Cohort: November 15, 2022

Project Title: Epistolution: Could Oscillators Drive Function During Development?

Project Description

The current gene-centered interpretation of life represents organisms as replication vehicles driven by encoded information in the genome. This explanation poorly matches experimental results that show redundancy in the genome, indirect causal connections from genes to traits, and large amounts of non-coding genetic material. Knockout experiments suggest the majority of genetic coding regions may not affect phenotype under normal conditions [1]. In addition, a gene-centered view would not predict that epigenetic changes or behaviors could be heritable under many conditions, that some organisms can rearrange their genomes, or that mutations are often nonrandom with respect to function [2-4].

All variations have a genetic basis, but we now know that epigenetic and behavioral influences can also be inherited. If this is the case, then it shows that these non-genetic changes in the cell and the organism are independent drivers of function. If they were not, then they would be spoiling the usefulness of the information accumulated in the genome, and quickly driving lineages with these types of inheritance extinct. With no bias toward function, heritable changes at these levels would be a runaway process, like a game of "telephone." Epistolution is the idea that evolution must be united with epistemology, the sources of learning during development.

The DNA sequence changes very little during development. Therefore, the DNA sequence could not be flexibly controlling its own expression patterns during a cell's lifetime, causing epimutations that enhance function. Natural selection only acts between generations, not during development. In order for function to accumulate during development there must be a separate blind search being conducted at the level of the organism for functional configurations. This requires that we view all organisms as systems that are composed of smaller units that can be filtered by interaction with the environment during active life.

All organisms have biological rhythms driven by oscillators, and these rhythms are critical in integrating chemical processes. We define an oscillator as any chemical process in an organism that happens rhythmically with a causal connection to other chemical processes. These oscillators could form the units that are filtered during the process of development, reacting to the environment adaptively. Natural selection picks between organisms based on survival and reproduction. What could be the filter applied to oscillators during development? It must be some form of Lamarckian filter sorting use from disuse. Organisms respond to their environments by strengthening in some networks that are exercised and atrophy in networks that are in disuse. Sleep and dreaming, which have convergently evolved in distant lineages, may play a role in this cycle of damage and repair [5].

Our project is to build and test software-only prototypes of this hypothesis using a connectionist model of basal cognition. If we can blindly generate a network of oscillators which can acquire learning and memory, this might provide a model of cell-level and organism-level problem-solving. This could better explain how life could be instructed, as well as selected, by the environment. Once validated, this model might be used to understand and control non-genetic biological plasticity, goal-directedness, and purposive behavior, including the behavior of extracellular vesicles.

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