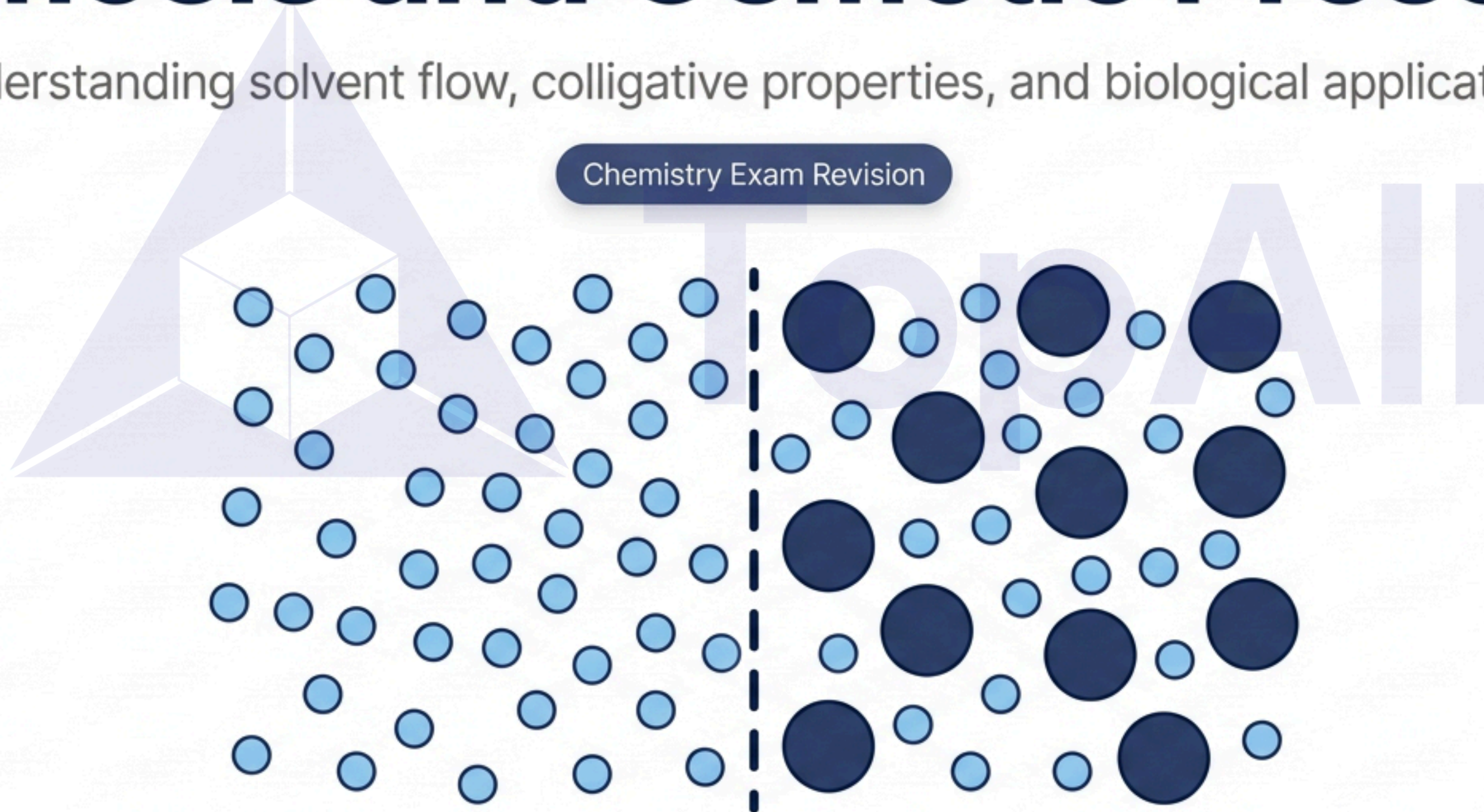


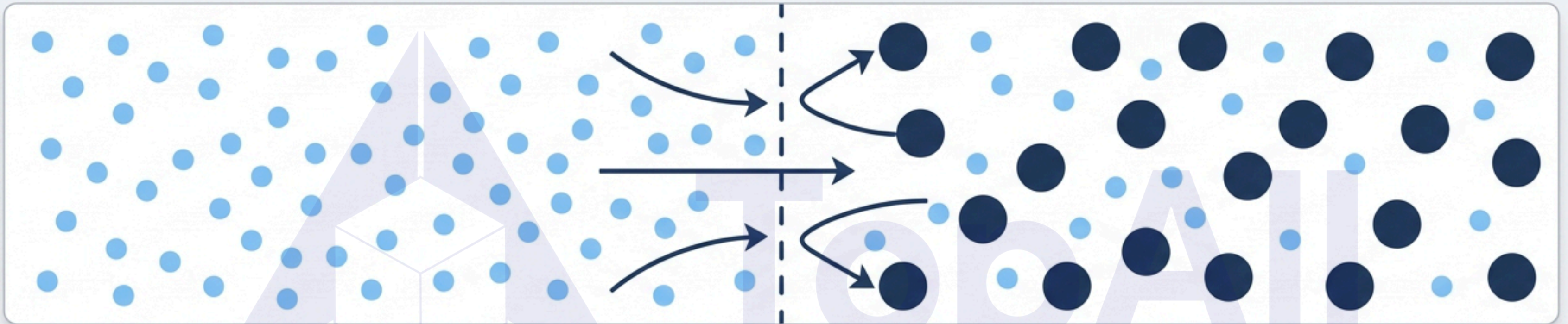
Osmosis and Osmotic Pressure

Understanding solvent flow, colligative properties, and biological applications.

Chemistry Exam Revision



The Membrane and The Movement



Semipermeable Membrane (SPM)

- **What it is:** A continuous film containing a submicroscopic network of pores.
- **Function:** Allows small solvent molecules (like water) to pass freely, but completely blocks larger solute molecules.
- **Examples:** Pig's bladder, parchment, synthetic cellophane.

Osmosis

- **Definition:** The spontaneous flow of solvent molecules through an SPM.
- **The Rule of Flow:** Solvent always flows from a region of **Lower Solute Concentration** to a region of **Higher Solute Concentration**.
- **Goal:** To equalize the concentration on both sides of the membrane.

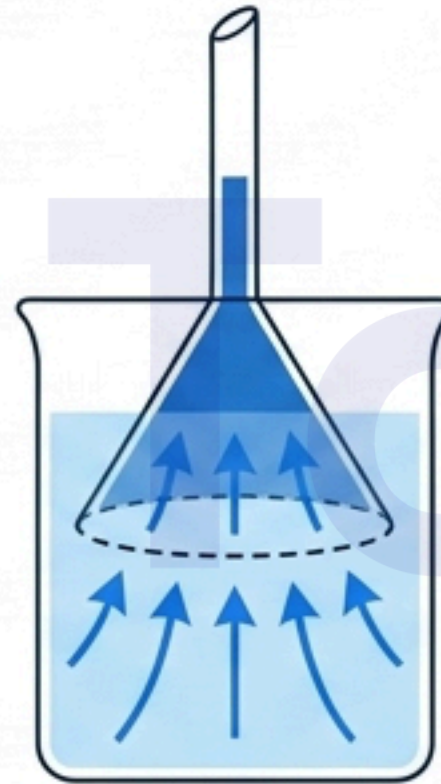
Visualizing Osmotic Flow: The Thistle Funnel

The Setup



A thistle funnel filled with concentrated sucrose solution is covered tightly with an SPM. It is inverted and placed into a beaker of pure water (solvent).

The Process



Water molecules move from the beaker (pure solvent) through the SPM into the funnel (solution). Why? Osmosis drives solvent from a region of **Lower Solute Concentration** to a region of **Higher Solute Concentration**.

The Result



The liquid level inside the stem visibly rises. The flow continues until hydrostatic pressure equals the osmotic pull, reaching dynamic equilibrium.



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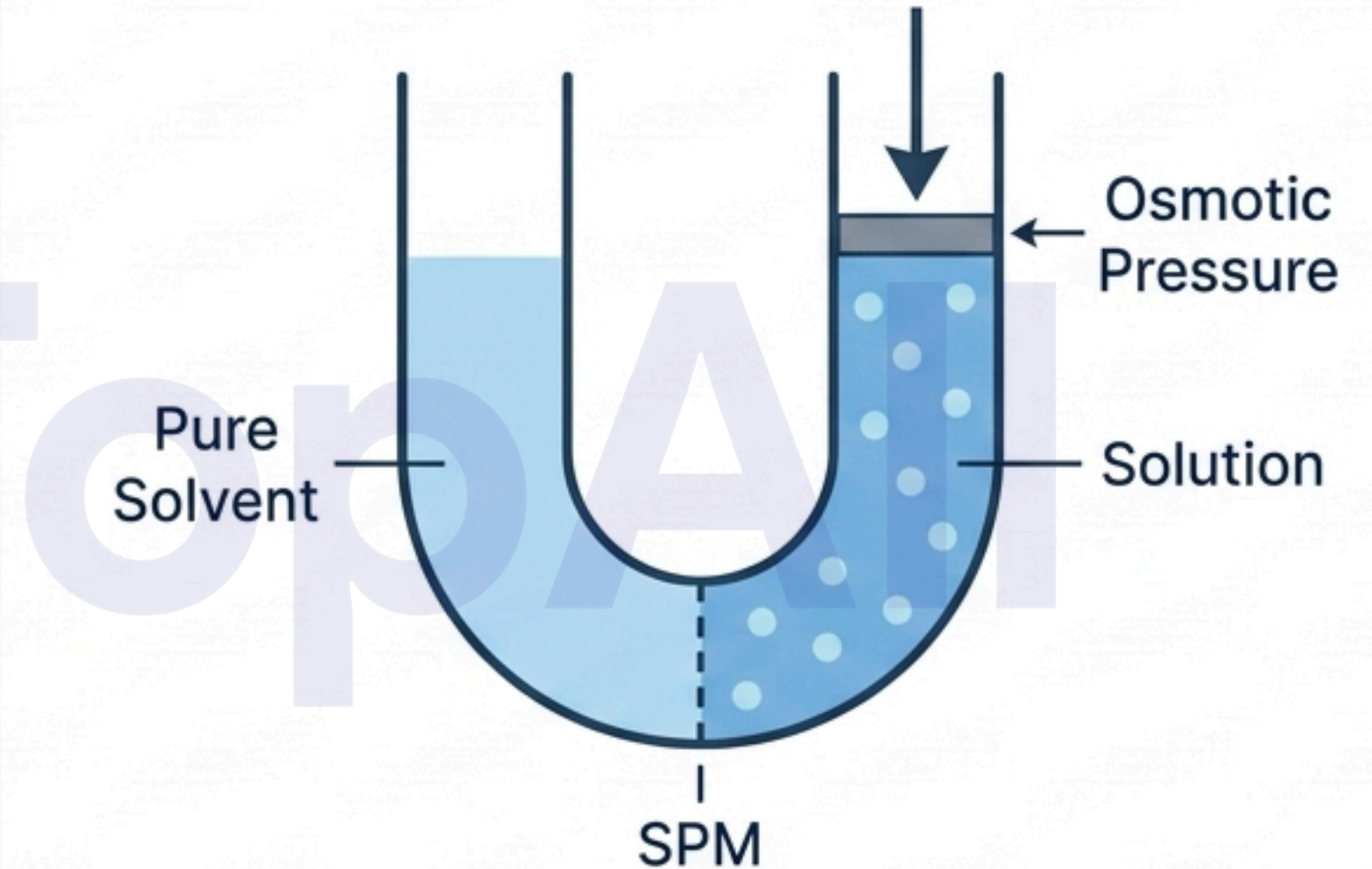


Defining Osmotic Pressure



Osmosis creates a natural flow of solvent.
But what if we want to stop it?

- Osmotic Pressure is the exact amount of excess pressure that must be applied to the solution side to completely prevent the passage of solvent molecules through the SPM.
- It is an applied mechanical force that counters the natural osmotic flow.



Key-Takeaway Box

Osmosis pushes solvent in. Osmotic Pressure is the external force required to keep solvent out.

Calculating Osmotic Pressure

$$\Pi = C R T$$

Π

atm or bar

Osmotic Pressure

C

mol/L

Molarity
(Concentration of
solution)

R

L · atm / (K · mol)

Universal Gas
Constant

T

Kelvin

Temperature

Deriving Molar Mass

Because $C = n_2 / V$ (moles of solute / Volume), we can expand the formula:

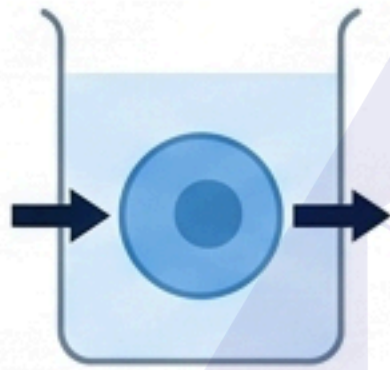
$$\Pi = (w_2 R T) / (M_2 V)$$

$$M_2 = (w_2 R T) / (\Pi V)$$

Note: A highly accurate method for determining the molar mass of biomolecules, proteins, and polymers.

Tonicity and Solvent Flow

Isotonic



Definition: Two solutions with the same osmotic pressure at a given temperature.

Net Flow: Zero. No net osmosis occurs across the SPM.

Example: 0.9% (m/v) NaCl is **isotonic** with human blood plasma.

Hypertonic

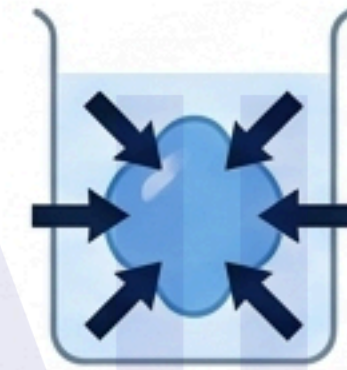


Definition: A **solution** with a higher concentration than the reference fluid.

Net Flow: Solvent flows **out** of the cell.

Result: **Cells shrink** (plasmolysis).

Hypotonic



Definition: A solution with a lower concentration than the reference fluid.

Net Flow: Solvent flows **into** the cell.

Result: **Cells swell** and may burst (cytolysis).

Osmosis in Nature and Medicine



Blood Cells & Medicine

- **Intravenous Injections:** Must be exactly isotonic (0.9% NaCl normal saline) to prevent RBC damage.
- **Edema:** High dietary salt increases tissue fluid concentration, drawing water out of cells and causing intercellular swelling (puffiness).



Plant Life & Food Preservation

- **Water Transport:** Osmosis drives water from soil into plant roots. Wilted plants revive in fresh water (a hypotonic environment).
- **Bacterial Protection:** Salting meat or candying fruit creates a hypertonic environment. Bacteria lose water via osmosis, shrivel, and die.

Osmotic Pressure as a Colligative Property

Core Takeaways

- **Dependence on Quantity:** Osmotic pressure depends only on the number of solute particles, not their chemical identity.
- **Molarity over Molality:** Unlike other colligative properties, it utilizes **Molarity (C)**, making it exceptionally useful at room temperature.
- **The Biomolecule Advantage:** The magnitude of osmotic pressure is large even for very dilute solutions, making it the preferred method to find the molar mass of unstable proteins and polymers.

The 4 Colligative Properties

1. Relative Lowering of Vapour Pressure

2. Elevation of Boiling Point

3. Depression of Freezing Point

4. Osmotic Pressure ($\Pi = CRT$)



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