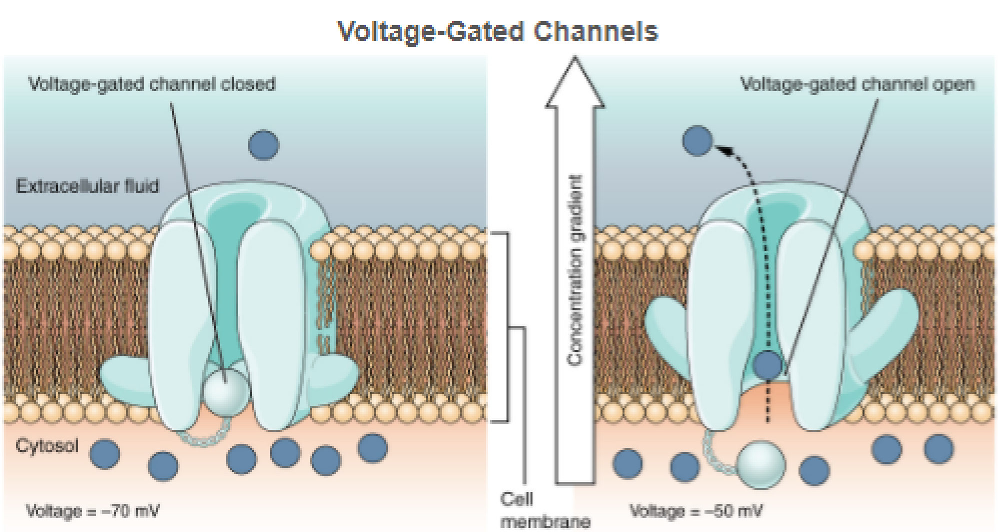
11.2

Facilitated Diffusion

Facilitated Diffusion represents the movement of substances across the membrane that are too big and/or too polar to pass through the membrane. This type of movement is mediated by integral membrane proteins called transport proteins. Unlike simple diffusion, this process of diffusion exhibits saturation, and its rate is directly related to the concentration of specific transport proteins within the membrane. In addition, this type of transport, like simple diffusion, does not require an input of energy. Facilitated diffusion can occur in two different ways, through channel proteins and carrier proteins.

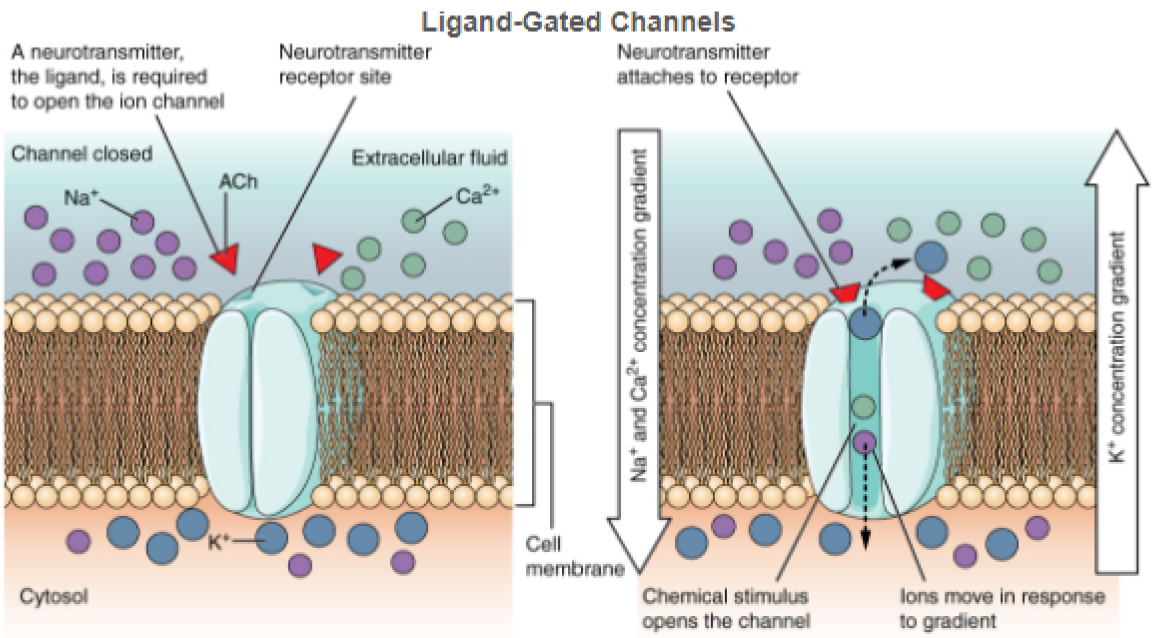
Channel proteins resemble fluid filled tubes through which the solutes can move down their concentration gradients across the membrane. These channels are often responsible for helping ions, such as Na^+, K^+, Ca^{2+}, and Cl^-, cross the membranes. Even though they are open tubes, they often only allow very specific ions to pass through them. For instance, a K^+ channel may allow K^+ to pass through but not Na^+ or Cl^-. This is due to the presence of a **selectivity filter** that selects for hydrated or dehydrated states of the specific ion. These channels are often gated (they have doors or gates that can be opened or closed). Depending on the channel, these gates may respond to voltage differences across the membrane (**voltage-gated channels**), specific signal molecules (**ligand-gated channels**), or even stretching or compressing of the membrane (**mechanically-gated channels**).



Voltage Gated Channel. *Author: OpenStax College; Site: https://books.byui.edu/-yThl License: Licensed under a Creative Commons Attribution 4.0 License*

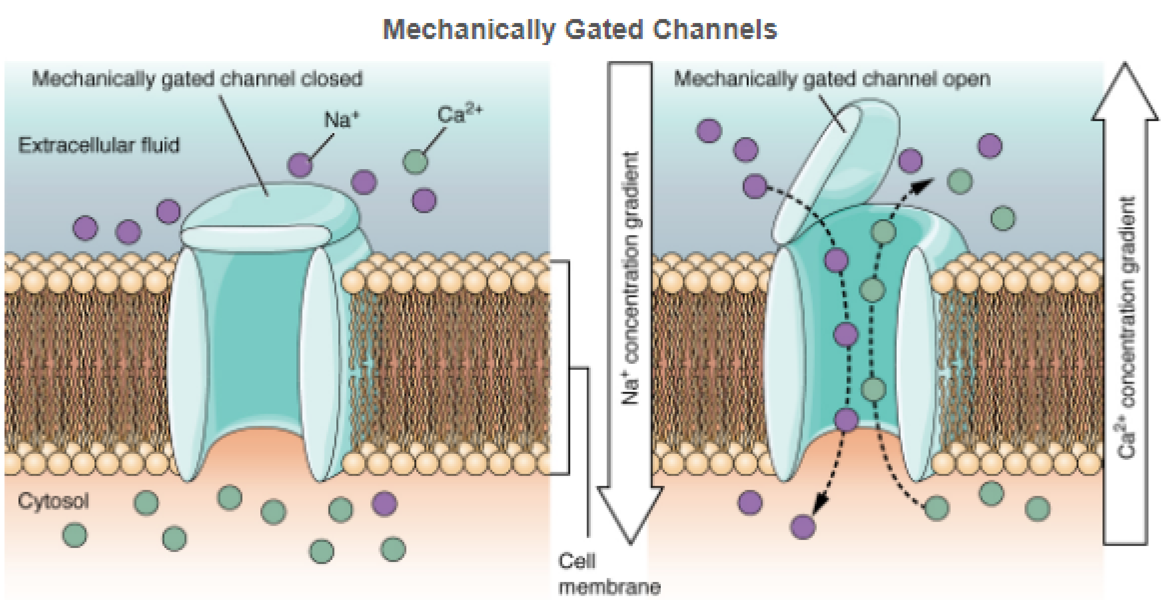
Voltage-gated channels (shown above) open when membrane voltage changes. The concentration of ions in the intracellular fluid creates the voltage. Amino acids in the protein transporter are sensitive to charge and cause the channel to open for a specific ion.

In ligand-gated channels the pore opens to ions when the ligand binds to a specific location on the extracellular surface of the channel protein. Acetylcholine is the ligand shown in the example below.



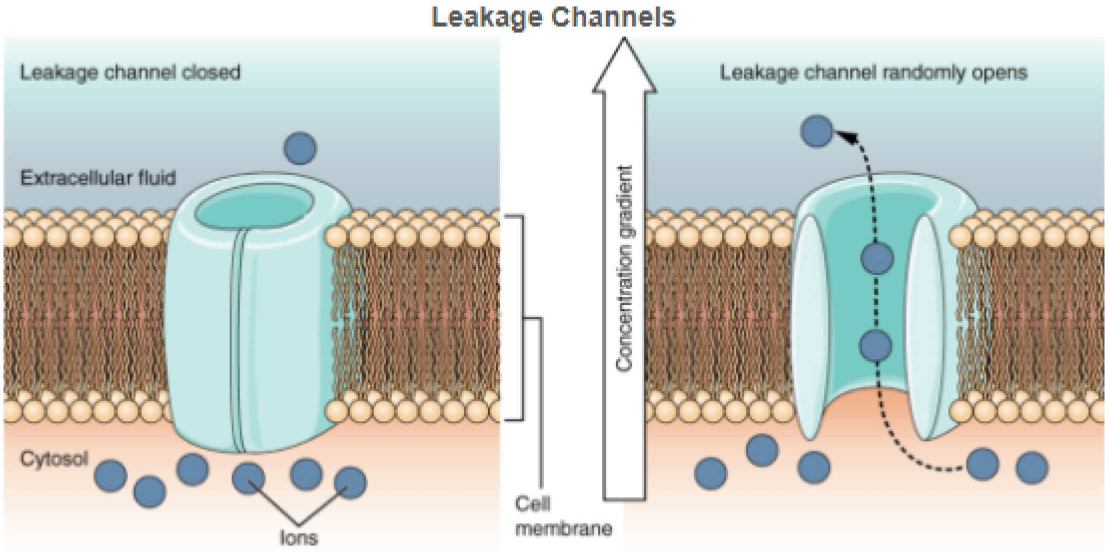
Ligand-Gated Channels. *Author: OpenStax College; Site: https://books.byui.edu/-dfk License: Licensed under a Creative Commons Attribution 4.0 License*

When a mechanical change happens such as pressure, touch, or a change in temperature mechanically gated channels open.



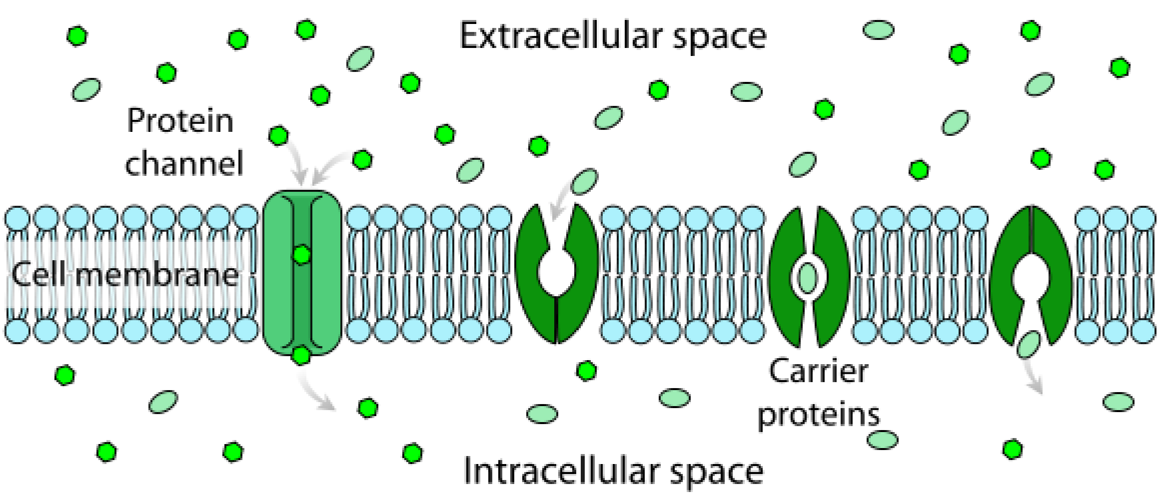
Mechanical-Gated Channels. *Author: OpenStax College; Site: https://books.byui.edu/-ULoF License: Licensed under a Creative Commons Attribution 4.0 License*

Another example of a gated channel protein is the K^+ **leak channel** which opens and closes intrinsically and contributes to the cell's electrical potential.



Leak Channel. Author: *OpenStax College; Site: https://books.byui.edu/-Mpz License: Licensed under a Creative Commons Attribution 4.0 License*

The second type of facilitated diffusion utilizes **carrier proteins** in the membrane and is known as carrier-mediated transport. Unlike the channel proteins, these carriers do not open to both sides of the membrane simultaneously. Instead, they bind to a specific solute on one side of the membrane. This binding causes the carrier to change shape, which moves the solute to the other side of the membrane (think of a revolving door).



Carrier Proteins. *By LadyofHats Mariana Ruiz Villarreal [Public domain], via Wikimedia Commons*

Like the channel proteins, these carriers can be very specific in the solute they transport since the solute must bind to a receptor site that is designed to fit a specific solute. Another interesting characteristic of these carriers is, like all channel proteins, that they have a maximum rate of transport and can thus become **saturated** if the solute concentration is high enough.

Active Transport

Primary Active Transport