes described by the relations (2) and (3), conducted through the body info-circuits of the various info-transducing "devices" toward the last terminal - which is the mind, constitutes the primary process/mechanism which determines/explains consciousness.

This analysis shows that no strictly necessary a nervous system for the transmission of information through the multicellular bodies (like that of plants), although the electrical conduction is advantageous for a rapid transit in the macrostructure multicellular organisms like human and animals. This work shows also that the structuration and behavior/functions of the living organisms can be understood and described in terms of information, by structuration/destructuration processes.

Conclusion

By using the new introduced concept of matter-related information, the informational behavior of the eukaryotic cell was analyzed, showing that this can be related with two main types of informational sources: info-genetic implicit source and external/extrinsic occasional sources. The info-genetic implicit/intrinsic source allows the body structuration, assisted by the connection to the matter nutrients for energy and micro-components generation, and the connection to external sources by specialized informational components/circuits and info-microdevices, allows the processing of information and the providing of a responsive reaction for adaption, with (at animals) or without (at plants) an electrical conduction/nervous cells. Such a behavior is similar with that of an informational device in standby state, which can be connected to an external informational source of signals, offering an output reactive response. The info-activity in human as a multicellular organism, can be similarly discussed in terms of information, showing that the mind operates as an informational device and consciousness is a virtual/"felt" representation in mind of the external reality, both of them resulting from consecutive transduction

processes of information operated by structuration/destructuration mechanisms for info-transmission (relations of the type (2) and (3)), toward the final terminal of representation, which is the prefrontal cortex.

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