Origin of Life in Earth in Microbes & Viruses: Random Collision & the Association & Rejection with the Acquisition of Added characteristic Hypothesis

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Abstract

Origin of life in our earth is the most mysterious thing in the field of scientific research & nobody exactly knows how the first life appeared in the earth. However, it is sure that the basic constituents of life like Carbon, Hydrogen, Nitrogen, Phosphorous and Oxygen combined in a proportionate way to create first life in earth. Probably the origin of life started from the first production of purine, pyrimidine rings, amino acids & nucleic acid chains & the first life in earth is prokaryotic microbes which probably evolved from the virus like particles but not the exact viruses. Structure of viruses which are lacking the cytoplasm and definite cellular structure but containing nucleic acid core and protein covering are the proof that nucleic acid strands were first produced and later on, in presence of water they evolved to produce the desired products to form cytoplasm and biological membrane to create primitive cell. To explain the systematic assembling of all the basic structural elements leading to a structural unit with functional autonomy with bio-chemical synthesis, degradation (metabolism) , energy production & self-replication which can be called "nano-scale organization", I have proposed a hypothesis which is called **Random Collision & the Association & Rejection with the Acquisition of Added characteristic Hypothesis** which can explain the creation of first functional unit of life as a virus like particle and later on prokaryotic microbes and with the help of Darwin's theory of evolution it can be explained that this first functional unit of life later evolved into more complex multi-cellular living forms.

Background

Though, early philosophers and naturalists believed to spontaneous generation to explain the origin of life, many scientists later on adopted the idea that living organisms were the historical outcome of gradual transformation of lifeless matter. The heterotrophic origin of life was proposed by **Oparin** and **Haldane** in the 1920. They proposed the idea of a primordial protoplasm & hypothesized that life had been preceded by a lengthy period of abiotic syntheses and accumulation of organic compounds from the "**hot primitive soup**". At the initial stage earth's environment was anaerobic and the primitive organisms must have been **heterotrophic bacteria**. Later on **Miller-Urey experiment(1953)** strengthened the hypothesis that "generation of the first living organisms might have taken place if large quantities of organic compounds had been present in the oceans of the primitive earth." (Oparin, 1957) Electric discharge of **thunder storm** and **UV radiation** from our solar system might have 'played a significant role in the formation of compounds like amino acids & other complex components of the living system in the primitive atmosphere containing ammonia, nitrogen, methane, hydrogen, water. (Miller, Science 1953) Later on with the developments of Biochemistry & Molecular Biology & the scientific trends towards the understanding biological phenomena at the molecular level led authors like **Troland** (1914), **Muller(**1961) and others to propose that single molecules or viruses represented primordial living systems. **Muller** proposed the **"naked gene"** theory for the origin of life. **RNA hypothesis** of origin of life was first proposed in 1968 by Leslie Orgel & supported by Crick & later on the term coined by Walter Gilbert in 1986 favors the assumption that RNA can simultaneously act as an enzyme (**Ribozymes)** & also as a storehouse of genetic informations (Gilbert Walter *1986).* However, from the 1960s onwards, scientists studying the origin of life split into camps. According to Sutherland the basic polarization was between the proponents of "metabolism-first" versus "genetics-first" theory. Meanwhile, a third group proposed the idea that "Compartmentalization must have come first, because there's no point doing metabolism unless you're compartmentalized."Compartmentalization-first–has its supporter in Pier Luigi Luisi of Roma Tre University in Rome, Italy.

Present Hypothesis

To make the total process of creation logically more comprehensible the origin of life can be divided into several steps discussed below –**Step I** – Formation of basic structural elements or building blocks of life like purine & pyrimidine rings, amino acids, glucose, phosphate energy bonds etc. **Step II** – Formation of more complex structural forms by chain elongation of basic structural molecules. **Step III** –Systematic assembling of all these structural elements leading to a structural unit with functional autonomy where all the biochemical reactions can occur automatically, repeatedly in a organized way, making it an autonomic functional unit. In this context it is worth mentioning that the **Step I** can be explained by the **Miller-Urey Experiment** demonstrating the spontaneous synthesis of **amino acids** & basic organic compounds of life on Earth, from the inorganic precursors and the simplest of organic molecules. But the most difficult part is to explain the **Step II** & **Step III**. To explain the formation of more complex structural form by chain elongation, it can be said that the purine & pyrimidine ring have some unusual property of organizing & assembling carbon, hydrogen, oxygen & nitrogen molecules in a systematic way. **RNA hypothesis** of origin of life favors the assumption that RNA can simultaneously act as an enzyme (**Ribozymes)** & also as a storehouse of genetic informations. It is also known that **uridine ring** & the **phosphate bond** (**UMP, UDP & UTP**) & **adenine ring** in **Co-enzyme-A** helps in the polymerization of carbohydrate & fatty acid chains. More importantly purine & pyrimidine ring creating the **mRNA** & **tRNA** helps in the polymerization of amino acids creating protein molecules which are the building block of life. So it strengthens the idea that purine & pyrimidine rings & phosphate bonds are the key structures towards the creation of life. However, the most difficult part is to explain how the systematic assemblage of these parts occurred in such a complex & organized way(nano-scale organization) to achieve the functional autonomy & forming the first living cell in earth. According to this hypothesis "**Random Collision & the Association & Rejection with the Acquisition of Added characteristic"** it can be said that at the beginning of the creation, just like inorganic molecules randomly come in contact with each other, in the similar way bio-molecules also came in contact with each other at random most probably in soupy sea. As we know that the bio-molecules have some affinity to each other if suitable condition prevails (just like a positively charged compound can be attached to a negatively charged compound), the combination occurred at random following the rules of permutation & combination. Here we can give some simple examples---"A" combining with "B" forming "AB", next "B" combining with "C" forming "BC" & so on *A + B = AB *B + C = BC. Now when "A" combines with "B" forming "AB" & if "AB" can acquire some extra property by which it can combine with another molecule "XY" to form "ABXY" then automatically it was selected by nature. On the contrary, if "B" & "C" after combining to form "BC" do not acquire some extra property or added character to combine with "XY", then it was rejected. This chain-wise selection & rejection processes can explain how it proceeds further to form more complex molecules. Whenever a new structural form was produced, if it acquired some extra functional capability, it was automatically selected by nature. Whereas the combinations that did not acquire some extra functional capability, that did not proceed further.

Example 1: AB+ XY ----------> ABXY +αβ ----------> ABXYαβ + γδ ----------> ABXYαβγδ If A acquires extra characteristic by combining with B forming AB & similarly if AB acquires extra characteristic by combining with XY forming ABXY & If ABXY acquires extra characteristic by combining with αβ forming ABXYαβ & if ABXYαβ with extra characteristic combine with γδ and proceeds further in a sequential way , then AB, ABXY, ABXYαβ, ABXYαβγδ and so on will be formed.

Example 2: AB+ XY ----------> ABXY + γδ ---------->ABXYγδ ---------->Ẍ Here AB acquires extra characteristics by combining with XY but ABXY does not acquire extra characteristic after combining with γδ. So it proceeds to form AB, ABXY & ABXYγδ. But as it does not acquire extra functional characteristics after combining with γδ , so it does not proceed further from ABXYγδ

So in this way, following the natures rule it can be explained that bio-molecules by random collision & then combination & then acquisition of some extra functional capability, proceeded towards the more complex form and ultimately led to the formation of living form with complete functional autonomy. Step by step by random association & rejection, it acquired the step by step functional capability. From the structures of viruses it can be depicted that before the origin of fully developed unicellular organisms only the RNA and then DNA core was developed with limited functional capability of producing few structural proteins & enzymes & in presence of water later the nucleic acid core evolved to form more complex form to produce all the necessary components of cytoplasm, cell membrane & other necessary enzymes to evolve into a independent existing cell. In this context Darwin's theory of evolution helps in explaining the development of higher living forms from the primitive cell or protocell & it can be explained at the molecular level by the fact that during DNA replication some errors can occur during base-pairing, leading to the mutations which can be propagated to the next generation and the accumulation of the favorable mutational changes in a cumulative way led to added characteristics.

Discussion

With the help of this currently mentioned Hypothesis, Oparin's primitive soup, Miller-Urey's experiment, Muller's "naked gene" and Orgel & Walter Gilbert's "RNA world" can be connected. However, it is worth mentioning here that the problem arose with the "RNA world" hypothesis in between 1980 to 2011 when Jack Szostak, David Bartel, (Szostak JW, Bartel DP, Luisi PL. 2001) Philipp Holliger, Gerald Joyce and Tracey Lincoln in separate experiments in their laboratory created RNA enzymes (R18, tC19Z) that replicates itself but can copy sequences up to 6 to 48% of its own length, but not the necessary 100%. So RNA has proved to be enormously difficult to make & it was assumed, might be there was some other type of molecule on the early Earth: something simpler than RNA, which really could assemble itself out of the primordial soup and started self-replicating. This might have come first, and then led to RNA, DNA and the rest. In 1991, Peter Nielsen (Nielsen PE et al 1991) of the University of Copenhagen in Denmark came up with Polyamide nucleic acid (PNA) where the backbone of the molecule was made up of polyamide instead of ribose sugar& it can coil up into a double helix, just like DNA and Stanley Miller also thought that PNA was a more plausible candidate for the first genetic material. In 2000, Albert Eschenmoser (Eschenmoser, A. et al 1999)made another nucleic acid named Threose nucleic acid (TNA) which is basically like DNA, but with a different sugar in its backbone & can pair up to form a double helix, and information can be copied back and forth between RNA and TNA. In 2005 Eric Meggers made glycol nucleic acid, which can form helical structures. Though each of these alternative nucleic acids has its supporters, but as there is no trace of them in nature, so it is very difficult to say whether the first life did use them or not at all. However, it can be said that studies of more specific conditions, including the laboratory simulation of localized environments such as volcanic islands, tidal zones and micro-enviroments, including liposomes, clays and mineral surfaces, montmorillonite (James Ferris, 1986) and volcanic ponds, which could have been prevalent in the primitive environment, may yield promising results (Antonio Lazcano, 2010). Now if we come to the currently described theory which is based on nature's rule- Random Collision & the Association & Rejection with the Acquisition of Added characteristic Hypothesis, it can be said that it can explain all the three theories like "Genetic first" ,"Metabolic first" or the "compartmentalization first" theory.

Now one thing that strikes the mind is what is meant by the acquisition of new functional capability. We can say that the bio-molecules in a living cell are interconnected in such a way that as an example it can be said if one interconnecting pathway is linked with the signal transduction, the effector molecule produced will result in a cleavage of another molecule & that cleaved product may be responsible for stimulating a particular gene to produce a final end product by transcription & translation. So we can say that all the bio-molecules are interconnected with one another in such a finely tuned way or we can say better in a finely programmed way which is responsible for several functional outcomes. Here with the help of this random collision, selection & rejection & acquisition of new functional capability hypothesis, it can be said that overall functional capability & structural organization was achieved step by step with the formation of new molecules. In each step the terminal product produced was one step ahead in functional capability from the preceding one, whether it was the formation of trans-membrane receptor or the formation of cAMP or cGMP molecules or the creation of signal transduction pathway or the creation of photosynthetic pigment like chlorophyll. Here we can give a simple example. We know that nitrogenous base combining with pentose sugar (or polyamide, threose , glycol) form nucleoside which is one step ahead in functional capability than that of nitrogenous base, so it was selected by nature. Similarly, Nucleoside combining with phosphate form mono-nucleotide which is also one step ahead in functional capability than that of nucleoside, and mono-nucleotide combining with other nucleotides form poly-nucleotide chain which is also one step ahead in functional capability than that of mono-nucleotide, so they were also selected by nature. Also it can be said that as the primitive earth's environment was reduced and probably that time primitive microbes were heterotrophic in nature and only after the generation of photosynthetic pigments & the generation of autotrophic organisms, gaseous O2 appeared in earth's atmosphere, so in the primitive unknown reduced atmosphere of earth, biochemical reactions might have occurred through a different unknown pathways to perform the nano-scale organization.

Conclusion

Though Günter Wächtershäuser's (Wachtershauser G. 1988) idea of the process of harnessing energy is utterly essential but it requires the confirmation that metabolic (protometabolic) routes can replicate and evolve & so far there are no indications that this is the case & on the contrary the form in which the energy is stored in biological world (ATP) is made up of nucleotide, so it can be said that the polymerization of nucleotide with the genetic first description of life if more pragmatic & initially the energy source was external from the surrounding environment and later on compartmentalization with the creation of enzyme on the membrane surface to harness energy from the proton gradient across the membrane in the form of ATP is more plausible to believe and one interesting thing is - Random Collision & the Association & Rejection with the Acquisition of Added characteristic Hypothesis**,** can explain all the three theories like "Genetic first" , "Metabolic first" or the "compartmentalization first" theory. Lastly it can be said that though several researchers tried to explain the origin of life supported by the newly developed knowledge of cellular biology, for example Thomas Cech & his colleagues (1982) first discovery of RNA as an enzyme made the Leslie Orgel & Francis Crick's assumption of RNA hypothesis more plausible & Günter Wächtershäuser's (1980) metabolism first hypothesis also acquired reasonable support with the fact that energy is required for survival and Peter Mitchell's (1978) clear delineation of proton gradient across a membrane and the stream of protons passing through give the enzyme residing on the membrane the energy it needed to make ATP, so until & unless more discoveries of cellular working pathways at the sub-cellular level comes to our knowledge, it will be hard to delineate the exact pathway of nano-scale organization of the first protocell and the lack of exact knowledge of the environmental condition of earth four billion years ago is another major problem to prove this nanoscale organization at the laboratory set-up.

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