MODELING OF BIOEVOLUTION BY NONEQUILIBRIUM THERMODYNAMICS METHOD

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The purpose of research - a statement of the method of studying bio evolutionary phenomena, as well as a method for evaluating the stability of dissipative structures.

Materials and methods of research. In chemical physics, thermodynamics, biology, there are general patterns that characterize the phenomena occurring. In this respect are essential questions of stability (instability) of the studied systems, dissipative diffusion entropy production, etc. Therefore, the study of phenomena bio evolutionary refer to the method used in the above mentioned fields of science.

One of the most profound consequences of non-equilibrium thermodynamics is manifested in the duality of the irreversible process: as the destroyer of order near equilibrium, and as the founder of the order of far from equilibrium. For systems far from equilibrium are not met the general principles of extreme predicting the state to which the transition of the system. In absent extremum principle uniquely predictive state to which seeks nonequilibrium system is a fundamental property of nonequilibrium systems. In contrast to equilibrium systems that convert to a state of minimum free energy nonequilibrium systems can develop unpredictably: their condition is not always uniquely determined by macroscopic equations. This stems from the fact that under the same set of conditions, the non-equilibrium system may move to different states. The reason for this may be fluctuations, small inhomogeneities, defects or other random factors. Which of a particular system will, in general, can not be predicted. The new state is achieved in this way are often "ordered states" that have space-time organization. The fundamental property of nonequilibrium systems is manifested in the ability to transition to an ordered state as a result of fluctuations - t. E. To carry out the "order through fluctuations".

In nonequilibrium systems by chemical reaction and diffusion may be fluctuations in the concentration and spatial structures; in a closed system is the same dissipative processes blur the heterogeneity and bring the system to a homogeneous, time-independent equilibrium. Since the emergence and maintenance of organized non-equilibrium states due to dissipative processes, these states are called dissipative structures.

The concept of dissipative structures and order through fluctuations into account the basic properties of nonequilibrium order.

The first model of dissipative structure dedicated to the issue of the spontaneous formation of dissipative structures was proposed by Turing. In this work, in general conditions were obtained under which breaks resistance to disturbances.

The theory of dissipative structures originated in biology, has been applied in physics and chemistry. Heterogeneous spontaneously occurring structures were observed and investigated in chemical reactions, superconductors, plasma, etc. Many processes in the thermodynamically nonequilibrium conditions and accompanied by dissipation of energy, there are dissipative structures. Dissipative structures included as an essential part of a new scientific direction - Synergetics.

Synergetics deals with the study of systems consisting of subsystems of different nature (cells, mechanical, energy bodies, biological and others.). The interaction of these subsystems leads to spatial, temporal or spatio-temporal structures in the macroscopic scale. At the same time, special attention is paid to situations where the structures are the result of self-organization.

Synergetic processes are manifested in muscle contraction, leading to all sorts of movement, electrical oscillations in the cerebral cortex, the formation of the charge electric fish, recognition of images, speech, etc.

The distinctive synergistic systems include stochasticity. Temporal evolution of synergetic systems depends on the reasons for not predictable with absolute precision. These reasons can be accounted for by introducing the so-called fluctuating forces.

In heterogeneous systems as a result of unequal concentrations of the components occurring diffusion processes. Diffusion leads to a uniform distribution of matter in the system, but when it is associated with an autocatalytic chemical reaction in non-equilibrium conditions, there are irregularities t. E. The spatial structure. For the formation of such structures reagent diffusion coefficients must be different. If the diffusion coefficients are almost equal, the diffusion does not cause instability; Diffusion only aligns existing heterogeneity. If one component diffuses faster than the other, the concentration of the other component is reduced in the small region. If this happens, the homogeneous state becomes unstable, and heterogeneity begin to grow.

Instability leads to organized states. These instabilities appear in the given system of chemical reactions. In nonequilibrium chemical systems can also manifest instability due to the introduction of these systems are new chemical components that cause new reactions; these new reactions can destabilize the system and bring it into a new state organization. In this case, a set of chemical reactions is the object itself changes. Each new component affects the kinetics of reactions and it can radically change the state of the system, ie. E. Due to the introduction of new chemical components of the system may become unstable and move to a new state.

This type of structural instability of the easiest way may be found in the evolution of "self-replicating" polymer molecules with permanent pri¬tokom monomers. Each new structural instability in general increases the dissipation or entropy production in the system. Structural instability may gradually lead to states of nonequilibrium systems with higher entropy production and order.

Many reactions can occur several cooperative interaction of reactants on a single enzyme, particularly if it has multiple active sites; Some of these catalytic sites, other regulatory. When specific effector molecules are attached to the regulatory regions, the catalytic function of the enzyme varies considerably. In some cases, the molecule that react produced by catalytic site or may act as effector molecules. These include - turn off the feedback loop.

Self-organization at different stages of evolution can occur in two different ways. The first mode is increased and the variety of possible system properties. This - divergent phase, it is necessary to search for new opportunities of existence. On the second - a variety of properties decreases, but the system (or its components) improved, so. E. The best adapted to the conditions. This corresponds to the stage of convergent evolution and adaptation processes in the classical sense. These two types are alternated in the development of self-life and any living object, each of them prepare other conditions.

The results of research. Sustainability criteria and follow the evolution of the general provisions of nonequilibrium thermodynamics.

In addition to concentration fluctuations in the system can occur fluctuations of a different type, seeking to change averaged (deterministic) laws of evolution. For example, may suddenly appear was absent earlier "mutant" or "wrong", a copy of a polymer. Because this may be a new reaction pathway even when present in mutant negligibly small amount. Thus, as a result of mutant polymers can be important even small parameter, which in the macroscopic evolution is usually unimportant.

Spontaneous fluctuation, or mutation, can not be taken into account in advance in a deterministic equation, which is obtained by statistical averaging over a large number of elements. Rather, such a mutation is caused by some stochastic process.

In the early stages of the standard deviation in the state intensity increases dispersion expressed entropy production.

The connection between entropy and information is relevant, as is related to the specific questions: what is the entropy and energy fee information, etc.

These issues are particularly acute in relation to the biological characteristics. Firstly, the information systems in nature have small (microscopic) dimensions. Second, they function at normal temperature, i.e. in an environment where thermal fluctuations are not negligible. Third, in the special importance Biology memorizing and storing information.

The system must be dissipative, ie the real parts of the characteristic numbers of stationary states are negative. This is a prerequisite for storing information.

The information recorded in the DNA, can have positive, negative or zero value.

One of the most important concepts in thermodynamics is entropy. Typically, entropy is defined as the logarithm of the statistical weight.

Decrease in entropy in the selection phase of code means more information. It is due to the instability of the symmetric state. It is due to the instability of random variations lead to great effect.

In the development of this type of biological object or the lowest possible level of entropy production in the body, combined with existing external devices can be achieved only after synthesizes all basic substances necessary for survival, for which, of course, need a new power consumption. It is obvious that low dissipation gives the body an advantage in the selection. As the driving force of evolution should be considered energy dissipation.

Main line of prebiotic evolution is that the early stages of development of the system tends to the state with the most stable with respect to errors or fluctuations. Note that the search for optimal stability corresponds Darwinian principle of "survival of the fittest."