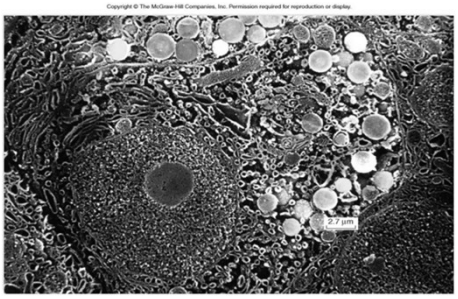
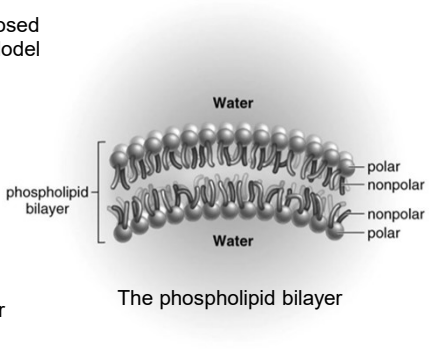
CO 5



The Cell Membrane and Transport

The Plasma Membrane

- S.J. Singer proposed the Fluid Mosaic Model to describe the cell membrane



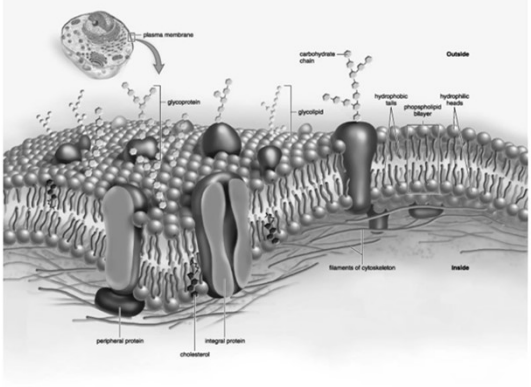
The phospholipid bilayer

The membrane is semipermeable (imagine a fence or screen door)

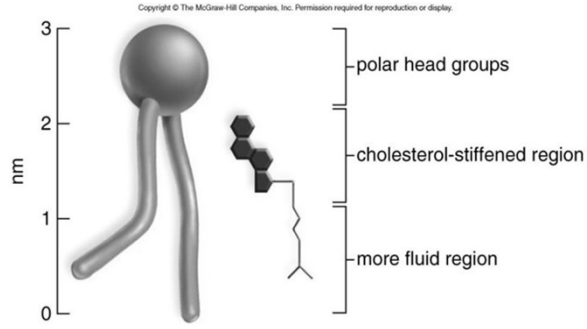
Jobs of the Cell Membrane

- Isolate the cytoplasm from the external environment
- Regulate the exchange of substances
- Communicate with other cells
- Identification

1. The plasma membrane is a **phospholipid bilayer** with embedded proteins.

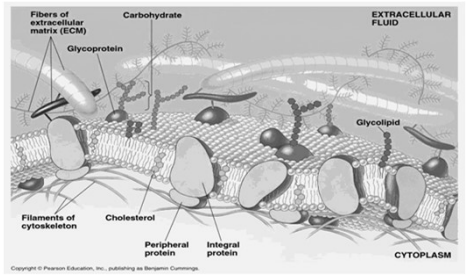


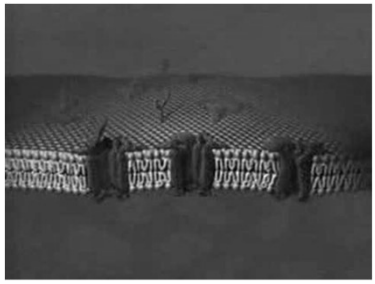
Phospholipids have both hydrophilic and hydrophobic regions; nonpolar tails (hydrophobic) are directed inward, polar heads (hydrophilic) are directed outward to face both extracellular and intracellular fluid



The proteins form a mosaic pattern on the membrane.

Cholesterol - stiffens and strengthens the membrane.
Glycolipids - protective and assist in various functions.
Glycoproteins - have an attached carbohydrate chain of sugar that projects externally

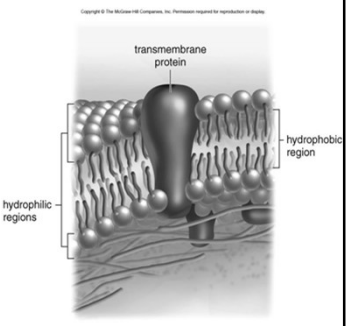




Proteins embedded in membrane serve different functions

Transport Proteins - regulate movement of substance

- **Channel Proteins** - form small openings for molecules to diffuse through
- **Carrier Protein**s- binding site on protein surface "grabs" certain molecules and pulls them into the cell
- **Gated Channels** - similar to carrier proteins, not always "open"



Receptor Proteins
- molecular triggers that set off cell responses (such as release of hormones or opening of channel proteins), binding site

Recognition Proteins
- ID tags, to identify cells to the body's immune system

Enzymatic Proteins
- carry out specific reactions

aquaporin = H_2O

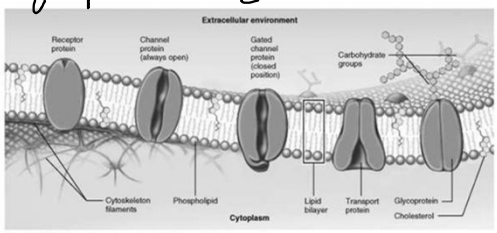
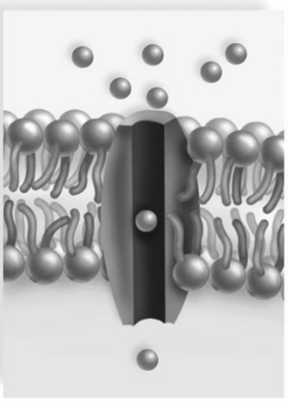


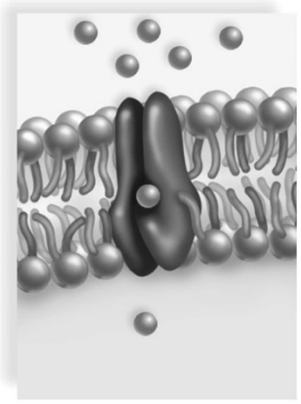
Figure 5.4a



Channel Protein
Allows a particular molecule or ion to cross the plasma membrane freely. Cystic fibrosis, an inherited disorder, is caused by a faulty chloride (Cl^-) channel; a thick mucus collects in airways and in pancreatic and liver ducts.

a.

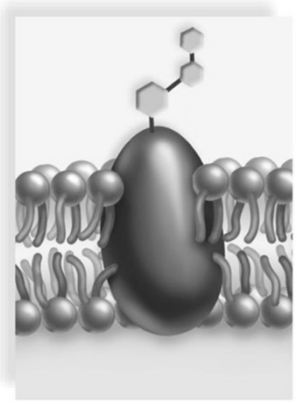
Figure 5.4b



Carrier Protein
Selectively interacts with a specific molecule or ion so that it can cross the plasma membrane. The inability of some persons to use energy for sodium-potassium (Na^+–K^+) transport has been suggested as the cause of their obesity.

b.

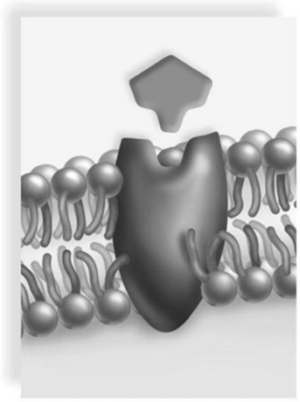
Figure 5.4c



Cell Recognition Protein
The MHC (major histocompatibility complex) glycoproteins are different for each person, so organ transplants are difficult to achieve. Cells with foreign MHC glycoproteins are attacked by white blood cells responsible for immunity.

c.

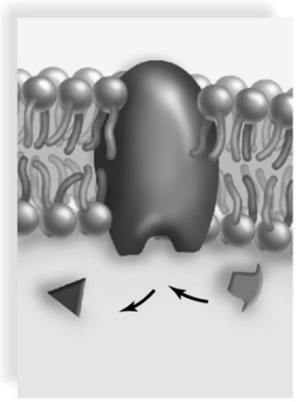
Figure 5.4d



Receptor Protein
Is shaped in such a way that a specific molecule can bind to it. Pygmies are short, not because they do not produce enough growth hormone, but because their plasma membrane growth hormone receptors are faulty and cannot interact with growth hormone.

d.

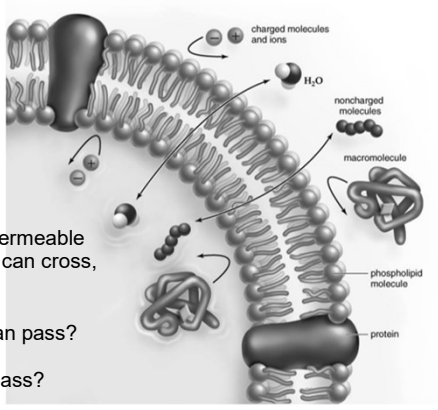
Figure 5.4e



Enzymatic Protein
Catalyzes a specific reaction. The membrane protein, adenylate cyclase, is involved in **ATP** metabolism. Cholera bacteria release a toxin that interferes with the proper functioning of adenylate cyclase; sodium ions and water leave intestinal cells, and the individual may die from severe diarrhea.

e.

Membrane Permeability → Transport Across Membrane



*Selectively or Differentially permeable – some things can cross, not others

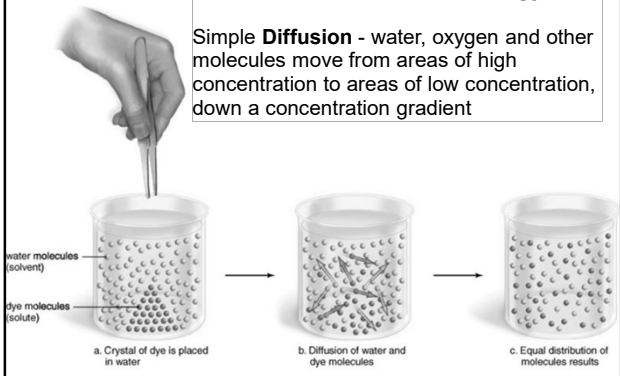
What things can pass?

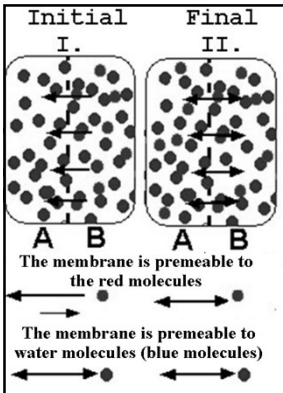
What cannot pass?

Figure 5.6

Passive Transport (no energy)

Simple **Diffusion** - water, oxygen and other molecules move from areas of high concentration to areas of low concentration, down a concentration gradient

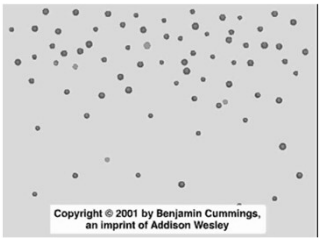




Passive Diffusion

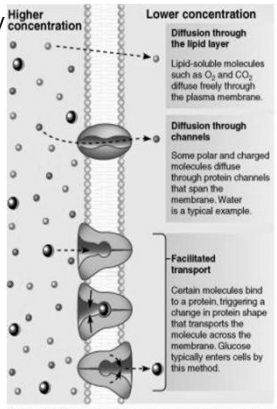
- The red molecules are initially more concentrated on side B. These molecules have more free energy.
- The net movement of the red molecules is from side B to side A, or from a higher concentration to a lower concentration.
- The water molecules (blue) are equally distributed and will move across at the same rate.

Diffusion

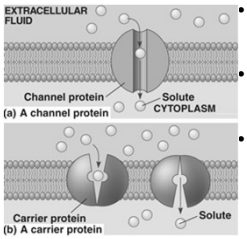


18

Facilitated Diffusion (#14)
- diffusion that is assisted by proteins (channel or carrier proteins)



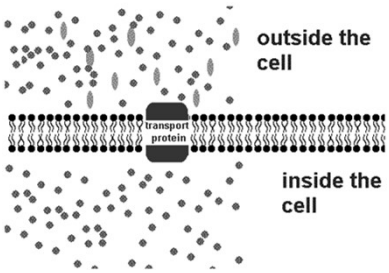
Facilitated Diffusion



- The molecule is impermeable to the membrane.
- The transport of the molecule requires a carrier protein or channel protein.
- It requires no ATP. The driving force is an increase in entropy. The molecules are moving from an area of higher concentration to lower concentration or from higher free energy to lower free energy.

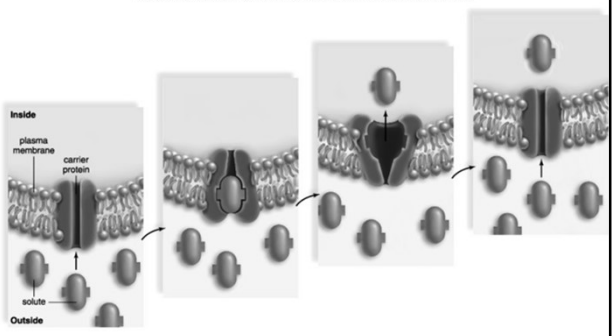
20

Facillitated Diffusion

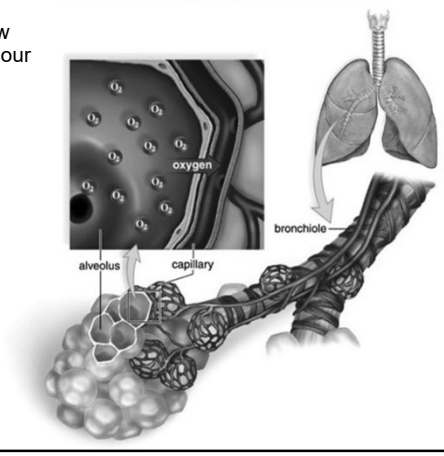


21

Figure 5.10



Diffusion is how oxygen enters our bloodstream.



OSMOSIS

Osmosis - diffusion of water.

Osmosis affects the turgidity of cells, different solution can affect the cells internal water amounts
Contractile Vacuoles are found in freshwater microorganisms - they pump out excess water (#13)
Turgor pressure occurs in plants cells as their central vacuoles fill with water.

flaccid

Simple rule of osmosis → Salt Sucks!

Figure 5.8a

Within the cell, there is a higher concentration of solute (*salt*)

This causes water to be "sucked" into the tube.

The solution in the beaker has LESS solute than the cell & is **HYPOTONIC**

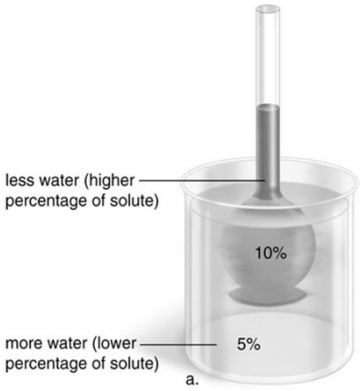
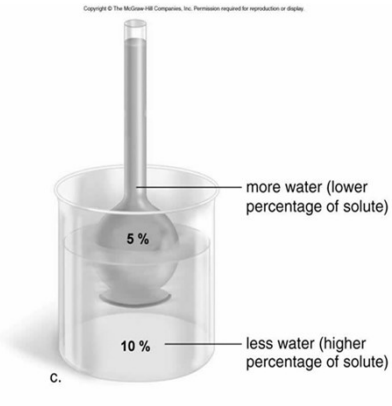


Figure 5.8c

Within the cell, there is a lower concentration of solute (*salt*)

This causes water to be "sucked" out into the beaker

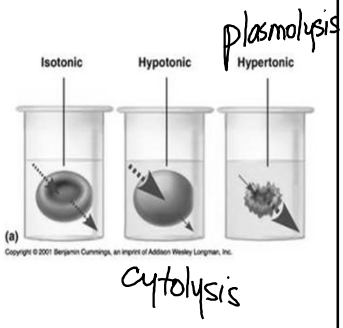
The solution in the beaker has MORE solute than the cell & is **HYPERTONIC**



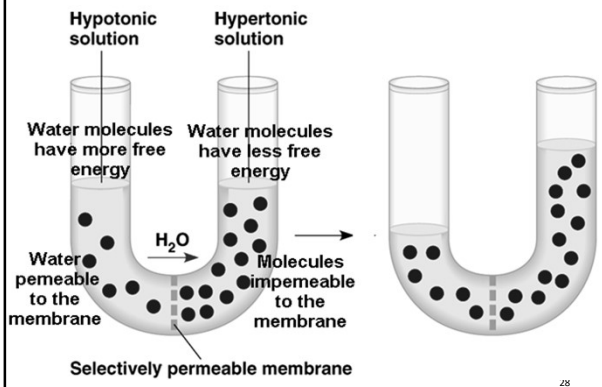
Isotonic - no **net** movement

Hypotonic - water moves into the cell, cell could burst

Hypertonic - water moves out of the cell, cell shrinks

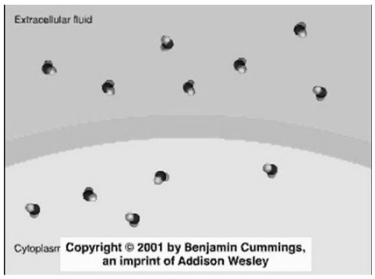


Osmosis



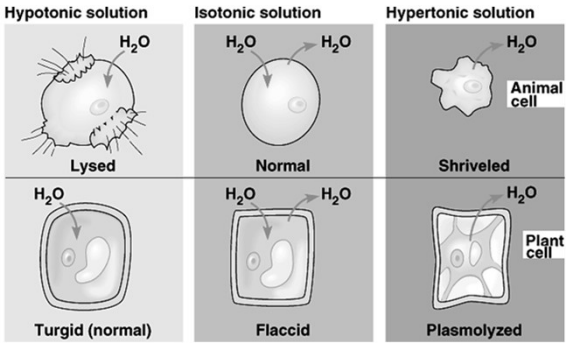
28

Osmosis



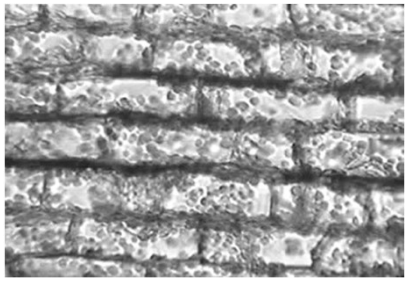
29

Osmosis in Plant Cells and Animal Cells



30

Plasmolysis



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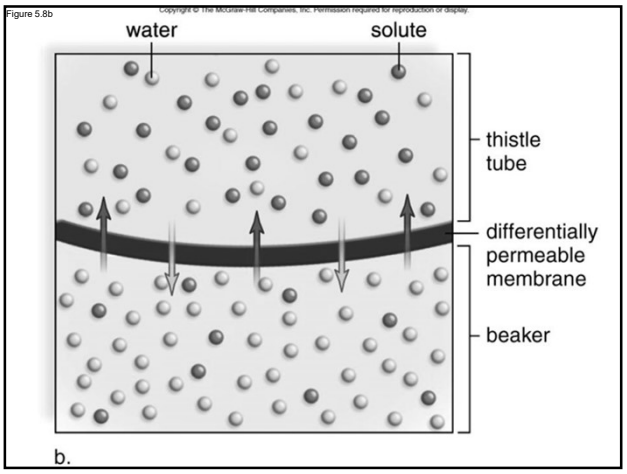
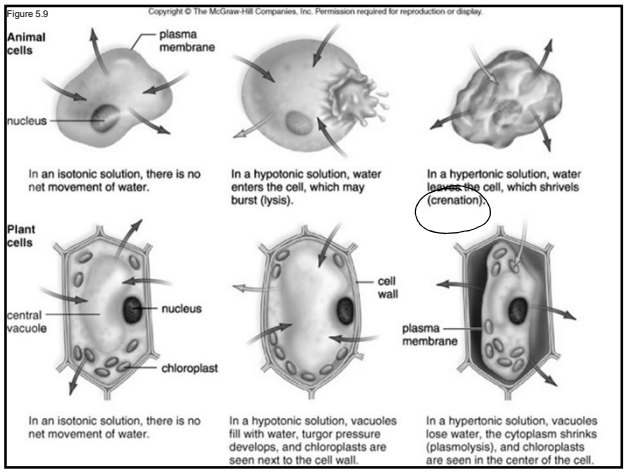
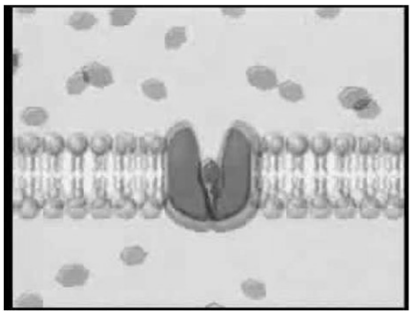




#15

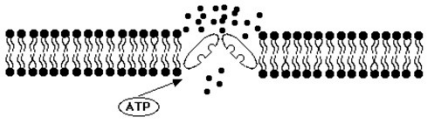
Passive Transport - requires no energy (diffusion, osmosis)

Active Transport - requires the cell to use energy (ATP)



Active Transport

- Membrane is impermeable to the molecules.
- Molecules are moving against a concentration gradient (from low to high) or from low free energy to high free energy.
- A transport protein and ATP are both needed.

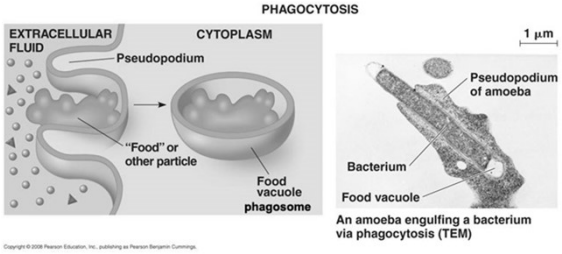


35

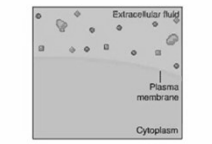
Active Transport

- involves moving molecules "uphill" against the concentration gradient, which requires energy

Endocytosis (#20) - taking substances into the cell
(pinocytosis for water, phagocytosis for solids)



Three Types of Endocytosis

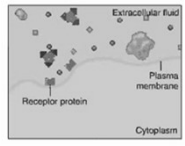


Endocytosis is the movement of larger particles into the cell by use of membrane vesicles.

- Phagocytosis
- Pinocytosis
- Receptor Mediated Endocytosis

37

Phagocytosis



- Phagocytosis "cell eating"- Larger molecules or particles are brought into the cell by engulfing them into a plasma membrane vesicle.

38

Phagocytosis

Coronin in Phagocytosis

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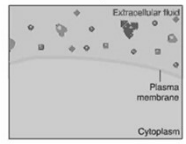
Maniak et al. Cell 83, 915-924, 1995

39

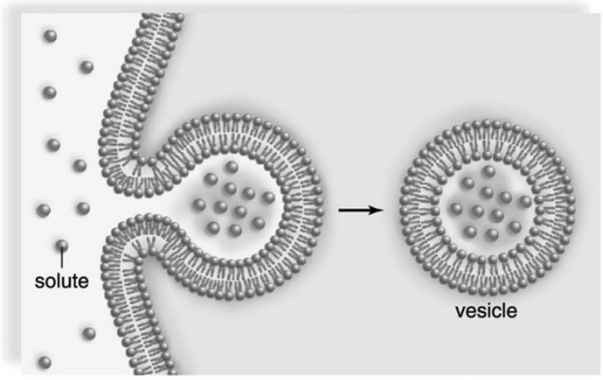
Pinocytosis



- Pinocytosis "cell drinking"- Dissolved molecules are brought into the cell by engulfing them into a plasma membrane vesicle.

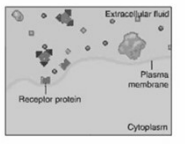
40

Figure 5.13ba



b. Pinocytosis

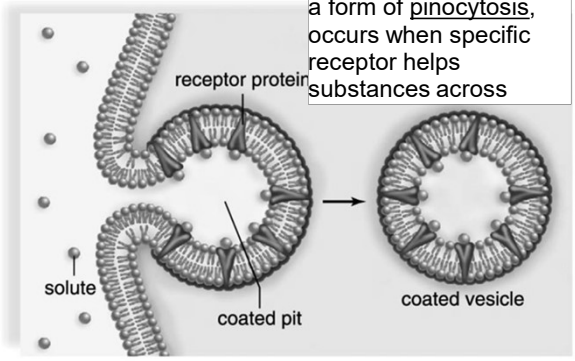
Receptor Mediated Endocytosis



- Receptor mediated- Receptors on the outside of cell membrane allow for the attachment of a particular molecule. When a certain number of receptor sites are filled, endocytosis occurs.

42

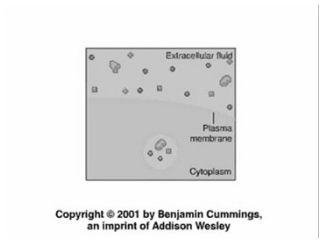
Figure 5.13ca



c. Receptor-mediated endocytosis

Receptor-mediated endocytosis (#21): a form of pinocytosis, occurs when specific receptor helps substances across

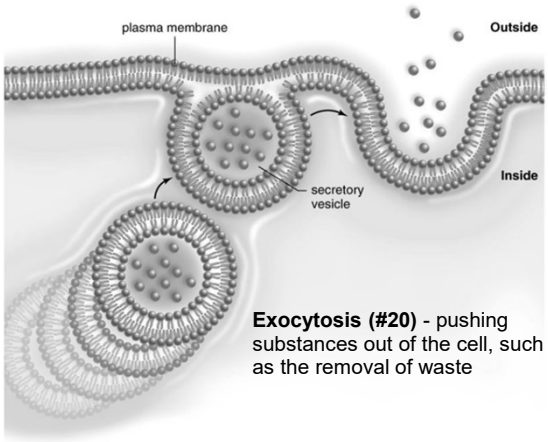
Exocytosis



- Exocytosis is just the opposite of endocytosis. Material to be secreted usually moves through the compartments of the Golgi apparatus where it may be modified. The material is then surrounded by membrane forming a vesicle.

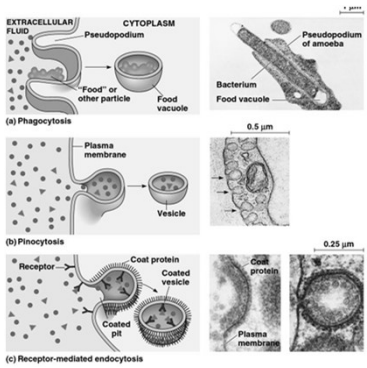
44

Figure 5.12



Exocytosis (#20) - pushing substances out of the cell, such as the removal of waste

Review of Endocytosis

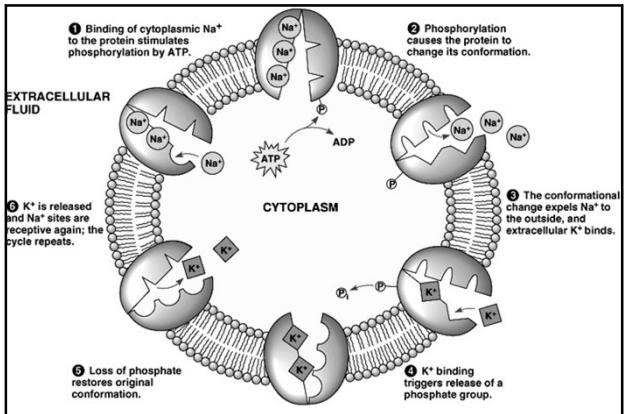


46

Sodium-Potassium Pump (#16) - pumps out 3 sodium ions for every 2 potassium ions taken in **against** gradient

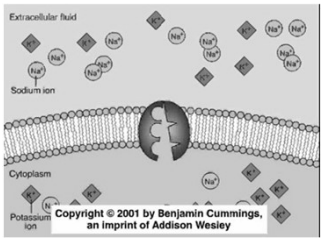
A huge amount of energy in our bodies is used to power this pump and prevent sodium from building up within our cells.

What would happen if you had too much sodium in your cells?



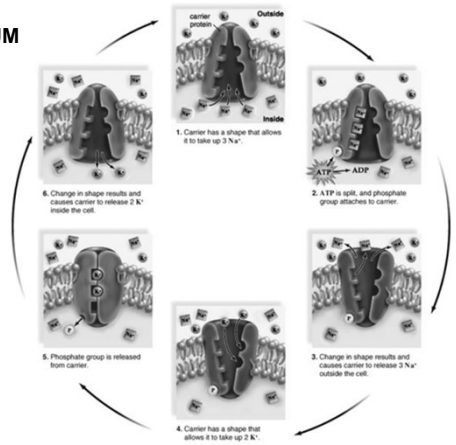
48

Active Transport



49

SODIUM POTASSIUM PUMP



- Sodium-Potassium Pump

Passive Diffusion

Type of Transport	Membrane is premeable	Use a Protein Carrier	Direction of molecule	Use of ATP	Examples
Passive Diffusion	Yes	No	High--->Low	No	CO_2, O_2 lipids
Facilitated Diffusion					
Active Transport					
Osmosis					
Endo and Exocytosis					
Phagocytosis					
Pinocytosis					

Facilitated Diffusion

Type of Transport	Membrane is premeable	Use a Protein Carrier	Direction of molecule	Use of ATP	Examples
Passive Diffusion	Yes	No	High--->Low	No	CO_2, O_2 lipids
Facilitated Diffusion	No	Yes	High--->Low	No	**glucose, amino acids**
Active Transport					
Osmosis					
Endo and Exocytosis					
Phagocytosis					
Pinocytosis					

Type of Transport	Membrane is premeable	Use a Protein Carrier	Direction of molecule	Use of ATP	Examples
Passive Diffusion	Yes	No	High--->Low	No	CO_2, O_2 lipids
Facilitated Diffusion	No	Yes	High--->Low	No	**glucose, amino acids**
Active Transport	No	Yes	Low--->High	Yes	**ions, polar molecules**
Osmosis					
Endo and Exocytosis					
Phagocytosis					
Pinocytosis					

Type of Transport	Membrane is premeable	Use a Protein Carrier	Direction of molecule	Use of ATP	Examples
Passive Diffusion	Yes	No	High--->Low	No	CO_2, O_2 lipids
Facilitated Diffusion	No	Yes	High--->Low	No	glucose, amino acids
Active Transport	No	Yes	Low--->High	Yes	ions, polar molecules
Osmosis	No	Yes	Water likes to "dilute"	No	water moves across the membrane
Endo and Exocytosis					
Phagocytosis					
Pinocytosis					

Type of Transport	Membrane is premeable	Use a Protein Carrier	Direction of molecule	Use of ATP	Examples
Passive Diffusion	Yes	No	High--->Low	No	CO_2, O_2 lipids
Facilitated Diffusion	No	Yes	High--->Low	No	glucose, amino acids
Active Transport	No	Yes	Low--->High	Yes	ions, polar molecules
Osmosis	No	Yes	Water likes to "dilute"	No	water moves across the membrane
Endo and Exocytosis	No	Membrane Vesicles	In or out	Some energy	Large Particles
Phagocytosis	No	Membrane Vesicles	In	Some energy	Large Particles
Pinocytosis	No	Membrane Vesicles	In	Some energy	Large Particles

Type of Transport	Membrane is premeable	Use a protein	Direction of molecule	Use of ATP	Examples
Passive Diffusion					
Facillitated Diffusion					
Active Transport					
Osmosis					
Endo and Exocytosis					
Phagocytosis					
Pinocytosis					

Mini Labs and Demos

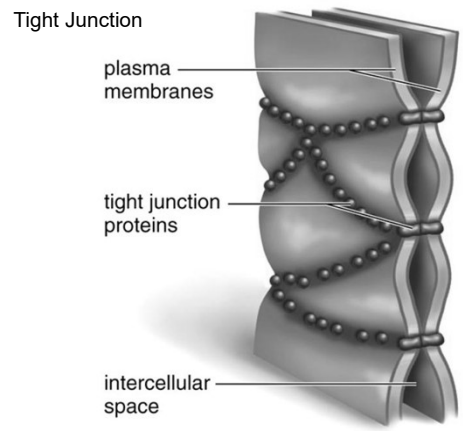
1. Place a baggie full of starch in a beaker that has iodine (an indicator for starch). Observe what happens.

2. Create a wet mount of elodea (anacharis) and observe what happens to the cells when you add salt water.

3. Observe what happens when food coloring is placed in a beaker of water. How does the process change if the water is heated first?

*There is an AP Lab on diffusion and osmosis that we will be doing later.

Tight Junction



Gap Junction

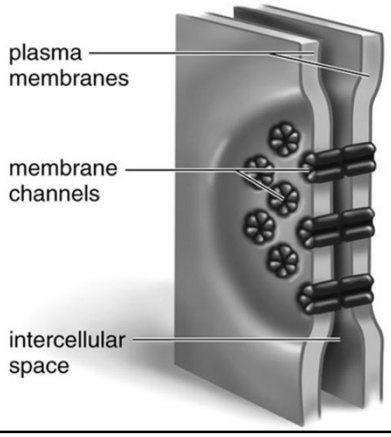
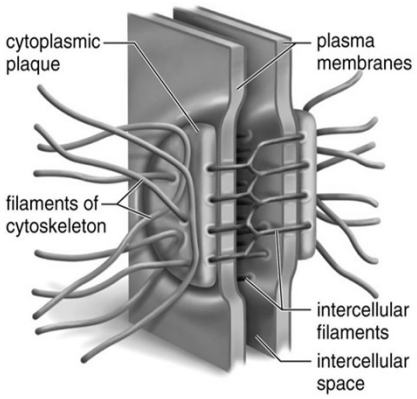


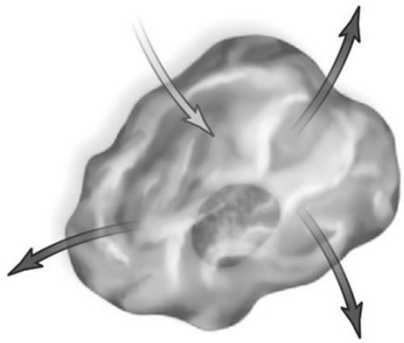
Figure 5.14ab

Desmosomes

(anchors)

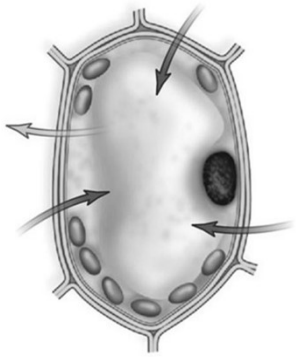


Pg 99a



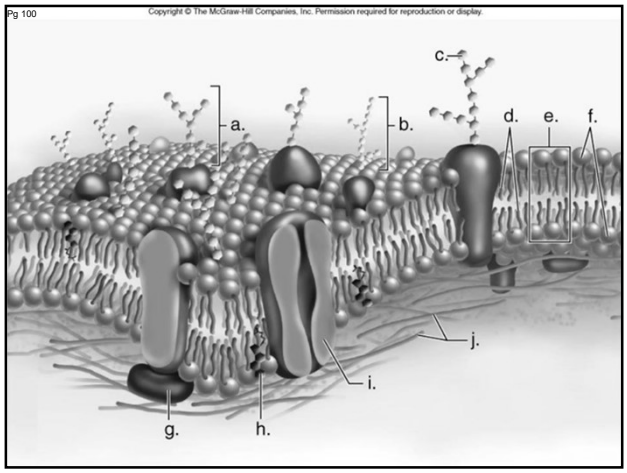
a. _____

Pg 99b

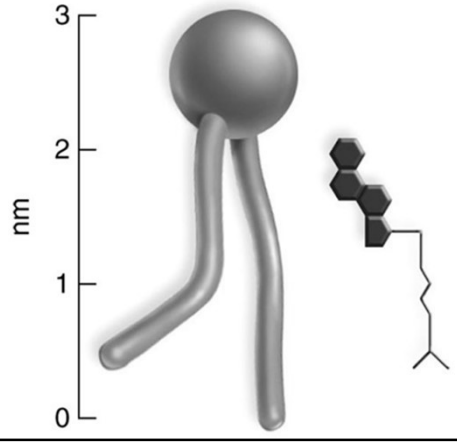


b. _____

Pg 100



Pg 85



Pg 86