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Aquaporin Water Channels: From Atomic Structure to Malaria

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Aquaporin (AQP) water channel proteins confer high water permeability to many biological membranes. Discovered in human red cells but expressed in multiple tissues, AQP1 has been thoroughly characterized and its atomic structure is known. Expression patterns of the thirteen known human homologs predict clinical phenotype. Although very rare, AQP1-null humans lack Colton blood group antigens and exhibit defective urine concentration in the proximal nephron and reduced fluid permeability by lung capillaries. AQP2 is expressed in renal collecting duct principal cells, and AQP2-null individuals suffer from severe nephrogenic diabetes insipidus. Under-expression of AQP2 is common in bedwetting, and over-expression leads to fluid retention in congestive heart failure. AQP0 is present in lens fiber cells, and mutations in the gene encoding AQP0 result in childhood cataracts. AQP4 resides in astroglial endfeet of brain, and AQP4 is implicated in brain edema – a common and tragic consequence of head injury, stroke, and brain tumors. AQP5 is found in the apical membranes of salivary and lacrimal gland acini, and defective trafficking is sometimes found in dry mouth and dry eye of Sjogren's syndrome. Conversion of glycerol to glucose during starvation requires the release of glycerol from adipocytes via AQP7 followed by uptake of glycerol into hepatocytes via AQP9 where the glycerol is converted to glucose. Plants exhibit dozens of different aquaporins which facilitate water uptake by rootlets and maintenance of stem turgor by tonoplast aquaporins. Parasitic diseases such as malaria involve aquaporins in the parasite, in the human hosts, and even in Anopheles mosquitoes where fluid release is important after taking a blood meal. Practical applications of aquaporin technology may provide new preventions of diseases and may boost agricultural production.

Recommended source of information:

http://nobelprize.org/nobel_prizes/chemistry/laureates/2003/agre-lecture.html