

**Review of “*The Flow of Information through Animate Matter and the Origin of Life*”
by Dmitry A. Kukuruznyak**

Reviewed by R. S. Kurti, J. Xavier and P. Marshall

Mr. Kukuruznyak,

Thank you for your submission to the Evolution 2.0 Prize. After reading over your submission, we are intrigued by your hypothesis. Having a self-organized arrangement of atoms arising from atom-emergent forces is an interesting idea. We took quite some time reviewing both your submission and responses to queries. Whenever we receive a serious scientific technical submission as yours, we are extremely happy because it shows there is a healthy undercurrent in real scientific circles looking for better answers to complexity, life, and the emergence of information.

We need to take all submissions seriously, but few of them rise to level of "good" as your submission does. We must be ready to give serious scientific consideration to papers such as yours, which are a genuine attempt to describe in sufficient technical detail processes which have eluded the explanation of the mainstream reductionist scientific circles for decades, if not centuries.

With that said, for the purposes of the present arrangement of the EVO2.0 prize, your submission does not meet the requirements, as you surmised in your cover letter and paper. We have within our team experts from Physics and Biology that unanimously agree on this assessment. Your submission admits, in the first two pages, that it does not try to create a translation table or a message to pass. Both of these admissions keep your solution from fitting the criteria for the EVO2.0 Prize. They do not necessarily reflect on the validity of your approach, but they do keep your submission from meeting the requirements (at this link: <https://www.herox.com/evolution2.0/guidelines>).

We would like to provide some extra feedback on the scientific consistency of your proposal. We particularly appreciated that in Chapters 2.3 and 2.4 you correctly identify and highlight the “primordial soup conundrum” that many other authors in the origin of life have pointed out. A liquid solution of molecules will not self-organize into a complex structure as the cell without another driving principle that is encoded. This is the principle we are looking for in the EVO2.0 prize.

Regarding your redefinitions of life, and cells, there are some remarks to be made. For example, the generalization “*the body of a biological cell is a giant interconnected macromolecule. It is composed of water reinforced with organic compounds. The body of the cell is something like an ordered polymer.*” falls outside the standards of basic chemistry and its concepts, which state that macromolecules (and polymers) are “large molecules composed of thousands of **covalently** connected atoms.” (emphasis ours). Even if we wish to be non-dogmatic, and stretch and break these chemical concepts to be as

encompassing as you suggest (and turn chemistry on its feet), if a cell is a “giant macromolecule”, and a jellyfish is also a “giant macromolecule”, everything we see that forms a single non-covalently connected system is a “giant macromolecule” – a human, a house, a volcano – even a planet. We do not see how this reductionist generalization would be helpful to the sciences that study the aforementioned systems. Moreover, the statement “*I will name a pair of atoms that produce a new chemical bond an elementary living subject*” will be extremely controversial for those studying life. Even though there is considerable lack of agreement on the definition of life, your definition eliminates Biology as a science and implies that everything above atoms is Chemistry. The cell continues to be agreed upon as the unit of life as we know it. However, for the EVO2.0 prize (and to overcome the conundrum of defining life) we focus on the self-organization of a code without the benefit of a designer (<https://www.herox.com/evolution2.0/guidelines>). With this said, we do find value in your concept of “*animate matter*” highlighted in Fig. 2 of the submission. We also find the suggestions regarding water in Chapters 4.1 and 4.2 and Fig. 5 very interesting and worth of further exploration. In future elaborations of this theory, it is our suggestion that the focus lies on the concept of ordered animate matter.

As to your point about reformulating the EVO2.0 prize criteria, we have forwarded your suggestions to the prize organizers for review. However, while some of the reviewers were not privy to all the discussions on the run-up to the creation of the Foundation and the Prize, suffice it to say, the founders have done their homework. Your solution is on the other side of the age-old “chicken and egg” problem. We are well aware of the dichotomy, “Which came first, the cell or the DNA?”. The challenge is that, if we are to truly consider how information emerged from randomness, we must have a starting point. We could have picked to start with the cell rather than the code within the cell (see Perry's response to your paper below). However, the question remains, where did the information about the cell originate if not from the DNA?

This fundamental question lives within your own framework of animate matter, namely how does an atom “want” something? What is the “something” that it wants? In other words, **where is the information stored that the atom is using to define “wants”?** For us to even study this question would require far more complex equipment than we currently have, and there are teleological implications in statements as “*atoms want*”, “*atoms aim*” and “*the desire of atoms*”. We could perhaps watch atoms using surface probe methods such as Atomic Force Microscopy to deduce possible “choices” being made, but surface probe methods cannot currently do this in real time, which is likely to be necessary as atoms operate on extremely short time scales (femtoseconds). So as much as we enjoyed reading your perspective on animate matter and considering the possibilities you put forth, it only moves the “information question” to a different position in the problem of emergent complexity.

We did genuinely appreciate your paper and the effort it obviously took to carefully craft your arguments and examples. It is clear that you are taking the EVO2.0 Prize seriously, and for that we are deeply appreciative. Even though we weren't able to match your paper

with the requirements of the prize at this time, we did take your effort seriously.

We forwarded your paper to Perry Marshall at the time we sent the previous response, and he asked us to forward his response to you which you will find in a separate message (below) to keep clarity. Perry was impressed just as we were that you are also trying to think clearly about the problem of emergent complexity and information.

Thank you for taking the time to submit a thought-out proposal and for sharing your perspectives on animate matter. You are courageous and tenacious to even attack such a large problem, and those of us on the EVO2.0 initial review team applaud your work. Please do not take our rejection of your current submission to the criteria as a final rejection of your theories. We will simply need to see more convincing proof that your work demonstrates emergent complexity leading to rule-based information exchange (see also Perry's response below). So, while you have more steps to fill in, we are impressed that you are taking the "problem of life", complexity, and emergent information as serious scientific questions. You are in a small minority of serious thinkers who are actually willing to engage with an extremely hard challenge. Please keep us posted as you continue your search for emergent complexity in animate matter. If you make headway in demonstrating your hypothesis in a laboratory setting, we would be very interested in seeing a second proposal.

Best Regards,

EVO2.0 initial review team

Perry Marshal's comments for Dmitry Kukuruznyak:

Your English is excellent, I really like your paper and I like what you're attempting to do. I appreciate how thorough and well-thought out it is. I find that people from physics who approach biology sometimes ask better questions than biologists.

I have had fairly similar comments from William Miller and Guenther Witzany, to the effect that my characterization of cellular communication is limited to a Shannon communication channel and thus does not capture the true complexity, subtlety and capability of cells.

I also got a comment from James Tour of Rice University that I have fallen far short of defining life.

There is no question about that. All of those comments are true. DNA transcription and translation in an actual cell is far more than simple mechanical encoding and decoding. But it is not LESS than that.

Therefore, what I hope I can convey is that I have formulated the most minimal definition of the information problem in biology which is one of its most central questions. I have

defined what I am looking for in 100% reductionist terms (which means not even the most ardent reductionist cannot disagree with my definitions) while still requiring the prize entrant to submit a system that behaves in a non-reductionist way. This is very important because I am trying to break the back of reductionism while still "playing by the rules" of empirical science.

So I don't think I need to change the prize specification. This is because I also believe that if anyone creates a form of life through, let's say, a "metabolism first" scenario, that those life forms sooner or later will become capable of producing code. Remember that it doesn't have to be genetic code, it just has to be digital communication.

You are also correct in noting that genetic instructions are not nearly sufficient information to build a cell, that there has to be more information contained elsewhere. I have believed this too for a long time, but I am afraid that at some points my book gives people the impression that genes determine everything. I apologize for leaving that impression.

Evolution 2.0 is an investment group that is looking for new ideas that we can invest in, so if you have developments that show a clear path to commercial viability, we are interested in looking at those.

Again, thank you for your submission.

We would like to publish it on our website with your permission. Let us know if that is OK.

Perry Marshall