Water flow in microtubules as lifeline of cells

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Life as we know it would be impossible without water. Although water is the most widespread molecule on planet Earth, we practically do not know very much about it. There is no other substance that is studied as much as water, and yet such simple molecule astonishes and intrigues scientists around the globe. Water has profoundly unique properties and it is quite unusual liquid, but despite that it is perfectly suited to be actual matrix of life.

Cells are the basis units of life. Eukaryotic cells are organized into membrane bound organelles (e.g. nucleus, the Golgi complex, the endoplasmic reticulum etc). The products of these have to be transported to the other parts of the cell, especially in cells like neurons which can be several centimeters long and there is also great need to transport various materials among other cells. **[**1]

This transportation task is carried out by complex machinery of proteins. Tubulin molecules in cells organize themselves in structures we call microtubules. Microtubules are trade routes between the cells which enable transportation of important cellular cargo, such as vesicles. A kinesin attaches to microtubules and moves along microtubule in order to deliver its cargo to the desired cell or part of the cell. **[**2]

In this paper we review the role of water for normal function of microtubules as transport engine and as basis of cytoskeleton. We discuss how the effects of water deficiency are reflected on function of microtubules and what is general role of water in it. Special attention will be given to better understanding micro and nano water flow **[**3], and how microtubules can translate information carried by electrophysiological impulses that enter the brain cortex. To better understand that, we must also discuss local electromagnetic fields in different neural compartments and how much water electromagnetic properties influences in neural activity of entire brain. In addition, one of the recently discovered phenomena - existence of water exclusion zones adjacent to various membranes or cytoskeletal structures, microtubules included, will also be discussed. [4,5]

References:

[1] Lenormand, G., et al., *Dynamics of the cytoskeleton: How much does water matter?* Physical Review E, 2011. 83(6): p. 061918.
[2] Leterrier, J.F., *Water and the cytoskeleton.* Cell Mol Biol (Noisy-le-grand), 2001. 47(5): p. 901-23.
[3] Karniadakis,G, beskok,A., Aluru,N., Microflows and Nanoflows, Springer, New Zork, 2005.
[4] Pollack, GH, and Clegg, J: Unsuspected linkage between unstirred layers, Exclusion Zones and water. Phase Transitions in Cell Biology, pp 143-152. Ed: GH Pollack, and W-C Chin, Springer, 2008.
[5] Georgiev, D. *Electric and magnetic fields inside neurons and their impact upon the cytoskeletal microtubules. Cogprints 3190-1, 2003*