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Section 1  Passive Transport

Section 2  Active Transport
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.
Diffusion

- **Passive transport** involves the movement of molecules across the cell membrane without an input of energy by the cell.

- **Diffusion** is the movement of molecules from an area of higher concentration to an area of lower concentration, driven by the molecules’ kinetic energy until equilibrium is reached.
Concentration Gradient

Click below to watch the Visual Concept.

Visual Concept
Diffusion, *continued*

- **Diffusion Across Membranes**
  - Molecules can diffuse across a cell membrane by dissolving in the phospholipid bilayer or by passing through pores in the membrane.
Diffusion

If you drop a lump of sugar into a beaker of water, the sugar particles will diffuse and become evenly distributed throughout the water.
Osmosis is the diffusion of water across a membrane.
Osmosis

Click below to watch the Visual Concept.

Visual Concept
Osmosis, continued

- **Direction of Osmosis**
  - The net direction of osmosis is determined by the relative solute concentrations on the two sides of the membrane.
Osmosis, continued

- **Direction of Osmosis**
  - When the solute concentration outside the cell is higher than that in the cytosol, the solution outside is **hypertonic** to the cytosol, and water will diffuse out of the cell.
Osmosis, *continued*

- **Direction of Osmosis**
  - When the solute concentrations outside and inside the cell are equal, the solution outside is *isotonic*, and there will be no net movement of water.
### Hypertonic, Hypotonic, Isotonic Solutions

<table>
<thead>
<tr>
<th>If the fluid outside the cell has...</th>
<th>Then outside fluid is...</th>
<th>Water diffuses...</th>
<th>Effect on cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>...lower free water molecule concentration than cytosol</td>
<td>...hypertonic.</td>
<td>...out of cell. $\rightarrow H_2O$</td>
<td>Cell shrinks.</td>
</tr>
<tr>
<td>...higher free water molecule concentration than cytosol</td>
<td>...hypotonic.</td>
<td>...into cell. $\rightarrow H_2O$</td>
<td>Cell swells.</td>
</tr>
<tr>
<td>...same free water molecule concentration as cytosol</td>
<td>...isotonic.</td>
<td>...into and out of cell at equal rates. $\leftrightarrow H_2O$</td>
<td>Cell stays same size.</td>
</tr>
</tbody>
</table>
Chapter 5

Comparing Hypertonic, Isotonic, and Hypotonic Conditions

Click below to watch the Visual Concept.

Visual Concept
Osmosis, continued

- **How Cells Deal With Osmosis**
  - To remain alive, cells must compensate for the water that enters the cell in hypotonic environments and leaves the cell in hypertonic environments.
  - **Contractile vacuoles** are organelles that regulate water levels in paramecia.
Facilitated Diffusion

• In facilitated diffusion, a molecule binds to a carrier protein on one side of the cell membrane.

• The carrier protein then changes its shape and transports the molecule down its concentration gradient to the other side of the membrane.
Facilitated Diffusion

**Facilitated Diffusion**

Carrier proteins transport substances down their concentration gradient.

1. A molecule outside the cell binds to a carrier protein on the cell membrane.
2. The carrier protein transports the molecule across the cell membrane.
3. The molecule is released from the carrier protein inside the cell.
Diffusion Through Ion Channels

- **Ion channels** are proteins, or groups of proteins, that provide small passageways across the cell membrane through which specific ions can diffuse.
Ion Channels

Ion channels allow certain ions to pass through the cell membrane.
Objectives

- **Distinguish** between passive transport and active transport.
- **Explain** how the sodium-potassium pump operates.
- **Compare** endocytosis and exocytosis.
Cell Membrane Pumps

• **Active transport** moves molecules across the cell membrane from an area of lower concentration to an area of higher concentration.

• Unlike passive transport, active transport requires cells to expend energy.
Some types of active transport are performed by carrier proteins called cell membrane pumps.
Cell Membrane Pumps, *continued*

- **Sodium-Potassium Pump**
  - The *sodium-potassium pump* moves three Na\(^+\) ions into the cell’s external environment for every two K\(^+\) ions it moves into the cytosol.
  - ATP supplies the energy that drives the pump.
Sodium-Potassium Pump

The sodium-potassium pump actively transports sodium ions, $\text{Na}^+$, and potassium ions, $\text{K}^+$, against their concentration gradient.

1. Three sodium ions, $\text{Na}^+$, and a phosphate group (P) from ATP bind to the pump.
2. The pump changes shape, transporting the three sodium ions across the cell membrane.
3. Two potassium ions, $\text{K}^+$, bind to the pump and are transported across the cell membrane.
4. The phosphate group and the two potassium ions are released inside the cell.

Diagram:
- Sodium ion, $\text{Na}^+$
- Outside of cell
- Potassium ion, $\text{K}^+$
- Inside of cell
- ATP and ADP
- Phosphate group

BIOgraphic
Movement in Vesicles

- **Endocytosis**
  - In *endocytosis*, cells ingest external materials by folding around them and forming a pouch.
  - The pouch then pinches off and becomes a membrane-bound organelle called a *vesicle*. 
Movement in Vesicles, continued

- **Endocytosis**
  - Endocytosis includes **pinocytosis**, in which the vesicle contains solutes or fluids, and **phagocytosis**, in which the vesicle contains large particles or cells.
Endocytosis

Click below to watch the Visual Concept.
Movement in Vesicles, *continued*

- **Exocytosis**
  - In *exocytosis*, vesicles made by the cell fuse with the cell membrane, releasing their contents into the external environment.
Exocytosis

Click below to watch the Visual Concept.

Visual Concept
Endocytosis and Exocytosis

Vesicles transport substances into and out of cells.

Endocytosis

Exocytosis