

Information: From Cognitive-Sentient Exploration of Reality to Predictive Big Data Assisted Informational Era

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Abstract. In this article it is shown that information is a concept not only useful and used for the communication systems and data operation, but also for the understanding of the matter non-living and living structuration. On this basis it is described the Informational Model of Consciousness and the functions and operability of the Informational System of the Human Body, allowing to define and understand the Cognitive-Sentient Exploration of Reality used as a tool by our predecessors to create some archaic models of the universe and human, remained up to date as references from philosophic point of view, and still operating nowadays in the creative sciences and arts fields in our informational era. Introducing the concept of information-related matter, it was possible to explain the informational processes in human body and eukaryotic/prokaryotic cells, the basic units of life, and to show that in the living entities an informational system operating similarly with that of the human can be identified and defined as Informational System of the Living Structures. The predictive properties of the Cognitive-Sentient Exploration of Reality is nowadays assisted by the predictive big data analysis, helping in various scientific domains where a high quantity of data was accumulated, including in the bioengineering field and human health, particularly for the prediction of the evolution of COVID-19 cases in the world, with examples for Romania, Spain and USA. Multiple applications involving artificial intelligence and the informational models of human and living structures for a healthy society are mentioned, in particular in neurosciences, biosciences and bioengineering. The priority of the Romanian concepts on information and the important contribution of the Romanian informational science oriented to understand the brain functions/operability and applications in biomedical field is highlighted.

Key-words: Applications; artificial intelligence; cognitive-sentient exploration of reality; information; informational era; informational model of consciousness; informational model of living structures; informational system of the human body; predictive big data analysis.

1. Introduction

In our informational era we benefit of a large range of communication systems by internet, telephony and mass-media tools and equipment, but the concept of information, at least when the intrinsic information contained in matter or in living structures are concerned, it was not practically approached [1]. The operability of mind and the nature of consciousness in terms of information are still not yet understood, although various models of consciousness were proposed, some of the most relevant based on quantum phenomena [2-5]. Only recently there were reported advanced results on this matter, allowing to solve the mind-body relation problem [6], to explain the “nature-nurture” problem (referred to the preponderant contribution of predisposition (“nature”) or the training (“nurture”)) [7], the concept of attitude and behavior [8], the control of the music-based therapy process in neuro-rehabilitation at any age but especially at older persons [9], the evaluation of attitude [10] with application in medicine, education, management, politic or personal private fields, the health equilibrium [11], mental aggressiveness and its consequences [12], the understanding of Near-Death Experiences and associated phenomena [13], religious and mystic experiences [14], extra-sensorial phenomena [15], the information-assisted evolution of the brain [16], the discussion on the free will and destiny [17, 18].

Taking into account the deep importance of such topics in philosophy, psychology, neurosciences, geriatrics/gerontology, social sciences, medicine and for the science of life, in this paper it is presented the model of *Cognitive-Sentient Exploration of Reality* (CSER), based on informational concepts, concerning both the operability with virtual and matter-related information, as a new concept involved in the understanding of structuration/destructuration processes of non-living and living systems. Such an approach is really new, starting from Draganescu’s philosophic view, which stipulated that active phenomenological events involving an “informatter” species as a fundamental component of matter allow the structuration both of matter and living structures [19], as it is presented bellow. The predictive power by means of the individual identified/defined informational cognitive/sentience centers as exploration tools in sciences and arts, and the significant progresses in the forecasting informational field concerning the big data analysis [20] as a helping contribution in the COVID-19 pandemic evaluation are further discussed.

After the introduction in the section 1, this article is structured on the following main directions: information as an active component of our reality presented and discussed in the section 2, the *Cognitive-Sentient Exploration of Reality* (CSER) based on the *Informational System of the Human Body* (ISHB), an informational model elaborated by author to describe the informational functionality of human organism (section 3), the *Informational Model of the Living Structures* (IMLS) elaborated by author, as an extension of the informational model on the entire evolutionary scale of the living structures in the section 4, and the implication in our informational era of the artificial intelligence in the section 5, in particular of the predictive big data analysis for the forecast of COVID-19 infections in Romania, USA and Spain, highlighting the applications of the *artificial intelligence* (AI) and of the ISHB/ISLS elaborated models in various fields of medicine and adjacent branches, for a healthy society.

2. Information

From ancient times, human has been trying to find a response to the questions: “What is the universe?”, “What is life?”, “What is consciousness?”. In our informational era, abundant in communication media based on informational processing and transmission/reception of data, these questions did not find yet an adequate solution, if they are approached only from the perspective of the specialized disciplines like philosophy, biology, biochemistry or neurosciences, without include the information science’s concepts into discussion [21, 22]. However, on the basis of the *Cognitive-Sentient Exploration of Reality* (CSER), as a combination between introspection and motivation at the certainty/uncertainty frontier, primordial in the ancient Egypt, Greece, China, India and other cultures [23], some philosophical models were initiated, which became an international patrimony from the philosophic point of view. But CSER is co-participatory today in many of the human activities, especially in scientific investigation and research, education and medicine, art and any other field of human creativity in general. The first archaic cognitive models recorded in the world are those of Lao Tzu and Confucius in the 500s BC, who initiated and developed the philosophy of Yin/Yang (female/male) dualism, almost at the same time with Buddha in India, who initiated the philosophy of the seven vital centers of the human body (chakras), and shortly before Socrates, Plato (4–300s BC) and Aristotle (300s BC) in Greece, who initiated and developed philosophies on the cognitive-sensitive perception of reality, remaining till nowadays in the attention of the traditional philosophy [1, 21, 23].

From such old philosophic concepts we can learn the following [6, 21, 23]: (i) the universe and human are constituted on a dual Yin/Yang (feminine/masculine) energy system, according to Confucius’s view; (ii) the vital constructive/functional system of human can be characterized by a group of seven vital centers (chakras), distributed along the body (Buddha), observable by the initiated persons through exercise, training and contemplation; (iii) the mind/soul is in fact a world of “Forms”/ideas, and reality is actually a “shadow” of them (Plato); (iv) at the opposite side of this idealistic concept, the Aristotle’s materialist conception shows that the mind is in fact a property of the body (matter). If we figurate these concepts on a triangle, putting in the top the world of ideas imagined by Plato plus the vital chakras system of human (Buddha), on the left bottom corner the Confucius’ Yin/Yang energies and on the right bottom corner the Aristotle’s materialist world (matter), we obtain the configuration of our living and non-living world reality, as viewed by our predecessors. This is the *Universal Triangle of Reality* (UTR), allowing to understand the building of our reality [1], where information is one of the fundamental component of the universe and our world of non-living and living structures, as it was recently argued [21, 22], on the entire scale of dimensions and complexity, from quantum information associated with microparticles to the cosmic information of the black holes [22], and from bacteria to the human as a top living organism on the evolutionary scale [24].

A challenging imaginary experiment known as a Maxwell’s demon, allowing to introduce later the concept of information, was proposed in 1867 by the physicist James Clerk Maxwell and described as follows: if an “intelligent demon” would observe and open a door at a suitable moment to permit to the more rapid molecules of an ideal gas in a container to pass into another container, the second law of thermodynamics would be violated [25]. A valuable explanation demonstrating that the second law is still valid was given by the physicist Leo Szilard in 1929 [26], taking into account that the so called “demon” must “spend” information to do all the necessary operations, as it was demonstrated experimentally recently [27]. Later, the physicist Erwin Schrödinger shown that the living entities work in opposite direction of the thermodynamic tendency which predicts the increase of entropy in nature in closed systems, gaining actually “negentropy” in the thermo-

dynamically open-type living organisms [28]. The theory of information was actually developed by Claude Shannon in 1948 for electronic communication systems [29], composed usually by a source, transmission channel, a receiver and a coding/decoding method, but also applicable in the analysis of scientific discourses or in any other communication processes [21, 23]. It was shown that more certainty (information I) in a system composed by N variants (states, possibilities or events) is obtained when more uncertainty (expressed by entropy H) is excluded, so I (as a positive value) is the result of the difference (ΔH) of the values of the entropy H , which in terms of info-theory is

$$I = \Delta H = \log_2 N \quad (1)$$

if all the states N are considered to have the same probability. This relation formally corresponds to Boltzmann's formula for the entropy S in a thermodynamic system of micro-components, except of the Boltzmann constant, but with different signification: while the entropy S is a quantity referring to disorder states, or a situation of uncertainty (H), the information refers to an ordered state in a system, so the amount of information is actually calculated by the entropy that must be reduced to obtain a structural order.

Defining "informer" as a species of matter, acting as an informational agent on "ortomatter", a passive deep substrate component in nature, otherwise not able to structure itself, Draganescu's philosophic view on matter and living structuring, can be synthetized by the following relations:

$$\text{"Ortomatter"} + \text{"Informer"} \Rightarrow \text{Structured Matter} \quad (2)$$

$$\text{Structured Matter} + \text{"Informer"} \Rightarrow \text{Living} \quad (3)$$

where "Ortomatter" and "Informer" are the concepts used to describe the primary "inert" (deep) matter substrate of matter, which in combination with "Ortomatter" (active agent), would be able to structure both ordinary matter and living systems [19]. This description corresponds with the phenomenology of structuring in nature, based on the participation of active/dynamic matter agents initiating an informational process, both in non-living and living structures, and the main merit of this view is the intuitive introduction of the operational processes involving information in the structuration of matter and living organisms. A general relation really expressing the interaction of information I with a system of the components A and B at any scale during a structuration/destructuration process could be written as [6, 30]:

$$(A + B) + I \Leftrightarrow (AB(I)) \quad (4)$$

where (I) would represent the implicit "embodied" ($\Rightarrow$) hidden information [31] into the new structured system, which can be "disembodied" ($\Leftarrow$) from this new system [31], according to the reverse relation. However, it is important to note that a certain biologic reaction is not reversible in a direct sense, relation (4) is only a schematic convenient representation to suggestively show an absorption/release information process in various distinct reactions.

Information could be therefore defined in a general sense in nature as a probability of a certain event distinct from the rest, a result of an operation in which the physics, chemistry, biology and mathematics laws act as operators, independently of the nature of this, and which can be interpreted/detected as a change/message of the system. At fundamental level, the operability of information is transduced in the action of laws and rules of operation for the structuration

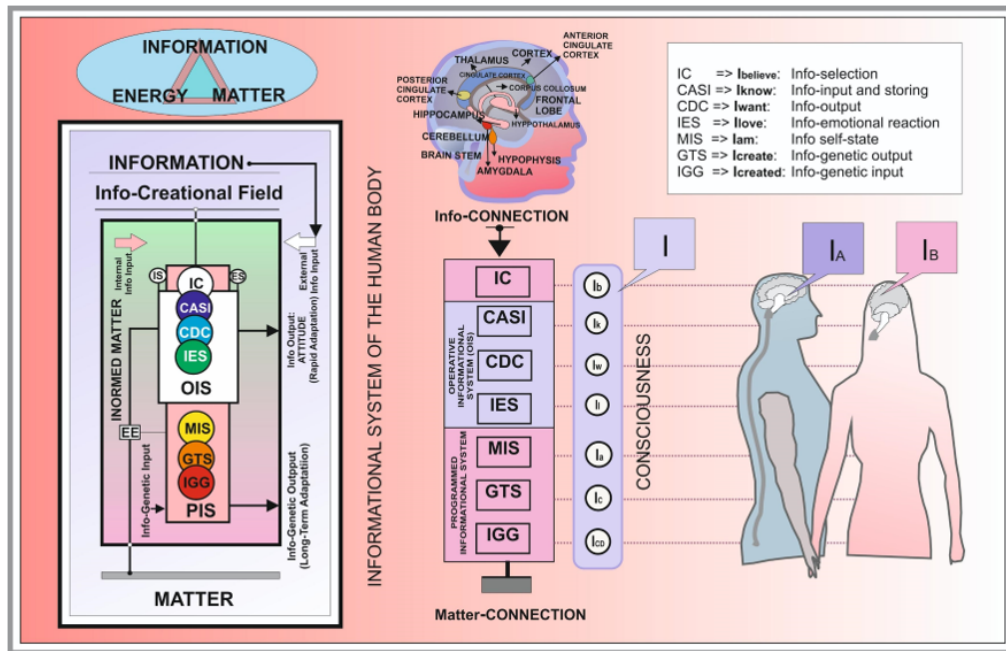


Fig. 1. Schematic representation of the *Informational System of the Human Body* (IMHB) and the *Informational Model of Consciousness* (IMC) (central side), on the basis of information as a fundamental component of the *Universal Triangle of Reality* – UTR (upper left side diagram).

and organization of matter in our world and in universe. The quantity of information is calculable actually by entropy which must be reduced to obtain a structural order or a certainty. The universe is therefore composed not only by matter and energy, but also by information, as a fundamental components. The reality can be therefore represented by the *Universal Triangle of Reality* (UTR), like in the triangle shown in the upper left corner of Fig.1, both for non-living and living structures, composed by energy, matter and information.

3. The Cognitive-Sentient Exploration of Reality

The recently elaborated *Informational Model of Consciousness* (IMC) [31-33] is the basis to understand how the reality is explored by the *Informational System of the Human Body* (ISHB) [34]. Represented schematically in Fig. 1 left/central side, this takes into account the information received by the body sensors (information input) and accumulated in the *Center of Acquisition and Storing of Information* (CASI), activated/operated (according to own decision criteria [17]) by the *Center of Decision and Command* (CDC), which consciously transmits by means of the thought (defined as informational operator on the info-creational field of data) the decisions to the *execution elements* (EE). The emotional reaction of the body is managed by the *Info-Emotional System* (IES), forming together with CASI and CDC the *Operative Informational System* (OIS), acting for rapid (dynamic) adaptation, with the attitude (mainly operated by CDC but determined also by other components of the info-system [10]) as an informational output. The *Programmed Informational System* (PIS), automatically and autonomically manages the metabolic processes

(connected to matter – foods, air, water) by means of the *Maintenance Informational System* (MIS), the genetic operations by means of the *Genetic Transmission System* (GTS) (info-genetic output) and the *Info-Genetic Generator* (IGG) (info-genetic input), responsible for the body development. IC is the *Info-Connection* system of the organism, administrating the selection YES/NO of the information before to attain the prefrontal cortex, responsible for short-time memory and judgement. This system is involved also in extreme phenomena like *Near-Death Experiences* (NDEs) [13], *Religious and Mystic Experiences* (RMEs) [14] and extra-sensitive phenomena like premonition, presentiments or intuition and inspiration [15], as parts of CSER in the detection of reality [23].

The information operated by OIS and PIS is matter-related information, carried by electrical (ionic) charges and chemical agents in the cells and inter-cells of the nervous system and mainly chemically supported information by YES/NO (Bit) type interactions between complementary components or unstable reactions of the type (2), evolving around of an equilibrium state to the right or left direction, depending on the local specific conditions [35, 11].

The *Informational System of the Human Body* can be therefore defined by the relation [36]:

$$ISHB = (CASI + CDC + IES + MIS + GTS + IGG + IC) \quad (5)$$

and is neuro-connected to the body organs [37] (transducers in the acceptance of IMC, conserving also the sensitive role [32, 34]), as it is shown by the corresponding horizontal dashed line (informational circuits) in Fig.1. The brain areas supporting the ISHB are shown in the upper side of Fig. 1 and are mainly the following [33, 37]: (i) CASI: prefrontal cortex (short-term memory – 1 min. duration), hippocampus – long-term memory, cerebellum, (learned behaviors and skills), thalamus – a relay for sensory impulses, cerebral cortex interpreting the main sensorial signals (touch, vision, hearing); (ii) CDC: is a sum of the associated areas responsible for the main dynamic abilities of the mind like thought, creativity, communication, intelligence, motivation, judgement, planning, voluntary control of muscles, operated especially by the cerebral hemispheres, frontal and prefrontal lobes of the cerebrum; (iii) IES: limbic system, represented by thalamus, hypothalamus, hippocampus, midbrain and amygdala; (iv) MIS: brain stem area, as a relay between the cerebrum and cerebellum to the spinal cord, controlling many automatic functions such as breathing, heart rate, body temperature; (v) GTS: hypophysis and hypothalamus; (vi) IGG: hypophysis and hypothalamus, regulating the body growth and development according to the age; (vii): IC system acts by means of the anterior [6, 16, 38] posterior [39] cingulate cortex as a YES/NO hub/switcher-type distributor operating the information received from the inferior anatomic zones of the brain to the frontal cortex, dedicated mainly to the awareness and judgment.

The activity of the posterior cingulate cortex is intriguing and not yet understood, but as it was explained recently, this brain zone, engaged in the disruptive YES/NO alternation of connection between internal and external world and in introspection of own daydreaming projects, is a higher energy consumer like the other brain areas even within the resting state, because of the simultaneous vigilance of the external reality and of the memory accumulated experience, used as reference data for the dreaming-assisted plans composition [39]. The anterior cingulate cortex plays a fundamental role in the adequate (GOOD/BAD) selection of information as a binary YES/NO Bit-type (acceptance/rejection) selection of information, according to the survival inherited/acquired/learned (“navigation”) criteria and life experience [40], and the participation of the sensorial spatial-temporal zone (temporo-parietal junction) of the brain [41] to the mental spatial-temporal exploration/“navigation”/body inside/outside “travels” and to anticipative phe-

nomena, and near-death, mystic and religious experiences [42].

The information received by sensors is transduced/transmitted by YES/NO-Bit-type mechanisms referred to the “ALL OR NOTHING” ionic (Na^+/K^+) polarization/depolarization inducing electrical discharge along the axons of the neurons due to the difference of the membrane selective permeability of the distinct ionic agent, and a new YES/NO-type competition process of the complementary excitatory/inhibitory neurotransmitters as chemical agents in the synaptic gap between the neighbor neurons, determining (YES) or NOT the firing of the next element of the neuronal transmission chain and mood states [43, 44]. This represents the info-perception input interface, connected to CASI. The cell membrane plays therefore a fundamental role in communication processes, permitting only a selective reception of information by means of the surface receptors, allowing to detect only a suitable (YES/NO) chemical agent with complementary structure, which must fit the receptor structure like the key into the lock [43, 44]. As the amplitude of the electrical signals along the axons are practically then same (about 55mV), the distinction between the signals transmitted in this specific “vocabulary”, is achieved by the frequency and number of electrical pulses, and the participatory contribution of the neurotransmitters and connection within a specific network between the excited neurons [43, 45]. Each kind of physical primary information transduced by the external and internal sensors (sight, hearing, taste, touch, smell or heat/cold, pain, hunger/thirst sensations and others) is processed in distinct circuits but integrated in thalamus (imprescriptible for conscious) at the info-detection interface, “projected” on the mental prefrontal “screen”/“display” as forms, colors, sounds, movements, smells, touches, etc. and converted into info-significance at the info-interpretation interface [45]. CDC works therefore at this level with information as significance/meaning attributed to distinct objects, situations and phenomena of reality, forming the informational “dictionary” accumulated by human/humanity during the interaction with environment, with himself and with collectivity, as a subjective reality.

The language allows the info-communication with himself and with others to express/distinguish by distinct words of the dictionary the large variety of the information received from the external and internal reality, operated by CDC as virtual/significance information in terms of concepts, symbols and meaning, used in the common conversation/communication and/or in scientific/arts discourse and representation. The high quantity of information represented by the life personal experience accumulated therefore in CASI, can be defined as an info-creational field of data, on which the thought acts as an informational operator. This is information as a communication process [43, 23], which can be described and understood as a emission/reception of a message between a source and a receiver of information by using a coder/decoder of information (words, language) transmitted on an informational channel, similarly with the communication process by means of electronic transmission/reception devices, which the information theory was for the first time addressed to [29]. The accuracy of the transmitted/received message depends on the personal “coding”/“decoding” abilities of the involved communicating partners and on their degree of preparation and interpretation. The mediated messages invading our personal world in our large-scale globalized informational era, are also subjected to a selective process, according to own mentality, tradition and education/instruction managed by IC, influencing the public opinion and its feedback response, and the intervention of the artificial intelligence by big data analysis/predictive process becomes an new and indispensable tool of intervention [46].

Information induces reactive effects in the body [40], one of them consisting in impression/emotion/affectivity (involving IES), as a sentience informational reaction to the received information, and another in reactive response by means of analysis/judgment and interpretation

of this information, according to personal decision criteria, expressed by decision/attitude and manifested at the output info-communication interface by attitude [8] (involving CDC and the contribution of the other informational components of the ISHB), measurable also in informational units (Bits) [10, 47]. The operative informational “software” system for rapid adaptation to external/internal received information $OIS = CAS + CDC + IES$ can be therefore defined, which overlaps its informational activity on the regular (stand-by) body activity, maintained by the programmed informational system defined as $PIS = MIS + GTS + IGG$, which permanently works for the maintenance of the body “hardware”, like an informational device [48, 49].

Because the body material is connected to information, this is defined as an informed matter system. The human body is therefore a bipolar structure, connected and working with matter-energy and information, as represented in Fig. 1. The composing elements of the universal triangle of reality – information-energy-matter, are convertible each others, as it was recently shown [21, 22]. On this triangle, OIS would correspond thus with a representation on the upper top side, while PIS would correspond with the management of the metabolic processes, with significant contribution in the bottom side of the triangle.

According to IMC, the projected activities of the informational components of ISHB are detected in mind as cognitive centers of consciousness, suggestively defined by the relation: (CASI, CDC, IES, MIS, GTS, IGG, IC) $\Rightarrow$ (Iknow (memory, life experience), Iwant (judgment, info-operability, decision), Ilove (emotions, affectivity, moods), Iam (self-state, power, vitality, health), Icreate (biologic creation expressed by sexual activity, social/family behavior), Icreated (genetic inheritance expressed by aptitudes, abilities, talents), Ibelieve (certainty vs. uncertainty, the need of trust/belief) according to the personal inherited/acquired mentality and culture, so the self-personality “I” (different for each person – $I_A = / = I_B$ in Fig.1), can be expressed as [36]:

$$I = (I_{know} + I_{want} + I_{love} + I_{am} + I_{create} + I_{created} + I_{believe}) \quad (6)$$

Because the body matter is connected to information, this is defined as informed matter. The human body is therefore a bipolar structure, connected and working with matter (energy) and information, as represented in Fig. 1. On the information-energy-matter triangle, OIS would correspond thus with a representation on the upper top side, while PIS would correspond with the management of the metabolic processes with representation in the bottom side of the triangle.

The functioning of the cognitive centers, connected to sensors/transducers/interpreters of information, allows the composition/transposition of the external reality into an internal awareness/consciousness relational state. The *Cognitive-Sentient Exploration of Reality* (CSER) refers to the synergic activation of the cognitive centers, depending on the proposed objective, particularly concerning the scientific investigation, at the frontier between certainty and uncertainty, to find a certain solution for a predictive anticipation, where the intuition/revelation, based on a perseverant/consistent preparation/investigation, can play a relevant role [23]. This exploration is proper to any branch of science and investigation, and the power of this exploration system is proven by the valid results of our ancestors in the reality prospection scrutinizing the unknown and uncertainty of the universe and human body, able to propose (in the absence of modern means of our present days), suitable models still remained as references in our informational era. The language development is also part of such a category [23].

4. The Informational Model of the Living Structures

While the intercellular communication in animals is mainly assured by the nervous system, hormones and direct contact, in plants this is achieved by some species of hormones, by direct cell-cell contact pathways and even by a specific nervous-like pathways electrical channels, acting as a “neurobiological” system [40]. A distinct communication process takes places in the cell, where the cell nucleus transmits ($\Rightarrow$) via *messenger ribonucleic acid* (mRNA) the genetic information from the *deoxyribonucleic acid* (DNA) to new proteins (DNA $\Rightarrow$ mRNA $\Rightarrow$ Proteins), which are the fundamental “bricks” for the building of the body. This intra-cell info-transmission is a communication process by a 4-“letter” type “alphabet” of the nucleotides adenine (A), thymine (T), guanine (G), and cytosine (C), to form “words” and “sentences” of various DNA sequences, with the participation of the amino acids in a “language” in which A can be paired only with T, and C only with G, on the basis of chemical (YES/NO) complementary structures. An intermediary intervention in ribosomes by the *transport-RNA* (tRNA), combines this language with another, written in 20 “letters” of the 20 type of amino acids (Fig. 2). Such type a communication is a suggestive example on a matter-related informational process by structuration/destructuration mechanisms “embodying”/“disembodying” information, as represented synthetically by relation (4). The activity of IGG (acting as an info-genetic input), allows the development of the single cell human egg (the result of the GTS activity as info-genetic output), with dimensions of only 200 micrometers, which by union with sperm gives rise to the 10 trillion cells of the human body [50]. This process shows the extraordinary power of the info-communication processes in the human organism, able to determine the building of the (“hardware”) body by the intervention of the natural “software”/info-algorithm, for the reorganization of the info-compressed (“zip”-type) matter-related informational unit (egg) into a fully-represented human structure [50, 40].

The strategies of intracellular communication are discussed in relation with Fig. 2, where is represented schematically the *Informational System of the Living Structures* (ISLS), as it was defined by comparison with the ISHB [35], as follows.

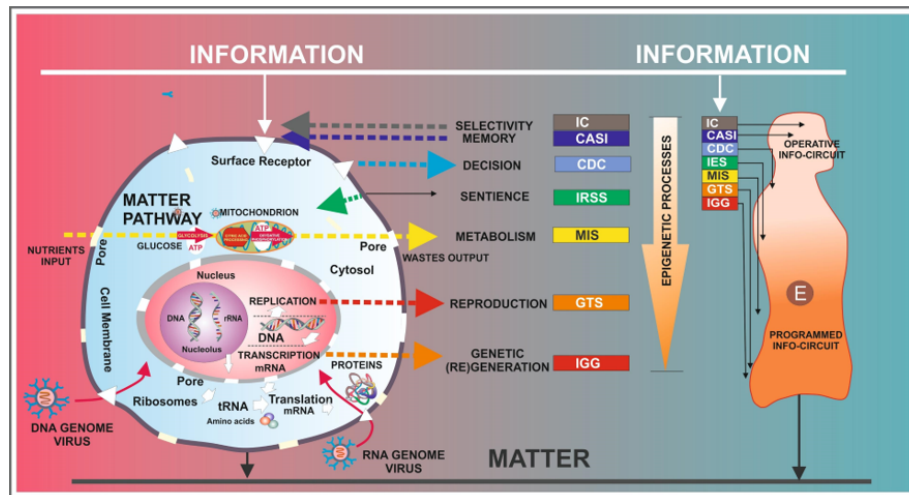


Fig. 2. Schematic representation of the eukaryotic cell and its functions and organelles, showing similar informational operability as the human body informational system.

- (1) The strategy based on a binary (informational) YES/NO process of reception/transmission/transduction of the external signals by cognition/recognition (CASI-assisted) complementary binding signaling proteins in membrane and receptors in cytosol [35], or in nucleus by switching YES/NO (Bit) CDC-type operations. An additional effect of the (CASI) interaction of the cell with information is a sentient reaction of the cell (function equivalent with IES, defined as *info-reactive sentience system* IRSS), which is a stimulatory cognitive/reactive perception of reality, for a (GOOD/BAD) experience/decision criterion, contributing to the adaptive selection/orientation on the evolutionary trajectory, according to the cell functionality driven by the environmental conditions [35]. During these processes, a fundamental role is played by enzymes, which can activate/deactivate various internal processes like the production of messengers or signal amplification, and can become active in a timely and locally way.
- (2) The *Deoxyribonucleic Acid* (DNA), the main informational structure of the cell, is a warehouse of information, which shows aperiodic configuration, in contrast with that of silicon, which forms specifically a solid-state crystalline lattice. Just for this reason, DNA structure allows to accumulate a high quantity of information, due to the high number of combinatory configurations between the four bases (nucleotides), *i.e.* *Adenine* (A), *Thymine* (T), *Cytosine* (C) and *Guanine* (G), binding the two very large helix-type strands of carbon chains. However, A may only bind the complementary T base and C only the complementary base G, acting as YES/NO informational type operator pairs, as mentioned above. The reproduction (GTS-type) process is based on the splitting of DNA molecule (replication), to form two new mother-daughter cells, and the info-genetic (IGG-type) transference to the body by the transcription/translation processes to form proteins, the building “bricks” of the cell [30]. Estimating values of the quantity of information were calculated for various cells as follows: 5.07×10^6 Bits for *Staphylococcus aureus* (bacterium); 1.08×10^8 Bits for *Aegypti* (mosquito); 4.13×10^8 Bits for *Gallus* (chicken); 5.28×10^8 Bits for *Bos Taurus* (cow); 8.38×10^8 Bits for *Homo Sapiens* (human) [51]. The replication process (Fig. 2) is an equivalent function of GTS in human and transcription/translation processes according with the necessities of cell with IGG functions [28].
- (3) The necessary (MIS-assisted) energy E to perform the needed tasks in the cell is provided by the cell itself, basically from the processing of glucose converted into *adenosine triphosphate* (ATP) either in cytosol and in the specialized organelle which is the mitochondrion (cytoplasm in plants), by an anaerobic and oxygen-assisted process respectively (and light-based intervention in plants) [24, 30]. The energetic processes are assisted by electrons gradients and are controlled by reactions of the type (4) [30].

The strategies for the entropy decrease are: (i) internal works for (re)structuration with absorption of information and delivery of heat in the external environment by metabolic processes; (ii) the aggregation of small molecules to form proteins and the change of their configuration to folded 3D proteins; (iii) epigenetic processes [52] (shown by the big vertical arrow in Fig. 2), which not only represents the natural pathway to absorb information from environment and to integrate it into the living structure (without modify the genetics of species), but lowering efficiently their entropy and gaining in organization/information on the evolutionary scale; (iv) the eukaryotic cells dispose of organelles with similar functions like the human/animals organs, as it can be seen in Fig. 2, most of them sustaining the metabolic processes (MIS equivalence): the

semitransparent membrane, filtering a selective interchange of matter and information with environment through pores and surface receptors is equivalent with the skin, the Golgi's apparatus with heart and distribution system of the nutrients by blood, the mitochondria with bowels and lungs (cytoplast in plants, sensitive to light), the endoplasmic reticulum with pancreas/blood vessels, the vacuoles with stomach, the lysosomes with spleen and liver-kidney, the cytoplasm with role of muscles, and cytoskeleton with the bones [40]. The master role in cell is played by nucleus and DNA/RNA molecules as genetic structures, managing the development/growth of the body (IGG) and reproduction (GTS). This type of organization allows to decrease the entropy of the structure. The prokaryotic cells disposes of similar functions, but not of compartmentalization in specialized organelles/organs like the eukaryotic cell or multicellular bodies.

The reactive/adaptive/operative informational system in the living organisms plays a significant/fundamental role, taking into account that the existence of the living structures is permanently and strictly determined by the resources dependence and matter-related interactions and info-communication with the environment, so that both the unicellular and multicellular organisms [53,40] dispose of a sensitive connection/system with the external and internal reality [24, 30, 35] as a necessary cognitive support [53] for detection, decision making [53, 54] and sentience [55]. Thus, corresponding informational components can be defined as CASI, sustaining the sensorial relation with the environment and memory as a comparative reference, CDC – as a reactive decision-making system, and an *info-reactive sentient system* (IRSS), similarly with CASI, CDC and IES respectively in human body, on the entire evolutionary scale. The specific functions of such systems are active on the entire living scale [16, 21, 53], depending on the complexity degree of the development of the informational system support in each species.

Therefore, as the functions of a cell are similar with that of the multicellular organisms, an *Informational System of the Living Structures* (ISLS) can be defined as following:

$$ISLS = (CASI + CDC + IRSS + MIS + GTS + IGG + IC)_{ISLS} \quad (7)$$

In this relation IC should be understood as a system, and its info-activity is relevant in the unicellular organisms by synchronized geometrical disposition shown for instance by the bacteria colonies, and in the superior multicellular organisms by magneto-reception/orientation of the migratory birds, echolocation (“radar” effect at bats), electroreception (sensitivity to electric fields) at some species of fish and sharks, sensitivity to infrared thermal radiation of some snakes, or by premonitory perception of bad weather or earth events by some animals and fishes, which assure a safe/reliable information for “navigation”/orientation of species between the multitude of signals of the environment [40], a certainty way learned/developed/practiced by many generation ago, for adaptation as a function of the local environmental conditions and living medium – earth, water, air. The plants are sensitive to external and internal signals like light (determining the driving sun-orientation), temperature, humidity, chemical substances – and their gradients, magnetic fields and mechanical pressure [40].

A recent detailed analysis of the biology of the plant cell and plants [56,57] and the inprescriptible role of information in plants and animals [58], shows that although without a nervous system, specific to animals, plants and plants/animals (eukaryotic) cells are able to detect/“feel” information, to decide and to adapt to the environmental conditions, by means of specific pathways (micro-“circuits”) distinct each other, the same for each species, with the contribution of specific proteins which drive the processes (in this case scaffold proteins [59]), in a strictly and rigorous way. Therefore, an *Informational Model of Plants Cell and Plants* (IMPCP) can be defined, composed by the same type of informational components described above. The experimental studies/evidences really support this model, showing that plants dispose of sophisticated

mechanoperception sensors and light receptors/signaling networks (based in this case on auxin modulation), to detect the light intensity/duration/spectral quality and localization (CASI), to control germination/flowering (IGG/GTS) – engaging the execution elements (EE), the damage status and defense response (IRSS/CDC), and they are able to control (CASI/CDC/EE) the trajectory of the root, even in an anticipative way (IC), for caching/intake/compete for food resources (MIS), showing even the capacity to learn by association with other info/event(s) [59], as already stipulated by the *Informational Model of Human Body and Living Structures* (IMHBLS) [24, 30, 52]. In a general sense, the operability of the info-connection system (IC) should be understood as the capability for the selection of a specific ‘window’ of ‘visibility’ from the high diversity of the informational panorama, through which each living structure/creature can detect and interpret as valid/trustworthy/compatible/GOOD (accepted) the world reality, according to own/species capability/versatility and to the local conditions of adaptation and to own development degree, or to specific tasks of individual cell in a multicellular organism [58, 59]. In terms of info-communication, that means that the individual/species “decoder” (IC) must be compatible with the “codified” information, accepted as reliable. Besides the importance in biology, such results reinforce the understanding of information as a coherent/effective investigation concept/strategy to approach biotechnology scientific and technical research, and highlight again the unitary structure and functionality of the living systems on the entire evolutionary/organization/development scale, independently on their constructive architecture and/or endowment or not with a nervous system [59, 60].

Representing the living organisms as informational “devices” [48, 49] on the information-energy-matter triangle, the metabolic processes would correspond with the bottom side of the triangle, relevant for the stand-by matter-related “polarization” operated automatically by PIS, while the activity of OIS would correspond with the signal modulating info-operational regime in the upper side of the triangle [21, 22]. The external information insistently and/or intensively operating on OIS is progressively integrated in PIS by epigenetic mechanisms, allowing the acquirement of new transgenerational traits, characteristic for living organisms, able to absorb and share information, and to self-organize themselves activity and body.

The following important/major merits of the ISHB/ISLS informational models can be highlighted [45]: (1) the identification of the basic structural functions of the brain/info-pathways respectively as informational sources, by suitable use of the virtual (conceptual)/matter-related defined information [31, 35]; (2) the unified description of the info-communication processes in terms of information, independently on the information source [31, 35]; (3) the neuro/pathway correlation between the informational functions and corresponding areas support [37, 16, 30]; (4) the understanding of the unitary life functioning on the entire dimensional and evolution scale [35, 24]; (5) the understanding of the hierarchical info-assisted organization/evolution of the brain on the evolutionary scale [16]. Specifically, besides of a major importance/contribution of ISHB in philosophy, neurosciences and biology, a special/unprecedented importance of the ISHB model in neuropsychology and behavioral sciences is played by its capability of unification under the concept of information of all theories of psychological and behavior science in human [45], *i.e.* cognition – operated by CASI/Ik and CDC/Iw, feelings by IES/II (“desires” in the Freud’s view) by MIS/Ia (metabolic signals), GTS/Ic (sexual sub-conscious signals), IGG/Icd (inherited/acquired predispositions/“archetypes”/prototypes), humanistic concepts by the individualization ($I(A) \neq I(B)$) of self (“I”) personality and according to the psychologist previous Jung’s view [14, 23], the behavioral theory on the responsivity to environmental stimuli – by CASI/Ik and CDC/Iw + IES/II reactivity for short-term adaptation, and epigenetic long-term transgenerational

(==>) adaptation (GTS/Ic ==>IGG/Icd), biologic theory by GTS/Ic and IGG/Icd info-activity.

The informational system of the human body and of the living structures reveals the following main conclusions: (1) the informational system works with the informed-matter (body) in a common concerted conformance to fulfill the adaptation/survival/maintenance necessities; (2) the living organisms are learning, sensitive and reactive structures, able to info-detect the environment conditions/changes and to react by (short-term) and long term (structural/generic) trans-generational adaptation, including the info-assisted modification/plasticity of own body structure; (3) the living organisms can reproduce themselves by sexual/asexual processes, based on DNA replication.

5. Predictive Big Data Analysis and Applications of AI and ISHB/ISLS Model for a Healthy Society

The CSER is a personal native and educable tool for investigation, based on the defined/described cognitive centers of consciousness, helping not only in scientific investigation to decipher unknown yet mysteries of matter at the frontier between uncertainty and certainty, but also in various design fields in technology, control and evaluation processes in industry and education, intelligence services, business management, medicine and even in the private life [23]. The capacity to predict is an important objective of almost all fields of human knowledge, so that this becomes a primary factor in the modern reality [46]. Predictability power of CSER can be explained by the synergistic educable contribution of cognitive center activities defined and described within IMC and is based by continuous observation and learning.

However, in order to affront nowadays the high accumulation of data in many domains, including the scientific investigation and medicine, the power of the big data forecasting analysis becomes a recognized useful tool for prediction [20], based this time on the learning machines and models, *i.e.* on the artificial intelligence. The pandemic wave at the global level, negatively affecting the economy, finances and industries, but especially the human health in the entire world, becomes a serious challenge for the scientific community to affront this terrible situation and the necessity to develop and apply the powerful tools for analysis and prediction at high quantitative scale [61]. COVID-19 is a pandemic RNA-genome-type virus (sub-living/parasite structure, because this does not dispose of own metabolic and reproduction system) [50], intervening with intruder information in the intracellular hosting cell transcription/translation communication, forcing the cell to produce its specific proteins, outside of the own necessities or the cell, producing the death of the cell [50]. The DNA genomic-type viruses transmit intruder instructions in the replication process, as it is schematically suggested the bottom-left side of Fig. 2, with the same consequences.

The big data analysis is a suitable predictive/forecasting solution [20], so scientific efforts are made to develop suitable predictive models to follow the pandemic evolution in various countries [61], allowing to the healthcare organizations and responsible factors to manage adequately this situation and provision more efficiently the needed resources to face this disease [61-64]. Moreover, the restrictive measures applied by the authorities against the spreading of virus in all countries, may lead to undesirable social behaviors like anxiety, depression and even violence [12], increasing the emergency needs of robust and efficient tools of prediction [61].

Among such efforts, thirteen models were analyzed recently comparatively to observe the efficacy to predict the trend of the COVID-19 cases evolution in 187 countries [59]. Although the statistical operations are performed objectively by a certain model, it is necessary to take

corresponding cautions when a predictive model is to be applied in each particular condition for accurate prediction of the infection rate, because the specific measures applied in each country as a function of the characteristics of the geographic and social behavioral traditions, could give rise to a strong dependence of the results on the used data set. For this, a new methodology for verifying the accuracy of time series models to capture the infection evolution and predict its trend was recently addressed to this item [56]. Analyzing the performance of each model in terms of root mean squared error and mean absolute percentage error, it was shown that the *autoregressive integrated moving average* (ARIMA) [64] model is the most suitable when an exponential increasing trend is operable in each particular case, generating the best prediction.

Autoregressive integrated moving average (ARIMA) is based on a combination of the *autoregressive* (AR) and *moving average* (MA) models, as it was proposed for the first time within the initial work [63]. Basically, the predictive/forecast value y_T of the time-series variable (an ordered sequence of values of a variable which are collected at equally spaced time intervals) is a function of the past values, according to the following polynomial expression [60]:

$$y_T = \alpha + \beta_1 y_{T-1} + \beta_2 y_{T-2} + \dots + \beta_p y_{T-p} + \varepsilon_T \quad (8)$$

where α and β are the regression coefficients, ε the noise (error) with respect to the signal (interest parameter), and p is the order of the time series considered in the past. Instead to use the observed past values of y_T as in AR, the model MA uses the past forecast errors in a regression model, as follows:

$$y_T = \alpha + \varepsilon_T + \phi_1 \varepsilon_{T-1} + \phi_2 \varepsilon_{T-2} + \dots + \phi_q \varepsilon_{T-q} \quad (9)$$

where this time α and ϕ are the regression coefficients, while q is the number of lagged forecast errors in the prediction equation. Therefore, the predicted values in ARIMA model can be written finally as:

$$y_T = \alpha + \beta_1 y_{T-1} + \beta_2 y_{T-2} + \dots + \beta_p y_{T-p} + \phi_1 \varepsilon_{T-1} + \phi_2 \varepsilon_{T-2} + \dots + \phi_q \varepsilon_{T-q} + \varepsilon_T \quad (10)$$

A specific parameter of this model is the differentiating number d , which represents the degree of the first differencing (the difference between the current time period and the previous time period), used to convert the time series into a stationary form, easier to be operated.

As an example of predictive power of the informational big data analysis applied in this domain, 95% confidence data captured from three countries, *i.e.* Romania, Spain and USA in the period 05/16-06/02/2020 collected from [61], are represented in Fig. 3 and compared with the predicted results given by a learning machine based on ARIMA model. The calculated prediction lines obtained in this work and represented in Fig. 3 in a log-linear scale, show that: $Cro = 16671 \times \exp(0.01349 \times t)$, $Csp = 231080 \times \exp(0.00370 \times t)$ and $Cusa = 1468237 \times \exp(0.01606 \times t)$, where C represents in this example the number of cases in Romania (Cro), Spain (Csp) and USA (Cusa) and t the time measured in days ($t=0, 1, 2, \dots, 17$).

More present and future applications in the range of predictive/diagnostic and operational/treatment by biocompatible systems and devices for a healthy society are now experimented and are/will be under development, and significant progresses are registered in this field, concerning: silicon capacitive sensors for biomedical applications [65], biocomputers and biotransistors with DNA and RNA, biological memories, cell biophotonics, DNA imaging based molecular crypto-systems for imaging, DNA based biosystems and nanotechnologies, genetic neuronal relays, bidimensional DNA nanostructures, FET biotransistors with carbon nanotubes, medical robotics (biosystems based on optic and magnetic phenomena, large scale genetic circuits for medical nanorobotic) [61, 66], helping the diagnostic and health care, an essential trend in our

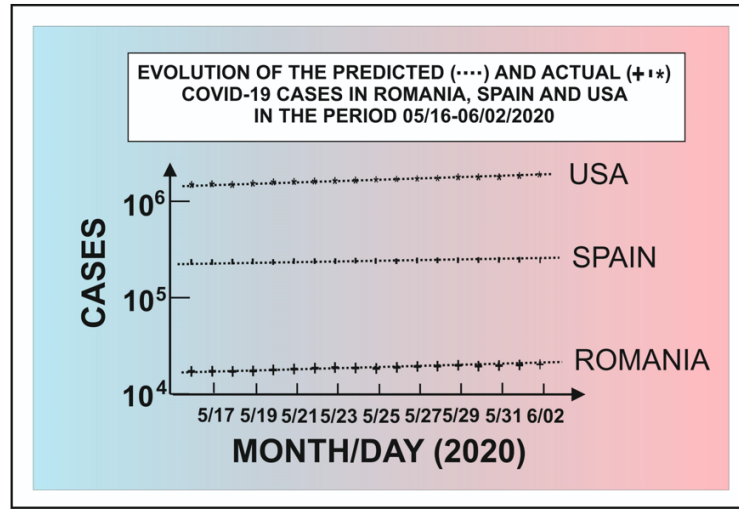


Fig. 3. Evolution of the predicted (dashed line – calculated in this work) and actual (+, |, ☆) COVID-19 cases in Romania, Spain and USA in the period 05/16-06/02-2020 on a data set of 95% confidence interval collected from [61].

nowadays informational era. Accurate analytical relations were recently reported, offering analytical solutions for nonlinear differential equations to solve the boron diffusion in silicon from boron tribromide liquid source [67] and boron nitride solid source [68] for the doping of silicon layers used as self-limiting etching process within the bulk micromachining technology and for test structures within the surface machining technology [69, 70] for the design and fabrication of the silicon capacitive sensors for Biomedical applications [71].

AI/learning machines are being used to support and help the decision making and management [20] as health compatible tools [62, 72], in particular addressed to affront the COVID-19 crisis and to assist the healthcare field [63, 73]. The following three priority directions are active on this domains: (i) virus research and development of drugs and vaccines [50, 73], in particular researches to predict the novel structure of virus proteins, new molecules that could serve as potential medications or even accelerate the time taken to predict the virus's RNA secondary structure, intelligent medical engineering tools in the healthcare domain [74, 48], like the image analysis for dermatology, pathology and radiology for fast diagnostic, the decreasing of the medical errors, for the optimization therapies in complex and chronic illnesses. medical exploration, analysis and diagnostic, and also as a basis for risk analysis and treatment in psychiatric disorders, hearth failure and more recently in the life science to explore the high throughput molecular assays in the so called “omics” branches (genomic, proteomic, epigenomic, metabolomic or organimics data) [74]; (ii) the management of services and resources at healthcare centers (AI involved to diagnose and customize medical care) [73]; (iii) the analysis of data to support public policy decisions aimed at managing the crisis, such as the confinement measures [73], the evaluation of the formation/deformation of the public opinion by means of the mass-media sources [46]. Several present or under development/future applications refer to [73]: blockchain technology (new non-centralized/non-erasable technology to transfer the digital data with very sophisticated/encryption/completely secure methods), open-source technologies (facilitating access to research data/scientific publications/sharing blueprints for production of critical medical

equipment such as ventilators and face shields), telehealth technologies (remote diagnosis via audiovisual, real-time, two-way interactive communication systems, online symptom checkers), three-dimensional printing (as additive local manufacturing use, with low-cost, one manufacturing machine only, compatible with blueprints computer-aided design (CAD)), gene-editing technologies (manipulation of the genetic (DNA) at particular locations in genome), nanotechnologies (nano-based products for diagnosis and treatment [71,73], synthetic biology (multidisciplinary approach using biology, engineering, genetics, chemistry and computer for mimic/redesigning of genomic components of the organism), drones (intelligent driven devices for disinfection, street patrols to food and medicine delivery), robots (intelligent solution for services and medical care in quarantine spaces, disinfection in hospitals, public and private sites, for handle of bio-hazardous waste, for delivery of food and medication, or for medical assistance).

The applications (A) of the ISHB/ISLS models cover a large range in life science/medicine, biology, psychology, neurosciences/neurology, psychiatry, behavioral sciences, geriatrics and aging neuro-rehabilitation, biomedicine and biotechnology/microbiology, biostatistic/biometrics [45, 46], in particular for: (A1) the successful understanding/solving of older philosophic problems like the elemental/fundamental constitution of the world on the basis of matter-energy and information, as a contributing structural component on the entire dimensional scale, described by of the Universal Triangle of Reality [21, 22]; (A2) the mind-body relation explained as a mutual info-communication process [6]; (A3) the nature-nurture dilemma, solved on the basis of the acknowledge of the (IGG=>Icreated) activity [7], i.e. IGG=>Icreated as nature (talent, predisposition) is a starting/native contributor to the operational decision (CASI/Iknow//CDC=>Iwant) as nurture (training), powered by the intervention of (IES=>Ilove) + (IC=>Ibelieve)); (A4) certainty/uncertainty in cognitive-sentient exploration of reality (CSER) [23]; (A5) the information-matter bipolarity of the human organism [34], of the living structures [21, 49] (the informational system/axis – IC/CASI and matter-related system/axis – MIS); (A6) the corresponding fundamental info-transmission circuits in neuroscience [21]; (A7) the sharp definition and evaluation/quantification of the attitude as the informational output [8, 10] (of Iknow, Ilove, Iam, Icreate, Icreated, Ibelieve); (A8) the evaluation/quantification of the attitude, with application in social relation, politics and marketing and industry; (A9) the info-relational cognitive operability of the anterior and posterior cingulate cortex (IC) [11, 16, 38] – a problem still not understood up to date in the brain sciences; (A10) the repetitive info-stimulation epigenetic-based mechanisms inducing transgenerational (==>) abilities/traits as of the next generation [52]; (A11) the hierarchical brain organization/evolution in neurology/neurosciences/life sciences [16], explained by info-stimulation and epigenetic/genetic integration of information; (A12) the relation with cognitive therapy in aging neurorehability, especially by music-based stimulation of CASI, with response in brain zones otherwise not accessible by regular/non-invasive techniques [9]; (A13) the brain response to beauty/ugly concepts [47] in neuropsychology/social behavioral sciences, explained by the activation of distinct CASI/CDC vs. IES circuits, the mental aggressive operability [12]; (A14) in psychiatry – by CASI/CDC inhibition versus IES excitatory/uncontrolled impulses, the pathological expression and circuits in addiction/mood disorders in psychiatry [44]; (A15) the understanding of the mind-body equilibrium and health by YES/NO stimulation/inhibition mechanisms [11]; (A16) the opening new ways of investigation in microbiology/biotechnology/biomedicine/bioengineering [24, 40, 49, 75]; (A17) the introduction/application of big data analysis and prediction concepts in biostatistic/biometrics applications [50, 76]; (A18) the understanding of plants behavior by means of the informational model of plant cell and plants; (A19) the approaching from informational perspective of the philosophic/biologic problem of the ex-

tension of consciousness concept to all living structures [59]; (A20) the discussion/evaluation of the positive/negative effects on the society of the mass-media information presented as mediated reality [46].

This new line of investigations, based on a deep experience in science and technology of information [20, 77–79], showing that information is deeply involved not only in the structuration of non-living matter [22, 66], but especially in the structuration and functionality of the living structures [21, 24, 30, 66], opens new ways of further development on: (i) biology, for the identification/understanding of intimate mechanisms in living organisms from informational perspective [35, 56, 59, 66]; (ii) biotechnology/medicine for further development of devices compatible with the human/living creatures [71, 72, 66] and analysis/control/decision methods for exploration/healing their body and functions [8–10, 50, 76, 77], or to create new biological products for medical/pharmaceutics/alimentary use [66]; (iii) artificial intelligence for accommodation of informational devices with biological structures and their functionality, with medical or any other practical applications [72, 66], or to use biological systems as models to mimic them for the preparation of artificial tissues and organs [66]. Such relevant results represent also a major advance in the field of science and technology of information addressed to the understanding of the information intervention and actuation in the biological structures, as it was recently recognized by their comprehension/presentation in a special chapter of a new edition of the encyclopedia of information science and technology, edited by IGI-GLOBAL (USA) [80], dedicated to information and informational modeling in the living structures.

6. Conclusions

Revealing the effort to understand on the basis of information concepts the nature and operability of mind and consciousness, starting with the archaic ancient models and continuing with the predecessors contribution to the definition of information in terms of entropy, the Draganescu's concepts on the structuration of non-living and living systems and the personal author's contributions to define and to show the fundamental role of information in living/non-living structures was highlighted. It was shown that information is an essential/universal component of reality, and the Informational Model of Consciousness, based on the distinct functions defined within the Informational Model of the Human Body and on their projection in mind as cognitive centers, allows to understand the Cognitive-Sentient Exploration of Reality as a prediction tool for investigation at the frontier between certainty and uncertainty, used in various manners in all creative fields of human activities, particularly in sciences and arts.

The analysis of the eukaryotic/prokaryotic cell functions and structuration in comparison with the functions and structure of the human body reveals that an Informational System of the Living Structures can be defined allowing the understanding of life operability on the entire evolution scale, including plants and cells, which are not endowed with a nervous system like animals. The same type of structure and functionality of ISHBLS, characterized by seven informational centers, justifies the conclusion that any living structure can explore reality and react in its own system of perception/interpretation of reality by an information system with less attributes than human, depending on the development degree of ISLS in each case and on adaptation necessities to the local conditions.

The enormous quantity of data accumulated nowadays in various scientific fields and the need of predictability of various phenomena, particularly the evolution of COVID-19 cases in the world (Romania, Spain, USA), are approached now by the informational big-data technique, as a helping

tool of investigation and scientific advances in various creative domains.

Present and perspective applications concerning the contributions of the artificial intelligence and of the ISHB/ISLS in the neurosciences, biomedical and bioengineering domain, for antivirus COVID-19 fight and for a healthy society in particular in life science, biology, psychology, neurosciences/neurology, psychiatry, behavioral sciences, geriatrics/gerontology and aging neurorehabilitation, biotechnology/microbiology, biostatistics/biometrics are also mentioned.

The original Romanian contributions to the information-based concepts and development both in non-living and living systems and their management is of a relevant representation and of a priority importance in the information-based domains, on the international scale.

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