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Hypotheses on Evolutionary Processes for Autonomous and Cooperative Mechanisms of Living 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

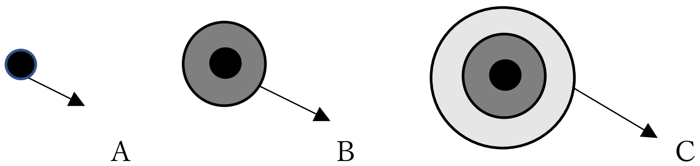
1． Physical phenomena relevant to living organisms

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.

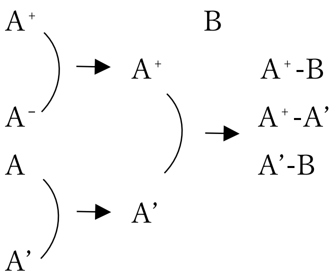
1.1.1 Hypothesis 1

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

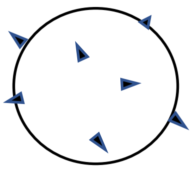
Of the substances produced in this way, do those that are advantageous for survival remain, then do they combine to leave a higher-order, more advantageous individual for survival?



(-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?

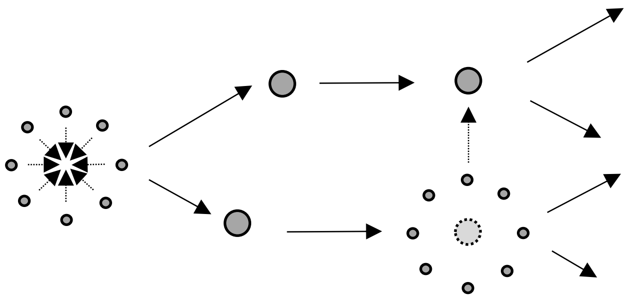


1.1.1 Hypothesis 4

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?

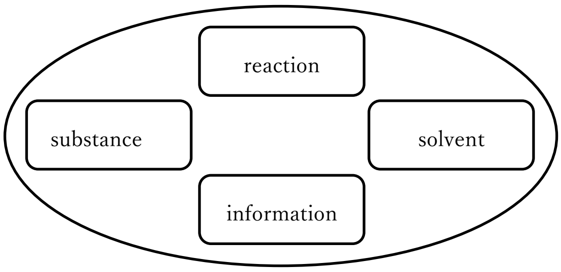
1.1.4 Hypothesis 5

Do repeatedly discrete and aggregating materials, in a slow aggregation process, selected 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?

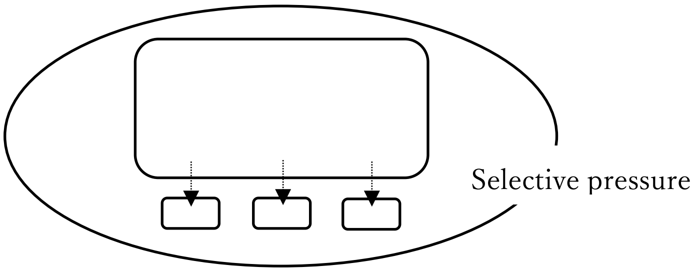


1.1.5 Hypothesis 6

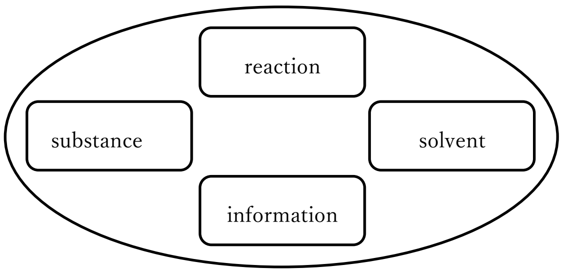
Do the elements of the system involved in increasing and decreasing entropy by interaction and transformation within the organism - chemical reactions, biomolecules, solvents, and information - undergo selection by other element as those exposed to entropy when their influence power to others is small,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



Influence of one elements increase.



Other elements are altered, the system evolves and stabilizes.



1.1.7 Hypothesis 7

Do organisms break down external waves into unique, internal waves, discarding noise and waves that are not in sync with their inherent oscillations? By doing so, do they then generate new waves, synthesized from these unique waves after being amplified or attenuated? This process could potentially enhance the harmony of the internal system and its interactions with the external environment. (- This mechanism is conceptually associated with the Belousov-Zhabotinsky reaction[1])

1.1.8 Hypothesis 8

In some biological processes, do adaptive substances, by remaining in the environment for long periods of time, increase their self-restoration potential function as direct feedback by moving back up the reaction cascade through reverse reactions that occur with little probability (Such mechanisms may be related to biological processes such as RNA reverse transcription and reverse reactions with ionic liquids).

high probability

→

low probability

←

(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.

The vicinity of hydrothermal vents on the ocean floor is one of the candidate sites for the birth of life.

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.

Mechanisms by which organisms resist increasing entropy include motor proteins, Maxwell's demon, clear-flow diodes, and materials that exhibit polarity with respect to forces [2].

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 (the edge of chaos) to create order and become an autonomous cooperative system[4].

Complex systems theory states that life evolves by increasing complexity through coevolution[3].

It also states that life arises as an intermediate between randomness and rigor[3].

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

Note that some of the hypotheses in this paper are novel and related to the concepts of dynamic equilibrium, the edge of chaos[4] and dissipative adaptation[5].

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

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?

2.1.3 Hypothesis 3

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?

2.1.4 Hypothesis 4

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?

2.1.5 Hypothesis 5

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?

2.1.6 Hypothesis 6

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?

2.1.7 Hypothesis 7

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?

2.1.8 Hypothesis 8

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?

2.1.9 Hypothesis 9

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?

2.1.10 Hypothesis 10

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

2.1.11 Hypothesis 11

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

2.1.12 Hypothesis 12

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?

2.1.13 Hypothesis 13

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

2.1.14 Hypothesis 14

Has organisms isolated unstable materials inside itself, thereby protecting them from vulnerability to environmental changes and used them as a center for processing information received from the outside?

2.1.15 Hypothesis 15

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?

2.1.16 Hypothesis 16

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?

2.1.17 Hypothesis 17

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?

2.1.18 Hypothesis 18

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

2.1.19 Hypothesis 19

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

2.1.20 Hypothesis 20

Do organisms also resist environmental entropy by separating and reorganizing entropy as selection pressure into information, matter, time, and quantity?

2.1.21 Hypothesis 21

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?

2.1.22 Hypothesis 22

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?

2.1.23 Hypothesis 23

Do organisms use internal circulation to create a phase flow within the body that is different from that of the outside world, thereby increasing resistance to increasing entropy?

2.1.24 Hypothesis 24

Do organisms resist increasing entropy by determining responses to changes in the environment as vectors with a certain direction and magnitude, thereby converging metabolic and motor processes?

2.1.25 Hypothesis 25

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?

2.1.26 Hypothesis 26

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

2.1.27 Hypothesis 27

Is organism a system that enhances the necessary and sufficient nature of the hypothesis based on the results? More theoretically and strictly speaking, organisms may be using feedback from the environment to generate efficient models for analyzing and coping with the world. (This is based on the concept of Existence Structure and Bayesian estimation[6])

2.1.28 Hypothesis 28

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?

2.1.29 Hypothesis 29

Do organisms die by accumulated responses to increasing entropy?

2.1.30 Hypothesis 30

Do organisms select for spatiotemporal pathways by reducing their interactions with the environment as cysts and gametes and moving through space and time? Cysts and gametes of organisms do not interact with the environment, but behave passively and create pathways in space-time. In this case, it may be important for connections to be made between locations that are temporally and spatially distant from each other.

2.1.31 Hypothesis 31

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

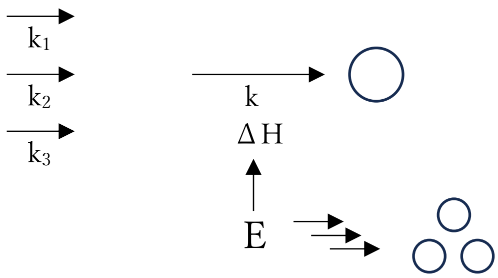
3. Evolutionary process of living systems

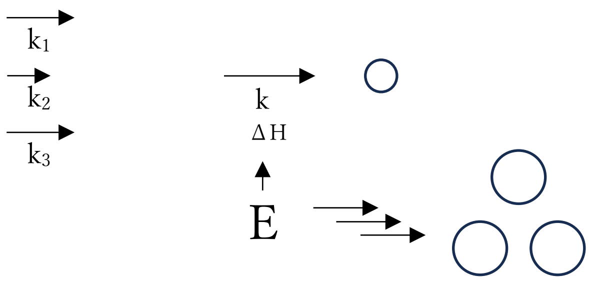
3.1.1 Hypothesis 1

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?

(This is untested hypothetical paper and additional experiments are needed to establish evidence.)

Discussion

In chemical evolution, the view that the integrity of microscopic structures and mechanisms supports the discipline and organization of macroscopic structures seems important. More specifically, it may be appropriate to say that systems with microscopic integrity and dynamism are selected for by the dynamism of the environment. It may also be important that organisms have an internal space. The mechanism of isolating the unstable substances in the internal space and allowing them to perform important functions may be applicable to many mechanisms of living organisms. It may be important to clarify the relevance of entropy, selection pressure, stress, and tension/relaxation (and even aging) mechanisms in the evolution of organisms. They are the processes of coping responses to time and change. In addition, their common feature of being surrounded by membrane structures may be important because of their association to counteract selection pressure. Also, by being surrounded by the cell membrane, the vectors of the cell's biochemical cascade are synthesized as vectors with a specific direction and magnitude of reaction and movement of the cell as a whole (and it may be important that these vectors have inertia or acceleration). Could such a mechanism have been one of the means by which the cell resisted increasing entropy? It may also be important to consider how topologies such as membrane structures and networks have conferred advantages on life. These would have given it the property of eliminating noise, abstracting information, and returning to a stable state. The evolution of the mechanisms that control and coordinate these dynamics may also be an important aspect of the evolution of life. At the boundaries of physicochemical phases, such as near hydrothermal vents, rock surfaces, ocean surfaces, and bedrock surfaces, energy conversion occurs by excitation, scattering, and absorption of light, and under such conditions it is easy to acquire free energy in the process. In addition, phase transformations are maximized and equilibrium is reached at the boundaries. The formation, adsorption, sedimentation and levitation of complexes may be related to the process of life and evolution. Temporal and spatial fluctuations may have been important for the origin and evolution of life. In contrast, contact between different systems may have been important for the coordination of different reactions and systems. It may be possible to think of life as the extraction of systems that resist entropy from fluctuations. What generalization is possible if we think of life as both a convergent and a divergent process, and death as both a convergent and a divergent process? What does the organism control itself and what does it leave to external control in this process? In addition to the process of differentiation of genetic traits, the process of convergence may also be important for biodiversity (horizontal transmission is also considered). It is also a process of abstraction of information in the environment that is important for the organism. Thus, the repetition of diffusion and convergence is an aspect of the dynamism of life.

Therefore, it is likely that the adaptive individuals in the environment are those on the edge of chaos. Individuals at the edge of chaos are more likely to be selected for because 1. they have longer residual time, 2. the balance between risk and opportunity, cost and performance are balanced, 3. genetic diffusivity and convergence are in harmony, 4. they have useful information, 5. individual fluctuations and environmental fluctuations are in harmony, 6. the balance between the accuracy of past learning and future prediction is balanced.
Furthermore, based on the hypotheses in the text, it may also be possible to define in general that "life system is an entity that organizes the dynamics of its parts and the whole, and metabolizes and exercises to increase the possibility of its existence". And more abstractly, it may be possible to define life as a system that resists increasing entropy by organizing time, place, continuity, and dimension.

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