

Lecture Outline: Diffusion & Osmosis

I. Three Major Categories of Transport Processes

A. Active Transport.

B. Passive Transport.

C. Vesicular Transport

1. Named because it uses vesicles.

2. Will be discussed in a separate lecture, but is noted as one of the three mechanisms.

II. Distinctions Between Active and Passive Transport

A. Energy Requirement Distinction

1. Both require energy for movement.

2. Passive transport: Energy is **built into the system** (no additional energy required).

3. Active transport: Requires additional energy to occur.

B. The Concept of a Gradient

1. Definition: A difference in measurements at two places.

2. Examples: Pressure gradient, voltage (gradient of electrical potential energy).

3. Concentration Gradient: Relevant type for the experiment; involves differences in solute/solvent concentration inside and outside the cell.

III. Passive Transport and Diffusion

A. Passive Transport Mechanism and Energy

1. Driven by the gradient itself, which is a form of potential energy.

2. Based on random movement in all directions (**Brownian motion**).

3. Net effect is directional: Movement from high concentration to low concentration (**down the gradient**).

4. Ceases when the gradient is zero (equilibrium).

B. Simple Diffusion (Without a Membrane)

1. Example: Sugar cube dissolving in water.
2. Solutes and solvents diffuse independently down their respective gradients simultaneously.

C. Diffusion Through a Selectively Permeable Membrane (SPM)

1. Definition of SPM: A membrane that allows certain things through but not others.
2. Requirements for Diffusion through SPM
 - a. A gradient must be in place (the tendency).
 - b. The particle must have a way to pass through the membrane.
3. Multiple solutes diffuse independently down their own gradients.

IV. Osmosis: The Diffusion of Solvent (Water)

A. Osmosis is a Special Case of Diffusion.

B. Two Requirements for Osmosis

1. The moving particle must be the **solvent** (water in biological systems).
2. Movement must occur through a **selectively permeable membrane**.

C. Direction of Water Movement

1. Water moves from high water concentration to low water concentration (down the water gradient).
2. This is equivalent to movement from **low solute concentration** to **high solute concentration**.

D. Total Solute Concentration

1. Only the **water concentration gradient** matters for osmosis.
2. Total solute concentration is an indirect measure of water concentration.

E. Achieving Equilibrium in Osmosis

1. Equilibrium occurs when the water gradient is zero.
2. In the U-tube setup, equilibrium occurs when the force of gravity equals the osmotic pressure (no net osmosis).

V. Tonicity and the Cell Environment

A. Definition: Tonicity refers to the tendency for osmosis to occur through a

cell membrane.

B. Usage Rule: Tonicity terms must **only describe the cell's surroundings or environment**, never the cell itself.

C. Hypotonic Environment (Hypo = Below/More Watery)

1. Characteristics: Lower solute concentration/**more watery** than the cell.

2. Osmosis: Water moves **into** the cell.

3. Effects on Cells

a. Animal cells: Swells, bursts (**Lysis**).

b. Plant cells: Swells, pressurized (**Turgid**); ideal condition for the plant.

D. Hypertonic Environment (Hyper = Above/Less Watery)

1. Characteristics: Higher solute concentration/**less watery** than the cell.

2. Osmosis: Water moves **out of** the cell.

3. Effects on Cells

a. Animal cells: Shrivels (**Crenation**).

b. Plant cells: Plasma membrane collapses away from the cell wall (**Plasmolysis/Plasmolyzed**); fatal.

E. Isotonic Environment (Iso = Same/Equal Wateriness)

1. Characteristics: Wateriness is the same inside and outside the cell.

2. Osmosis: Water moves in both directions at the same rate (no net volume change).

3. Effects on Cells

a. Animal cells: This is the **ideal condition**.

b. Plant cells: Limp state (**Flaccid**); survivable but not ideal.