Intelligent Design and Evolution Awareness Center

Problems with the Natural Chemical "Origin of Life"

As found on the IDEA Center website at www.ideacenter.org

By Casey Luskin

Introduction

The "origin of life" (OOL) is best described as the chemical and physical processes that brought into existence the first self-replicating molecule. It differs from the "evolution of life" because Darwinian evolution employs mutation and natural selection to change organisms, which requires reproduction. Since there was no reproduction before the first life, no "mutation - selection" mechanism was operating to build complexity. Hence, OOL theories cannot rely upon natural selection to increase complexity and must create the first life using only the laws of chemistry and physics.

There are so many problems with purely natural explanations for the chemical origin of life on earth that many scientists have already abandoned all hopes that life had a natural origin on earth. Skeptical scientists include Francis Crick (solved the 3-dimensional structure of DNA[1]) and Fred Hoyle (famous British cosmologist and mathematician), who, in an attempt to retain their atheistic worldviews, then propose outrageously untestable cosmological models or easily falsifiable extra-terrestrial-origin-of-life / panspermia scenarios[2] which still do not account for the natural origin of life. So drastic is the evidence that Scientific American editor John Horgan wrote, "[i]f I were a creationist, I would cease attacking the theory of evolution ... and focus instead on the origin of life. This is by far the weakest strut of the chassis of modern biology."[3]

A Brief History of Origin of Life Theorization

The dominating scientific paradigm for the chemical origin of life was derived over 70 years ago at a time when the popular cosmology held that the universe, and essentially the earth itself, were infinitely old.[4] Those trying to explain life in purely naturalistic terms liked having an infinite universe, for it made irrelevant any high improbabilities associated with the natural origin of life. As Hubert Yockey states, "even if life proves to be improbable, it will happen in such a[n infinite] universe."[4] In other words, given infinite time, infinite things are possible.

Darwin first conceived of the origin of life happening in some "warm little pond" with ammonia, and sulfates, and electrical charges.[5] Surprisingly, the modern paradigm isn't all that different. These ideas influenced Aleksandr Oparin and JBS Haldane who in the 1920's postulated that life formed as a result of "chemical evolution," where natural reactions between the chemicals present on the early earth eventually formed life. It was soon realized that the infinite universe was little more than wishful thinking. Einstein's general theory of relativity predicted that the universe must expand or contract if it contains any matter.[4] Thus, the universe must be finite both in size and age; not only did the universe have a beginning, but time is limited. Many cosmologists opposed these ideas because they wanted an infinite universe where life's natural origin wasn't improbable. Yockey notes that "[i]n spite of other successes of the general theory of relativity, the Big Bang, and in particular the idea that the universe had a beginning, was fought bitterly every step of the way."[4] Eventually the math and a slew of astrophysical data wouldn't have it, and science accepted the finite, time-limited universe. Thus says the "Big Bang" theory: "time is limited". And thus says mathematics, chemistry, and physics: "the natural chemical origin of life is highly improbable."

Although mainstream scientists cannot date the OOL precisely,[6] they believe that bacteria lived as early as 3.5 billion years ago,[7] and life existed as early as 3.8 billion years ago.[8] Given that mainstream scientists believe Earth is about 4.54 billion years old, and that the earth's crust did not solidify until 4 billion years ago,[6] there may be as few as 200 million years allowed for the OOL. That may seem like a long time, but it only represents about 1/22 of the earth's total history. Recognition of this fact has led to a paradigm shift among OOL researchers, reflected in the following quotes:

**"Given so much time,
the "impossible" becomes possible,
The possible probable,
And the probable virtually certain,
One only has to wait:
Time itself performs the miracles."**

(Wald, G., Scientific American, 1954)

"...we have now what we believe is strong evidence for life on Earth 3,800 thousand million years [ago]. This brings the theory for the Origin of Life on Earth down to a very narrow range ... we are now thinking, in geochemical terms, of instant life..."

(Ponnamperuma, C. from "Evolution from Space," 1981)

"[W]e are left with very little time between the development of suitable conditions for life on the earth's surface and the origin of life. Life is not a complex accident that required immense time to convert the vastly improbable into the nearly certain. Instead, life, for all its intricacy, probably arose rapidly about as soon as it could."

(Gould, S. J., "An Early Start," *Natural History*, February, 1978)

In 1953 Stanley Miller and Harold Urey decided to test the "Oparin-Haldane" hypothesis by "zapping" methane and ammonia gas with electric charges.[9] They obtain various amino acids, and the experiment was hailed as "proof" of the origin of life! This same year, Watson and Crick discover the double-helix structure of DNA.[1] I want to note that it is a common, though given what many classes teach, forgivable misconception that the natural chemical origin of life has been proven because these experiments created life in the lab. This is mistaken, for not only has life nothing close to life ever been produced in lab experiments, but even if true life were one day created, it still wouldn't prove anything about what actually took place when the first life-forms came into existence.[6] As professor William Stansfield says,

> *"Creationists have looked forward to the day when science may actually create a "living" thing from simple chemicals. They claim, and rightly so, that even if such a man-made life form could be created, this would not prove that natural life forms were developed by a similar chemical evolutionary process. The [evolutionist] scientist understands this and plods on testing theories."*[10]

Events of the past, such as the origin of life, are ultimately untestable by science. Science can never absolutely prove anything regarding these matters and thus any belief, no matter how scientific one may think it to be, requires some measure of faith. Science can, however, disprove hypotheses which are internally contradictory or go against the laws of physics, chemistry, mathematics, or geological evidence. Accordingly, a belief that life arose naturally on earth can be effectively disproved, to the point that anybody who chooses to believe in it can be shown to be holding great amounts of faith. At this point, one must ask the more personal and philosophical question, why?

Starting with the right question:

One might expect the most important question regarding the OOL to be: *Could it happen?* Surprisingly, this is not the way most mainstream scientists approach the issue. Only one type of hypothesis is allowed for to explain this event, evidenced in the following statement by the National Academy of Sciences:

> *"[I]f a living cell were to be made in the laboratory, it would not prove that nature followed the same pathway billions of years ago. But* ***it is the job of science to provide plausible natural explanations for natural phenomena****."*[6] (emphasis added)

OOL scientists thus assume there was a purely natural cause, though often there is no external scientific evidence for that cause, only philosophical assumptions. This fact is well-illustrated by admissions made by famous OOL researcher Stanley Miller about why he used certain gasses in experiments producing the building blocks of life:

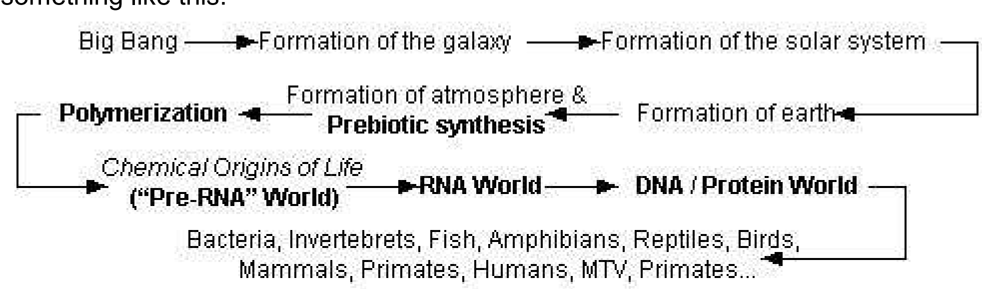
> *"It is assumed that amino acids more complex than glycene were required for the origin of life, then these results indicate a need for CH_4 (methane) in the atmosphere"*[11]
> &
> *"We believe that there must have been a period when the earth's atmosphere was reducing, because the synthesis of compounds of biological interest takes place only under reducing conditions."*[12]

Modern geochemists know Miller was wrong to make these assumptions because the early earth probably had a non-reducing atmosphere that did not contain methane (discussed further on the next page). However, the point is that there exists a materialistic philosophy inherent in OOL research which assumes that only natural causes were involved in the OOL in the first place. In this "retroactive science," the hypothesis that life could have arisen naturally is not tested, it is assumed, and research proceeds from there. This is why the eminent Harvard zoologist Richard Lewontin states:

> *"[W]e have a prior commitment, a commitment to materialism. It is not that the methods and institutions of science somehow compel us to accept a material explanation of the phenomenal world, but, on the contrary, that we are forced by our a priori adherence to material causes to create an apparatus of investigation and a set of concepts that produce material explanations…that materialism is absolute, for we cannot allow a Divine Foot in the door."*[13]

The Science:

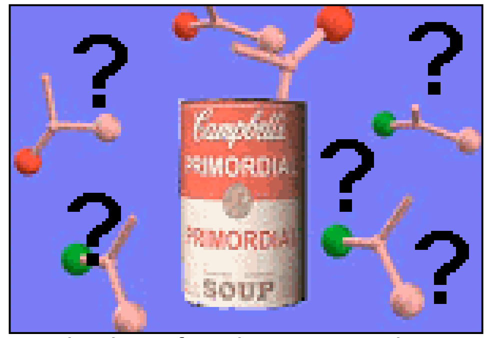
The basic idea behind the chemical origin of life is that simple molecules became more complex molecules which eventually allowed the first auto-catalytic self-reproducing molecule to exist. Many would define the chemical origin of life as the existence of a single molecule that was not only able to replicate on its own, but could produce any molecules necessary to facilitate that replication. According to Stanley Miller, famous origin of life researcher, the chain of events looked something like this:[14]



The touted sequence of events leading from a "random" explosion of matter and energy to DNA-based life. Please note, emboldened terms will be discussed in the text.

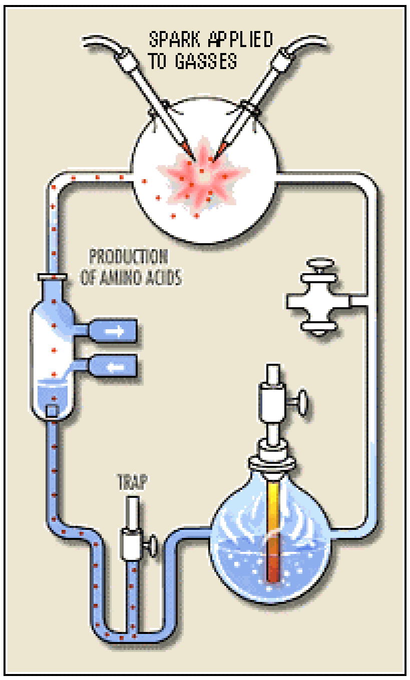
Most origin of life researchers would generally agree with such a diagram, although some add "extraterrestrial input" in varying amounts somewhere along the line. For example, Stanley Miller believes extraterrestrial input (i.e. comets, asteroids, and random dust particles) contributed about 5% of the pre-biotic organic molecules on earth.[14]

Step 1: Pre-Biotic Synthesis and the "primordial soup"
In order to bake a cake, you first need all the ingredients. Pre-biotic synthesis is the means by which sufficient quantities of all the ingredients thought to be necessary for life's natural origin were formed. Many have called this collection of chemicals the "primordial soup". We will ask 2 questions regarding this “soup:”



1) Could the soup have even been produced?
2) Is there any geological evidence that the soup existed?

1. Could the soup have ever been produced?



As noted, in the 1950’s, Stanley Miller appeared to have found a way to make some of the ingredients of the primordial soup by "zapping" a mixture of H_2, HCN, H_2O, CH_4, CHO, and NH_3 gasses with an electric spark (see graphic at left from http://science.msfc.nasa.gov/headlines/images/comet-seeds/anim.htm). The first time Miller got nothing but brown tar but after more experiments he has obtained (albeit often in very small amounts) at least 19 of the 20 amino acids upon which life is built. Furthermore, it has been found that comets and carbonaceous asteroids, which are thought to have been constantly bombarding the earth early in its history, can contain appreciable amounts of organic molecules. All this looks promising at first when trying to build up an ancient storehouse of pre-biotic organic chemicals.

However, the cake-baking analogy from above analogy now holds quite true! Just as a baker adds the proper ingredients to bake a cake, so the researchers designed their pre-biotic synthesis experiments in such a way as to get the s ought-after organic molecules. Methane (CH_4) and ammonia (NH_3), were chosen not because they were actually thought to be a part of the early atmosphere but rather because they are essential to the production of the proper amino acids and gave the desired results. As noted, Stanley Miller admits that he assumed that the atmosphere had methane and ammonia—he did not test that hypothesis. They just wanted to see if they could produce the right molecules using various contrived mixtures of gasses. Given the simple molecules they were trying to synthesize, these experiments are little more than simple exercises in organic chemistry and literally say nothing about the chemical origin of life. Though at the time, Miller’s experiment was promoted as supporting the hypothesis that life arose out of a primordial soup, subsequent research has enumerated problems with the hypothesis:

1. As previously noted, Miller’s experiment requires a reducing methane and ammonia atmosphere,[11, 12] however geochemical evidence says the atmosphere was hydrogen, water, and carbon dioxide (non-reducing).[15, 16] The only amino acid produced in a such an atmosphere is glycine (and only when the hydrogen content is unreasonably high), and could not form the necessary building blocks of life.[11]
2. These "pre-biotic chemicals" are formed only in very small amounts and degrade quickly into a tar-like substance.[17, 18] Not only would UV radiation destroy any molecules that were made, but their own short lifespans would also greatly limit their numbers. For example, at 100ºC (boiling point of water), the half lives of the nucleic acids Adenine and Guanine are 1 year, uracil is 12 years, and cytozine is 19 days[20] (nucleic acids and other important proteins such as chlorophyll and hemoglobin have never been synthesized in origin-of-life type experiments[19]). Such short-lived molecules could never be stockpiled, even if they could be produced naturally. For this reason, Miller proposed a cold origin of life (for at 0ºC their half-lives jump about 1 million years) even though even at that low temperature Ribose, a sugar which helps build DNA, has a short half-life of 44 years,[14] and cytozine a relatively short half-life of 17,000 years.[20] Either way the rate of degradation is too high to accumulate enough pre-biotic organics to form a soup. But models for earth's formation indicate the earth was hot, meaning degradation would occur even faster! If it the earth had been cold, this would work against the OOL by slowing the chemical reactions that supposedly allowed life to form, increasing the time needed for the OOL.
3. Catch-22 situation: We all have know ozone in the upper atmosphere protects life from harmful UV radiation. However, ozone is composed of oxygen which is the very gas that Stanley Miller-type experiments avoided, for it prevents the synthesis of organic molecules like the ones obtained from the experiments! Pre-biotic

synthesis is in a "damned if you do, damned if you don't" scenario. The chemistry does not work if there is oxygen because the atmosphere would be non-reducing, but if there is no UV-light-blocking oxygen (i.e. ozone - O_3) in the atmosphere, the amino acids would be quickly destroyed by extremely high amounts of UV light (which would have been 100 times stronger than today on the early earth).[20, 21, 22] This radiation could destroy methane within a few tens of years,[23] and atmospheric ammonia within 30,000 years.[15]

4. At best the processes would likely create a dilute "thin soup,"[24] destroyed by meteorite impacts every 10 million years.[20, 25] This severely limits the time available to create pre-biotic chemicals and allow for the OOL.
5. Chemically speaking, life uses only "left-handed" amino acids and "right-handed" genetic molecules, yet no chemical explanation has been made for the origin of "chirality."[26] As one scientist stated, "the basis for the origin of biomolecular chirality still remains obscure".[27]

It should be noted that some critics of intelligent design have begun to perpetuate the claim that amino acids have been produced in the presence of oxygen or non-reducing atmospheres, thus allowing Miller-Urey Experiments to be relevant to atmosphere on the early earth. All those making this claim[32] have cited to Rode (1999)[16] and Hanic et. al.[33] The citation to Rode is duplicative because Rode also cites to work by Hanic (and Morvova). Thus, we need only examine the work of Hanic et. al.[33] to see if the claim that amino acids could be made in the presence of oxygen is correct.

According to Hanic et. al., “the final product of the process is a powder” which can only be dissolved with “difficulty” in extremely strong Hydrochloric acid (HCl). This is very different from the soluble form obtained by Miller. Secondly, the amino acids were only able to be produced on the surface of a strongly negatively charged electrode, in a gas cell corona discharge tube:

> *“Activation is followed by … formation of catalytic spots on electrode surfaces … and surface reactions on electrodes.”*[33]

The electrodes were necessary for the reactions to take place as the paper stated, “A very important role is played by the reactions on the electrode surfaces.”[33] Thus, although there may have been oxygen present, but this created an artificially high reducing environment—far beyond what would probably ever be found in nature! There are no strongly negatively charged electrodes in nature upon which you can force these sorts of reactions to take place in a gas cell corona discharge tube. Of course if you create an artificially high reducing environment you could produce amino acids—even in the presence of oxidizing oxygen gas. But that environment would not exist in nature had the atmosphere contained oxygen. Numerous authors have demonstrated the impossibility of forming amino acids in the presence of an oxygenic atmosphere.[11, 33, 34, 35, 36, 37, 38] The fact that this experiment could only produce amino acids in the presence of oxygen if on the surface of a strongly negatively charged electrode concentrated inside a discharge tube only testifies to the impossibility of such a reaction taking place in nature.

And what about building a soup by comets and asteroids? This hypothesis has been refuted by many authors who have shown that organic carbon could not be delivered in large amounts to the early earth because it would be generally superheated and destroyed during impact.[28]

2. Is there any geochemical evidence that the soup ever existed?

There is no geological evidence left in the rocks that a primordial soup ever existed. If there was ever a soup, the earliest Precambrian rocks should contain high levels of non-biological carbon, for biologically produced carbon contains an excess of "isotopically light" carbon. Ancient sedimentary rocks, however, do not reveal this signature,[29] and thus there is no positive evidence for this soup. If these processes produced a soup, they should have left a significant (1-10 meter thick) layer of tar encircling the earth, but there is no geochemical evidence of such a layer[30] nor any published geochemical evidence of a primordial soup.[31] Had there been a soup, then the rocks thought to be from that time period ought to contain an "unusually large proportion of carbon or organic chemicals" which they do not.[15]

So drastic is the evidence against pre-biotic synthesis, that in 1990 the Space Studies Board of the National Research Council recommended to scientists a "reexamination of biological monomer synthesis under primitive Earthlike environments, as revealed in current models of the early Earth."[23]

Many speculate that given a primordial soup, the chemical origin of life does not seem quote so improbable. However, it would appear that the existence of the primordial soup itself may have been greatly improbable. For as second, let's reason like the scientists do: The primordial soup seems necessary for life's natural origin, life evolved naturally, therefore the primordial soup must have existed! Unfortunately, the converse is also true. If the primordial soup is necessary for life's origin, but the soup didn't exist, than life didn't arise naturally. Assuming, for a second, that the primordial soup did come to exist, we are now ready to analyze the second major step in the chemical origin of life: could the molecules in the soup have come together to make larger, more complex molecules.

Step 2: Polymerization

Polymerization is the process by which "monomers" (simple organic molecules) form covalent bonds with one another to produce "polymers" (complex organic molecules). Monomers are thought be the constituents of the pre-biotic soup (amino acids, sugars, lipids, simple carbohydrates, nucleic acids), but polymers are chains--often very long chains--of monomers (peptides, phospholipids, RNA?, DNA?). This step is basically the method by which you get bigger molecules from the smallest molecules.

To help, here's a little analogy which might give some understanding of the types of structures we're dealing with here: monomers are like the letters, polymers are the words, biochemical pathways are the sentences, cells are the paragraphs, biological systems are the chapters, and the organism is the whole book! The only difference? Polymers are like words which are thousands of letters long.

During polymerization, a two monomers combine, forming a polymer and a water molecule:

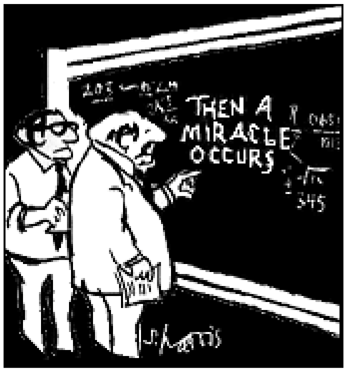
$$\boxed{\text{monomer} + \text{monomer} \rightleftharpoons \text{polymer} + \text{H20}}$$

If the origin of life took place in the pre-biotic soup, then it took place in an aqueous (i.e. water-based) solution of pre-biotic monomers. According to Le Chateliers Principle, one of the basic laws of chemistry, the presence of a product (in this case, water) will slow the reaction. If one tries to polymerize monomers into polymers in an aqueous solution (one where water is the solvent), it not possible to obtain any appreciable amount. The bottom line, the polymerization step in the chemical origin of life could never take place in water—this step is impossible in the primordial soup.

"Polymerization" thus requires “dehydration synthesis.” Many have proposed alternatives to get around this stumbling block. Since polymerization reactions also require an input of energy, heating and drying has been theorized to input energy, and remove the water. However, this heating and drying has to take place in such a way as to not wipeout the created polymers. Some theorized locations for this reaction have been intertidal pools or volcanic ridges where repeated cycles of heating and drying can take place. The problem is that all the water must be removed, but you don’t want to over-cook the polymers you are creating. Organic molecules tend to break down rapidly (i.e. cook) in the presence of heat. This would have to be a very fine balancing act that would also requires rapid input of organic material to overcome the rate at which the heat would destroy the molecules. A successful scenario is very difficult to imagine. Even under ideal laboratory conditions using pure monomers and carefully measured heating and drying cycles, only small amounts of polymers have been created.

Quick Summary of Problems with Various Locations for the Origin of Life	
1. Deep sea thermal vents	This would be under water and could not allow for polymerization through dehydration synthesis. Furthermore, organic compounds would quickly decompose if exposed to the high heat of deep sea thermal vents.
2. Tide pools (or somewhere in the intertidal zone)	Organic material would still exposed to water, inhibiting polymerization (dehydration-synthesis). Experiments which have mimicked optimal heating and drying conditions near tide pools have only created small to modest amounts of polymers.
3. Anywhere in the ocean	Water prevents polymerization because polymerization cannot take place in the presence of water. According to Le Chateliers principle, chemical reactions do not take place in the presence of large quantities of the product. Plus, the ocean would dilute the chemicals necessary for life.
4. Volcanic Ridges	This scenario encounters the same problems as the tide-pools—it must dry out the ‘soup’ through volcanic heat to allow polymerization. But even if dry monomers could exist in high concentrations under perfect temperature conditions (as occurs only in experiments), experiments suggests the resulting polymers are still too small to allow for the next steps in the origin of life. One reason that the primordial soup was hypothesized is because in such an aqueous environment, there would be a high rate of random chemical interaction. In other words, molecules would always be bumping into new neighbors, increasing the odds that many chemical reactions could take place. Even if the necessary polymers could be produced, here they are outside of water and there will not be a high rate of random chemical interactions to further form complex molecules. However, since the polymerization step can't take place in water, the number of random chemical interactions would be almost infinitely reduced. Instead of trying to make life in a liquid environment, you're now trying to make it in a more solid goo, which is much less congenial to random chemical interactions. How could life originate if the proper molecules have such a small chance of even finding each other? Furthermore, volcanic ridges also face the same problems as deep sea thermal vents as they are very hot and would destroy organic molecules.
5. Clay surfaces	This theory was first proposed about 1400 B.C. by Moses in the book of Genesis. Moses proposed that God created man out of dust, or clay. The theory has also enjoyed a new twist in the 20th century as A. Graham Cairns-Smith, hypothesized that clay crystals could have acted as a template which could allow for the continued creation and replication of organic material. Hypothetically this scenario could create a wide variety of organic molecules, however it lacks any experimental evidence. As there are no experiments, there are no results to judge and no practical problems encountered.
6. Extra-terrestrial Origin	See our Problems with Panspermia or Extraterrestrial Origin of Life Scenarios page.

Step 3: Pre-RNA World: Getting A Sufficient Self-Replicating Molecule



Though the OOL appears to be dead in the water, because of the lack of evidence for a “primordial soup” and the problems facing polymerization, let’s assume that those hurdles could be overcome. What would happen next? Many researchers have hypothesized that once polymers somehow formed, some of them came together to form the first self-replicating molecules. Somewhere within this step--the Pre-RNA world--the true origin-of-life occurred. However, nothing even close to a complete scenario by which polymers can naturally form a self-replicating molecule has ever been put forth. Chemists can artificially synthesize some self-replicating molecules in the lab, but they are not synthesized under conditions resembling the early Earth. Essentially, this is an appeal to a miracle.

Stanley Miller once said, "making compounds and making life are two different things."[14] This is quite true, for life, by definition, must have the ability to self-replicate--a process requiring many enzymes and genetic biochemical molecules. According to Joyce (2002), molecules like RNA or DNA are too complex to have arisen out the soup (assuming it existed) so there must have been some other more simple precursor to RNA or DNA.

A few self-replicating molecules have been created in the lab (i.e. in thoughtful and carefully-designed experiments). None have yet yielded candidates which could be stable replicators in an early earthlike environment that have the capacity to evolve into a more complex form. But is this anything more than rife speculation fueled by naturalistic thought? Consider these words by Arthur Shapiro:

> *“Another evolutionary principle is therefore needed to take us across the gap from mixtures of simple natural chemicals to the first effective replicator. This principle has not yet been described in detail or demonstrated, but it is anticipated, and given names such as chemical evolution and self-organization of matter. The existence of the principle is taken for granted in the philosophy of dialectical materialism, as applied to the origin of life by Alexander Oparin.”*[37]

One commentator noted that these self replicating molecules contain vastly less information compared to what is necessary for even the most primitive cell:

> *"This system carries very little information, in contrast to even the simplest cell. Mycoplasma gentalium has the smallest known genome of any living organism, which contains 482 genes comprising 580,000 bases. This organism is an obligate parasite. A free-living organism would need many more genes."*[19]

Life (at least today through the molecule DNA) contains huge amounts of information. As previously noted, the Darwinian mechanism requires replication, or reproduction. Prior to the origin of replication, life could only rely upon the basic laws of chemistry. But how could the basic laws of chemistry and physics create the information present in life? The origin of this information that is key to understanding the origin of life. As B. O. Küppers wrote, "the problem of the origin of life is clearly basically equivalent to the problem of the origin of biological information."[50] Yet, there are no known chemical laws that determine the order of the nucleotide bases in DNA (or any other self-replicating molecule). Küppers notes, "the properties of nucleic acids indicate that all the combinatorially possible nucleotide patterns are, from a chemical point of view, equivalent."[48] Hubert Yockey writes that the sequence of the DNA is not affected by any physical or chemical law:

> *Informational macromolecules can code genetic messages and therefore can carry information because the sequence of bases or residues is affected very little, if at all, by [self-organizing] physico-chemical factors.*[49]

The first self-replicating molecule is not said to be DNA. But it is said to have been similar to DNA in that it carried the information needed for life. If there are no known chemical or physical laws which can create this complex and specified information needed for a self-replicating molecule, then this stage of the origin of life faces severe hurdles.

Step 4: RNA World

Some time after the first “self-replicating” molecule formed, according to the story, RNA came along. Today, RNA is a genetic molecule in all cells, similar to DNA, but more versatile within the cell. The "RNA World" is essentially a hypothetical stage of life between the first replicating molecule and the highly complicated DNA-protein-based life. The chief problem facing an RNA world is that RNA cannot perform all of the functions of DNA adequately to allow for replication and transcription of proteins. OOL theorist Leslie Orgel notes that an "RNA World" could only form the basis for life, "if prebiotic RNA had two properties not evident today: a capacity to replicate without the help of proteins and an ability to catalyze every step of protein synthesis."[41] The RNA world is thus a hypothetical system behind which there is little positive evidence, and much materialist philosophy:

> *"The precise events giving rise to the RNA world remain unclear … investigators have proposed many hypotheses, but evidence in favor of each of them is fragmentary at best. The full details of how the RNA world, and life, emerged may not be revealed in the near future."*[41]

The best claimed evidence of an "RNA World" includes the fact that there are RNA enzymes and genomes, and that cells use RNA to convert the DNA code into proteins.[42] However, RNA plays only a supporting role in the cell, and there is no known biochemical system completely composed of RNA.[42]

RNA experts have created a variety of RNA molecules which can perform biochemical functions through what is commonly termed "test tube evolution." However, "test tube evolution" is just a description for what is in reality nothing more than chemical engineering in the laboratory employing Darwinian principles; that does not imply that there is some known pathway through which these molecules could arise naturally.

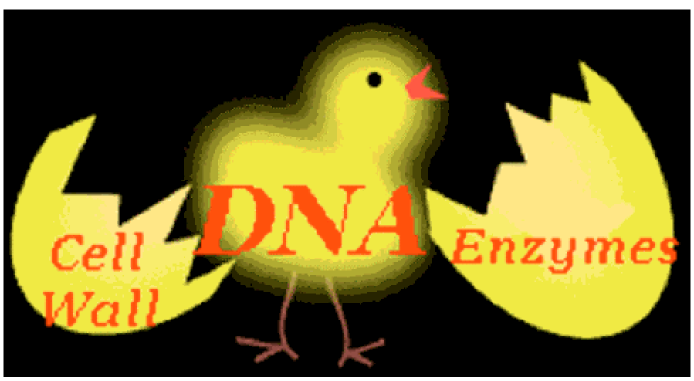
The most interesting RNA molecule synthesized is perhaps an RNA "polymerase" which can replicate 14 base pairs of RNA.[42] Yet, the polymerase itself is 200 pairs long.[42] As Gerald Joyce noted, OOL theorists are thus 14 / 200 towards achieving a possible model molecule for the RNA World. [$2] However, Joyce also noted that the replication accuracy of this molecule is too poor to allow for it to persist as a functional form of life.[42]

These purely speculative scenarios aren't bad on their own merits, but they are just another reminder of the philosophical presupposition driving this research in the first place: naturalism. Only when scientists assume there must be a natural explanation do they turn to completely unfalsifiable unverifiable and incomplete speculatory hypotheses.

The theory then says that some unknown precursor of RNA turned into RNA through an unknown process. This "RNA-world hypothesis" states that life then arose from a population of self-replicating RNA molecules. RNA is a sister molecule to DNA, used when DNA breaks up to create proteins or replicate. Like a copy from the library, RNA has a complementary code to DNA and goes out to do the dirty work. A few types of RNA have been known to have auto-catalytic self-replicating abilities, however this scenario inevitably encounters a chicken and egg problem18.

But these molecules must be encapsulated within a "cell wall structure" or a small protective enclosure from the outside world. But, the protective cell requires replicating genetic machinery to be created. Thus, we now have a "chicken and egg scenario"--which came first? the self-replicating machinery (which needs a cell to operate), or the cell itself, which protects (and is created by) the cellular machinery? The answer is neither came first for both are required for self-replication. How could self-replicating RNA arise naturally when it essentially is an irreducibly complex system that cannot functionally replicate without other distinct components.

Step 5: DNA/Protein World.



Scientists sometimes bluff that they have the OOL understood. For example, the National Academy of Sciences writes:

"[T]he question is no longer whether life could have originated by chemical processes… The question has become which of many pathways might have been followed to produce the first cell."[6]

A more accurate statement would be to admit that there is currently no known chemical pathway for many steps in the OOL including how an "RNA world" could transform into a "DNA/protein world." Somewhere along the line, RNA is then said to have turned into DNA, which is main genetic molecule in all life today. How did this happen? The answer is that nobody has a clue. Problems with such a scenario are put well by biologists John Maynard Smith and Eors Szathmary:

> *"The origin of the [DNA] code is perhaps the most perplexing problem in evolutionary biology. The existing translational machinery is at the same time so complex, so universal) and so essential that it is hard to see how it could have come into existences or how life could have existed without it. The discovery of ribozymes has made it easier to imagine an answer to the second of these questions, but the transformation of an 'RNA world' into one in which catalysis is performed by proteins, and nucleic acids specialize in the transmission of information [a DNA world], remains a formidable problem."*[44]

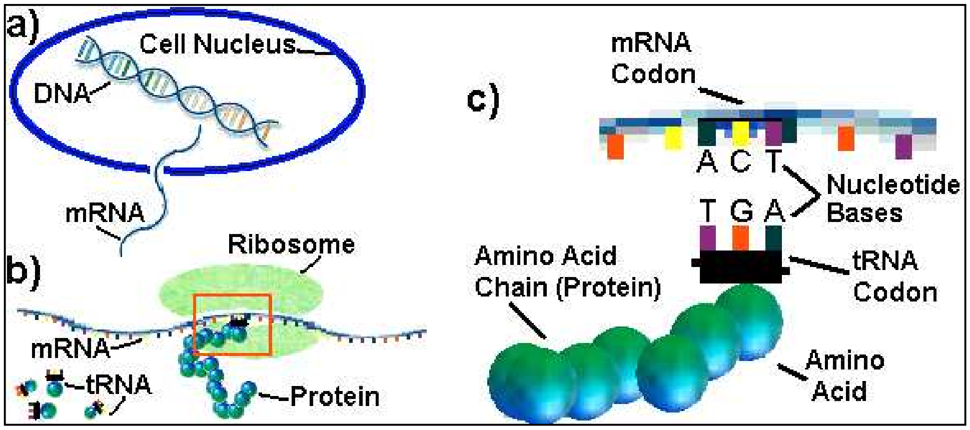
Furthermore, this transition presents an example of the infamous "chicken and egg problem":[43]

Which came first? DNA needs enzymes to replicate, but the enzymes are encoded by DNA. DNA needs protection of the cell wall, but the cell wall is also encoded by the DNA. The answer is that neither came first for all are required in DNA-based life. These fundamental components form an irreducibly complex system in which all components must have been present from the start. Biologist Frank Salisbury described the problem as one which essentially requires the extreme difficulty of overcoming the hurdle of building an irreducibly complexity:

> *It's nice to talk about replicating DNA molecules arising in a soupy sea, but in modern cells this replication requires the presence of suitable enzymes. Furthermore, DNA by itself accomplishes nothing. Its only reason for existence*

is the information that it carries and that is used in the production of a protein enzyme. At the moment, the link between DNA and the enzyme is a highly complex one, involving RNA and an enzyme for its synthesis on a DNA template; ribosomes; enyzmes to activate the amino acids; and transfer-RNA molecules. … How, in the absence of the final enzyme, could selection act upon DNA and all the mechanisms for replicating it? It's as though everything must happen at once: the entire system must come into being as one unit, or it is worthless. There may well be ways out of this dilemma, but I don't see them at the moment.[51]

The origin of this system presents a challenge to the step-by-step evolution required by Darwin's theory, or any other theory of the origin of life:



The Irreducible Complexity of the Transcription-Translation Process: The transcription - translation process is the means by which the information in the DNA code creates protein--the molecules which do things in the cell. In part a, DNA in the cell nucleus is "transcribed" into mRNA, which is then transported out of the nucleus to the ribosome. In part b, free-floating pieces of DNA, called tRNA, bind to the mRNA at the ribosome. All tRNA have amino acids attached to them. When the tRNA binds to the mRNA, the amino acids are linked into a protein. Part c is an expansion of the area in the red box of part b. Each tRNA has a "codon" and each type of codon always carries a particular amino acid. A "codon" is a small piece of DNA with 3 nucleotide bases. In DNA, there are 4 types of nucleotide bases. An "A" (Adenine) only bonds with a "T" (Thymine) and a "C" (Cytozine) matches only with a "G" (Guanine). Thus, the codon on the tRNA can only match specific codons on the mRNA. This forms the basis of the language in the DNA, allowing the amino acids to be strung together in the sequence specified by the DNA.

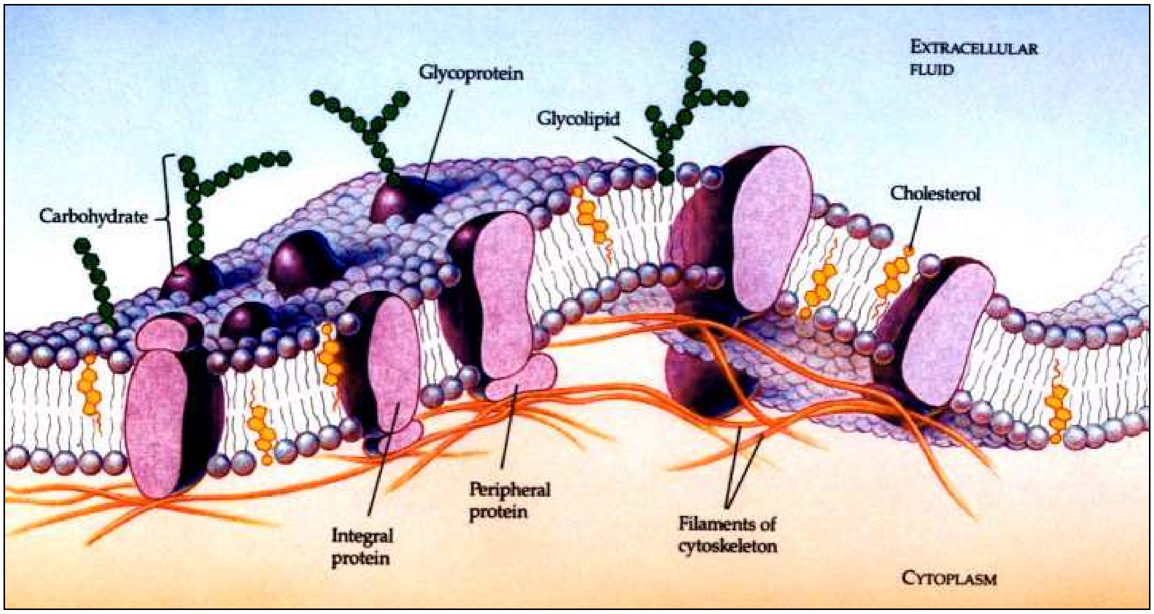
Another level of complexity in this process is how the tRNA get assigned to the right amino acids. For the DNA language to be translated properly, each tRNA codon must be attached to the correct amino acid. If this crucial step in DNA replication is not functional, then the language of DNA breaks down. Special enzymes called aminoacyl - tRNA synthetases (aaRSs) ensure that the proper amino acid is attached to a tRNA with the correct codon through a chemical reaction called "aminoacylation."[52] Accurate translation requires not only that each tRNA be assigned the correct amino acid, but also that it not be aminoacylated by any of the aaRS molecules for the other 19 amino acids. Amazingly, these aaRSs themselves are coded for by the DNA: this forms the essence of an irreducibly-complex chicken-egg problem. The enzymes themselves help perform the very task which constructs them! This is an irreducibly "all or nothing system" whose evolution seems impossible!

Step 6: Making Proto-cells

Leaving the "chicken-egg" problem aside for a moment, how would we get the first cell-walls for these early replicating sets of molecules? According to one major biology textbook:

> *"One of the earliest episodes in the evolution of life may have been the formation of a membrane that could enclose a solution of different composition from the surrounding solution, while still permitting the selective uptake of nutrients and elimination of waste products. This ability of the cell to discriminate in its chemical exchanges with the environment is fundamental to life, and it is the plasma membrane that makes this selectivity possible."*[46]

A proto-cell would need the protective cell wall to keep out harmful substances in the environment. But such a cell wall must also be able to let in useful and beneficial substances. Some OOL researchers have created very small "soap-bubble" like structures which they call "protenoid microspheres." These "protenoid microspheres" however would not make adequate cell walls for early self-replicating molecules: there is no known mechanism by which the molecules would find their way into the "protenoid microspheres" and once inside, there would be no mechanism for metabolic growth. More importantly, these "protenoid microspheres" would not be "alive" or biologically connected to the molecules—and they would lack the ability to "discriminate" between nutrients and waste products:



Cells today have complex and specified "glycoproteins" which can recognize and "discriminate" between harmful and beneficial substances. This is part of what gives a modern cell wall the special ability to act as a living filter for the interior of the cell. But a protenoid microsphere would just be like a little "soap-bubble" like entity without any "fundamental" properties needed to discriminate between inviting beneficial molecules into the cell, and excluding harmful substances from the cell. Picture from Reference 53.

What about intelligent design?

In 1988, Klaus Dose said the following about the state of OOL research:

> *"More than 30 years of experimentation on the origin of life in the fields of chemical and molecular evolution have led to a better perception of the immensity of the problem of the origin of life on Earth rather than to its solution. At present all discussions on principal theories and experiments in the field either end in stalemate or in a confession of ignorance. New lines of thinking and experimentation must be tried."*[47]

If naturalistic theories are not bearing fruit for science, perhaps we feel justified looking outside the reigning paradigm for an answer to the origin of life.

Intelligent design theory begins with the observation that intelligent agents tend to produce large amounts of information when they create objects. If life is designed, one might expect that life will contain large amounts of information. This is exactly what is found in the cell. Consider this statement by famous Oxford evolutionary biologist, Richard Dawkins:

> *"Physics books may be complicated, but…the objects and phenomena that a physics book describes are simpler than a single cell in the body of its author. And the author consists of trillions of those cells, many of them different from each other, organized with intricate architecture and precision-engineering into a working machine capable of writing a book.…Each nucleus…contains a digitally coded database larger, in information content, than all 30 volumes of the Encylopaedia Brittanica put together."*[45]

The simplest known single-celled life forms contain over 400 genes,[31] and are much more complex than any hypothetical pre-RNA world. To merely exist, life requires an incredible amount of complexity, which is perhaps why Dawkins also wrote:

> *"Biology is the study of complicated things that give the appearance of having been designed for a purpose."*[45]

After seeing difficulties faced by the origin of life, perhaps this is why over 20 years ago, the noted scientist who discovered the structure of DNA, Francis Crick, said:

> *The origin of life appears to be almost a miracle, so many are the conditions which would have had to be satisfied to get it going."*[38]

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The work of Jonathan Wells and Stephen C. Meyer helped contribute to some of the research behind this paper.

Appendix 1: The Complexity of Life

It is a common misconception that some forms of life are “primitive” and thus might be easily produced through natural chemical processes. These quotes will help show that while some forms of life are indeed “less complex” than many “higher forms” of life, such as vertebrate animals, even these “less complex forms” have a complexity which is staggering. Consider these quotes in response to the question, “**Is the Cell a Simple Ball of Protoplasm?**”

"High school textbooks used to make a big point about the materials that make up the human body being worth about 97 cents. Yale molecular biologist, Harold J. Morowitz got out a biochemical company's catalog and added up the cost of the synthesized materials, such as hemoglobin and came up with a six million-dollar man ($6,000,015.44) to be exact). Professor Morowitz's calculations drive home a more important point, however--that 'information is more expensive than matter.' What the biochemical companies offer is simply the highest 'informational' (most organized) state of materials commercially available. And even these are mostly taken from living animals; if synthesis of all the compounds offered had been done from basic elements, their cost might be as high as $6 billion. The logical extreme of the exercise, obviously, is that science is nowhere near getting close to synthesizing a human. Just to take the next step of organization--the organelle level--would cost perhaps $6 trillion."

(Morowitz, Harold J., "The Six Million-Dollar Man," Science News (July 31, 1976))

"the most elementary type of cell constitutes a 'mechanism' unimaginably more complex than any machine yet thought up, let alone constructed, by man."

(W. H. Thorpe [evolutionist scientist] as quoted in W. R. Bird, The Origin of Species Revisited)

"Is it really credible that random processes could have constructed a reality, the smallest element of which - a functional protein or gene - is complex beyond ... anything produced by the intelligence of man?"

(Molecular biologist Michael Denton, Evolution: A Theory in Crisis)

"Biology is the study of complicated things that give the appearance of having been designed for a purpose."

(Dawkins, Richard [Zoologist, Oxford University], "The Blind Watchmaker,")

"Biologists must constantly keep in mind that what they see was not designed, but rather evolved."

(Crick F.H.C., [Co-discoverer of DNA helix, Nobel laureate 1962, Professor at Salk Institute, La Jolla])

"The simplest bacteria is so damn complicated from the point of view of a chemist that it is almost impossible to imagine how it [the natural chemical origins of life] happened"

(Harold P. Klein, Santa Clara University, affiliate of National Academy of Sciences)

"The post-reductionist era has been with us for some time, and cell biologists are now accomplished reconstructionists, building pictures of cellular structures from proteins identified through biochemistry and genetics. Understanding the beauty of cellular structures requires a knowledge of their inner architecture and engineering. The complexity of Millennium domes, Eiffel towers and 'Ferris wheels' are likely just pale reflections of life at the heart of the cell."

("The nano-scale architecture of the nucleus" Paul Ko Ferrigno, Trends in Cell Biology 2000, 10:366)

"It is possible to make a more fundamental distinction between living and nonliving things by examining their molecular structure and molecular behavior. In brief, living organisms are distinguished by their specified complexity. Crystals are usually taken as the prototypes of simple, well-specified structures, because they consist of a very large number of identical molecules packed together in a uniform way. Lumps of granite or random mixtures of polymers are examples of structures which are complex but not specified. The crystals fail to qualify as living because they lack complexity; the mixtures of polymers fail to qualify because they lack specificity."

(Orgel, Leslie E. [Biochemist, Salk Institute for Biological Studies, UCSD])

"We have repeatedly emphasized the fundamental problems posed for the biologist by the fact of life's complex organization. We have seen that organization requires work for its maintenance and that the universal quest for food is in part to provide the energy needed for this work. But the simple expenditure of energy is not sufficient to develop and maintain order. A bull in a china shop performs work, but he neither creates nor maintains organization. The work needed is particular work; it must follow specifications; it requires information on how to proceed."

(Simpson, George Gaylord & Beck, William S. [Harvard University)

"But let us have no illusions. If today we look into situations where the analogy of the life sciences is the most striking--even if we discovered within biological systems some operations distant from the state of equilibria--our research would still leave us quite unable to grasp the extreme complexity of the simplest of organisms."

(Ilya Prigogine, Professor Physics Department, Universite Libre de Bruxelles)