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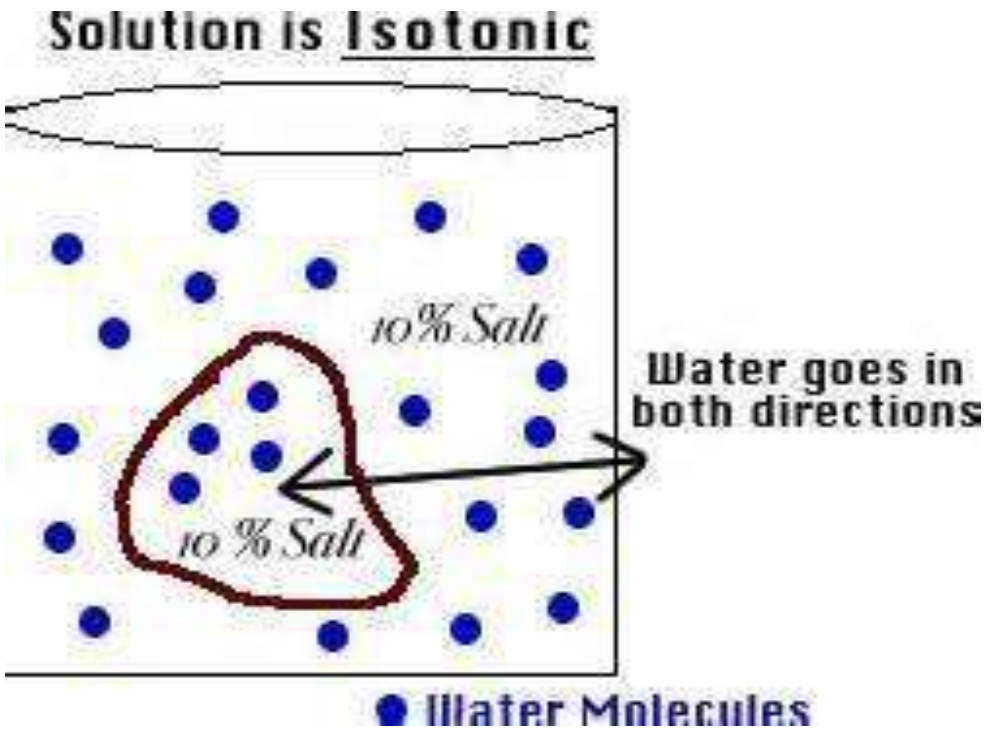
PERCENTAGE CALCULATIONS
&
ISOTONIC SOLUTIONS

ISOTONIC SOLUTIONS

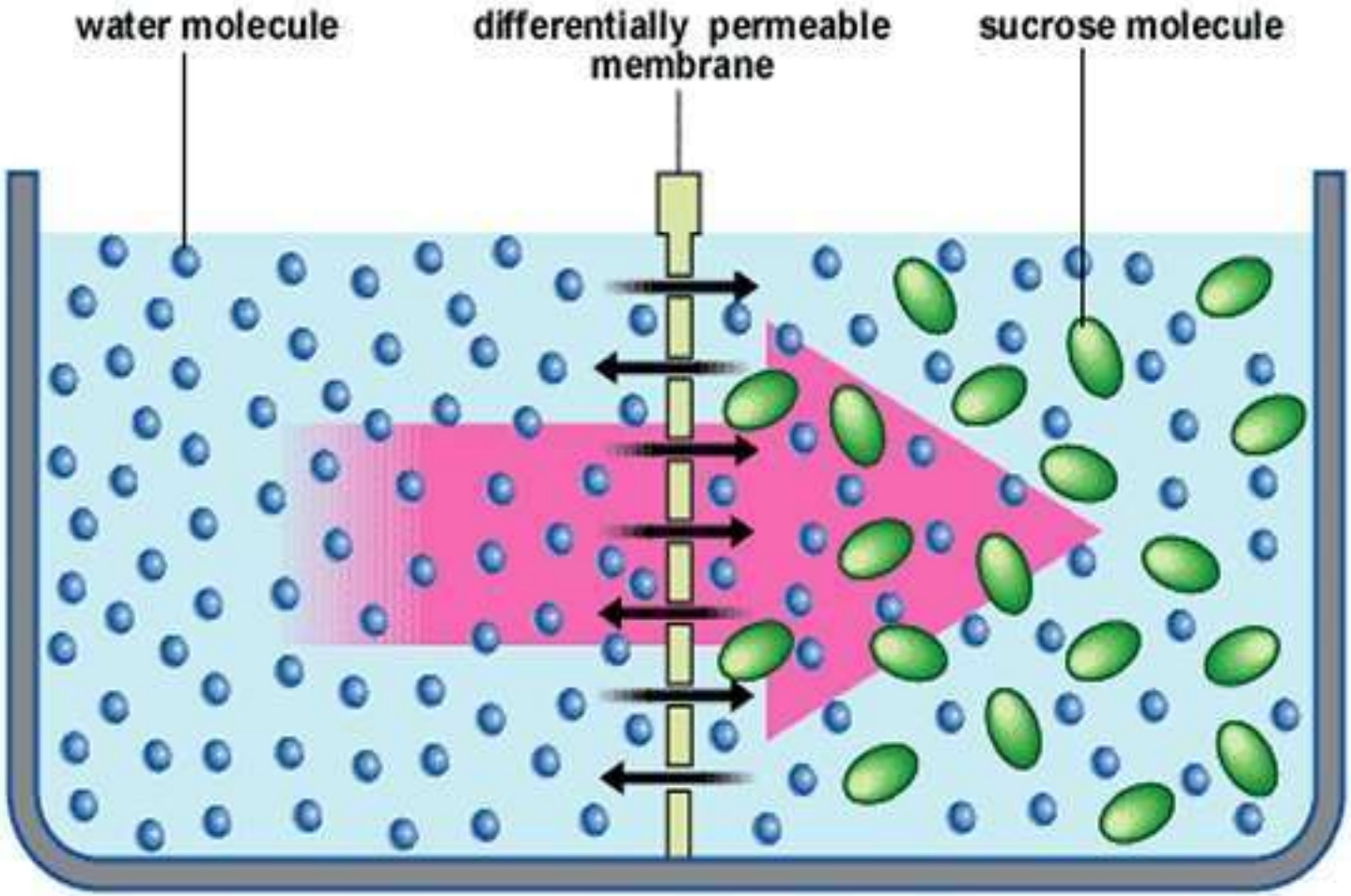


ISOTONIC SOLUTIONS

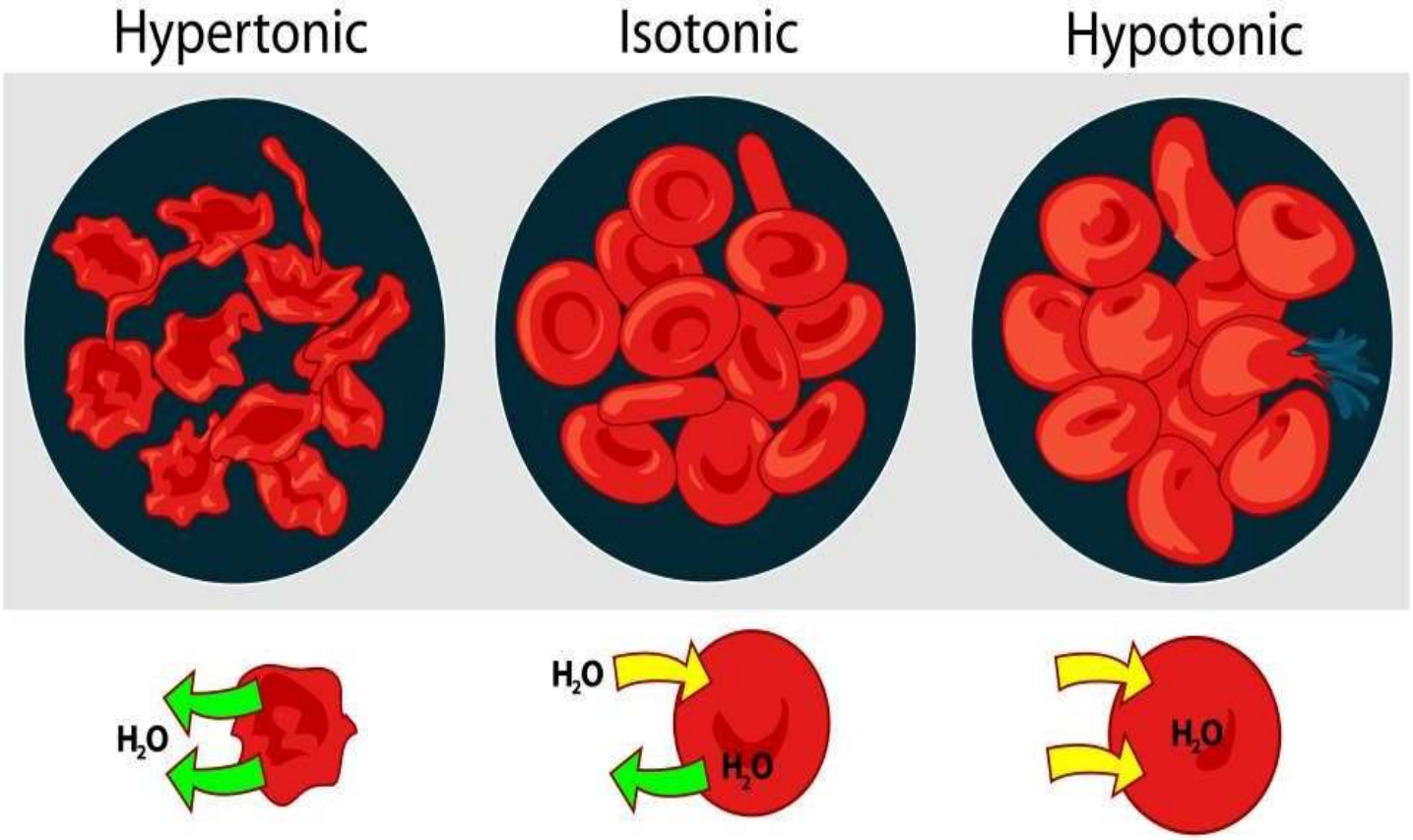
- A solution containing 0.9% of sodium chloride is practically isotonic with blood plasma and is regarded as standard.
- A solution containing more than 0.9% sodium chloride is called 'hypertonic'.
- A solution containing less than 0.9% sodium chloride is called 'hypotonic'.

ISOTONIC SOLUTIONS

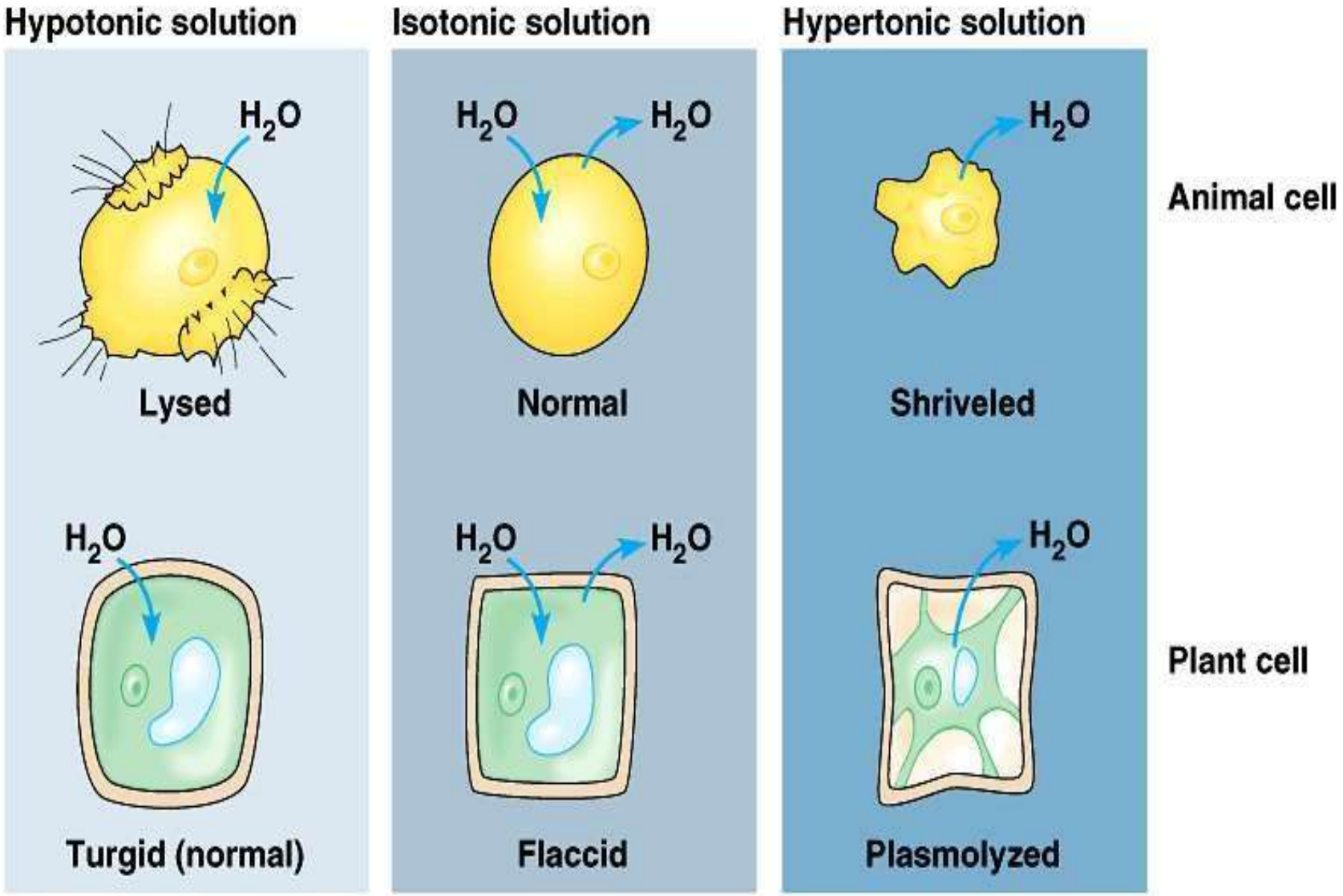
- **Osmosis** : the diffusion of solvent molecules from a region of lower solute concentration to a region of higher solute concentration through a semi- permeable membrane.
- **Semi- permeable membrane:** membranes which allow solvent molecules to pass through but resist the passage of dissolved substances.
- Excess of solvent molecules passing in one direction creates a pressure called '**Osmotic pressure**'


water molecule
differentially permeable membrane
sucrose molecule

ISOTONIC SOLUTIONS



ISOTONIC SOLUTIONS



ISOTONIC SOLUTIONS

- **Iso- osmotic solutions**: solutions having same osmotic pressure.

  (all Iso osmotic solutions are not necessarily isotonic)

- **Paratonic solutions:** solutions with different osmotic pressure.

GENERAL PRINCIPLES FOR ADJUSTMENT OF ISOTONICITY

1. Parenteral preparations should be isotonic with blood plasma (depending on the route of administration).

i. intravenous injection- isotonicity is always desirable.

ii. Subcutaneous injection- not essential.

iii. Intramuscular- hypertonic.

iv. Intrathecal injection- isotonic

2. Nasal drops- should be isotonic.

3. Ophthalmic preparations- should be isotonic.

CALCULATIONS FOR SOLUTIONS ISOTONIC WITH BLOOD AND TEARS.

1. Method based on freezing point data.
2. Method based on molecular concentration.
3. Graphic method based on vapour pressure and freezing- point depression.
4. Method based on sodium chloride equivalent.

1. METHOD BASED ON FREEZING POINT DATA

- Physical properties of solutions- colligative properties.

a) Osmotic pressure

b) Depression of freezing point- simpler.

- Temperature at which blood plasma and tears freeze is -0.52^{0}C.
- Any solutions which freezes at -0.52^{0}C is isotonic with blood plasma and tears.

GENERAL FORMULA FOR CALCULATION FOR SOLUTIONS TO BE MADE ISO- OSMOTIC WITH BLOOD SERUM IS AS FOLLOWS:

- **Percentage *w/v* of adjusting substance needed** $= \frac{0.52 - a}{b}$

Where a = Freezing point of the unadjusted solution

b= Freezing point of a 1% *w/v* solution of the adjusting substance.

2. METHOD BASED ON MOLECULAR CONCENTRATION

- **Molecular concentration:** number of units i.e. molecules or ions or both present in a solution.
- A solution containing **1 g** molecule of a non- ionising solute in **22.4 litres** at normal temperature and pressure (NTP) has an atmospheric pressure of **one atmosphere.**
- Therefore a solution containing **one gram** molecule in **1 litre (a mole solution)** will have osmotic pressure of **22.4 atmosphere.**

- Osmotic pressure of blood plasma and lachrymal secretion is approximately 6.7 atmosphere.
- Molarity of these fluids = 6.7/22.4 = 0.3 M (approx.)
- Conc. of un- ionised medicaments needed to produce iso- osmotic solutions, $W = 0.3\ M$

where W= concentration required in g per litre.

M= molecular weight of the solute.

- In case of ionised medicaments,

$$W = 0.3\ M / N$$

N= no. of ions

3. Graphic method based on vapour pressure and freezing-point depression.

- Solutions of various concentration of Nacl are prepared.
- Their freezing points are determined with accuracy.
- A graph is prepared from this data.
- Percentage concentration versus freezing point.
- Prepared for each medicament.
- Percentage of adjusting substances required to make any percentage of medicament isotonic with blood plasma can be determined.

4. METHOD BASED ON SODIUM CHLORIDE EQUIVALENT:

- Factor called ‘sodium chloride equivalent’ which can be used to convert a specified concentration of medicament to the concentrate of sodium chloride which will produce same osmotic effect.

- Sodium chloride equivalent of a medicament = $\frac{\text{Freezing point depression produced by a soln of a medicament}}{\text{Freezing point depression produced by a Nacl soln of the same strength.}}$

- Percentage of sodium chloride for adjustment to isotonicity = 0.9 - (Percentage strength of medicament solution × Nacl equivalent of medicament.)

PERCENTAGE CALCULATIONS

1. Per cent *w/w*
2. Per cent *w/v*
3. Per cent *v/v*
4. Per cent *v/w*

COMMON FORMULAE USED IN PERCENTAGE CALCULATIONS

1. **Preparation of 1%w/v solution in the imperial system**.

a) Solid- 1gr

Solvent, to produce 110m

b) Solid – 4.375 gr

Solvent, to produce 1 fluid ounce

c) Solid – 35 gr

Solvent, to produce 8 fluid ounce

2. **Preparation of 1% w/v solution in metric system.**

a) Solid-1 g

Solvent, to produce 100 ml

COMMON FORMULAE USED IN PERCENTAGE CALCULATIONS

3. **Preparation of percentage solution by diluting the concentrated solution.**

$$\text{Strength of dilute solution} = \frac{\text{Strength of concentrate}}{\text{Degree of dilution}}$$

$$\text{Volume of stronger alcohol to be used} = \frac{\text{Volume required} \times \text{Percentage required}}{\text{Percentage used}}$$

$$\text{Weight of stronger acid to be used} = \frac{\text{Weight required} \times \text{Percentage required}}{\text{Percentage used}}$$

Percentage calculations

1 in 100	100/100 per cent	1 %
1 in 400	100/ 400 per cent	0.25 %
1 in 1000	100/ 1,000 per cent	0.1 %
3 in 1000	3 × 100/ 1000 per cent	0.3 %
4 in 5000	4 × 100/ 5000 per cent	0.08 %
2 in 10,000	2 × 100/ 10, 1000 per cent	0.02 %