The origin of life: the evolution of viruses, the simplest bacteria and the last universal DNA molecule.

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Abstract: Since viruses are the first form of life on Earth, it can be shown that it was viruses that formed and spread biological life on the planet. The evolutionary transition from giant viruses to the first protozoan bacteria is logical and can be considered proven. The genome of the organism is encoded in DNA and viruses are the first form of life, therefore, in the past, there should have been the last universal DNA molecule, which contained the genes of all possible living beings in our biosphere.

Keywords: the origin of life, the world of RNA, the evolution of viruses, giant viruses, the simplest bacteria, the last universal DNA molecule.

INTRODUCTION.

The origin of life on Earth has been a major problem in biology since the time of Aristotle. A similar, but more modern problem is viruses and their appearance on the evolutionary tree of life. It can be shown that it was viruses that were the first life form on the planet, and it was viruses that actually shaped and spread biological life on Earth. For this, we will start from the very beginning, that is, with the hypothesis of the "world of nucleic acids", and then show how life gradually developed up to the first simple bacteria. Moreover, since the genes of all organisms of the biosphere have universal information, it can be concluded that life on planet Earth began to develop from one universal DNA molecule. This is a complete analogy with the last universal ancestor. That is, there was a single universal DNA molecule containing all genes, all living beings that can exist in our biosphere, and it was she who initiated the origin of life and its further evolution. But for this we will return to the "RNA world".

RESULTS AND DISCUSSION.

So first we have the "RNA world" [1, 2].

«The “RNA world” is a hypothetical stage in the evolutionary history of life on Earth, in which self-replicating RNA molecules proliferated before the evolution of DNA and proteins...

Alexander Rich first proposed the concept of the RNA world in 1962, and Walter Gilbert coined the term in 1986...

…the evidence for an RNA world is strong enough that the hypothesis has gained wide acceptance. The concurrent formation of all four RNA building blocks further strengthened the hypothesis» [3].

Consider the moment when the “assembly” of one RNA molecule or one DNA molecule happened by chance (the probabilities of their “assembly” are equal). Or suppose that the RNA (or DNA) molecule was introduced from outside, from space. But, RNA can copy itself, but DNA does not. To copy DNA need a protein (enzyme called DNA polymerase). All proteins are synthesized on messenger RNA (or matrix RNA), in the ribosome of the cell. But, in the “world of RNA” there are no ribosomes. Therefore, we will assume that messenger RNA will be fixed on some kind of solid catalyst in the primary ocean. For example, on a mineral or volcanic rock. Considering that both DNA and RNA strands are composed of phosphoric acid and ribose (or deoxyribose) residues, we can state that the attachment of these molecules to minerals containing silicon dioxide (SiO2) and various metal oxides will be very good. Since there is a certain similarity between the phosphoric acid molecule and the silicon dioxide molecule, this will inevitably lead to good binding of the DNA/RNA molecule with natural minerals. And the more islands in the ocean, craters of underwater volcanoes, various seamounts, the faster the primary RNA molecule will fix on the mineral. Moreover, it does not matter whether it was brought from space or "collected" in the ocean. After the fixation of messenger RNA, the building blocks will come from the surrounding space (ocean), and the "assembly" of the protein on the fixed RNA will begin. It can be argued that after the start of the process of copying the corresponding molecules (RNA, DNA, proteins), the evolution of the "RNA world" will begin.

Therefore, if at the beginning of the "world of RNA" we have at least one RNA molecule, then there will be another such molecule, and the third, and the thousandth... Moreover, when the evolution of the original RNA leads us to the messenger RNA, we will get an "assembly" proteins. And if there are proteins, then they can participate in copying DNA molecules that are spontaneously synthesized. These processes mark the beginning of the evolution of our biosphere. That is, the evolution of the "RNA world" will inevitably lead us to a mixture of three types of molecules: DNA, RNA and proteins. And this is exactly what is needed for the birth of the first life on Earth, that is, viruses. After all, what are viruses? It is a DNA or RNA molecule wrapped in a protein coat (capsid). There are also simple viruses and without a protein coat (viroids). Therefore, it is quite obvious that at the end of the "RNA world" the evolution of viruses will begin. So, let's look at their evolution.

After the beginning of the evolution of viruses, after a while, we will get a primary ocean filled with an incredible number of viruses. Moreover, the variety of viruses will also be gigantic. Note that the number of viruses in modern oceans is very large, and science is just beginning to study them. Moreover, viruses are still the most numerous and diverse form of life on the planet.

A wide variety of viruses is exactly the condition that is needed for the emergence of the first simplest bacteria. This process needs detailed research, since it is of the greatest interest, since bacteria and viruses are fundamentally different: a virus is a large molecule, but still a molecule, and a bacterium is a biochemical factory. The difference is enormous!!! Since even in the simplest bacteria, biochemical reactions will be coordinated, and their number is enormous. How, then, could a bacterium arise from viruses at all? To answer this question, let's remember the giant viruses.

"Giant viruses are a group of very large viruses that can be seen under a light microscope; in size are not inferior to bacteria, because of this, they were first classified as gram-positive bacteria. Their genomes are extremely large and often contain genes encoding components of protein synthesis, which is never seen in other viruses; in addition, some genes identified in representatives of this group of viruses are unknown for any other organisms. Most giant viruses have a protein capsid that is common to other viruses...

Some giant viruses are parasitized by virophages...

The history of the study of giant viruses began in 1992 in England. Studying the causes of the outbreak of pneumonia, scientists examined water samples taken from the air-cooling system...

Researchers were able to find an unknown pathogen that was visible through a light microscope and stained positively according to Gram, and therefore was attributed to bacteria. However, the newly discovered bacterium could not be grown in a pure culture without amoeba. For more than ten years, attempts to classify the new bacterium have failed...

In 2003, an unknown microorganism was studied using electron microscopy by the French research group Didier Raoult. It turned out that this is not a bacterium, but a very large virus with an icosahedral capsid...

Subsequently, scientists began to grow viruses not only in cultures of amoebas, but also in cultures of other protists. At the moment, about a hundred types of mimiviruses are known. Giant viruses have even been found in a sample of the Siberian permafrost...

In 2008, the first virophage (Sputnik) was discovered - a virus that can multiply in cells only in the presence of a host virus (usually a giant virus) and interferes with its successful reproduction. More than ten species of virrophages are currently known" [4]. See foto do Tupanvirus [5].

The development of science is not devoid of irony: after the discovery of viruses at the end of the 19th century, everyone knew that viruses cannot be seen with a light microscope, since they are much smaller than bacteria (about 100 times). This is an empirical fact. But, 100 years have passed, and first 1992 came, and then 2003: and it turned out that some viruses are so large that we can easily examine them with an ordinary microscope. Moreover, these giant viruses behave in a sense like bacteria. For example, some of the giant viruses are infected with viriophages, that is, parasitic viruses. And how does this differ from bacteria that are affected by bacteriophages? Nothing! But, and this is not all, giant viruses have a number of features that bring them closer to bacteria/cells. For example, their genomes are always double-stranded DNA and contain a significant proportion of orphan genes (from 31 % to 84 %). Double-stranded DNA is understandable since the next stop is bacteria! Likewise, orphan genes (these are genes that are no longer found in any organisms): they are nowhere to be found, since in the process of evolution they were "rejected", but in the "source-material", that is, viruses, they must be required.

The most important difference between giant viruses and other viruses is that molecules involved in translation (aminoacyl-tRNA synthetases, translation factors and tRNA) are encoded in their genomes. And translation is protein synthesis on messenger RNA, from amino acids, in the ribosomes of the cell [6]. That is, in giant viruses, nature has completed the process of preparing the transition from viruses to bacteria, since in the presence of ribosomes, translation will begin automatically. But where does the ribosome come from in the virus?

From where the mitochondria originated in bacteria. That is, a giant virus engulfs a smaller virus (which is evolutionarily suitable for the role of a ribosome), and then the absorbed virus begins to play the role of a ribosome. Please note that most common viruses range in size from 20 to 300 nm. Giant viruses are already the size of bacteria, that is, the size of about 1 micron. Ribosomes have a sphere diameter from 15 nanometers (prokaryotes) to 30 nanometers (eukaryotes), and these are the sizes of small viruses [7]. Moreover, from a chemical point of view, the ribosome is a nucleoprotein, which consists of specific (ribosomal) RNA, specific (ribosomal) proteins, and a small amount of low molecular weight components. This means that the evolution of viruses must inevitably lead to a virus that can be used as a ribosome. Since chemically the ribosome consists of RNA and proteins, and these are the components of the RNA virus. Here is a quote that fully confirms what was said [7]:

“Structurally and functionally, the ribosome is, first of all, its RNA. [1] Ribosomal RNA (rRNA) in the ribosome is very compact, has a complex tertiary structure and is densely encrusted with molecules of various ribosomal proteins. High molecular weight ribosomal RNAs purified from proteins under specially selected conditions (20 mM Mg2 +, ionic strength 0.3-0.5, sometimes the conditions also include the presence of di- and polyamines, ethanol) spontaneously fold into compact particles, morphologically (shape, internal structure and size) are very similar with ribosomal subunits, the basis of which they constitute. [2] Thus, the general plan of the structural organization of the ribosome is determined by the properties of rRNA. The tertiary structure of rRNA acts as a framework for the placement of ribosomal proteins, while proteins, in a certain sense, play only a minor role in the formation and maintenance of the ribosome structure and its functioning".

Therefore, the evolutionary transition from giant viruses to protozoan bacteria can be considered proven, since a protozoan bacterium can be represented as genomic DNA and ribosome. Namely, this structure will be obtained if a giant virus engulfs the "virus-ribosome". Despite all the diversity of bacteria, they, like all living organisms, have ribosomes that provide protein synthesis, and genomic DNA! Naturally, bacteria also contain various other structural elements (simple and complex), but the basis of life in a biological sense is simple: it is the genome (DNA) and the ribosome, which begins to synthesize proteins! Everything else is just details, simple or complex.

CONCLUSION.

Last universal DNA molecule.

Walter Gehring [8] in 1994 isolated a gene that is responsible for the formation of the eyes of fruit flies. Naturally, if this gene is not present in the body, then the fly is born without eyes. Gehring also had a gene that was responsible for the formation of eyes in mice (this is another, isolated gene). And he wondered: what will happen if we are in a fruit fly (embryo), replace the "eye gene" with the mouse gene, which is responsible for the formation of mouse eyes. What kind of eyes are formed in a fruit fly? And are they formed at all? An ordinary eye was formed in the fruit flies. That is, the typical compound eye of a fruit fly.

That is, the “mouse gene” that is responsible for the formation of the mouse eyes has formed the faceted eye of the fly in the fruit fly. This means that all living things use the same set of genes. In a particular organism, this gene works in such a way that a "detail" is obtained for this particular organism. But, what is important, all genes initially have all the necessary information for any organism. This is similar to the mechanism for updating drivers in an operating system. The operating system installs the most suitable driver. It is the same here: the gene "works" in a given organism in such a way that the most suitable "detail" for this organism is formed. That is, if we introduced the "fruit fly eye gene" into a dinosaur embryo, then the dinosaur should form normal eyes (for a dinosaur). Amazing! Nature is really economical. The described mechanism has very serious consequences...

It turns out that all genes have universal information, a universal code. When this information is read by a DNA molecule (of a specific organism), then the most suitable version of the gene for the given organism is established (that is, the gene “works” for the functionality of the given organism, like a normal gene). Hence, the DNA molecule is the operating system. And genes are device drivers. Devices are organs and other "parts" of the body. But, one logical conclusion follows from this: the entire Biosphere of the planet Earth began to evolve from a last universal DNA molecule. This is a complete analogy to the last universal ancestor [9]. That is, there was a only universal DNA molecule that contained all genes, all living things that can exist in our biosphere. At least theoretically, we can easily imagine such a universal DNA molecule based on the universal work of genes. Such a DNA molecule could have come to Earth from cosmic dust (interstellar or intergalactic), since cosmological DNA synthesis is most likely [10]. After falling into favorable conditions, the universal DNA/RNA molecule began to evolve: first, the era of viruses, then the era of bacterial evolution, and then the evolution of multicellular organisms...

REFERENCES.

1. Neveu M., Kim H. J., Benner S. A. The "strong" RNA world hypothesis: fifty years old. Astrobiology. 2013, 13 (4): 391 – 403. DOI: 10.1089/ast.2012.0868. https://doi.org/10.1089%2Fast.2012.0868
2. Cech T. R. The RNA worlds in context. Cold Spring Harbor Perspectives in Biology. 2012, 4 (7): a006742. DOI: 10.1101/cshperspect.a006742. https://doi.org/10.1101%2Fcshperspect.a006742
3. RNA world. Wikipedia. https://en.wikipedia.org/wiki/RNA_world
4. Giant virus. Wikipedia. https://en.wikipedia.org/wiki/Giant_virus
5. Jônatas Abrahão. Foto do Tupanvirus. https://diarionline.com.br/i.php?i=static/arquivo/2018-03/virus_gigante-a61e.jpg&w=753
6. Translation (biology). Wikipedia. https://en.wikipedia.org/wiki/Translation_(biology)
7. Ribosome. Wikipedia. https://en.wikipedia.org/wiki/Ribosome
8. Walter Jakob Gehring. Wikipedia. https://en.wikipedia.org/wiki/Walter_Jakob_Gehring
9. Last universal common ancestor. Wikipedia. https://en.wikipedia.org/wiki/Last_universal_common_ancestor
10. Bezverkhniy V. D., Bezverkhniy V. V. The origin of life on Earth, the panspermia hypothesis and cosmological DNA synthesis. SSRN Electronic Journal (2020). DOI: 10.2139/ssrn.3678305. https://dx.doi.org/10.2139/ssrn.3678305