A model for active streaming: novel implications for the physics, chemistry and biology of water. Reuven Tirosh, Physics Department, Bar Ilan University, Israel.

Abstract**:** Active streaming (AS) is defined as being able to generate and overcome pressure gradients. A molecular model is proposed for spontaneous generation of such AS in pure liquid water: A ballistic proton, H^+, may be released at velocity of 10km/sec from the high-energy complex of H_2O-H^+, carrying kinetic energy of $8*10^{-13}$erg = 0.5proton*volt = 20kT. By coherent exchange of microwave photons of $6*10^{-17}$erg , the H^+ energy is efficiently converted during 100psec, along 500nm, into cooperative precession of 13300 electrically-polarized H_2O=H_2O dimers. A hybrid configuration of double-hydrogen-bonds, having in turn either covalent or electrovalent nature, is proposed to construct rigid dimers in flexible chains. This allows for dimer spin and precession at angular momentum of 25ħ and 1ħ, respectively, whereby each water molecule circulates at 14 m/sec. The dynamic dimers rearrange along the proton trajectory into non-radiating rings, forming a persistent tube-like rowing soliton. By peripheral viscose propulsion during a life-time of 20 msec, this proton-induced water soliton (pwason) can generate streaming velocity of 25 micrometer/sec against a maximal pressure-head of 1kgwt/cm^2, having power density of 5 Watt/cm^3.

This model relies and reflects on the physical-chemistry of water. It further suggests irreversible and reversible pathways in bioenergetic transformations. Thus, enzymatic hydrolysis of ATP by myosin heads along oriented actin filaments is proposed to catalyze stereo-specific cleavage of H_2O-H^+ ions, so as to induce unidirectional fluxes of such energetic protons and solitons. Intracellular transport, cell motility, intercellular interaction, and associated electro-physiological aspects, are consistently explained by this electro-hydraulic mechanism. Contraction of an elongated smooth muscle cell, or of a sarcomere in striated muscle, is quantitatively described as hydraulic compression driven by the suction power of centrally oriented pwasons. By this fluid mechanism, the enzymatic proteins are uninvolved mechanically in tension generation. This simple prediction by the AS hypothesis was experimentally tested and verified, whereby the established motor-protein paradigm was clearly refuted.

Reversible catalysis of ATP hydrolysis/synthesis in membrane-bound F_O-F_1 systems, is hereby related to hydration/dehydration of a phosphate bond by trans-membrane release/absorption of a ballistic H^+ by H_2O-H^+. This process requires a hydrophobic compartment in order to uncouple the ballistic proton from AS induction. Thus, ballistic protons of 0.5proton*volt can generate and overcome trans-membrane electric-potential-difference of up to 0.5volt, while creating, or reversibly consuming, a trans-membrane concentration difference of H_2O-H^+ ions. This mechanism elucidates the thermodynamic view of a proton-motive-force in the chemiosmotic hypothesis. The abrupt H^+ impact/ejection at the catalytic site might electrically drive fast rotation between hydrophobic and hydrophilic states of the triple-site F_1-head, to allow for appropriate product-substrate exchange. This electrical rotation should have no share in the H^+ kinetic energy, whereby the conventional motor-proteins coupling is unneeded.

Thus, by the AS hypothesis, various bio-energetic functions might evolve ballistic protons throughout enzymatic catalysis of a spontaneous hydrolytic reaction in water.

See online article: Ballistic Protons and Microwave-induced Water Solitons in Bioenergetic Transformations. http://www.mdpi.org/ijms/list06.htm#issue9