

IS LIFE SUPERNATURAL?

By

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ABSTRACT

The big question of the origin of life is examined. The paradox created by Pasteur's resounding edict: Life only comes from life, pitted against the need for spontaneous generation is explored. This seemingly dead-end conundrum contrasts sharply with the great progress we have made in understanding the evolution of the species since Darwin's revolutionary insight. The conditions and sources of energy that might have promoted non-living molecules and compounds to cross the sharp line from inert to living are contemplated. Abiotic synthesis might help explain the origin, but still fails to explain the moment of vitalization. A different approach to discovering when the inert becomes alive is proposed. The need for, and a way to bring forth, a "Bio-Einstein" to solve this penultimate question of life's origin are presented.

THE TOUGHEST PROBLEM IN SCIENCE

It is often said that physicists are saddled with the toughest problem of all: "Where did the universe and all its stuff and energy come from?" However, I believe that the dubious honor of confronting the ultimate conundrum goes to biologists: "How and where did life originate?"

In pursuit of the origin of life, it would seem essential to define life. Alas, there is no universally accepted definition. There continues to be much debate, with the consensus generally being: "Something that metabolizes, responds to stimulus, reproduces and is subject to mutation." This leaves many things that do not exhibit all these properties, such as viruses and prions, in a gray area. Perhaps, even a computer program could be devised to express all the stated properties of life. But few people would agree that the machine were alive. These difficulties make many scientists deplore attempts to arrive at a definition of life. However, like pornography, all recognize it when they see it.

Louis Pasteur, Figure 1, accomplished an enormous feat with his experiments that led him to assert¹ "Spontaneous generation is a dream." In simple elegant demonstrations, he showed that non-living objects do not breed life. Until then, it was widely accepted that rotting meat and other organic matter gave rise to living organisms, "spontaneous generation," because they were seen in such decaying matter. Despite heroic scientific efforts, no one has been able to contradict Pasteur's axiom to this day. Our faith in science leads us to believe that someone, someday will abiotically assemble a form that comes to, or is brought to, life. Then, it might be stated that the "disproof" of spontaneous generation may have been Pasteur's version of Einstein's greatest mistake. If life originally emerged from inert objects, then Pasteur was wrong – spontaneous

generation had occurred, if only once and never again. That leaves the question of why, to our knowledge, it never arose again.

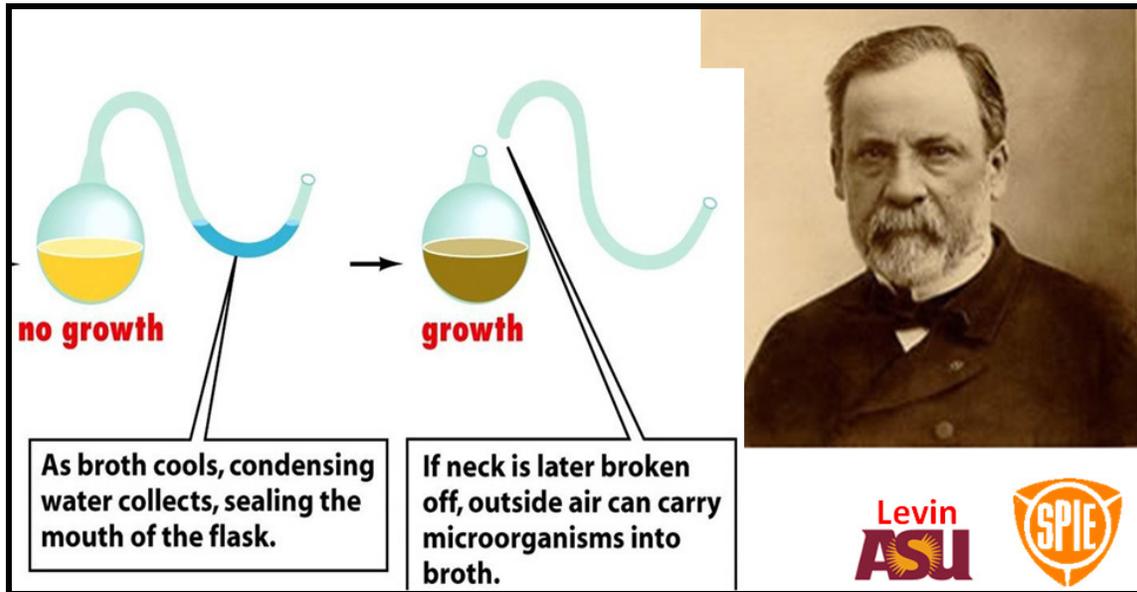


Figure 1. Louis Pasteur: Life only comes from life.

Most of us now believe there was a “Big Bang” from which everything emerged initially as plasma. No life could exist under these conditions. Therefore, it follows that, as the plasma cooled and matter emerged in increasingly complex form, the phenomenon of life began. This is the spontaneous generation Pasteur denied! But why has it never, to our knowledge, happened again? Why have our astute modern scientists not been able to produce life in the laboratory? Is there a mystical force that transforms inert matter to become alive?

There seems to be only three possible answers to the origin of life: 1. spontaneous generation of matter and energy resulting from the Big Bang, and subsequent cosmic events, 2. intelligent design by a deity or some other intelligent supernatural entity, or 3. there was no beginning, life always existed. The defects in each answer are obvious: 1. defies Pasteur’s dictum, 2. merely begs the issue, deferring the question to the origin of the intelligent designer, and 3. requires the believer to confront the regression of time’s arrow that points to a beginning.

In recent years, physicists have been tendering quantum mechanics and more advanced theories about the origin of the universe, or even of multiple universes. A “standard model” for our universe has been established. It begins with matter, energy and space-time, all suddenly fluctuating out of “the vacuum,” followed by other cosmic events that, over some 14 billion years, led to our present condition. Granting that hypothesis, it becomes a fairly straight course to arrive at the universe as we know it, or as we think we know it, that is, *except for life*.

We now pretty much understand how particles and waves evolve and react to produce our physical universe. Of course, as with life, the question of origin remains. But the physicists are much further along the road to the beginning than are the biologists. However, we must acknowledge that the biologist's road is much harder. Biologists seek to discover how the physicists' particles, waves and products thereof somehow became assembled into the ill-defined, uniquely functioning thing we call "life."

Charles Darwin (Figure 2) made the epic discovery² that let us connect and trace all species back to the primal mud, but that does not tell us where the first living organism, perhaps similar to that in Figure 3, came from, or how it arose. Unless life also fluctuated full-formed out of the vacuum that yielded our physical environment, biologists have no theory paralleling that of the physicists. However, this simple "echo theory" is unavailable to biologists, because the initial products of the Big Bang were in plasma form, non-particle, and too hot to have allowed for living organisms.

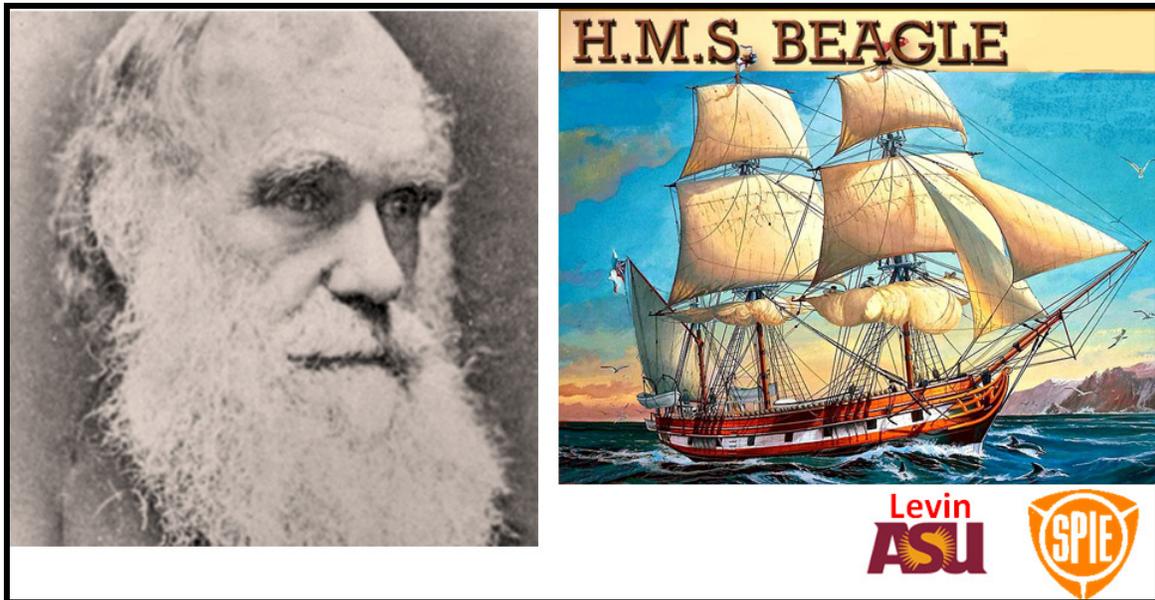
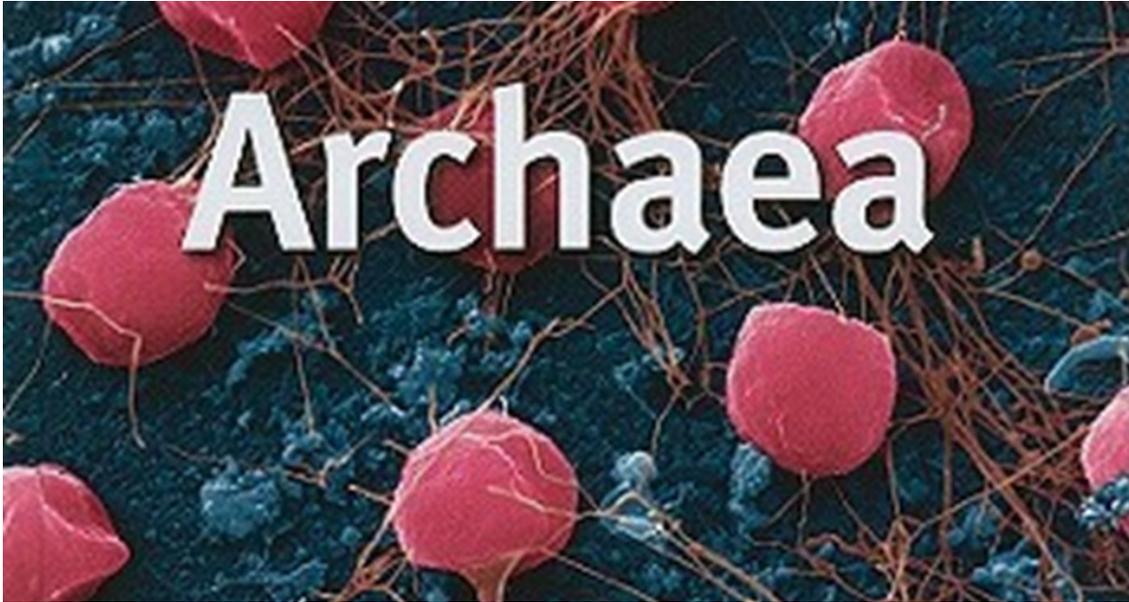


Figure 2. Darwin: Voyage to Evolution.



Early form of life, no internal membranes. Has cell wall differing from those of bacteria. Chiral specific.



Figure 3. Near the Origin?

Since Darwin's discovery of biological evolution, we have made great progress in learning how and when life developed into its myriad forms. This story is schematically depicted in Figure 4 (a presumed origin and fate are shown in the dashed portions of the event curve). Since the historic discovery by Watson and Crick³ of the structure and function of DNA, we have come to know essentially how our life works, but little about how it began. Darwin deeply considered the problem of origin as he developed his theory. Initially, he viewed pondering the origin as a useless endeavor, at one point writing "It is mere rubbish to think about the origin of life."⁴ Nonetheless, a considerable discussion on the subject ensued among Darwin and many of the leading scientists of the time. After rapid and sometimes heated exchanges, Darwin changed his thinking, saying, "Even the vital force may hereafter come within the grasp of modern science."⁵

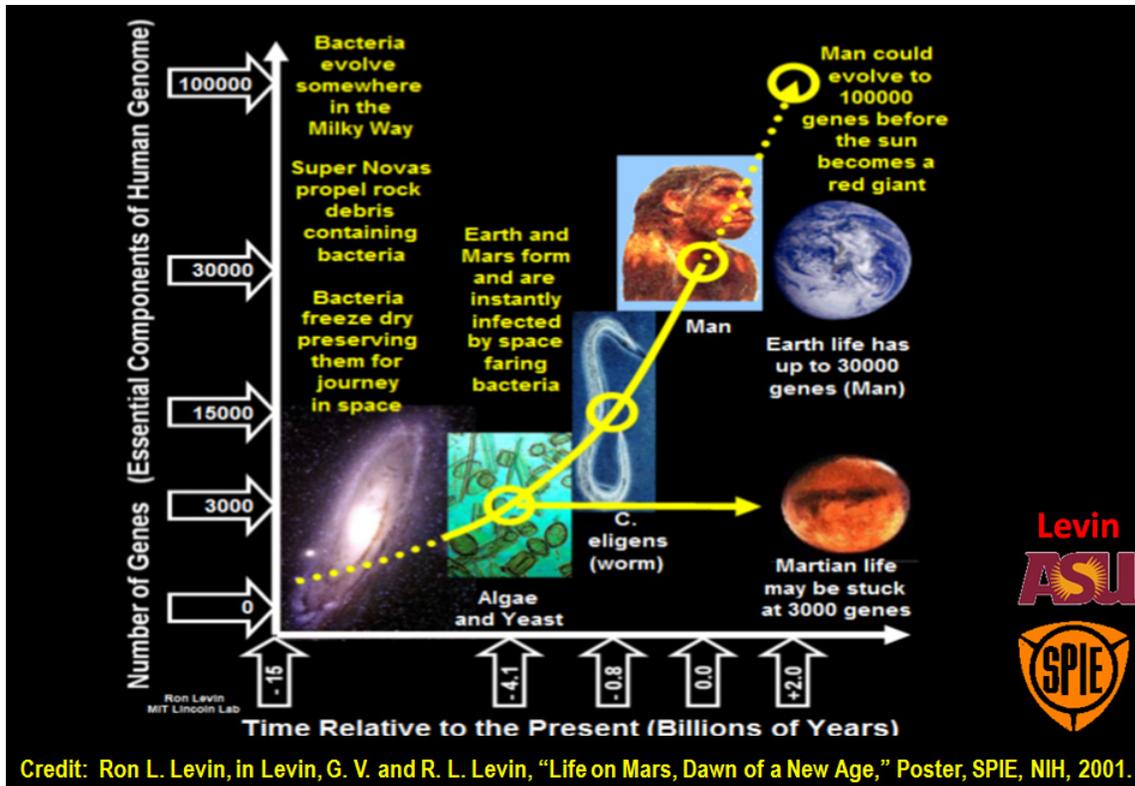


Figure 4. Origin and Evolution of Life on Earth and Mars

The 3.5 billion years back to currently detectible fossils seems to some not long enough to allow for evolution to reach its present state. However, it must be remembered that vastly more individuals were available to mutation and the evolutionary process than simply the number of generations, large as that is. Each generation of a species hosted a huge mass of individual organisms of that species, each of that multitude subject to mutation. Microbial multiplication is so rapid that, within a very short, respective geological time span, the Earth would have supported what for practical purposes would be an infinite number of copies of each generation of each species. Multiplying this huge number of individuals present in a single generation by the number of generations through time might well provide sufficient opportunity for the evolution we observe to have occurred.

BEYOND EARTH

Many say that genesis is so complex that there was not sufficient time for it to occur between the span of Earth's sufficient cooling and the emergence of life. They conclude that our genesis must have occurred somewhere else other than on Earth. However, invoking another celestial venue only pushes the baffling process back to another time, another place, leaving the fundamental problem unsolved. Conditions unavailable on Earth might have been available elsewhere to promote genesis. I have previously cited⁶ the possibility that comets contain or collect organic matter and might preserve it as on a cold finger with incident cosmic radiation making free radicals of some of the pinioned molecules. Then, when the comet reaches an area of high ionizing radiation, as near some sun, the concentrated collection of free radicals may be suddenly released to react

to form products along life's pathway. A new article⁷ reports that, at ultrahigh magnetic fields, unique changes occur that affect hydrogen bonding and alter its chemical bonding energy. Fields of such strength occur in the atmospheres of magnetic white dwarfs and neutron stars. Perhaps, such a change in bonding promotes reactions required for the genesis of life. Even so, it is not obvious exactly how this energy would make that vital transition.

Sir Fred Hoyle and Chandra Wickramasinghe point⁸ to other celestial bodies, or outer space itself, as the source of life on Earth. However, they only move the question back in space and time. They also said "it is impossible to synthesize organic materials in appreciable quantity from inorganic materials without the intervention of biological systems."⁹ This is a profound statement that goes even a step further than Pasteur's axiom. The Miller-Urey reaction¹⁰ refuted this latter claim by producing amino acids from supposedly primitive Earth atmospheric gases subjected to electrical energy. However, this theory has come under some criticism¹¹ in that doubts have been raised as to whether the Earth's early atmosphere were sufficiently reducing for the reaction to take place. However, the Pyrolytic Release life detection experiment executed on Mars by the Viking Mission did unknowingly demonstrate¹², as subsequently reported¹³, the abiotic synthesis of simple organic compounds. Simulated Martian atmosphere subjected to simulated sunlight in a sterile chamber produced formaldehyde, acetaldehyde, glycolic acid and other simple compounds. Calling attention to possible significance on primitive Earth, the experimenters said, "Our findings suggest that UV presently reaching the Martian surface may be producing organic matter . . . the amount of product found could be considerable over geologic time." Until this current paper, however, this mechanism has not been appreciated as possibly providing the long-sought first step in genesis, the conversion of inorganic matter into organic matter. This conversion of inorganic matter, CO, to organic matter avoids the criticism directed at Miller-Urey. Although this finding may provide the first rung on the ladder to life, it does not solve our problem of determining how the subsequent products became alive. Similarly, the claimed¹⁴ detection of microbial life on Mars by the Viking Mission Labeled Release experiment, while making the important discovery that life exists beyond Earth, does not answer the origin question.

SYNTHESIZING LIFE

In his book¹⁵, Lawrence Krauss comments on "the recent decade's incredible progress in molecular biology," with its synthesis of key biological molecules, concluding that "Now few biochemists doubt that life can arise naturally from nonlife, even though the specifics are yet to be discovered." However, even if the specifics are yet to be discovered by man, why have they not yet been rediscovered by nature? If biochemists can now create a significant number of biomolecules to convince themselves that the remaining molecules needed for life can also be synthesized abiotically and then become alive, why hasn't that happened again on Earth over the last 3.5 billion years? Our singular origin, depicted in Figure 5, strongly indicates that some special event or environmental factor not present since the first genesis is needed.

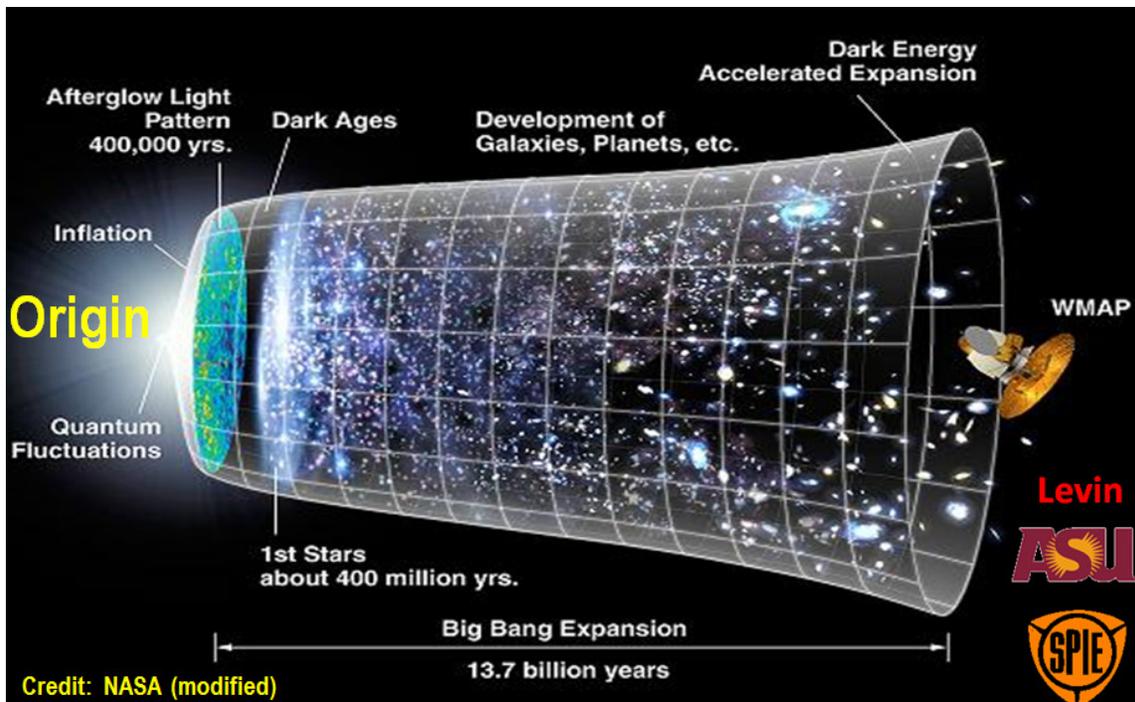


Figure 5. Regression to the Origin

Philosophers, chemists and nascent biologists addressed the issue long before the more scientific efforts made by, for example, Sidney Fox¹⁶ to convert amino acids into proteins, membranes and vesicles in his attempted march to life. Recently, self-organized “growth” of alkaline-earth carbonates into nanocrystalline ultrastructures, “biomorphs, (which) exhibit curved morphologies reminiscent of biominerals” has been reported¹⁷. The self-assembly continued for hours, and, after terminating, silica “skins” formed around them. Even the self-assembly of multiple single strands of DNA into long variant constructs has been accomplished¹⁸. Insight into the progress in synthetic biology, with possible bearing on the origin question, is given by Benner, Chen and Yung¹⁹ who state, “If taken to its limit, this synthesis would provide a chemical understanding of life.” Another report²⁰ recounts the self-assembly of porphyrins into miniature four-leaf clover-shaped “biomorphs.” The image in this report seems to indicate symmetry. The roles of symmetry and symbiosis need to be incorporated into the tale of life’s origin and evolution.

A review²¹ of the RNA World theory, some 50 years after its publication²², showed the self-assembly concept has grown in strength. New work was included showing that boron improved the coupling powers of RNA. Since there is a greater concentration of boron on Mars than on Earth, the possibility was raised that our life might have originated on Mars. In addition, inorganic phosphate is limiting to biology on Earth and possible substitutes (that might be more available on Mars) were suggested. While interesting in the pursuit of our origin, these possibilities do not close the gap. Many advances have been made ranging from the astounding denouement of life’s genomes, to the abiotic synthesis of many important biomolecules, to the substitution²³ of one cell’s nucleus for that in another living cell. But this falls short of creating that cell.

The conditions on Earth today, and for the past approximately 3.5 billion years since life appeared here, obviously were and are fully adequate to sustain life, and to have promoted its deep, multi-pronged and relentless evolution. Long having regarded life as tenuous, we have now come to appreciate the biologic imperative that pervades our entire planet, and, at least at the mono-cellular level, survives all manner of seemingly destructive insults.

Nonetheless, while all the conditions still prevail for the existence and support of life, they are not sufficient for a new creation of life. Through all the eons of life's journey on Earth, there has been no new genesis, at least no one has, as yet, found evidence of such. This indicates some change away from the factor(s) responsible for life. However, any such change cannot have proved inimical to the continuation of life: the change must prevent new geneses, but not be harmful to survival of the first life form. This puts a strong constraint on any such change.

LIFE ON EARTH

Confining ourselves to the possibility that life originated on Earth, what prevalent condition(s) might have ushered it in? Perhaps, the most extraordinary concept is that of Carl Gibson²⁴, in which life emerged in a "Big Biological Bang" only some 300,000 years after the Big Bang. As with all origin theories, the details of the emergence of life are not given. More conservative approaches consider a prominent role for polymerase chain reaction (PCR), which can achieve manifold amplification of pieces of DNA through appropriate thermal cycling. It is thought this might have occurred naturally. However, PCR relies on an enzyme for assembly of the multiple strips of DNA produced. Recently the reported progress in making artificial enzymes makes PCR of greater interest to the origin question. Synthetic enzymes that catalyze bimolecular reactions with high stereoselectivity and substrate specificity have been demonstrated²⁵. This offers a mechanism for carbon bonding, controlling both substrate specificity and stereoselectivity that may have been available in the past that is not performed by today's natural enzymes. Another development²⁶ in the design of synthetic enzymes is a general approach to the computational design of enzymes to catalyze arbitrary reactions toward the goal of making synthetic proteins. Demonstrations²⁷ have also shown that abiological processes can preferentially concentrate L-isomers of amino acids. These and similar developments are aimed at facilitating research and practical purposes, but the non-currently prevailing conditions applied may possibly have some significance to the genesis problem.

All life forms we know are intimately related, operate on the same biochemistry and utilize the same nucleic acid genetic system. They even have the same chirality. The absence of life with a different chirality is particularly puzzling. Darwin was first to explain the existence of only one fundamental form of life on Earth by stating "It is often said that all the conditions for the first production of a living being are now present, which could ever have been present. But if (and oh what a big if) we could conceive in some warm little pond with all sort of ammonia and phosphoric salts, light, heat, electricity present, that a protein compound was chemically formed, ready to undergo still

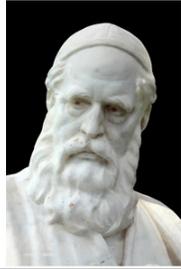
more complex changes, at the present such matter would be instantly devoured, or absorbed, which would not have been the case before living creatures were formed ...”²⁸ Many years later, Alexander Oparin supported that view stating “Should any new form of life spontaneously arise in his (Darwin’s) primeval soup, the nascent life would quickly be consumed by the overwhelming numbers of existing forms.”²⁹

However, I submit this is not likely to be the case. Many closely related forms of life on Earth have long competed and, nonetheless, survive. Beyond mere competitive survival lies the fact that, if the new life form had a different chiral preference than ours, the new and existing forms could not compete with each other for food. All life we know can metabolize proteins only if they are made of L-amino acids, and can metabolize carbohydrates only if they are of D-chirality. Were a new life form to arise with a different homochirality than ours, the two forms could not beneficially feed on each other. The enzymes of one life form would not physically fit the strange chiral compounds of the other life form. Therefore, neither could metabolize the other. While some species have learned to invert chirality and transform a D-amino acid to an L- form that can be metabolized, this is a slow and not very prevalent phenomenon, and not in life’s mainstream. Thus, from the paramount standpoint of nutrition, a new life of a different chirality would not threaten or be threatened by the existing form. They might, of course compete for space, light, water and the like, but, as in our current ecosystem, a great number of such competitors would survive and flourish. As far as we can tell, either chirality has a 50 percent chance of being selected by an emerging life form. Where are these other life forms?

THE FINE LINE

The fine line that separates life from death has long intrigued mankind. As plaintively asked by Omar Khayyam (Figure 6) in the 11th century, “A Hair perhaps divides the False and True - And upon what, prithee, may life depend?” To approach this question, let us assume that Miller-Urey compounds of the species incorporated into the life we know, did develop in Darwin’s warm little pond. Assume further, as did Alexander Oparin³⁰, that these compounds then chemically evolved to produce all the molecular types needed for life. Oparin assumed they eventually attained cell integrity, began metabolism, thus becoming alive and having the power to reproduce. But is it that simple? Suppose membranes and vesicles form, and that the essential life components, including RNA and DNA, form, and all are respectively incorporated into their appropriate membranes and vesicles. Even assume that self-assembly occurs. It remains hard to imagine how this assemblage can cross the fine line to become alive. But if it did, why would this not have happened again and again over the eons since life’s first appearance? And why wouldn’t some of these new geneses have identifiable distinctions from the life of the first genesis, such as opposite chirality, a variant form of DNA, or use of something other than ATP for energy transfer? No such variant life form has been found. Proposing a search for such an alien life form, Paul Davies stresses³¹ that our “Goldilocks” universe is so finely tuned for life that even the tiniest change in any of its physical constants would render it uninhabitable. He then reviews the pertinent theories on the origin of life, but, like his prominent predecessor, Omar Khayyam, “came out by the same door where in I went.”

•Would you that spangle of Existence spend
About the Secret – Quick about it, Friend!
A Hair perhaps divides the False and True –
And upon what, prithee, may life depend?



Verse XLIX.

**Omar
Khayyám**
11th Century AD



Figure 6. The Ultimate Question in an Ancient Quatrain

A DIFFERENT APPROACH

While recent research has revealed the composition and mechanism of life, little progress has been made, and no success achieved, in creating life from inert materials. There remains an enormous gulf between the ingredients of life and life itself.

We have been unsuccessful in attempting to discover the secret of life's origin by researching it from the bottom up, that is, by synthesis and assembly of molecules and compounds. Perhaps, we should try a top-down approach: conceiving a new theory of genesis testable by experiment. This is how, one hundred years ago, Albert Einstein, Figure 7, achieved the breakthrough to our current understanding of the genesis of the physical universe. Einstein launched into a gedankenexperiment that led to a revolutionary top-down theory, replacing Newtonian concepts that had prevailed for nearly three centuries. He proposed a whole new approach to reality. Fiercely resisted as outlandish, his theory was soon proven correct by an experiment verifying his prediction. He explained his approach by stating, "We cannot solve our problems with the same thinking we used when we created them."

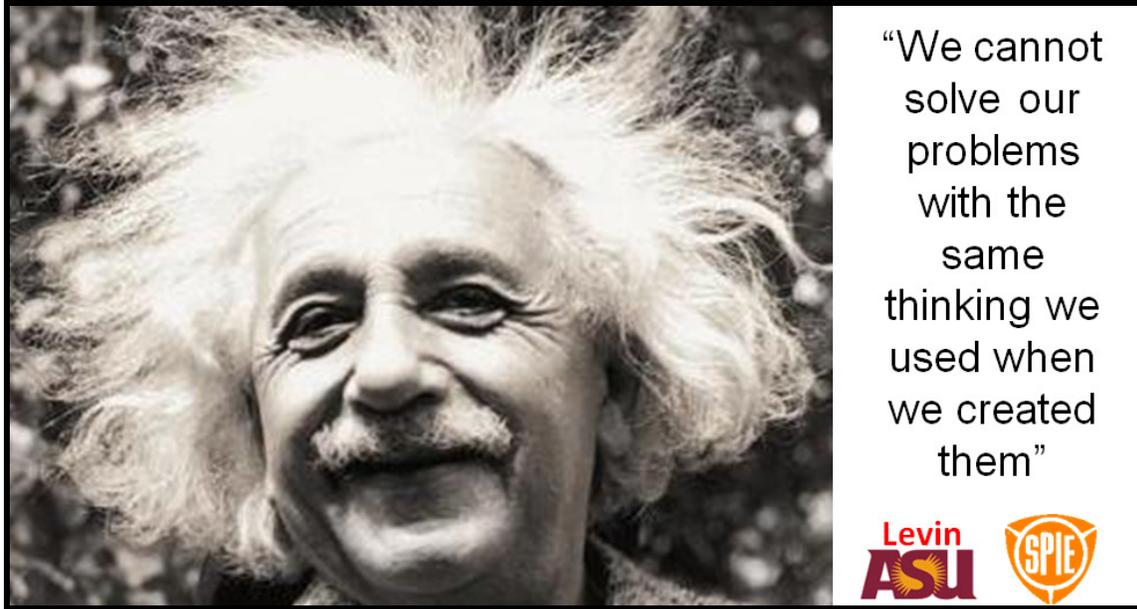


Figure 7. The Origin of Modern Physics

With the top-down approach, the researcher starts with the goal in hand and seeks to learn how the object of his inquiry arrived there by examining its retreat from the goal post, rather than seeking the answer by blindly kicking the ball from midfield, hoping it enters the goal. That is not meant to belittle the bottom-up approach, but to propose an additional path that, even falling short of its objective, might yield valuable information about the mystery of life. The basis for the effort should be some theory conceived in a biogedankenexperiment, posing a new concept of the living cell and indicating the critical factors involved. The proof of the theory would lie in its demonstration of applying these factors to achieve resuscitation of the killed cell.

H. C. Bastian, contemporary of Darwin, was intrigued with Darwin’s theory, but was determined to create a link between the living and the inert to explain the origin. He first attempted this approach with experiments³² starting with a complete living organism, dismembering it and trying to re-generate the living organism from the remnants. However, his experiments were hopelessly compromised by contamination with living cells.

With our vastly improved methods, we might re-examine this means to discern the boundary between life and death. The first theory so proposed might be Bastian’s, that a functioning cell can be killed and its intact components resuscitated by procedures to be tested. **We might first experiment with a culture of archaea**, deemed the earliest life form on Earth and, thus, likely the simplest. A recent paper³³ supports archaea as our earliest known life form. The paper suggests that the original terrestrial life form might have been methanogenic. A methanogenic-methanotrophic ecology has been proposed³⁴ for Mars as possibly the organism, or among the organisms detected by the Viking Labeled Release Experiment which would have detected methanogens. In the proposed experiment, we could slowly impose, or control, conditions, exploring single variables and combinations, that lead to the demise of the cells. Again, archaea would be a good

choice, because they do not form spores that might be confused with death. By carefully monitoring their metabolism, we might determine exactly when the line between life and non-life was crossed, leaving all life's components still assembled, but not metabolizing. Attempts might then be made to go back across the line, restoring the living condition. **All experimental inducements deemed pertinent could be applied.** The multiple variables available would best be culled by selecting the choices based on a theory. The use of ^{14}C -labeled molecules in monitoring radiorespirometry could readily monitor such "backward" and "forward" determinations with exquisite sensitivity. If the first experimental approach were successful, the lethal process might be applied more extensively, driving the cellular components apart and into successively further disarray until revitalization no longer takes place. Careful study might isolate the life-rendering factor(s).

PROSPECT FOR THE FUTURE

Obviously, the genius of an Einstein will be hard to find. But why not seek for him or her? Some will say any such genius will inevitably come to the fore, and need not be sought. But it seems likely that encouragement and support might help to find those "gems of purest ray serene" that might otherwise remain unseen and unproductive. Why not have conferences inviting young, bright participants to present their top-down biogedankenexperiments? Perhaps a publication could be dedicated to the subject. Grants and prizes might coax forth the needed genius. The awards need not be large since no equipment or staff are needed. Only the P.I. need be supported to flesh out his or her theory into testable form. Thus many grants and awards could be made at modest financial investment. Government, industry and private parties could participate in the funding. We should try all of these things. The benefit-to-cost ratio is enormous. Obviously, the genius of an Einstein will be hard to find. But why not seek for him or her? If after all these years we have not come up with even a tolerable theory about how life began, scientific objectivity compels us to admit the possibility that life is supernatural (Figure 8).



Figure 8. Supernatural Genesis

While it can readily be argued that such a possibility must be considered, it would surely irk the very scientists having had to make such a “non-scientific” concession. This is a very uncomfortable state of affairs.

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