1.2.4

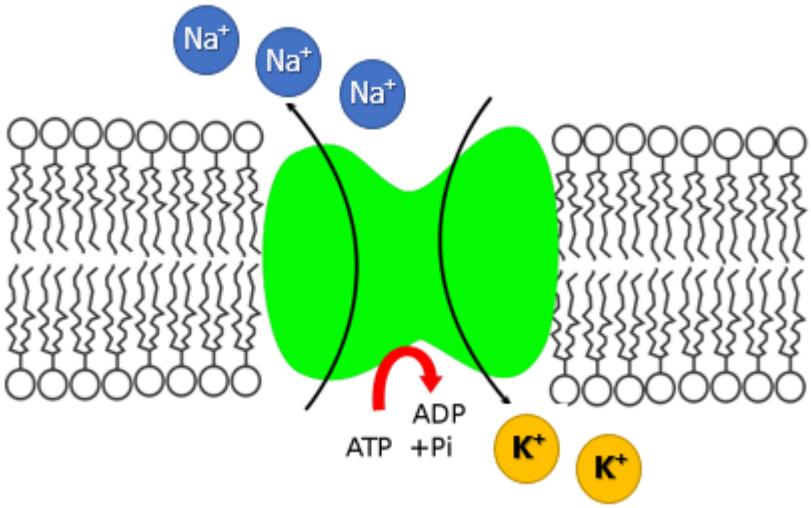
Active Transport

1.2.4 - Active Transport

To this point, the transport processes we have discussed have all been passive processes in which the solute or the water movement has been down a concentration gradient with no input of energy required. However, there are times when it is important for the cell to be able to move solutes against their concentration gradient. Just like moving water from the first to the top floor of a high-rise building, these processes require an energy source. Processes that require energy are called **active transport** processes.

Primary Active Transport

Primary active transport can move solutes, such as ions, against their concentration gradient. This process requires a carrier protein that is much like the proteins involved in carrier-mediated diffusion mentioned above. However, in this case, the carrier has a site for the binding of ATP, which provides the energy to move the solute against its gradient. These transport systems can move one or multiple ions across the membrane. One of the most important active transport systems is the **Na-K ATPase** (see figure below). This system moves sodium out of the cell and moves potassium into the cell. Each cycle of the pump moves three sodium ions out of and two potassium ions into the cell. Potassium is the primary intracellular cation in the body while sodium is the primary extracellular cation, and Na-K ATPase is responsible for maintaining this distribution. The Na-K ATPase pump exists in two different conformational states: an E1 form, where the binding sites for the ions face intracellularly and an E2 form, where the binding sites face the extracellularly. The drug ouabain binds and inhibits the pump in the E2 form, this drug will be important in latter applications.



Sodium Potassium- ATPase pumps

Image created at BYU-Idaho by MG 2013

Three Na^+ ions are moved out of the cell in exchange for two K^+ ions with the aid of ATP. In addition to the Na-K ATPase pump other types of ATPase pumps exist as well, these include the H-K pump, Ca pump (SERCA), H pump, and MDR (multidrug-resistance transporters).

Secondary Active Transport

Like primary active transport, secondary active transport also moves solutes against their concentration gradients. However, with secondary active transport, ATP is not directly involved in the pumping of the solute. Instead, this process uses the energy stored in concentration gradients to move the solute. Since sodium is always in a higher concentration outside of the cell (due to primary active transport), the sodium gradient is often used to power secondary active transport. In this process, the carrier protein has a binding site for the solute to be transported, as well as a binding site for sodium. Once both solutes have bound, sodium moves down its concentration gradient and moves into the cell, much like what happens with carrier-mediated diffusion, and in the process pulls another solute into the cell (**symport**) or moves another solute out of the cell (**antiport**), against its concentration gradient. A number of organic molecules are transported across membranes by this process, such as glucose and amino acids. ATP energy is required to generate the sodium concentration gradient but is not directly involved in moving the desired solute across the membrane, hence the designation as *secondary active transport*.