Aquaporin-mediated transport

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20/11/2021
Introduction

Reactome is open-source, open access, manually curated and peer-reviewed pathway database. Pathway annotations are authored by expert biologists, in collaboration with Reactome editorial staff and cross-referenced to many bioinformatics databases. A system of evidence tracking ensures that all assertions are backed up by the primary literature. Reactome is used by clinicians, geneticists, genomics researchers, and molecular biologists to interpret the results of high-throughput experimental studies, by bioinformaticians seeking to develop novel algorithms for mining knowledge from genomic studies, and by systems biologists building predictive models of normal and disease variant pathways.

The development of Reactome is supported by grants from the US National Institutes of Health (P41 HG003751), University of Toronto (CFREF Medicine by Design), European Union (EU STRP, EMI-CD), and the European Molecular Biology Laboratory (EBI Industry program).

Literature references


Reactome database release: 78

This document contains 4 pathways (see Table of Contents)
Aquaporin-mediated transport

Stable identifier: R-HSA-445717

Compartments: plasma membrane

Aquaporins (AQP’s) are six-pass transmembrane proteins that form channels in membranes. Each monomer contains a central channel formed in part by two asparagine-proline-alanine motifs (NPA boxes) that confer selectivity for water and/or solutes. The monomers assemble into tetramers. During passive transport by Aquaporins most aquaporins (i.e. AQP0/MIP, AQP1, AQP2, AQP3, AQP4, AQP5, AQP7, AQP8, AQP9, AQP10) transport water into and out of cells according to the osmotic gradient across the membrane. Four aquaporins (the aquaglyceroporins AQP3, AQP7, AQP9, AQP10) conduct glycerol, three aquaporins (AQP7, AQP9, AQP10) conduct urea, and one aquaporin (AQP6) conducts anions, especially nitrate. AQP8 also conducts ammonia in addition to water.

AQP11 and AQP12, classified as group III aquaporins, were identified as a result of the genome sequencing project and are characterized by having variations in the first NPA box when compared to more traditional aquaporins. Additionally, a conserved cysteine residue is present about 9 amino acids downstream from the second NPA box and this cysteine is considered indicative of group III aquaporins. Purified AQP11 incorporated into liposomes showed water transport. Knockout mice lacking AQP11 had fatal cyst formation in the proximal tubule of the kidney. Exogenously expressed AQP12 showed intracellular localization. AQP12 is expressed exclusively in pancreatic acinar cells.

Aquaporins are important in fluid and solute transport in various tissues. During transport of glycerol from adipocytes to the liver by Aquaporins, glycerol generated by triglyceride hydrolysis is exported from adipocytes by AQP7 and is imported into liver cells via AQP9. AQP1 plays a role in forming cerebrospinal fluid and AQP1, AQP4, and AQP9 appear to be important in maintaining fluid balance in the brain. AQP0, AQP1, AQP3, AQP4, AQP8, AQP9, and AQP11 play roles in the physiology of the hepatobiliary tract.

In the kidney, water and solutes are passed out of the bloodstream and into the proximal tubule via the slit-like structure formed by nephrin in the glomerulus. Water is reabsorbed from the filtrate during its transit through the proximal tubule, the descending loop of Henle, the distal convoluted tubule, and the
collecting duct. Aquaporin-1 (AQP1) in the proximal tubule and the descending thin limb of Henle is responsible for about 90% of reabsorption (as estimated from mouse knockouts of AQP1). AQP1 is located on both the apical and basolateral surface of epithelial cells and thus transports water through the epithelium and back into the bloodstream. In the collecting duct epithelial cells have AQP2 on their apical surfaces and AQP3 and AQP4 on their basolateral surfaces to transport water across the epithelium. Vasopressin regulates renal water homeostasis via Aquaporins by regulating the permeability of the epithelium through activation of a signaling cascade leading to the phosphorylation of AQP2 and its translocation from intracellular vesicles to the apical membrane of collecting duct cells.

Here, three views of aquaporin-mediated transport have been annotated: a generic view of transport mediated by the various families of aquaporins independent of tissue type (Passive transport by Aquaporins), a view of the role of specific aquaporins in maintenance of renal water balance (Vasopressin regulates renal water homeostasis via Aquaporins), and a view of the role of specific aquaporins in glycerol transport from adipocytes to the liver (Transport of glycerol from adipocytes to the liver by Aquaporins).

**Literature references**


**Editions**

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In the collecting duct epithelial cells have AQP2 on their apical surface and AQP3 and AQP4 on their basolateral surface to transport water across the epithelium. The permeability of the epithelium is regulated by vasopressin, which activates the phosphorylation and subsequent translocation of AQP2 from intracellular vesicles to the plasma membrane.

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Transport of glycerol from adipocytes to the liver by Aquaporins

**Location:** Aquaporin-mediated transport

**Stable identifier:** R-HSA-432030

**Compartments:** plasma membrane, extracellular region

Triglycerides stored in adipocytes are hydrolyzed to yield fatty acids and glycerol. The glycerol is passively transported out of the adipocyte and into the bloodstream by Aquaporin-7 (AQP7) located in the plasma membrane of adipocytes. Glycerol in the bloodstream is passively transported into liver cells by AQP9 located in the plasma membrane of hepatocytes. Once inside the liver cell the glycerol is a substrate for gluconeogenesis.

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