

CHAPTER 6

HOMEOSTASIS AND TRANSPORT

LECTURE NOTES FROM <http://www.sirinet.net/~jgjohnso/homeostasis.html>

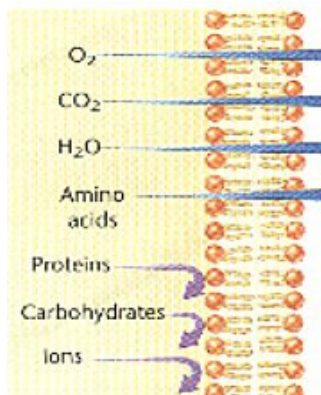
DIFFUSION AND OSMOSIS

OBJECTIVES:

- Explain how an equilibrium is established as a result of diffusion.
- Distinguish between diffusion and osmosis.
- Explain how substances cross the cell membrane through facilitated diffusion.
- Explain how ion channels assist the diffusion of ions across the cell membrane.

Cell membranes help organisms maintain Homeostasis by controlling what substances may enter or leave cells. Some substances can cross the cell membrane without any input of Energy by the cell. The movement of such substances across the membrane is known as **PASSIVE TRANSPORT**.

1. The activities of a cell depend on the materials that enter and leave the cell.
2. To stay alive, a CELL MUST EXCHANGE Materials such as Food and Waste With Its ENVIRONMENT.
3. These materials must cross the Cell Membrane.



4. Small molecules like WATER, OXYGEN, AND CARBON DIOXIDE can move in and out freely.

5. Large molecules like PROTEINS AND CARBOHYDRATES CANNOT.

6. The Cell Membrane is **SEMIPERMEABLE**.

7. A **SEMIPERMEABLE MEMBRANE OR SELECTIVELY PERMMEABLE** ONLY ALLOWS CERTAIN MOLECULES TO PASS THROUGH.

DIFFUSION

1. The Simplest type of **PASSIVE TRANSPORT**, Does Not require the cell to use Energy, is **DIFFUSION**. Small molecules can pass through the cell membrane by a process called **DIFFUSION**.
2. **DIFFUSION** IS THE MOVEMENT OF MOLECULES FROM AN AREA OF HIGHER CONCENTRATION TO AN AREA OF LOWER CONCENTRATIONS.
3. This difference in the Concentration of Molecules across a space is called a **CONCENTRATION GRADIENT**.
4. Diffusion is Driven By the **KINETIC ENERGY** the molecules possess. Because of their Kinetic Energy, molecules are in Constant Motion. Diffusion occurs when molecules move randomly away from each other in a liquid or gas.

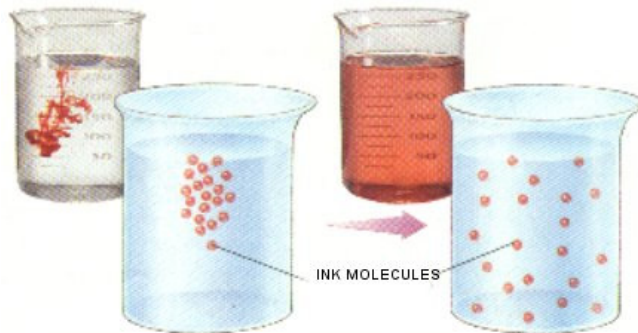
5. The Rate of Diffusion depends on the **TEMPERATURE, SIZE** and the **TYPE OF THE MOLECULES THAT IS DIFFUSING**.

6. Molecules Diffuse **FASTER** at **HIGHER TEMPERATURES** than at lower temperatures.

7. **SMALLER** Molecules Diffuse **FASTER** than **LARGE** Molecules.

8. MOST Short Distance Transport of Materials into and out of cells occurs by Diffusion.

9. A **CONCENTRATION GRADIENT** IS THE DIFFERENCE BETWEEN THE CONCENTRATION OF A PARTICULAR MOLECULE IN ONE AREA AND THE CONCENTRATION IN AN ADJACENT AREA.



10. **DIFFUSION ALWAYS OCCURS DOWN A CONCENTRATION GRADIENT, FROM THE AREA OF GREATER or HIGHER CONCENTRATION TO THE AREA OF LESS OR LOWER CONCENTRATION.**

11. When molecules are dispersed **EVENLY**, there is no longer any Diffusion because there is no longer a Concentration Gradient.

12. Diffusion will Eventually cause the Concentration of molecules to be the **SAME** Throughout the Space the Molecules Occupy.

13. When the Concentration of the molecules of a Substance is the Same Throughout a Space, a State of **EQUILIBRIUM** EXISTS.

OSMOSIS

1. **THE DIFFUSION OF WATER** ACROSS A SEMIPERMEABLE MEMBRANE IS CALLED **OSMOSIS**.

2. OR THE PROCESS BY WHICH WATER MOLECULES DIFFUSE ACROSS A CELL MEMBRANE FROM AN AREA OF HIGHER CONCENTRATION TO AN AREA OF LOWER CONCENTRATION IS CALLED **OSMOSIS**.

3. Water move across a Cell Membrane from a region of **HIGH** Concentration of Water to a region of **LOW** Concentration.

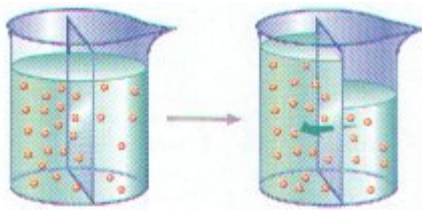
4. Like any other Diffusing Molecule, Water moves **DOWN** its Concentration Gradient.

5. **OSMOSIS OCCURS IN RESPONSE TO THE CONCENTRATION OF SOLUTES DISSOLVED IN WATER.**

6. **SOLUTES ARE DISSOLVED SUBSTANCES IN A SOLUTION.** Cytoplasm is Mostly Water containing many dissolved solutes.

7. Because no **TWO** Molecules can occupy the same space at the same time, the more Solutes there are in a certain volume of Water, The **FEWER** Water Molecules there can be in the same volume.

8. Solutions with many Solutes contain **FEWER** Water Molecules than do solutions with fewer solutes.



9. Water Moves from AREAS of LOW Solute Concentration to AREAS of HIGH Solute Concentration.

10. Water will cross the Membrane toward the Higher Solute Concentration until the Concentration Gradients of BOTH WATER and SOLUTES EVEN OUT.

11. The Net Direction of Osmosis DEPENDS on the Relative Concentration of Solutes on the TWO Sides of the Cell Membrane.

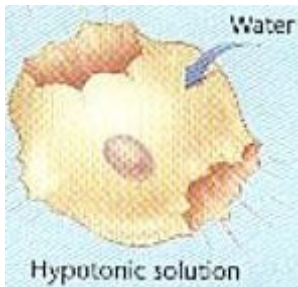


12. IN A **HYPERTONIC SOLUTION**, THE CONCENTRATION OF SOLUTE MOLECULES OUTSIDE THE CELL IS HIGHER THAN THE CONCENTRATION OF SOLUTES INSIDE THE CELL CYTOSOL.

13. In Hypertonic Solutions, **WATER DIFFUSES OUT OF THE CELL** until Equilibrium is established.

14. If the cell loses too much water, the cell will shrivel and shrink.

15. Cells in Hypertonic Solutions usually DIE because the cell's activities are Disrupted by LACK OF WATER.



16. IN A **HYPOTONIC SOLUTION**, THE CONCENTRATION OF SOLUTE MOLECULES OUTSIDE THE CELL IS LOWER THAN THE CONCENTRATION OF SOLUTES INSIDE THE CELL CYTOSOL.

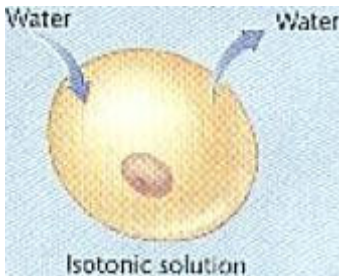
17. In Hypotonic Solutions, **WATER DIFFUSES INTO THE CELL** until Equilibrium is established.

18. In Hypotonic Solutions, Water flows into the Cell because there is a Greater Concentration of Solutes inside than outside the Cell.

19. The Flow of water into a cell causes it to swell.

20. Animal cells placed in distilled water (Hypotonic Solution) and they will swell and often burst because of Osmosis. The Bursting of Cells is called **CYTOLYSIS**. (sie-TAHL-uh-suhs)

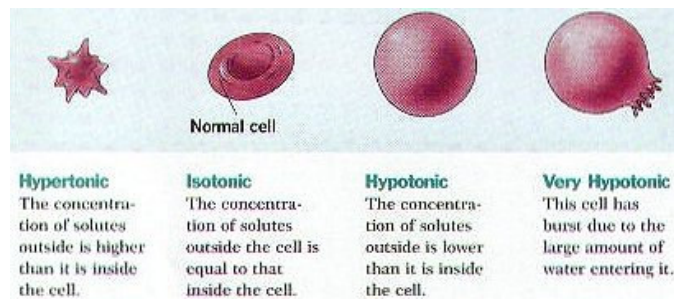
21. Plant Cells do not burst because of their Rigid Cell Wall. The pressure that Water molecules exert against the cell wall is called **TURGOR PRESSURE**.



22. IN AN **ISOTONIC SOLUTION**, THE CONCENTRATION OF SOLUTES OUTSIDE AND INSIDE THE CELL ARE EQUAL.

23. Under these conditions, water Diffuses Into and Out of the Cell at EQUAL RATES, so there is NO Net Movement of Water.

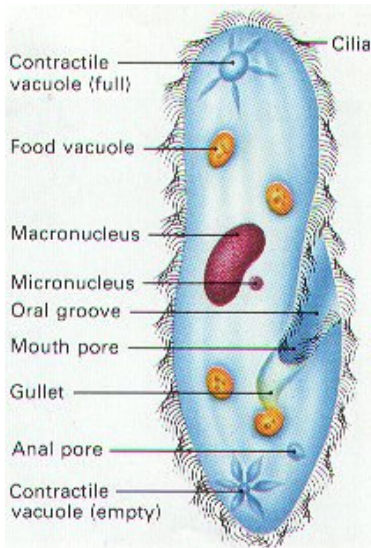
24. Water tends to Diffuse from HYPOTONIC SOLUTIONS to HYPERTONIC SOLUTIONS.



HOW CELLS DEAL WITH OSMOSIS

1. Cells that are exposed to an Isotonic External environment Usually have no difficulty keeping the movement of water across the cell membrane in balance.

2. This is the case with the cells of vertebrate animals on land and most other organisms living in the sea.



3. Many cells function in a Hypotonic environment, such as Unicellular Freshwater Organisms. Water Constantly Diffuses into these Organisms.

4. Because they require a relatively Lower Concentration of Water in the Cytosol to function Normally, Unicellular Organisms must rid themselves of the Excess Water that enters by Osmosis.

5. Some such as the paramecia (Figure 5-2), do this with **CONTRACTILE VACUULES**, which are organelles that remove Water.

6. Contractile vacuoles collect the excess water and then contract, **PUMPING THE WATER OUT OF THE CELL.**

7. Unlike Diffusion and Osmosis, this pumping action Requires The Cell to Expend **Energy - A FORM OF ACTIVE TRANSPORT.**

8. Plant cells also live in Hypotonic environment. The Cells that make up the roots may be surrounded by water.

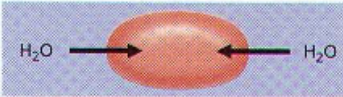
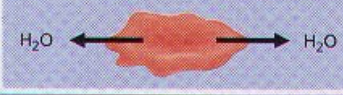

9. Water moves by Osmosis into Plant Cells, which Swell as they fill with water. The Swelling stops when the Cell Membrane is pressed against the Cell Wall. (Figure 5-3)

10. The Cell Wall is strong enough to resist the pressure, the pressure that water molecules exert against the Cell Wall is called **TURGOR PRESSURE.**

11. In a Hypertonic environment, Water Leaves the Cells through Osmosis. The Cells Shrink away from the Cell Wall, and Turgor Pressure is lost. This condition is called **PLASMOLYSIS**, and is the reason Plants Wilt.

12. Animal Cells placed in a Hypertonic environment will have Water leave the cells, making them shrink and shrivel.

13. Place in a Hypotonic environment, Water Diffuses into the cells, causing them to Swell and eventually Burst - **CYTOLYSIS.**

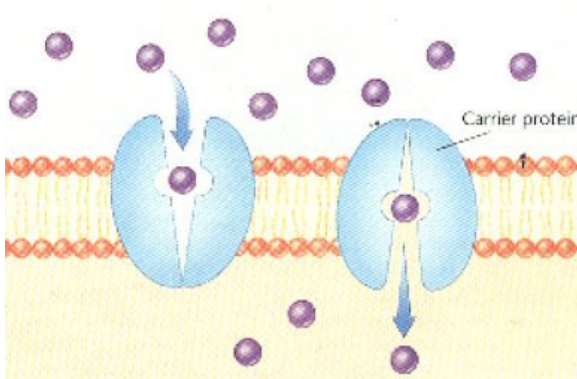
Condition	Net movement of water
External solution is hypotonic to cytosol	into the cell 
External solution is hypertonic to cytosol	out of the cell 
External solution is isotonic to cytosol	none 

FACILITATED DIFFUSION

1. **PASSIVE TRANSPORT** across a Membrane requires **NO ENERGY** and **ALWAYS** occurs **DOWN A CONCENTRATION GRADIENT**.

2. **DIFFUSION AND OSMOSIS ARE TYPES OF PASSIVE TRANSPORT.**

3. Most Molecules cannot cross the Membrane by simple diffusion.



4. Some Molecules are **CARRIED** across by **CARRIER PROTEINS** EMBEDDED IN the Cell Membrane.

5. Carrier Proteins **CHANGE SHAPE** when Molecules ATTACH to them. (Figure 5-5)

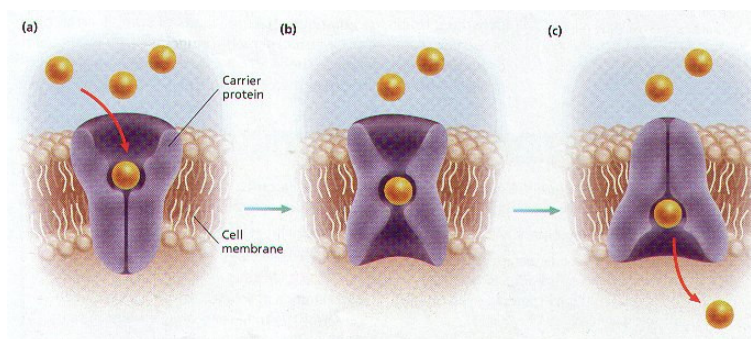
6. The Change in Shape of the Carrier Protein **ENABLES** the Molecule to **CROSS** the Membrane.

7. THE USE OF **CARRIER PROTEINS** FOR DIFFUSION IS CALLED **FACILITATED DIFFUSION**. Facilitated

Diffusion can help substances move Either INTO or OUT of a Cell, Depending on the Concentrated Gradient.

8. A Good Example of Facilitated Diffusion is the transport of Glucose into the Cell. Many Cells depend on Glucose for much of their Energy Needs.

9. Facilitated Diffusion is a FORM of PASSIVE TRANSPORT AND THEREFORE REQUIRES NO ENERGY INPUT.



10. Some molecules, such as Ions like Sodium (Na^+) and Potassium (K^+) cross through TUNNELS made of PROTEIN called **ION CHANNELS**. Ion Channels provide a small passageways across the Cell Membrane through which ions can diffuse.

11. Some ION CHANNELS are always open. Others have "Gates" that open to allow ions to pass or close to stop their passage.

12. Gates open and close in response to conditions in the ENVIRONMENT and IN THE CELL. There are Three kinds of Stimuli that may open or close the Gates: Stretching of the Cell Membrane, Electrical Signals, or Chemicals in the Cytosol or External Environment.

ACTIVE TRANSPORT

OBJECTIVES:

- Distinguish between passive and active transport.
- Explain how the sodium-potassium pump operates.
- Compare and contrast endocytosis and exocytosis

In many cases, cells must move materials up their concentrated gradient, from an area of lower concentration to an area of higher concentration. Such movement of materials is known as **ACTIVE TRANSPORT**. Unlike Passive Transport, Active Transport **REQUIRES A CELL TO EXPEND ENERGY (ATP)**.

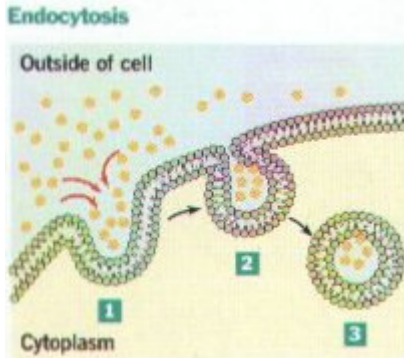
CELL MEMBRANE PUMPS

1. Cells often move molecules across the membrane **AGAINST** a Concentration Gradient.
2. From an area of **LOW** Concentration to areas of **HIGH** Concentration.
3. Moving molecules **AGAINST** the Concentration Gradient **REQUIRES ENERGY**. (**ACTIVE TRANSPORT**)
4. **WHEN ENERGY IS USED TO TRANSPORT MOLECULES ACROSS THE MEMBRANE, THE PROCESS IS CALLED ACTIVE TRANSPORT**.
5. Active Transport often involves **CARRIER PROTEINS** like those in Facilitated Diffusion.
6. The **CARRIER PROTEINS** act as **PUMPS** that **USE ENERGY** to move **IONS** and Molecules across the membrane. The Carrier Proteins that serve in Active Transport are often called **CELL MEMBRANE PUMPS**.
7. **ACTIVE TRANSPORT** is especially **IMPORTANT** in **MAINTAINING ION CONCENTRATION IN CELLS AND BETWEEN CELLS**.
8. **SODIUM-POTASSIUM PUMPS** ARE IMPORTANT FOR MUSCLE CONTRACTIONS, THE TRANSMISSION OF NERVE IMPULSES, AND THE ABSORPTION OF NUTRIENTS.
9. **SODIUM-POTASSIUM PUMPS** IN ANIMAL CELLS PUMP **SODIUM IONS OUT**, AND **POTASSIUM IN**, UP THEIR CONCENTRATION GRADIENT. (Figure 5-6)
10. **ATP** supplies the energy needed by carrier proteins.
11. In Plants, **ACTIVE TRANSPORT** enables roots to absorb nutrients from the soil.

12. Plant Nutrients are more concentrated inside the roots than in the surrounding soil.
13. WITHOUT ACTIVE TRANSPORT, NUTRIENTS would DIFFUSE OUT OF THE ROOTS.
14. Active Transport in the root cell membrane enables the plant to absorb the nutrients against the Concentration Gradient.

BULK TRANSPORT- ENDOCYTOSIS AND EXOCYTOSIS

1. Some Molecules, such as COMPLEX PROTEINS, are too LARGE to cross the Cell Membrane.
2. These Substances cross the Membrane by BULK TRANSPORT.
3. IN **BULK TRANSPORT**, LARGE MOLECULES, FOOD, AND OTHER SUBSTANCES ARE PACKAGED IN MEMBRANE-BOUND SACS CALLED A VESICLE AND MOVED ACROSS THE MEMBRANE.
4. THERE ARE SEVERAL TYPES OF BULK TRANSPORT, INCLUDING **ENDOCYTOSIS, EXOCYTOSIS, PINOCYTOSIS, AND PHAGOCYTOSIS.**



5. During **ENDOCYTOSIS** the Cell Membrane (figure 5-7) Folds into a POUCH that Encloses the Particles.
6. The Pouch pinches off INSIDE the Cell to form a **VESICLE** (membrane-wrapped bubbles).
7. The VESICLE can then fuse with other Organelles (LYSOSOMES) or Release its contents into the Cytoplasm.

8. **PINOCYTOSIS AND PHAGOCYTOSIS ARE TWO TYPES ON ENDOCYTOSIS.**

9. **PINOCYTOSIS** IS SOMETIMES CALLED "CELL DRINKING".

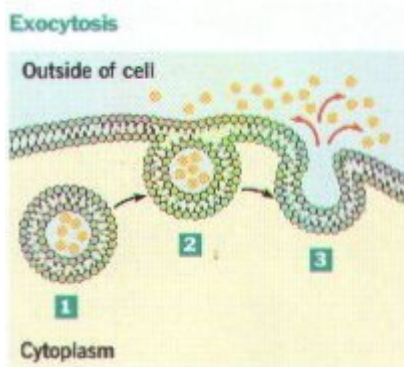
10. Solutes or Fluids outside the Cell Membrane can be brought into the Cytoplasm by **PINOCYTOSIS**.

11. **PHAGOCYTOSIS** IS LIKE PINOCYTOSIS, EXCEPT THE CELL ENGULFS A FOOD PARTICLE OR OTHER CELLS INSTEAD OF A DROP OF LIQUID. "CELL EATING"

12. The Food Vesicle can then Fuse with a **LYSOSOME** that contains DIGESTIVE ENZYMES.

13. White Blood Cells (WBC, **PHAGOCYTES**) Destroy Bacteria and other Unwanted Cells by Phagocytosis.

14. These cells engulf and digest millions of old RBC in your body daily.



15. **EXOCYTOSIS** IS THE OPPOSITE OR REVERSE OF ENDOCYTOSIS. (Figure 5-8)

16. DURING **EXOCYTOSIS**, WASTE AND CELL PRODUCTS LEAVE THE CELL.

17. Products MADE IN the Cell are Packaged in GOLGI VESICLES, which then FUSE with the Cell Membrane and Secrete Material OUT OF THE CELL.

18. MUCUS AND WASTE PRODUCTS ARE MATERIALS SECRETED BY EXOCYTOSIS.