Programming of Life

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<u>نبذة مُختصرة عن الكتاب</u>:

كتاب آخر للعالِم الأمريكي «**دونالد جونسون**» بعُنوان: «**برمجة الحياة**»، ولعل العُنوان مشهور بسبب الفيلم الوثائقي الممتاز جداً الذي يحمل نفس الاسم، والمُكوَّن من جُزئين.

هذا الكتاب يُعتبر نُسخة مُنقَّحة ومزيدة من كتابه الأول «**طبيعة الاحتمال**»، فهناك أجزاء كاملة من فُصُول منسوخة كما هي منه، ولا أعتقد أنَّ هذا الكتاب يُقدِّم موضوعات جديدة مُميَّزة، وإنَّما يدور مرَّة أخرى في نقد نظرية التَّطوُّر والاهتمام بالمعلومات الجينية كدليل واضح جداً على صحَّة نظرية التَّصميم الذَّكي (ID).

الكتاب يحتوي على مجموعة مُمتازة جداً من الاقتباسات العلمية المُتنوِّعة، ولكنَّ الكتاب كسابقه مُملّ، ولا يحتوي على في الغالب على شرح وبيان، فالمؤلَّف يكتفي غالباً بمُجرَّد النَّقل وسرد الأدلَّة، وهكذا، فالكتاب كسابقه، أنفع أكثر للباحثين، وليس للمُبتدئين.

الكتاب هذه المرَّة يهتمّ مُباشرة بالمعلومات الجينية، ويدور حوله بالكامل، ولا يتكلَّم عن التَّعقيد أو الوظائف الحيوية إلَّا قليلاً، ولا يذكر على الإطلاق موضوعيّ الخلق والإيجاد، والضَّبط الدَّقيق للكون، ولا يهتمّ كثيراً بموضوع احتمالية نشأة الحياة بقدر بيانه استحالة تكوين المعلومات الجينية بأي طريقة مادِّيَّة معروفة!

وهكذا يُقارن المؤلَّف بين نظام الحاسب الآلي وبين الخلية الحية، ويتكلَّم عن أنواع المعلومات المُختلفة المُستخدمة داخل الخلية الحيَّة، ثمَّ يُبيِّن عجز المادِّيِّين عن إيجاد أي تبرير مادِّي لنشأة المعلومات الجينية أولاً، ثمَّ زيادة حجم المعلومات الجينية من أجل حصول التَّطوُّر ثانياً.

2 Information Basics: Data and Information Types

- Carl Sagan wrote: "The information content of a simple cell has been established as around 10^{12} bits, comparable to about a hundred million pages of the Encyclopaedia Britannica" [Sag97]. That's in a "simple" cell! [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p7.]

- It's important to realize that information content is essentially massless, but the information medium has physical qualities. For example, a computer USB flash drive has the capacity to hold a certain quantity of data, but its weight doesn't measurably change by changing the data content. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p7.]

- Richard Dawkins has noted, "The machine code of the genes is uncannily computer-like. Apart from differences in jargon, the pages of a molecular biology journal might be interchanged with those of a computer engineeringjournal" [Daw95p 17]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p11.]

3 Evolution of Computer Hardware and Software

- "For me, the brain is not a supercomputer in which the neurons are transistors; rather it is as if each individual neuron is itself a computer, and the brain a vast community of microscopic computers. But even this model is probably too simplistic since the neuron processes data flexibly and on disparate levels, and is therefore far superior to any digital system. If I am right, the human brain may be a trillion times

- more capable than we imagine, and 'artificial intelligence' a grandiose misnomer ... I think it is time to acknowledge fully that living cells make us what we are, and to abandon reductionist thinking in favour of the study of whole cells. Reductionism has us peering ever closer at the fibres in the paper of a musical score, and analysing the printer's ink. I want us to experience the symphony" [For09]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p30, 31.]

- "The main distinctive features of the living beings are their extreme complexity, which is unmatched in the non-living world, and (not independently) the rather obvious but still overlooked fact that, besides matter and energy, they receive and transmit information, and that life heavily relies on information transfer and conservation. This last point has no equivalent outside the living world and appears as the specific mark which radically differentiates the living world from the non-living one. It makes biology especially relevant to information theory ... prompting biologists to

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use information theory as a main tool" [Bat07]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p31, 32.]

5 Shannon Information in Life

- Evolutionary biologist George Williams observed, "Evolutionary biologists have failed to realize that they work with two more or less incommensurable [incomparable] domains: that of information and that of matter ... These two domains will never be brought together in any kind of the sense usually implied by the term 'reductionism. ' ... Information doesn't have mass or charge or length in millimeters. Likewise, matter doesn't have bytes ... This dearth of shared descriptors makes matter and information two separate domains of existence, which have to be discussed separately, in their own terms" [Wil95]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p33.]

- "There are no chemical bonds between the bases. Thus, there are no chemical rules to determine the order in which the bases will be attached to the background" [Dav02]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p33.]

- "One cell division lasts from 20 to 80 minutes, and during this time the entire molecular library, equivalent to one thousand books, is copied correctly" [Git97p90]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p33.]

- "Crick expounded and enshrined what he called the 'Central Dogma' of molecular biology. The Central Dogma shows that influence can flow from the arrangement of the nucleotides on the DNA molecule to the arrangement of amino acids in proteins, but not from proteins to DNA. Like a sheet of paper or a series of magnetic points on a computer's hard disk or the electrical domains in a random-access memory -or indeed all the undulations of the electromagnetic spectrum that bear information through air or wires in telecommunications - DNA is a neutral carrier of information, independent of its chemistry and physics ... As the Central Dogma ordains and information theory dictates, the DNA program is discrete and digital, and its information is transferred through chemical carriers - but it is not specified by chemical forces. Each unit of biological information is passed on according to a digital program - a biological code - that is transcribed and translated into amino acids " [Gil06]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p33.]

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- "The genetic information system operates without regard for the significance or meaning of the message, because it must be capable of handling all genetic messages of all organisms, extinct and living, as well as those not yet evolved. .. The genetic information system is the software of life and, like the symbols in a computer, it is purely symbolic and independent of its environment" [Yoc05p7]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p36.]

- "Wherever you go in the world, whatever animal, plant, bug or blob you look at, if it is alive, it will use the same dictionary and know the same code. All life is one. The genetic code, bar a few tiny local aberrations, mostly for unexplained reasons in the ciliate protozoa, is the same in every creature. We all use exactly the same language" [Rid99]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p36.]

- "It seems that the two-pronged fundamental question: 'Why is the genetic code the way it is and how did it come to be?', that was asked over 50 years ago, at the dawn of molecular biology, might remain pertinent even in another 50 years. Our consolation is that we cannot think of a more fundamental problem in biology" [Koo08]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p36.]

6 Prescriptive Programming Information in Life

- "Peer-reviewed life-origin literature presupposes that, given enough time, genetic instructions arose via natural events. Thus far, no paper has provided a plausible mechanism for natural-process algorithm-writing. .. Both the semantics [meaning] and syntax [grammar rules] of codonic language must translate into appropriate semantics and syntax of protein language. That symbolization must then translate into the 'language' of three-dimensional conformation via minimum-freeenergy folding [for a stable protein]. No combination of the four known forces of physics can account for such conceptual relationships. Symbolism and encryption/decryption are employed. Codons represent functional meaning only when the individual amino acids they prescribe are linked together in a certain order using a differentl anguage. Yet the individual amino acids do not directly react physicochemically with each triplet codon. Even after a linear digital sequence is created in a new language, 'meaning' is realized at the destination only upon folding and lock-and-key binding" [Tre04]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p39.]

- Prescriptive information (PI) "instructs or directly produces nontrivial function ... Prescriptive information either tells us what choices to make, or it is a recordation of wise choices already made" [Abe09P]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p39.]

- "For prescription to be realized, the destination of any message must have knowledge of the source's alphabet, rules, and cipher. The destination must also possess the ability to use the cipher" [Abe09P]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p40.]

- "Biological information is not a substance... biological information is not identical to genes or to DNA (any more than the words on this page are identical to the printers ink visible to the eye of the reader). Information, whether biological or cultural, is not a part of the world of substance" [Hof05]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p41.]

- "What kind of information produces Junction? In computer science, we call it a 'program. ' Another name for computer software is an 'algorithm. ' No man-made program comes close to the technical brilliance of even Mycoplasmal genetic algorithms. Mycoplasmas are the simplest known organism with the smallest known genome, to date. How was its genome and other living organisms' genomes programmed?" [Abe05] [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p43.]

- Take note anyone that wants to earn an "easy" $1 million: "The Origin-of-Life Prize® ... will be awarded for proposing a highly plausible mechanism for the spontaneous rise of genetic instructions in nature sufficient to give rise to life" [OOLprize]. "The Origin-of-Life Foundation, Inc. is a science and education foundation encouraging the pursuit of natural-process explanations and mechanisms within nature. " Since no theory of genetic information is complete without a model of mechanism for the source of such prescriptive information within Nature, "all submissions must address the source of the prescriptive information through non-supernaturalistic natural processes. Which of the four known forces of physics, or what combination of these forces, produced prescriptive, functional information, and how? What is the empirical evidence for this kind of prescriptive information (instruction) spontaneously arising within Nature?" [OOLprize]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p44.]

- If RNA-first is true, "the real issue of life origin lies in answering how the initial single positive strands of RNA instructions got sequenced so as to prescribe microRNA regulation, amino acid sequencing and eventual folding function. No new information is generated in base-pairing replications...

Base-pairing is purely physicodynamic, and quite secondary to the already-programmed, formal, linear digital instructions of the single positive strand. .. Prior to an algorithm having computational function, no basis exists for selection in nature ... How did any computational program arise in nature? Computation is formal, not physical. Natural selection cannot generate formalisms. It can only prefer the results of formal computations- already living organisms ... No organism exists without hundreds of cooperating formal algorithms all organized into one holistic scheme. The more computational steps that are required to achieve integrated halting, the harder it becomes for an inanimate environment to explain optimization" [Abe09G]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p45.]

- "How did inanimate nature give rise to an algorithmically organized, semiotic and cybernetic life? Both the practice of physics and life itself require traversing not only an epistemic cut, but a Cybernetic Cut- a fundamental dichotomy of reality" [Abe08]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p45.]

- "The Cybernetic Cut must be crossed to program computational halting into any form of physical hardware. To prescribe, instruct or program formal utility is to traverse The Cybernetic Cut ... The bifurcation points found in the simplest binary system of choice contingency are bona fide decision nodes. Crossing the Cybernetic Cut requires the ability to purposefully steer through successive bifurcation points down a path toward a desired goal ... Bifurcation points, in the absence of the intentional choice that would convert them to true decision nodes, consistently fail to generate sophisticated utility. In symbol systems, the randomization of symbols and denial of intentional symbol selection quickly leads to the loss of even rudimentary meaning and function ... What exactly is the missing ingredient that renders life unique from inanimate physics and chemistry? The answer lies in the fact that life, unlike inanimacy, crosses the Cybernetic Cut" [Abe08]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p45, 46]

7 Combining Life's Information Types

- The coded information system in a cell "may be compared to a book or to a video or audiotape, with an extra factor coded into it enabling the genetic information, under certain environmental conditions, to read itself and then to execute the information it reads. It resembles, that is, a hypothetical architect's plan of a house, which plan not only contains the information on how to build the house, but which can, when thrown into the garden, build entirely of its own initiative the house all on its own without the need for

contractors or any other outside building agents ... Thus, it is fair to say that the technology exhibited by the genetic code is orders of magnitude higher than any technology man has, until now, developed. What is its secret? The secret lies in its ability to store and to execute incredible magnitudes of conceptual information in the ultimate molecular miniaturization of the information storage and retrieval system of the nucleotides and their sequences" [Wil87]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p49, 50.]

- "Neither order nor complexity is the determinant of algorithmic function ... This is one of most poorly understood realities in life-origin science. Selection alone produces functionality. Without selection, evolution would be impossible ... A 'cybernetic program 'presupposes a cybernetic context in which it operates. One has to have an operating system of 'rules' before one can have an application software. And of course one must have a hardware system too. All of these components only come into existence through 'choice contingency, ' not through 'chance contingency' or law. One of many problems with metaphysical materialism is that it acknowledges only two subsets of reality: chance and necessity. Neither can write operating system rules or application software. Neither can generate hardware or any other kind of sophisticated machinery, including molecular machines (the most sophisticated machinery known) " [Abe07]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p51.]

- "The reductionist approach has been to regard information as arising out of matter and energy. Coded information systems such as DNA are regarded as accidental in terms of the origin of life and that these then led to the evolution of all life forms as a process of increasing complexity by natural selection operating on mutations on these first forms of life" [Mc109]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p51.]

- "All the equations of physics taken together cannot describe, much less explain, living systems. Indeed, the laws of physics do not even contain any hints regarding cybernetic processes or feedback control. Thus, the term 'dissipative structures' does not adequately describe the 'informed', purposive organization of living systems. It is comparable to characterizing jet engines -- which are painstakingly designed and manufactured with extremely precise dimensional properties and tolerances-- as dissipative structures. They are neither self-designed nor are their dissipative properties among their most salient features" [Cor05]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p52.]

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- "The complexity of biology has seemed to grow by orders of magnitude.. . the signaling information in cells is organized through networks of information rather than simple discrete pathways" [Hay l0]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p52.]

- Biocomplexity professor Stuart Kauffman points out, "the genetic regulatory network in humans has some 2 3, 000 genes, among which are at least 2,040 transcription factor genes. These TFs regulate one another's transcriptional activity and those of genes that are regulated but not regulating. Work on yeast gene networks shows that they appear to be one large interconnected network. .. This genetic regulatory network is a non-linear dynamical system of high complexity. Modeling genes as binary, on, off, devices and studying large 'random Boolean networks' has shown that these networks, and piecewise linear networks, and linear ordinary differential equation networks all show the same generic behaviors, " all being complex data processing implementations [Maz10p223]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p52.]

- All the known laws, theorems, and principles of information science indicate that codes, complex functional information, and prescriptive algorithmic information cannot arise from physicality. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p54.]

- "There is no known law of nature, no known process[,] and no known sequence of events which can cause information to originate by itself in matter" [Git97p 1 07]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p54.]

8 Programming Increasing Complexity in Life

- "The human genome is a big document full of information, like a blueprint... In this study, we're looking at transposons that insert themselves in new places in various genomes and disrupt the blueprint ... If you think of the human genome as a manual to build a complex machine like an aircraft, imagine what would happen if you copied the page that describes passenger seats and inserted it into the section that describes jet engines. Transposons act something like this: they copy themselves and insert the copies [not new information] into other areas of the human genome, areas that contain instructions for the complex machine that is the human body. These areas and the instructions they contain may then become corrupted and hard to understand. This, in turn, can alter human traits or even cause human diseases" [Dev 1 0]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p64, 65.]

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- 'There is no evidence that genetic information can build up through a series of small steps of microevolution ... Mutations reduce the information in the gene by making a protein less specific. They add no information, and they add no new molecular capability ... None of them can serve as an example of a mutation that can lead to the large changes of macroevolution ... The failure to observe even one mutation that adds information is more than just a failure to find support for the theory. It is evidence against the ... neo-Darwinian theory" [Spe97p 159-160]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p65.]
- "Stunningly, information has been shown not to increase in the coding regions of DNA with evolution. Mutations do not produce increased information ... the amount of coding in DNA actually decreases with evolution ... No increase in Shannon or Prescriptive information occurs in duplication" [Abe09G]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p65.]
- Biologist Lynn Margulis writes, "We agree that very few potential offspring ever survive to reproduce and that populations do change through time, and that therefore natural selection is of critical importance to the evolutionary process. But this Darwinian claim to explain all of evolution is a popular half-truth whose lack of explicative power is compensated for only by the religious ferocity of its rhetoric. Although random mutations influenced the course of evolution, their irifluence was mainly by loss, alteration, and refinement. One mutation confers resistance to malaria but also makes happy blood cells into the deficient oxygen carriers of sickle cell anemics. Another converts a gorgeous newborn into a cystic fibrosis patient or a victim of early onset diabetes. One mutation causes a flighty red-eyed fruit fly to fail to take wing. Never, however, did that one mutation make a wing, a fruit, a woody stem, or a claw appear. Mutations, in summary, tend to induce sickness, death, or deficiencies. No evidence in the vast literature of heredity changes shows unambiguous evidence that random mutation itself, even with geographical isolation of populations, leads to speciation. Then how do new species come into being?" [Mar03] [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p65, 66.]
- "None exists in the literature claiming that one □pecies has been shown to evolve into another. Bacteria, the simplest form of independent life, are ideal for this kind of study, with generation times of twenty to thirty minutes, and populations achieved after eighteen hours. But throughout 150 years of the science of bacteriology, there is no evidence that one species of bacteria has

changed into another" [LinO 1]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p66.]

- "Yes, small-scale evolution is a fact, but there is no reason to think it is unbounded. In fact, all our data suggests that small-scale evolution cannot produce the sort of large-scale change Darwinism requires" [Hun03]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p66.]

- At a Conference on Macroevolution, anthropologist Roger Lewin said, "The central question of the Chicago conference was whether the mechanisms underlying microevolution can be extrapolated to explain the phenomena of macroevolution. At the risk of doing violence to the position of some people at the meeting, the answer can be given as a clear, No" [Lew80]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p66.]

- "Evolution ... must be gradual when it is being used to explain the coming into existence of complicated, apparently designed objects, like eyes ... Without gradualness in these cases, we are back to miracle, which is simply a synonym for the total absence of explanation" [Daw95]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p67.]

- "The problem of how eyes have developed has presented a major challenge to the Darwinian theory of evolution by natural selection. We can make many entirely useless experimental models when designing a new instrument, but this was impossible for Natural Selection, for each step must confer some advantage upon its owner, to be selected and transmitted through the generations. But what use is a half-made lens? What use is a lens giving an image, if there is no nervous system to interpret the information? How could a visual nervous system come about before there was an eye to give it information? In evolution there can be no master plan, no looking ahead to form structures which, though useless now, will come to have importance when other structures are sufficientlyd eveloped. And yet the human eye and brain have come about through slow painful trial and error" [Gre72]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p67, 68.]

- "Natural selection can't be the mechanism of evolution ... Introducing mental states into the operation of natural selection would allow it to reconstruct the distinction between selection and selection-for ... but the cost would be catastrophic. Mental processes require minds in which to happen" [Fod10Wp114&155]. [Donald E. Johnson: ***Programming of Life***, Big Mac Publishers 2010, p77.]

- NASA Astrobiology Institute ChiefBruce Runnegar says, "Natural selection is not a mechanism, it's the process by which the results of evolution are sorted. .. all of the processes are much more complicated than people

imagine. There are many more loops in the biochemistry of organisms. There are many cases where the RNA itself does the job and feeds back into the protein loop. So this whole system has become so much more complex. We understand the nature of life a lot more than we did 10 years ago" [Maz 1 Op 188& 190]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p77.]

- Presidential Medal of Science winner Lynn Margulis notes, "as far as 'survival of the fittest' goes, ... [natural selection is] neither the source of heritable novelty nor the entire evolutionary process... [making] Darwinism 'dead, ' since there's no adequate evidence in the literature that random mutations result in new species ... Natural selection is the failure to reach the potential, the maximum number of offspring that, in principle, can be produced by members of the specific species in question. This has been shown zillions of times in zillions of organisms" [Maz 1 Op257 &267]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p77.]

9 Unresolved Difficulties of Life's Information Requirements

- "The failure of purely physical theories to describe or explain information reflects Shannon 's concept of entropy and his measure of 'news. ' Information is defined by its independence from physical determination: if it is determined, it is predictable and thus by definition not information. Yet Darwinian science seemed to be reducing all nature to material causes" [Gil06]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p79.]

- "A certain wish fulfillment emerges from our naturalistic metaphysical presuppositions that uncontrolled physicodynamic phenomena will spontaneously self-organize into extraordinary degrees of formal ingenuity. Empirical support, logic, and prediction fulfillment evidence is sorely lacking for this blind, unfalsifiable belief" [Abe 1 OJ.] [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p79.]

- The argument for abiogenesis (life from non-life) "simply says it happened. As such, it is nothing more than blind belief Science must provide rational theoretical mechanism, empirical support, prediction fulfillment, or some combination of these three. If none of these three are available, science should reconsider that molecular evolution of genetic cybernetics is a proven fact and press forward with new research approaches which are not obvious at this time" [Tre04] [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p79.]

- "Biological functionality is turning out to be much more highly specified and precise than we had originally envisioned... biology is really a science of

engineering, where the constraints for biofunctionality are extreme - to the point that nearly every molecular interaction is remarkably precise and tightly controlled. Molecular biology is much like a jigsaw puzzle where each piece must be specifically shaped to fit with the other pieces around it" [Bra03]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p79.]

- Nobel laureate Linus Pauling said, "Science is the search for truth, the effort to understand the world; it involves the rejection of bias, of dogma, of revelation, but not the rejection of morality ... One way in which scientists work is by observing the world, making note of phenomena, and analyzing them " [Pau Web]. [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p82.]

- How did nature write the prescriptive programs needed to organize life-sustaining metabolism? Programs are shown by computer science to require a formal solution prior to implementation. How did inanimate nature formally solve these complex problems and write the programs? How did nature develop the operating systems and programming languages to implement the algorithms? How did nature develop Turing machines capable of computational halting? How did nature develop the arbitrary protocols for communication and coordination among the thousands (or millions) of computers in each cell? How did nature develop multiple semiotic coding systems, including the bijective codon-based coding system (for symbolic translation) that involves transcribing, communicating, and translating the symbolic triplet nucleotide block-codes into amino acids of the proteins? How did nature develop alternative generation of such messages using techniques such as overlapping genes, messages within messages, multilevel encryption, and consolidation of dispersed messages? A protein may obtain its consolidated prescriptive construction instructions from multiple genes and/or from the "junk" DNA, sometimes with over a million nucleotides separating the instructions to be combined. How did nature defy computer science principles by avoiding software engineering's top-down approach required for complex programming systems? How did nature produce complex functional programs without planning by randomly modifying existing algorithms? How did multiple such programs become simultaneously modified to result in the production of irreducibly complex structures? [Donald E. Johnson: *Programming of Life*, Big Mac Publishers 2010, p83, 84.]

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