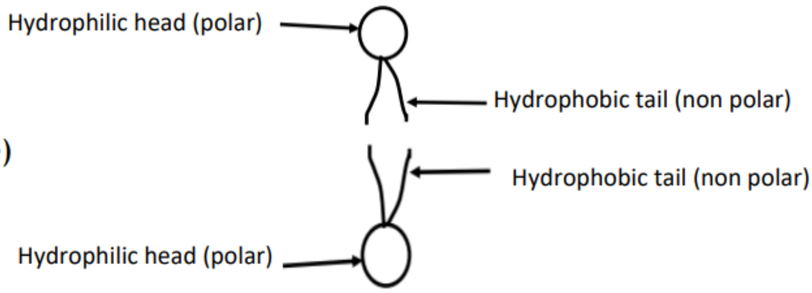
1.3 Membrane Proteins

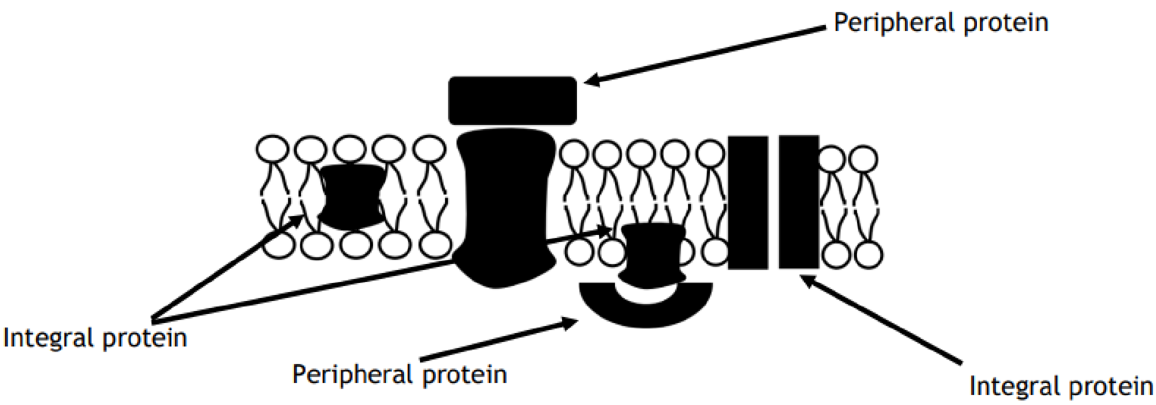
Cell membrane

Made up of a phospholipid bilayer

1. Hydrophilic head (outer/inner edge)
2. Hydrophobic tail (middle)



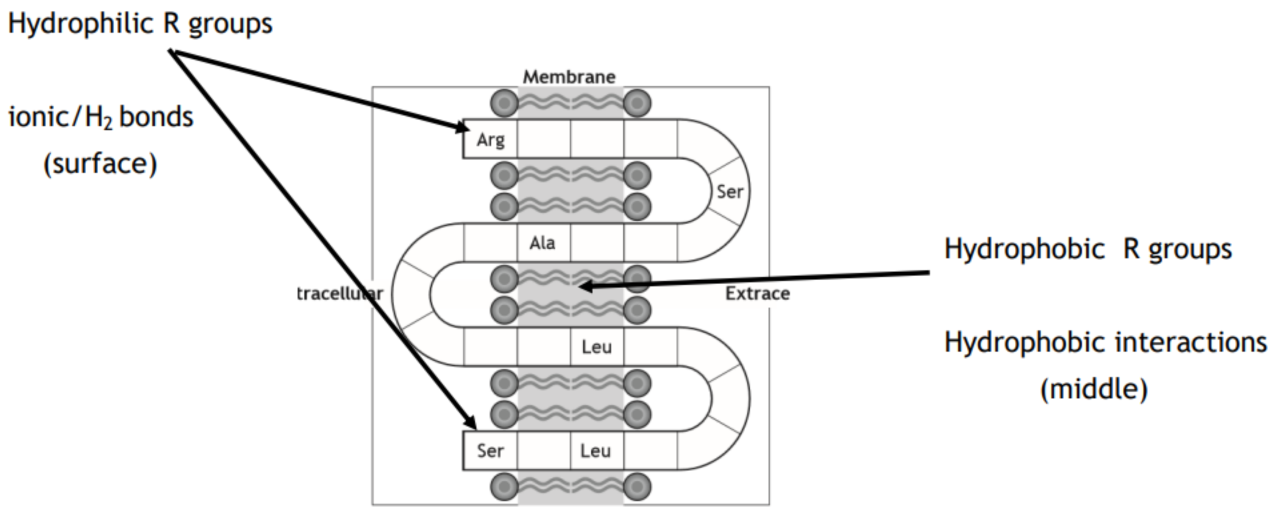
Types of membrane protein



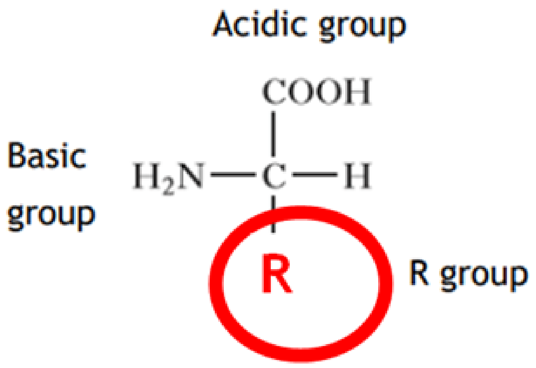
Many peripheral membrane proteins interact with the surfaces of integral membrane protein

Type of Membrane protein	Description	Type of R groups on protein	Type of interactions
Integral	Held within the phospholipid bilayer Some are transmembrane	Hydrophobic R groups in middle of protein Hydrophilic R groups at surface	Strong hydrophobic interactions
Peripheral	Bound to surface of membrane	Hydrophilic R groups at surface	Ionic or hydrogen bonds

1.3 Membrane Proteins



Hydrophilic/Hydrophobic Amino Acids



Type of Amino Acid	Hydrophilic/Hydrophobic	R group
Basic	Hydrophilic (+ve charge)	NH_3^+ group
Acidic	Hydrophilic (-ve charge)	COO^- group
Polar	Hydrophilic	OH group
Non Polar	Hydrophobic (no charge)	CH_3 group

1.3 Membrane Proteins

Movement of Molecules across membrane

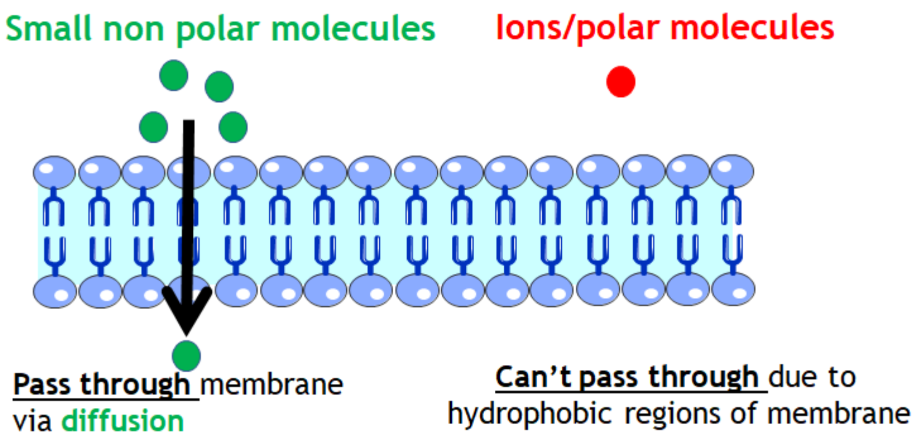
Phospholipid bilayer acts as a **BARRIER** across the membrane to **MOST** molecules.

STOPS

1. **Large uncharged (non polar) molecules**
2. **Ions/polar molecules**

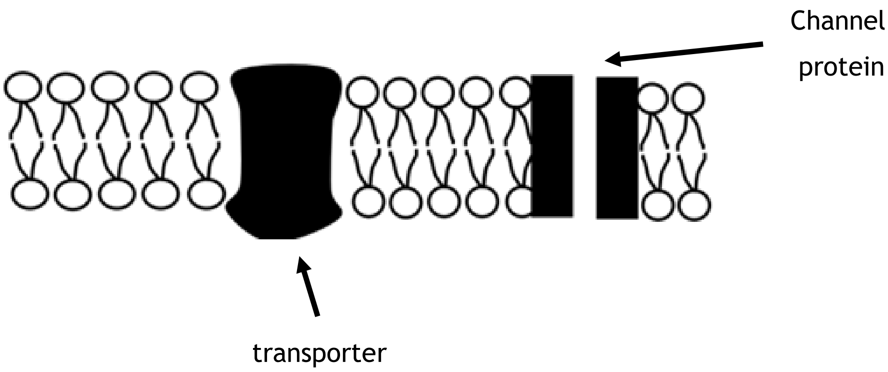
GO

Some **small non polar** molecules (O_2/CO_2) can squeeze in between the phospholipid bilayer heads, diffusing across the membrane.



Facilitated Diffusion

Passive transport of substances across the membrane through specific **transmembrane** proteins



To perform **specialised functions**, different cell types have **different** channel & transporter proteins

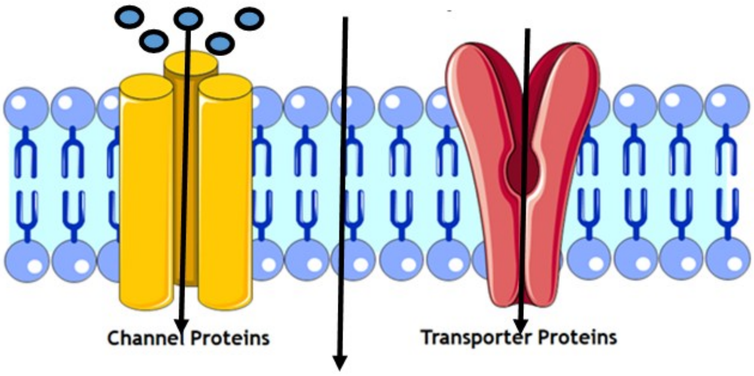
1.3 Membrane Proteins Summary

Movement across the Membrane

1. Water
2. Ions: $Cl^-/K^{+/}$

O_2/CO_2

1. Ions: Na^+& K^+
2. Glucose (larger non polar)



Diffusion ONLY

May change conformation (gated)

Diffusion OR active transport

MUST change conformation

Movement across the Membrane

Movement across membrane

Small uncharged molecules e.g. (O_2 & CO_2)

Phospholipid bilayer

Simple diffusion

Ions or uncharged polar molecules

Transmembrane proteins

Channel protein

Transporter proteins

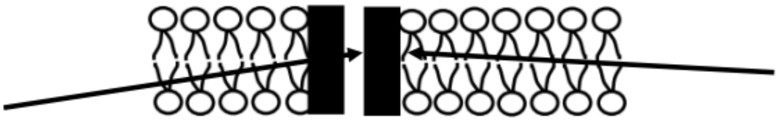
Transmembrane protein	Process	Example of protein
Channel	Passive (diffusion)	Simple channels Ligand & Voltage gated channels
Transporter	Active transport Facilitated Diffusion	Sodium Potassium Pump Glucose Symport

1.3 Channel Proteins

Channel Proteins

Multi-subunit proteins with the subunits arranged to form **water-filled pores** that extend across the membrane

Water filled pore



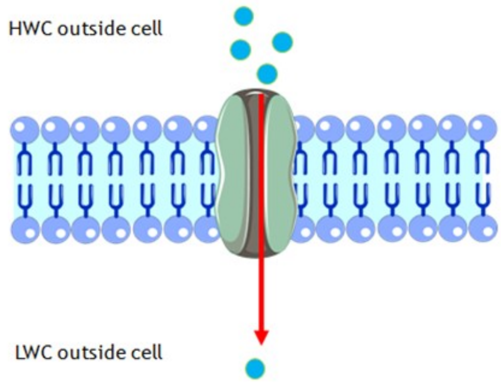
Multi-protein sub units

Function of channel proteins

To move molecules across the membrane by **diffusion.**

Types of Channel Proteins

1. Simple ungated (Aquaporin)



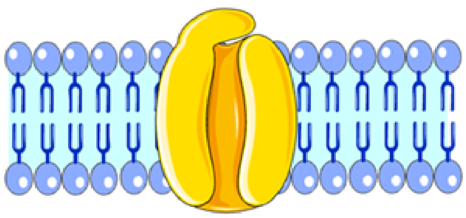
Highly specific facilitated diffusion of **water** into cell.

Always open —no conformational change required.

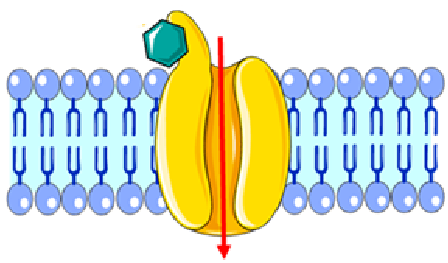
2. Gated Channel Proteins

These channel proteins **change conformation** to allow/prevent **diffusion**,

Closed (inactive)



Open (active)



Gt7hln ,u,vo7htyj8,l.

closed

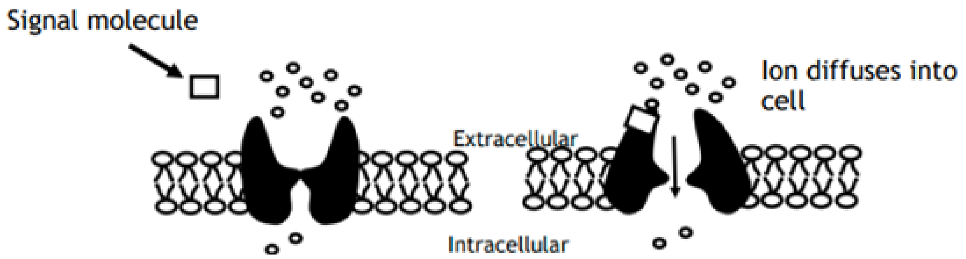
open

1.3 Gated Channel Proteins

These channel proteins **change conformation** to allow/prevent **diffusion**,

1. Ligand-gated channels

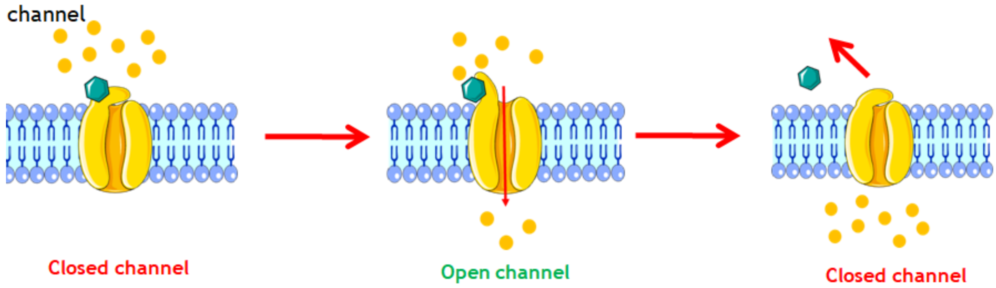
Controlled by the binding of **signal molecules**. **Ion moves In/out cell by diffusion.**



1. **Ligand** binds to the EC surface of the closed channel causing a CC, opening channel

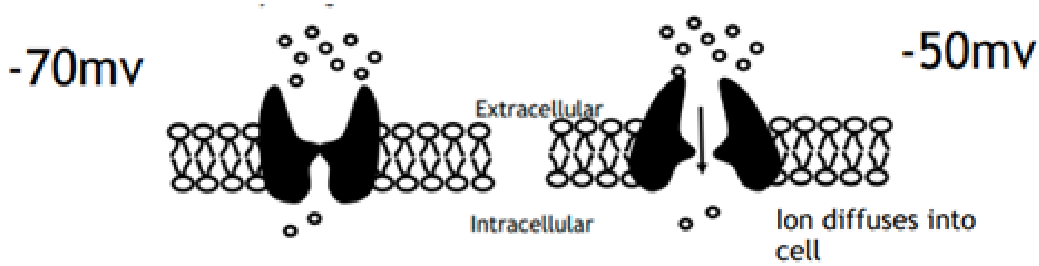
2. Ions move across the membrane via the open channel

3. Ligand released which closes the channel via a second CC

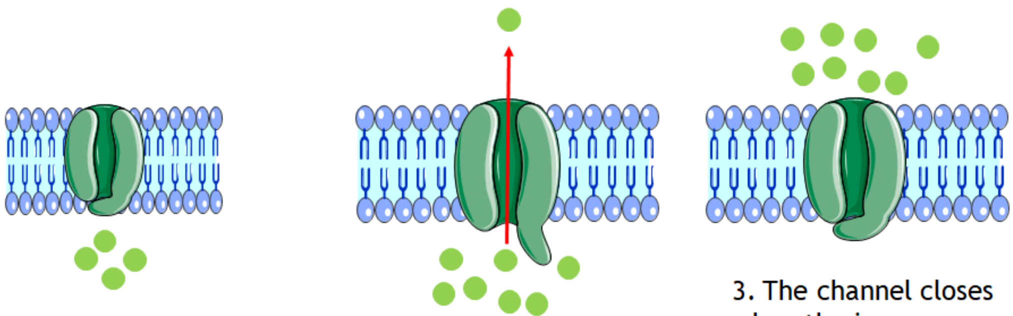


2. Voltage gated channels

Controlled by changes in **ion concentration** as this affects the **membrane potential**.
Ion moves In/out cell by diffusion.



2. Ions move across the membrane via the open channel



1.Changes in ion concentration causes a CC that opens channel.

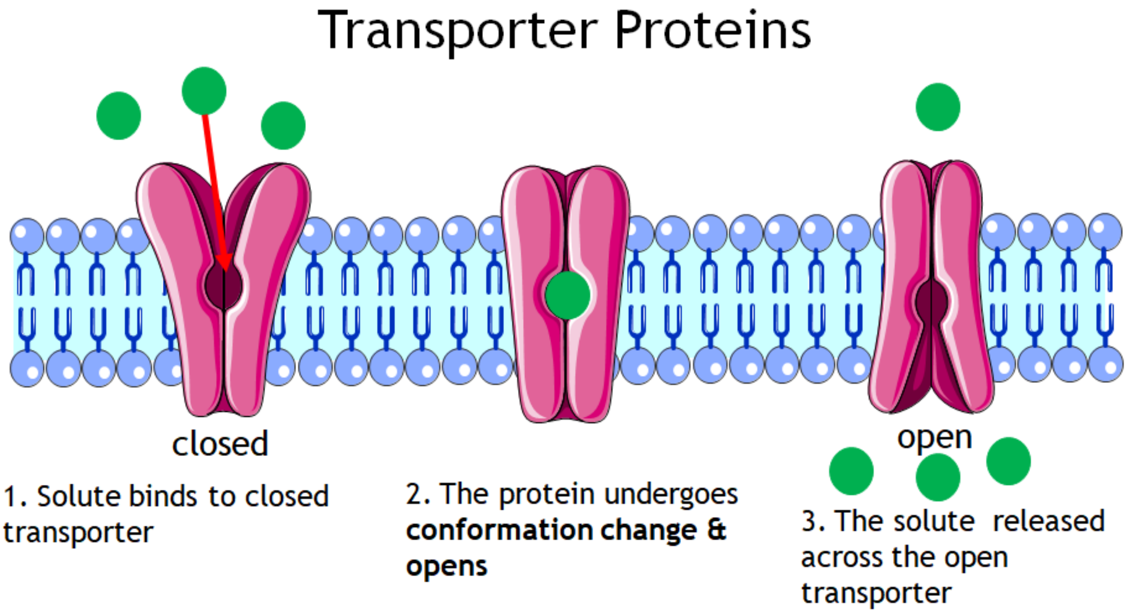
3. The channel closes when the ion concentration inside cell changes

1.3 Channel Proteins

Transporter proteins

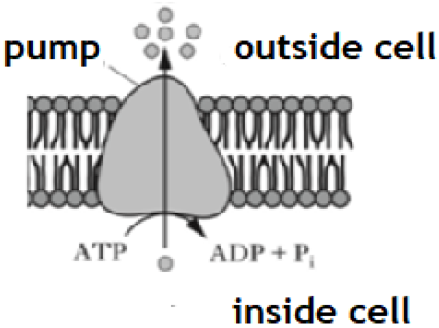
Operate between **two conformations** to move substances across the membrane.

1. A **specific** substance binds to the transporter protein
2. This results in a **conformational change** in the transporter protein
3. This releases the substance on the other side of the membrane



Pumps

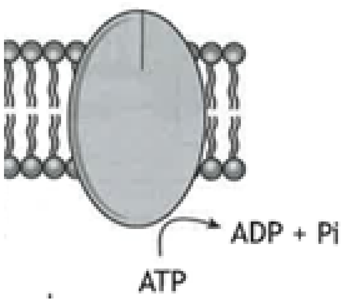
One type of transporter proteins that is coupled to an **energy source** to enable **active transport.**



ATPases

Protein pumps that **directly hydrolyse ATP** to provide the energy for the conformational change required to move substances by active transport.

Example Na K ATPase



1.3 Channel Proteins

Na/K ATPase

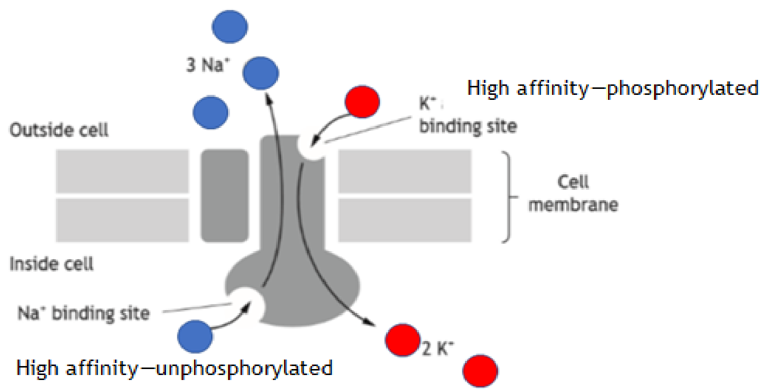
3 Sodium move **OUT** the cell by active transport when pump is **unphosphorylated**

2 Potassium move I**N** by active transport when pump is **phosphorylated.**

Energy Cost of Pump

The pump uses **energy directly** from ATP hydrolysis(ATPase) for active transport.

This accounts for a high proportion of the basal metabolic rate



Function

Na/K pump establishes both **concentration gradients** and an **electrical gradient** (membrane potential) within the cell.

Stages of Na K ATPase

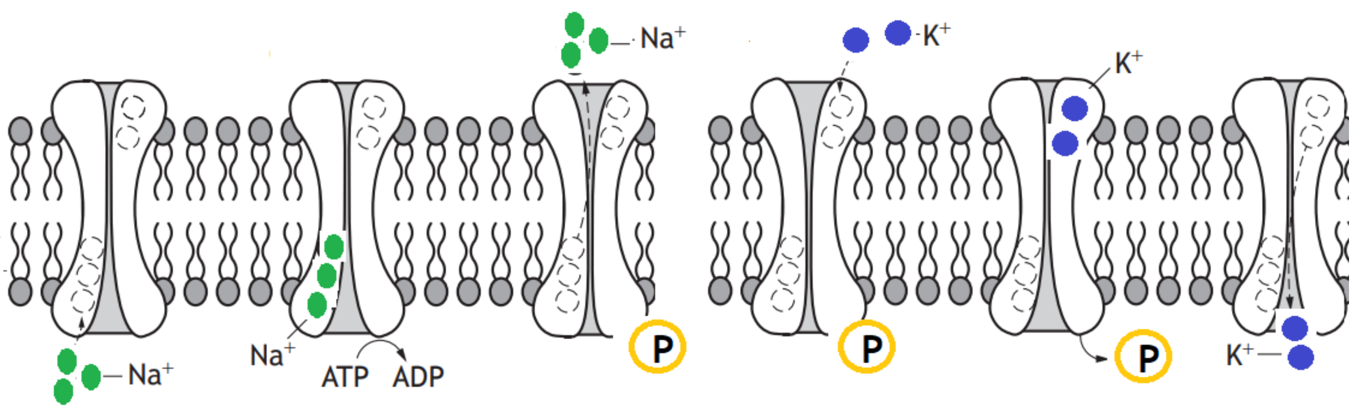
1. In the **unphosphorylated stage**, the pump has **high affinity** for **Na^+ ions** and 3 Na^+ ions bind to the pump inside cell.

2. **Phosphorylation by ATP** causes a **conformation change** of the pump which lowers the affinity for Na^+ releasing **3Na^+** ions outside of the cell

3. **2 K^+ ions** bind outside the cell in the **phosphorylated state** as they have high affinity for the pump in the phosphorylated state.

4. **Dephosphorylation** causes a **further conformation change** which lowers the affinity of K^+ ions and 2 K^+ ions are released inside the cell

5. The pump returns to its original conformation.



unphosphorylated unphosphorylated phosphorylated phosphorylated unphosphorylated unphosphorylated

1.3 Transporters: Glucose Symport

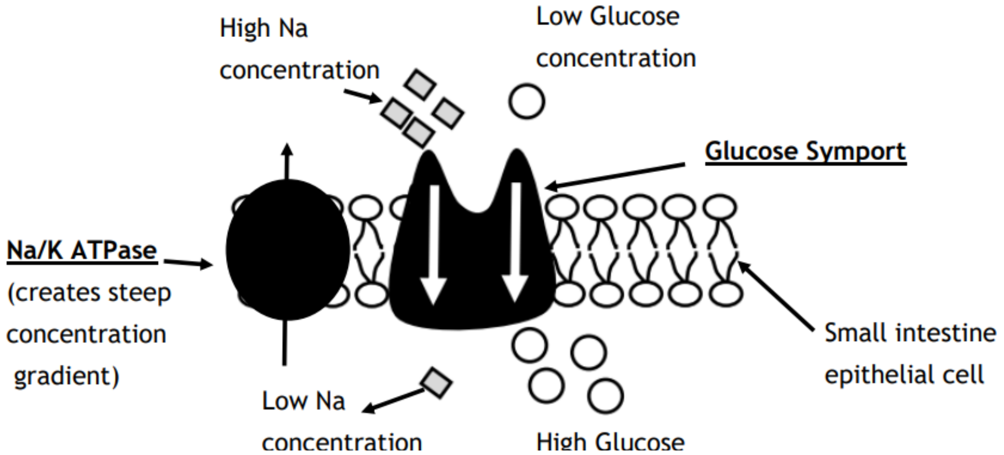
Location—small intestinal epithelial cells

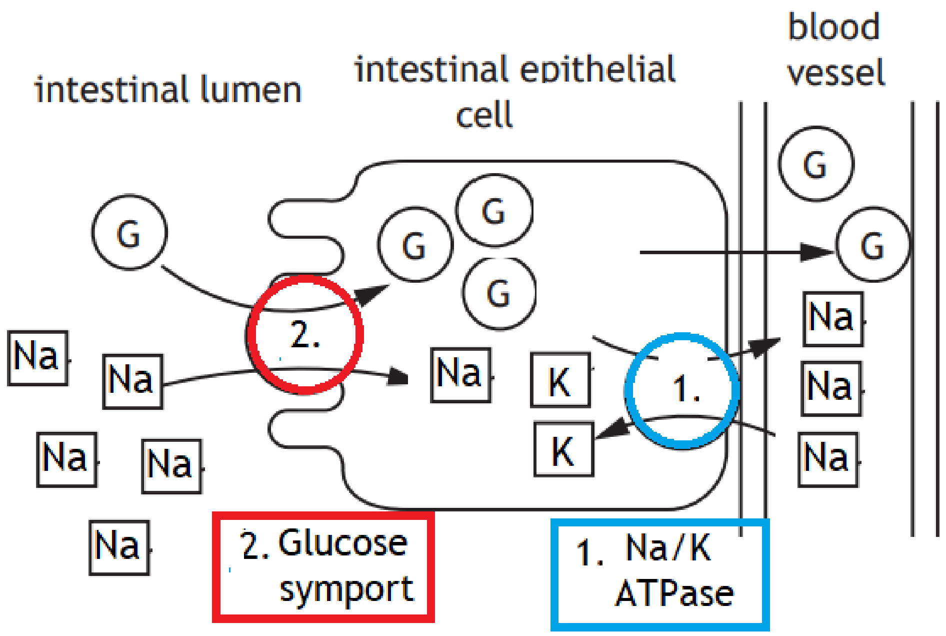
Glucose & Na$^+$ ions are transported **INTO** the cell at the same time via the glucose transporter.

1. Na$^+$ ions move in by **diffusion**

2. Glucose moves in by **active transport.**

The NaK pump creates a **very steep concentration gradient of sodium** to enable rapid diffuse into cells by the glucose symport which enables glucose to be driven into cells against its concentration gradient at the same time in same direction





Steep extracellular Na concentration enables glucose to be driven into cells at same time

Creates steep extracellular concentration of Na

3 Na OUT for 2K in

1.3 Transmembrane proteins