The First Gene, David L. Abel, Editor 2011, pp 55-74 ISBN: 978-0-9657988-9-1

3. The Cybernetic Cut and Configurable Switch Bridge*

David L. Abel

Department of ProtoBioCybernetics/ProtoBioSemiotics
Director, The Gene Emergence Project
The Origin-of-Life Science Foundation, Inc.
113 Hedgewood Dr. Greenbelt, MD 20770-1610 USA

ABSTRACT. The Cybernetic Cut delineates perhaps the most fundamental dichotomy of reality. The Cybernetic Cut is a vast ravine. The physicodynamics of physicality ("chance and necessity") is on one side. On the other side lies the ability to choose with intent what aspects of ontological being will be preferred, pursued, selected, rearranged, integrated, organized, preserved, and used to achieve sophisticated function and utility (cybernetic formalism). The Cybernetic Cut can be traversed across the Configurable Switch (CS) Bridge. Configurable switches are especially designed and engineered physical devices that allow instantiation of nonphysical formal programming decisions into physicality. The flow of traffic across the CS Bridge is one-way-only. Physicodynamics never determines formal computational and control choices. Regulation, controls, integration, organization, computation, programming and the achievement of function or utility always emanate from the Formalism side of the Cybernetic Cut.

Correspondence/Reprint request: Dr. David L. Abel, Department of ProtoBioCybernetics/ProtoBioSemiotics Director, The Gene Emergence Project, The Origin-of-Life Science Foundation, Inc., 113 Hedgewood Dr. Greenbelt, MD 20770-1610 USA E-mail: life@us.net

*Sections from previously published peer-reviewed science journal papers [1-9] have been incorporated with permission into this chapter.

Introduction: Chance and Necessity cannot steer, program, compute or regulate

Neither randomness (if it is possible at all) nor the cause-and-effect determinism of nature has ever been demonstrated to generate nontrivial algorithmic utility. Physical generation of nonphysical formalisms is a logical impossibility. Cause-and-effect determinism produces highly-ordered events containing almost no uncertainty or information. These highly-ordered events can be described using a compression algorithm much shorter than the sequence of events being described. The latter ability is the very definition of sequence order, low uncertainty, and minimal information content [10-14].

Algorithmic optimization, on the other hand, requires choice contingency rather than chance contingency, and typically produces highly-informational instructions and control. Any physical matrix capable of retaining large quantities of Prescriptive Information (PI) must offer high degrees of Shannon uncertainty and high bit content [2, 8, 15]. High bit content refers only to combinatorial possibilities within the physical matrix. But it is an essential requirement of any physical medium if PI is to be instantiated into that medium.

1. What is The Cybernetic Cut?

The Cybernetic Cut is a vast ravine that runs through the center of reality. The physicodynamics of physicality ("chance and necessity") is on one side. On the other side is the ability to choose with intent what aspects of ontological being will be preferred, pursued, selected, rearranged, integrated, organized, preserved, and used to achieve sophisticated function and utility (cybernetic formalism) [4, 16]. The Cybernetic Cut [4, 16] delineates perhaps the most fundamental dichotomy of reality.

Cybernetic (control) function requires freedom of selection. All formalisms can invariably be traced back to the exercise of choice contingency and its role in decision theory. Achieving formal utility requires crossing The Cybernetic Cut [4]. The extent of this ravine is far too wide to allow any jump from physicality to formalism. Algorithmic and computational processes are necessary to traverse the chasm of The Cybernetic Cut from formalism to physicality. This is made possible only by unique devices discussed below. Appreciating the Cybernetic Cut is the key to understanding the instantiation of any type of formal creativity and engineering success into physicality.

The Cybernetic Cut extends far beyond Howard Pattee's epistemic cut [17-19] to address two major areas: 1) the gulf between formal, purposeful choices and a materialistic world limited to chance and/or necessity, and 2) crossing that great divide through the instantiation of deliberate choices into physicality to achieve algorithmic utility in the material world. Such choices

constitute much more than mere constraints. Controls are needed. The difference between constraints and controls is explained in Chapter 2, Section 4. The far side of The Cybernetic Cut manifests designing and engineering-like ability to organize abstract concepts and to instantiate those concepts into a pragmatic physical reality. The far side of the Cybernetic Cut emanates instructions, prescription, and creativity. Programming choices must wisely pursue future function and be carefully integrated and managed.

Traversing The Cybernetic Cut can be clearly observed in innumerable examples of formal controls of physicality. Pattee's excellent description, measurement, and complementarity points do not fully explain this phenomenon. Table 1 shows the difference between Pattee's description-based Epistemic Cut and its extension to a much more inclusive prescription-based Cybernetic Cut. Table 2 shows the difference between physicality and those aspects of reality that traverse the Cybernetic Cut into the sphere of functional and pragmatic controls.

Single-celled organisms *seem* to make true choices (e.g., approach/ avoidance to food sources and noxious stimuli) even though they lack physical brains and formal minds. However, at a prokaryotic level, such "choices" could be pre-programmed (as with robots and AI) by their genetic instructions, molecular nanocomputers, operating systems, software, and various pre-existing epigenetic control mechanisms. We would not attribute "mind" to a robot or bacterium even though they *seem* to make choices. Preprogramming would not require true choices by the robot or bacteria. But the question is, how were bacteria pre-programmed to approach food and avoid noxious stimuli? Typically the inanimate environment gets the credit for the source of controls in abiogenesis. But environmental fluctuations do not constitute controls. The control mechanisms lie within the cell's instruction set. The programming of the cell anticipates all environmental constraints and eventualities, and wisely responds to them. To give the inanimate environment credit for preferring improved formal function is ludicrous.

We are hard-pressed to provide empirical evidence, rational justification, or references showing *how* programming can be accomplished without intentional choices of mind (crossing The Cybernetic Cut). It is only one's materialistic metaphysical commitments that make this fact difficult to acknowledge, not anything scientific. What we repeatedly observe is that cybernetics is accomplished only across bona fide decision nodes, highly specific logic gate configurations and intentional configurable switch settings that integrate circuits and achieve formal computational halting.

Table 1. The difference between Pattee's description-based Epistemic Cut and its extension to a much more inclusive prescription-based Cybernetic Cut.

The Epistemic Cut	The Cybernetic Cut
Knowledge based	Decision-node based
Constraint based	Control based
Description based	Prescription based
Measurements taken of existing constraints	Constraints are deliberately chosen
Uses laws	Uses rules
Learns	Instructs
End-user based	Programmer based
Non-creative	Creative
Cause and effect	Choice with intent steers the path
Observational	"Makes things happen"
Self-ordering events	Organizational
Describes causal chains of "necessity"	Optimization of genetic algorithms
No choices required	Requires choice with intent
Uses existing laws of motion	Programs configurable switches
Reads semantic information	Writes prescriptive information
Follows orders	Managerial

2. What is the Configurable Switch (CS) Bridge?

Through "configurable" switch settings, formal choice contingency can become a source of physical causation. The setting of these configurable switches and logic gates constitutes the building of the Configurable Switch (CS) Bridge [4, 16] across the vast ravine of materialistically untraversable Cybernetic Cut.

Nonphysical formalism itself can never be physical. As we have seen in previous chapters, the chance and necessity of physicality cannot steer objects and events towards formal utility. Chance and necessity cannot compute or make programming choices. Mere constraints cannot control or regulate. The inanimate environment does not desire or pursue function over nonfunction.
So how does physicality ever get organized into usefulness of any kind? How does stone and mortar ever become a building? The answer lies in our ability to build a CS Bridge from the far side of The Cybernetic Cut—the formal side

of reality—to the near side—the physicodynamic (physical) side of the ravine. The scaffolding needed to build this bridge consists of devices that allow instantiation of formal choices into physical recordations of those choices.

Table 2. The difference between physicality and those aspects of reality that traverse the Cybernetic Cut into the sphere of functional and pragmatic controls.

Physicodynamics	**Traversing the Cybernetic Cut**
Physical	Nonphysical & Formal
Incapable of making decisions	Decision-node based
Constraint based	Control based
Natural-process based	Formal prescription based
Constraints just "happen"	Constraints are deliberately chosen
Forced by laws & Brownian movement	Writes and voluntarily uses formal rules
Incapable of learning	Learns and instructs
Product of cause-and-effect chain	Programmer produced
Determined by inflexible law	Directed by choice with intent
Blind to practical function	Makes functional things happen
Self-ordering physicodynamics	Formally organizational
Chance and necessity	Choice
No autonomy	Autonomy
Inanimacy cannot program algorithms	Programs configurable switches
Oblivious to prescriptive information	Writes prescriptive information
Blind to efficiency	Managerially efficient
Non-creative	Creative
Values and pursues nothing	Values and pursues utility
Cannot pursue algorithmic optimization	Optimizes genetic algorithms

This is accomplished through the construction of physical logic gates—the equivalent of Maxwell's demon's trap door. The gate can be opened or closed by agent choice at different times and in difference contextual circumstances. The open or shut gate corresponds to "yes" vs. "no," "1" vs. "0." Because the gate can be opened or closed by the operator at will, we call it "configurable." It's the equivalent of an "On" or "Off" configurable switch. We saw such a switch in Chapter 2, Figure 1a. No physical force determines how the configurable switch is set. On a horizontal circuit board with old-

fashioned binary switches, the forces of gravity and electromagnetism work equally on either possible setting of these switches. The only other forces of physics, the strong and weak nuclear forces, are also irrelevant to how configurable switches are set. Only one thing determines how they are set—choice contingency. The deliberate, purposeful setting of a single binary configurable switch constitutes crossing The Cybernetic Cut across the CS Bridge.

Another means of crossing the CS Bridge across The Cybernetic Cut is to select physical symbol vehicles (tokens) from an alphabet of tokens available in a material symbol system. Like configurable switches, the tokens are unique physical devices. Each token is specially marked with a particular formal symbol. Scrabble tokens, for example, theoretically could be "randomly selected" (technically a self-contradictory nonsense phrase), just as configurable switches theoretically could be "randomly set." But universal empirical experience has long since taught humanity, including the scientific community, that "random selections" never produce or improve sophisticated programming function. "Garbage in, Garbage out!" Mutations cannot be distinguished from "garbage." The one and only factor that produces or improves sophisticated function is purposeful and wise choice contingency. The specifically symbolized tokens have to be deliberately chosen from an alphabet of "physical symbol vehicles" [20-23] to spell a meaningful message. Similarly, configurable switches have to be deliberately set to integrate a circuit or to successfully program computational success. The essence of crossing the CS Bridge across the vast ravine of The Cybernetic Cut is *purposeful choice contingency.*

3. The one-way-only nature of traffic across the CS Bridge

The need for "semantic closure" between natural physicodynamics and the seemingly very unnatural (abstract, conceptual, formal) control functions employed by life has been widely known for some time [18, 19, 24-35]. The hope for a naturalistic semantic closure, complementarity and "code duality" [36-39] is usually pursued along the lines of blurring the clear distinctions between categories of constraints vs. controls. Despite decades of trying to bridge the gap, The Cybernetic Cut [4, 16] remains untraversed except across the unidirectional CS (Configurable Switch) Bridge [4, 16]. Traffic flow across this bridge has thus far been observed to be one-way-only. Said Howard H. Pattee,

> The amazing property of symbols is their ability to control the lawful behavior of matter, while the laws, on the other hand, do not exert control over the symbols or their coded references. [40]

Formalism can be instantiated into physicality. But physicality cannot reverse the traffic flow across the CS Bridge to invade the world of formal controls. The reason is that physicality offers nothing but constraints and chance contingency with which to attempt programming controls, computation, circuit integration, complex machine generation, algorithmic optimization, organization, and sophisticated utility of any kind. Neither chance nor necessity can steer toward "usefulness," pragmatism, or generate nontrivial formal function.

Physicality cannot choose which way to throw a horizontal binary switch knob to produce desired function. The physical environment might be able to constrain the switch knob to be thrown in a certain direction if the switch comes near a magnet, for example. But if the switch just happened to be near a magnet, no formal determinism would be in play that would program that switch setting for potential formal function. And if multiple switches just happened to be near the magnet, all of the metal switches would be set the same way. A program consisting of all 1's, or of all 0's would result that could not integrate a circuit or compute anything functional. All the switches would be set to "open," or all the switches would be set to the "closed" position *by law*. Programming would be impossible. Freedom from law is necessary to program. Yet chance contingency cannot program switch settings either. Thus physicality (chance and necessity) on the near side of The Cybernetic Cut cannot generate nonphysical formal controls and regulation. Physicodynamics cannot generate programming choices so as to generate sophisticated (nontrivial) formal function. Thus to generate any kind of formal, cybernetic, computational, utilitarian function requires choice contingency, not chance contingency or law. The introduction of choice contingency into physicality requires traveling across the CS Bridge. All traffic across this Configurable Switch Bridge flows in one direction only—from the nonphysical formal world of abstract conceptuality, organizational specification, and engineering into the physical world.

4. Evidence that The Cybernetic Cut has been traversed

Nonphysical formal programming can *use* physicodynamics to accomplish its ends. But the programming decisions themselves are intangible. A cybernetic switch is physical. The flipping of that switch is also a dynamic process through time. The selection of a certain option from among multiple options that the switch offers, however, is as formal as mathematics itself. The consideration and choice of switch positions precedes the physicodynamic action of actually flipping that switch. Choice contingency has the ability to determine future dynamic effects. But the intent of which choice commitment will be made (using the switch to accomplish some utilitarian purpose) is en-

tirely nonphysical—non-physicodynamic. And it is not merely descriptive. It is *prescriptive*. Whatever switch position is chosen will *determine the degree of utility* of the physical integrated circuit. Function is determined by the formal computational success of the system. But computational success is accomplished by passing through a series of individual decision nodes. In addition, overall integration of those individual decisions must be made with purpose and intent to bring about holistic success (e.g., metabolism). Coordination of solitary configurable switch settings into holistic function constitutes even more abstract meta-control. But this control is instantiated into physicality at the point of each purposeful decision-node selection.

Over the last ten years, this author has published in numerous peer-reviewed papers many versions of the following null hypothesis: "If these decision-node programming choices are made randomly or by law rather than with purposeful intent, no nontrivial (sophisticated) utility will result." [41]. It would take only one exception (without behind-the-scenes steering) to falsify this null hypothesis. At the time of the writing of this book, so far this repeatedly published null hypothesis has never been falsified. The hypothesis now can and should be extended into a formal testable scientific prediction: *"No nontrivial algorithmic/computational utility will ever arise from chance and/or necessity."* How can such a bold, dogmatic prediction be made? The answer is that it arises from logical necessity, not from empirical observation alone or inductive reasoning. The prediction is a logically sound inference based on prior deductive absoluteness within its own axiomatic system. The only possibility of error on the deductive side would be an axiomatic one where a presupposition is "out of touch with reality" (as theoretical physics is sometimes accused of being). Since no axiom is ever proven, we are forced to consider the deduction best-thus-far, and the prediction that flows from it tentatively valid. After another decade or two with no worldwide success at falsification, this formal scientific prediction should become a mature generalized theory, if not a tentative law of science, which I shall name in advance, ***"The Law of Physicodynamic Insufficiency."*** This proposed tentative law states that physicodynamics is completely inadequate to generate, or even explain, formal processes and procedures leading to sophisticated function. Chance and necessity alone, in other words, cannot steer, program or optimize algorithmic/computational success to provide desired nontrivial utility. When we see sophisticated function of any kind, we have strong evidence suggesting that the Cybernetic Cut has been traversed across the one-way-only CS Bridge. Nonphysical formalism (purposeful choice contingency) has been instantiated into physicality via logic gates, configurable switch settings, the purposeful

selection of tokens from an alphabet of tokens, or cooperative integration of physical components into formal systems and conceptually complex machines.

Whenever we observe nontrivial conceptually-complex function, programming that leads to computational success, design, engineering, integrated circuits, or sophisticated organization of any kind of physical components, we know that The Cybernetic Cut has been traversed across the one-way-only CS Bridge from formalism to physicality. Physicality can self-order. But it cannot organize itself into formal algorithmic systems. Physicodynamics cannot integrate parts into holistic, cooperative, functional metasystems. Physicodynamics does include spontaneous non-linear phenomena, but it cannot produce the formal *applied*-science known as "non-linear dynamics." The latter is produced only by agents, not by inanimate nature.

5. Life traverse's the Cybernetic Cut

Base-pairing of existing positive nucleotide single strands to form double strands is a purely physicodynamic phenomenon. Base pairing is mediated by simple hydrogen bonds which themselves are not directly related to informational syntax. Montmorillonite adsorption of ribonucleosides and other forms of templating in primordial models of life-origin are also purely physicodynamic [42]. What physicalism cannot explain, however, is how each template or original positive strand acquired its own prescriptive informational *sequencing*. Physicodynamics such as base-pairing appears to play no role in the determination of which particular monomer is added next to a forming positive single-stranded instructional biopolymer. Neither the individual nucleotide selections in these positive single strands nor optimization of life's literal genetic algorithms proceeds according to the laws of physics and chemistry. Life provides the very basis for the notion of artificial genetic algorithms [43-45]. Sequencing (primary structure) instructs the folding of ribozymes, the prescription of structural proteins, catalysts, ribosomes, and regulatory ncRNAs. Life uses these strings of dynamically-inert configurable switch settings to record formal programming selections. Nothing is more highly-informational than the instructional organization of the components of life. Even supposedly-epigenetic regulatory proteins and ncRNAs are genetically prescribed by a vast syntax of sequential nucleotide selections. Such programming cannot be an effect of physical "necessity." Any law-based selection (e.g., clay surface adsorption) would produce only low-informational redundancy (e.g., a polyadenosine with near zero Shannon uncertainty [46]). For highly-prescriptive information content to be instantiated into any physical matrix, high Shannon combinatorial uncertainty is required. This in turn requires freedom from law and necessity. Yet in the absence of physicochemical causation and spontane-

ous self-ordering, equally nonfunctional "noise" would occur in the form of stochastic ensembles. Noise produces no more formal function than redundant low-informational laws. Spontaneous self-ordering of Progogine's dissipative structures (in chaos theory) is very different from formal organization. Genetic prescription requires uncoerced—arbitrary, yet non-random—selection of monomers.

The sequencing of initially non-templated positive strands is thus "dynamically incoherent" or "dynamically decoupled" [19, 21, 28]. Turing and von Neumann were inspired by, and modeled early computer technology after, the dynamic inertness of genetic cybernetics [47, 48]. Each single-stranded nucleotide selection represents a new "dynamically inert" configurable switch setting. Any of the four nucleotides is polymerized with relatively equal physicodynamic difficulty. Genes are sequences of specifically set quaternary (four-way) decision-node logic gates. While many selections *seem* inconsequential, others are essential to achieving computational function. Because of recently discovered overlapping of linear digital prescription and reads in the opposite direction, sections previously thought to be inconsequential for one protein are now known to be highly prescriptive of regulation and other overlapping prescriptions.

Genetic instruction requires freedom to make efficacious biological programming selections at the genetic level. Open-ended evolution (OEE) [18, 49, 50] is impossible without such freedom of selection of physical symbol vehicles. Each logic gate must be freely configurable. Nucleotide selection and sequencing cannot be determined by chance or necessity. Nucleotides are physical symbol vehicles in a material symbol system (MSS) [21, 29, 51, 52]. The sequencing of these physical symbol vehicles is critical to how the DNA positive strand instructs protein translation. In addition, most DNA is transcribed into regulatory RNA in which the sequencing of ribonucleosides is also critical. Functional Sequence Complexity (FSC) [8, 53] rather than Ordered Sequence Complexity (OSC) or Random Sequence Complexity (RSC) is instantiated into the physical linear, digital, resortable, physical-symbol-vehicle syntaxes known as genes [13, 14, 54, 55] (See chapter 5 by Kirk Durston and David Chiu). A great deal of sophisticated editing of DNA is required to piece together genes from remote sites. This only adds to the layers of Prescriptive Information employed by living organisms. But only the instantiation of formal Prescriptive Information (PI) [6, 56] into physicality makes genetic control possible. The nucleic acid of living organisms contains extraordinarily sophisticated linear digital programming. We are only just beginning to understand the many superimposed dimensions of Prescriptive Information found in this programming [6, 57, 58]. Particular monomeric sequencing is crucial to

life. More than any other characteristic, computational linear digital prescribed algorithms distinguish life from non-life [54] [59]. Says Yockey,

> The existence of a genome and the genetic code divides living organisms from non-living matter. In living matter chemical reactions are directed by sequences of nucleotides in mRNA. . . . There is nothing in the physico-chemical world that remotely resembles reactions being determined by a sequence and codes between sequences. [55, pg. 54]

Küppers [60, pg 166] makes the same point as Jacques Monod [61], Ernst Mayr [62, 63], and Hubert Yockey [13, 64], that physics and chemistry do not explain life. Niels Bohr argued that "Life is consistent with, but undecidable from physics and chemistry"[65]. What exactly is the missing ingredient that sets life apart from inanimate physics and chemistry? The answer lies in the fact that *life, unlike inanimacy, emanates from the far side of The Cybernetic Cut.*

These specific switch settings also determine how RNA strands fold back onto themselves, forming helices, bulges, loops, junctions, coaxial stacking, etc. Not even the hypothesized pre-RNA World and RNA World escape the formal linear digital algorithmic governance of computational function. The generic chemical properties alone of nucleic acid and protein are insufficient to generate life.

In molecular biology, "The 'meaning' (significance) of prescriptive information is the function that information instructs or produces at its metabolic destination" [8]. Szostak has used the term "functional information" [66]. Prescriptive information includes instruction and algorithmic/ computational programming, not just description. Genes provide instructions and algorithmic prescription of computational function. The oft used term "complexity" in life-origin literature is grossly inadequate to define the nature of genetic control [2, 8, 9, 53, 67]. As Hoffmeyer and Emmeche point out [39, pg. 39], "Biological information is not a substance." Later they repeat, "But 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." [39, pg. 40]. As stated earlier, the formal, nonphysical, prescriptive selections instantiated into configurable switch settings (nucleotide selections in this case) must never be confused with the physicality of those configurable switches themselves.

Most information theorists are trained to define information from the perspective of an observer. The problem with this perspective is that in the ab-

sence of an observer, no information can exist. Yet clearly information was at work in the organization of early life. No observers existed >3.5 billion years ago [68]. Real prescriptive information, therefore, has to have predated animal observation. Certain types of prescriptive information must *objectively* exist [2]. Early prokaryotic genetic programming cannot be reduced to the subjective mental constructs or observation of any animal knower/observer [2]. *A purely epistemological definition of biological Prescriptive Information (PI) is grossly inadequate.*

The previous maximum length of oligoribonucleotides in aqueous solution was only 8-10 mers [69]. Recently the number has been increased through heating [70, 71]. But these oligomers are homopolymers, not potential informational messenger molecules. And they are cyclical, not linear.

The genetic programming of longer strands is certainly not "blind." Stochastic ensembles of single-stranded small RNAs or of polyamino acids do not fold into functional shapes. Yet both single nucleotide and dipeptide overall frequencies are close to random in living organisms [72, 73]. Biomessages are unique in nature in that they are formally and functionally sequenced. They are not randomly sequenced, and they are not ordered by physical laws. They are sequenced so as to encrypt programmed instructions for the undeniable goal of achieving homeostatic metabolism. The realization of this goal requires algorithmic processing with nanocomputers, operating systems and software [57]. Transcription is required, along with transcriptional editing, decryption (translation), folding, and sometimes even post-translational editing [74]. These processes are fundamentally formal—as formal as their underlying mathematics. The genome and its editing algorithmic processes not only prescribe, but directly and indirectly compute the end product.

In a Peptide or Protein World model of life origin, efficacious selection of each amino acid must be explained at the level of covalent peptide bond formation. Polyamino acid primary structure (sequence) is formed prior to folding. Primary structure is the main determinant of how the strand will fold. Thus functional shapes must be prescribed by linear digital sequencing. The covalent bonds of these highly-informational strings are "written in stone" prior to when weak hydrogen-bond folding secondarily occurs. Instructive sequencing must be completed before tertiary shape and function can occur. The Genetic Selection (GS) Principle obtains [2, 8]. This Principle states that selection must operate at the genetic level, not just at the phenotypic organismal level, to explain the origin of genetic prescription of structural and regulatory biological function. This is the level of configurable switch settings (nucleotide selection). Selection must first occur at each decision node in the syntactical string. Initial programming function cannot be achieved by chance plus

after-the-fact selection of the already-existing fittest programs (phenotypes). Evolution is nothing more than differential survival and reproduction of already-existing fittest phenotypes. *The computational programming proficiency* that produced each and every phenotype must first be explained. Programming takes place at the genetic level. Even epigenetic prescription, development, and regulation ultimately trace back to the genetic programming of ncRNAs and regulatory proteins. Thus far, no "natural-process" explanation has been published for selection at the decision-node, configurable-switch, nucleotide-selection level [5].

Even the translated polyamino acid language is physically nonfunctional while forming until after it dynamically folds according to the instructions contained within its linear digital programming (its primary structure). Only later does this syntax of covalently (rigidly) bound monomeric sequencing determine minimum-Gibbs-free-energy folding. Even then, not even three-dimensional shape, or tertiary structure, is selectable by the environment. A far more holistic context of differential organismic survival and reproduction are required for natural selection to kick in.

In molecular biology, recipe code is translated from nucleotide sequence language into a completely different conceptual amino acid language via code bijection. Bijection is a correspondence of representational meaning between arbitrary alphanumeric symbols in different symbol systems. Codons are not "words"! Each triplet codon is a Hamming "block code" for a single letter (amino acid) of a very long protein word [13], the longest known to be around 30,000 amino acids but most in the few hundred range. A prescriptive codon prescribes a certain amino acid letter at the receiver upon decoding. It is often argued that the symbol system and code bijection (translation) of molecular biology are only heuristic. Yet the correspondence between the codon-block-code sequencing and amino-acid sequencing is clearly both real and nonphysicalistic. Nucleotide sequencing is physicodynamically arbitrary and resortable. Bijection is formal, not physicodynamic. In addition, whatever the initial alphabet was, the Shannon Channel Capacity Theorem [75] guarantees that it was at least as symbolically complex as today's codon alphabet [57, pg. 112, 76, pg. 104]. No binding or physicochemical reaction occurs between nucleotide symbols and the amino acid symbols they represent. Anticodon and amino acid are on opposite ends of each tRNA. Amino acyl synthetases are also independent enzyme molecules that have no direct binding affinity to codons. Neither fixed laws nor chance contingency can explain the integration of 20 different kinds of each formally-linked entity: amino acyl synthetase, the specific amino-acid end of each tRNA molecule, the specific anticodon opposite end of each tRNA, and the Hamming "block code" of each triplet codon.

The number of permutations is staggering. The spontaneous integration of all these individual entities into a *formal association* capable of promoting even a protometabolism is statistically prohibitive. In addition, the hypothesis of self-organization of all these integrated biochemical pathways and cycles into a holistic cooperative metabolic scheme can be definitively falsified by the Universal Plausibility Principle [77].

The key to life is controls, not constraints. Because life is so dependent upon true controls rather than mere constraints, life clearly traverses the Cybernetic Cut. It cannot be reduced to physicodynamics.

6. Even the laws of inanimate physics and chemistry traverse the Cybernetic Cut

Mathematical formalism gave birth to the formulaic relationships known as natural laws. The unreasonable effectiveness of mathematics [78-81] can be explained only by formalism's organizational governance of physicality. Albert Einstein in his Sidelights on Relativity mused, "How is it possible that mathematics, a product of human thought that is independent of experience, fits so excellently the objects of physical reality?" How did Einstein determine that mathematical formalism could only be the product of human thought? Was not Einstein's $e = mc^2$ objectively in effect long before the *Homo sapiens* species came along to discovery it? Was not $F = ma$ in effect prior to human existence? Before life formed, did physicality not obey Boyle's "Law"? How could Einstein have been so blind as to think that humans are the source of such mathematical and formal controls of physical relationships?

The singularity's differentiation into gravity and the other three fundamental forces of physicality (electromagnetism, weak and strong nuclear forces) presumably occurred with the realization of the first units of Planck length and Planck time following the Big Bang at 10^{-43} seconds [82, 83]. Our current understanding of space and time breaks down prior to that. But the mathematically predictable physical relationships that appeared at 10^{-43} seconds can hardly be attributable to a human consciousness that did not yet exist. Formal mathematical logic would have needed not only to pre-date, but to organize the instantiation of formalism into physicality by 10^{-43} seconds.

To count, measure and weigh in physics traverses The Cybernetic Cut, as does the scientific method itself. The modeling and successful predicting of physical interactions using mathematics points to an underlying rational and cybernetic structure to physicality. Physics (the study of physicality) functionally consists of 80% mathematics. Mathematics is a formal concept, not a physical entity. The percentage of physics that does not employ mathematics certainly employs language and logic—both of which are formalisms—not mere physicodynamics. It is therefore not just biology that has to explain the

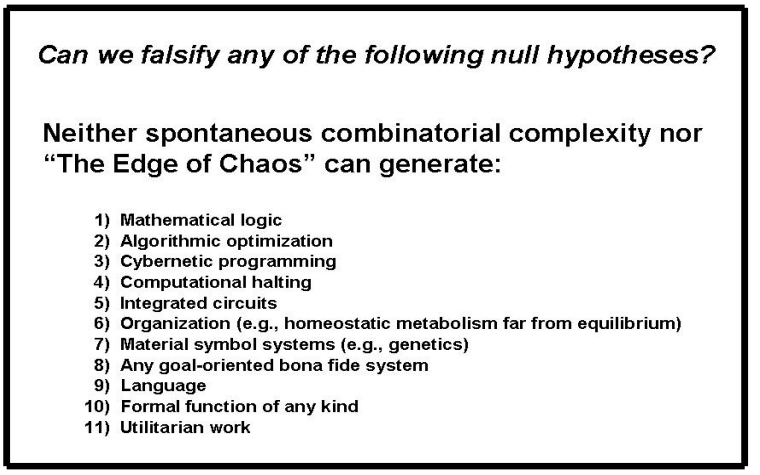
controlling formal components of reality. All of these realizations support the validity of the Formalism > Physicality (F > P) Principle, which is covered in Chapter 12.

If general relativity and quantum mechanics are ever successfully unified into a formal theory of quantum gravity, the model will be mathematical, though likely with some form of "new math." But physicodynamics itself cannot explain the Big Bang or any other cosmogony. Physicality cannot explain its own origin, or the nonphysical formal relationships that govern and predict that physicality.

We have no reason to doubt, and every reason to believe, that the mathematical structure of physical relationships predates human consciousness. Numerology seems to objectively exist in the periodic table. All sorts of formalisms in objective reality (e.g., geometric formulae like the volume of spheres) cannot be reduced to human mental construction. Geometric relationships predated their discovery. Such formalisms lie on the far side of The Cybernetic Cut. Traversing The Cybernetic Cut cannot be limited to human consciousness or even to biology. The structure of the known universe is mathematical. It is only our solipsistic metaphysical tendencies, not anything scientific, that make us think that this mathematical structure of physicality was of *our* making. It would be arrogant and anthropocentric of us to think for one second that the mathematical nature of physicality is nothing more than a purely subjective human mental construction.

The contention that Pattee's "semantic closure" can be accomplished in the absence of intentionality has never been fully explained. Examples of spontaneous semiotic closure in the inanimate "real world" are also sorely lacking. While Pattee and Rosen never denied the existence of intentionality, prescription, control and creativity, neither investigator has succeeded in explaining *the derivation* of these phenomena from physicality itself. The same is true of Rocha, Barbieri and many others who believe in infogenesis from within physicality alone. A big part of the problem comes from confusion over the definition of information. Mere combinatorial uncertainty most certainly can arise within physicodynamics alone, but not Prescriptive Information (PI) [1-9, 53, 56, 67]. The major challenge to naturalistic science is to elucidate how cause- and-effect physicodynamics (including heat agitation and quantum uncertainty) could have generated the intentionality of biotic messages.

Figure 1. Null hypotheses that need falsifying.



Used with Reprinted with permission from: Abel DL: The capabilities of chaos and complexity. *Int J Mol Sci* 2009, 10:247-291

Inanimate physicodynamics cannot generate the phenomenon of choice with intent. The particular setting of configurable switches to achieve formal function is beyond physics to explain. The latter statement is the essence of the meaning of "metaphysical." The answer to the riddle of *cybernetic causal determinism* lies only in the arena of *formal choice contingency*—of *control,* not the arena of physicodynamic constraints, fixed forces and highly-ordered relationships. Until naturalistic science is willing to acknowledge this fact of reality, progress will be thwarted in many investigative specialties. A Kuhnian paradigm rut prevails: "Physicality (e.g., the cosmos) is all there is, ever was, or ever will be." The scientific method itself cannot be practiced with such a naïve and misguided metaphysical pontification governing science. In opposition to this religious materialistic belief system is the supervening role of formal mathematics, logic theory, language, and cybernetics so universally employed and required by science. "Information is information, not matter or energy," said Norbert Wiener. "No materialism which does not admit this can survive at the present day." [84, pg. 132] "Biological information is not a substance," say Hoffmeyer and Emmeche [39, pg. 39]. "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" [39, pg. 40].

7. Conclusion

The Cybernetic Cut is the great divide between physicality and formalism. On the one side of this canyon lies everything that can be explained by the chance and necessity of physicodynamics. On the other side lies those phenomena than can only be explained by formal choice contingency and decision theory—the ability to choose with intent what aspects of ontological being will be preferred, pursued, selected, rearranged, integrated, organized, preserved and used. Nonphysical formalisms can be instantiated into physicality by traversing The Cybernetic Cut across the one-way-only CS bridge (Configurable Switch Bridge) from formalism into physicality. Not only life, but even inanimate physicality traverses The Cybernetic Cut by virtue of the mathematical organization of physical relationships. The F > P Principle (Formalism > Physicality Principle) which will be covered in Chapter 12 states that Formalism precedes, instructs, prescribes, organizes, controls, regulates, governs and predicts the unfoldings of Physicodynamics. Formalism, not physicality, is the primary source of and the most fundamental aspect of reality. Any attempt to falsify this most fundamental Principle of physics only employs the very formalism that falsification quest seeks to deny.

References

1. Abel, D.L. 2009, The capabilities of chaos and complexity, Int. J. Mol. Sci., 10, (Special Issue on Life Origin) 247-291 Open access at http://mdpi.com/1422-0067/10/1/247
2. Abel, D.L.; Trevors, J.T. 2006, More than metaphor: Genomes are objective sign systems, Journal of BioSemiotics, 1, (2) 253-267.
3. Abel, D.L. 2007, Complexity, self-organization, and emergence at the edge of chaos in life-origin models, Journal of the Washington Academy of Sciences, 93, (4) 1-20.
4. Abel, D.L. 2008, 'The Cybernetic Cut': Progressing from description to prescription in systems theory, The Open Cybernetics and Systemics Journal, 2, 234-244 Open access at www.bentham.org/open/tocsj/articles/V002/252TOCSJ.pdf
5. Abel, D.L. 2009, The GS (Genetic Selection) Principle, Frontiers in Bioscience, 14, (January 1) 2959-2969 Open access at http://www.bioscience.org/2009/v14/af/3426/fulltext.htm.
6. Abel, D.L. 2009, The biosemiosis of prescriptive information, Semiotica, 2009, (174) 1-19.
7. Abel, D.L. 2010, Constraints vs. Controls, Open Cybernetics and Systemics Journal, 4, 14-27 Open Access at http://www.bentham.org/open/tocsj/articles/V004/14TOCSJ.pdf.
8. Abel, D.L.; Trevors, J.T. 2005, Three subsets of sequence complexity and their relevance to biopolymeric information., Theoretical Biology and Medical Modeling, 2, 29 Open access at http://www.tbiomed.com/content/2/1/29.
9. Abel, D.L.; Trevors, J.T. 2006, Self-Organization vs. Self-Ordering events in life-origin models, Physics of Life Reviews, 3, 211-228.
10. Kolmogorov, A.N. 1965, Three approaches to the quantitative definition of the concept "quantity of information", Problems Inform. Transmission, 1, 1-7.
11. Chaitin, G.J. 1988, Algorithmic Information Theory. Revised Second Printing ed., Cambridge University Press: Cambridge.
12. Li, M.; Vitanyi, P. 1997, An Introduction to Kolmogorov Complexity and Its Applications. 2 ed., Springer-Verlag: New York.
13. Yockey, H.P. 1992, Information Theory and Molecular Biology. Cambridge University Press: Cambridge.
14. Yockey, H.P. 2002, Information theory, evolution and the origin of life, Information Sciences, 141, 219-225.
15. Chaitin, G.J. 2001, Exploring randomness. Springer: London ; New York.
16. Abel, D.L. The Cybernetic Cut [Scirus Topic Page]. http://www.scitopics.com/The_Cybernetic_Cut.html (Last accessed May, 2011).
17. Pattee, H.H. 1972, The Evolution of Self-Simplifying Systems. In The Relevance of General Systems Theory, Laszlo, E., Ed. George Braziller: New York, pp 32-41; 193-195.
18. Pattee, H.H. 1982, Cell psychology: an evolutionary approach to the symbol-matter problem, Cognition and Brain Theory, 5, 325-341.
19. Pattee, H.H. 1995, Evolving Self-Reference: Matter, Symbols, and Semantic Closure, Communication and Cognition-Artificial Intelligence, 12, 9-28.
20. Rocha, L.M. 2001, The physics and evolution of symbols and codes: reflections on the work of Howard Pattee, Biosystems, 60, 1-4.
21. Rocha, L.M. 2001, Evolution with material symbol systems, Biosystems, 60, 95-121.
22. Rocha, L.M.; Hordijk, W. 2005, Material representations: from the genetic code to the evolution of cellular automata, Artif Life, 11, (1-2) 189-214.
23. Rocha, L.M.; Joslyn, C., 1998, Simulations of embodied evolving semiosis: Emergent semantics in artificial environments In Simulations of embodied evolving semiosis: Emergent semantics in artificial environments, Proceedings of the 1998 Conference on Virtual Worlds and Simulation, 1998; Landauer, C.Bellman, K. L., Eds. The Society for Computer Simulation International: pp 233-238.
24. Pattee, H.H. 1979, The complementarity principle and the origin of macromolecular information, Biosystems, 11, (2-3) 217-26.
25. Pattee, H.H. 1979, Complementarity vs. reduction as explanation of biological complexity, Am J Physiol, 236, (5) R241-6.
26. Emmeche, C. 2000, Closure, function, emergence, semiosis, and life: the same idea? Reflections on the concrete and the abstract in theoretical biology, Ann N Y Acad Sci, 901, 187-97.
27. Pattee, H.H. 1978, The complementarity principle in biological and social structures, Journal of Social and Biological Structure, 1, 191-200.
28. Umerez, J. 1995, Semantic Closure: a guiding notion to ground Artificial Life. In Advances in Artificial Life, Moran, F.; Moreno, J. J.Chacon, P., Eds. Springer-Verlag: Berlin, pp 77-94.
29. Rocha, L.M. 2000, Syntactic autonomy: or why there is no autonomy without symbols and how self-organizing systems might evolve them, Annals of the New York Academy of Sciences, 207-223.

30. Sarkar, S. 2003, Genes encode information for phenotypic traits. In Comtemporary debates in Philosophy of Science, Hitchcock, C., Ed. Blackwell: London, pp 259-274.
31. Lemke, J.L. 2000, Opening up closure. Semiotics across scales, Ann N Y Acad Sci, 901, 100-11.
32. Joslyn, C. 2000, Levels of Control and Closure in Complex Semiotic Systems, Annals of the New York Academy of Sciences, 901, (Special issue on "Closure", ed. J. Chandler, G. van de Vijver) 67-74.
33. Hoffmeyer, J. 1995, The semiotic body-mind. In Essays in Honor of Thbomas A. Sebeok, Tasca, N., Ed. Porto: pp 367-383.
34. Hoffmeyer, J. 1996, Signs of Meaning in the Universe Nature: The natural history of signification. Indiana U. Press: Bloomington.
35. Hoffmeyer, J. 1997, Biosemiotics: Towards a new synthesis in biology, European Journal for Semiotic Studies, 9, 355-376.
36. Hoffmeyer, J. 2000, Code-duality and the epistemic cut, Ann N Y Acad Sci, 901, 175-86.
37. Hoffmeyer, J. 2002, Code duality revisited, SEED, 2, 1-19.
38. Hoffmeyer, J.; Emmeche, C. 1991, Code duality and the semiotics of nature. In On Semiotic Modeling, Anderson, M.Merrell, F., Eds. Mouton de Gruyter: New York, pp 117-166.
39. Hoffmeyer, J.; Emmeche, C. 2005, Code-Duality and the Semiotics of Nature, Journal of Biosemiotics, 1, 37-91.
40. Pattee, H.H.; Kull, K. 2009, A biosemiotic conversation: Between physics and semiotics, Sign Systems Studies 37, (1/2).
41. Abel, D.L.; Trevors, J.T. 2007, More than Metaphor: Genomes are Objective Sign Systems. In BioSemiotic Research Trends, Barbieri, M., Ed. Nova Science Publishers: New York, pp 1-15
42. Ferris, J.P. 2002, Montmorillonite catalysis of 30-50 mer oligonucleotides: laboratory demonstration of potential steps in the origin of the RNA world, Origins of Life and Evolution of the Biosphere, 32, (4) 311-32.
43. Mitchell, M. 1998, An Introduction to Genetic Algorithms. Bradford Books: Cambridge, MA.
44. Davis, L. 1991, Handbook of genetic algorithms. Van Nostrand Reinhold: New York.
45. Goldberg, D.E. 1989, Genetic Algorithms in Search, Optimization and Machine Learning. Addison-Wesley: Reading, MA.
46. Ertem, G.; Ferris, J.P. 2000, Sequence- and regio-selectivity in the montmorillonite-catalyzed synthesis of RNA, Orig Life Evol Biosph, 30, (5) 411-422.
47. Quastler, H., 1958, A Primer on Information Theory in Symposium on Information Theory in Biology In A Primer on Information Theory in Symposium on Information Theory in Biology, The Gatlinburg Symposium, Gatlinburg, 1958; Yockey, H. P.; Platzman, R. P.Quastler, H., Eds. Pergamon Press: Gatlinburg, p pages 37 and 360.
48. von Neumann, J.; Burks, A.W. 1966, Theory of Self-Reproducing Automata. University of Illinois Press: Urbana,.
49. Pattee, H.H. 1969, How does a molecule become a message? In Communication in Development; Twenty-eighth Symposium of the Society of Developmental Biology., Lang, A., Ed. Academic Press: New York, pp 1-16.
50. Pattee, H.H. 1972, Laws and constraints, symbols and languages. In Towards a Theoretical Biology, Waddington, C. H., Ed. University of Edinburgh Press: Edinburgh, Vol. 4, pp 248-258.
51. Rocha, L.M. 1998, Selected self-organization and the semiotics of evolutionary systems. In Evolutionary Systems: Biological and Epistemological Perspectives on Selection and Self-Organization, Salthe, S.; van de Vijver, G.Delpos, M., Eds. Kluwer: The Netherlands, pp 341-358.
52. Rocha, L.M. 1997, Evidence Sets and Contextual Genetic Algorithms: Exploring uncertainty, context, and embodiment in cognitive and biological systems. . State University of New York, Binghamton.
53. Abel, D.L. 2002, Is Life Reducible to Complexity? In Fundamentals of Life, Palyi, G.; Zucchi, C.Caglioti, L., Eds. Elsevier: Paris, pp 57-72.
54. Yockey, H.P. 2000, Origin of life on earth and Shannon's theory of communication, Comput Chem, 24, (1) 105-123.
55. Yockey, H.P. 2002, Information theory, evolution, and the origin of life. In Fundamentals of Life, Palyi, G.; Zucchi, C.Caglioti, L., Eds. Elsevier: Paris, pp 335-348.
56. Abel, D.L. Prescriptive Information (PI) [Scirus Topic Page]. http://www.scitopics.com/Prescriptive_Information_PI.html (Last accessed May, 2011).
57. Johnson, D.E. 2010, Programming of Life. Big Mac Publishers: Sylacauga, Alabama.
58. Wells, J. 2011, The Myth of Junk DNA. Discovery Institute Press: Seattle.
59. Turvey, M.T.; Kugler, P.N. 1984, A comment on equating information with symbol strings, Am J Physiol, 246, (6 Pt 2) R925-7.
60. Küppers, B.-O. 1990, Information and the Origin of Life. MIT Press: Cambridge, MA.
61. Monod, J. 1972, Chance and Necessity. Knopf: New York.
62. Mayr, E. 1988, Introduction, pp 1-7; Is biology an autonomous science? pp 8-23. In Toward a New Philosophy of Biology, Part 1, Mayr, E., Ed. Harvard University Press: Cambridge, MA.

63. Mayr, E. 1982, The place of biology in the sciences and its conceptional structure. In The Growth of Biological Thought: Diversity, Evolution, and Inheritance Mayr, E., Ed. Harvard University Press: Cambridge, MA, pp 21-82.
64. Yockey, H.P. 2005, Information Theory, Evolution, and the Origin of Life. Second ed., Cambridge University Press: Cambridge.
65. Bohr, N. 1933, Light and life, Nature, 131, 421.
66. Szostak, J.W. 2003, Functional information: Molecular messages, Nature, 423, (6941) 689.
67. Abel, D.L. 2006 Life origin: The role of complexity at the edge of chaos, Washington Science 2006, Headquarters of the National Science Foundation, Arlington, VA
68. Mojzsis, S.J.; Arrhenius, G.; McKeegan, K.D.; Harrison, T.M.; Nutman, A.P.; Friend, G.R.L. 1996, Evidence for life on Earth before 3,800 million years ago., Nature, 384, 55-59.
69. Joyce, G.F.; Orgel, L.E. 1999, Prospects for understanding the origin of the RNA World. In The RNA World, Second ed.; Gesteland, R. F.; Cech, T. R.Atkins, J. F., Eds. Cold Spring Harbor Laboratory Press: Cold Spring Harbor, NY, pp 49-78.
70. Grant, R.P. 2010, Alphabet soup, The Scientist, 24, (7, July 1) 23
71. Costanzo, G.; Pino, S.; Ciciriello, F.; Di Mauro, E. 2009, RNA: Processing and Catalysis: Generation of Long RNA Chains in Water, J. Biol. Chem., 284, 33206-33216.
72. Kok, R.A.; Taylor, J.A.; Bradley, W.L. 1988, A statistical examination of self-ordering of amino acids in proteins, Origins of life and evolution of the biosphere, 18, (1-2) 135-42.
73. Weiss, O.; Jimenez-Montano, M.A.; Herzel, H. 2000, Information content of protein sequences, J Theor Biol, 206, (3) 379-86.
74. Roth, M.J.; Forbes, A.J.; Boyne, M.T., 2nd; Kim, Y.B.; Robinson, D.E.; Kelleher, N.L. 2005, Precise and parallel characterization of coding polymorphisms, alternative splicing, and modifications in human proteins by mass spectrometry, Molecular & cellular proteomics, 4, (7) 1002-8.
75. Shannon, C. 1948, Part I and II: A mathematical theory of communication, The Bell System Technical Journal, XXVII, (3 July) 379-423.
76. Johnson, D.E. 2010, Probability's Nature and Nature's Probability (A call to scientific integrity). Booksurge Publishing: Charleston, S.C.
77. Abel, D.L. 2009, The Universal Plausibility Metric (UPM) & Principle (UPP), Theor Biol Med Model, 6, (1) 27 Open access at http://www.tbiomed.com/content/6/1/27.
78. Einstein, A. 1920, Sidelights on Relativity. Dover: Mineola, N.Y.
79. Wigner, E.P. 1960, The unreasonable effectiveness of mathematics in the natural sciences, Comm. Pure Appl., 13 (Feb).
80. Hamming, R.W. 1980, The unreasonable effectiveness of mathematics, The American Mathematical Monthly, 87, (2 February) 81-90.
81. Steiner, M. 1998, The Applicability of Mathematics as a Philosophical Problem. Harvard University Press: Cambridge, MA.
82. Planck, M. 1899, Über irreversible Strahlungsvorgänge, Sitzungsberichte der Preußischen Akademie der Wissenschaften, 5, 479
83. Planck, M. 1960, A Survey of Physical Theory. Dover: New York.
84. Wiener, N. 1961, Cybernetics, its Control and Communication in the Animal and the Machine. 2 ed., MIT Press: Cambridge.