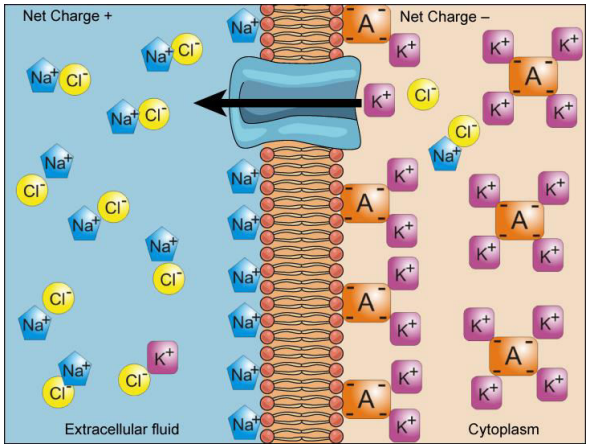
Key terms

- active transport movement of a substance across a cell membrane against its concentration gradient (from low to high concentration) facilitated by ATP conversion
- adenosine triphosphate a multifunctional nucleoside triphosphate used in cells as a coenzyme, often called the "molecular unit of energy currency" in intracellular energy transfer
- electrochemical gradient The difference in charge and chemical concentration across a membrane.
- electrogenic pump An ion pump that generates a net charge flow as a result of its activity.
- Na+-K+ ATPase An enzyme located in the plasma membrane of all animal cells that pumps sodium out of cells while pumping potassium into cells.
- secondary active transport A method of transport in which the electrochemical potential difference created by pumping ions out of the cell is used to transport molecules across a membrane.

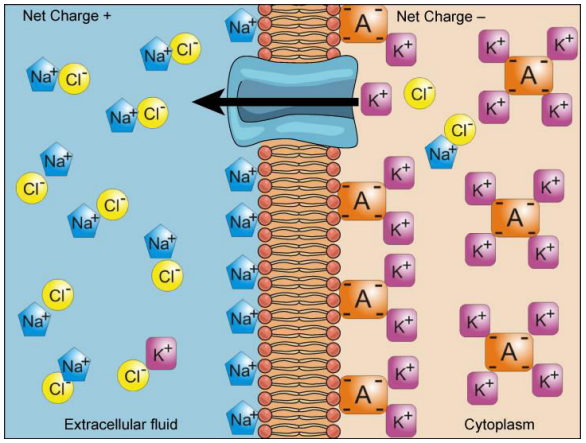
Active Transport



- Electrochemical Gradient
- Primary Active Transport
- Secondary Active Transport (Co-transport)

Electrochemical Gradient

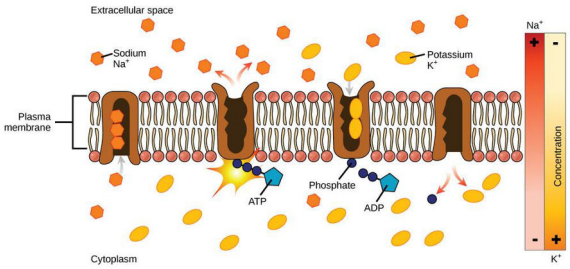
- The electrical and concentration gradients of a membrane tend to drive sodium into and potassium out of the cell, and active transport works against these gradients.
- To move substances against a concentration or electrochemical gradient, the cell must utilize energy in the form of ATP during active transport.
- Primary active transport, which is directly dependent on ATP, moves ions across a membrane and creates a difference in charge across that membrane.
- Secondary active transport, created by primary active transport, is the transport of a solute in the direction of its electrochemical gradient and does not directly require ATP.
- Carrier proteins such as uniporters, symporters, and antiporters perform primary active transport and facilitate the movement of solutes across the cell's membrane.



Electrochemical Gradient

Primary Active Transport

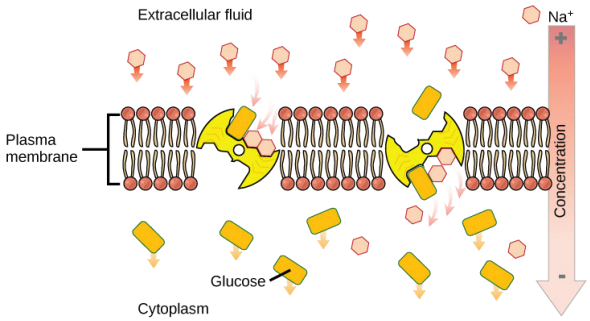
- The sodium-potassium pump moves K+ into the cell while moving Na+ at a ratio of three Na+ for every two K+ ions.
- When the sodium-potassium-ATPase enzyme points into the cell, it has a high affinity for sodium ions and binds three of them, hydrolyzing ATP and changing shape.
- As the enzyme changes shape, it reorients itself towards the outside of the cell, and the three sodium ions are released.
- The enzyme's new shape allows two potassium to bind and the phosphate group to detach, and the carrier protein repositions itself towards the interior of the cell.
- The enzyme changes shape again, releasing the potassium ions into the cell.
- After potassium is released into the cell, the enzyme binds three sodium ions, which starts the process over again.



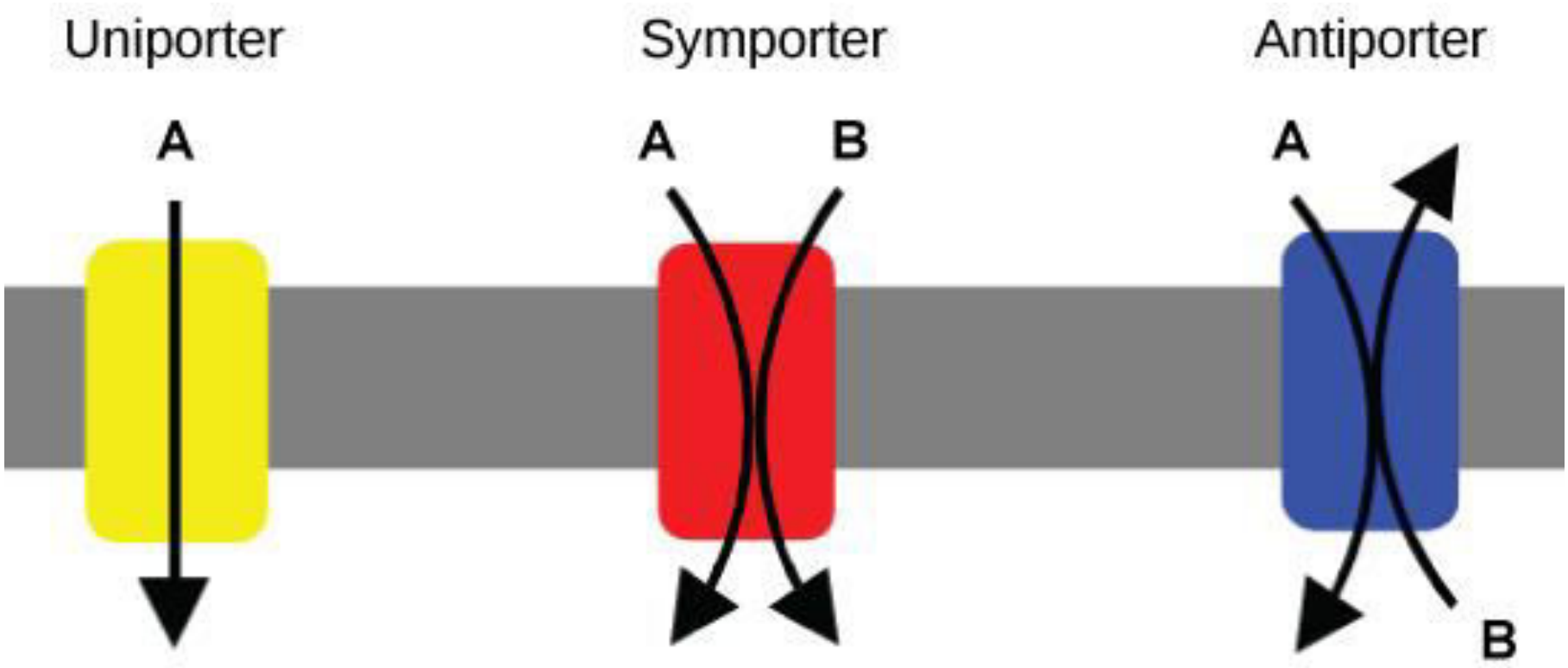
Active Transport of Sodium and Potassium

Secondary Active Transport (Co-transport)

- While secondary active transport consumes ATP to generate the gradient down which a molecule is moved, the energy is not directly used to move the molecule across the membrane.
- Both antiporters and symporters are used in secondary active transport.
- Secondary active transport brings sodium ions into the cell, and as sodium ion concentrations build outside the plasma membrane, an electrochemical gradient is created.
- If a channel protein is open via primary active transport, the ions will be pulled through the membrane along with other substances that can attach themselves to the transport protein through the membrane.
- Secondary active transport is used to store high-energy hydrogen ions in the mitochondria of plant and animal cells for the production of ATP.
- The potential energy in the hydrogen ions is translated into kinetic energy as the ions surge through the channel protein ATP synthase, and that energy is used to convert ADP into ATP.

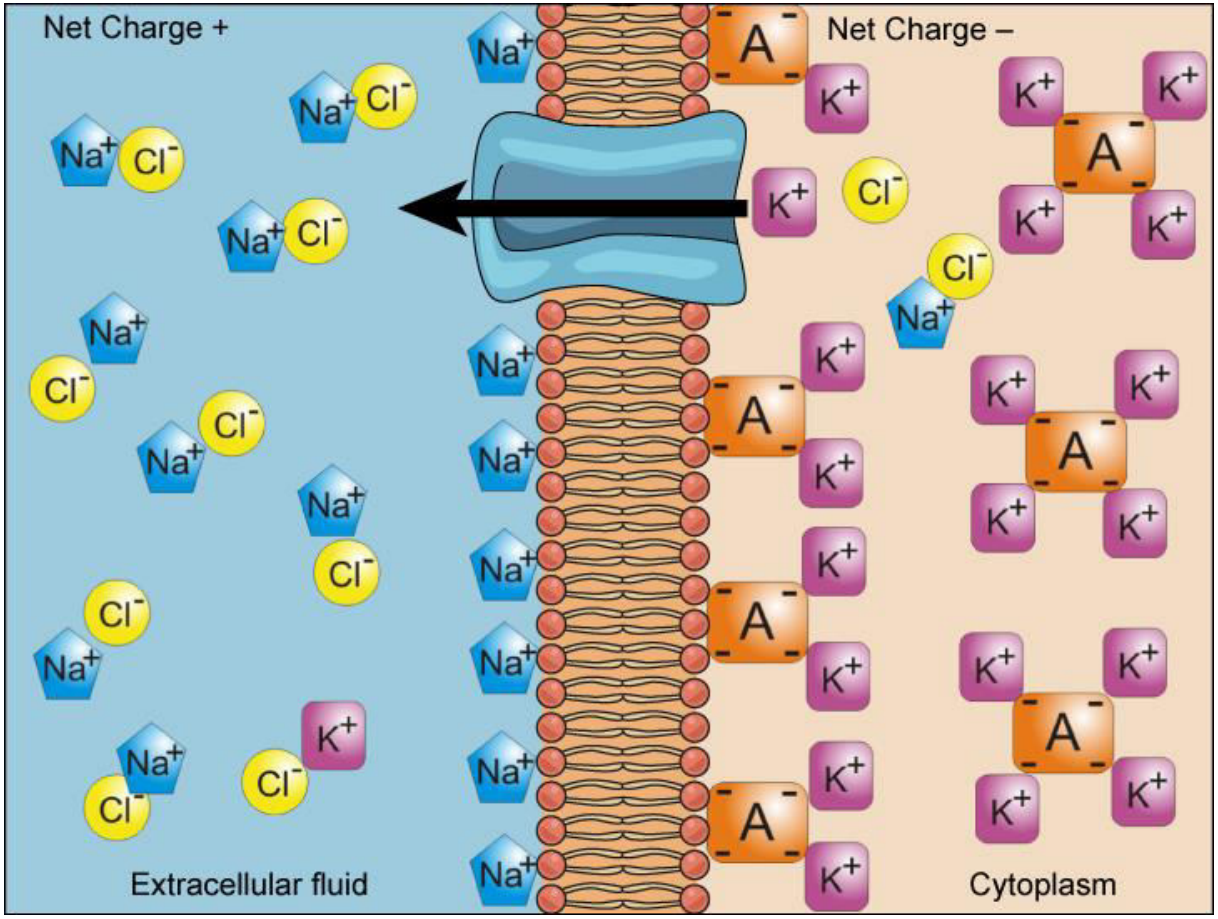


Secondary Active Transport



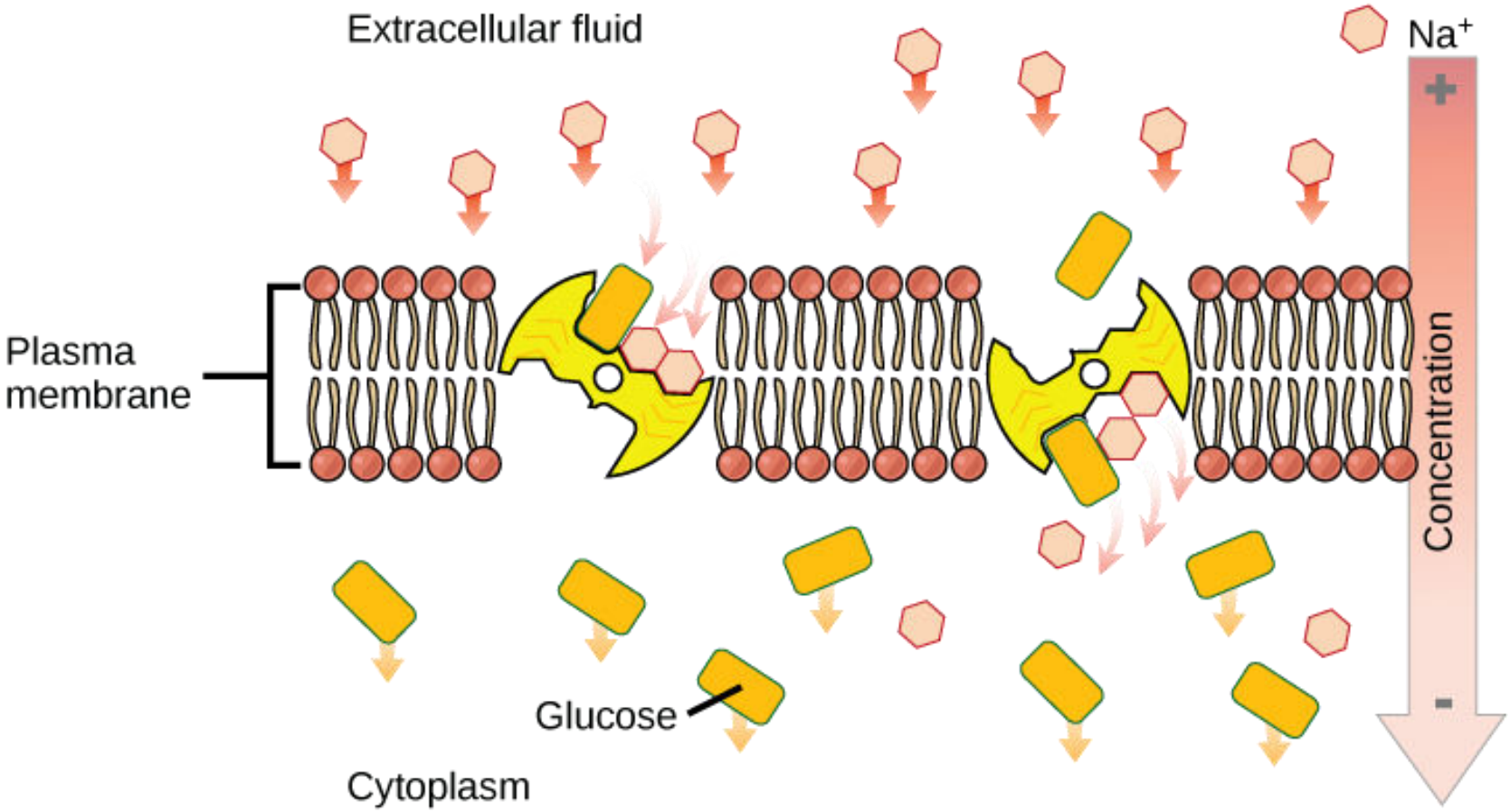
Uniporters, Symporters, and Antiporters

A uniporter carries one molecule or ion.A symporter carries two different molecules or ions, both in the same direction.An antiporter also carries two different molecules or ions, but in different directions.



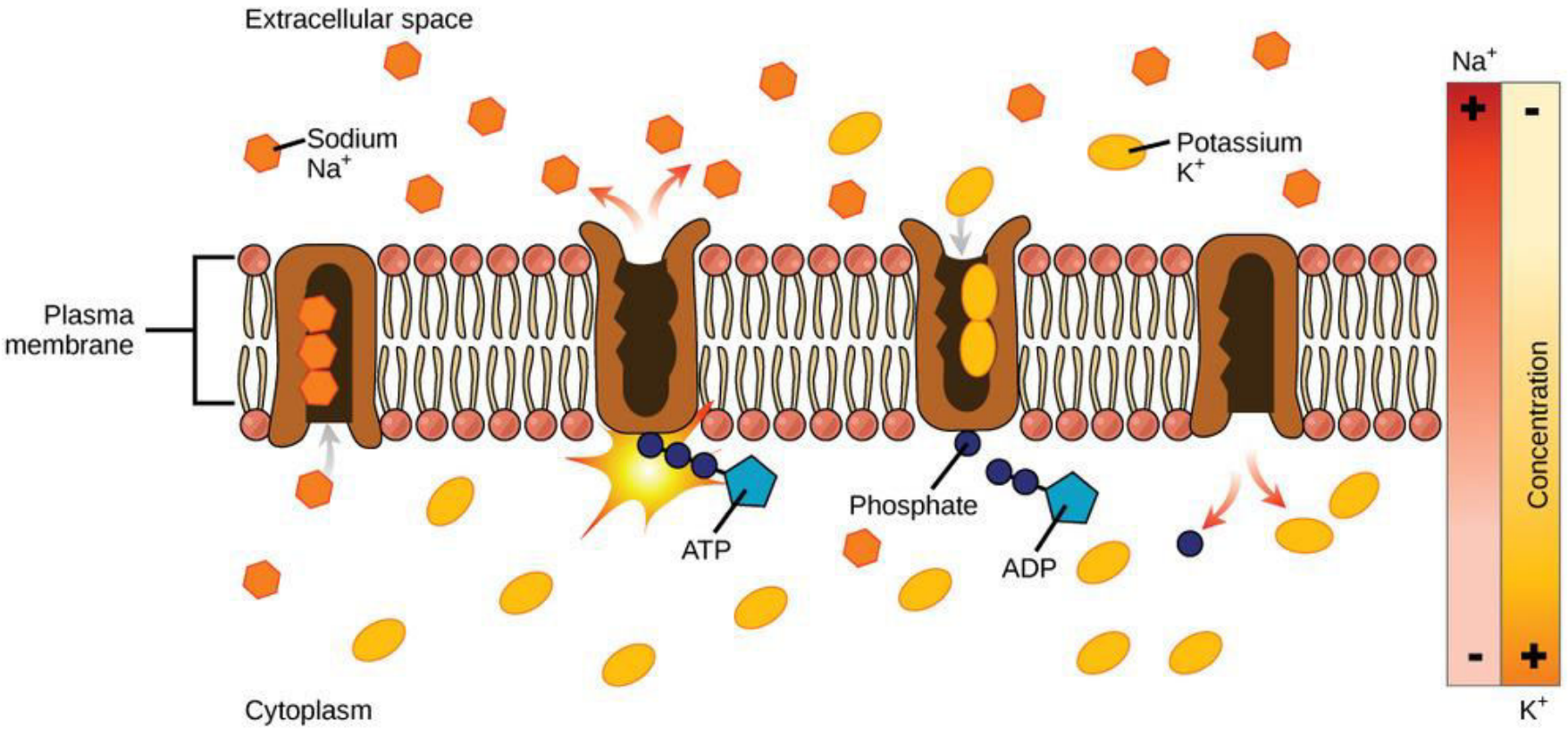
Electrochemical Gradient

Electrochemical gradients arise from the combined effects of concentration gradients and electrical gradients.



Secondary Active Transport

An electrochemical gradient, created by primary active transport, can move other substances against their concentration gradients, a process called co-transport or secondary active transport.



Active Transport of Sodium and Potassium

Primary active transport moves ions across a membrane, creating an electrochemical gradient (electrogenic transport).