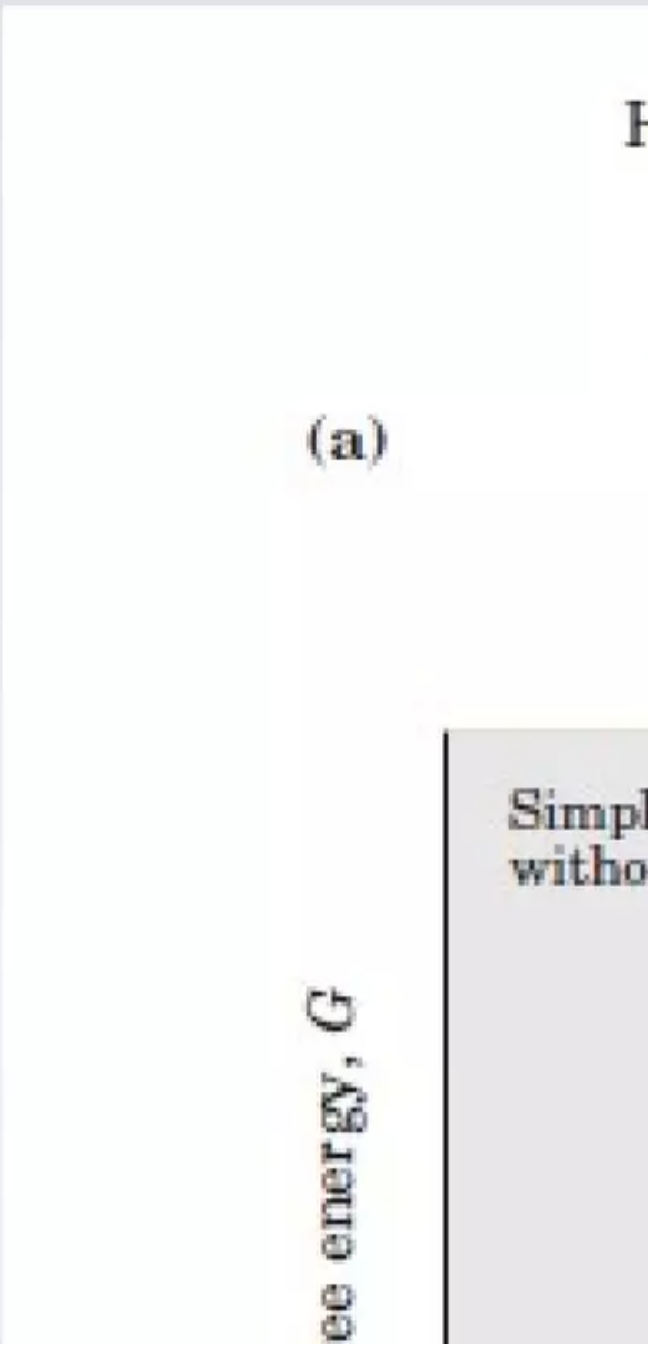
Some Physico-chemical Laws Applied to Physiology (Biophysics)

Some Physico-chemical Laws Applied to Physiology (Biophysics)

Some Physico-chemical Laws Applied to Physiology (Biophysics)

why facilit

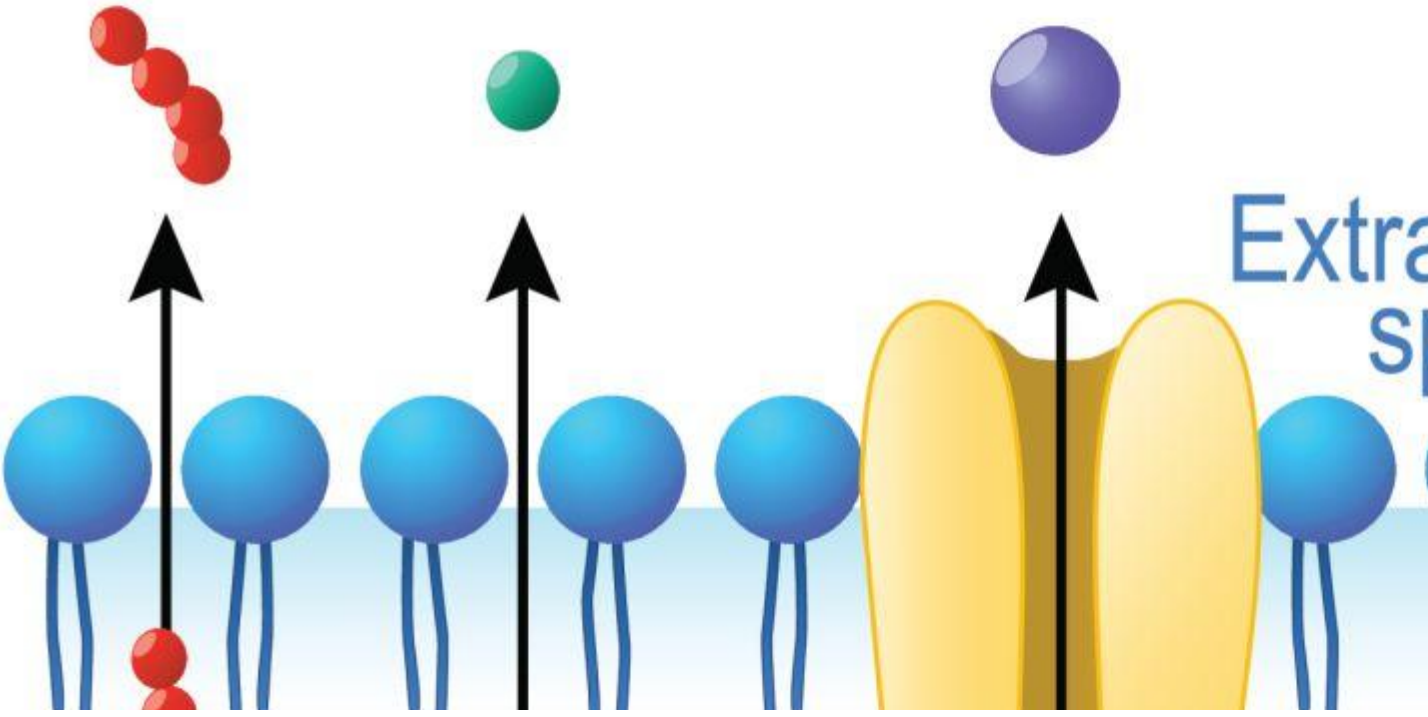


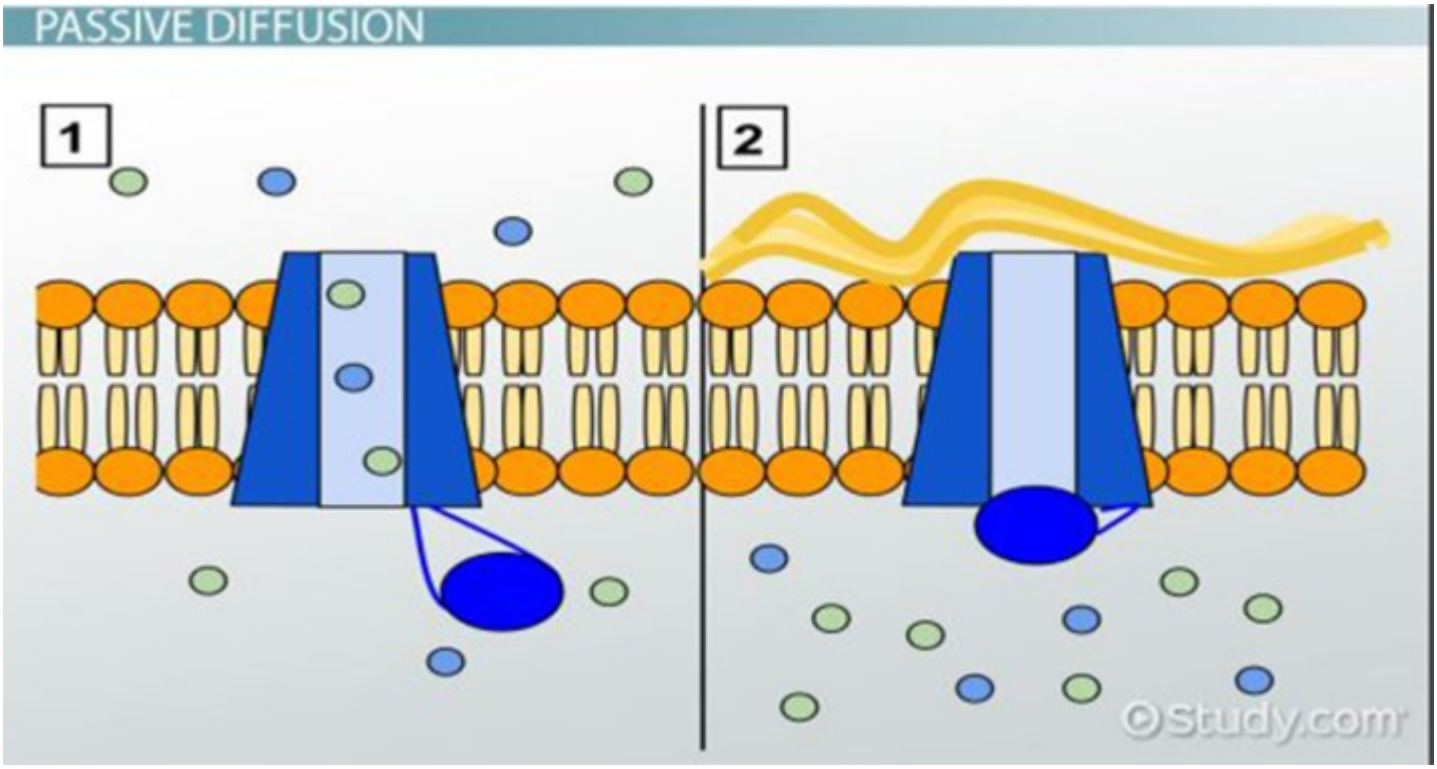
Notes downloaded from **Medmentoredu** | Page 3

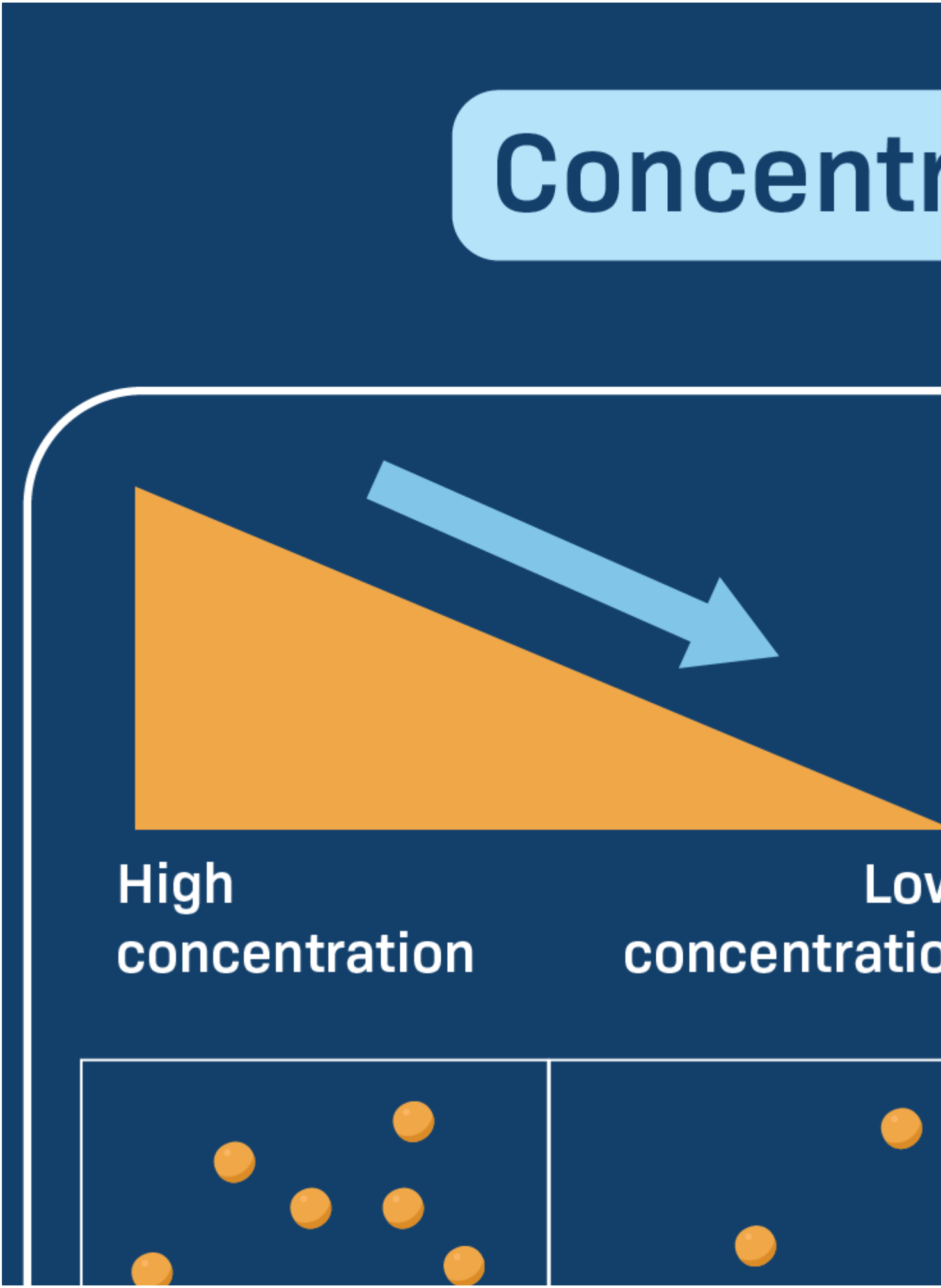
Memb

Simple diffusion

Aquaporin




PASSIVE DIFFUSION
1
2
©Study.com


Concentr
High
concentration
Lov
concentratio

• **Biophysics** deals with application of **physical and chemical laws to biological systems**.
• Many physiological processes follow **physico-chemical principles**.
• Important processes include:
• **Diffusion**
• **Filtration**
• **Osmosis**
• **Electrolyte balance**.
• These laws explain **movement of substances across biological membranes**.

Units of Concentration of Solutions

Chemical Concentration

Molarity (M) – Mole per Lite

Moles of solute dissolved in 1 liter of solution.

$$M = \frac{\text{Moles of solute}}{\text{Volume of solution (L)}}$$

Molality (m) – Mole per Kg

Moles of solute per kilogram of solvent.

$$m = \frac{\text{Moles of solute}}{\text{Mass of solvent (kg)}}$$

Normality (N) – Equivalent per Liter

Gram equivalents of solute per liter of solution.

$$N = \frac{\text{Gram equivalents}}{\text{Volume of solution (L)}}$$

Formality (F) – Ionic Mass per Liter

Gram formula masses of ionic solute per liter of solution.

$$F = \frac{\text{Mass of solute (g)}}{\text{Formula mass} \times \text{Volume (L)}}$$

Mole Fraction (χ) – Ratio of Moles

Ratio of moles of one component to total moles in mixture.

$$X_A = \frac{n_A}{n_A + n_B}$$

Parts Per Million (ppm) – Ultra Low Concentration

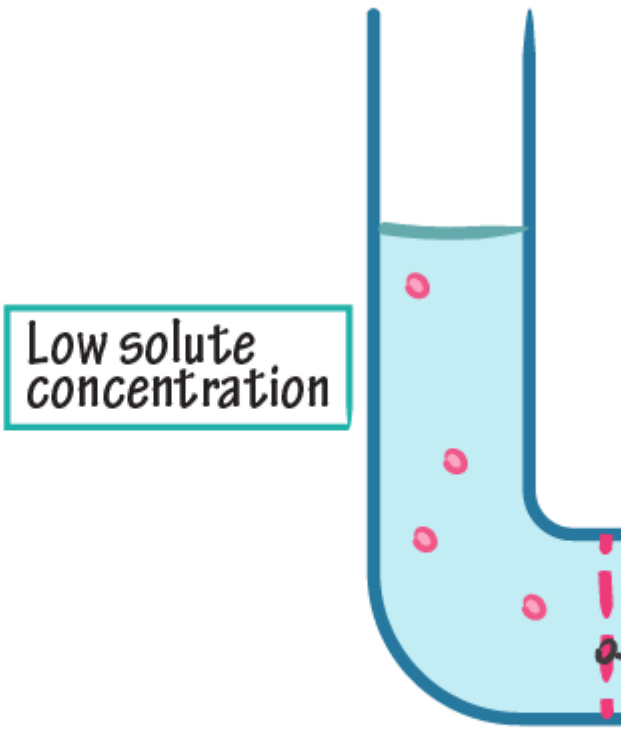
Mass of solute per million parts of solution.

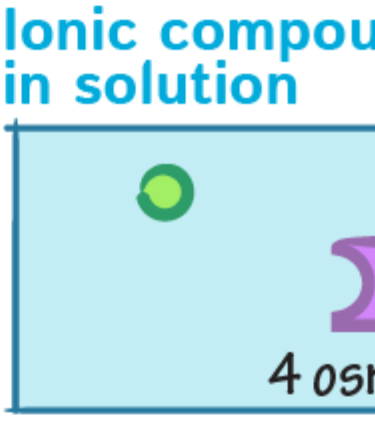
$$ppm = \frac{\text{Mass of solute}}{\text{Mass of solvent}} \times 10^6$$

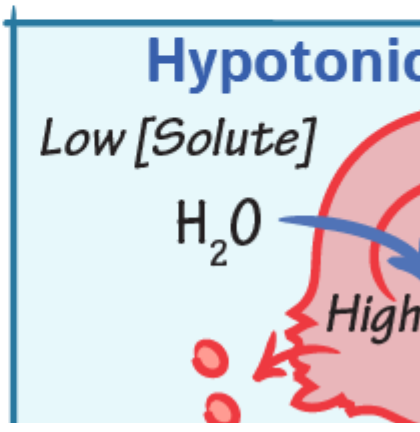
OSMOSIS & OSMOLARITY

Key Concepts

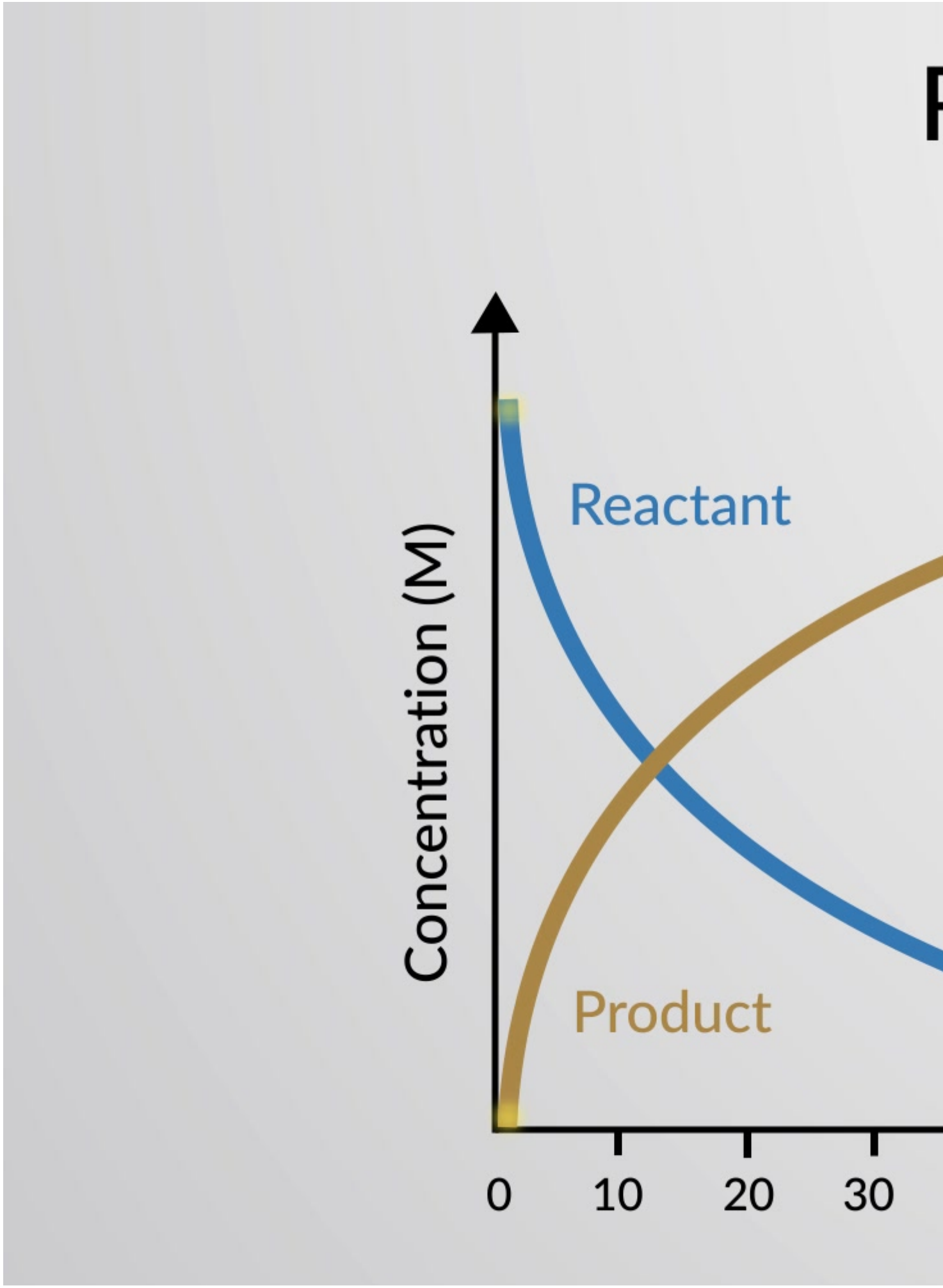
- ✓ *Osmosis* —
  - ✓ Diffusion of water across a semi-permeable membrane
- ✓ *Osmolarity* (osmotic concentration) —
  - ✓ Solute concentration, osmoles of solute per liter of solvent







Image

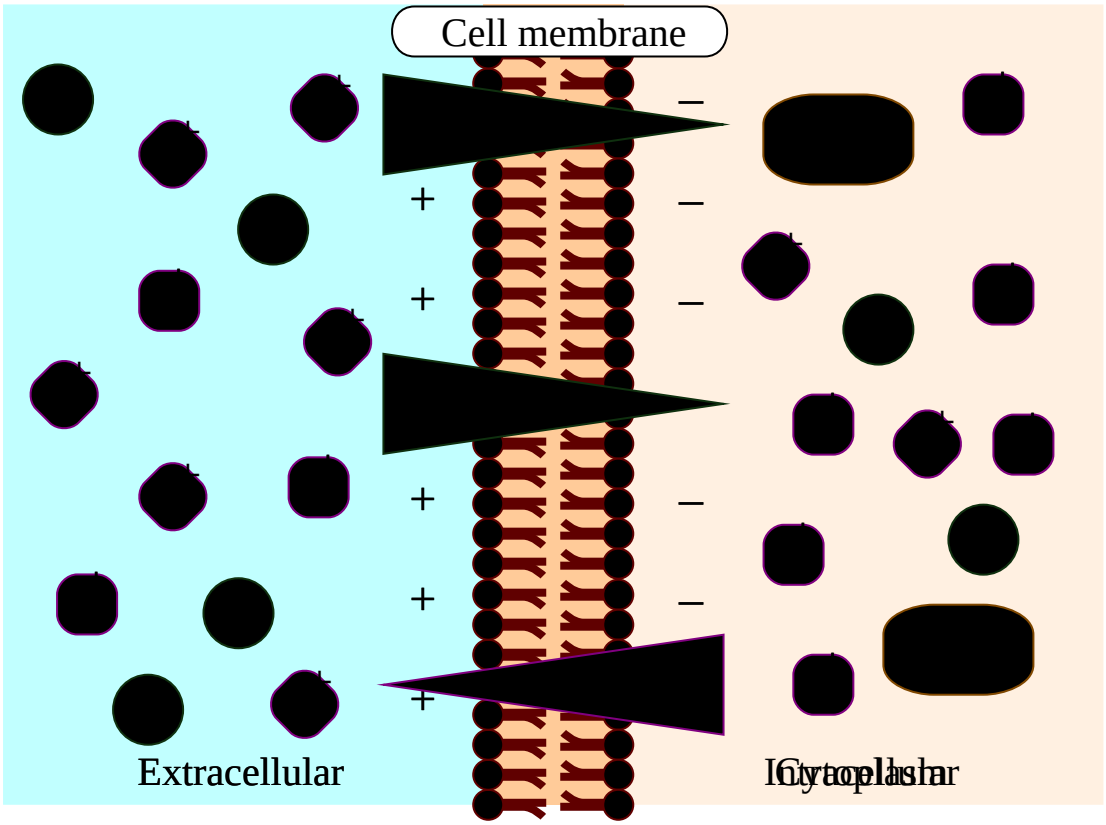


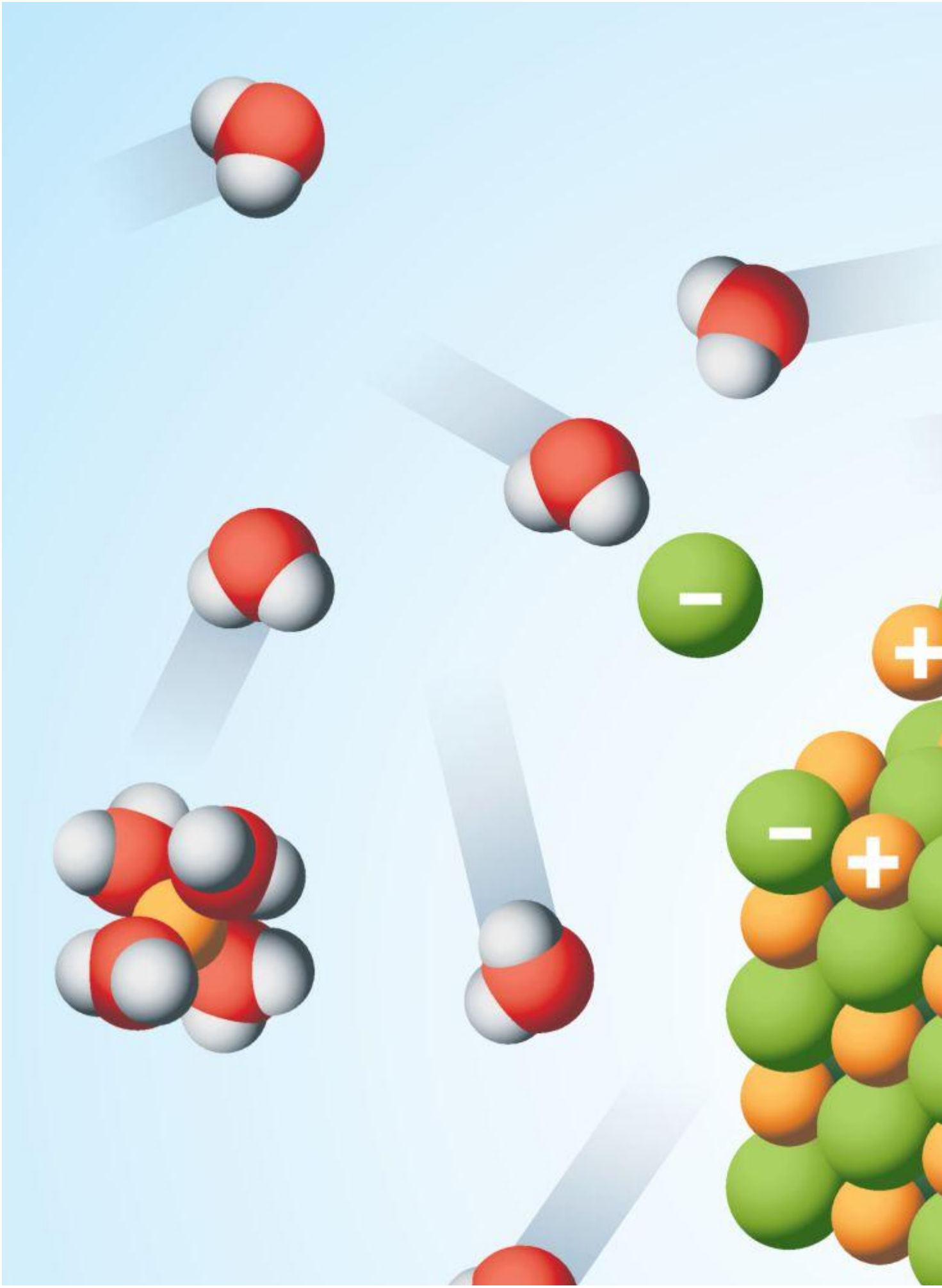
Notes downloaded from **Medmentoredu** | Page 12

• Concentration expresses **amount of solute dissolved in a solvent**.
• Important units used in physiology include:
• **Molarity** – number of moles of solute per litre of solution.
• **Normality** – number of gram equivalents per litre of solution.
• **Percentage concentration** – grams of solute in 100 mL of solution.
• **Osmolarity** – concentration of osmotically active particles.

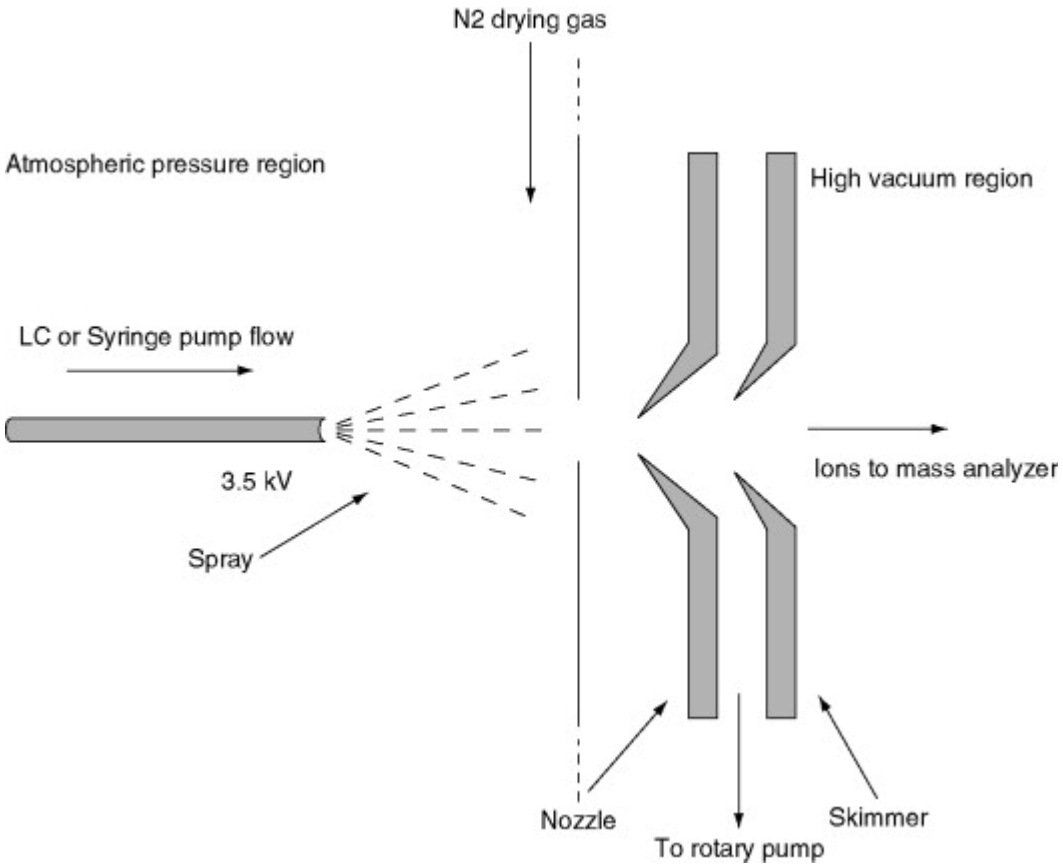
• These units are useful in **physiological and clinical calculations**.

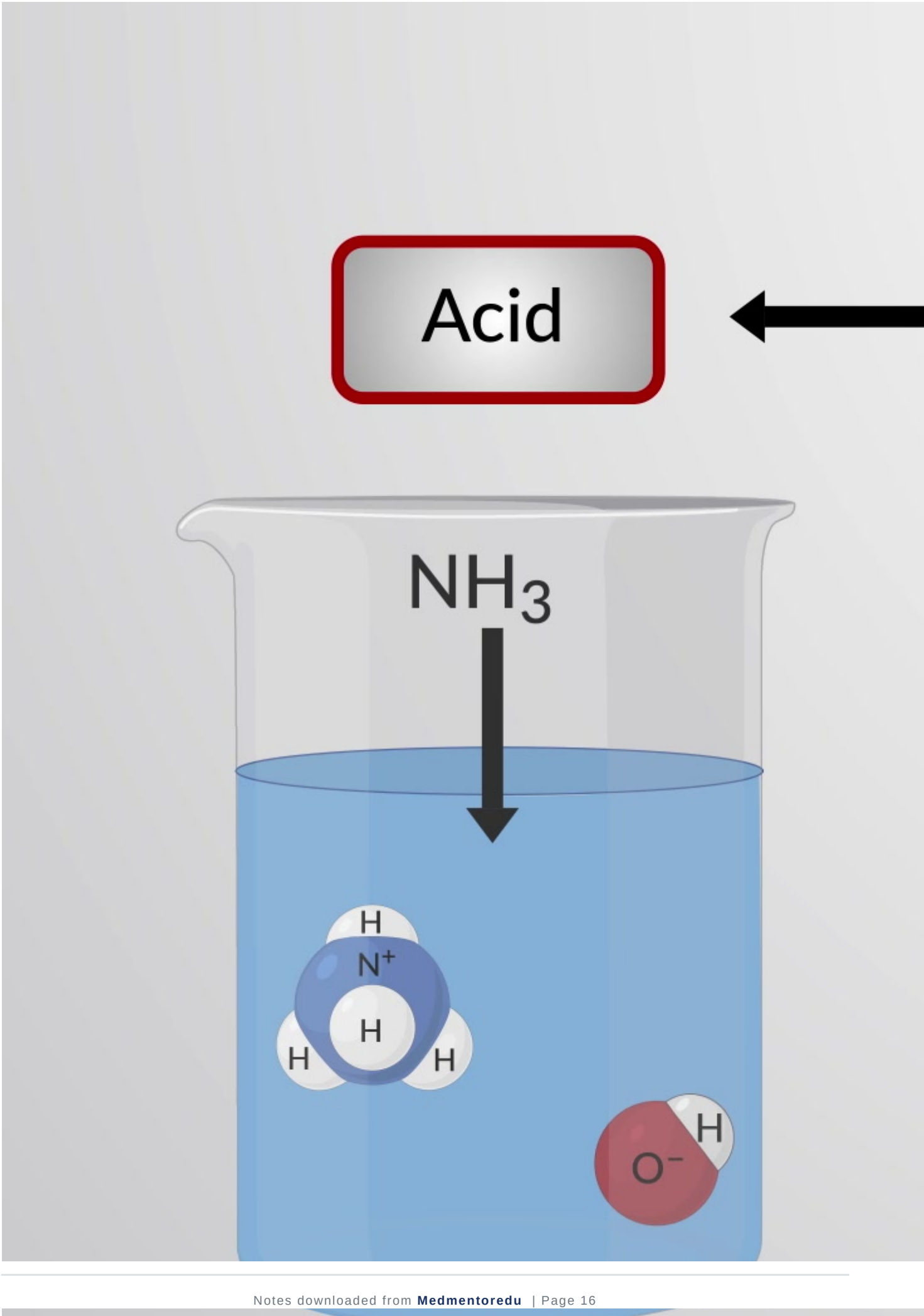
Ions, Electrolytes and Non-electrolytes





Notes downloaded from **Medmentoredu** | Page 14


N2 drying gas
Atmospheric pressure region
High vacuum region
LC or Syringe pump flow
Ions to mass analyzer
3.5 kV
Spray
Nozzle
To rotary pump
Skimmer



Notes downloaded from **Medmentoredu** | Page 16

• Substances in solution may exist as **ions or molecules**.
• Based on their dissociation in water they are classified as:
• **Ions**
• **Electrolytes**
• **Non-electrolytes**.

Ions

• **Ions are electrically charged particles** formed by dissociation of substances in solution.
• **Positive ions (cations)** – sodium (Na^+), potassium (K^+), calcium (Ca^{2+}).
• **Negative ions (anions)** – chloride (Cl^-), bicarbonate (HCO_3^-).
• Ions are essential for **nerve conduction, muscle contraction and fluid balance**.

Electrolytes

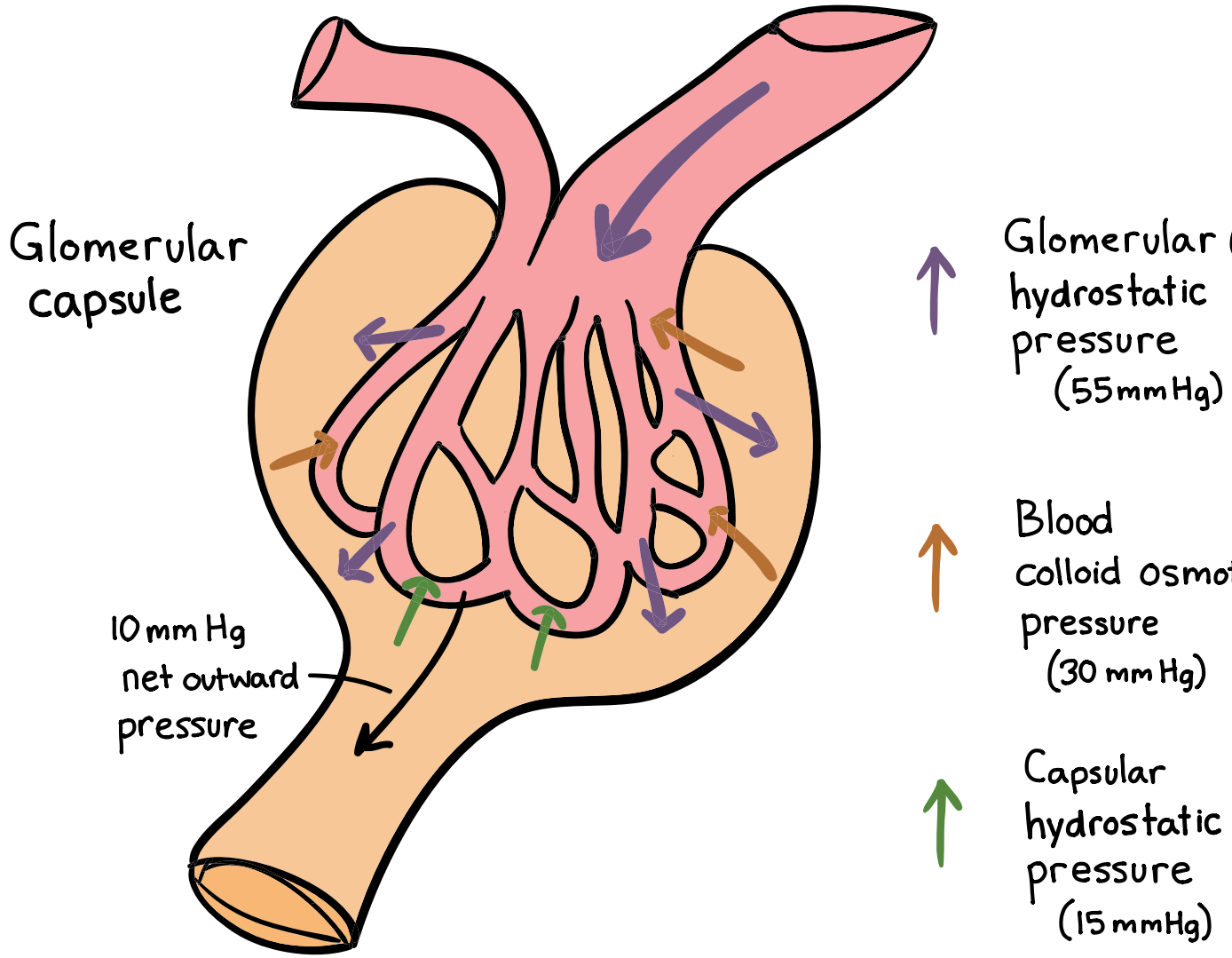
• **Electrolytes are substances that dissociate into ions in aqueous solution**.
• They conduct **electric current** when dissolved in water.
• Examples include **sodium chloride, potassium chloride and calcium salts**.
• Electrolytes are important for **osmotic balance and physiological functions**.

Non-electrolytes

• **Non-electrolytes do not dissociate into ions in solution**.
• They remain as **uncharged molecules**.
• Examples include **glucose, urea and alcohol**.
• They do not conduct **electric current in solution**.

Filtration

Image


Glomerular capsule
10 mm Hg net outward pressure
Glomerular hydrostatic pressure (55 mm Hg)
Blood colloid osmo pressure (30 mm Hg)
Capsular hydrostatic pressure (15 mm Hg)

UI

Afferent arte

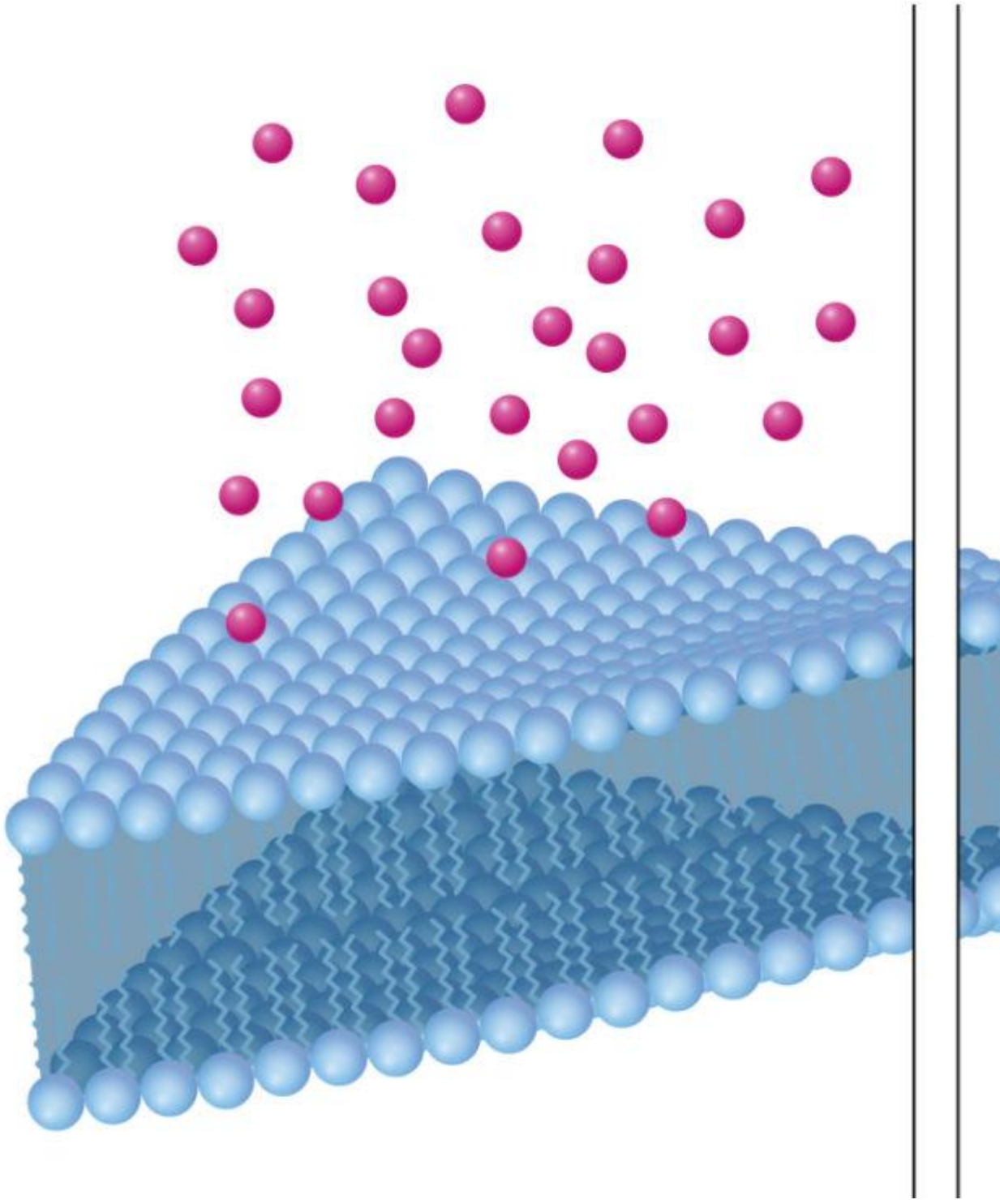
Image

• **Filtration** is movement of fluid and dissolved substances through a membrane due to **pressure difference**.
• Driven mainly by **hydrostatic pressure**.
• Occurs across **capillary walls and kidney glomerulus**.

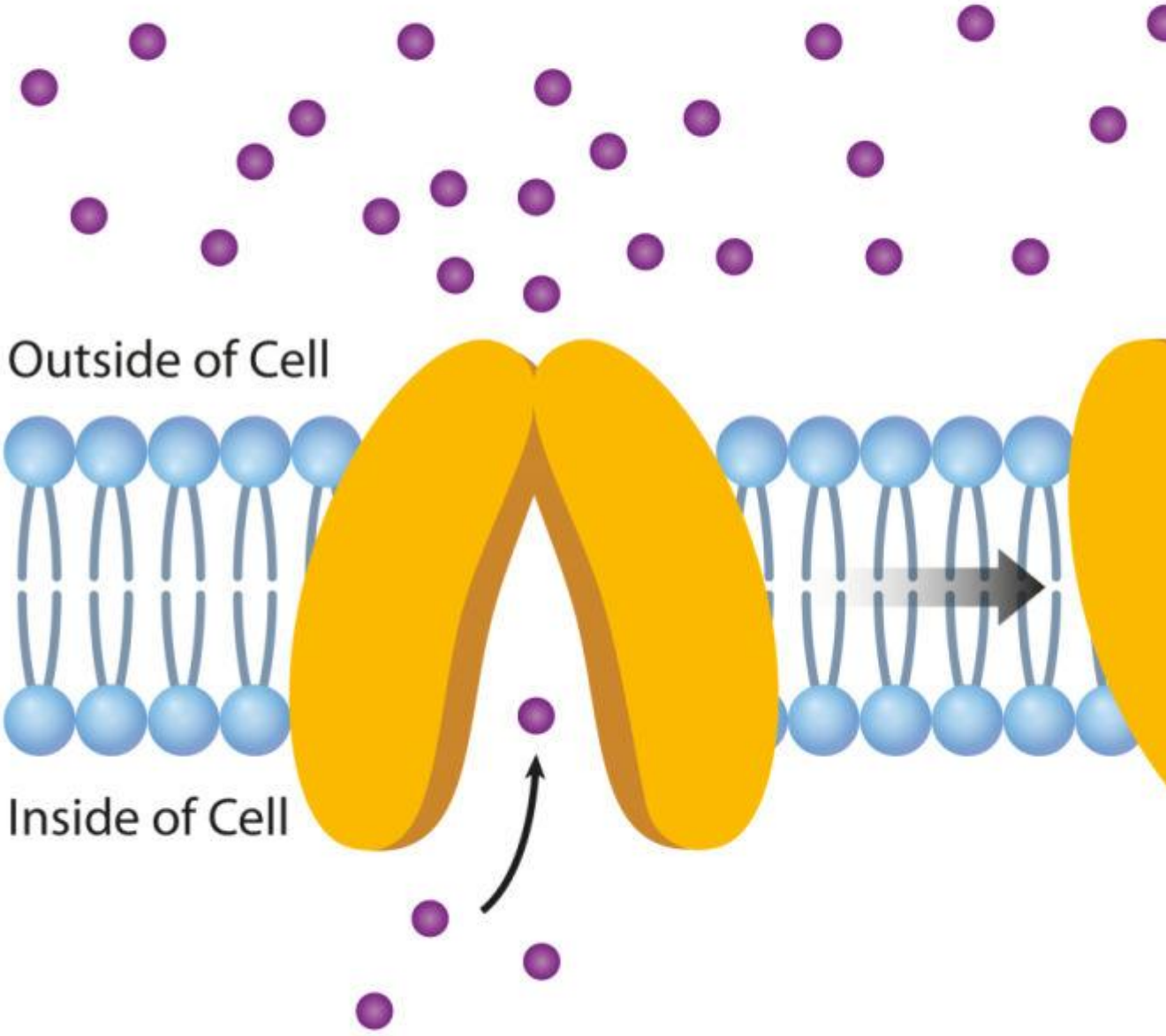
Physiological Importance of Filtration

• Important in **formation of tissue fluid from capillaries**.
• Essential in **glomerular filtration in kidneys**.
• Helps remove **waste products from blood**.

Diffusion

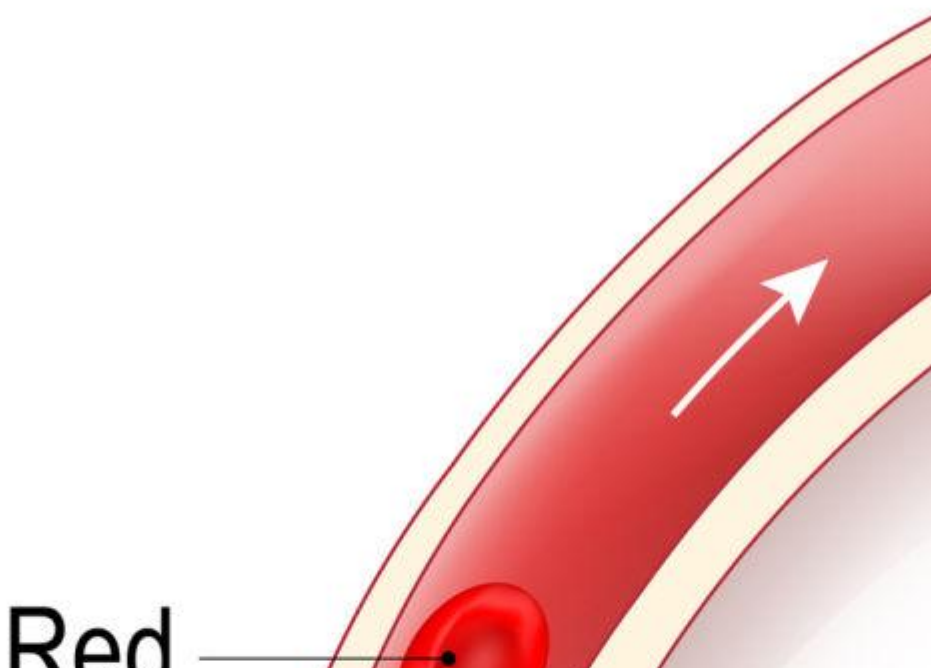

Solute concentration
higher on one side
of membrane

Active diffusion on a cell



Pulr

Capillary



Notes downloaded from **Medmentoredu** | Page 24

EXTE

GAS E

ALVEO

FROM

PULMONARY ARTERY

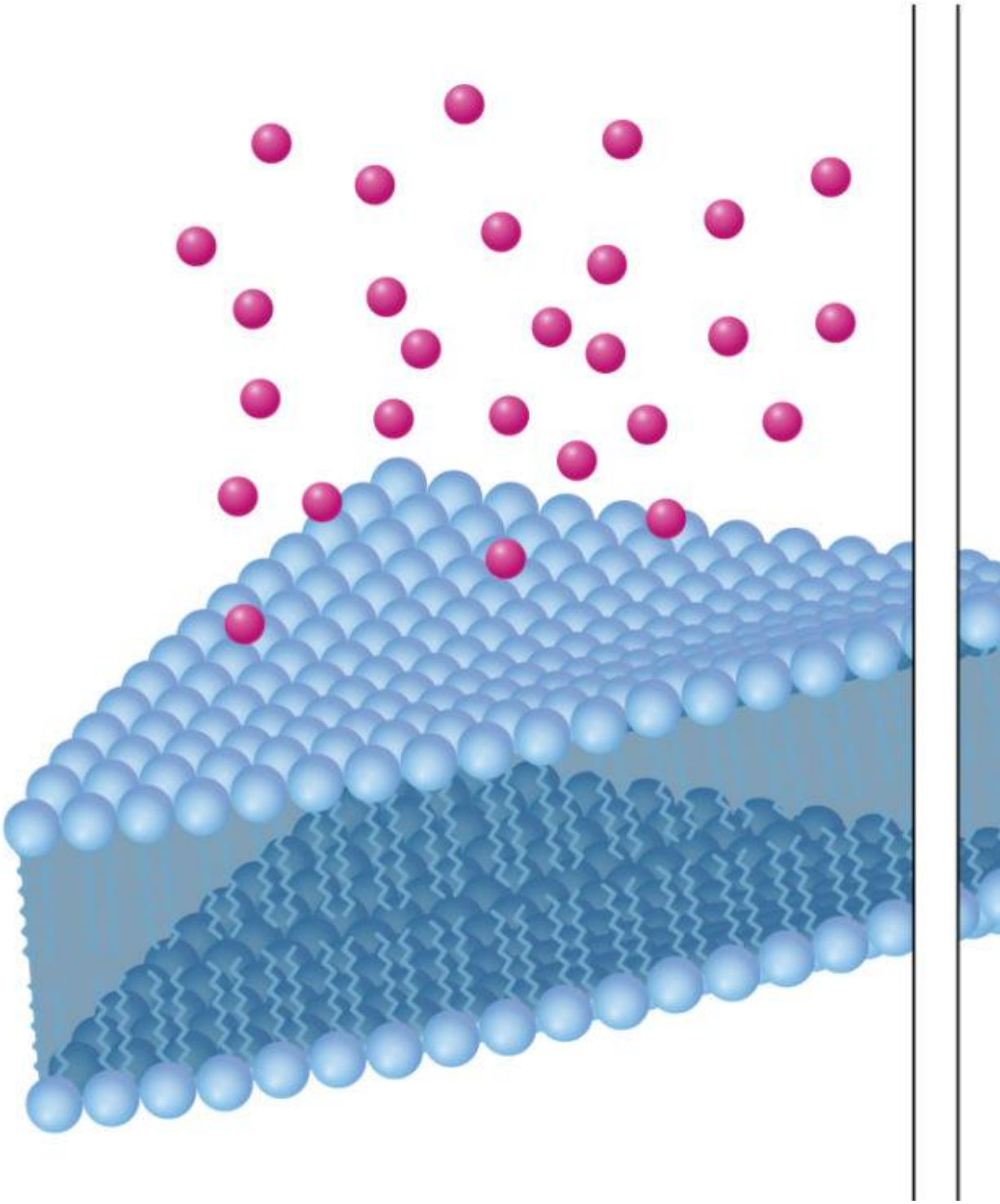
Notes downloaded from **Medmentoredu** | Page 25

• **Diffusion** is movement of molecules from **higher concentration to lower concentration**.
• Occurs due to **random molecular motion**.
• Does not require **energy expenditure**.
• Continues until **equilibrium is reached**.

• Examples in physiology:
• Exchange of **oxygen and carbon dioxide in lungs**.
• Movement of **solutes across cell membranes**.

Concentration

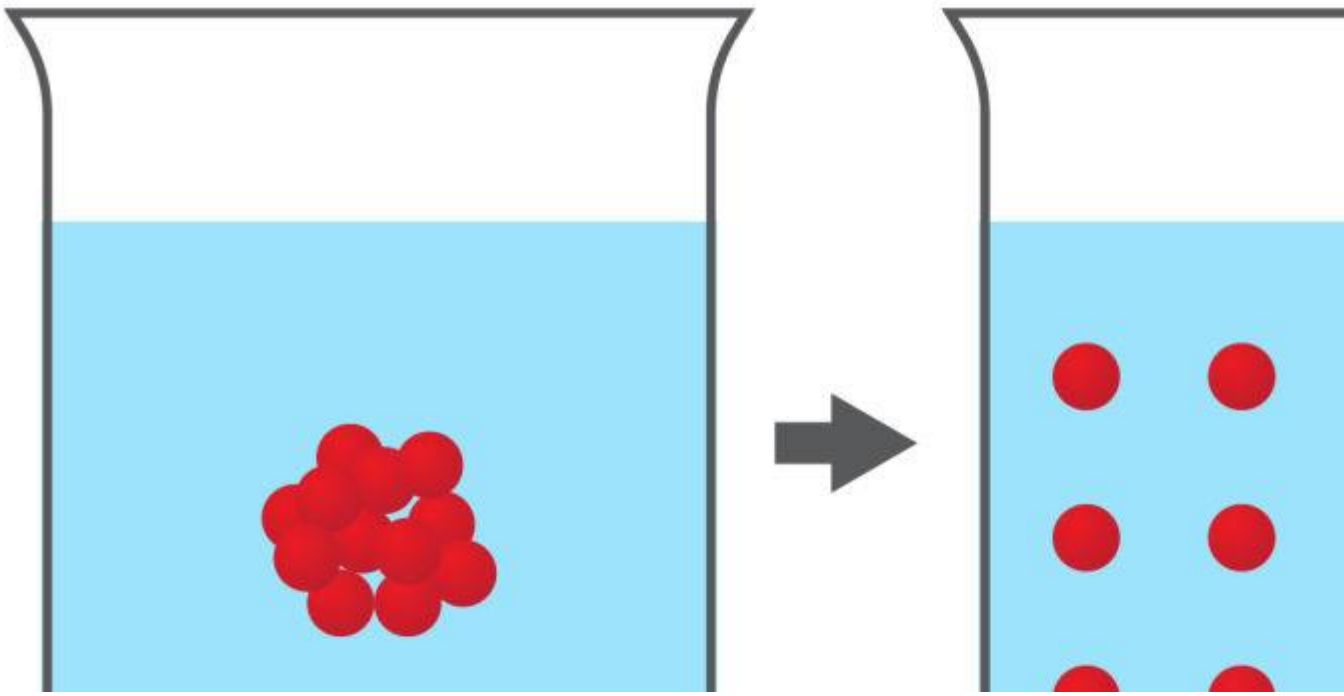
Solute concentration higher on one side of membrane



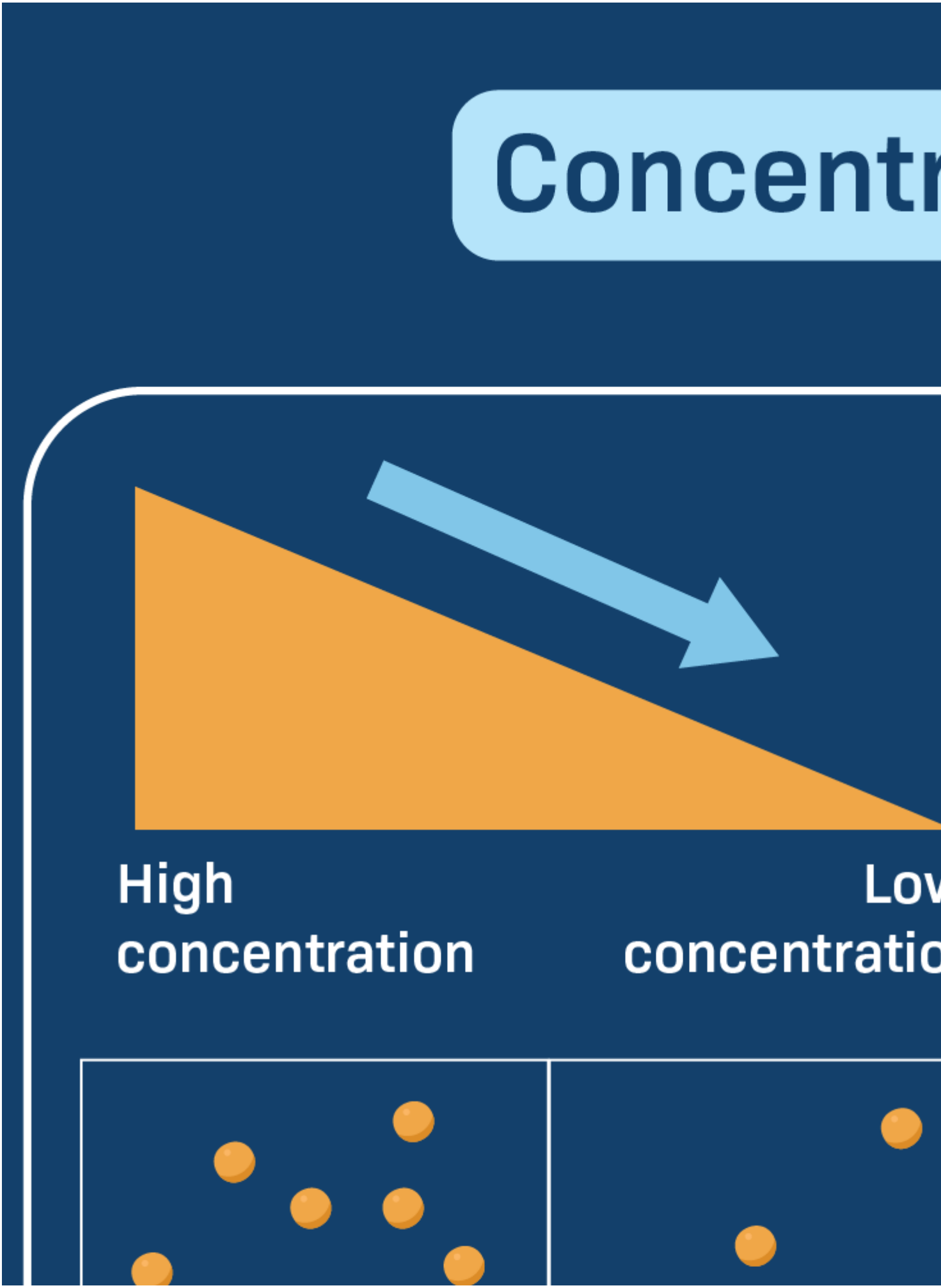
Science

Diffusi

Diffusion



Image



Notes downloaded from **Medmentoredu** | Page 31

• **Concentration** refers to the **amount of solute present in a given volume of solution**.
• A **concentration gradient** exists when two regions have different solute concentrations.
• Diffusion occurs **along this gradient from higher to lower concentration**.
• Concentration gradient is a **major driving force for diffusion in physiological processes**.

Biology often looks complicated, but at its core it obeys the same simple rules as chemistry and physics: particles drift from **crowded places to emptier ones**, pressure pushes fluids through filters, and electric charges guide ions—life simply organizes these basic forces into astonishingly complex systems.