

# **Cell membrane structure and transport across cell membrane**

# objectives

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**At the end of this session, the students should be able to:**

- **Describe the fluid mosaic model of membrane structure and function.**
- **Define permeability and list factors influencing permeability.**
- **Identify and describe transport processes: Primary active transport, secondary active transport, facilitated diffusion, simple diffusion, osmosis.**

# Cell Membrane

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- **It covers the cell.**
- **It is a fluid and not solid.**
- **Plasma membrane .**

# Composition

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**Protein**

**Phospholipids**

**Cholesterol**

**Glycolipid**

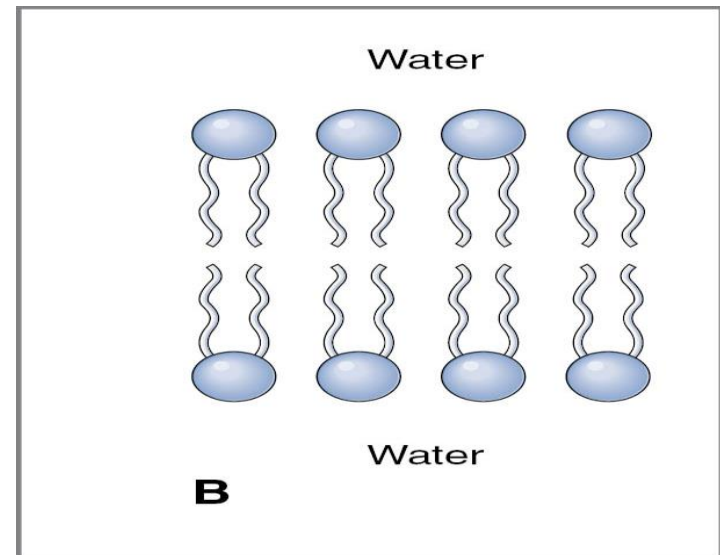
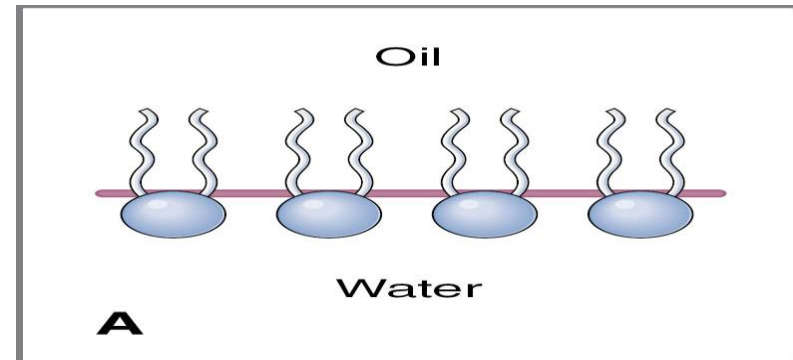
**Carbohydrates**

**lipid**

# The Cell Membrane Phospholipids

Consist Of :

1. Glycerol head (hydrophilic).
2. Two fatty acid "tails" (hydrophobic).



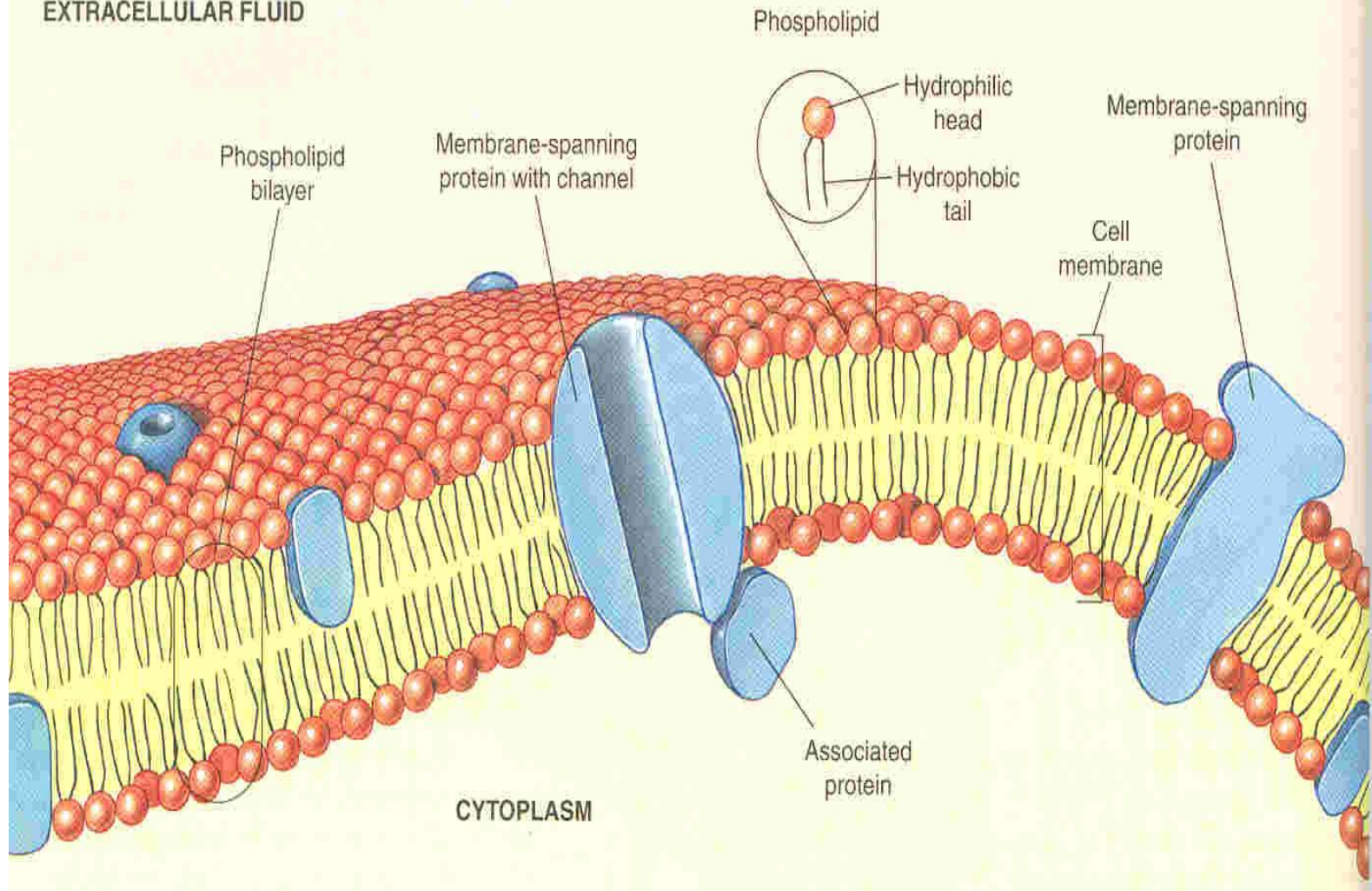
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- **Heads (hydrophilic) facing ICF and ECF and tails (hydrophobic) face each other in the interior of the bilayer.**
  - **Amphipathic.**

# The Cell Membrane Proteins.

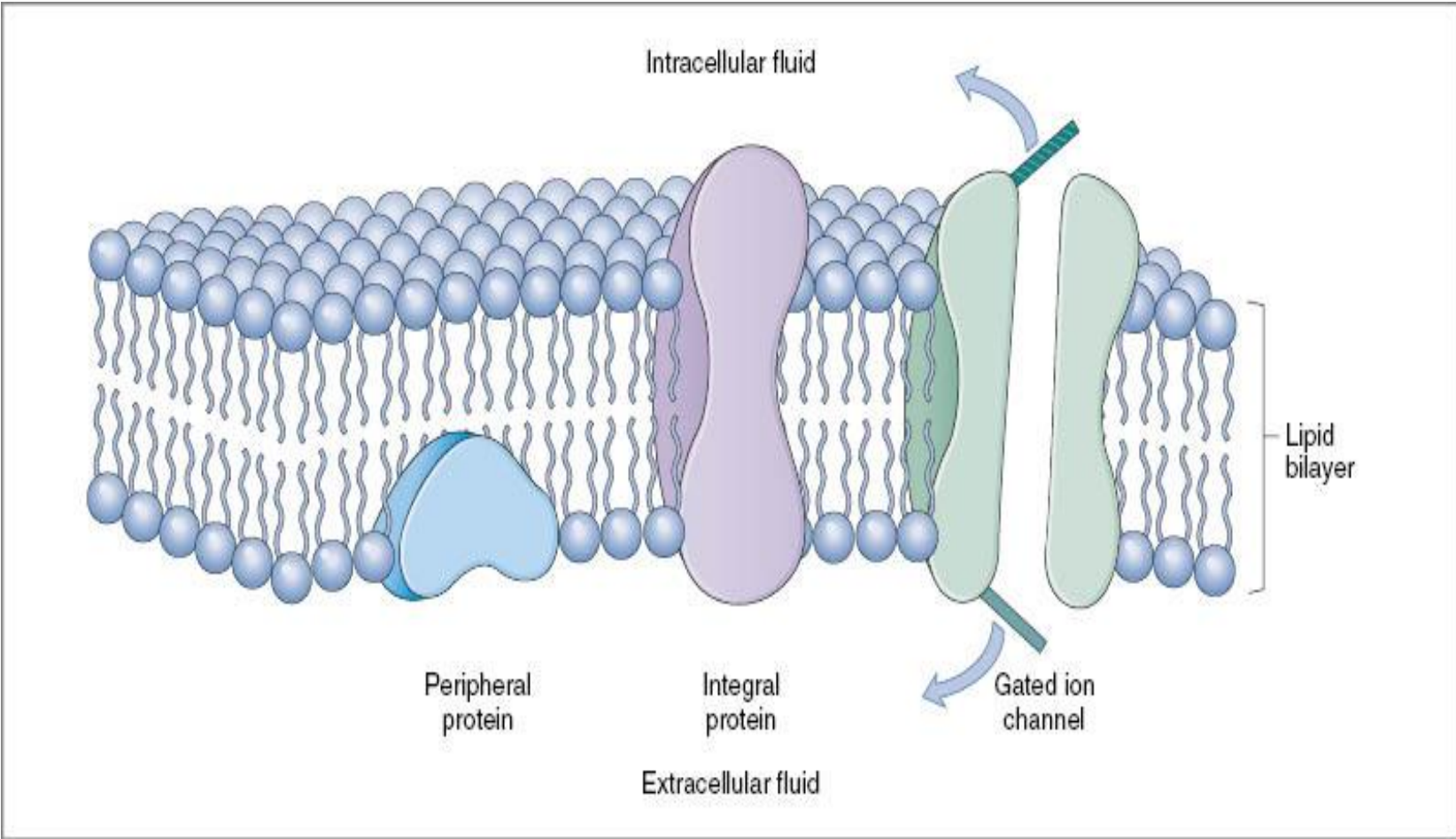
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- 1. Integral proteins** span the membrane .  
Proteins provide structural channels or pores.
- 2. Peripheral proteins** (carrier proteins)
  - Present in one side.
  - Hormone receptors ..

EXTRACELLULAR FLUID

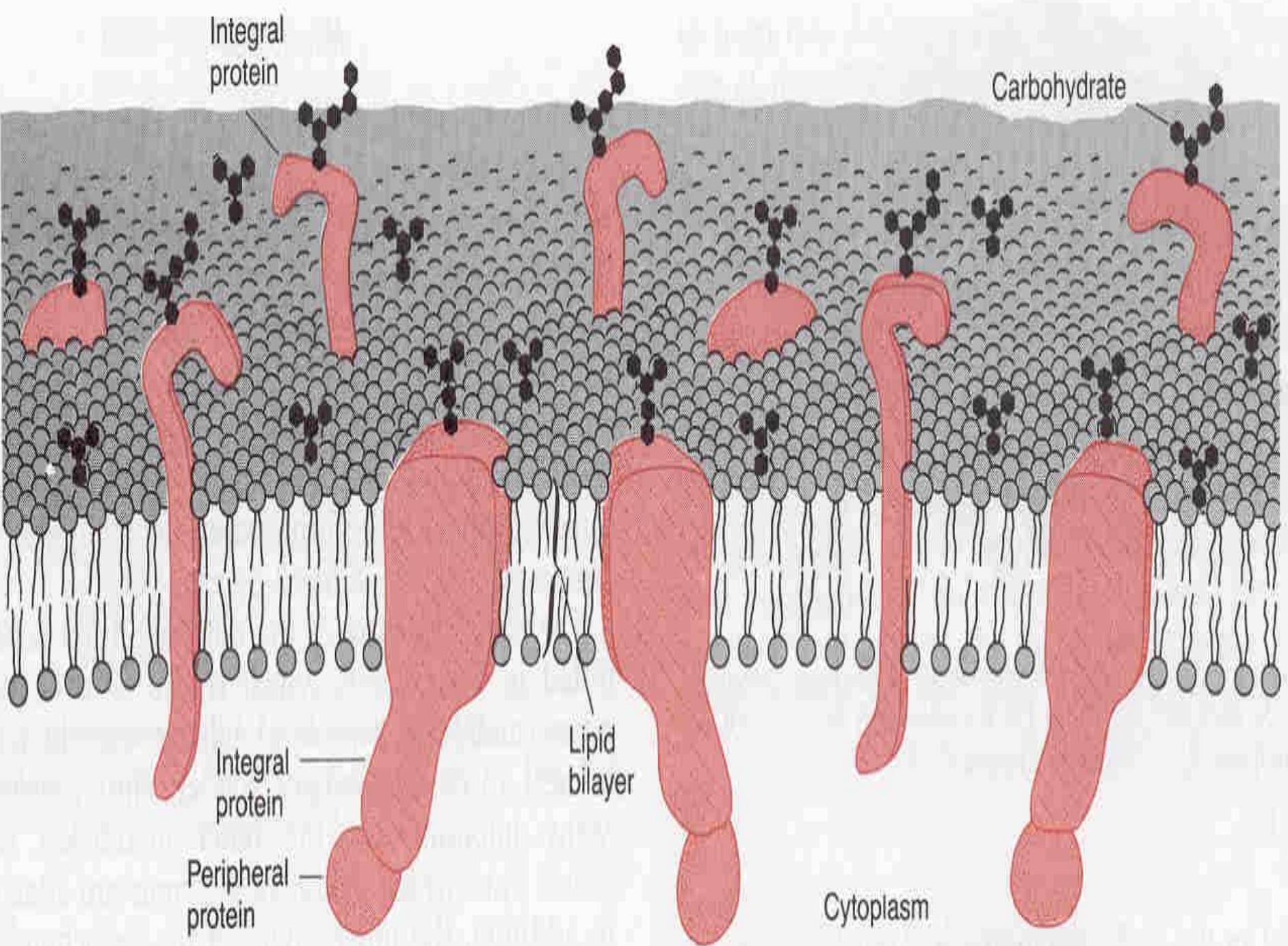






Integral protein

Carbohydrate



Integral protein

Lipid bilayer

Peripheral protein

Cytoplasm

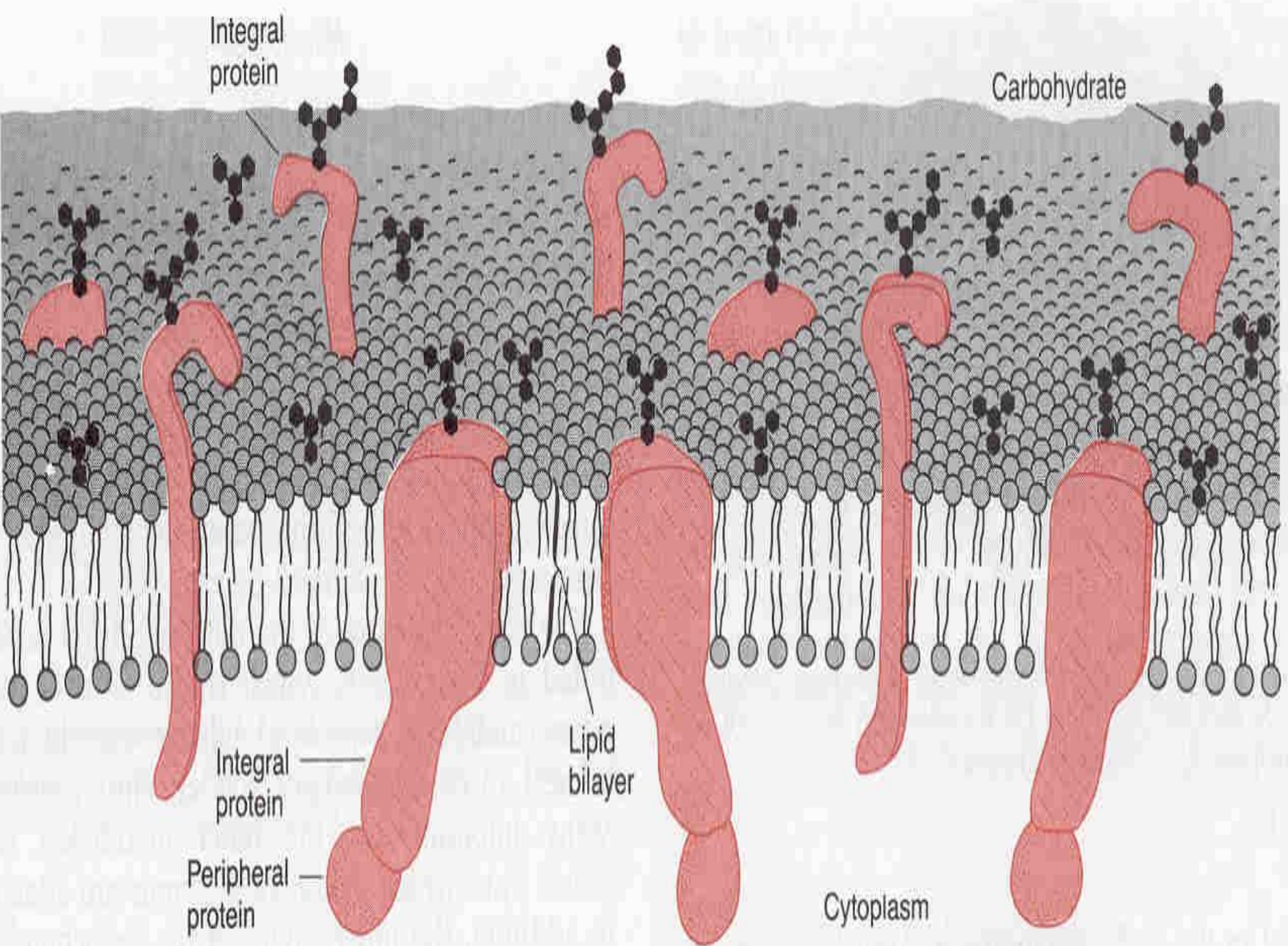
## *The Cell Membrane Carbohydrates:*

- *Glycoproteins (most of it ).*
- *Glycolipids*
- *Proteoglycans (mainly carbohydrate substance bound together by protein)*
- *‘glyco’ part is in the surface forming.*
- *Glycocalyx. (loose coat of carbohydrates.*



Integral protein

Carbohydrate



Integral protein

Lipid bilayer

Peripheral protein

Cytoplasm

# Function Of Carbohydrates:

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- **Attaches cell to each others.**
- **Act as receptors substances. (help ligend to recognize its receptor ).**
- **Some enter in to immune reactions.**

# Transport Through The Cell Membrane

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- **Cell membrane is selectively permeable.**
- **Through the proteins.**  
**water** –soluble substances e.g. ions, glucose .
- **Directly through the bilayer.**  
**Fat** – soluble substance (O<sub>2</sub>, CO<sub>2</sub>, OH..



Extracellular fluid		Intracellular fluid
Na <sup>+</sup>	142 mEq/L	10 mEq/L
K <sup>+</sup>	4 mEq/L	140 mEq/L
Ca <sup>++</sup>	2.4 mEq/L	0.0001 mEq/L
Mg <sup>++</sup>	1.2 mEq/L	58 mEq/L
Cl <sup>-</sup>	103 mEq/L	4 mEq/L
HCO <sub>3</sub> <sup>-</sup>	28 mEq/L	10 mEq/L
Phosphates	4 mEq/L	75 mEq/L
SO <sub>4</sub> <sup>-</sup>	1 mEq/L	2 mEq/L
Glucose	90 mg/dl	0 to 20 mg/dl
Amino acids	30 mg/dl	200 mg/dl ?
Cholesterol Phospholipids Neutral fat	0.5 gm/dl	2 to 95 gm/dl
PO <sub>2</sub>	35 mm Hg	20 mm Hg ?
PCO <sub>2</sub>	46 mm Hg	50 mm Hg ?
pH	7.4	7.0
Proteins	2 gm/dl (5 mEq/L)	16 gm/dl (40 mEq/L)

# Types Of Membrane Transport

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- **1- Diffusion**
- a)- Simple diffusion.
- b)- Facilitated diffusion.
- **2- Active transport.**
- a)- Primary active transport.
- b)- Secondary active transport.
- **3- Osmosis.**



# Diffusion

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- Random movement of substance either through the membrane directly or in combination with carrier protein down an electrochemical gradient.

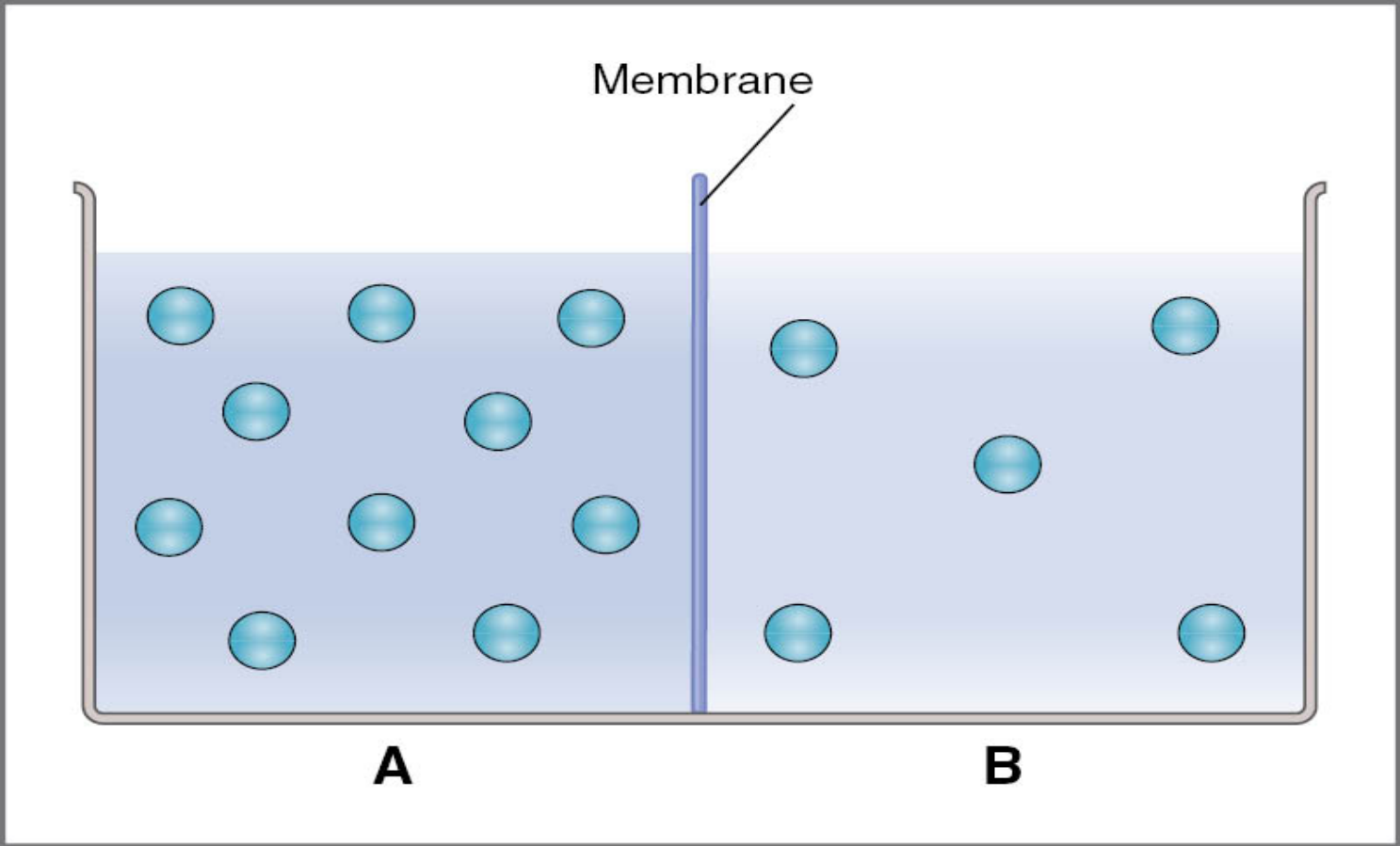
1- Simple diffusion.

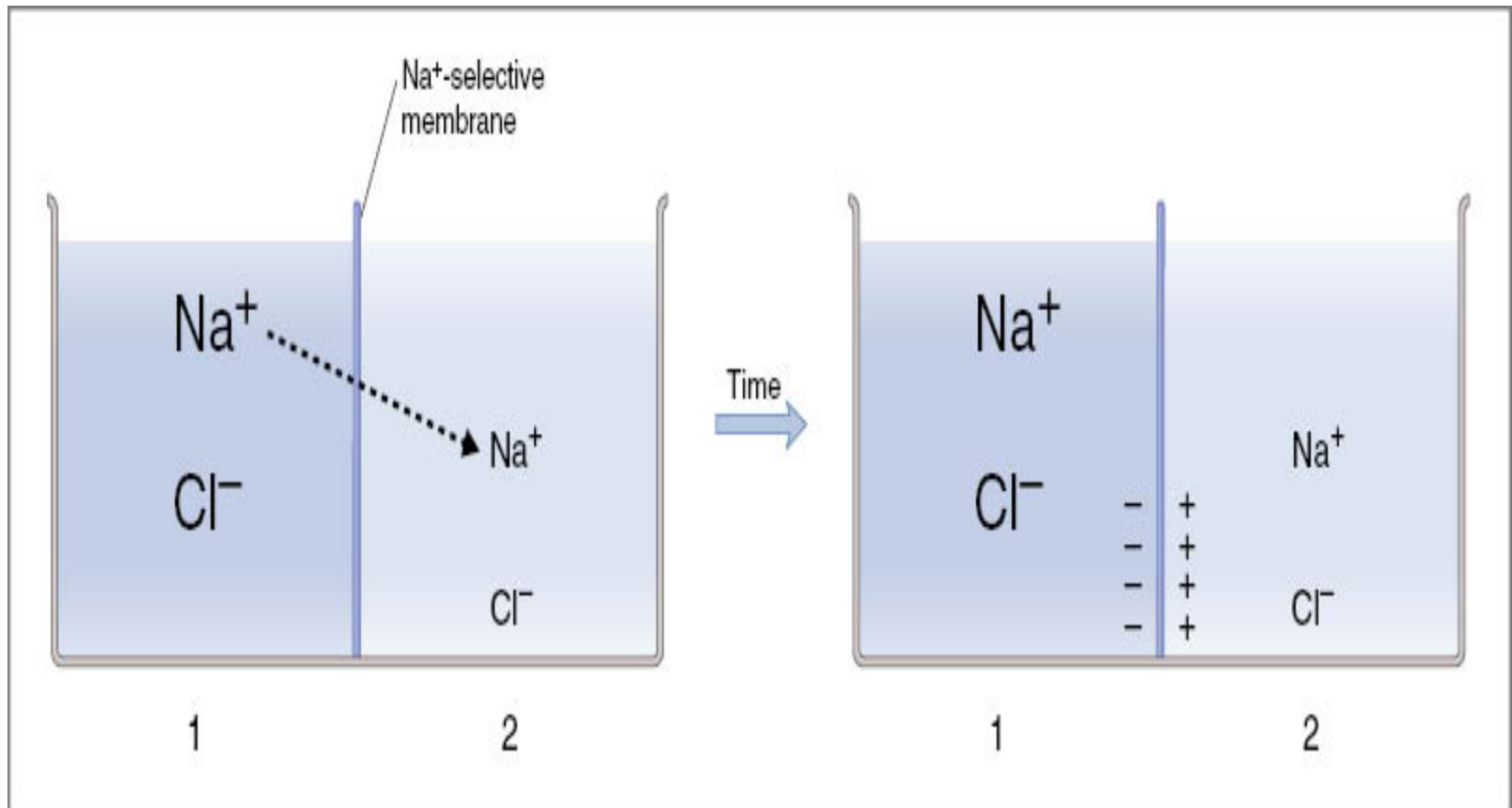
2- Facilitated diffusion.

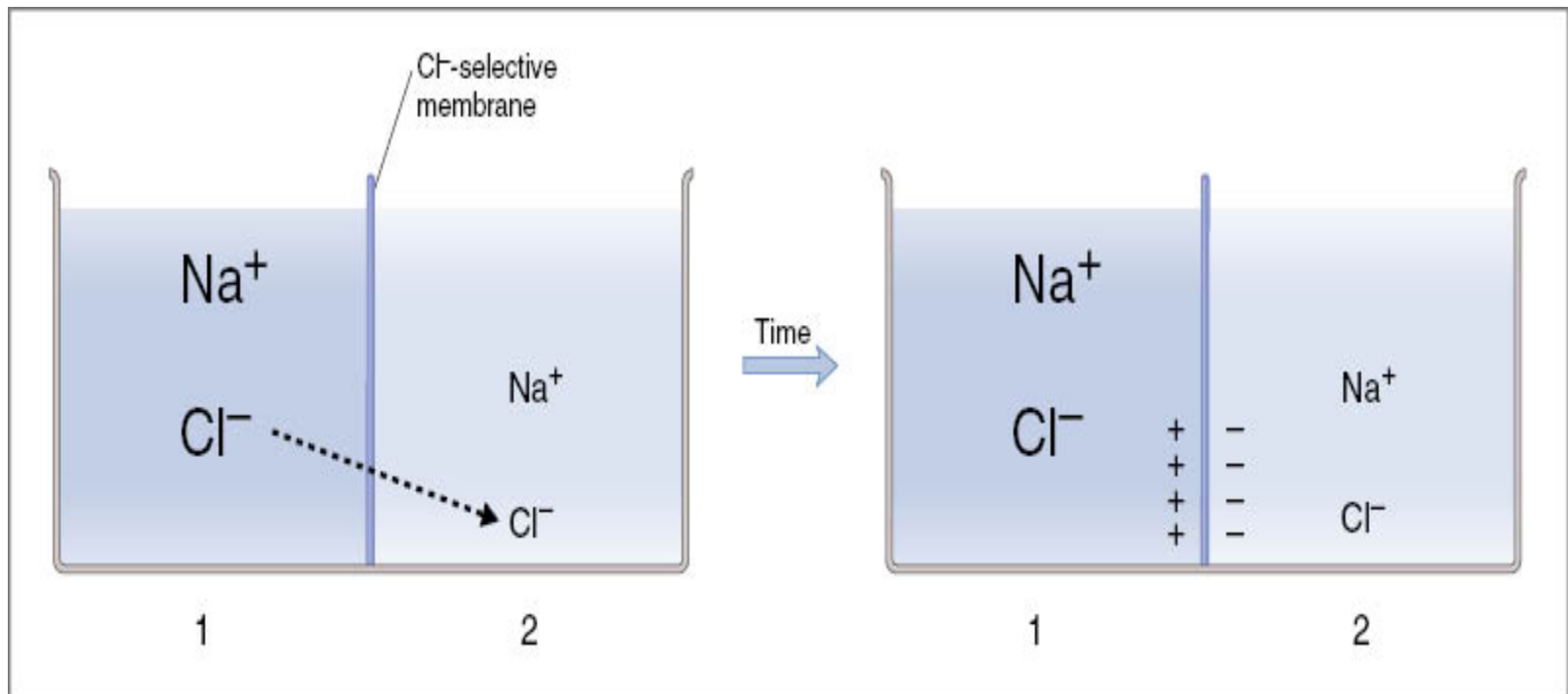
# Simple Diffusion

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- **Non carrier** mediated transport **down** an electrochemical gradient.
- **Diffusion of nonelectrolytes** (uncharged) from high concentration to low concentration.
- **Diffusion of electrolytes** (charged) depend on both chemical as well as electrical potential difference.







# Rate Of Simple Diffusion Depend On:

**1- Amount of substance available.**

**2- The number of opening in the cell membrane for the substance.**

**selective gating system**

**3- Chemical concentration difference.**

**net diffusion=  $P \times A (C_o - C_i)$**

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**4- Electrical potential difference.**

**5- Molecular size of the substance.**

**6- Lipid solubility.**

**7- Temperature.**

# Facilitated Diffusion

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- **Carrier mediated transport down an electrochemical gradient.**



# Features Of Carrier Mediated Transport

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## 1- Saturation:

↑ concentration → ↑ binding of protein

If all protein is occupied we achieve full saturation.

## 2- Stereopecificity:

The binding site recognize a specific substance

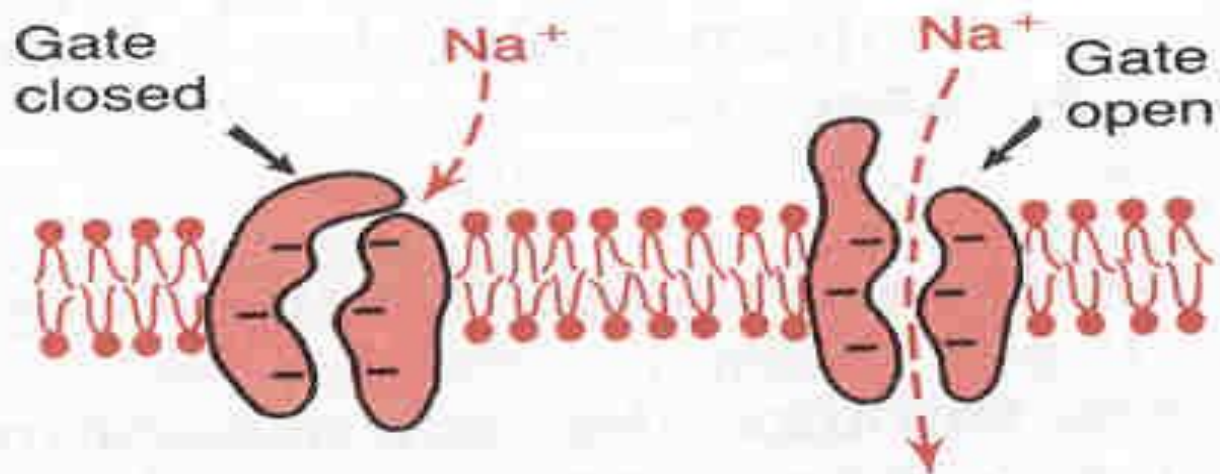
D-glucose but not L-glucose

### 3- Competition:

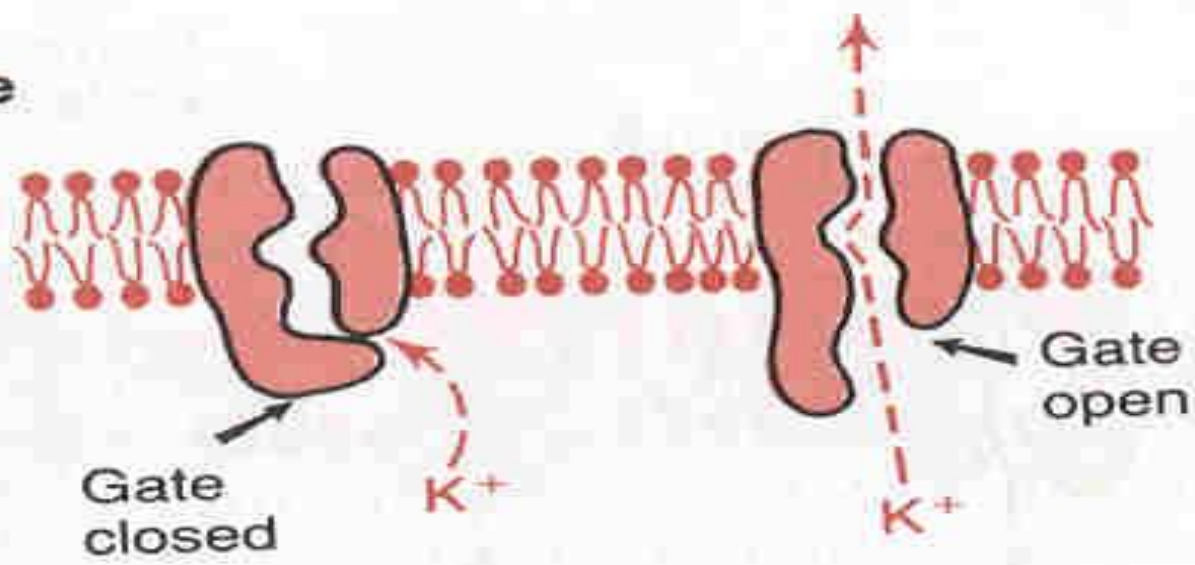
Chemically similar substance can compete for the same binding site.

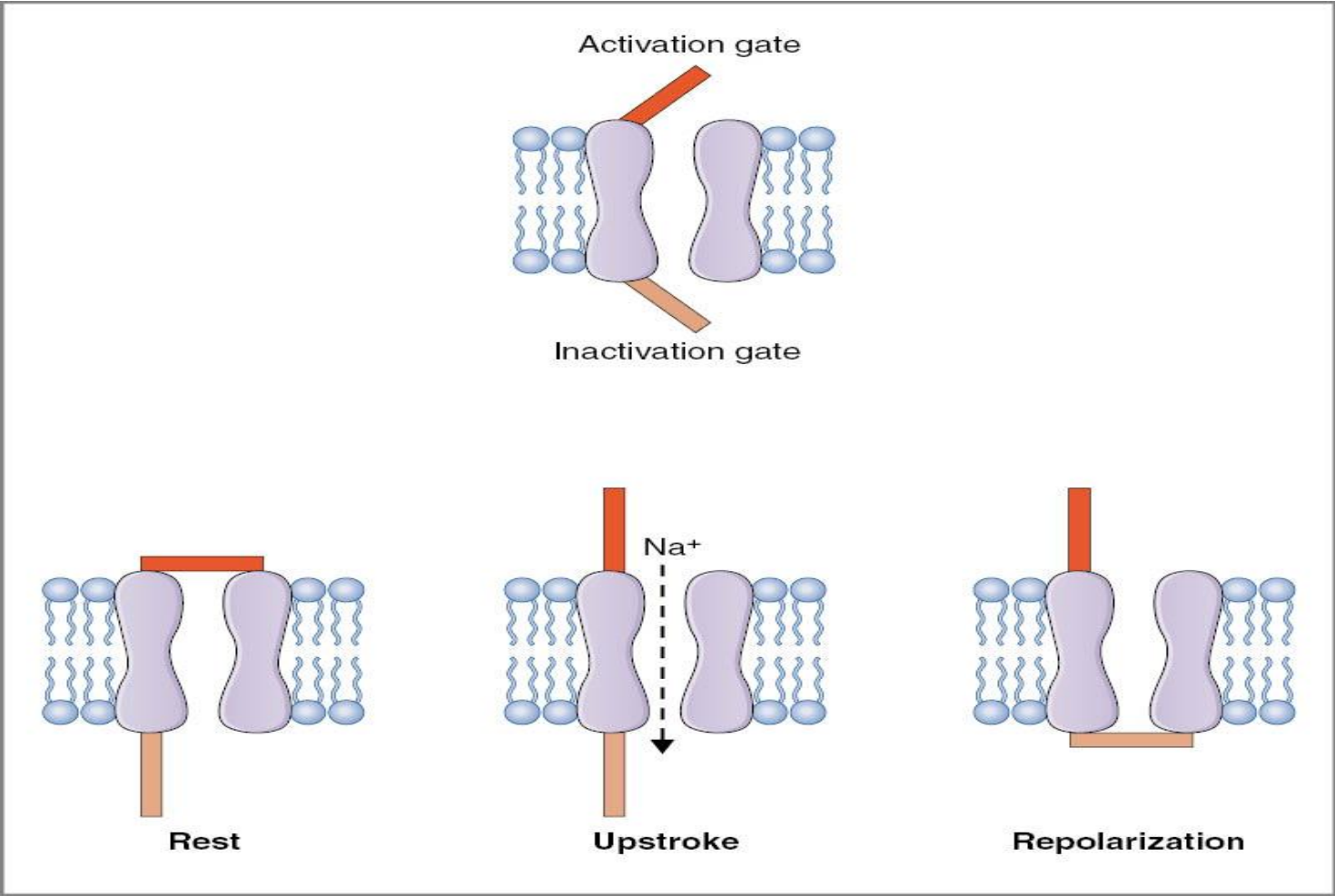
Substance → binding site → substance protein  
complex → conformational changes  
release of substance

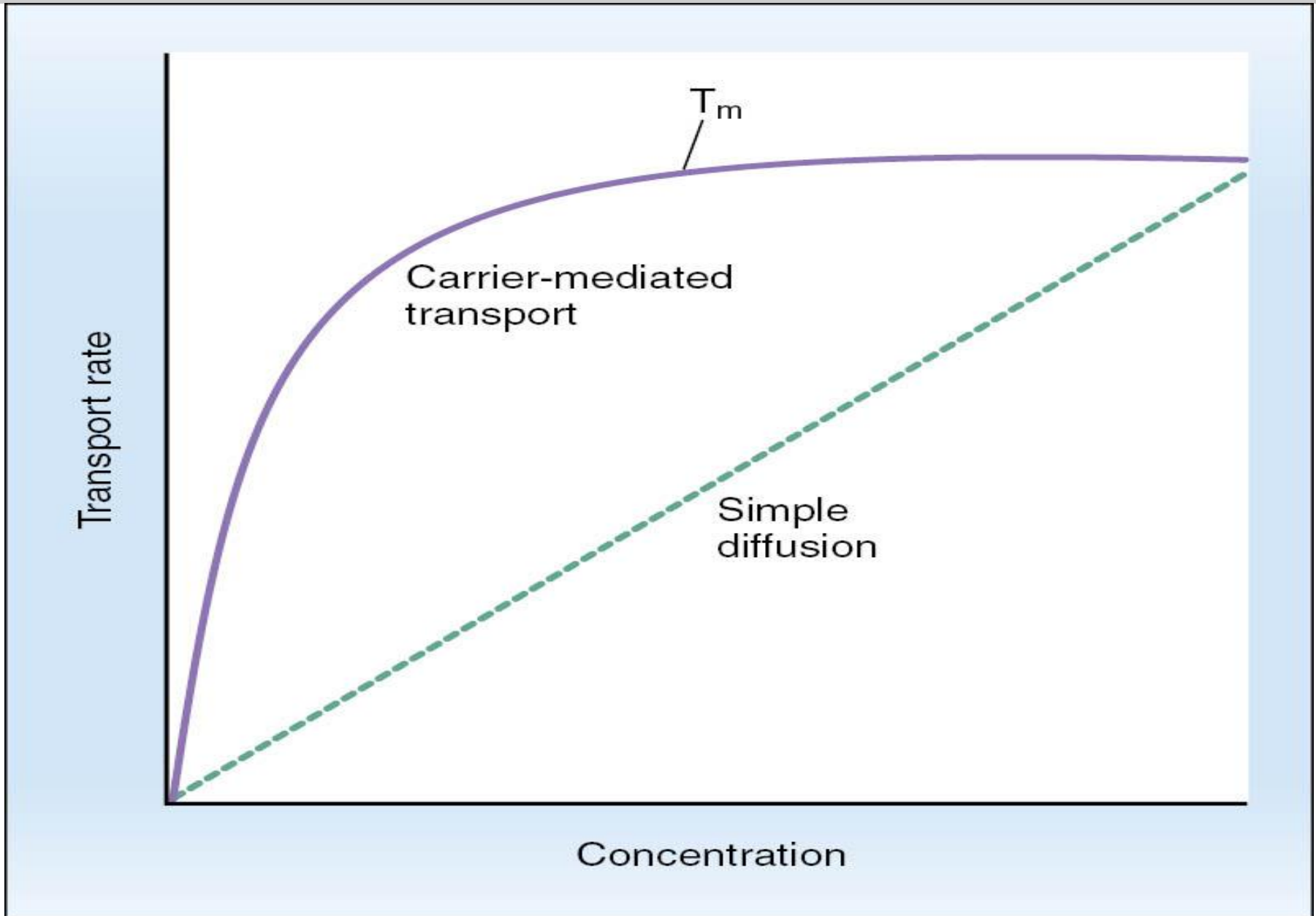
Outside



Outside



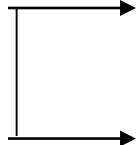




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- Glucose, most of amino acids.

# Active Transport:

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- Transport (**uphill**) → against electrochemical gradient.
- Required energy  **direct.**  
**indirect.**
- Required **carrier** – protein.

# 1- Primary Active Transport:

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-Energy is supplied directly from ATP.

ATP  $\longrightarrow$  ADP + P + energy.

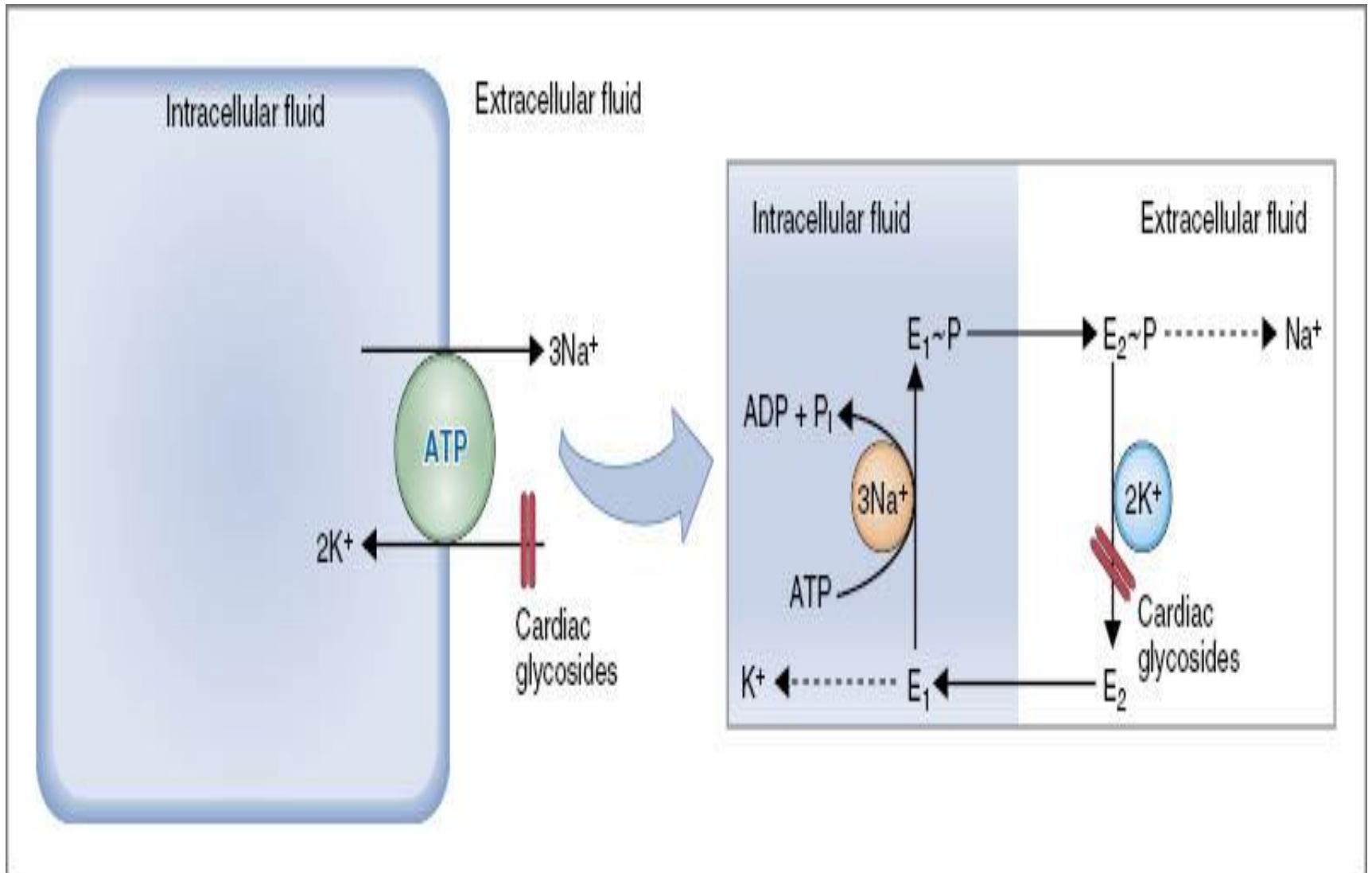
## A. - **Sodium-Potassium pump (Na-K pump).**

- its present in all cell membranes.

- Na in  $\longrightarrow$  out.

- K out  $\longrightarrow$  in.

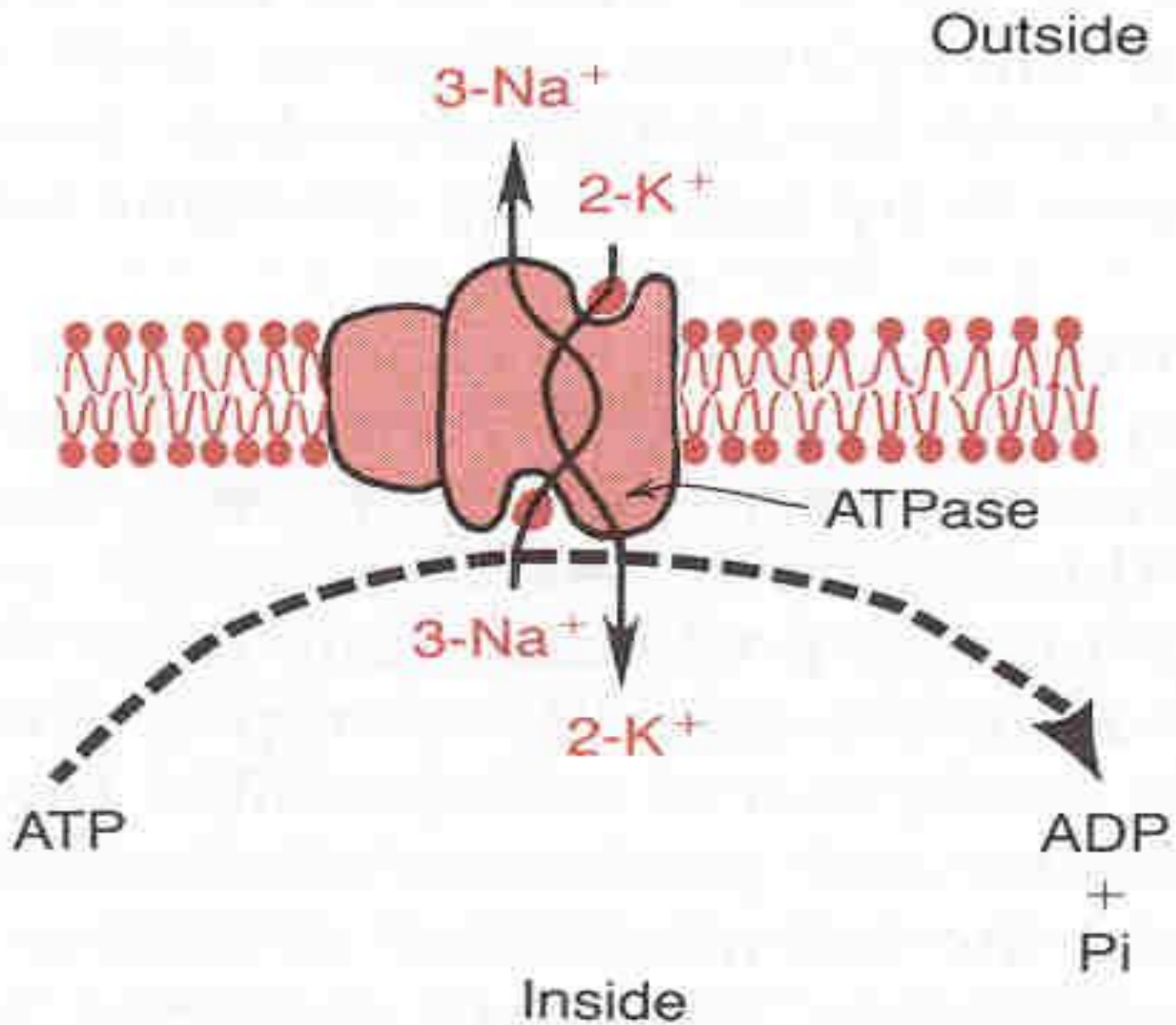




# Characteristic Of The Pump:

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1. Carrier protein is formed from  $\alpha$  and  $\beta$  subunits.
2. Binding site for **Na inside** the cell.
3. Binding site for **K outside** the cell.
4. It has **ATPase** activity.
5. 3 Na out.
6. 2 K in.



# Function:

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1. Maintaining **Na and K concentration** difference .
2. It's the basis of nerve signal transmission .
3. Maintaining  $-Ve$  potential inside the cell.

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**B. - Primary active transport of calcium  
(Ca<sup>2+</sup> ATPase).**

- sarcoplasmic reticulum (SR).
- mitochondria.
- in some cell membranes.

**Function:**

Maintaining a low Ca<sup>2+</sup> concentration inside the cell.

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- **C. - Primary active transport of hydrogen ions H<sup>+</sup>-K ATPase.**
    - stomach.
    - kidneys.
    - pump to the lumen.
    - H<sup>+</sup>-K ATPase inhibitors (treat ulcer disease). (omeprazol)

## 2) Secondary Active Transport:

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- **Co- transport and countertransport:**

is transport of one or more solutes against an electrochemical gradient ,coupled to the transport of another solute down an electrochemical gradient .

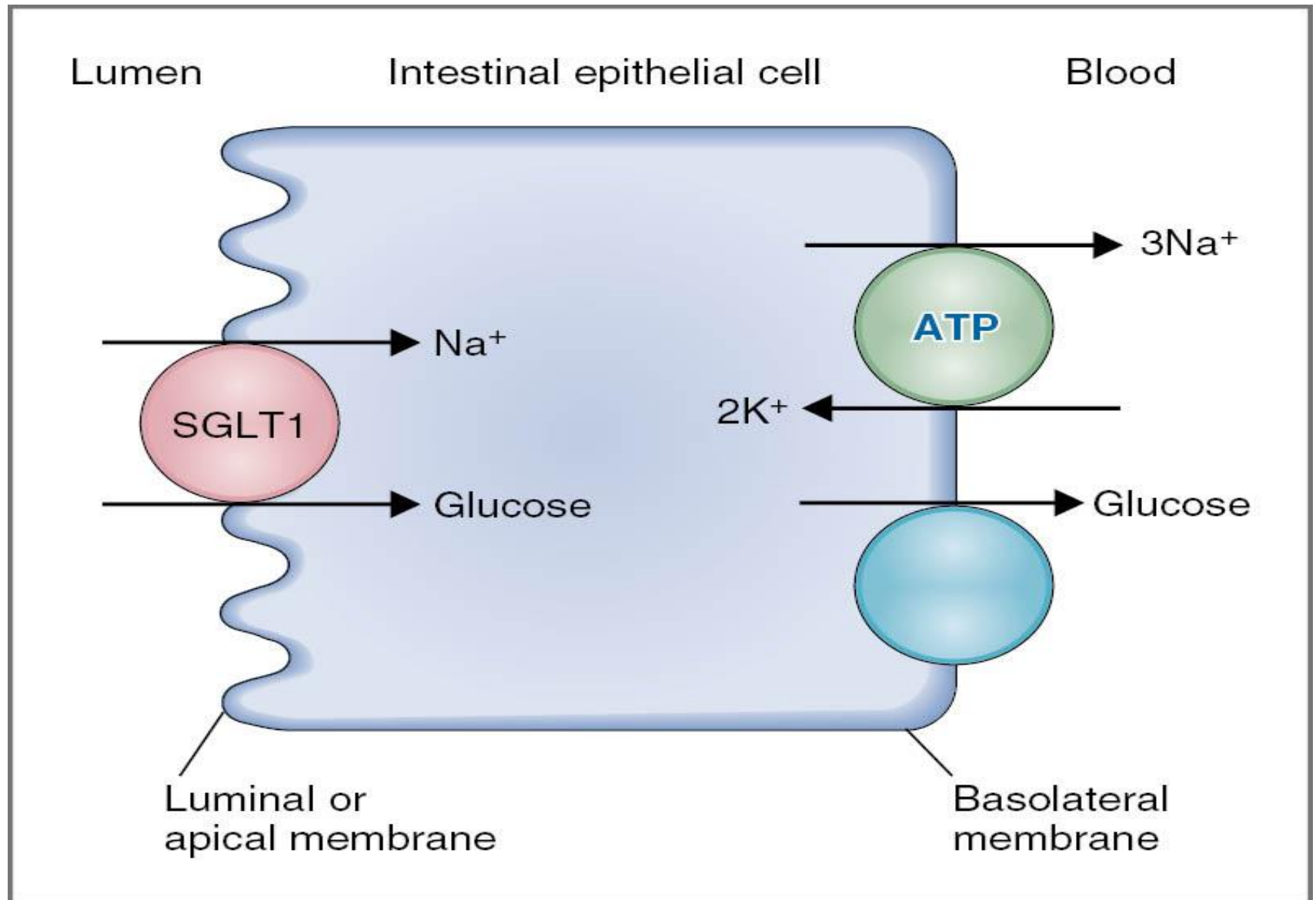
- “downhill” solute is Na.
- Energy is supplied indirectly form primary transport.

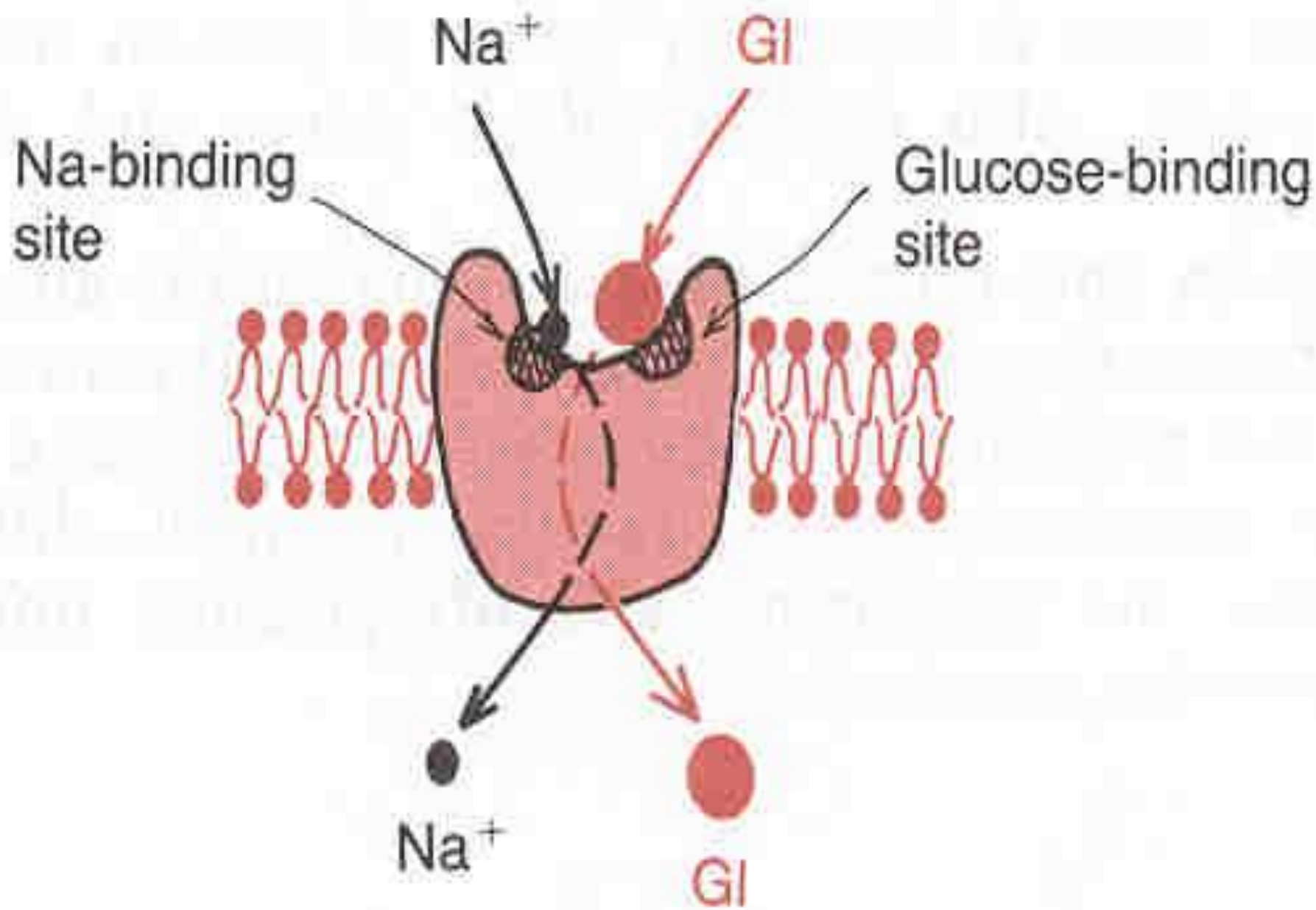
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- **Co transport:**

- All solutes move in the **same direction** “inside cell”.
- e.g. - Na - glucose Co transport.
  - Na – amino acid Co transport.
  - in the intestinal tract kidney.

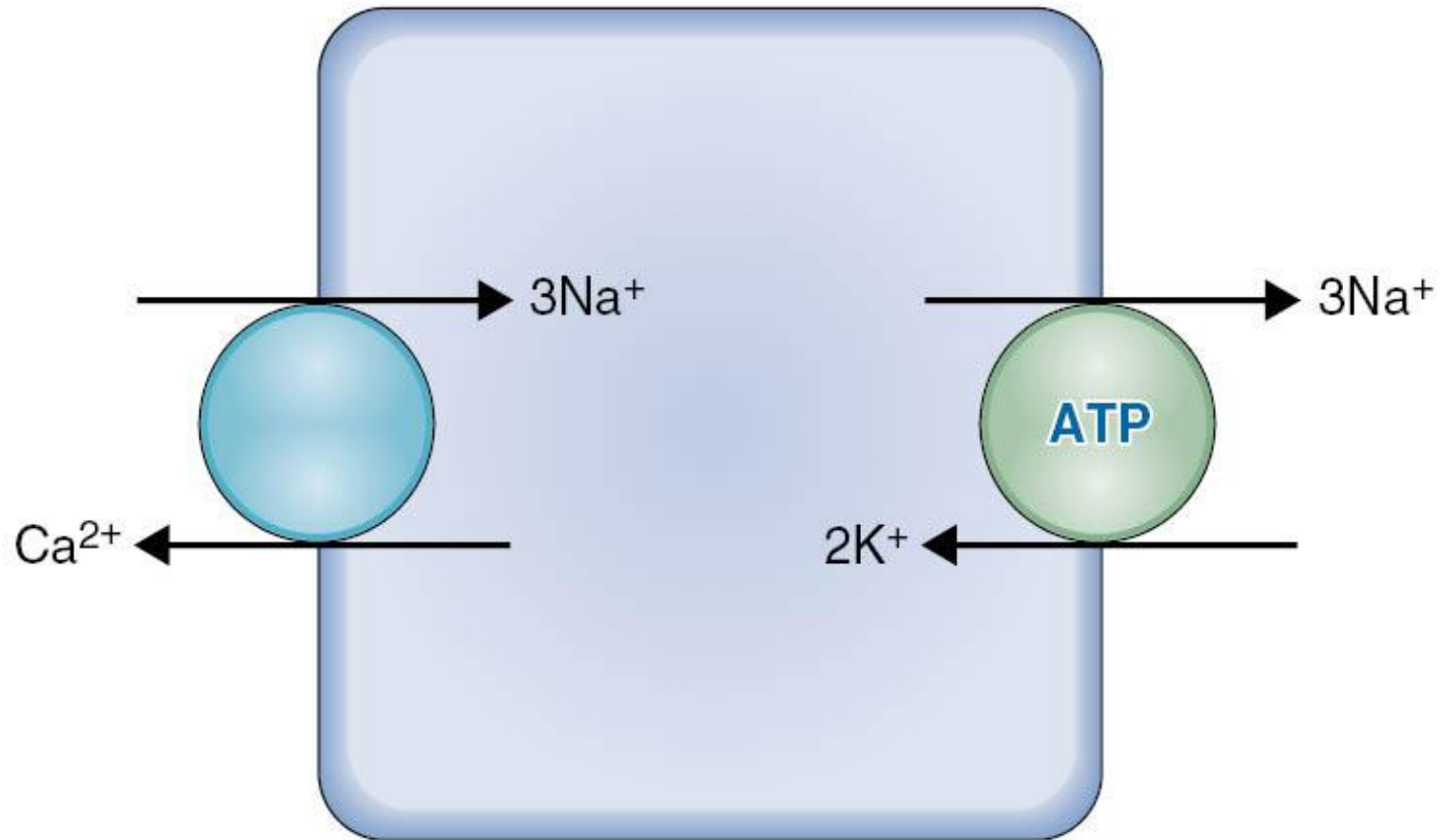






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- **Countertransport:**
  - Na is moving **to the interior** causing other substance to **move out**.
  - $\text{Ca}^{2+}$  -  $\text{Na}^{+}$  exchange.  
(present in many cell membranes)
  - $\text{Na} - \text{H}^{+}$  exchange in the kidney.

Muscle cell

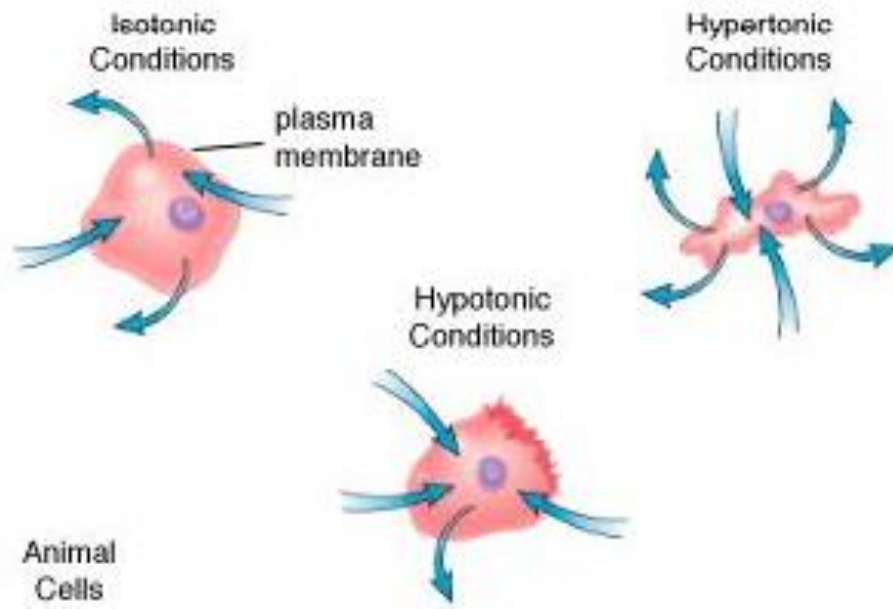
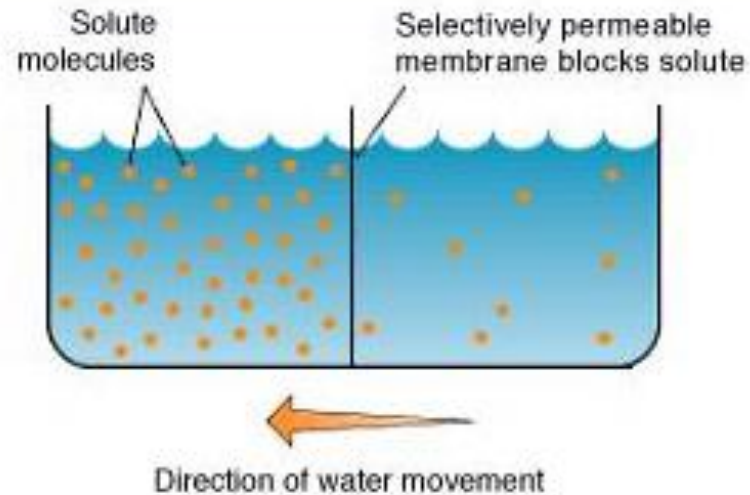


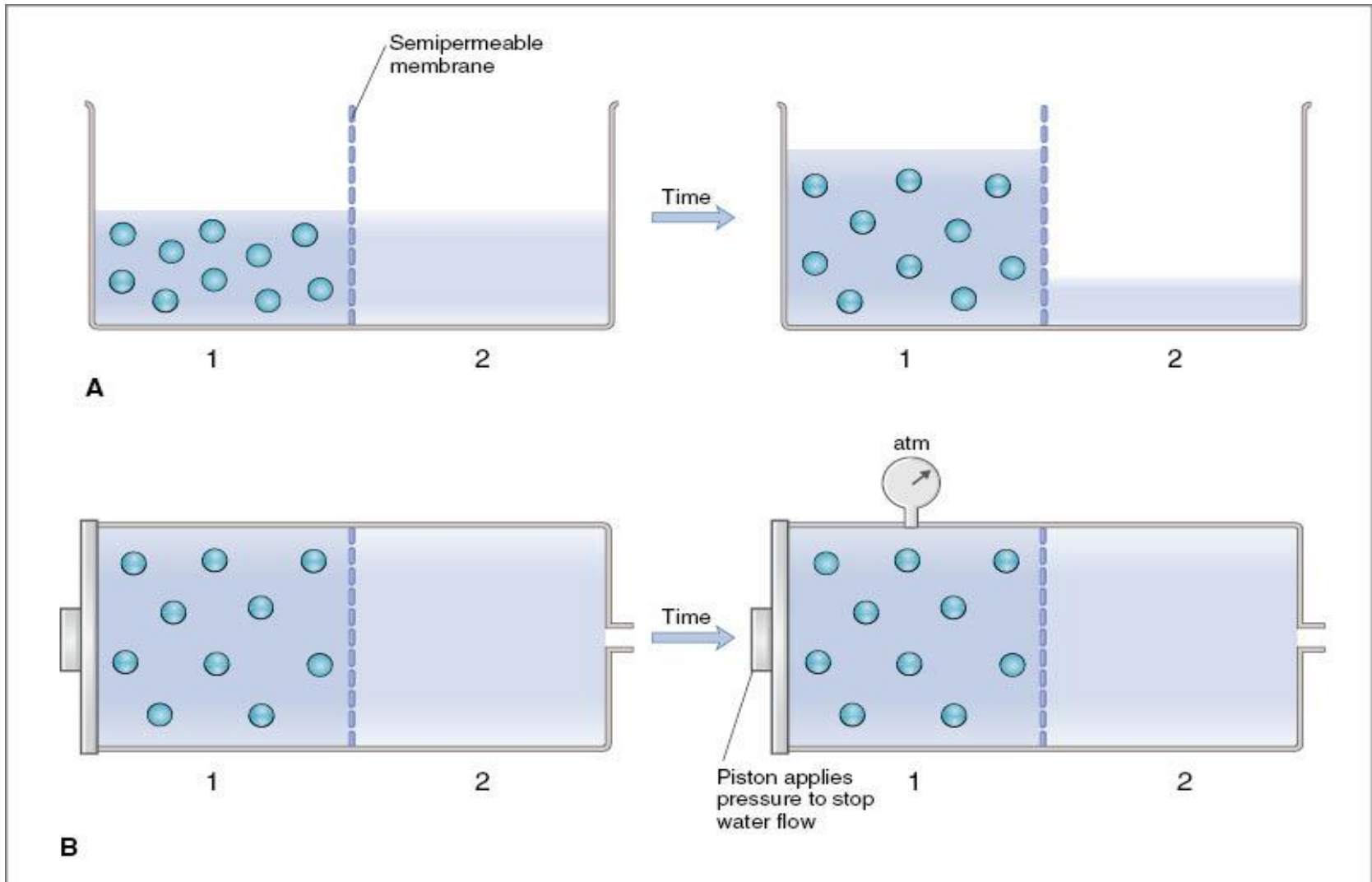
# osmosis

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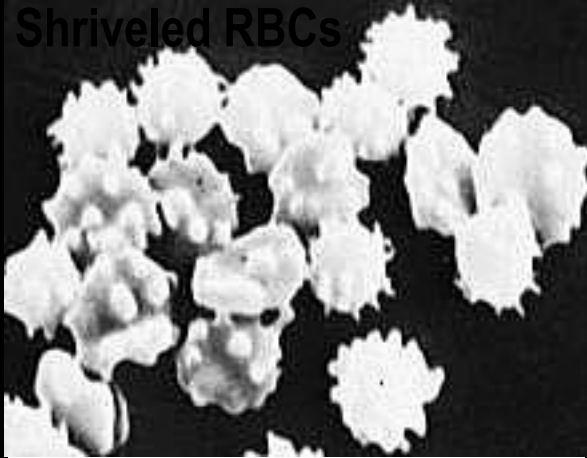
- **net diffusion of water from a region of high water concentration to region of low water concentration.**

# Osmosis

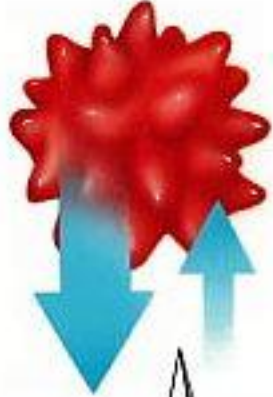




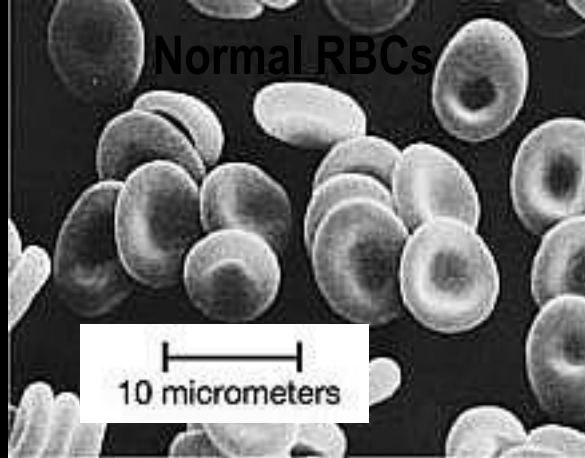
# Osmosis



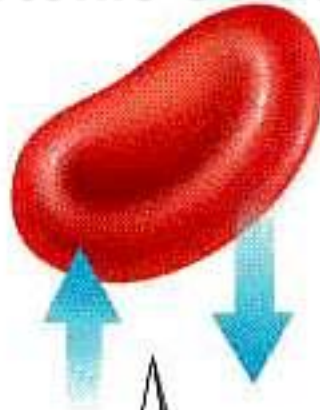
Hypertonic Solution



Net movement of water out of cells



Isotonic Solution



Equal movement of water into and out of cells

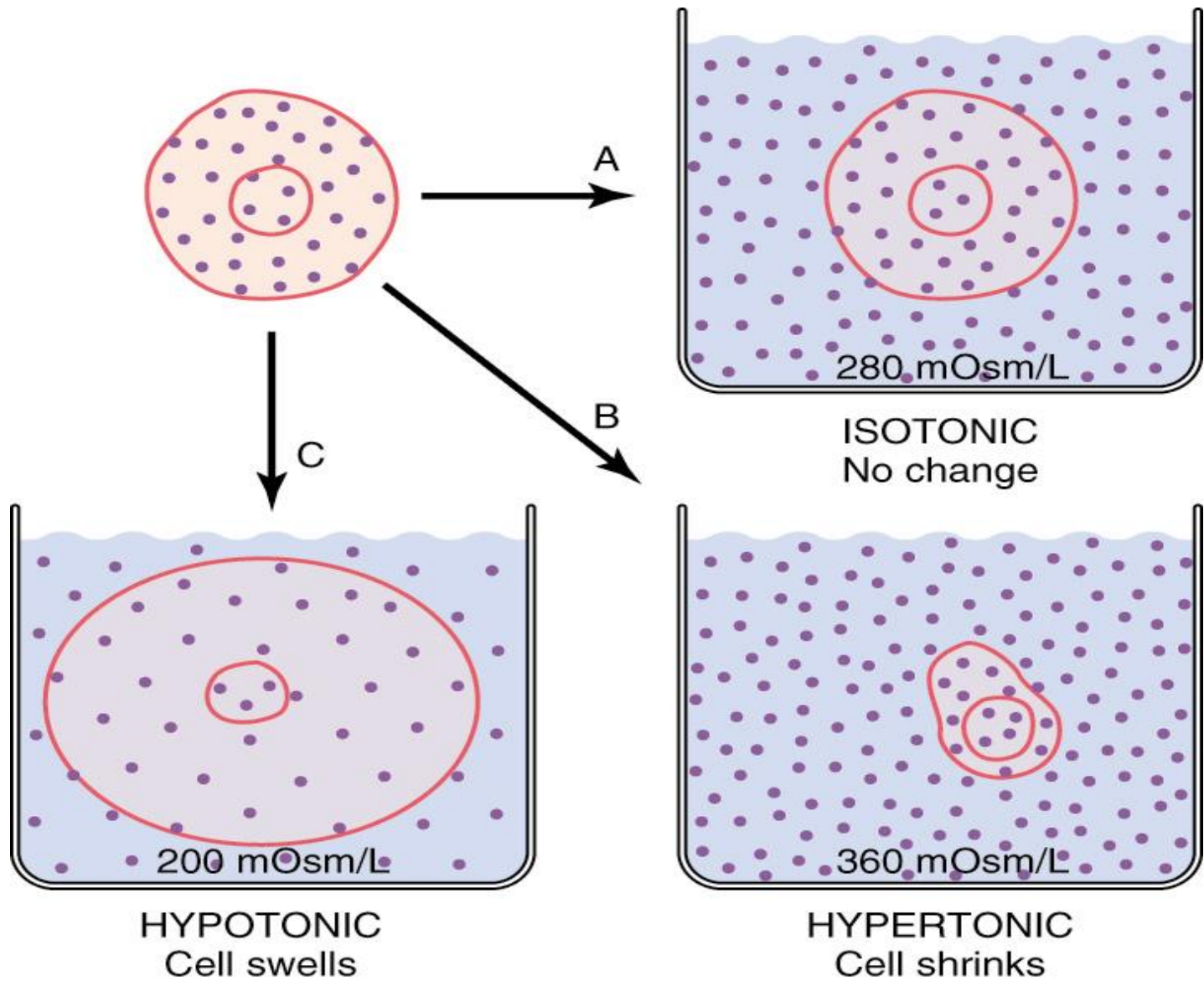


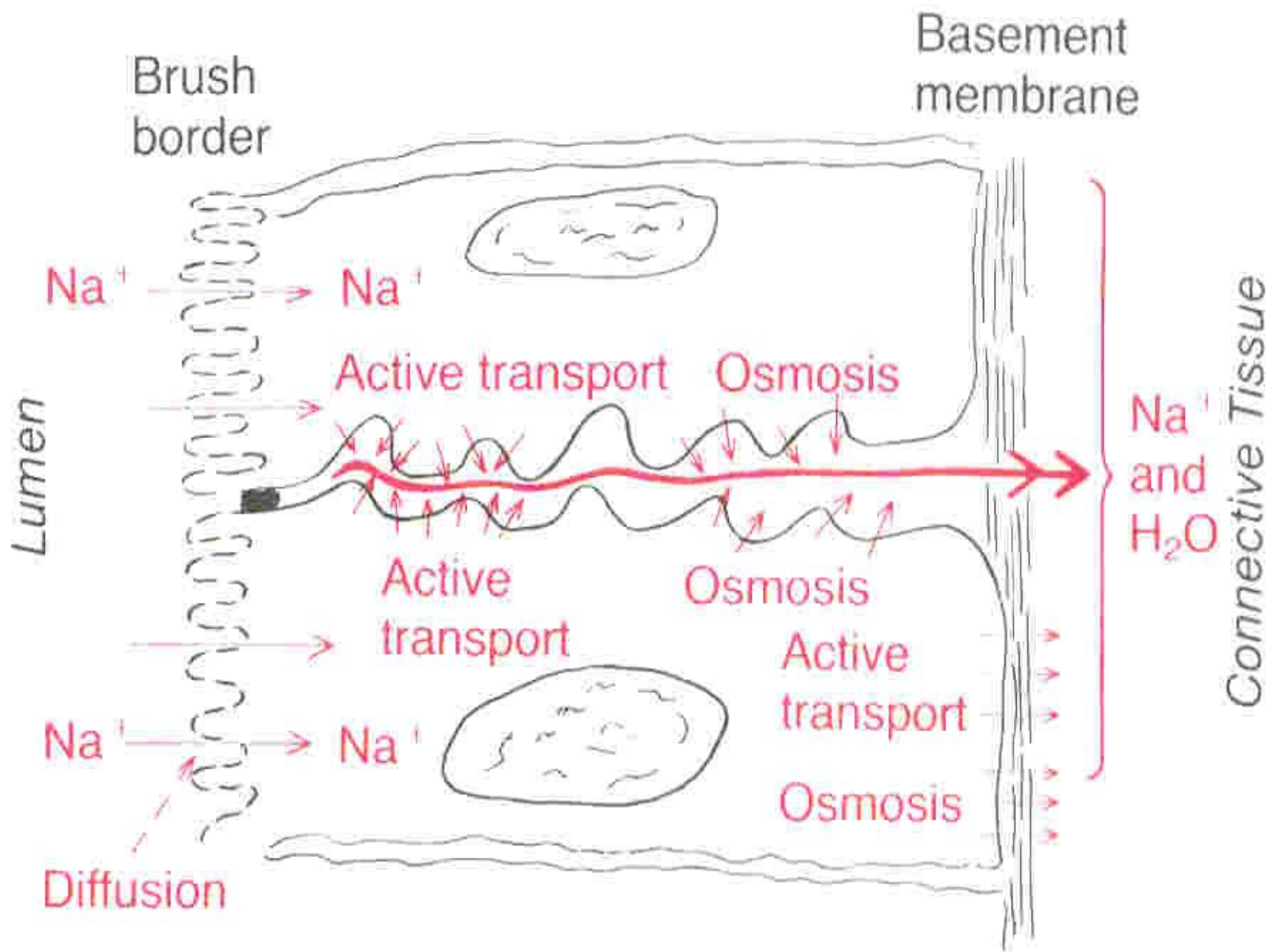
Hypotonic Solution



Net movement of water into cells







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*Thank you*