

Abstract for the general public

Reconstructing the process of cellularization at the origin of life

This project aims at reconstructing one of the important processes that happened at the origin of life: the process of cellularization (i.e. formation of a cell delimited by a membrane). This event is what truly marked the beginning of life as we know it, because only after cellularization has taken place, we can talk about having an individual cell, a discrete “unit” of life. So how do we plan to reconstruct this?

We start from a very central concept: life is a cyclic phenomenon. This can be seen at all levels, from biochemistry to physiology to ecology - think of the life/death cycle as a prime example. It seems logical, therefore, that life was born out of a cyclic process.

One of the most interesting cyclic processes that have been proposed is wet/dry cycles, in which a small body of water (think of Charles Darwin’s proverbial “warm little pond”) is being cyclically dried and rehydrated. It’s amazing what can happen just by doing something as simple as this: scientists before us have shown that many molecules that constitute the basis of life, such as small proteins and RNA, can spontaneously form in these conditions! In this proposal, we are modifying this cycle a bit to accommodate the needs of membranes, because we want to study specifically their role in the process of cellularization. In our lab, we have been able to recreate a “membrane cycle” that leads to the formation of so called “proto-cells”, and in this project we want to understand exactly how this process unfolds.

In addition, we want these proto-cells to have a metabolism of their own, because this is integral part of the process of cellularization. Again, based on the work of scientist that addressed this problem before us, we have a fairly good idea of what molecules need to be present in order to kickstart a simple metabolism. The question is: will it work inside our protocells, in our experimental conditions? In order to achieve this, we first need to encapsulate all these molecules in our protocells: this turns out to be easier said than done. This is because some of these molecules and elements, such as Chromium and Zinc, can be “toxic” to protocell. It will require a lot of try and error to be able to get them inside proto-cells in just the right amount. And this is the beautiful thing about this project: it delves into the unknown, into uncharted territory. No AI can help you there: this requires human curiosity and imagination.

What will we get out of this? I wish I could tell you we will recreate life in the lab. I have no doubt this will happen at some point, but it will take longer than the four years that this project will last. But we will get a little bit closer, and we will have a clearer idea on how it can be done.

There are also other outcomes. We may be able to tell what are the condition for proto-cells to emerge, which is a very important piece of information in our search for life in the universe: sending probes to other planets is very expensive, so we’d better know what we are looking for, and look in the right place.

We will also shed light on a very old question: you may be surprised, but even seasoned scientists who have spent their entire life studying this topic don’t know exactly what life is. Or, to be more specific: they think they know, but they can’t agree with one another. This is because their definition depend on their point of view, and there are several, apparently incompatible, points of view. What is urgently needed is some kind of convergence point, where these different theories can be tested and compared. This is precisely what we are trying to do by building this system, because only by building consensus we can hope to progress in our quest to understand and recreate life.