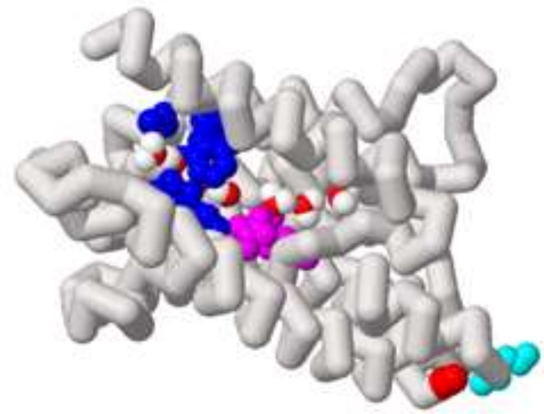
Aquaporins....

Allowing (Just) Water to Go with the Flow



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Blue: Aromatic/Arginine (ar/R) Filter

Magenta: Asparagine, Proline, Alanine (NPA) Motif

Cyan and Red: Amino and Carboxyl Terminal Intracellular Residues

Note: A couple of helices have been pared away to better reveal how the water molecules interact with the selectivity filter and the NPA site.

Transporting the liquid of life, aquaporins carry out the vital function of supplying water within cells in almost all living entities. Discovered only a decade ago, aquaporins are channel proteins found in cell membranes that are responsible for the transport and filtering of water and specific molecules into and out of cells. Depending on their location and function, aquaporins may transport different varieties of compounds in addition to water, such as glycerin, to assist in certain organ functions or concentration of cells. Thus, aquaporins play a major role in diseases such as diabetes insipidus due to their regulation of intake and release of water from vital organs.

There are thirteen different aquaporins expressed in humans; however, aquaporins are found in all living things, ranging from animals to plants to bacteria. Though there are several types of aquaporins, their structures are similar in composition. Aquaporin monomers consist of six long segments of helices and two short segments of helices, which encompass a narrow transmembrane channel through which water and other molecules travel in single file. Only 20 Å in diameter, this channel is just wide enough for water molecules to pass through. Within cell membranes, monomers assemble as tetramers, each monomer acting independently. They are able to transport molecules at an extremely high rate--just one human AQP1 molecule has a permeation rate of three billion molecules per second, the direction of which changes depending on the prevailing osmotic gradient.

Aquaporins must be highly selective in order to perform their specific functions, and they achieve this on an atomic level. The aquaporin contains two separate filters to facilitate the selection of water molecules and the exclusion of everything else: an ar/R filter (blue), and an NPA motif (magenta). Its positively charged ar/R filter allows the aquaporin to both bind to water molecules and weaken the molecule's hydrogen bonds so it can more readily interact with the filter. Meanwhile, the NPA motif involves the local electrical fields of the atoms and amino acids along the water channel walls, which cause water molecules passing through the channel to rotate and orient themselves towards the atom's positive charge. Because of the positive charge at the center of the channel, protons and cations are prevented from passing, thereby regulating the balance of protons inside and outside of the cell membrane.

Bibliography:

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