

to avoid an error catastrophe, the maximum replication error rate for an informational molecule such as DNA or RNA is equal to the inverse of the molecule length.⁶ As the authors mention, an RNA ribozyme that can serve both as an informational storage and catalytic molecule must be at least several hundred nucleotides. But even a very small such molecule of, say, 50 nucleotides means that the replication error could not exceed 2%; that is, a 98% accuracy is required. This is far beyond the capacity of any such early replicator as far as we know at present.

While we can imagine a form of life that might not evolve yet still carries out various metabolic and even replication functions,⁷ many biologists assume that “life” began when the process of biological evolution became possible. Some textbooks even use this as a definition for life.

The evolutionary process requires pretty much everything we see in the central dogma, including DNA as the informational storage molecule with highly accurate replication, transcription, and translational machineries.⁸ Once we begin to have functional biological evolution (with high replication fidelity), we have reached a cell indistinguishable from the Last Universal Common Ancestor (LUCA). We have no good theories as to how life could have evolved before biological evolution, as we know it, was possible.

I am not arguing against the authors’ overarching view of continuity in nature and the difficulty, if not impossibility, of determining any particular point at which a new feature of the universe began. For most purposes, continuity is a coherent and useful way to approach the reality of biology and all of nature, both scientifically and theologically. My goal is to stress the aspects of those natural processes, such as the origin of life, that show a greater degree of discontinuity than is seen, for example, in the evolution of life after LUCA. This includes the problem of the evolution of replication fidelity.⁹ More attention on these questions is likely to produce interesting and perhaps even revolutionary new information on the mechanisms by which God’s creation has come to be the marvel we know.

Notes

¹Eugene V. Koonin, “The Biological Big Bang Model for the Major Transitions in Evolution,” *Biology Direct* 2 (2007): 21, <https://doi.org/10.1186/1745-6150-2-21>; Walter Fontana and Peter Schuster, “Continuity in Evolution: On the Nature of Transitions,” *Science* 280, no. 5368 (1998):1451–55, <https://doi.org/10.1126/science.280.5368.1451>; and Luciana Raggi, Jeffrey L. Bada, and Antonio Lazcano, “On the Lack of Evolutionary Continuity between Prebiotic Peptides and Extant Enzymes,” *Physical Chemistry Chemical Physics* 18, no. 30 (2016): 20028–32.

²Lynn Margulis, “Archaeal-eubacterial Mergers in the Origin of Eukarya: Phylogenetic Classification of Life,” *Proceedings of the National Academy of Sciences of the United States of America* 93, no. 3 (1996): 1071–76, <https://doi.org/10.1073/pnas.93.3.1071>; and William F. Martin, Sriram Garg, and Verena Zimorski, “Endosymbiotic Theories for Eukaryote Origin,” *Philosophical Transactions of the Royal Society B Biological Sciences* 370, no. 1678 (2015), <https://doi.org/10.1098/rstb.2014.0330>.

³Jeremy E. Coate and Jeff J. Doyle, “Divergent Evolutionary Fates of Major Photosynthetic Gene Networks Following Gene and Whole Genome Duplications,” *Plant Signaling and Behavior* 6, no. 4 (2011): 594–97, and Paramvir Dehal and Jeffrey L. Boore, “Two Rounds of Whole Genome Duplication in the Ancestral Vertebrate,” *PLoS Biology* 3, no. 10 (2005): e314.

⁴Stephen Jay Gould and Niles Eldredge, “Punctuated Equilibrium Comes of Age,” *Nature* 366 (1993): 223–27, <https://doi.org/10.1038/366223a0>.

⁵Manfred Eigen, “Error Catastrophe and Antiviral Strategy,” *Proceedings of the National Academy of Sciences of the United States of America* 99, no. 21 (2002): 13374–76, <https://doi.org/10.1073/pnas.212514799>.

⁶Jack W. Szostak, “The Eightfold Path to Non-Enzymatic RNA Replication,” *Journal of Systems Chemistry* 3, no. 1 (2012): 2, <http://www.jsystchem.com/content/3/1/2>; and Martin A. Nowak, *Evolutionary Dynamics: Exploring the Equations of Life* (Cambridge, MA: Belknap Press, 2006).

⁷Sy Garte, “Teleology and the Origin of Evolution,” *Perspectives on Science and Christian Faith* 69, no. 1 (2017): 42–50.

⁸Ibid.

⁹Sy Garte, “The Continuity Principle and the Evolution of Replication Fidelity,” manuscript submitted, 2020.

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Key Speculation

The major unsolved problem of life on Earth has been how life emerged from nonliving organic material. This problem has confounded scientists starting with Alexander Oparin in 1924, John Haldane in 1929, through the carefully controlled laboratory tests in 1953 by Harold Urey and Stanley Miller, and has continued to occupy biochemists, biophysicists, and synthetic organic chemists from 1953 until today, with no apparent success. In addition, *all these efforts to date have involved intelligent beings, i.e., human interaction, under carefully controlled experiments.*

One of the most recent efforts has been by Nobel Laureate Jack Szostak, who obtained microcapsule prebiotic samples in his laboratory. In “Rethinking Abiogenesis: Part 1, Continuity of Life through Time,” (*PSCF* 72, no 1 [2020]: 25–35) by Emily Boring, J. B. Stump, and Stephen Freeland, I do not see any reference to Szostak.

Because the authors are committed to evolutionary creation, it is no surprise that their key speculation is summarized in paragraph 4, under the section entitled “Why Does the Perspective of Continuity Matter?” Given their presuppositions, they seek to avoid any and all discontinuities, even though, as C.S. Lewis aptly stated regarding biblical miracles, God is the author of

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the natural and the supernatural, and *therefore can seamlessly interact [not intervene] with his creation.*

I hope that some of these important caveats will be addressed:

1. To date, replicating life in the laboratory from non-living material has been unsuccessful since the Urey/Miller experiment.
2. Any and all efforts to date, have been done under controlled laboratory conditions.
3. All such efforts trying to create life in the laboratory involve *human interaction*.
4. According to most geophysicists, the atmosphere four billion years ago was oxidizing, not reducing, and thus inimical to the formation of complex molecular systems.

I recommend that the authors consult James M. Tour of Rice University, who is considered one of the world's top synthetic organic chemists. The authors do quote, in passing, Douglas Axe of Biola University, but they do not mention Tour. Neither Axe nor Tour support the authors' evolutionary position regarding life's origin.

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“Rethinking Abiogenesis” Authors Respond

We thank both Drs. Garte and Touryan for taking the time to write with regard to our article, “Rethinking Abiogenesis: Part 1, Continuity of Life through Time” (*PSCF* 72, no 1 [2020]: 25-35). The honor of seeing our argument pass through peer review into publication in *PSCF* is exceeded by learning that it has engaged readers enough for them to respond.

In response to Garte's letter, we express direct gratitude for balancing our argument with the points he makes. We agree with the existence of one-way transitions into ever deeper states of feedback over the course of biological evolution; we perceive no “either/or” in suggesting that evolution is continuous. In other words, we perceive that a continuous evolutionary process may involve transition into higher rates of change over time. Our article's emphasis on continuity reflects our perception that, to date, this aspect of abiogenesis has been underexplored to the detriment of science. Our emphasis, as originally expressed, might well overstate the useful re-balancing that can occur to advance science. Both faces of abiogenesis deserve further research: we write with passion about the one which we perceive as currently lagging. For example, Szathmáry and Smith's seminal work on “major transitions in evolution” (including abiogenesis)¹ predates De Queiroz's “rediscovery” of concepts of continuity² by a decade, suggesting that the topic of continuity merits extra attention and research today to account for this lag.

Illustrating what we describe as this balancing act, we appreciate Garte's reference to Gould and Eldredge's theory of punctuated equilibrium as a case in which “an apparent discontinuity should lead us to more in-depth exploration” [quote]. Rather than a counter-example to our argument for continuity, however, we view punctuated equilibrium as illuminating the way in which perspectives of continuity vs. discontinuity have informed and honed one another toward deeper understanding. The theory of punctuated equilibrium arose as a challenge to a longstanding interpretation of the “notorious imperfection of the fossil record” as negative information. If written off as artifacts of missing data, seemingly “sudden” changes over evolutionary time could remain fully consistent with the prevailing theory of gradualism. Recasting the missing data as positive information in its own right, on the other hand, produced evidence for “geologically instantaneous origination and subsequent stability” of morphospecies. In other words, the theory of punctuated equilibrium emerged from a scientific moment in which the evidence at hand—a gap in the fossil record—could be interpreted in two different ways: one, supporting a steady rate of evolution; the other, supporting a view that morphological evolution can speed up to produce rapid change and slow down to produce seeming stasis. Over decades, considerable evidence has favored instances of the latter interpretation,³ although active debate continues.⁴ In this process, the scientific community has not rejected continuity but, rather, has been forced to define the concept of continuity in much more precise terms: the tempo vs. mode of evolution, characteristics of micro- vs. macro-evolution, and stasis in data vs. stasis in the processes that scientific data reflect.

The question in our present exchange of letters remains whether the difference between continuity and discontinuity is merely a product of the speed at which a process occurs, or a fundamental difference in type? We perceive in Garte's words a shared interest in this question and an alignment with our views.

To support the interpretation that different rates are not the same thing as discontinuities, we find a point of mutual agreement and interest with Garte in noting that “transition” should not be conflated with one, singular event labeled abiogenesis. As Garte points out, the emergence of eukaryotes is as much a paradigm of such one-way transitions as the emergence of the standard genetic code ... and neither of these transitions involves abiogenesis except in our stated sense that abiogenesis is still underway and “as-yet-incomplete” (p. 25). In other words, we perceive a shared goal with Garte in continuing to balance “continuity” with “transition” in order to advance the science of origins.

While we appreciate the concerns in Touryan's letter, we find less common ground with his position. He writes of our “commitment to” evolutionary creation and our “presuppositions” as though these were chosen without