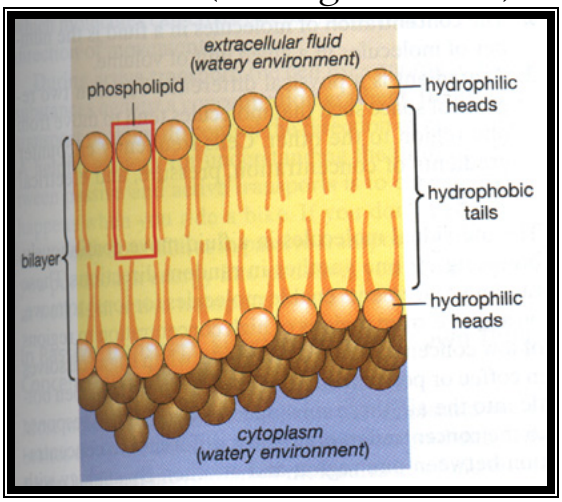
TRANSPORT

Definition: life process that involves the absorption and circulation of materials within a cell and/or throughout an organism.

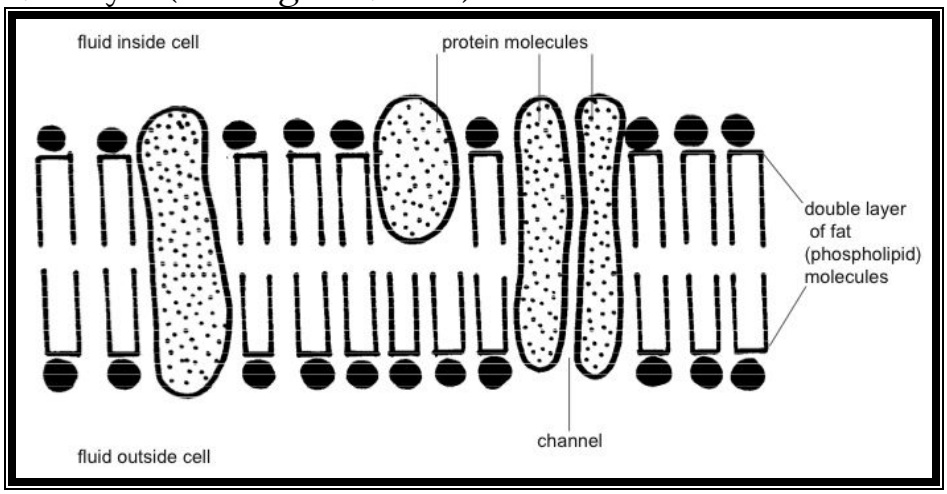
- **Absorption:** the process by which the end products of digestion (amino acids, monosaccharides, and fatty acids and glycerol) as well as dissolved solids and gases enter the fluids and cells of an organism.

Structure of the Cell Membrane

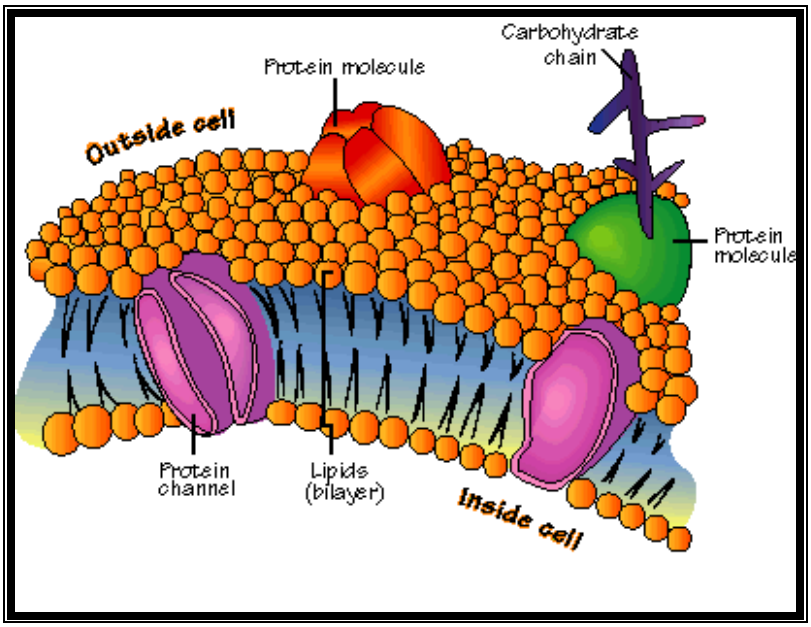
1. ***Double phospholipids layer*** (lipid bilayer)
   a. Phospholipids are made up of phosphate heads that are hydrophilic ("water loving") and lipid tails that are hydrophobic ("water hating")
   b. Since there is fluid outside and inside the cell, the phospholipids line up in a double layer with the phosphate heads oriented to the water and the lipid tails facing away from the water (see diagram below).



2. ***Protein Molecules***
   a. protein molecules are scattered throughout the phospholipid double layer.
   b. Some proteins are partially embedded in one layer of the cell membrane; other proteins rest on the surface of the membrane or poke completely through the double layer (see diagram below)



3. ***Fluid-Mosaic Model of the Cell Membrane***
    a. Picture a "lipid" sea that is in continual motion where "protein" icebergs are floating, forming various mosaic patterns in the lipid sea (see diagram below).
    b. Notice that some of the proteins go all the way through the phospholipids bilayer – these proteins are used in the transport of certain substances into/out of the cell.



Maintaining Homeostasis in the Cell

1. The ability of cells to establish and maintain a constant internal environment is a result of the special properties of the cell membrane.
2. Remember that the cell membrane is semi-permeable. That means it allows certain substances to enter/leave the cell.
3. Size has a great deal to do with passes through the cell membrane. Small molecules like water, carbon dioxide, oxygen, and amino acids pass easily through the cell membrane
4. Substances that dissolve well in lipids, like alcohol, also can pass through the cell membrane,
5. In addition to size, the charge of the molecule also affects its ability to pass through the cell membrane. Ions and larger molecules, like glucose, need a little help from protein channels to get through the cell membrane.
6. However, large molecules like starch and proteins do not easily pass through the cell membrane..

Check your Understanding

1. Describe the life function of transport..
2. List three functions of the cell membrane (review – put on your thinking caps!)
3. Describe the structure of the cell membrane.
4. Why are the phospholipids oriented like a double layer of soldiers lined up in a row?
5. Differentiate between the terms hydrophilic and hydrophobic.
6. How do some proteins in the cell membrane help in the transport of substances in/out of the cell?

7. What are some substances that easily pass through the spaces between the phospholipids?
8. How does the cell membrane help the cell to maintain inner homeostasis?

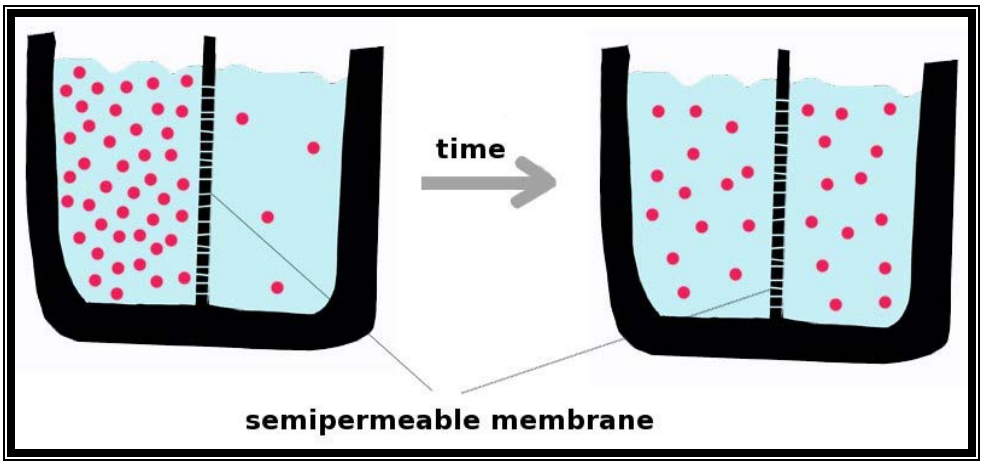
Transport Across the Cell Membrane

1. Molecules are always in constant motion. They move in all directions until they run into other molecules or into the walls of their confining container.
2. When molecules collide, they bounce off and head in new directions, so their paths often appear to zigzag.
3. As a result, molecules tend to spread from an area of high concentration to an area of low concentration. (Think about the perfume or cologne you put on after gym - after a few minutes in the classroom, I can smell your "special" scent in the back of the room!)

Diffusion

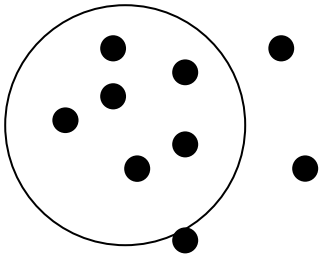
1. **Def:** The movement of particles from an area of high concentration to an area of low concentration.
2. ***Concentration Gradient*** is the difference between the two areas of concentration (high concentration vs low concentration of a particular molecule)
3. ***Equilibrium***: Over time, the molecules will be evenly distributed throughout the available space, since as many molecules will move into an area as will move out of this area.
4. For example., if you put a drop of food coloring into a beaker of water, it will stay concentrated in a small area at first. Then, even without mixing, if given enough time, the molecules of food coloring will disperse and spread out evenly through the water. Over time, the color will be evenly distributed within the beaker.
5. ***Diffusion of molecules requires NO energy and is a PASSIVE process.***.
6. Although the molecules constantly move back and forth and eventually establish equilibrium, the ***NET movement of molecules in diffusion is WITH the concentration gradient, from an area of high concentration to an area of low concentration.*** (see diagram below)
7. Molecules that easily diffuse across a cell membrane include **oxygen, carbon dioxide, water,, and amino acids.**

Net Movement of Molecules is from Right to Left in Order to Establish Equilibrium

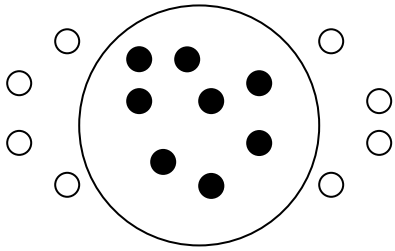


Check your Understanding

9. Define the term diffusion.
10. Why does diffusion occur?
11. How is diffusion important to cells?
12. Explain what is meant by a concentration gradient.
13. Why is diffusion considered to be a passive process (requires no energy)?
14. How is equilibrium established during the diffusion of molecules?
15. List some molecules that can cross the cell membrane by diffusion.
16. In the cell below, there are carbon dioxide molecules inside and outside the cell. What will happen to the carbon dioxide molecules in the cell? Explain your answer. (● = carbon dioxide molecule)



17. In the cell below, carbon dioxide, (black circles) is inside the cell. Oxygen (open circles) is the cell,
    a. Over time, what will happen to the oxygen and carbon dioxide with respect to the cell?
    b. What is the overall net movement of the oxygen and carbon dioxide molecules?



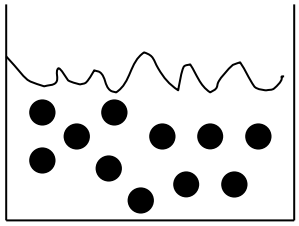
Osmosis

1. Osmosis ***is the diffusion of water across a membrane***.
2. Water is a small molecule and can easily pass between the lipids of a cell membrane.
3. As with all molecules, water molecules are constantly moving back and forth across the cell membrane., always from an area of high concentration of water to a low concentration of water.
4. If the concentration of **water OUTSIDE the cell is high**, ***water will move INTO the cell***
5. If the concentration of **water is high INSIDE the cell**, ***water will move OUT of the cell***.
6. If water has a great deal of particles in it (ex: saltwater) then the water concentration is low. **THINK ABOUT THIS –**

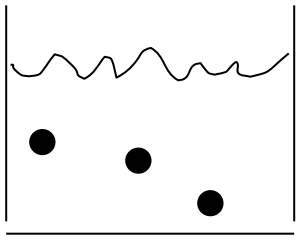
    c. If there are salt molecules in a beaker of water, these salt molecules take up space. **So, there is less water in the beaker (concentration of water is low)**

d. If there was only water in a beaker, there are very few particles in the water, **so the concentration of water is high.**

Try these problems before we move on:

a. 

In this beaker there is a 95% salt solution (NaCl) meaning there is 5% water in this solution,
Is the water concentration high or low? Explain.

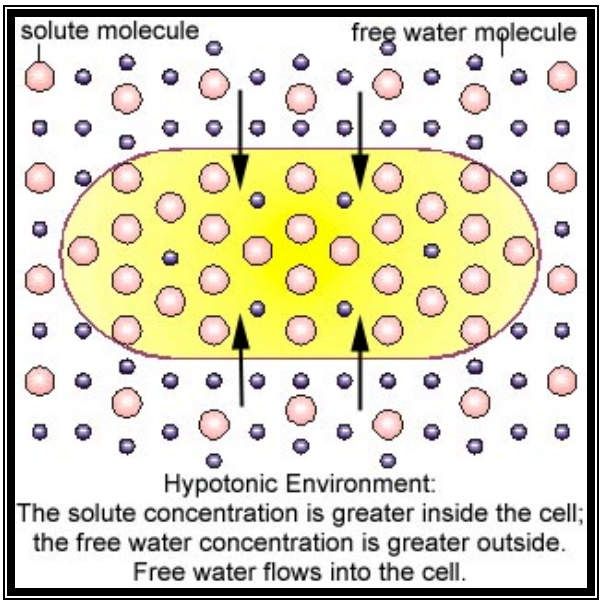
b. 

This beaker is filled with a 5% salt solution. **What is the of percentage of water that is in this solution?**
Is this a high or low water concentration?

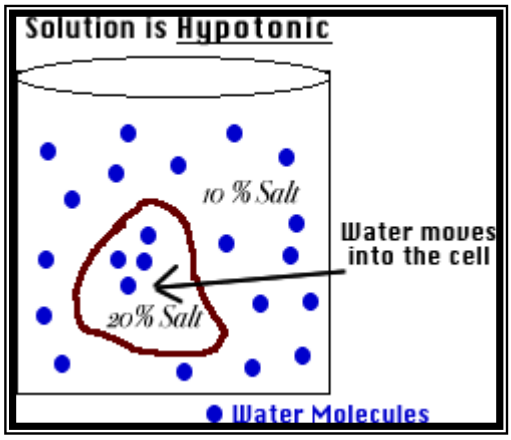
Vocab.Time!

Solvent: the substance in which other materials can dissolve in. In the above two examples, **water is the solvent.**
Solute: The substance being dissolved in the solution,. In the above two examples, **salt is the solute.**

7. In the diagram below, a cell has been placed into a ***HYPOTONIC*** solution in which there are less solute molecules outside the cell than inside. This means that the water concentration outside the cell is greater than inside. In this case, the water will ***MOVE INTO*** the cell.

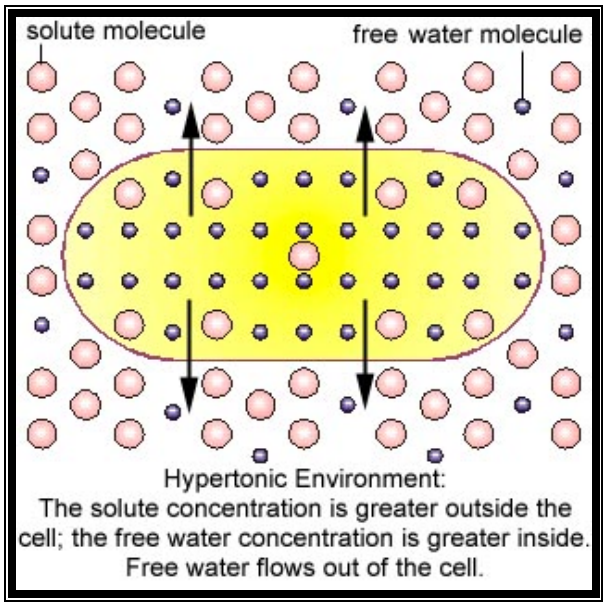


Consider the following situation: A cell is placed in a 10% salt
solution. The cytoplasm of this cell is made up of 20% particles. This means that compared to the cell, the solution is
hypotonic., with more water outside the cell than inside. In order to try to establish equilibrium, water will flow into the cell, making it larger.



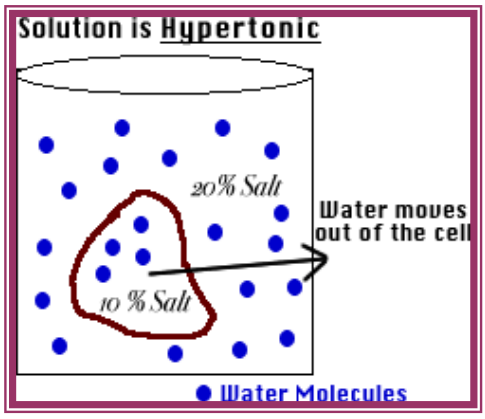
Q: If water keeps moving into the cell, what could eventually happen?

8. In the diagram below, a cell has been placed into a ***HYPERTONIC*** solution in which there are more solute molecules outside the cell than inside. This means that the water concentration inside the cell is greater than inside. In this case, the water will ***MOVE OUT*** of the cell.

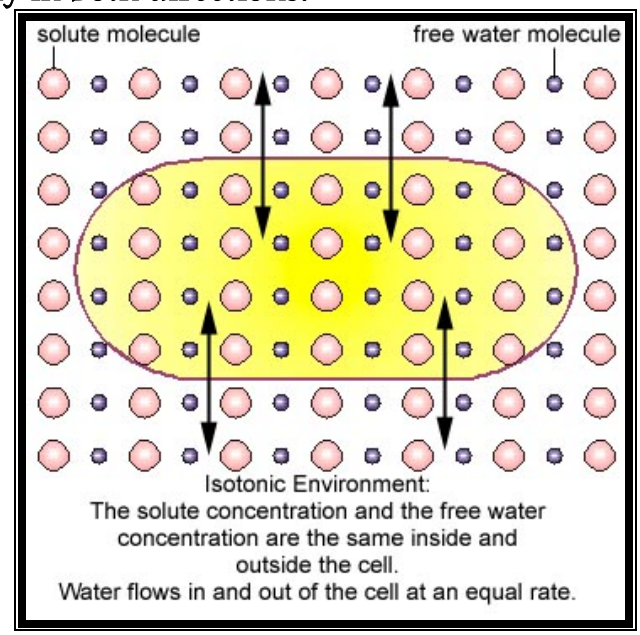


Now consider this scenario: A cell is placed into a 20% salt
The cytoplasm of this cell is made up of 10% particles. This means that compared to the cell, the solution is
hypertonic, with more water inside the cell than inside. In order to try to establish equilibrium, water will flow out of the cell,

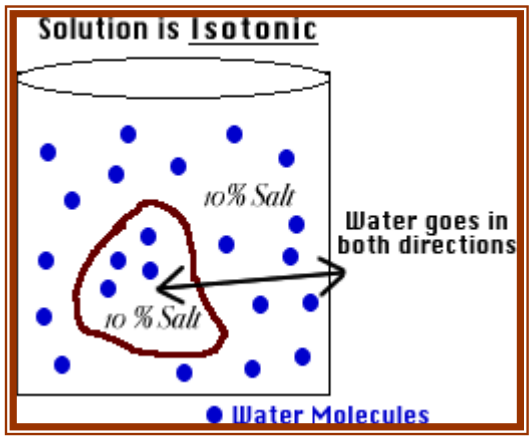
Q: If water continues to move out of the cell, predict what the cell will look like.



8. A cell is placed into a solution where the solute and water concentrations inside and outside the cell are equal. This solution is **ISOTONIC.** Since the water concentrations are the same on both sides of the cell, the cell is in equilibrium with its environment, **water flows equally in both directions.**



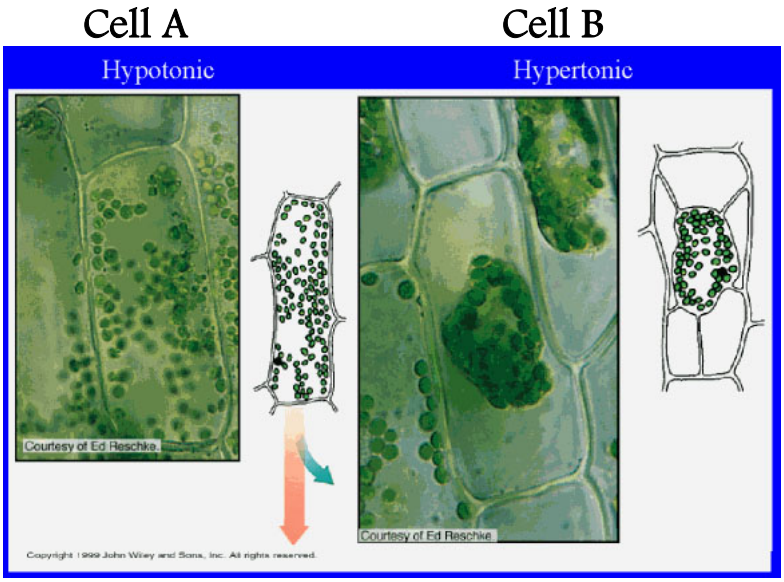
Examine the following situation: A cell with a 10% particle concentration is placed in a cell with a 10% salt solution. This means that that the water concentration for both the cell and the solution is 90%. Since the solution is **isotonic** with the cell, the water flows in both directions equally.



Check your Understanding:

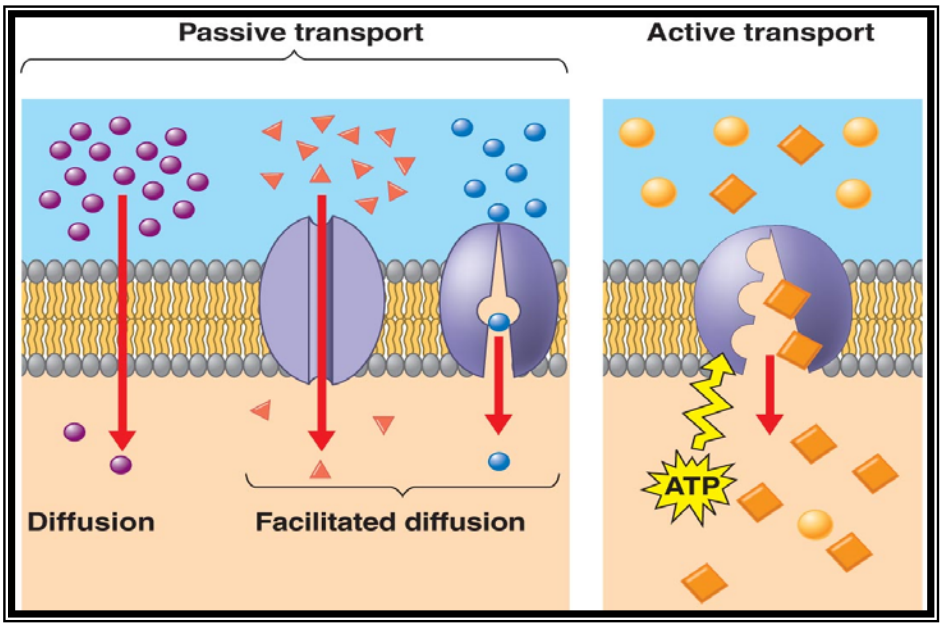
18. How does osmosis differ from diffusion?
19. Why is osmosis considered passive transport?
20. Differentiate between solutes and solvents.
21. Describe the differences among hypertonic, hypotonic, and isotonic solutions..
22. A cell's cytoplasm is made up of 85% water.
    a. With drawings, illustrate what would happen if the cell was placed in a 25% salt solution.
    b. Is the salt solution hypertonic or hypotonic?
23. Examine the micrographs of the leaf cells below. Cell A was placed in a hypotonic environment.
    Cell B was placed in a hypertonic environment.
    a. What are the little green organelles seen in both micrographs and illustrations?
    b. Describe how cell A differs from Cell B.
    c. Hypothesize as to what type of solution Cell A was exposed to. Do the same for Cell B.

d. Think about the structure of a plant cell. What keeps Cell A from exploding from continued inward osmosis?
e. Describe what could happen if cell B continues to lose water.



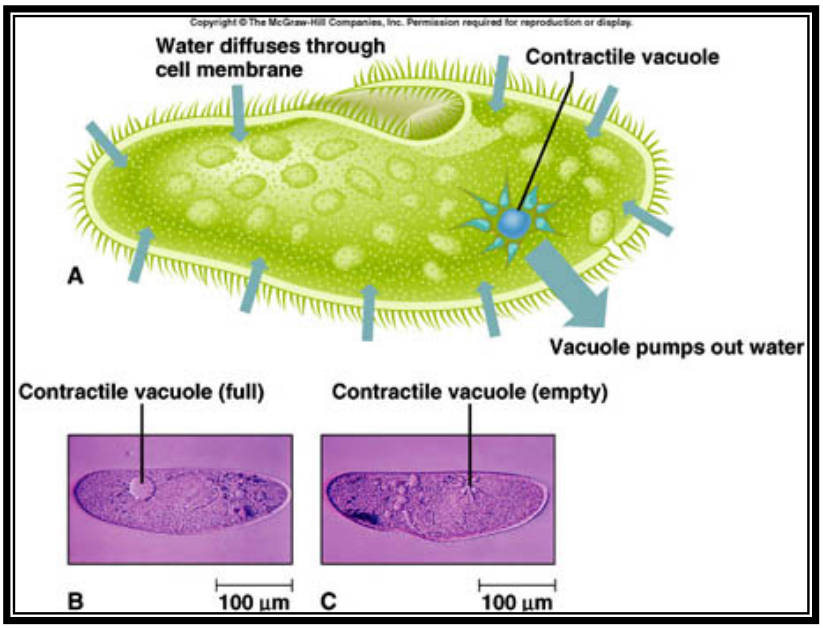
Facilitated Diffusion

1. **Form of passive transport., NO energy needed!**
2. Some larger molecules such as glucose are too large to fit between the spaces between phospholipids molecules. Instead, these molecules are helped across the cell membrane by proteins that make up the cell membrane.
3. Such substances require carrier proteins that bind to the molecule on one side of the cell membrane and then release it on the other side of the membrane. This is how glucose can get into the cell. (see diagram below)
4. Since lipids repel ions, protein channels enable certain ions to get across the cell membrane and into the cell. (see diagram below)



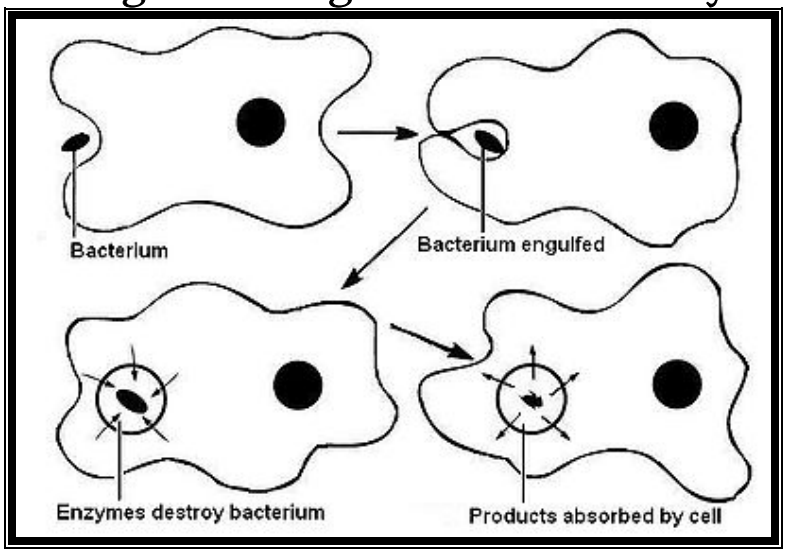
Active Transport

1. Certain substances need a bit of help in order to move across the cell membrane.
2. This help comes in the form of some **ENERGY INPUT (ATP)**
3. When substances are moved **AGAINST** the concentration gradient, from low concentration to high concentration, energy is required. (see diagram above).
    a. Recall when we talked about protozoans and contractile vacuoles. The paramecium, for example, lives in fresh water in a hypotonic environment (less particles, more water) as compared to the inside of its single cell. As a result, the water continually flows into the paramecium. In order to keep the paramecium from exploding from too much water, it has a contractile vacuole that collects the water and periodically pumps excess water across the cell membrane against the concentration gradient (low to high) into the environment. To do this, the cell requires energy. (see diagram below):



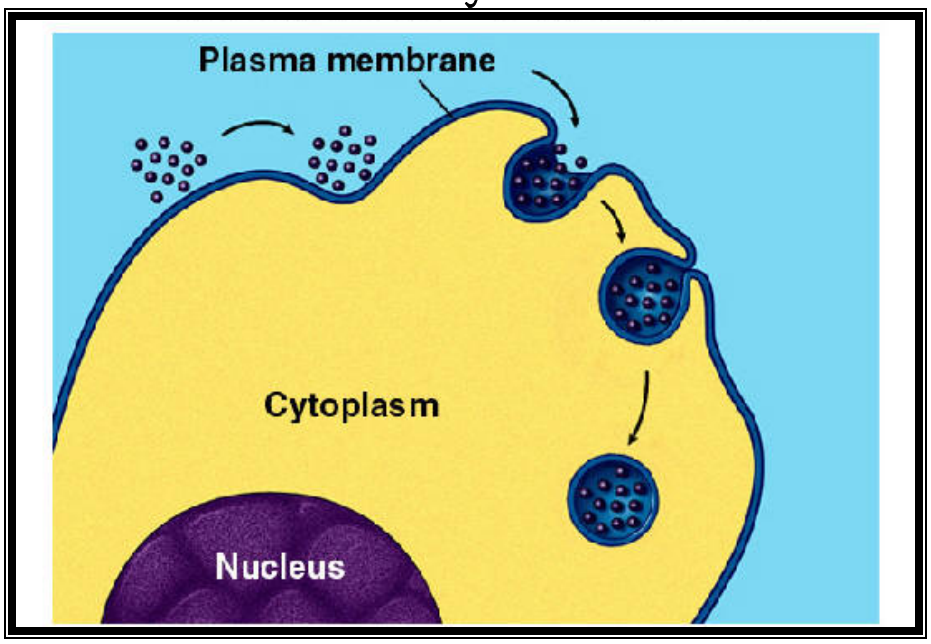
4. Certain ions, like sodium (Na^+ and potassium K^+) are assisted by carrier protein molecules to help them across the cell membrane (see diagram above).
5. In other cases, some materials are too large to cross the cell membrane and the cells have to take these substances in by using energy enhanced processes.
    a. **Phagocytosis**: (cell "eating")
    --requires an input of energy
    --process by which **large, undissolved particles are taken into the cell**
    --molecules are engulfed by the cell and enclosed in a vacuole where chemical digestion and absorption take place.
    --examples: **ameba** take in food this way; **white blood cells (phagocytes)** engulf and destroy bacteria by phagocytosis.

Ameba engulfs and digests a Paramecium by Phagocytosis



b. Pinocytosis: (cell "drinking")
--**requires energy** (active transport)
--process by which large, dissolved molecules become enclosed in a vacuole.
--to accomplish this, the **cell membrane pockets inward** and after the dissolved material is in the pocket, it pinches off from the main membrane to form a vacuole.

Pinocytosis



Check Your Understanding:

24. Describe the difference(s) between passive and active transport.
25. Which three processes can be classified as passive transport?

26. Why is facilitated diffusion necessary for the transport of glucose across the cell membrane?
27. Describe the role of a channel protein in facilitated diffusion.
28. Why do charged ions (like calcium, sodium, and potassium) need help in crossing the cell membrane?
29. Why do you think energy is needed to move molecules across the cell membrane against the concentration gradient?
30. Why is phagocytosis called "cell eating"?
31. Why is pinocytosis called "cell drinking"?
32. Compare the transport processes of phagocytosis and pinocytosis.