MOLECULAR PRESENTATIONS

HYDRATION QUANTIZATION WITHIN LIVING CELLS

J. C. Collins, PhD

Dedicated to the late Professors Carl Djerassi and William S. Johnson of Stanford University

Although water is the essential medium of life, it is never displayed around natural molecules and rarely mentioned in biochemical processes.[1] For example, the formation of proteins is considered to be driven and directed by a decrease in internal free energy within natural polypeptides with little or no consideration for surface water.[2] Yet, in 1959 Kaufmann proposed that water forms hydration shells around proteins[3] and thousands of studies have documented that water exhibits dynamic structuring properties on non-hydrogen-bonding hydrophobic surfaces.[4] Now, an entire issue of *Chemical Reviews* (July 2016) has been devoted to the analysis of water with the conclusion by professor Gallo and fifteen coauthors that there are two distinct density-forms of water molecules in the liquid state and on surfaces.[5] The conclusion, which is based primarily on studies published by Professor Stanley in 2009,[6] is so profound that, for the first time, there appears to be experimental documentation to answer the question of how water provides spontaneity and order within living cells.

The purpose of this presentation is to translate, for all those with access to the web, how transitions between two different forms of hydrogen-bonding between water molecules on surfaces drive and assist in directing the assembly and functions of molecules in living cells. For example, as polypeptides are released from ribosomes, hydrophobic surfaces must immediately become coated with covalently hydrogen-bonded linear elements of water molecules in hexagonal/cubic patterning.[5] In fact, coating is so rapid and repetitve on those surfaces, that it is as if they are covered by sheets of water molecules. However, covalent hydrogen-bonding is unstable above 0^{o}C and, as water molecules spin and retrun to dynamic point-charge hydrogen-bonding in the liquid state, they absorb quantized units of energy from those surfaces and force peptides within them into internal-bonding coils and beta-sheets. At the same time, small peptides in polar and ionic regions of polypeptide chains, by continually hydrogen-bonding with dynamic surface water, provide sufficient mobility and solubility for chains to wrap into thermodynamically-stable protein assemblies. By spontaneously and rapidly transitioning from covalent order toward point-charge dynamics, surface water removes quantized units of energy from natural molecules and moves them from multiple options of motion to specific functional forms.

However, covalent hydrogen bonding between water molecules performs another vital function. As positive charges are generated at nerve endings in axons, it is covalent linear elements of hydration which form on the inner surfaces of the nerves that transport protons at extremely high speeds to provide for communication from end to end. It is ions and protons, not electrons, which provide for communication within living cells. If nerve cells were filled with metal rather than water, we would be combusted by the resistance. It is a challenge to realize that surface water plays such critical roles in the living cell! [1]