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Evolutionary Processes of Living Systems: Mechanisms of Driving Autonomous and Cooperative Systems to Work and Evolve

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The internal systems of an organism are composed of many different systems of matter, phase flows, and networks that coordinate and function together to regulate the organism's autonomy and responsiveness to the external world. These systems have evolved through interactions between organisms and their environment. This study proposes several hypotheses that explain and generalize the mechanisms of evolution and coordination of these living systems based on physical laws and models. In Chapter 1, we propose several hypotheses to generalize physical phenomena related to living organisms. In Chapter 2, we propose several hypotheses to explain the processes and mechanisms of chemical evolution and selection of substances as biomolecules. In Chapter 3, we propose several hypotheses to explain the evolutionary process and mechanism of formation of living systems.

Key words: evolution of life system, entropy, chemical evolution, physical phenomena, biomembrane

1. Physical phenomena relevant to living organisms

2. Chemical evolution

3. Evolutionary process of living systems

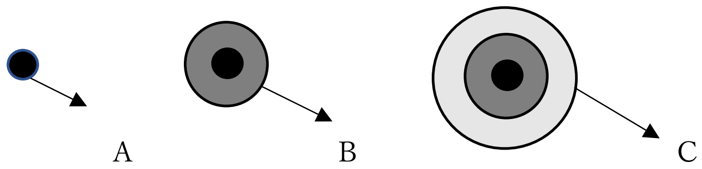
1． Physical phenomena relevant to living organisms

1.1 Backgrounds and Objectives

Organisms are organized as units of parts that combine their constituent components, and the combination and network of reactions of different systems maintain their vital activities. These systems have evolved in interaction with the environment. We will attempt to generalize this process as several mechanisms. Several of the hypotheses in this paper are related to several of the previously proposed concepts of dissipative adaptation.

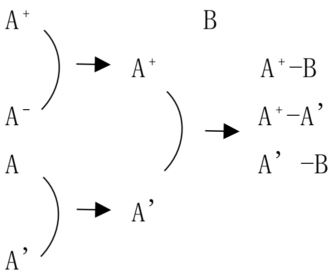
1.1.1 Hypothesis 1

Do materials aggregate on a surface of the sphere, forming a new layer composed of different materials, and react differently than before with the outside world at the surface boundary surface to produce new materials?



1.1.2 Hypothesis 2

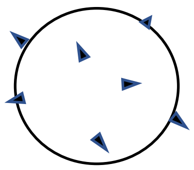
Of the substances produced in this way, do those that are advantageous for survival remain, then do they combine to leave a higher-order, more advantageous individual for survival?



(-This is a generic conceptual diagram.)

1.1.3 Hypothesis 3

Membrane structures are pressurized inward by surface tension, and membrane structures become distorted by the bias of the materials that compose them and by the attachment of materials from the lumen and the outside world. Then channels are created to release internal energy. Is this an inevitable phenomenon according to the laws of physics, in which energy converging from the outside to the center must be released to the outside in order to maintain the physical individual? Since the membrane structure takes in fat-soluble substances and the absorption and dissipation processes are not equivalent, and homeostasis cannot be maintained by ATP or enzymes, the physical properties and functions of the membrane structure deteriorate over time, resulting in deterioration of the membrane structure and the process like this contributing to cell death?

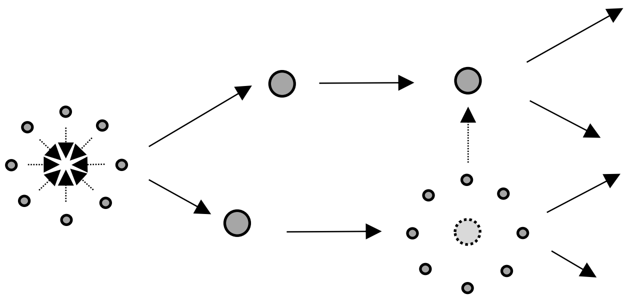


1.1.1 Hypothesis 4

Individuals in the environment maintain their structure by exchanging substances with the outside world through channels. In the competition for survival among individuals, the individual that exchanged substances efficiently and was superior in the competition for survival was eliminated. In this process, were the channels responsible for transmitting individual substance in and out, transmitter substance, and methods of transmission selected along with the individuals?

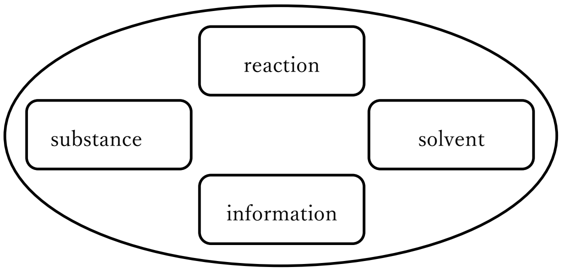
1.1.4 Hypothesis 5

Do repeatedly discrete and aggregating materials, in a slow aggregation process, learn by selection pressure and produce adaptive individuals in their environment? Do the resulting more adaptive individuals persist longer in the environment? On the other hand, are the less adaptive individuals degraded sooner and absorbed into the formation process of more adaptive individuals, or do they attempt the cohesion process again? Through the repetition of such a process, is the system selected for the formation of more adaptive individuals, and does it repeat live and die, then become a life to evolve by selection?

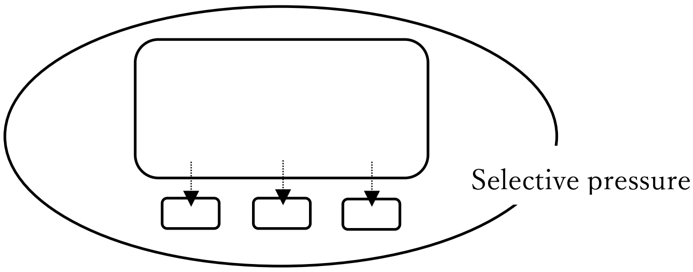


1.1.5 Hypothesis 6

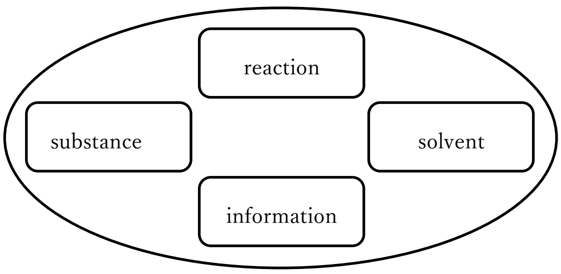
Do the elements of the system involved in increasing and decreasing entropy by interaction and transformation within the organism - chemical reactions, biomolecules, solvents, and information - undergo selection by other element as those exposed to entropy when their influence power to others is small, while they select other elements as entropy-producing solvents when their influence power is large?



Influence of one elements increase.



Other elements are eliminated, the system evolves and stabilizes.



1.1.7 Hypothesis 7

Does the organism by breaking down the waves received from the outside into different waves unique to the organism, discarding noise and waves that are not in sync with the waves in the organism, and generating waves that are synthesized again from the unique waves changed in amplitude by amplification and attenuation in the organism? By generating new waves, do organisms improve the harmony of the in vivo system and its interaction with the outside world?

(Please note that this is untested hypothetical paper and additional experiments are needed to establish evidence.)

2. Chemical evolution

2.1 Background and Objectives

Organisms use biomolecules such as nucleic acids, lipids, and amino acids as the basic substances of organization. These biomolecules provide many structural and functional benefits to the organism.

Matter in the universe is moving toward increasing clutter and divergence due to the law of increasing entropy, while life is seen as a system that resists increasing entropy through energy input.

In complex systems, life is explained by a mechanism in which matter interacting with each other undergoes a phase transition beyond a certain critical value to create order and become an autonomous cooperative system.

Many studies have been conducted on these topics to understand living systems and to elucidate the evolutionary process of life.

Here we propose several hypotheses concerning the analysis of the functional significance and structure of biomolecules, chemical evolution and the environment, mechanisms by which living systems resist increasing environmental entropy, and a framework for the theoretical generalization of living systems.

2.1.1 Hypothesis 1

In the environment, did substances that increased their own potential for existence and were adaptive to the environment persist for long periods of time? In addition, were substances that are changeable and responsive advantageous for adapting to a changing environment as to persist?

2.1.2 Hypothesis 2

Biomolecules in a dynamic equilibrium must be reversible in their formation and degradation, and for their formation and degradation to be reversible in water as a solvent, they must undergo dehydration-condensation and hydrolysis. Therefore, were nucleic acids, amino acids, and lipids, which have hydroxy, amino, and carboxy groups and are elongated and degraded by dehydration-condensation and hydrolysis, selected as biomolecules?

2.1.3 Hypothesis 3

Were the high temperature and pressure in the vicinity of the hydrothermal vents, where chemical reactions in which molecules are added to each other by concerted reactions can easily process and pyrimidine and purine bases which are less degradable in the environment formed and remain?

2.1.4 Hypothesis 4

Although energy derived from heat is supplied near the hydrothermal vents, was the area suitable as an environment for experimenting biomolecular reactions because explosive reactions were unlikely to occur due to the high pressure and the low dissolved oxygen content caused by the supply of hydrogen?

2.1.5 Hypothesis 5

In living organisms, among the reactions between biomolecules, thermal energy is distributed throughout the system and affects the reactivity between molecules, whereas light energy has a different amount of energy accepted depending on its structure and position, disrupting biomolecular bonds in a disorderly manner and making it difficult to maintain order in the system of reactions. In addition, many of reactions caused by heat are reversible, whereas those caused by light are often irreversible. Therefore, for organisms that wished to discipline the reaction as a whole system and control the reaction reversibly, was heat preferable to light as an energy source for reactions between biomolecules?

2.1.6 Hypothesis 6

N (nitrogen), C (carbon), and O (oxygen) have their bonding distances are of similar length then, five- and six-membered rings composed by them are geometrically symmetrical. Therefore, was it allowing pyrimidine and purine bases to arrange nucleic acids composed of these elements complementary to each other through hydrogen bonds?

2.1.7 Hypothesis 7

In the vicinity of hydrothermal vents, do precipitation of materials settling in seawater and increased solubility of materials due to thermal energy cause water molecules to be used for hydration and facilitate dehydration-condensation reactions? Did the dehydration-condensation reaction between biomolecules proceed by such a mechanism?

2.1.8 Hypothesis 8

Were nucleic acids, amino acids, and lipids, which were persistent, cohesive, and extensible, did they suitable as biomolecules that enhance the possibility of their own existence?

2.1.9 Hypothesis 9

Since nucleic acids can react with nitro compounds, and in the primitive earth environment of active volcanism, did nucleic acids become the basic building blocks for life that responded to changes in the environment?

2.1.10 Hypothesis 10

Were nucleic acids with conjugated π-bonds used as biomolecules in organisms that have responsive dynamics to changes in temperature and pressure and respond to changes in their environment?

2.1.11 Hypothesis 11

Were amino acids, pyrimidine and purine bases and their derivatives used as biomolecules, the basic components of living organisms, because they had amino and carboxy groups, etc., and interacted easily with metal ions and vitamins? Also, were these substances easy to discipline orientation in arrangement and bonding due to their polarity?

2.1.12 Hypothesis 12

Do organisms use endothermic reactions as one of the means of resisting increasing entropy?

2.1.13 Hypothesis 13

Do membrane and network structures warp the connectivity of physical interactions by their structural specificity?

2.1.14 Hypothesis 14

Do biomembranes sequester chemically unstable substances inside, thereby protecting them from vulnerability to environmental changes and maintaining their reactivity?

2.1.15 Hypothesis 15

Because there were many charged materials in the vicinity of the hydrothermal vents, did the insulating properties of the biomembrane function to protect the intracellular materials?

2.1.16 Hypothesis 16

Do organisms use the fluidity of membrane structures to resist environmental entropy by dispersing vertically applied pressure, attenuating molecular motion, etc.?

2.1.17 Hypothesis 17

Has organism isolated unstable materials inside itself and used them as a center for processing information received from the outside?"

2.1.18 Hypothesis 18

Did the biological membrane of the organism function to maintain a lower temperature inside the cell by lowering the heat of the biomembrane through an endothermic reaction at the surface of the biomembrane?

2.1.19 Hypothesis 19

Is the structure of a network surrounded by membrane structures the basic structure of life that maintains internal homeostasis, abstracts information, and increases residence time in the environment?

2.1.20 Hypothesis 20

Are network and membrane structures important for organisms in that they can be reused repeatedly and that the distance between structures does not change, using these structures to separate complex reaction cascades by scalars?

2.1.21 Hypothesis 21

Did the biological membrane of the organism inhibit RNA degradation by preventing air bubbles from entering the tissue?

2.1.22 Hypothesis 22

Does the organism load entropy onto its own tissues to enhance adaptability?

2.1.23 Hypothesis 23

Do organisms resist increasing entropy by increasing the complexity of the dynamic equilibrium?

2.1.24 Hypothesis 24

Do organisms organize adaptive individuals to changes in environment and time by taking in what they need and expelling what they do not need as a result of maintaining dynamic equilibrium? Do they also resist environmental entropy by separating and reorganizing entropy as selection pressure into information, matter, time, and quantity?

2.1.25 Hypothesis 25

Do organisms use sequences of nucleobases to shrink the spatial and temporal proximity of different information acquired at a point of separation and resist entropy growth?

2.1.26 Hypothesis 26

The biomolecules that establish dynamic equilibrium must be reversible in formation and decomposition, and for formation and decomposition to be reversible in water as a solvent, dehydration, condensation, and hydrolysis must occur. Therefore, were nucleic acids, amino acids, and lipids, which had hydroxy groups, amino groups, carboxy groups, etc. and be elongated and decomposed by dehydration condensation and hydrolysis which are elongated and degraded by dehydration-condensation and hydrolysis selected as biomolecules? Also, were these molecules suitable, as biomolecules, because of their diversity, selectivity (easy interaction with molecules of similar structure), modifiability, and uniqueness of three-dimensional structure under certain conditions?

2.1.27 Hypothesis 27

Do organisms use a plateau of dynamic equilibrium to cope with the unpredictability of environmental change, respond to environmental changes, and remain in the environment for long periods as a result of maintaining dynamic equilibrium?

2.1.28 Hypothesis 28

Do organisms recognize stress as an external factor that interferes with the steady state of biological responses that signal the approach to the collapse process and attempt to avoid the collapse process through tension, stress response, or escape?

2.1.29 Hypothesis 29

Does the network structure generate hypotheses by synchronizing internal and external phases?

2.1.30 Hypothesis 30

Is organism a system that enhances the necessary and sufficient nature of the hypothesis based on the results?

2.1.31 Hypothesis 31

Is it possible for nucleobase sequences to conserve the likelihood of past information owing to the equivalence and interchangeability of bases and alignment in nucleobase sequences? Does this mechanism allow nucleobase sequences to recover information from the near past/more important information more quickly?

2.1.32 Hypothesis 32

Does the organism remain in space and time by dying in response to an increase in entropy as a stress that it cannot cope with, and move to a point where entropy decreases?

2.1.33 Hypothesis 33

Is the organism a system that tries to maintain the likelihood of restoring itself in harmony with entropy?

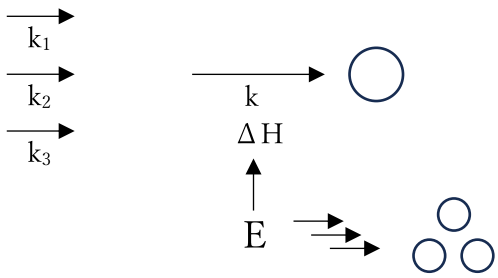
3. Evolutionary process of living systems

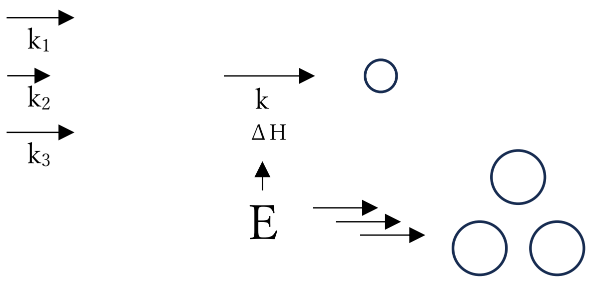
3.1.1 Hypothesis 1

In general, life, which is established by the combination of different substances and the concert of various chemical reactions, which is oriented toward the stability of the physicochemical parameters of the environment, and which accepts energy through chemical reactions. Therefore, is it likely to occur and evolve at the boundaries of physicochemical phases in the earth environment, such as hydrothermal vents, seawater surfaces, rock surfaces, and ground surfaces?

3.1.2 Hypothesis 2

Organisms converge systems of reactions in rate-limiting reactions, and for a given system of reactions, the reactants of the rate-limiting stage are satisfied and the products increase when the reactions of the preceding stage are sufficiently advanced. Subsequently, energy is consumed, and the energy distributed to other reactions in the system is reduced. On the other hand, if the reaction in the preceding stage does not proceed sufficiently, the reactants in the rate-limiting stage are insufficient, and the products decrease. Then, energy is not consumed, and the energy distributed to the reactions in the other systems





Thus, when the sufficiency of the reactants in the rate-limiting step is satisfied, the reaction of the system is enhanced and the products increase. On the other hand, when the sufficiency of the reactants in the rate-limiting is insufficient, the reaction of the system is inhibited and the products decrease. By such a mechanism, the organism optimizes the distribution of energy and the balance of the system of reactions?

3.1.3 Hypothesis 3

Is the death of organism also a process of expulsion of unnecessary information, waste products, and parasites accumulated during its existence?

3.1.4 Hypothesis 4

The segregation of organisms in their environment may also be caused by differences in specific gravity, viscosity, and velocity of locomotion, etc. Do these different physical parameters reduce the likelihood of contact and interaction between individuals?

3.1.5 Hypothesis 5

Do higher organisms have greater material continuity during their transgenerational processes?

3.1.6 Hypothesis 6

On Earth, are organisms in calm environments more vulnerable to sudden major changes in their environment, whereas organisms in extreme environments are more resistant to sudden changes in their environment?

(Please note that this is untested hypothetical paper and additional experiments are needed to establish evidence.)

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