Open questions on the Origin of Life in 2014

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The Origin of Life (OoL) community aspires to discover chemical evolution or abiogenesis. This is the supposed historical, continuous, and naturalistic path from lifeless chemicals to cellular life, encompassing both genetics and metabolism. The gap between their aspirations and their OoL evidence is vast. As a leading OoL chemistry professor summarized in 2010:

> "The origin of life on Earth is still a mystery, one of the greatest mysteries in science today … . Our ignorance about the origin of life is profound—not just some simple missing mechanistic detail … . This ignorance stems not only from our experimental difficulties with prebiotic chemistry, but is also conceptual, as we are not yet able to conceive on paper how all these things came about."[1]

Recent evolutionist conferences concerning Open Questions on the Origin of Life (OQOL) were held in Sicily (2006), Spain (2009), Leicester UK (2012), and Japan (2014). These conferences discussed possible scientific and philosophical explanations to dozens of vast gaps in understanding the OoL. Scientists can often be each other's harshest critics. They critique each other's research and theories by challenging unwarranted assumptions, poor experimental methodology, inadequate data analysis, and unjustified conclusions. We can accept the criticism OoL researchers shower on one another without accepting the incomplete evidence they may provide for their own competing, naturalistic explanations of the OoL. Though I did not attend these conferences, the work presented at OQOL conferences is well documented in the peer-reviewed literature and on conference websites.[2] The OQOL2014 conference in Japan addressed six OQOL selected from among fifteen OQOL by online poll (see table 1).

So much research, so little progress

One session at OQOL2014 focused on "Why is the origin of life still a mystery?" This important OQOL persists. One proposed OQOL for the 2009 conference pondered why the field of OoL research "has not progressed much since the early experiments of Stanley Miller [in the 1950s]".[2] In 2001, Lahav *et al.* concluded that "After almost 50 years of modern research, there is no paradigm of the origin of life."[3] The OoL community has not even agreed to fundamental assumptions, including those pertaining to (1) where did life begin?, (2) which came first: genetics or metabolism?, (3) how did genetics and metabolism unify?, (4) was RNA or protein the gateway from lifeless chemicals to cellular life, and (5) was the "origin of life" a singular event or were the "origins of life" a confederacy of independent events?

The lack of progress in naturalistic OoL research is a shocking admission, especially when compared to the staggering and impressive advancements in operational-scientific fields in the past seven decades.

While not extensively discussed at OQOL2014, emergence is a common theme in the OoL community. Emergence is the idea that order, coherence, and complexity (which are not evident at the microscopic level) can arise at a macroscopic level far from equilibrium. The search continues for natural laws governing complex systems that can explain how biochemistry and biology emerge from chemistry and physics. Emergence guides both top-down and bottom-up OoL research approaches. Top-down OoL research looks for evidence of progressively simpler ancestors of modern cellular life toward the first 'living' creature, often called the Last Universal Common Ancestor (LUCA). Bottom-up OoL research strives to understand how lifeless inorganic chemicals formed all the biochemical polymers necessary for life, and how those materials self-organized into the LUCA.

Prigogine investigated emergence and non-equilibrium thermodynamics of "order through fluctuations" for which he won the Nobel Prize in Chemistry in 1977.[4] Typical examples of emergence used in OoL discussions today include hurricanes, schooling fish, and sand dunes. The gaps in complexity between these examples and biochemicals, much less cellular life, cannot be overstated. A critical problem is that every emergent system is still constrained by the known laws of thermodynamics: (1) conservation of mass and energy, and (2) never decreasing entropy.

The mystery of biopolymers

Session 2 at OQOL2014 was "How can we make ordered sequences of amino acids, or mononucleotides by prebiotic means?" Proteins, enzymes, RNA, and DNA are the essential biopolymers of all life. Life requires many identical copies of biopolymers with precisely ordered sequences of hundreds to thousands of amino acids in enzymes, and millions to billions of mononucleotides in DNA. OoL research has not produced any evidence or plausible explanation for abiotic synthesis of ordered polypeptides or polynucleotides of even a few dozen biomonomers in length.[5] Related OQOL concern (1) the prebiotic source of amino acids and mononucleotides since their production requires mutually incompatible conditions,[6]

Table 1. Open questions on the Origins of Life for OQOL2014 (Japan).

Sessions at OQOL2014	
1	Why is the origin of life still a mystery?
2	How can we make ordered sequences of amino acids, or mononucleotides by prebiotic means?
3	Is the molecular crowding critical for the beginning of life?
4	Can Artificial Life or Synthetic Biology contribute to the origin of life?
5	Universality—What properties of life are universal?
6	What are the physical mechanisms underlying the assembly of primitive cell-like structures?
Proposed but not selected for OQOL2014	
7	Can catalysts come out from the free ticket of thermodynamics?
8	Can we construct real RNA world and RNA-based biological systems in a test tube?
9	What is the origin of genetic code?: Investigating design principle of aa-tRNA and aa-RS?
10	Prior to genetic code: Is the notion of prebiotic cells conceivable?
11	What is the list of prebiotic molecules present in primordial cells?
12	On Contingency vs Determinism
13	How to make prebiotically long hetero-peptides or hetero-nucleic acids?
14	On the origin of catalytic cycles
15	Life as unity or confederacy

(2) controlling the folding and coiling necessary for the precise secondary and tertiary structure of biopolymers,[7] and (3) the origin of homochirality in amino acids and sugars.[8]

One explanation for lack of evidence for intermediate stages from mere chemicals to 'life' is that early OoL metabolic cycles or genetic replicators "ate the evidence".[9] This incredible claim implies that once upon a time there was at least one continuous pathway from mere inorganic chemicals to 'life'. Next, this 'life' existed long enough for the living creature(s) to become established. Then, those living creatures consumed any and all evidence for intermediates and transitional stages along the OoL path. This explanation is comparable to a bridge built between remote islands. After everyone finished travelling between the islands, all evidence of the bridge was destroyed, including any evidence that anyone ever knew how to build a bridge or had any other way to travel between these remote islands. However, a theory that predicts its own lack of evidence has left the realm of science.

Water, water everywhere and not a biomolecule in sight

Two sessions at OQOL2014 addressed the dilution problem: (1) is molecular crowding critical for the beginning of life? and (2) what are the physical mechanisms underlying the assembly of primitive cell-like structures? Much OoL research has sought and succeeded in finding abiotic routes to individual organic compounds. Theories on Emergence propose ways that chemicals self-assemble into complex chemical networks and biochemical structures that then self-assemble into living cells. But the details of OoL self-assembly remain largely speculative and controversial.

The concentration of individual organic and biochemical compounds in living cells is enormously high. OoL researchers can only speculate that lipid vesicles may have acted as cell-like compartments to aggregate the necessary chemical components of life to reach concentrations necessary for emergence toward the OoL.[10] These vesicles somehow also preserved biochemical networks and structures from various degradative forces. However, the same concentrating mechanisms would also have intensified many destructive reactions. An OQOL related to the dilution problem concerns the unfavourable thermodynamics of the condensation reactions to form biopolymers compared to the hydrolysis of proteins and DNA/RNA into amino acids and mononucleotides, respectively.

Redefining life?

The final sessions at OQOL2014 addressed (1) artificial life and (2) the universal properties of life. No broadly accepted criteria exist for 'life' in the OoL community. Proposed requirements demarcating life from non-life range from the restrictive to the extensive.[11] The discoveries of extra-solar planets and the advances in synthetic biology challenge preconceived and historical scientific and philosophical definitions of 'life'. Within even the limited criteria of 'life' being capable of metabolism, self-reproduction, and evolvability, many OoL researchers are seeking different forms of 'life' from the laboratory to the cosmos. They hope that simpler forms of 'life' might explain the historical OoL path from lifeless chemicals to cellular life. So far, theories and modelling are the primary substitute for evidence of any simpler forms of 'life'.

Conclusion

Scientists and philosophers, standing on naturalistic and materialistic assumptions, have not explained the OoL. Their scenarios remain vague

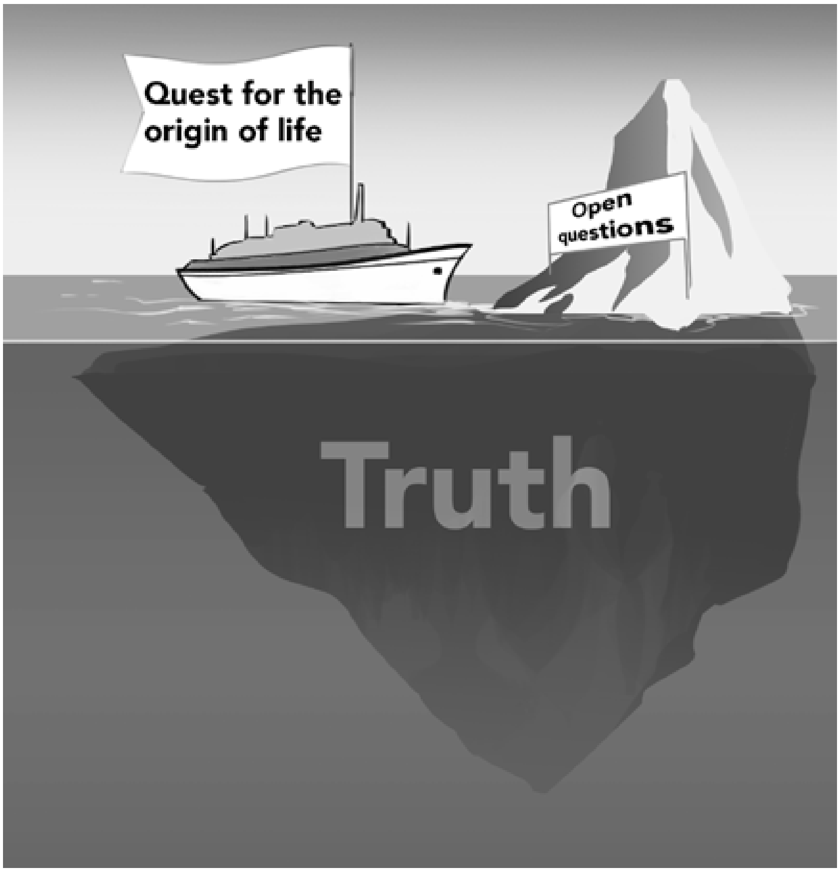

Figure 1. The quest for the origin of life can't avoid the truth forever.

enough to gain some consensus but not comprehensive or detailed enough to risk falsifiability. Advocates for the biblical account of creation in Genesis must not be naïve in debating OoL issues. Like picking up a 7–10 split in bowling, if we merely knock down one of the multiple naturalistic explanations or theories for some aspect of an OQOL, then other naturalistic scenarios remain and perhaps gain credibility. For example, the OQOL of 'where did life begin?' attracts advocates for deep-sea thermal vents, extraterrestrial sources (panspermia), and Darwin's 'warm little pond'. Each group provides valuable and valid critiques of their rivals. Creationists should wisely use all these criticisms to leave no credible abiogenesis scheme. Since divine creation did not proceed through a long evolutionary history of intermediate chemical and biochemical transitions toward living creatures, all naturalistic explanations for the OoL will ultimately be proven untrue by the standard of being consistent with known scientific laws.

In mathematics, an 'indirect proof' establishes the truth of a proposition by (1) assuming that the proposition is false, and (2) showing a resulting contradiction. World-class 21st century research continues to show how difficult (perhaps impossible) it will be to answer dozens of OQOL with a naturalistic and materialistic worldview. Some scientific disciplines accept intelligent causes including the Search for Extraterrestrial Intelligence (SETI), archeology, cryptography, and forensics. In these fields, once all possible natural explanations for their observations and evidence are eliminated, some other explanation must be pursued. As OQOL continue to accumulate over time, the vast gaps in explaining how mere chemicals became cellular life will reveal the false assumptions of creation apart from God and contrary to biblical revelation.

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