

FUNDAMENTAL ROLE OF WATER IN BIOENERGETICS

Vladimir L. Voeikov

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

Half a century ago Albert Szent-Gyorgyi introduced the term “Bioenergetics” in a small paper published in “Science” (124, 3227, p. 873, 1956). There he stated that to understand how energy is transformed into useful biological reactions we will have to introduce three new factors into our thinking: “water structures, the electromagnetic field, and triplets or some other unusual form of excitation made possible by water structures”. Contemporary textbook bioenergetics is nonetheless limited to “energy metabolism” -- the chemical reactions involved in energy transformations within cells, and even to a more narrow part of it – “ATP-related metabolism”. The peculiar role of water in it is practically neglected though one may suppose that the state of water at sites where $ATP + H_2O$ are produced from ADP and P_i and at sites where ATP is *hydrolyzed* should not be the same. The functional role of water still needs careful consideration even in “classical” bioenergetics.

However, “energy metabolism” may not be confined to biochemical machinery dealing with ATP synthesis and hydrolysis. In the paper cited above Szent-Gyorgyi prophetically asserted that “some more mobile and active form of energy has to go into biological action. Such an energy, on the molecular level, could hardly be anything other than the energy of electronic excitation” (EEE). Recently water became known to be one of the major sources of this high grade energy. It turned out that on the one hand water may serve as a transformer of low grade energy (for example, vibrational energies) into EEE, and on the other hand water may be directly oxidized by oxygen (a kind of slow burning, combustion) releasing EEE. These both forms of energy generation strictly depend upon the particular water structuring provided by its contacts with different surfaces, by the dissolved substances, by the organizing influences of external EM fields upon aqueous systems. In particular quazi-crystalline structure of interfacial water abundant in cellular and extracellular compartments significantly increases the efficiency of transformation of low grade energy into EEE by such water. Water oxidation by singlet oxygen (water combustion) catalyzed with antibodies has been shown to take place in blood. Besides, such a process may occur even in model aqueous solutions, in particular, in solutions containing a necessary component of organismal water, bicarbonate, acting as a catalyst of water oxidation.

EEE may be used locally for the performance of different kinds of chemical and physical work; it may accumulate and pool in aqueous systems and migrate within them without dissipation on macroscopic distances. Slow combustion in water and combustion of water is capable to self-organization in space and time expressed in the development of oscillatory-wave regimes of these processes serving as time-keepers of other biochemical processes dependent on them as well as sensitive antennas for external oscillatory signals.

Energy-transforming and EEE-donating properties of water are intrinsic to environmental water as well, be it atmospheric or hydrosphere water. Inasmuch as the expression of this property strongly depends upon chemical composition of aqueous systems, hydrodynamic conditions, electromagnetic situation, water treatment for drinking and other usage, this previously unrecognized property of water should be taken into consideration as a global environmental factor.