LIFE AND NATURAL SELECTION OF COMPLEX BIOCHEMICAL REACTIONS

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ABSTRACT

Here we discuss the concept that life has to do with the evolution and survival of the most stable and fittest combinations of chemical reactions over time. In this case, regardless of the initial conditions, the result will be similar due to selection. Once organic chemistry comes into play, the spatial complexity of the interactions became too enormous for equillibrium.

In addition, if one excludes our perspective biases (forcing us to divide into individual organisms, systems, organs) then life's reactions as a whole seems to be more about disorder than order. The final resulting reactions will appear to have survival and self-sustaining capacities but this might be more of a self-fulfilling prophesy if the observers are exactly the resulting reactions.

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When somebody is studying the phenomenon of viruses, he can see that when viruses are not coming in contact with a host organism, they are only considered a sum of chemical compounds that do not necessarily fulfill the criteria to be considered alive. While on the other hand they start reacting with a host, or in other words they start making chemical reactions with the compounds of the host, they become alive. The same thing happens with prions, which are proteinaceous compounds that while they react with proteins of the host, they become alive in a way.

So a simple chemical reaction, while happening, is the simplest form of life, or the sparkle of life. This means that the superior organisms as well as all organisms are summations of chemical reactions. What happens now when they die? There is a disorder in a system of reactions (for example brain necrosis, which means that in a large number of neural cells there is a defect in the reactions supposed to be normally happening there) that leads to a cascade of disorders in other reactions and then in others and so on. The final result is that there is a defect in the whole body, transmitted in a chain reaction way.

What is the difference between a man that is alive and a man that is dead? In both cases the body is consisted from similar elements and compounds. But in the first case these compounds are reacting with each other and the structure of the body changes every moment. In the second case the chemical reactions of the body are lead to an equilibrium.

The majority of scientists speculate that life was originated from a single cell, which was the first cell on earth. This composed the first thing that was a form of life. The evolution of this cell had as a result the formation of life the way we know and see today. A problem with this idea is that if we had just a single cell in earth and outside of it there was nothing, then not only this would not lead to the formation of more complicated forms of life, but this single cell soon would be dead because of lack of food.

In the beginning, life on earth was more simple than today. This means that there was a system (network) of chemical reactions that gave its place to a more complicated one, and the system was getting more and more complicated, with more reactions happening. This sounds a bit strange because if a system of chemical reactions does not get energy from outside, leads to an equilibrium state.

Question: Can systems of primordial and inorganic chemical reactions with the help of external energy avoid chemical equilibrium and go towards a constantly increasing complexity state?

If you have a large number of initial substrates and they are reacting with other bi-directly, then the number of substrates will be increasing over time. Additionally, at the time that organic molecules with different stereochemistries will be formed, then the possibility of equilibrium will be virtually vanished, as now the possible ways of molecular interactions would be greatly increased. In fact, after some time, only organic-based reactions will be present and selected, because all the others would be lost in equilibrium.

Complex organic stereochemistry doesn't reach equillibrium state easily due to the variability of possible isoforms and thus, everytime they were created, they persisted and survived, adding to the chemical systems complexity. Additionally, every time they reacted with other organic or inorganic material (eg water, CaCO3 etc), they corrupted the other materials, adding to stereochemical complexity, and thus constantly adding novel material into the available for life chemical machinery. In a similar way that the prions corrupt the chemistry of host organisms. This constantly increases the organic stereochemical reservoir. This can in theory can undergo evolution and selection of the most sustainable chemical systems and theoretically eventually create amazingly more and more sustainable complex chemical systems such as ourselves or the other living beings.

In conclusion, we see that a perpetually increasingly complex system of organic chemicals with infinite stereochemical variations can easily be created, provided there is a source of external energy in the system. As a result of this complex system, nucleic acids will be formed (inevitably), proteins, as well as membranes. Thus, the latter are both not necessarily the starting point of life.

Question: What other forces will act on this primordial chemical system, adding to non-equillibrium and determining its fate in the long term?

1) Hydrophobicity (hydrophobic bonds, spatial configuration, separation and isolation of chemical systems, membranes, etc.

2) Another crucial factor is the property of some molecules to strongly adhere to each other, or to adhere to membranes. (In fact, if you put living cells and dead cells in a flask, then you can sort them easily because only the living ones will strongly adhere to the walls). Sticky reactions will eventually prevail and become the basis for further chemical complexity, because the chemical compounds will not diffuse around and lead to dead ends. This will make the process multifocal rather than diffuse, enhancing its ability to thrive.

To see the importance of stickiness, take for instance the sponges. Recent studies has shown that they were one of the first organisms on earth, along with corals. They don't seem quite like the other animals. In fact, I would say that they are something in between, more like random chemical systems. However, the strong adhesions between molecules (as well as multiple other factors) in sponges makes those systems sustainable over time. In fact, they were created because they were not destroyed. They can sustain themselves for millennia. The same thing happens with corals. These systems could serve as something like "chemical labs" performing chemical experiments for thousands of years before they die. Any chemical novelty that can sustain itself will survive and will be selected.

3) In a chaos of chemical reactions, those with some kind of repeatability and periodicity will have an advantage and not lead to a dead end as will be able to continue happening in the long term.

4) Also, the reactions with the ability to promote their own existence would prevail and continue to exist, in a process which is a kind of natural selection and survival of the fittest reactions. For instance, if a process can make numerous copies of critical chemical compounds then it will have an advantage because it will be continuously over-represented in the chemical system.

Question: How can chemical reactions like that, which occur in a random way, lead to the formation of the structures we see and perceive as animals, plants, organisms, etc. Why don't we just see a random soup and mixture of gasses and fluids?

If you consider life as a WHOLE (without dividing it into species organisms, etc), you get a sum of just chemical reactions. In other words, if you remove human biased concepts, such as organisms, systems, etc, then life as a whole seems to lose a lot of its order.

Imagine that with the help of a source of light we cultivate in a way some chemical reactions in a small place. After a period of time, they are getting more and more complicated. Let's hypothesize that someday the whole system becomes extremely complicated. We get to a point where we see nothing more but a mixture of colors and shapes. This is life. But human is a part of this complicated system which means that he sees things in a mirror like way, because he is in the system. He is a sum of reactions that keep happening. So it is very difficult for him to see life (the other reactions) in a fully objective way, because he is running inside the whole system. It is all a matter of perspective.

For instance, the property of reproduction in living beings that are chemical reactions seems to actually be a result of the energy that forces the chemical reactions to continue happening. Life continues because chemical reactions continue. We as an internal part of this system, see this as regeneration of the creatures, but it's only because we are running inside the system.

Living organisms normally are also not dying because the chemical reactions that are composing them are continuing to happen. If we analyze all these reactions we will have a very good view of their homeostasis and the way they sustain themselves. As we said we are seeing the world from the inside, or else in a mirror like direction, because we ourselves are a part of things, so we appreciate things from its results. We think that homeostasis and self-sustainability are very magical and sophisticated self-sustaining mechanisms, because we are the result of homeostasis, but the theory that we analyzed says that homeostasis simply is the catalogue of the chemical reactions that are still happening, and just because they keep happening, the organism is alive. In other words, we find a purpose in every single reaction or procedure, but it's only because of our perspective.

There is not a certain plan in the flask full of chemicals that is favored, however the system will continue happening. The final resulting reactions will appear to have survival capacities if the observers are exactly those resulting reactions. Everything that happened leads to them. So the final combination of reactions will be the most sustainable of all combinations, given the particular conditions, because that's exactly what happened. Those reactions prevailed in the long term.

Life as we see it is simply the result of the chemical reactions on earth. As we said, we are part of the system and we don't realize it, but if we were alien forms of life for example, and we were watching the earth from the outer space, then we would see only a very complicated network of reactions. According to this reasoning, life seems to be more of an invention of us, or else a concept that we use to describe anything that looks like us functionally. An organism is the reactions that we see, and we think they are something amazing because we see them separately from all the other reactions that are happening in the world. We judge them from their result, which is that they become like us. We are a part of the reactions that are happening as well, and while we see organisms that look like us, we think they are independent creatures, but actually they can't be separated from the whole soup of reactions.

Question: Ok, the basic forms of life is chemistry, but as we go higher, we find levels of organization. Functions like killing, walking, talking etc gives some reactions an advantage to survive over others. But, surviving is only important because of us. If you ask an observer outside the system of life, he will not find any organization in these functions, because their results mean nothing to them.

Question: The described system of chemical reactions is one of increasing entropy and disorder over time. But this is in contrast with our long held belief that living beings are characterized by order, and thus a lowering entropy state (see ideas of Schrodiger).

If we want to examine if entropy of living beings during evolution is actually increasing or decreasing, we must abandon human-created terms such as "order", and instead check-out for entropy changes using more objective tools and concepts such as "heat release", etc.

For instance, one might argue that for a nonliving object, such as a random stone, all the reactions of living beings are meaningless. A stone only perceives life as a whole to be a chemical disordered chaos. On the other hand, we are what we are because of some properties of these reactions. Hence, through our perspective, there is a lot of order there.

Remember that previously we said that human is not a neutral objective observer of things, but he is changing together with the system. This confuses him. It means that if human entropy is raising slower than the whole living systems entropy, he will think that his entropy is lowering. One example is this: Imagine a large number of birds that are flying one next to other to the same direction. If we tell them to fly one apart from the other, so the group will start separating, the entropy of the system will start raising. Imagine also that there are three birds that are very close to each other, somewhere in the group. If they separate with less speed than the others and we consider these 3 birds as a system the systems entropy will actually lower relatively with the whole system of the birds.

As we said, we are viewing the world through our eyes. This can lead to some subjectivities and misconceptions of our viewpoint, especially with respect to systems in which we are ourselves involved. We can objectively judge changes in entropy in systems we are not involved, but in a system of reactions e.g A+B->C+D+....X+Z, if the reference frame (i.e. observer) is an insider subgroup of this system (for instance K+L->M+N), and judges changes in entropy inside larger systems, then this subset can only perceive entropy changes relatively to themselves. Remember the example of the birds.

Question: Someone might say that if living beings are only a sum of complex chemical reactions then what prevents them from degrading into chemical chaos? For instance, if there is not a major adverse event or a catastrophic external factor, how can a human maintain its body structure at a viable state for nearly 100 years instead of spontaneously degrading towards a higher entropic state?

A possible answer lies in our inability to fully appreciate and comprehend big numbers.

(Note: The numbers used in this comment are rough approximations. They are used as an example in order to better explain my thoughts).

Let's assume that human body everyday degrades towards a higher entropic state. Let's assume for this reason, that after each day, the body loses, let's say hypothetically 100 thousand of chemical reactions. Suppose we have an 80 years old man. He has lived 29200 days. This means that he has lost or changed nearly 3 billion reactions during his lifetime. If the total amount of chemical reactions he has in his body is, let's say 1 trillion, then after 80 years he will be composed of 997 billion reactions, which means virtually still 1 trillion. So the impact of the whole process on the chemical reaction count will be almost negligible macroscopically.

Question: How can chemical reactions like that gain or sustain their repeatability, so we see repeated patterns in life (eg. reproduction)?

Although in theory a process that can protect some repeatable reactions can evolve and be selected, another option is possible, that personally I think is more likely to be the case. And the second thing is this: Are there truly repeatable processes in nature? For instance, if a descendant is 99% the same as its ancestor, and they are both composed of 100 trillion reactions, this means they differ by 1 trillion reactions. Also, if you have two systems of 100 organic compounds with various stereochemistries that interact with each other and they become increasingly complex to the point that each system becomes 100 trillions of different compounds, then one would expect that 99% percent of the compounds of one system will be somewhat similar to the other system, only as a result of pure chance.

Now if two systems of 100 trillion reactions or possible interactions are exposed to the same chemical laws and conditions (variability prevails, hydrophobic bonds, adhesive properties prevail, stable molecules prevail, influx of external substances, same temperature, etc etc, then the two systems that will be mainly composed of the same substances, will share approximately the same fate, at least to our eyes. Because if by 95% the same thing happens in both systems, this means they differ by many trillion reactions, but for us, it is enough to consider the two processes identical.