

## Water -- the Base of the Living State and Vital Functions

V.L. Voeikov

*Faculty of Biology, Lomonosov Moscow State University, Moscow, Russia.*

The dominant substance in all the organisms is water. Some hydrobionts where it represents more than 99% by their mass may be considered “living water”. However, to elicit most basic properties of this water making it so special one needs to define what a “living state” is.

More than 70 years ago Russian-Hungarian biologist Ervin Bauer formulated the fundamental principle of Stable Non-Equilibrium to differentiate between animate and inanimate systems: *“All and only living systems are never at equilibrium. At the expense of their free energy they ceaselessly perform work against equilibrium, demanded by the physical and chemical laws appropriate to the actual external conditions”*. Stable non-equilibrium (excited) state of matter is displayed at all the levels of a living system organization, including the molecular one. Inasmuch as the structure of matter in an excited state differs from structure of the same matter in the equilibrium (ground) state Bauer defined free energy of EXCITED structural elements of the living system (“living matter”) as “structural energy”. Growth and development of a living system goes on due to assimilation of food – conversion of its potential energy into structural energy of “living matter” and transformation of the consumed matter into a non-equilibrium state characteristic of living matter. All forms of work including assimilation of food as are performed by a living system at the expense of structural energy of living matter. To retard spontaneous relaxation of excited state of workable structural elements they should be so interdependent, that a living system may be considered a multilevel coherent system. All vital functions: metabolism and assimilation, multiplication, adaptability, excitability and even evolution may be derived from this principle.

However, Bauer’s theory of a living state does not consider how it could primordially emerge. Besides no conclusive answer is given to the question of what particular substance may stably reside in a non-equilibrium state and return back to it when it releases structural energy for the performance of useful work providing for the continuity of “living matter”.

We’ll reason here that unique properties of interfacial water (EZ-water after G. Pollack) fully meet all the requirements of the Principle of Stable Non-Equilibrium. Most important property of EZ-water is its electron-donating capacity due to much higher state of excitation of electrons in it in comparison to “bulk” water. The natural electron acceptor always present in water is oxygen. If energy of activation even in a form of a triggering stimulus is available EZ-water may donate electrons to oxygen, and the overall reaction of full oxygen reduction may proceed:



Though the molecular species at the left and right sites of this equation are the same (water and oxygen) up to 8 eV of energy may be donated by this reaction. It is structural energy (in Bauer’s sense) of EZ-water residing in the stable non-equilibrium state that is released when two water molecules belonging to it (left side of the equation) convert into the ground state water molecules (right side of the equation).

Part of this energy may be used for the restoration of EZ-water. If CO<sub>2</sub> and N<sub>2</sub> are present in water some part of energy may be used for their excitation and chains of chemical reactions in the course of which complex organic molecules are produced may be initiated. New surfaces turning water into EZ-water appear and the overall stock of structural energy of such aqueous system increases. Thus its ability to perform work against equilibrium enhances.

The necessary condition for this scenario to realize is availability of sufficient energy to keep enough water in a liquid state in which EZ-water (or coherent domains according to E. Del Giudice) and ground state water coexists. This is the necessary condition for spontaneous emergence and sustainability of living systems in all the forms known to us.