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## LIFE, AN EVIDENCE FOR CREATION

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### KEYWORDS

Biochemistry, chemical evolution, criticism of spontaneous abiogenesis

### ABSTRACT :

The advanced state of understanding of the biochemistry of the bacterial cell, as evidenced by the knowledge of the complete nucleotide sequences of *Haemophilus influenzae* and *Escherichia coli*, allows the re-examination of the plausibility of the spontaneous generation of life. It is seen that in order to function these one-celled organisms require approximately 1700 and 4300 genes and gene products respectively. In the living state, none of the chemical reactions, though catalyzed very efficiently by specific enzymes, is allowed to reach its end point. The phenomenon of life depends on the **steady state, nonequilibrium** condition of all chemical reactions. This is the consequence of two features. One, the design of the substrates and their catalysts causes the dove-tailing of chemical changes into interconnected biochemical assembly lines. During growth, the influx of carbon, nitrogen etc. and energy sources is balanced by the utilization of the end-products of biosynthetic pathways and the efflux of waste. Secondly, somewhere in the past, these biochemical chain-reactions were ignited successfully, and they continue uninterrupted since the dawn of life, over many generations. This is recognized by the biologist's dictum: "life comes from life". Forty five years of futile laboratory efforts to demonstrate the plausibility of **spontaneous** abiogenesis have underscored the incredibility of the postulates of chemical evolution. Furthermore, the inability of modern biochemists to generate living matter even **nonspontaneously**, drives home the concept that life was created by an Intelligence far exceeding ours.

### INTRODUCTION

We stand in awe of the complexity, sophistication and ingenuity of the chemistry of living matter. Our current, very impressive level of understanding biochemistry is the result of a century of diligent probing by tens of thousands of dedicated scientists. One aspect of this science, however, has not kept up with recent advances. It is that the implications of the great discoveries of biochemistry call into question the spontaneous origin of life.

The first proposals by Oparin and Haldane regarding life's spontaneous origins were elaborations of Darwin's suggestion that "life arose in some warm pond" [7]. At that time, the 1920's, biochemistry was in its infancy. The first protein with enzyme activity, urease, was not crystallized until 1924. The major metabolic pathways were elucidated in the 1930's and beyond. The structure and function of the genetic material has been increasingly understood from the early 1950's onward. The first amino acid sequence of a protein, insulin, was obtained in 1955 and the first complete nucleotide sequence of the chromosome of an organism was published only quite recently, in 1995.

As the chemical basis of life processes became clearer, and turned out to be far more complex than originally imagined, there did not seem to be a move to reconsider the validity of the early chemical evolutionary postulates. Instead, scientists embarked on a long (45 years and counting) journey toward seeking experimental demonstration of the plausibility of spontaneous abiogenesis.

The apparent biochemical complexity seen in modern cells is viewed by many as having evolved from simpler, hypothetical, "protocells" [17]. As of now, there is no evidence available to support the existence of such cells. In contrast, fossils of putative "ancient" microorganisms have been shown to be photosynthetic, requiring a very complex biochemistry [14].

## RELEVANT CONCEPTS OF THE CHEMISTRY OF LIFE

Biologists tell us that "life comes from life". There is no known exception to this law of biology. Among the millions of species of living organisms, each generation receives a complete set of genetic material from the previous one. The quality of transfer is of such high fidelity that hundreds of millions of bits of information are transferred before a chance error happens. This situation presents an obvious problem with regard to origins. Each organism is locked into a "genetic box" by the laws of heredity. Although there is room for genetic variability within each "box", the extent of observable variations is limited. It does not readily allow for organisms to jump from one "genetic box" into another. This situation leaves the question of origins shrouded in mystery.

Logically there are only two choices with regard to the origin of life. Either living matter originated from inert substances in the past spontaneously by the action of natural forces or it was brought into existence by a Creator.

To be sure, there are those who see an unbroken continuum between living and nonliving matter. If this is so, then the question of life's origins becomes a moot point. Viruses, prions, mycoplasmas, rickettsiae and chlamydiae are offered as examples of organisms that bridge the chasm between living and nonliving. But both viruses and prions are inert infectious entities with no more life in them than the enzyme additives in some detergents. The replicating activity of viruses depends on the metabolic capacity of the infected cell. Prions are unique protein molecules that can alter other protein molecules by promoting conformational changes in them. The newly altered proteins in turn acquire prion-type activity, creating a domino effect of protein alteration [23]. In contrast, rickettsiae, chlamydiae and mycoplasmas are among the smallest known living organisms. The fact that chlamydiae and rickettsiae are obligate intracellular parasites does not alter this fact.

There is, in fact, a wide chasm between living and nonliving matter. We can convert one form of nonliving substance to another in the chemistry laboratory, but in spite of all our biochemical know-how, we cannot bring a nonliving entity to life. Furthermore, the latest results of biochemical research consistently suggest that we still have a long way to go before we can fully appreciate the intricacies of the biological machinery undergirding the phenomenon of life.

The chemical composition of nonliving matter may be organic or inorganic and its molecular structure may be simple or complex. Inert organic substances once may even have been part of a living organism. But the commonality among all of these diverse materials is that they do not exhibit the attributes of life.

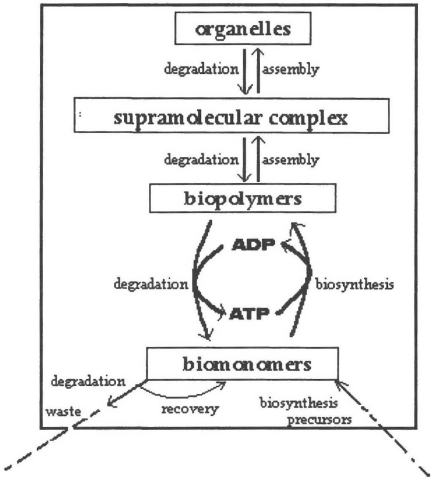
Life may be defined as "the property or quality that distinguishes living organisms from dead organisms and inanimate matter, manifested in functions such as metabolism, growth, response to stimuli and reproduction" [1, p. 728]. The smallest unit of living matter is the cell. The earth's biosphere is populated by unicellular and multicellular organisms.

In multicellular organisms living cells join to form tissues, which in turn fashion organs. Organs then interact to animate an organism, which is thus composed of a complex hierarchy of living matter. The word "life" takes on different technical meaning, depending on whether it refers to a cell, a tissue, an organ or an organism. For example, at the death of an organism, it is possible to transfer a "live" heart, liver or a kidney from one individual into another. Under appropriate conditions the transplanted organ will continue to live in the new host. Organs and tissues depend on the lives of their constituent cells. The following discussion is about **cellular life**.

The term "life" on the cellular level refers to the behavior and capacity of the intact cell. It is not legitimate to use this term in reference to any sub-cellular component, no matter how vital its function is. If the cell disintegrates, life disappears. In theory, if it were possible to restore all of the components of the cell just the way they were prior to disintegration we would have a live cell again. In actual practice we are unable to do this. **Our inability to restore disintegrated cells to life is one of the bases for the assertion here that the very existence of life is an evidence for creation.**

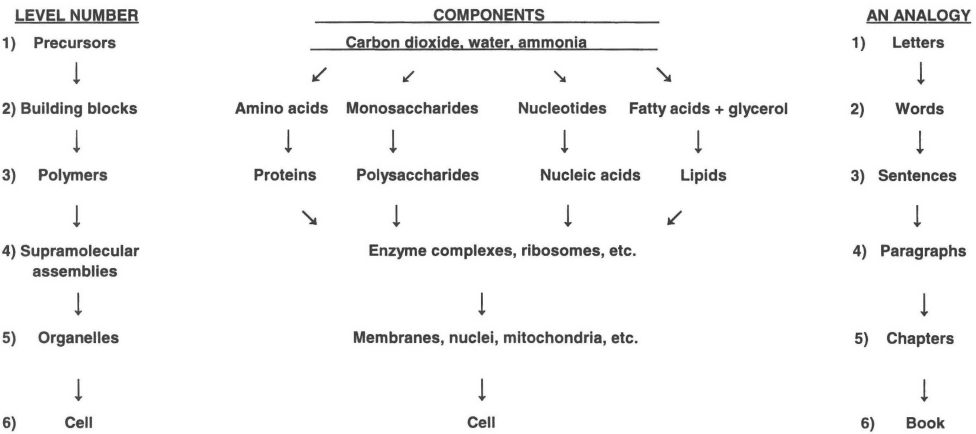
Cells that are alive, regardless of whether they are independent or are part of a multicellular complex, must be able to transduce chemical or light energy into chemical work. Chemical work is the synthesis of substances of high energy content, such as ATP, proteins, nucleic acids, polysaccharides and lipids. Chemical work is also the creation of substance-gradients across membranes. In all of these processes, the cell functions as a chemical machine (Figure 1).

**FIGURE 1.**  
**The Dynamics of the Chemical Machine Called the Cell.**



This chemical machine incorporates from its environment simple substances that contain oxygen, hydrogen, carbon, nitrogen, sulfur and phosphorus, along with chemical energy-containing substances. The simple precursor compounds are systematically incorporated into gigantic biopolymers, supramolecular complexes and into subcellular organelles. The relationships between the layers of organization of biomatter are shown by an analogy in Figure 2.

**FIGURE 2.**  
**Organization of Matter in the Cell.**



Just as appropriate combinations of letters form meaningful words in a given language, and words placed

into sentences can express coherent thoughts, the proper linear sequences of nucleotides and amino acids form functional genes and enzymes in the cell. However, for cells to operate, this is not enough. Coherency of meaning has to be preserved at successively higher levels of organization by the coordinated workings of the various biopolymers. This is analogous to forming meaningful paragraphs, chapters and a book.

The recent triumphs of sequencing the entire genomes of microorganisms [26] permit an accurate assessment of the biochemical complexity of these organisms. Three genomes are considered here: *Haemophilus influenzae* (1743 genes) [8], *Mycoplasma genitalium* (471 genes) [9] and *Escherichia coli* (4288 genes) [5]. Two of these, *Haemophilus* and *Mycoplasma* are adapted to grow only in the nutritionally enriched environment of humans, and as such, cannot synthesize a number of complex organic substances. *E. coli*, on the other hand, is a metabolically versatile organism, capable of independent growth on even such a mundane carbon-energy source as acetate.

The comparatively small genome of *M. genitalium* quickly led researchers to contemplate the theoretical minimum number of genes necessary for cellular life. Not taking into account the parasitic nature of the organism, it was suggested that 256 genes may be close to the theoretical minimum number of genes necessary for the simplest cell [21]. But to appreciate what it takes for a cell to exist independently, it is more helpful to look at *E. coli*.

This organism has a circular chromosome, consisting of 4,639,221 nucleotide base pairs. Computer analysis suggests 4288 identifiable genes. Using existing databases, 2656 genes could be assigned a function tentatively, leaving 1632 genes unassigned. Fourteen functional categories are listed on Table 1, along with the numbers of genes in each category for the three organisms.

TABLE 1.  
Distribution of Genes by their Functions in Three Bacterial Cells.

Function	<i>H. influenzae</i>	<i>M. genitalium</i>	<i>E. coli</i>
Amino acid metabolism	68	1	131
Biosynthesis of cofactors, prosthetic groups and carriers	54	5	103
Cell envelope	84	17	195
Cellular processes	53	21	188
Central intermediary metabolism	30	6	188
Energy metabolism	105	31	243
Fatty acid and phospholipid metabolism	25	6	48
Purines, pyrimidines, nucleosides and nucleotides	53	19	58
Regulatory functions	64	7	45
Replication	87	32	115
Transcription	27	12	55
Translation	141	101	182
Transport and binding proteins	123	34	284
Miscellaneous functions	93	27	824
Unassigned	736	152	1632

The first thirteen categories give an over-view of the biochemical needs which have to be satisfied in a typical independently living cell. They are an expanded definition of cellular life using biochemical terminology. These functions are mandatory for the cell's existence. These biochemical requirements are the consequence of what Dr . Michael Behe calls the "irreducible complexity" of living matter [3]. For *E. coli* this represents about 1900 different chemical transformations, not all of which have to occur simultaneously. But the chemical transformations that maintain the life of the bacterium at any given moment have to have

a special relation to each other. **They must keep each other from reaching equilibrium.**

All chemical reactions are rearrangements of bonding electrons among reactants. The driving force behind these processes is the lower energy states of the products. Each reaction has a beginning and an end. Reactions begin when the reactants are mixed, and end in a state called equilibrium, when there is no further net chemical change. Typically, a characteristic ratio of products to reactants is present at equilibrium, which, under the reaction conditions, remains constant indefinitely. This is illustrated in Figure 3.

**FIGURE 3.**  
**The Time Course of a Chemical Reaction.**

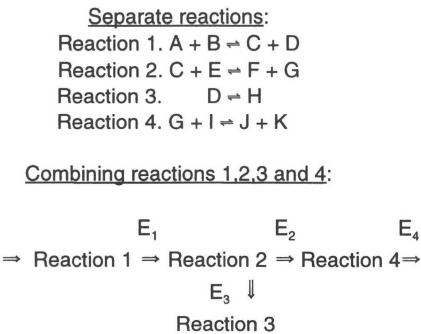
For the chemical reaction:  $aA + bB \rightleftharpoons cC + dD$ , at time = 0 there are only substances **A** and **B** present. At time =  $t$ , at equilibrium, the concentrations of the four substances are: **A** =  $[A]$ , **B** =  $[B]$ , **C** =  $[C]$ , **D** =  $[D]$ . The equilibrium constant  $K_{eq}$  equals:

$$K_{eq} = \frac{[D]^d * [C]^c}{[A]^a * [B]^b}$$

Chemical reactions that reach equilibrium are useless to the cell, because they are not able to yield useful products or chemical energy. In fact, **when all of the reactions reach equilibrium, the cell is dead.** Paradoxically, every chemical reaction in the cell has its own catalyst. Catalysts are agents that speed the reactions toward equilibria. Biological catalysts, enzymes, are extremely efficient and frequently specific. Their presence ensures that all of the chemical conversions in living matter follow predetermined paths, and that there will be few random "side reactions".

These highly efficient catalysts, however, would doom the cell by rapidly establishing the equilibrium of all chemical conversions were it not for the special relationship among the chemical reactions. In living matter the reactions are so organized that the products of one reaction become the starting reactants of the next chemical change ( Figure 4).

**FIGURE 4.**  
**Connecting Separate Chemical Conversions into Chemical Chain Reactions.**



**The linkage of chemical reactions in living matter prevents them from reaching their end points.** The biochemical pathways, whether linear or circular, have specific functions. Pathways sometimes intersect, as in Figure 4, when a compound participates in more than one reaction. The composite of all biochemical pathways is a network of interconnected molecular assembly lines which can only operate **if every component is working simultaneously.** This concept can be illustrated by considering the process of protein synthesis.

Twenty different amino acid biosynthetic pathways (consisting of approximately 85 reactions) produce a

metabolic pool of 20 different amino acids. Twenty different kinds of aminoacyl transfer ribonucleic acid (tRNA) molecules transport the amino acids to the ribosome, the site of protein production. The manufacture of the twenty kinds of tRNA's, as well as that of the messenger RNA, requires first the biosynthesis of the four types of ribonucleotides (27 biosynthetic steps), second their polymerization into pre-tRNA molecules by RNA polymerase and third, extensive modification of tRNAs by a battery of enzymes. Messenger RNA molecules, which are transcripts of appropriate segments (genes) of the chromosome, also are needed to direct the formation of appropriate amino acid residue sequences. The bacterial ribosome is a complex of three different ribonucleic acids and 52 different protein molecules [22].

Therefore, in order to make proteins, the cell needs amino acids, tRNAs, ribosomes, specific mRNA molecules, and in addition other protein factors and chemical sources of energy. The absence of any of more than a hundred separate chemical events will prevent protein synthesis.

This scenario repeats in all facets of cell growth. Each biosynthetic pathway feeds into successively more complex levels of organization of matter. Every pathway is regulated so that concentrations of its end products are appropriate to the needs of the cell. A common regulatory mechanism found in biosynthetic pathways is the inhibition of the first reaction by the end product. This is possible because the enzymes promoting the first committed step have specific binding sites not only for their reactants and products, but also for the metabolic end-product, which may be five to ten biosynthetic steps removed. These regulatory enzymes are so constructed that when the metabolic end-product binds, the catalytic action of the enzyme is inhibited.

The life of the cell depends on the harmonious and nearly simultaneous operation of its many components. During balanced growth, there are only minimal perturbations in the flux of material through the pathways. All of the reactions are in a "steady state". The term **"nonequilibrium, steady state"** succinctly summarizes the mandatory statuses of chemical reactions in living matter.

The reason we are not able to restore life by putting cellular components back together is that we are unable to restore the nonequilibrium status of the chemical reactions. In the very process of assembling biocatalysts and their substrates, the reactants would undergo chemical conversions and equilibria would set in.

## CHEMICAL EVOLUTIONARY EFFORTS

If there are forces in nature which bring about life, we ought to search diligently to discover and harness them. There can be many significant uses for abiogenesis. What if deteriorating tissues could be replaced or if dead organisms could be revived? Creating life or even reversing death, would be the most significant scientific achievement by mankind!

Numerous scientists, in fact, have been looking for natural processes which would lead to the formation of living matter. The search intensified, beginning with the famous Miller-Urey experiment, reported in 1953 [19], which converted inorganic gases to racemic mixtures of amino acids and other organic molecules under conditions thought to have prevailed on a hypothetical primordial earth. Subsequently an entire sub-discipline emerged, which provided laboratory evidences for the production of racemic mixtures of 19 of the 20 amino acids needed for protein synthesis, 4 of 5 nitrogenous bases, racemic mixtures of monosaccharides and even some lipids under a variety of hypothetical primordial earth conditions [27].

## A Test of the Predictive Power of Chemical Evolutionary Theory

These results were the basis of the great optimism that we were well on the way toward solving the mystery of life's origins. In the 1970's an opportunity offered itself to test the predictive power of the chemical evolutionary postulates. The US government made 1 billion dollars available to search for life on the planet Mars.

Of all our planetary neighbors, Mars is the most suitable candidate to harbor life. The conditions on the Red Planet, including the temperature and atmospheric composition, are thought to be able to sustain anaerobic microorganisms. In 1974 Stanley Miller wrote: "We are confident that the basic process [of chemical evolution] is correct, so confident that it seems inevitable that a similar process has taken place on many other planets in the solar system...We are sufficiently confident of our ideas about the origin of life that in 1976 a spacecraft will be sent to Mars to land on the surface with the primary purpose of the experiment

being a search for living organisms" [20].

In July 1976 the spacecraft Viking 1 touched down on Mars. A month and a half later a second spacecraft, Viking 2 landed 4,600 miles away. These automated laboratories surveyed their surroundings with cameras, scooped up soil samples, and performed a number of tests. Among the experiments was the analysis of Martian soil for organic chemicals. Soil samples were heated, and the gases obtained were analyzed by a gas chromatograph coupled to a mass spectrometer. The results surprised scientists. No organic substance was detected at concentrations as low as 10 parts per billion. In comparison, similar experiments done on terrestrial soil from Antarctica yielded 0.01-10 parts per million organic matter [4]. It was reluctantly concluded that there was no evidence for life on Mars, past or present.

Recently, in 1996, the world was electrified by the announcement that evidence may have been found for the existence of life on Mars after all [18]. A team of nine scientists from five institutions, under the leadership of Dr. David McKay of the Johnson Space Center, Houston, Texas, came to this conclusion after studying a meteorite, which they supposed originated from Mars. Inside the rock they found organic substances which were assumed to be remnants of bio-matter. In addition, they observed ovoid shaped deposits which resembled small micro fossils of bacteria.

The Martian origin of the meteorite is merely a supposition, based on similarities in the relative amounts of the four noble gases trapped within this rock and those measured on Mars. It is not unusual to find organic residue associated with meteorites. At the annual Lunar and Planetary Conference at Houston, Texas, some scientists argued that the putative micro fossils look suspiciously like linear magnetite grains [15].

The July 4, 1997 landing of the "Pathfinder" vehicle at the Ares Vallis region of Mars opened a new chapter in the exploration of this planet. The lander and the little rover, named Sojourner, operated for nearly 3 months, sending more than 16,000 images, chemical analyses of the soil and of 15 different rocks, and weather data. Interestingly, the chemical compositions of the rocks, analyzed by  $\alpha$  proton X ray spectrometry, were different from those of the putative "Martian" meteorites found here on Earth [2, 11]. Taking everything into consideration, until authentic samples are brought back from Mars and analyzed, the results of the 1976 Viking experiments should be considered authoritative on this topic. At present, Mars can be considered a sterile planet.

### **What Have We Learned from the Chemical Evolutionary Efforts?**

In the past 45 years chemical evolutionary work has been on-going in at least four separate arenas: 1. Experiments synthesizing bio-molecules in simulated putative "primordial earth and atmospheric conditions" 2. Experiments with bio-polymers and enzymes to search for evidences of molecular evolution 3. Comparisons of bio-polymer sequences in various organisms in an attempt to trace evolutionary relationships through establishing phylogeny 4. Creation of new models of chemical evolution.

These efforts have been critically examined in several excellent monographs [3, 24, 27]. It is not the purpose here to summarize or repeat their conclusions. From a perspective of more than 45 years, it can be said that research has not uncovered any new principle which would suggest that molecules seek to aggregate to form living matter. However, the results of biomolecular synthesis in simulated primordial conditions do shed light on how organic matter may form in space on meteorites.

### **The RNA World**

The "holy grail" of chemical evolutionary efforts has always been to find a self-replicating polymer with possible enzymatic activity. The discovery of ribozymes [13, 16] suggested to some scientists that ribonucleic acid molecules could be these polymers.

Prior to the emergence of RNA as a possible self-replicating biopolymer, origin of life scientists have worried about which came first, nucleic acids or proteins? In all living matter nucleic acids are synthesized by proteins. Proteins, in turn, are produced by a machinery composed of both nucleic acids and proteins. Since RNA could perform the functions of both proteins and nucleic acids, goes the theory, it should have been the first biopolymer on the primordial planet Earth. The term "RNA World" has been coined to refer to a primordial world where living matter emerged from RNA molecules [12].

Experimental results, however, do not support this model. First, the only known source of the sugar component of RNA, D-ribose, under prebiotic conditions is the reaction of formaldehyde with alkali. Out of more than 30 different products, D-ribose constitutes less than 1% of the total and under the reaction conditions it is unstable [25]. Secondly, a prebiotic source of pyrimidine nucleosides is not known. Heating purine mixtures with D-ribose and sea water (to provide mineral catalysts) at 100 °C for 4 hrs yielded nucleosides in good (25%) yields. However, when these experiments were repeated with pyrimidines, no nucleosides were found [10]. Thirdly, there are 45 different ways to link a purine base, a ribose and a phosphate together to form a nucleotide, resulting in that many isomers [28].

If RNA is not the answer to the theoretical solution of abiogenesis, other substances such as inorganic silicon scaffolds [6], or two dimensional organic biofilms growing on pyrite [29] have been suggested. Regardless of the particulars, all of these schemes imply that through molecular evolution any enzyme activity can come into existence by some form of "natural selection".

None of these theoretical constructs has any experimental support and they also suffer from a lack of feasibility. Living cells grow, replicate, adjust to changing environmental conditions and defend against toxic insults. In a population of cells, those that are best equipped to respond to adverse conditions will be the survivors. This type of behavior is the result of the coordinated regulation of biochemical networks of the living matter. Isolated biopolymers or subcellular supramolecular assemblies do not have these capacities. Instead, these substances follow the laws of thermodynamics, seeking the lowest energy state. In the case of biopolymers, this means their hydrolysis into monomeric fragments.

## **WHY IS LIFE AN EVIDENCE FOR CREATION?**

If we treat bacterial cells with toluene for a few seconds we kill them. Bacteria die because holes were created in their membranes, permitting small metabolites within the cells to equilibrate with the environment. We now have cells, complete with sets of perfectly functional proteins, nucleic acids, lipids and polysaccharides, in other words the substances which a series of successful chemical evolutionary processes should produce. Let us overlook that these biopolymers were not produced under primordial conditions, since the question at hand is whether it is feasible to postulate abiogenesis, under any conditions?

This issue has been obscured for a long time by arguments over the details of biomolecular synthesis in primordial environments. Having a collection of intact, but dead bacterial cells brings us face to face with the question, what do we have to do to revive these cells? This is where we are confronted with the reality that living matter is alive not simply because it is composed of the appropriate protein and nucleic acid molecules, but because of the existence of the cellular network of chemical processes at nonequilibrium steady states.

If nonequilibrium steady states could be restored, the dead cells would live again. In theory this could be accomplished by restoring each of the hundreds of interconnected biochemical pathways to its nonequilibrium condition. First the integrity of the cells' membranes would have to be repaired, and a continuous supply of starting substrates of the first reactions of every pathway would have to be supplied, in order to launch all of the chemical processes, more or less simultaneously. This would turn the metabolic wheels of the organisms and they would live again.

While we can transfer any substance across a cell membrane by "electroporation" ( a short pulse of high voltage), the continuous delivery into cells of large numbers of different metabolites for which there are no built in transport mechanisms, is beyond our current technical know how. Herein lies the reason why we cannot reverse death on the cellular level.

To postulate spontaneous abiogenesis is to suggest that natural processes occurred in the distant past, in a hostile environment, which not only brought into existence the necessary biomolecules, large and small, but also achieved a steady state nonequilibrium status among them. The absurdity of this concept can be appreciated most fully by those who try to duplicate it in the laboratory.

## **CONCLUSION**

Spontaneous abiogenesis is a logical corollary of the theory of evolution. It becomes a logical necessity if

the existence of a Creator is axiomatically ruled out. However, chemical evolutionary work of the last 45 years has revealed the bankruptcy of this concept of life's origins. In this paper we reason that intelligent creation is indicated for life's origin, primarily from a consideration of the chemistry of life processes. These require the parallel operations of numerous biochemical chain-reactions, sustained in nonequilibrium steady states. Not only is it an impossibility to expect the **spontaneous formation** of inter-linked chemical reactions in nonequilibrium steady states, but, in spite of our high degree of technical sophistication, we have not been able to produce living matter **in the laboratory**. The time has come to recognize the phenomenon of life for what it is, **an evidence for creation**.

Both modern life forms and fossilized remnants of biological matter suggest that **cellular life** has always been the basis of all life on Earth. Thus in the creation of life very complex biological systems had to be constructed at the outset, where hundreds of biochemical pathways could operate simultaneously.

Creation of living matter needed to include the establishment of the nonequilibrium status of all biochemical pathways. To accomplish this **the Creator had to have absolute control over the millions of molecules** in the cell. Such a process could have included possible temporary restraint of enzymes from catalysis, the prevention of noncatalytic side reactions and the creation of metabolite and ionic gradients across membranes.

Every aspect of the cellular economy appears flawless under the closest scrutiny. **There is no room for improvement**. For instance, complex structures are built from simpler blocks in the most efficient manner. Elaborate regulatory mechanisms are in place to prevent waste or accumulation of potentially toxic intermediates. Biosynthetic and degradative processes are carefully balanced so as to allow for continued renewal of biomatter and to provide for the recovery of valuable biochemical intermediates. Functionally, each level of biochemical organization feeds into a more complex network of biological hierarchy. The integration of functions continue beyond the level of the organism, until a seamless biosphere is formed, covering the Earth. The biosphere does not seem to have a "belly button", that is an obvious starting place.

From the rich variety of life forms seen in the fossil record it has to be assumed that **many different types of living matter were formed, essentially simultaneously**. This conclusion can be reached also from the laws of genetics as well as by considering the strong mutual interdependence of various life forms on one another.

The abundant variety of life forms seen in Earth's biosphere argues against the existence of life on other planets only in the form of microorganisms. Based on what is seen on Earth, the creationist would predict that planet Mars is devoid of organisms, past and present. The planets of the solar system appear to be in an unfinished state, not unlike the description of Earth in Genesis 1:1.

In the INTRODUCTION we referred to the awe that is evoked in us by the complexity, ingenuity and sophistication we see in the chemistry of living matter. This awe rightly belongs to the Creator, whose thoughts we are privileged to discover in the study of the chemistry of life.

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