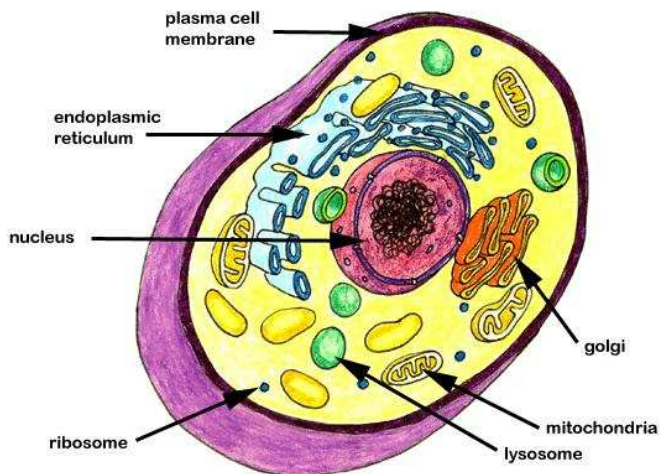


# Rutgers 642:613 - Fall 2003

Instructor: Eduardo D. Sontag

Bio "Review": Cells, Cell Membranes, Channels

<http://www.math.rutgers.edu/~sontag/613.html>



<http://web.jjay.cuny.edu/acarpi/NSC/13-cells.htm>

## Cells

the cell is one of the most basic units of life

there are millions of different types of cells  
some are organisms onto themselves (amoeba, bacteria)  
others only function as part of larger organism  
all cells have unique functions and features  
the 'skin' is the *plasma membrane* (more below)  
working parts: nucleus and organelles:

- *nucleus* contains the cell's DNA, the genetic code that coordinates protein synthesis
- *ribosomes*: after transcription in nucleus, mRNA travels to the cell's ribosomes, where translation into proteins occurs
- *mitochondria*: "power plants" the cell: many of the reactions that produce energy take place there
- *lysosomes* contain enzymes that aid in the digestion of nutrient molecules and other materials

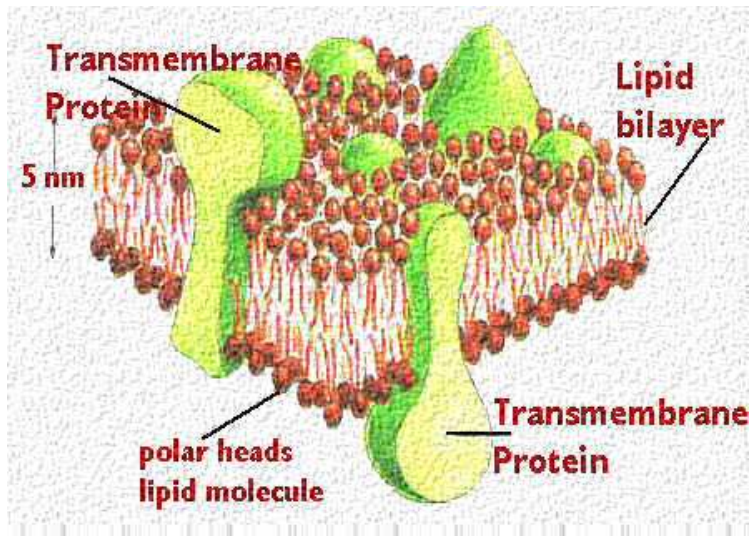
## membranes

cell and organelles limited by one or more membranes; membranes are specialized, containing specific proteins and lipid components that them to perform their unique roles for that cell or organelle:

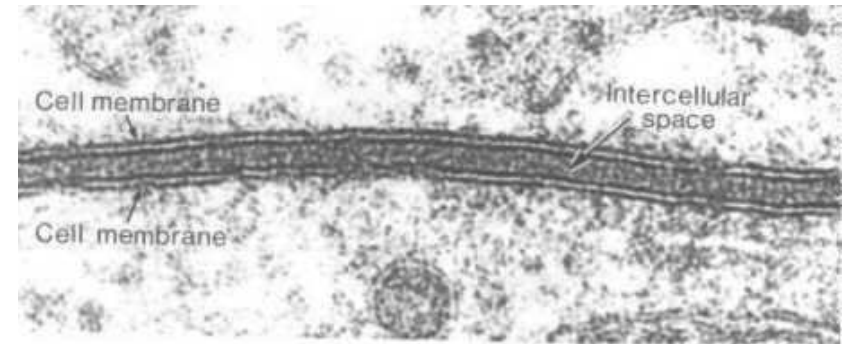
- protection
- provide a passageway across the membrane for certain molecules
- allow selective receptivity and signal transduction by providing transmembrane receptors that bind signaling molecules
- allow cell recognition
- provide anchoring sites for cytoskeletal filaments or components of the extracellular matrix (allows the cell to maintain its shape and perhaps move to distant sites)
- help compartmentalize subcellular domains or microdomains
- provide a stable site for the binding and catalysis of enzymes
- regulate the fusion of the membrane with other membranes in the cell via specialized junctions
- allow directed cell or organelle motility

membrane is a lipid bilayer

lipids have hydrophilic polar heads pointing out, with the hydrophobic portion forming the core <http://www.cytochemistry.net/Cell-biology/membrane.htm>

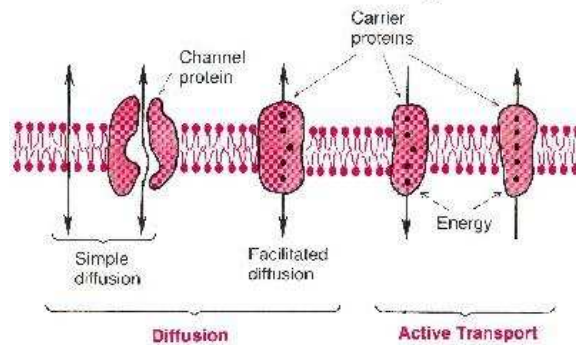


cells separated by membranes



<http://www.cytochemistry.net/Cell-biology/membrane.htm>

mechanisms of cell membrane transport:

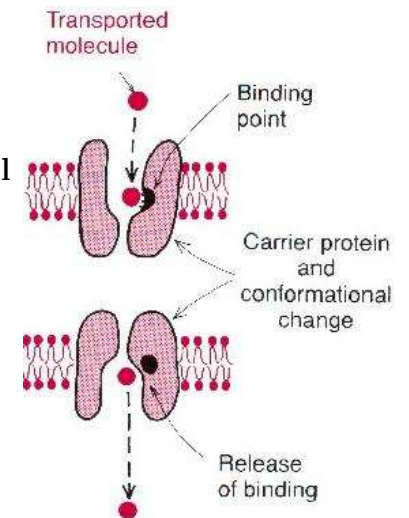


[http://jimswan.com/237/channels/channel\\_graphics.htm](http://jimswan.com/237/channels/channel_graphics.htm)

- lipids-soluble through phospholipid matrix
- water-soluble through gated or non-gated protein channels
- carrier mediated transport (e.g. facilitated diffusion)
- osmosis of water through protein channels
- active transport (pumps)

facilitated diffusion

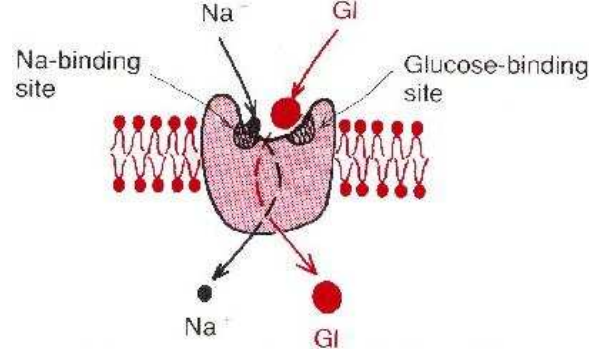
molecule to be transported (e.g. glucose) enters channel and binds to a receptor in the protein carrier, causing conformational change and release on opposite side of membrane



another example: sodium co-transport of glucose  
 sodium outside cell is high compared to inside  
 (due to Na/K pump)  
 so gradient provides energy for transport

when both sodium and glucose are attached, conformational change in protein molecule happens, and both are transported to inside cell

[http://jimswan.com/237/channels/channel\\_graphics.htm](http://jimswan.com/237/channels/channel_graphics.htm)

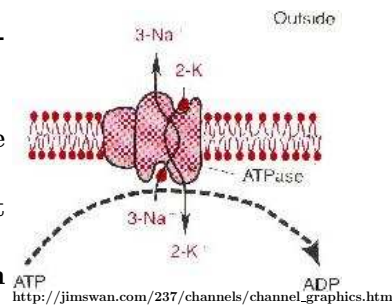


**electrogenic Na<sup>+</sup>-K<sup>+</sup> pump**

three sites for Na<sup>+</sup> attachment on inside surface of carrier, and two for K<sup>+</sup> outside

ATPase on intracellular surface hydrolyzes ATP, releasing energy that causes carrier conformational change

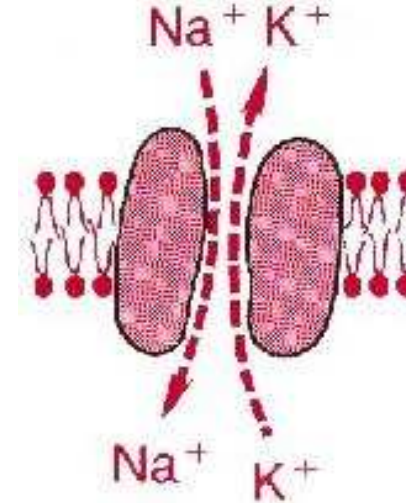
this pumps the 3 Na<sup>+</sup> ions out and then potassium attaches and 2 K<sup>+</sup> ions are pumped in



on balance, more +’s pumped out, but on the other hand negative (other) ions are not permeable - this creates a polarization across the membrane

non-selective ion channels: e.g. K/Na leak channels  
 (potassium is about 100 times more permeable than sodium)

[http://jimswan.com/237/channels/channel\\_graphics.htm](http://jimswan.com/237/channels/channel_graphics.htm)



**membrane resting potential due to passive and active forces**

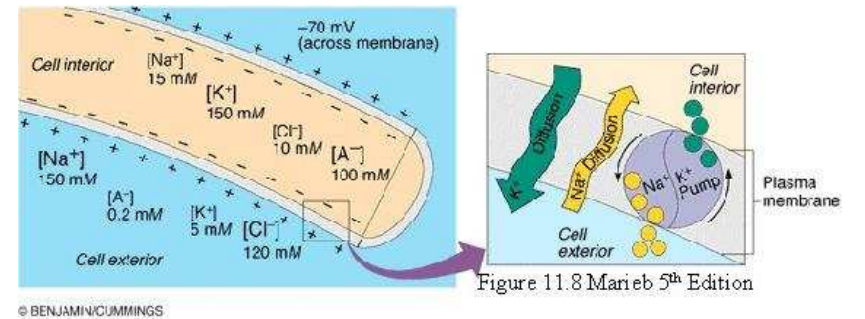
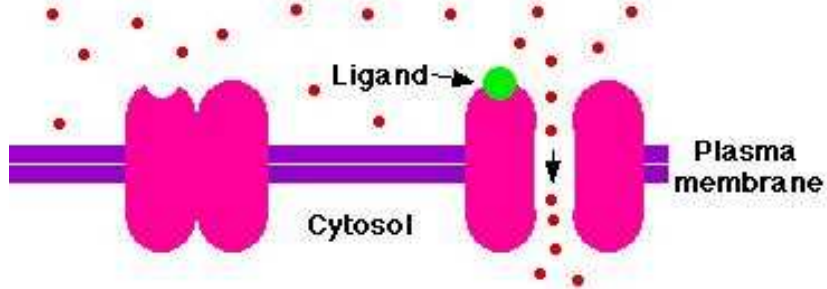


Figure 11.8 Marieb 5<sup>th</sup> Edition

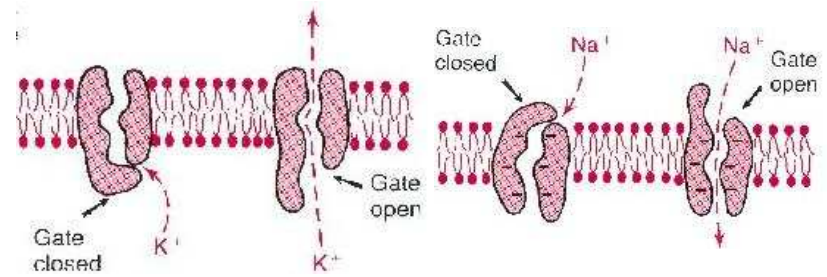
## chemically-gated channels

<http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/D/Diffusion.html>



a chemical, e.g. a neurotransmitter, triggers a conformational change in the channel protein, allowing passage of e.g. Na

## voltage-gated channels (we'll get back to this later!)

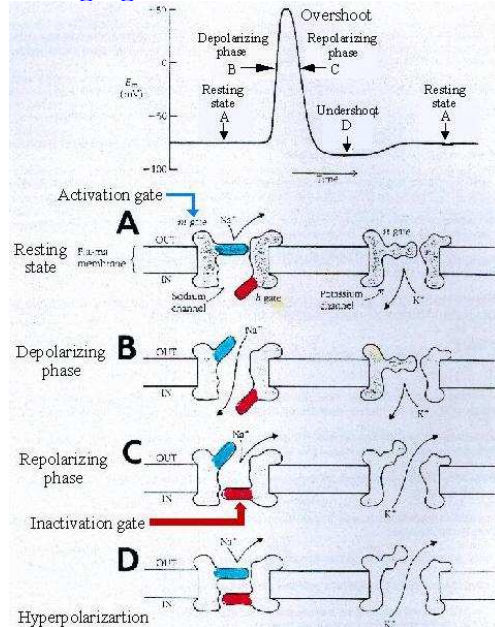


change in membrane potential towards depolarization triggers opening of ion gates

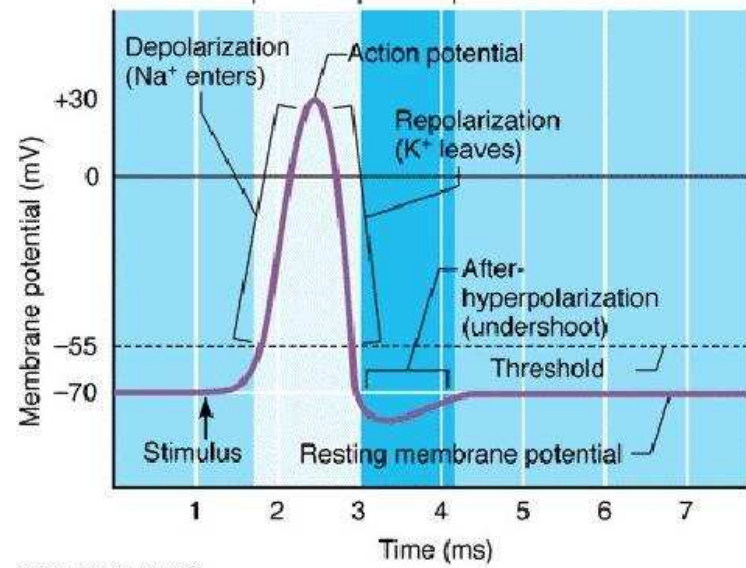
Na-gated channels have activation and inactivation gates, but K channels have only activation gates

[http://jimswan.com/237/channels/channel\\_graphics.htm](http://jimswan.com/237/channels/channel_graphics.htm)

## voltage-gated channels [http://jimswan.com/237/channels/channel\\_graphics.htm](http://jimswan.com/237/channels/channel_graphics.htm)



Absolute refractory period    Relative refractory period



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