Science and Religion

Workshop 3: Life

(Note: articles have been reduced for the sake of brevity)

What is life?

https://www.britannica.com/science/life

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Life, living matter and, as such, matter that shows certain attributes that include responsiveness, growth, metabolism, energy transformation, and reproduction. Although a noun, as with other defined entities, the word life might be better cast as a verb to reflect its essential status as a process. Life comprises individuals, living beings, assignable to groups. Each individual is composed of one or more minimal living units, called cells, and is capable of transformation of carbon-based and other compounds (metabolism), growth, and participation in reproductive acts. Life-forms present on Earth today have evolved from ancient common ancestors through the generation of hereditary variation and natural selection. Although some studies state that life may have begun as early as 4.1 billion years ago, it can be traced to fossils dated to 3.5–3.7 billion years ago, which is still only slightly younger than Earth, which gravitationally accreted into a planet about 4.5 billion years ago. But this is life as a whole. More than 99.9 percent of species that have ever lived are extinct.

The phenomenon of life can be approached in several ways: life as it is known and studied on planet Earth; life imaginable in principle; and life, by hypothesis, that might exist elsewhere in the universe. As far as is known, life exists only on Earth. Most life-forms reside in a thin sphere that extends about 23 km (14 miles) from 3 km (2 miles) beneath the bottom of the ocean to the top of the troposphere (lower atmosphere); the relative thickness is comparable to a coat of paint on a rubber ball. An estimated 10–30 million distinguishable species currently inhabit this sphere of life, or biosphere.

Q1. In your group, agree a working definition of 'life'.

Scientific Explanations for Life

https://www.livescience.com/13363-7-theories-origin-life.html

Introduction

Life on Earth began more than 3 billion years ago, evolving from the most basic of microbes into a dazzling array of complexity over time. But how did the first organisms on the only known home to life in the universe develop from the primordial soup?

It started with an electric spark

Lightning may have provided the spark needed for life to begin.

Electric sparks can generate amino acids and sugars from an atmosphere loaded with water, methane, ammonia and hydrogen, as was shown in the famous Miller-Urey experiment reported in 1953, suggesting that lightning might have helped create the key building blocks of life on Earth in its early days. Over millions of years, larger and more complex molecules could form. Although research since then has revealed the early atmosphere of Earth was actually hydrogen-poor, scientists have suggested that volcanic clouds in the early atmosphere might have held methane, ammonia and hydrogen and been filled with lightning as well.

Molecules of life met on clay

The first molecules of life might have met on clay, according to an idea elaborated by organic chemist Alexander Graham Cairns-Smith at the University of Glasgow in Scotland. These surfaces might not only have concentrated these organic compounds together, but also helped organize them into patterns much like our genes do now.

The main role of DNA is to store information on how other molecules should be arranged. Genetic sequences in DNA are essentially instructions on how amino acids should be arranged in proteins. Cairns-Smith suggests that mineral crystals in clay could have arranged organic molecules into organized patterns. After a while, organic molecules took over this job and organized themselves.

Life began at deep-sea vents

The deep-sea vent theory suggests that life may have begun at submarine hydrothermal vents spewing key hydrogen-rich molecules. Their rocky nooks could then have concentrated these molecules together and provided mineral catalysts for critical reactions. Even now, these vents, rich in chemical and thermal energy, sustain vibrant ecosystems.

Life had a chilly start

Ice might have covered the oceans 3 billion years ago, as the sun was about a third less luminous than it is now, scientists say. This layer of ice, possibly hundreds of feet thick, might have protected fragile organic compounds in the water below from ultraviolet light and destruction from cosmic impacts. The cold might have also helped these molecules to survive longer, allowing key reactions to happen.

The answer lies in understanding DNA formation

Nowadays DNA needs proteins in order to form, and proteins require DNA to form, so how could these have formed without each other? The answer may be RNA, which can store information like DNA, serve as an enzyme like proteins, and help create both DNA and proteins. Later DNA and proteins succeeded this "RNA world," because they are more efficient.

RNA still exists and performs several functions in organisms, including acting as an on-off switch for some genes. The question still remains how RNA got here in the first place. And while some scientists think the molecule could have spontaneously arisen on Earth, others say that was very unlikely to have happened.

Life had simple beginnings

Instead of developing from complex molecules such as RNA, life might have begun with smaller molecules interacting with each other in cycles of reactions. These might have been contained in simple capsules akin to cell membranes, and over time more complex molecules that performed these reactions better than the smaller ones could have evolved, scenarios dubbed "metabolism-first" models, as opposed to the "gene-first" model of the "RNA world" hypothesis.

Life was brought here from elsewhere in space

Perhaps life did not begin on Earth at all, but was brought here from elsewhere in space, a notion known as panspermia. For instance, rocks regularly get blasted off Mars by cosmic impacts, and a number of Martian meteorites have been found on Earth that some researchers have controversially suggested brought microbes over here, potentially making us all Martians originally. Other scientists have even suggested that life might have hitchhiked on comets from other star systems. However, even if this concept were true, the question of how life began on Earth would then only change to how life began elsewhere in space.

Q2. How do these possible scenarios fit with your understanding of Genesis?

Creationist Arguments

https://creation.com/origin-of-life

An explanation of what is needed for abiogenesis (or biopoiesis) by Don Batten

Published: 26 November 2013 (GMT+10) Last amended 3 July 2019.

Introduction

Life is based on long information-rich molecules such as DNA and RNA that contain instructions for making proteins, upon which life depends. But the reading of the DNA/RNA to make proteins, and the replication of DNA or RNA to make new cells both depend on a large suite of proteins that are coded on the DNA/RNA. Both the DNA/RNA and the proteins need to be present at the same time for life to begin—a serious chicken-and-egg conundrum.

So, what do we need to get life? We can break the problem of the origin of life into a number of topics in an attempt to explain to non-scientists what is involved (although it still might be mind-stretching).

What is it that we have to obtain to produce a living cell? A living cell is capable of acquiring all the resources it needs from its surroundings and reproducing itself. The first cell had to be free-living; that is, it could not depend on other cells for its survival because other cells did not exist. Parasites cannot be a model for ‘first life’ because they need existing cells to survive. This also rules out viruses and the like as the precursors to life as they must have living cells that they can parasitize to reproduce themselves.

Getting all the right ingredients

Right here there is a major problem for chemical soup approaches to the origin of life: all the components have to be present in the same location for a living cell to have any possibility of being assembled. But necessary components of life have carbonyl chemical groups that react destructively with amino acids and other amino compounds. Such carbonyl-containing molecules include sugars, which also form the backbone of DNA and RNA. Living cells have ways of keeping them apart and protecting them to prevent such cross-reactions, or can repair the damage when it occurs, but a chemical soup has no such facility.

Cells are incredibly complex arrangements of simpler chemicals. I am not going to cover every chemical that a first cell would need; it would take a book and some to cover it. I am just going to highlight some of the basic components that have to be present for any origin of life scenario.

a. Amino acids

Living things are loaded with proteins; linear strings of amino acids. Enzymes are special proteins that help chemical reactions to happen.

Some reactions necessary for life go so slowly without enzymes that they would effectively never produce enough product to be useful, even given billions of years.

Other proteins form muscles, bone, skin, hair and all manner of the structural parts of cells and bodies. Humans can produce well over 100,000, whereas a typical bacterium can produce one or two thousand different ones.

Proteins are made up of 20 different amino acids. Amino acids are not simple chemicals and they are not easy to make in the right way without enzymes.

The 1953 Miller–Urey experiment, which almost every biology textbook still presents, managed to make some amino acids without enzymes. It is often portrayed as explaining ‘the origin of life’, but that is either very ignorant or very deceitful.

Although tiny amounts of some of the right amino acids were made, the conditions set up for the experiment could never have occurred on Earth. Furthermore, some of the wrong types of amino acids were produced, as well as other chemicals that would ‘cross-react’, preventing anything useful forming.

The amino acids required for functional proteins could never have been made by anything like this experiment in nature. When Stanley Miller repeated the experiment in 1983 with a slightly more realistic mixture of gases, he only got trace amounts of glycine, the simplest of the 20 amino acids needed.

The origin of the correct mix of amino acids remains an unsolved problem.

b. Sugars

Some sugars can be made just from chemistry without enzymes. Sugars are supposed to have formed from naturally occurring formaldehyde in the presence of alkali by the formose reaction. However, the very same alkaline conditions that are needed for this reaction also destroy sugars such as ribose and glucose that are essential for life.

c. The components of DNA and RNA

How can we get the nucleotides that are the chemical ‘letters’ of DNA and RNA without the help of enzymes from a living cell? The chemical reactions require formaldehyde to react with hydrogen cyanide. However, formaldehyde and cyanide are deadly poisons. They would destroy critically important proteins that might have formed!

d. Lipids

Lipids (‘fats’) are essential for the formation of a cell membrane that contains the cell contents, as well as for other cell functions. The cell membrane, comprised of several different complex lipids, is an essential part of a free-living cell that can reproduce itself.

Lipids have much higher energy density than sugars or amino acids, so their formation in any chemical soup is a problem for origin of life scenarios (high energy compounds are thermodynamically much less likely to form than lower energy compounds).

The fatty acids that are the primary component of all cell membranes have been very difficult to produce. Even if such molecules were produced, ions such as magnesium and calcium, which are themselves necessary for life would combine with the fatty acids, and precipitate them, making them unavailable.

e. Handedness (chirality)

Amino acids, sugars, and many other biochemicals, being 3-dimensional, can usually be in two forms that are mirror images of one another; like your right and left hand are mirror images of each other. This is called handedness or chirality.

Now living things are based on biochemicals that are pure in terms of their chirality: left-handed amino acids and right-handed sugars, for example. Here’s the rub: chemistry without enzymes (like the Miller–Urey experiment), when it does anything, produces mixtures of amino acids that are both right-and left-handed. It is likewise with the chemical synthesis of sugars.

Origin-of-life researchers have battled with this problem and all sorts of potential solutions have been suggested but the problem remains unsolved. Even getting 99% purity, which would require some totally artificial, unlikely mechanism for ‘nature’ to create, doesn’t cut it. Life needs 100% pure left-handed amino acids.

What are the minimum requirements for a cell to live?

A minimal free-living cell that can manufacture its components using chemicals and energy obtained from its surrounding environment and reproduce itself must have:

A cell membrane. This separates the cell from the environment. It must be capable of maintaining a different chemical environment inside the cell compared to outside. Without this, life’s chemical processes are not possible.

A way of storing the information or specifications that instructs a cell how to make another cell and how to operate moment by moment. The only known means of doing this is DNA and any proposals for it to be something else (such as RNA) have not been shown to be viable—and then there has still to be a way of changing from the other system to DNA, which is the basis of all known life.

A way of reading the information to make the cell's components and also control the amount produced and the timing of production. The major components are proteins, which are strings (polymers) of hundreds to thousands of some 20 different amino acids. The only known (or even conceivable) way of making the cell's proteins from the DNA specifications involves over 100 proteins and other complex co-factors.

There are also mechanisms to make sure that the proteins made are folded three-dimensionally in the correct way that involve chaperones to protect the proteins from mis-folding, plus chaperonin folding 'machines' in which the proteins are helped to fold correctly). All cells have these.

Whew! And that's just the basics.

Sir Karl Popper, one of the most prominent philosophers of science of the 20th century, realised that,

"What makes the origin of life and of the genetic code a disturbing riddle is this: the genetic code is without any biological function unless it is translated; that is, unless it leads to the synthesis of the proteins whose structure is laid down by the code. But … the machinery by which the cell (at least the non-primitive cell, which is the only one we know) translates the code consists of at least fifty macromolecular components which are themselves coded in the DNA. Thus the code cannot be translated except by using certain products of its translation. This constitutes a baffling circle; a really vicious circle, it seems, for any attempt to form a model or theory of the genesis of the genetic code.

"Thus we may be faced with the possibility that the origin of life becomes an impenetrable barrier to science, and a residue to all attempts to reduce biology to chemistry and physics."

Origin of life scenarios

Did life originate in a warm pond, near a deep sea vent, on clay particles, or somehow/somewhere else? The number of scenarios proposed, with no winner, suggests that they all have major deficiencies.

A major problem with warm pond and deep sea vent ideas is the presence of water, which prevents many of the reactions needed; to get polymers, for example. Furthermore, the heat in deep sea vents would speed up the breakdown of any lucky chemical formation.

Because of these problems with the presence of water, physical chemist and origin-of-life researcher, Graham Cairns-Smith proposed that clay surfaces were involved in facilitating some of the needed reactions.

However, experiments in warm volcanic ponds have shown that clay particles bind amino acids, DNA and phosphate, essential components of life, so strongly that the clay prevents any necessary reactions from occurring.

The origin of a whole cell including the DNA, proteins and RNA needed for it to reproduce will never happen by an accident in a chemical soup, as demonstrated above. So advocates of abiogenesis have tried to imagine scenarios whereby life began with simpler requirements and then progressed to life as we know it today.

Proteins first?

Most effort has gone into a ‘proteins first’ approach, whereby proteins supposedly formed first and the DNA sequences to make the needed proteins and the RNAs necessary to make proteins from the sequences of DNA came later. However, other than the problem of getting the correct set of optically pure amino acids and the problem of polymerisation to make the protein chains of amino acids, few proteins can act as templates to make copies of themselves. Also, a fundamental problem is that there is no mechanism for creating the DNA sequence for a protein from the protein itself.

RNA first?

In the 1980s, some RNA molecules were discovered that have the ability to catalyse some chemical reactions; these were dubbed ‘ribozymes’. This finding stimulated a lot of excitement and so a lot of effort has gone into RNA-first scenarios, or the ‘RNA world’. At least there are enzymes that can generate DNA code from RNA code; that is, if you could get the RNA you might be able to imagine a scenario for getting the DNA. However, the enzyme complexes that can make a DNA copy of an RNA sequence are phenomenally complex and themselves would never arise by natural processes.

The multiplicity of scenarios proposed reinforces the conclusion that researchers really have little idea how life could have ‘made itself’. There is no viable hypothesis as to how life could start off simpler and, step-wise, progress to become an actual living cell.

Life from outer space?

Francis Crick, co-discoverer of the DNA double helix structure, is a well-known proponent of ‘life from space’. He proposed that aliens sent life to earth, known as ‘directed panspermia’. Another form of this idea, simply ‘panspermia’, is that life arose somewhere else in the universe and came to earth as microbes on meteorites or comets; Earth was ‘seeded’ with life in this manner. Either version of panspermia effectively puts the matter beyond the reach of science. About the only element of panspermia that is testable is the ability of microbes to survive riding on/in a meteorite to earth. And this has been tested and found wanting; microbes don’t survive.

Probability calculations for the origin of life

Many attempts have been made to calculate the probability of the formation of life from chemicals, but all of them involve making simplifying assumptions that make the origin of life even possible (i.e. probability > 0).

Mathematician Sir Fred Hoyle stated in various ways the extreme improbability of life forming, “Now imagine 1050 blind persons each with a scrambled Rubik cube and try to conceive of the chance of them all simultaneously arriving at the solved form. You then have the chance of arriving by random shuffling of just one of the many biopolymers on which life depends. The notion that not only the biopolymers but the operating program of a living cell could be arrived at by chance in a primordial soup here on earth is evidently nonsense of a high order. Life must plainly be a cosmic phenomenon.”

“The likelihood of the formation of life from inanimate matter is one to a number with 40,000 noughts after it … It is big enough to bury Darwin and the whole theory of evolution. There was no primeval soup, neither on this planet nor any other, and if the beginnings of life were not random, they must therefore have been the product of purposeful intelligence.”

Conclusion

Life did not arise by physics and chemistry without intelligence. The intelligence needed to create life, even the simplest life, is far greater than that of humans; we are still scratching around trying to understand fully how the simplest life forms work. There is much yet to be learned of even the simplest bacterium. Indeed, as we learn more the ‘problem’ of the origin of life gets more difficult; a solution does not get nearer, it gets further away. But the real problem is this: the origin of life screams at us that there is a super-intelligent Creator of life and that is just not acceptable to the secular mind of today.

The origin of life is about as good as it gets in terms of scientific ‘proof’ for the existence of God.

Q3 Which points raised by the creationist author seem to be unanswered by the first section of this paper? Do any of these points make you think that we can reasonably reject any of the theories?

Q4 Based on all of the above, and your own knowledge and beliefs, what is the most likely explanation for the beginning of life?

Q5 Consider the following quotes from the first article (Which is from the Britannica website)

- “More than 99.9 percent of species that have ever lived are extinct.”
- “Most life-forms reside in a thin sphere that extends about 23 km (14 miles) from 3 km (2 miles) beneath the bottom of the ocean to the top of the troposphere (lower atmosphere)”

If life was created, why would the creator limit it to such an infinitesimally small area of an almost infinite universe and why let most of it become extinct?