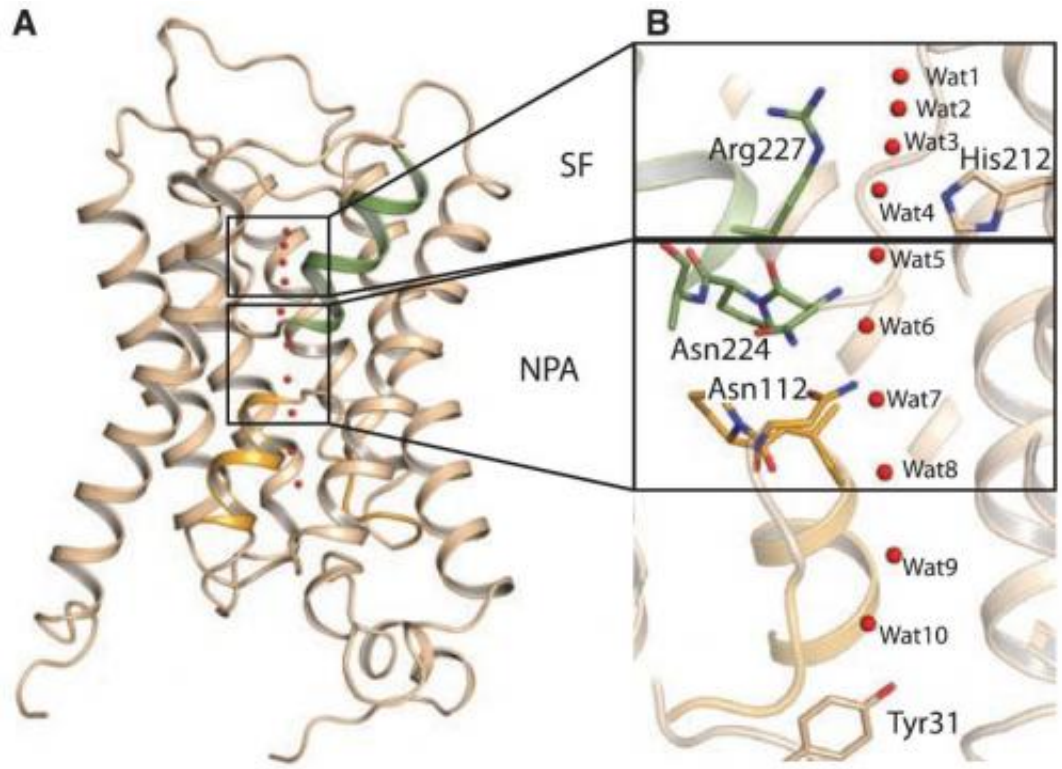
Ultra-high-resolution microscopy reveals yeast aquaporin transporting water across cell membrane

June 14 2013, by Bob Yirka



Fold of Aqy1. (A) The six transmembrane helices and the seventh pseudo-transmembrane helix formed by loops B (orange) and E (green). (B) Water molecule positions within the channel (red spheres). The dual-NPA–aquaporin signature motif (bottom box) and the SF (top box) are highlighted. Credit: *Science* 14 June 2013: Vol. 340 no. 6138 pp. 1346-1349 DOI: 10.1126/science.1234306

(Phys.org) —A team of chemists with members from Sweden and the United States has succeeded in capturing the process by which yeast aquaporin transport water across cell membranes while preventing unwanted protons to pass through. In their paper published in the journal *Science*, they describe how they used ultra-high resolution microscopy to reveal the transportation process.

In order for cells in living creatures to function properly, they must have a means for allowing water to pass through from the outside world into their inner structure—through their membranes. This is how they receive nutrients. At the same time, the water that passes through the membrane must be filtered to keep unwanted material from being carried through with the water. How this happens has been somewhat of a mystery because the channels that carry the water (aquporins) are so small—traditional methods only allow for snapshot views. Progress was made a decade ago, however, when a team of researchers developed a technique that allowed for viewing the process by which potassium ions are transported through potassium channels. In this new effort. the joint American-Swedish team took a similar approach to help them capture the process by which Pichia pastoris yeast is transported through an aquaporin 1 protein.

The technique involved capturing the process as it happened at ultra-high resolution—in this case just 0.88 Angstroms. This resolution allowed the researchers to see that the process is very similar to the one found by the team that captured the movement of potassium ions. They found that the way hydrogen bonds were shaped prevented protons from passing through the cell membrane along with the water that carried them. Of particular note, they found that two distinct structures, the NPA-signature motif and the selectivity filter caused water molecules to be oriented in just the right fashion to facilitate the passage of the molecules through the pores in the channel while stopping the unwanted protons.

The technique the team developed marks a record for high-resolution captures of cell membrane processes, and paves the way for other research efforts looking to determine how water carrying other unwanted material is filtered by channels in cell membranes.

More information: Subangstrom Resolution X-Ray Structure Details Aquaporin-Water Interactions, *Science* 14 June 2013: Vol. 340 no. 6138 pp. 1346-1349 DOI: 10.1126/science.1234306
www.sciencemag.org/content/340/6138/1346

ABSTRACT
Aquaporins are membrane channels that facilitate the flow of water across biological membranes. Two conserved regions are central for selective function: the dual asparagine-proline-alanine (NPA) aquaporin signature motif and the aromatic and arginine selectivity filter (SF). Here, we present the crystal structure of a yeast aquaporin at 0.88 angstrom resolution. We visualize the H-bond donor interactions of the NPA motif's asparagine residues to passing water molecules; observe a polarized water-water H-bond configuration within the channel; assign the tautomeric states of the SF histidine and arginine residues; and observe four SF water positions too closely spaced to be simultaneously occupied. Strongly correlated movements break the connectivity of SF waters to other water molecules within the channel and prevent proton transport via a Grotthuss mechanism.