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Structural Mechanism of Plant Aquaporin Gating. Susanna Tornroth-Horsefield, Yi Wang, Kristina Hedfalk, Urban Johanson, Per Kjellbom, Richard Neutze, Dept. of Chemical and Biological Engineering, Molecular Biotechnology, Chalmers Univ. of Technology, Medicinaregatan 9E, Lundberg laboratory, Gothenburg, SE 405 30 SWEDEN.

Aquaporins (AQP) are membrane water channels that play a critical role in controlling the water content of the cell. They are widely distributed in all kingdoms of life; from bacteria to yeast, plants and humans. They facilitate the rapid transport of water in response to osmotic gradients. In plants cells, the cell wall allows for the maintaining of a large osmotic gradient between the cell interior and exterior. This results in turgor pressure and is crucial for many aspects of plant physiology. To counteract fluctuations in the water supply, land plants have evolved to regulate all aquaporins which lie within the plasma membrane. One of the most abundant proteins in the spinach leaf plasma membrane is the aquaporin SoPIP2;1, previously known as PM28A. It is regulated by phosphorylation of two highly conserved serines and by pH involving protonation of a conserved histidine. Both events close the water channel in response to drought stress (phosphorylation) or low pH in the cytosol during for example flooding (protonation).

We have solved the structure of SoPIP2;1 to 2.1 Å resolution. This is the first high resolution structure of a plant aquaporin as well as of a regulated aquaporin and reveals SoPIP2;1 captured in a closed conformation. We have also solved the structure of SoPIP2;1 in an open conformation at 3.9 Å and have performed molecular dynamics simulations of the initial events governing gating. From these results we have proposed a detailed mechanism for how SoPIP2;1 is regulated by phosphorylation and pH.