


Research Article

Life is Programmed Computation

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Abstract

All known life is:

- Multi-dimensionally programmed
- Instructed by *Functional* Informational
- Representationally symbol-system prescribed
- Coded
- Transcribed and translated
- Successfully cybernetically processed (“halts”)
- Is literally computed
- Algorithmically orchestrated
- Processed by ingeniously integrated circuits

These are all formal concepts, not mere mass/energy interactions. Thus, life is fundamentally abstract, conceptual and formal. Its formalisms are instantiated into mass/energy physicality using physicodynamically-inert configurable switch-settings. Representational Material Symbol Systems (MSS) are also used to prescribe logical functions instructed by Prescriptive Information (PI). Physical symbol vehicles (tokens) are sequenced according to rules, not laws. These rules are shared by source and destination governed only by arbitrary pre-agreements, not by laws or physical constraints. Most of life’s instructions are prescribed by coded programming which is often superimposed and multi-dimensional. This programming must be cybernetically processed by nanocomputers. Formal functional work, not just the work of physics, is done by ingenious molecular machines. Life exists in the form of Sustained Functional Systems (SFS) that continually compute interdependent, highly cooperative haltings. Integrated circuits orchestrate into physicality homeostatic metabolism. Active selections alone achieve sustained far from equilibrium defiance of 2nd Law thermodynamic propensities. Life is not a thermodynamic state. Life consists of prescribed computational processes.

Keywords: Life Definition; Primordial Life; Protocells; Abiogenesis; Life Origin; Molecular Evolution; Chemical Evolution; Pre-Darwinian Evolution; Computational Biology; Self-Organization; Emergence; Protometabolism; ProtoCellular Metabolomics; ProtoBioCybernetics.

Introduction

One of the great benefits of abiogenesis research is that it allows great reductionism in addressing the question, “What is life?” ProtoCellular metabolomic models strip considerable complexity from homeostasis to focus only on the bare essentials. How does any Sustained Functional System (SFS) [1] maintain itself through time far from equilibrium despite 2nd Law propensities [1-4]? What biosystems must be developed to convert raw energy into usable energy, store it, and use it when needed? [5-9]. How did these

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SFS's come into existence in an inanimate environment? And how do these SFS's produce the incredible products (both conceptual and physical) known to arise only from "life"? But long before we get to protocellular metabolomic models, we are confronted with a peculiar ontological reality and necessity foreign to naturalistic physicydynamics. We call it "Maxwell's demon" [10-18]. He is a silly cartoon character that should have no place in naturalistic scientific literature. On the other hand, not even the simplest heat engine can spontaneously form without the agency of this silly little imagined personage. Why does this bizarre figure keep popping up in every elementary physics text? Why can't self-respecting naturalists once and for all dispense with him and terminate his existence?

Maxwell's demon sits at the top of the trap door that divides thermodynamic compartments [19-21]. The trap door is not and cannot be constrained in any way by physical forces or laws. To produce any formal function, its opening and closing must be fully contingent upon the demon's purposeful choice. No physicydynamic causation can concentrate hotter faster moving molecules on one side of the partition. Linkages between thermodynamic disequilibria "push" and entropy "pull" do not solve the problem of steering toward biofunction. It's very simple: No demon—no sustained energy differential. Who is this guy? Where did he come from? How and why does he become a cause of real, actual physical effects? Why can't we kill him off and get serious about real science—you know—naturalistic science? The answer is because Maxwell's demon is the very one responsible for scientists' brains and minds. Science would not exist without him [22]. Maxwell's demon is who chooses which nucleoside next to polymerize [23-30]. The demon is the one who chooses how each epigenetic configurable switch should be set to turn on and off certain instructions [31-38]. The demon is the one who orchestrates the integrated circuits into the symphony we call life [39-45]. He is the one who programs and cybernetically processes formal holistic "biosystems" [46,47]. The demon alone can account for genetic overlapping transcriptions [48,49], genes within genes, shared promoters, transcriptions in opposite directions, enhancers up to a million bases away from the genes they regulate, genes that prescribe both forward and backward at the same time, "gene neighborhood" interactions, environmental influence on genetic Prescriptive Information (PI) [23,50] itself [51,52], chromatic remodeling, epigenetic controls, alternate genetic splicing and functioning, and the innumerable long non-coding regulatory RNAs. Hundreds more proteins and functional RNAs are produced than the total number of genes in DNA. What law of physics or chemistry—what thermodynamic probabilism—is masterminding all this abstract, conceptual complexity? If we ever succeeded in killing off Maxwell's demon, we would

not only commit suicide ourselves, we would succeed in killing off all known lifeforms.

Where did Maxwell's demon come from?

We will never know as long as we refuse to accept the reality of Physicydynamic Incompleteness—Physicydynamic Insufficiency [37,38]. There are way too many pieces of the puzzle of reality than cannot be corralled by the perimeter defined by the naïve, simplistic philosophy of naturalism [53-57]. One of those pieces of the puzzle is the very real Maxwell's demon. So where did the demon come from? He came from the far side of The Cybernetic Cut [58,59]. The Cybernetic cut is an infinitely deep ravine that divides mass/energy physicydynamics from formalisms. The demon was born and raised on the far side of The Cybernetic Cut. His influence gained entrance to the near side of The Cybernetic Cut only across the narrow one-way bridge known as the Configurable Switch Bridge [58,59]. Physicydynamically-inert configurable switches had to be set by purposeful Choice Causation [53] to be able to generate any formal effect into physicality. Gravity doesn't turn our light switches off. Agent choice does. Configurable switches are deliberately designed and engineered that way. They are "physicydynamically incoherent." [3,26,27,56] Only active selection at true decision nodes, not just mere bifurcation points, produces formal effects. Irreversible nonequilibrium thermodynamics is incapable of setting configurable switches with the intent of achieving pragmatism. Choice Causation alone produces this physical effect. Subcellular life is replete with such configurable switch settings.

An alternative route across the Configurable Switch Bridge is the use of Material Symbol Systems [60,61] [23,24,28,29,54,61,62]. Physical symbol vehicles (tokens) have to be purposefully chosen, arranged and sequenced so as to communicate meaningful instructions according to formal rules [25,28,55], not laws, of how to produce non-trivial utility [30,63]. No sophisticated function has ever been observed to arise spontaneously out of physicydynamics alone [56,57]. Not even a simple piece of wire has ever self-organized or emerged from raw mass/energy interactions and reactions [1-4]. Irreversible nonequilibrium thermodynamics has never produced so much as a paper clip [64]. Neither has Chaos Theory nor Complexity Theory [37,53,54,62,63,65,66]. Prigogine's "dissipative structures" destroy formal organization, not produce it [26,27,30,38,56,57,63,67,68].

Is the demon physical?

We live in a mass/energy world, don't we? Doesn't the demon have to be physical? Everything else is physical, isn't it? Or is it? What about the laws of physics? Are the abstract, conceptual, mathematical equations that govern all physical interactions physical [65] [69,70]? What about scientific logic theory? Is that physical? What about the categorization

and tabulation of results, and the drawing of conclusions? What about scientific ethics? Are we sure everything boils down to nothing more than mass and energy? Is the scientific method physical? Why is the mind/body problem still such an intractable problem?

What is so different about Maxwell's demon?

Despite physical law, the demon can actively select from among real physical options. Probabilism only describes possibilities. It produces no efficacious results. Thermodynamic possibilities do not generate focused physical utility. The demon does far more than to deal with chance contingency. The demon exercises choice contingency. He enters the scene with a peculiar interest in and ability to cause physical effects never before observed to arise from physiodynamics alone. The demon sets foot on the stage of otherwise naturalistic reality with the unique ability to make purposeful choices. None of the forces of physics, no law or constraint, can make purposeful choices that cause physical, yet formal effects. We are talking about a third fundamental category of reality in addition to Chance and Necessity: Choice Causation [22,23,27,29,30,38,53,55,57-59,71]. The demon also possesses the unique ability to actually do something useful. He can identify, value and pursue utility. It is the demon who introduces a new definition of "work" that is completely foreign to physics. Not only is a mass moved through space, it is moved through space for some valuable reason. The demon's choices alone value and pursue function. The demon alone says, "why don't I operate this trap door "in order to" concentrate hotter, faster moving molecules on one side, and cooler, slower moving molecules on the other, so that I can create a differential that might eventually allow generating a heat engine." Maxwell's demon alone provides the essential element of steering toward function. The demon controls; physiodynamics constrains.

If we want to ever finally succeed in defining life, we had better begin acknowledging the reality and roles of formal subcellular controls. Mere laws and constraints have never been observed to control any formal process. Unlike inanimate physiodynamics, the demon is not only able to identify, sense and value usefulness; he pursues it. Unlike the physics definition of "work," the demon's definition of "work" requires accomplishing something of formal worth and mechanical profit. The demon's choices are purposefully pragmatic. Physiodynamics knows nothing of pragmatism. The demon believes in expediency. He asks, "What would be helpful in this situation?" Would this choice be efficacious in accomplishing some yet-to-be-realized goal?

The majority of the demon's choices have to be made prior to the realization of any function—"final" function especially. He often lacks the benefit of favoring what already works. Technically, neoDarwinian evolution doesn't even do

that. Evolution doesn't select for function. It only selects the fittest organisms. In molecular evolution, organisms do not exist yet. The demon's selection is not "natural" (after the fact of already-programmed, already-cybernetically-processed, already optimized, already-living organisms). His selection is active, not passive or secondary [3]. He has to generate from scratch what will eventually work through wise immediate choices. What will be advantageous upon successful computation? What will eventually be expedient? What will wind up being handy? What will be valuable? What will be suitable? Worthwhile? Nifty? Creative? Efficacious? These are not naturalistic physics or chemistry terms and concepts. They are purely formal notions. They are engineering terms, not natural science terms. They did not arise from the near side of The Cybernetic Cut. They arose from the far side, from the demon's neighborhood of agency.

When the demon programs, he faces Turing's nagging halting problem. The only thing is, somehow, unlike our finest programmers, Maxwell's demon seems to be able to overcome the halting problem. He actively selects and polymerizes the needed sequences of nucleosides to prescribe primary, secondary and tertiary protein structure. How does he know what programming choices will compute only upon later cybernetic machine processing? He has insights physiodynamics not only lacks, but which the best of human programmers lack.

Imagined reality without the demon

The abiogenic literature is filled with all manner of hypothetical demon-less life-origin scenarios [43,72-124] [105,111-124]. They all sneak in steering and controls through the back door, hoping that no colleague will notice the investigator involvement in experimental design. When the details are studied of all the latest and best models of spontaneous establishment of homochirality, for example [125,126], we find that a number of specific conditions must be met at the right time and place. These supposedly naturalistic models become not only statistically prohibitive, but their scenarios violate the Universal Plausibility Principle with a UPM of $\xi < 1.0$. This renders the hypothesis untenable for reasons of scientific implausibility [127,128].

Why can't reputable scientific naturalists kill off Maxwell's demon?

The answer is very simple:

No Maxwell's demon

- no simplest heat engine.
- no sustained circumvention of the 2nd Law.
- no life
- no scientists
- no science

- no philosophic naturalism, or any other metaphysical belief system conjured up by human agents.

Life is fundamentally abstract, conceptual and Formal [2-4,22,24,26,27,29,30,37,38,53-59,61,62,64,65,67,68,129]. Its formalisms are instantiated into mass/energy physicality using physiodynamically-inert configurable switch-settings [60,130,131]. Representational Material Symbol Systems (MSS) are also used to prescribe logical functions instructed by Prescriptive Information (PI) [23,25,28]. Physical symbol vehicles (tokens) are sequenced according to rules, not laws. These rules are shared by source and destination governed only by arbitrary pre-agreements, not by physical constraints [27,29,30,55,57,59]. Most of life's instructions are prescribed by coded programming which is often superimposed and multi-dimensional [132]. This programming must be cybernetically processed by nanocomputers. Formal functional work, not just the work of physics, is done by ingenious molecular machines [133-141]. Life exists in the form of Sustained Functional Systems (SFS) [1] that continually compute interdependent, highly cooperative haltings. Integrated circuits orchestrate into physicality homeostatic metabolism. Active selections alone achieve far from equilibrium defiance of 2nd Law thermodynamic propensities [3].

Conclusion

At the turn of the millennium, the finest life-origin scientists in the world gathered in Modena, Italy to address the question "What is life?" [142,143]. Not only were no two of our definitions the same at that conference; they all failed to recognize the essential ingredient of what makes life alive. It is the fact that all known life is programmed, computed and cybernetically processed by highly sophisticated nanocomputers and molecular machines that could only have come into existence through agency. Only the demon's agency can practice formalisms like the abstract, conceptual, nonphysical, mathematical laws of physics. Life is a constellation of exquisite formalisms only secondarily instantiated into physicality. No agency: no formalisms: no life. Any model attempting to reduce abiogenesis to nothing more than inanimate physiodynamics measures out with a Universal Plausibility Metric $\xi = < 1.0$, thereby requiring editorial and peer-review rejection for reasons of scientific implausibility. Agency cannot fit within the narrow-minded worldview of metaphysical naturalism. Disallow the agency of Maxwell's demon, and we not only throw a monkey wrench into the scientific method, we murder life itself. Naturalism is by far the worst Kuhnian paradigm rut [144] in the history of science. Our naturalistic god is too small. And this pathetic fanatical religion is greatly impeding scientific progress, biology in particular. Maxwell's demon is ontologically and scientifically real.

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