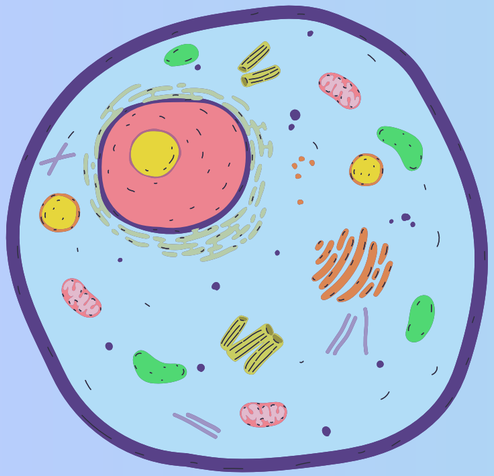
Basic Cell Physiology

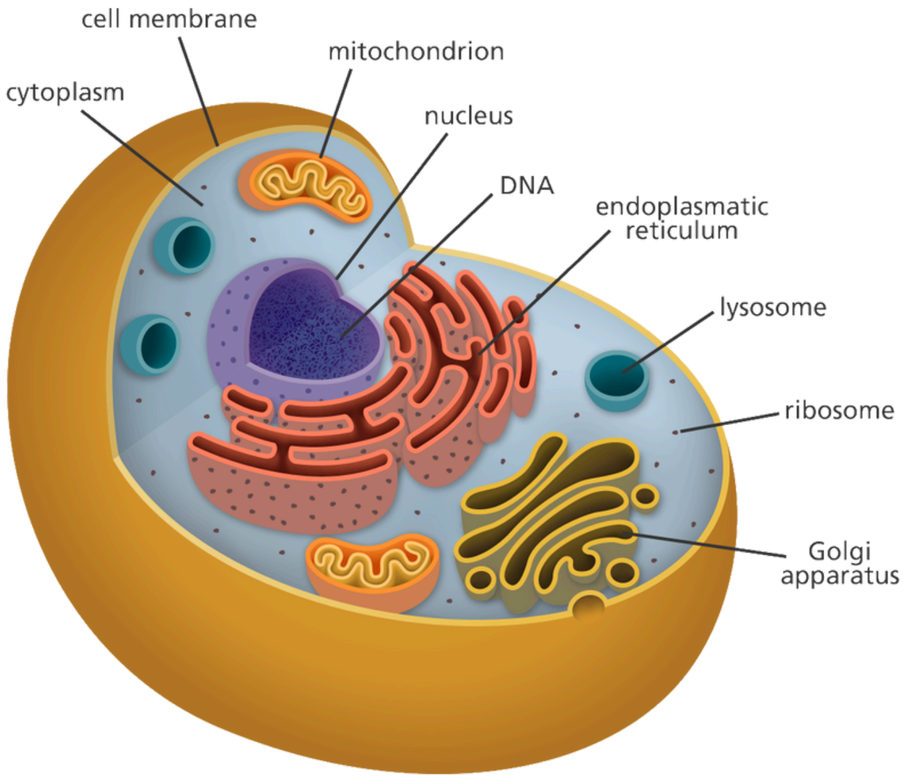
By Sarah Cullen

Basic Cell Physiology



- Structure
- Fluids
- Transport
  - Passive
  - Primary Active
  - Secondary Active

Cell Structure



Animal cells **do not** contain a cell wall!

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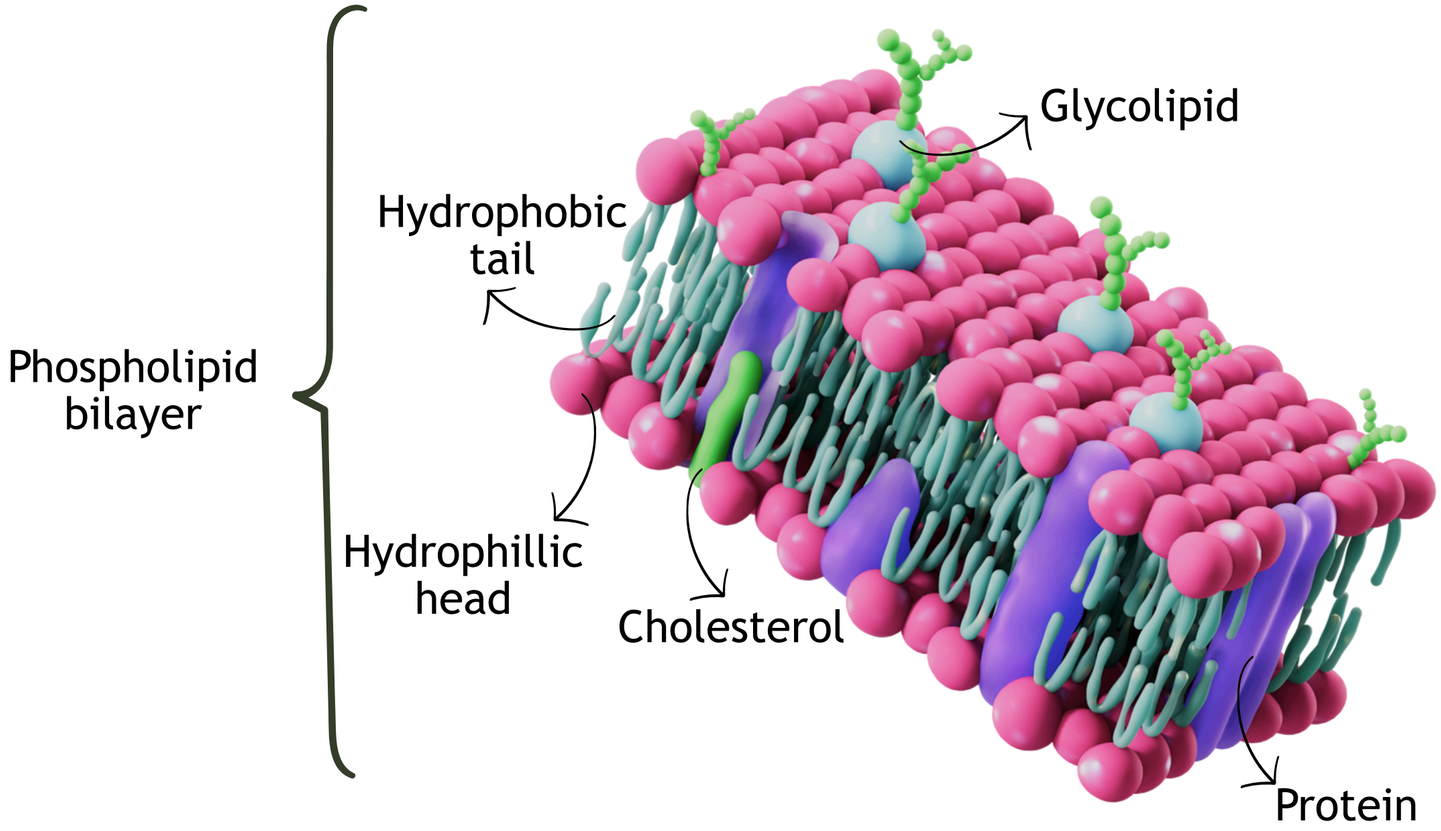
Cell Membrane

Membrane consist largely of a lipid bilayer, which is a double layer of phospholipid, cholesterol, and glycolipid and protein molecules



Functions:

1) Keep toxic substances out
2) Passage of ions, nutrients & metabolic products
3) Separate incompatible metabolic processes within organelles

Cell Membrane Proteins

Integral Proteins

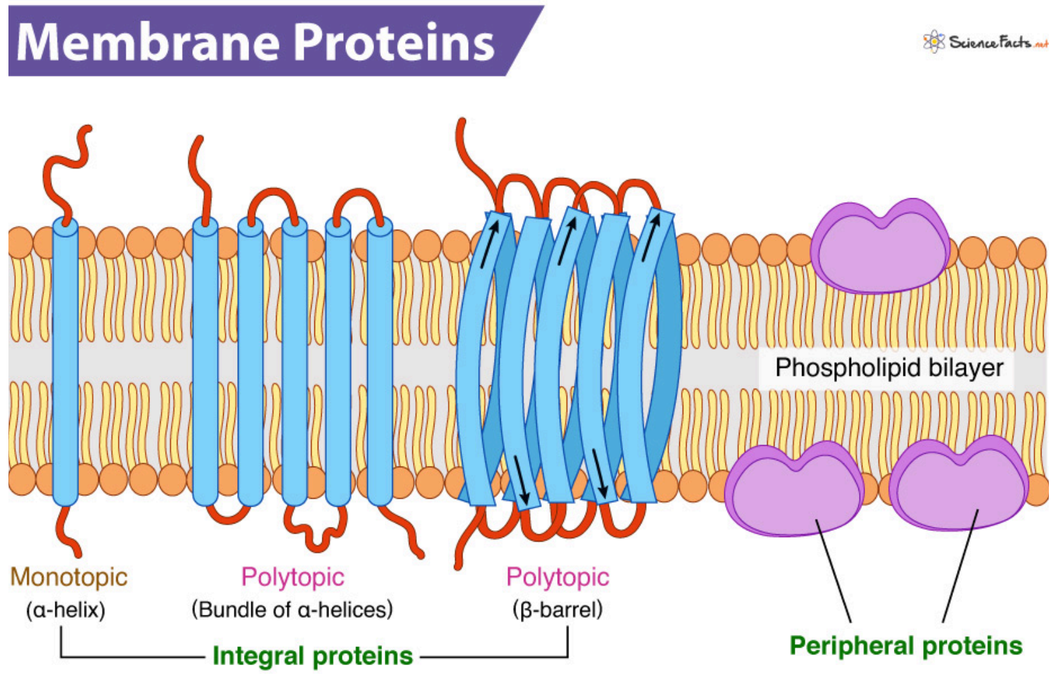
Facilitate passage of water and solutes

Firmly embedded in phospholipid bilayer

Extrinsic/Peripheral Proteins

Act as receptors and transporters of molecules

Temporarily attached to lipid bilayer or integral proteins through ionic bonds or calcium bridges



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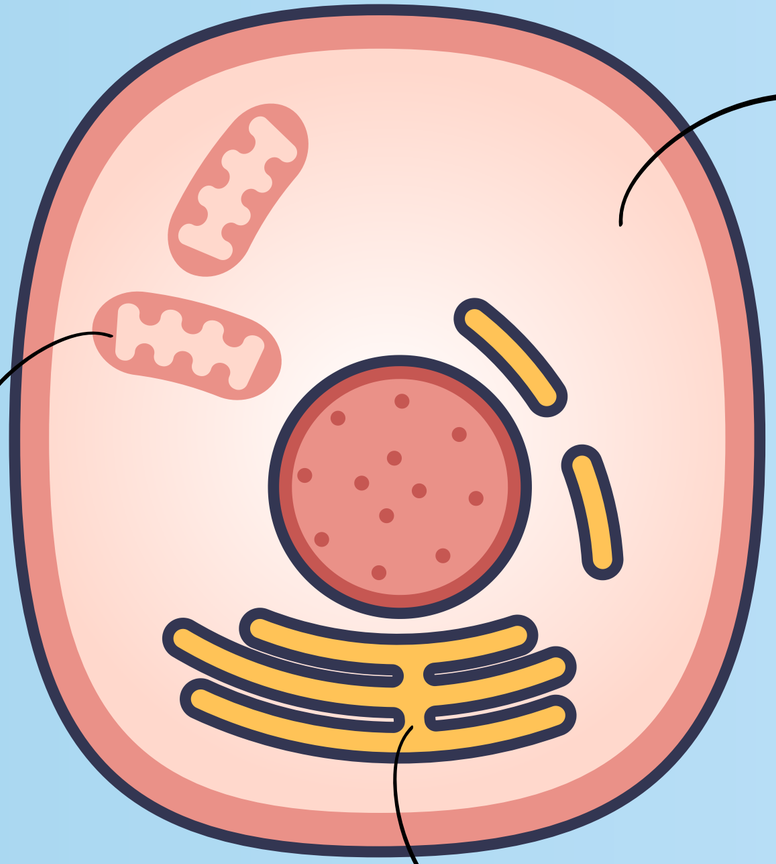
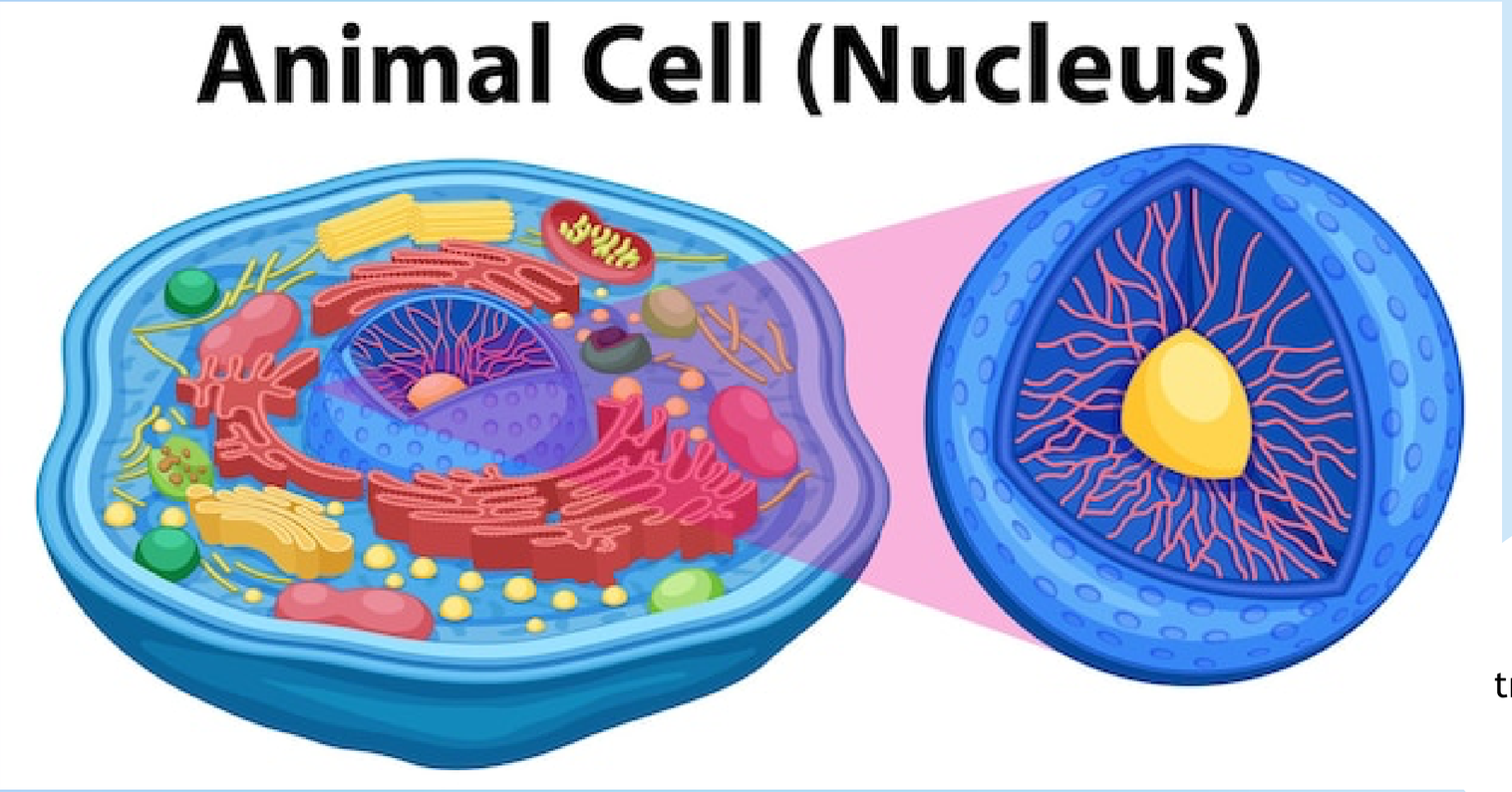
Cytoplasm



Cytoplasm

Gelatinous fluid that fills inside of the cell

Nucleus



Hosts DNA replication, transcriptaion and RNA processing!

Contains almost all of the cells DNA
Contains information of the genome and acts as the cells control centre

Basic Cell Physiology

- ~~Structure~~
- Fluids
- Transport
  - Passive
  - Primary Active
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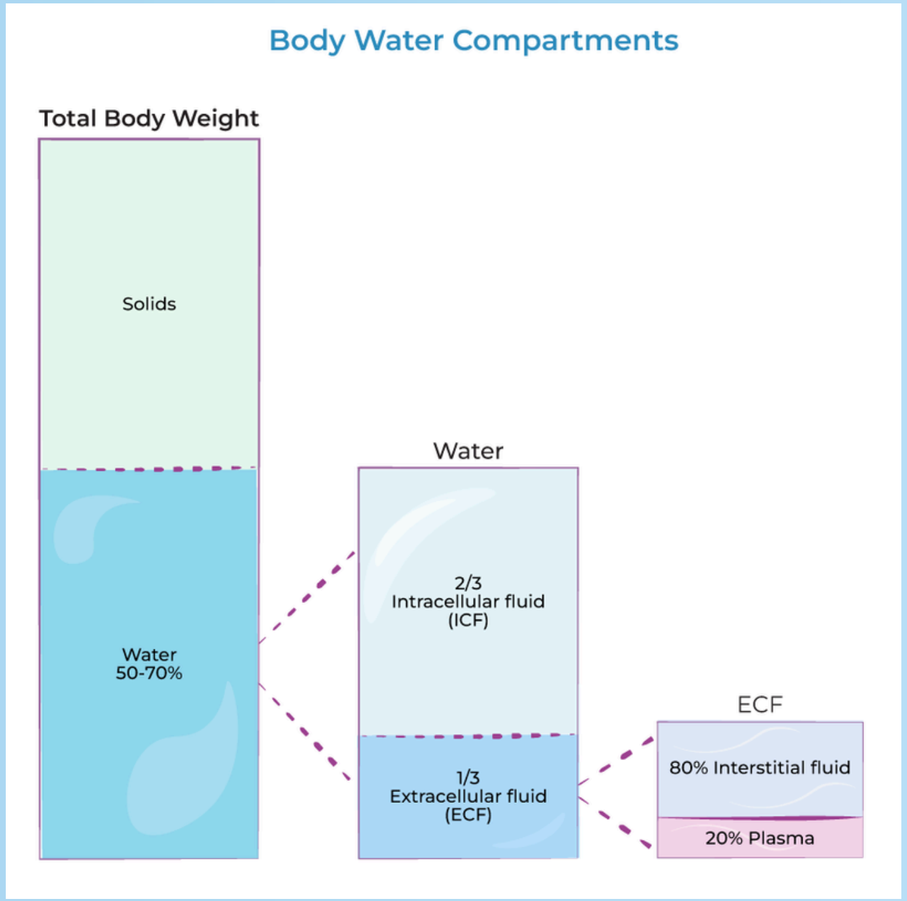
Fluid Composition

Total Body **Weight** is Solids + Fluids



Total Body **Water** is **<u>ONLY</u>** Fluids

Water equates to approx. 60% of Total Body Weight

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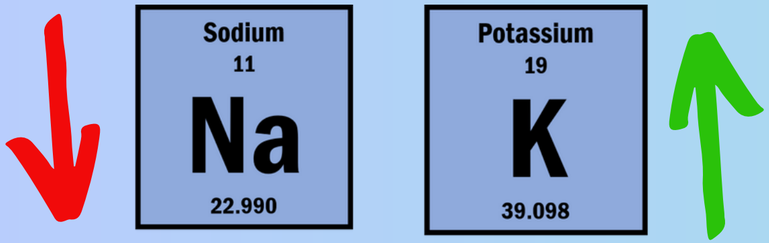
Intracellular Fluid

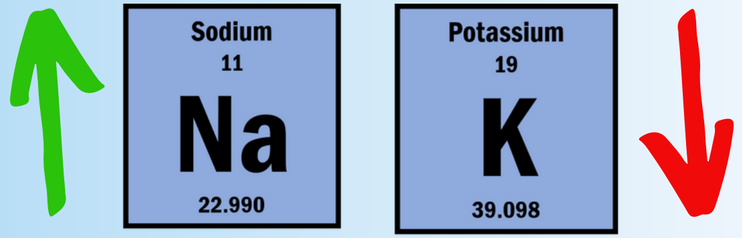
Found **inside** the cell
Comprises the **cytosol**
Concentration of Na+ is **low**, K+ is **high**
Comprises approx **2/3** of body water

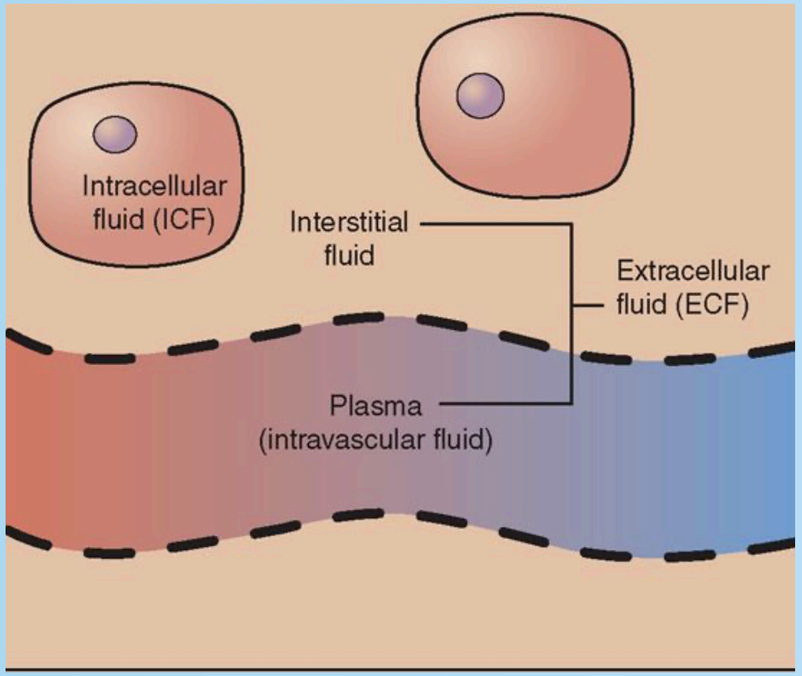
VS

Extracellular Fluid

Found **outside** the cell
Comprises the **plasma**, **tissue fluid** and **transcellular fluid**
Concentration of Na+ is **high**, K+ is **low**
Comprises **1/3** of body water







Potassium is the ion present in the highest concentratin inside most cells

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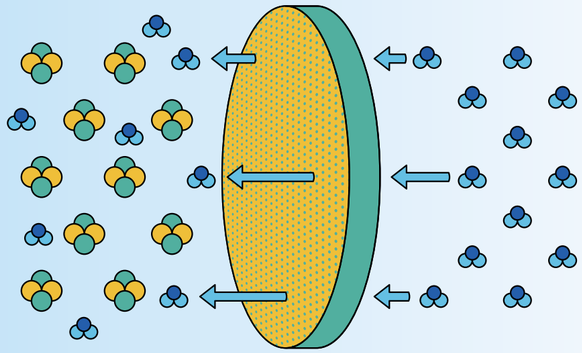

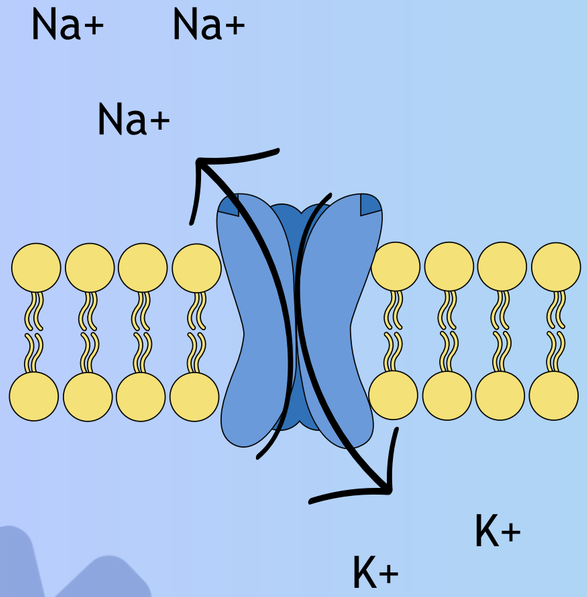

- ~~Structure~~
- ~~Fluids~~
- Transport
  - Passive
  - Primary Active
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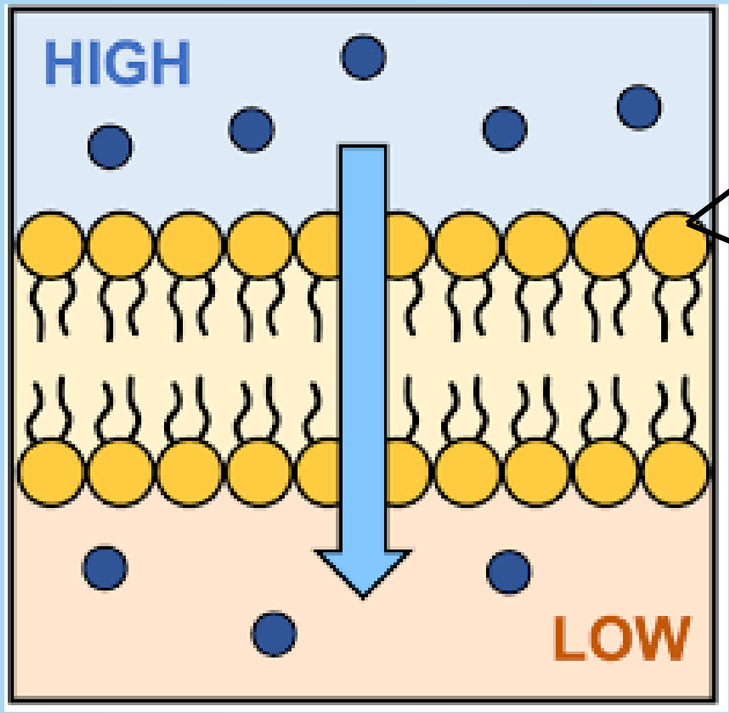
Passive Transport

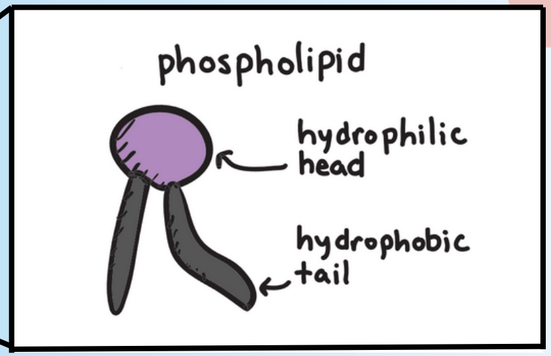
Simple Diffusion

Does not require energy
Allows small and non-charged molecules to enter the cell

Molecules:

Oxygen
Carbon Dioxide
Steroid Horomes
Lipid soluble drugs





Polar hydrophilic head prevents polar (charged) cells entering the cell

Fatty acid tails are non-polar and allow non-polar molecules to pass through

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Rate of Diffusion

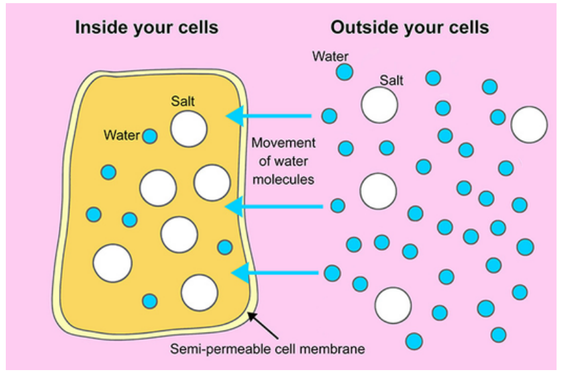
Surface Area ↑
Concentration Gradient ↑
Thickness of Membrane ↓
Weight ↓

$$\frac{\text{S.A. x C.G.}}{\text{T.M. x W}} = \text{Rate of Diffusion}$$

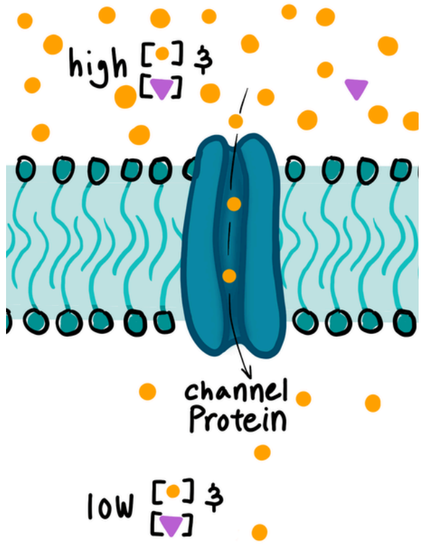
Passive Transport

Facilitated Diffusion

Does not require energy
Allows charged and large molecules can enter through this
Needs a carrier or channel

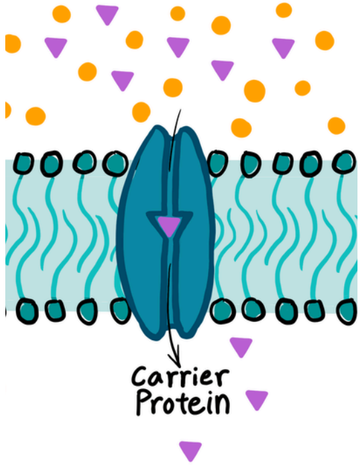


Osmosis
Movement of water from areas of high concentration to low concentration through aquaporin



Channel Mediated

1. Leaky channel
2. Voltage Gated
3. Ligand Gated Channel
4. Mechanically Gated



Carrier Mediated
GLUT transporters

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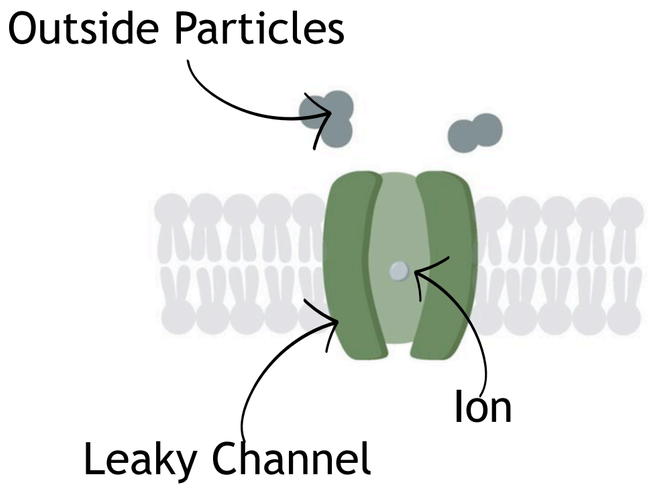
Leaky Channels

Non-gated and remain continuously open
Can be K+, Na+ or Cl-
Resting membrane potentials depend on leaky channels

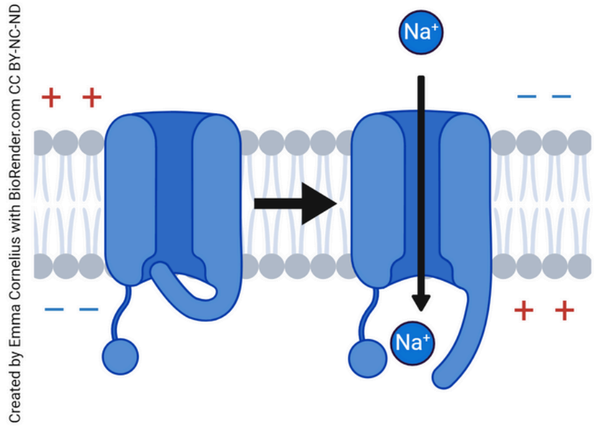
Flows from high ion concentratin to low ion concentration



Voltage-Gated Channels

Transmembrane channel proteins that respond to changes in voltage of the membrane
Can be K+, Na+, Ca++, and Cl-

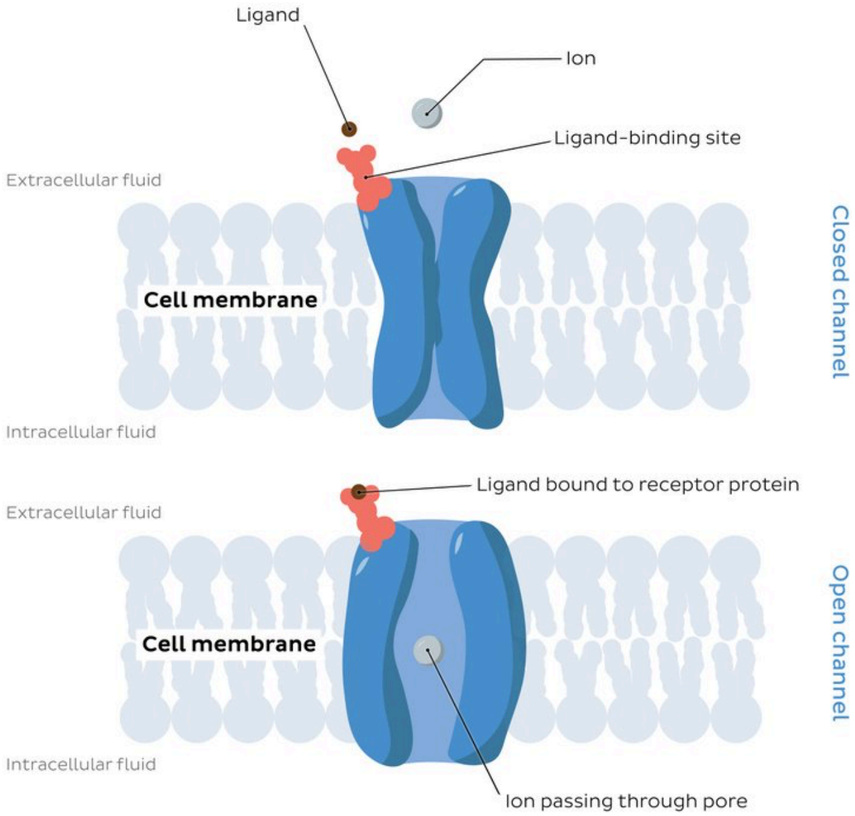
Must reach voltage threshold to open - all or none phenomenom



Upon depolarization, the channels are activated and open - action potential

Ligand-Gated Channels

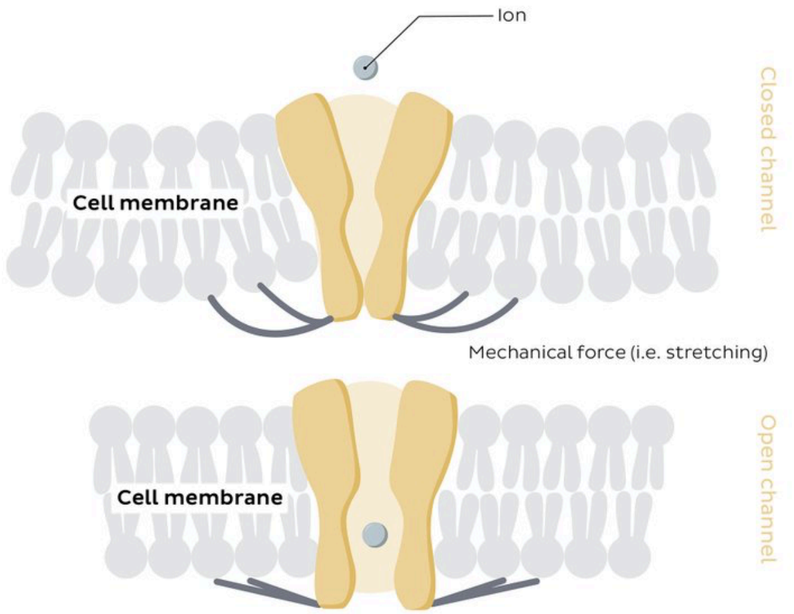
Integral proteins that activate upon binding to specific signaling molecules known as ligands
Can be Glutamate, GABA and Acetylcholine



Mechanically-Gated Channels

Respond to gravity, vibration, pressure and sound waves

Predominantly found in sensory organs e.g.cochlear and vesitbular hair cells



Mechanical force e.g. streching can cause opening

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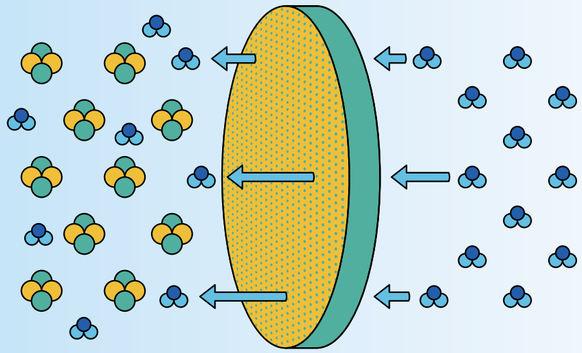

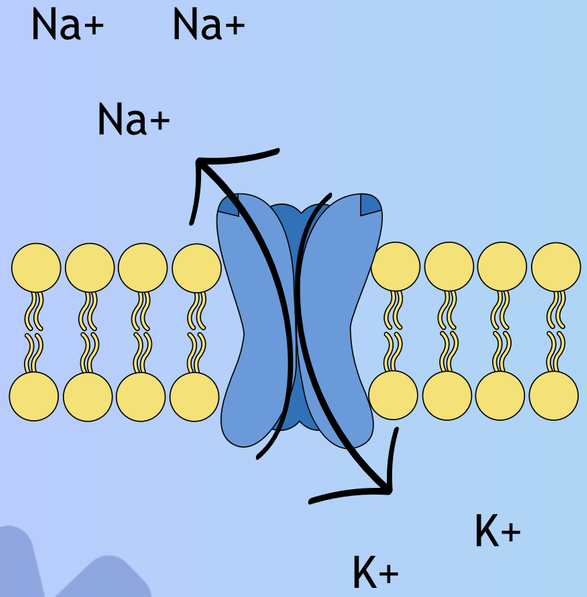

- ~~Structure~~
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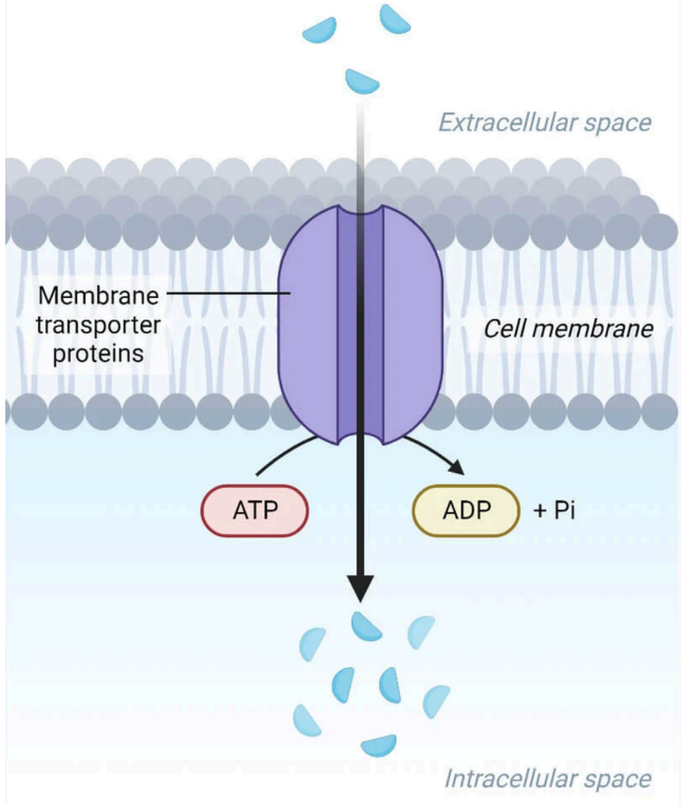
Primary Active Transport

Molecules move from areas of low concentration to areas of high concentration against the concentration gradient
Requires direct energy - ATPase generates ADP

1. Na+/K+ Pump
2. Ca++ Pump
3. Proton Pump



Proton Pump Inhibitors prevent acid formation and are used in the treatment of **ulcers** and **GERD**

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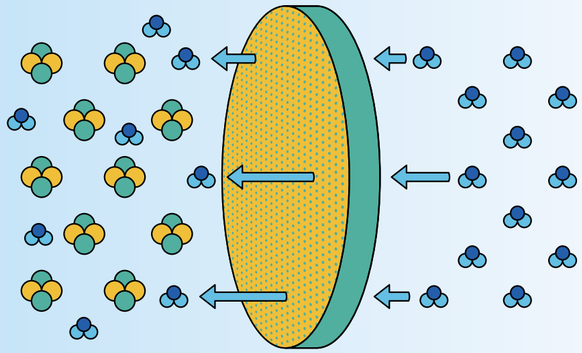

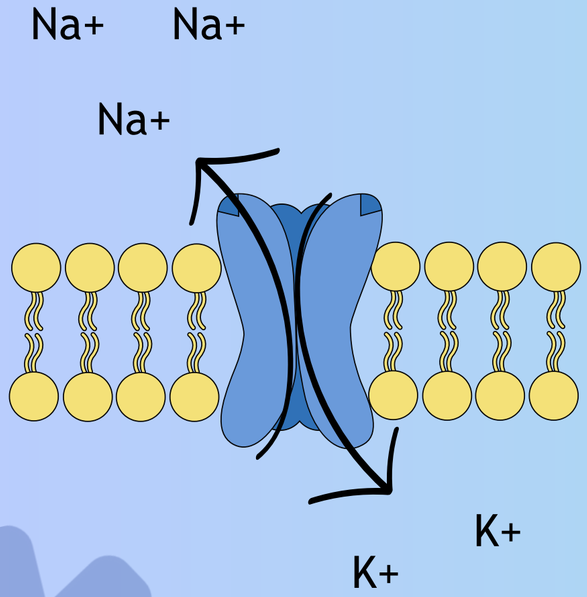

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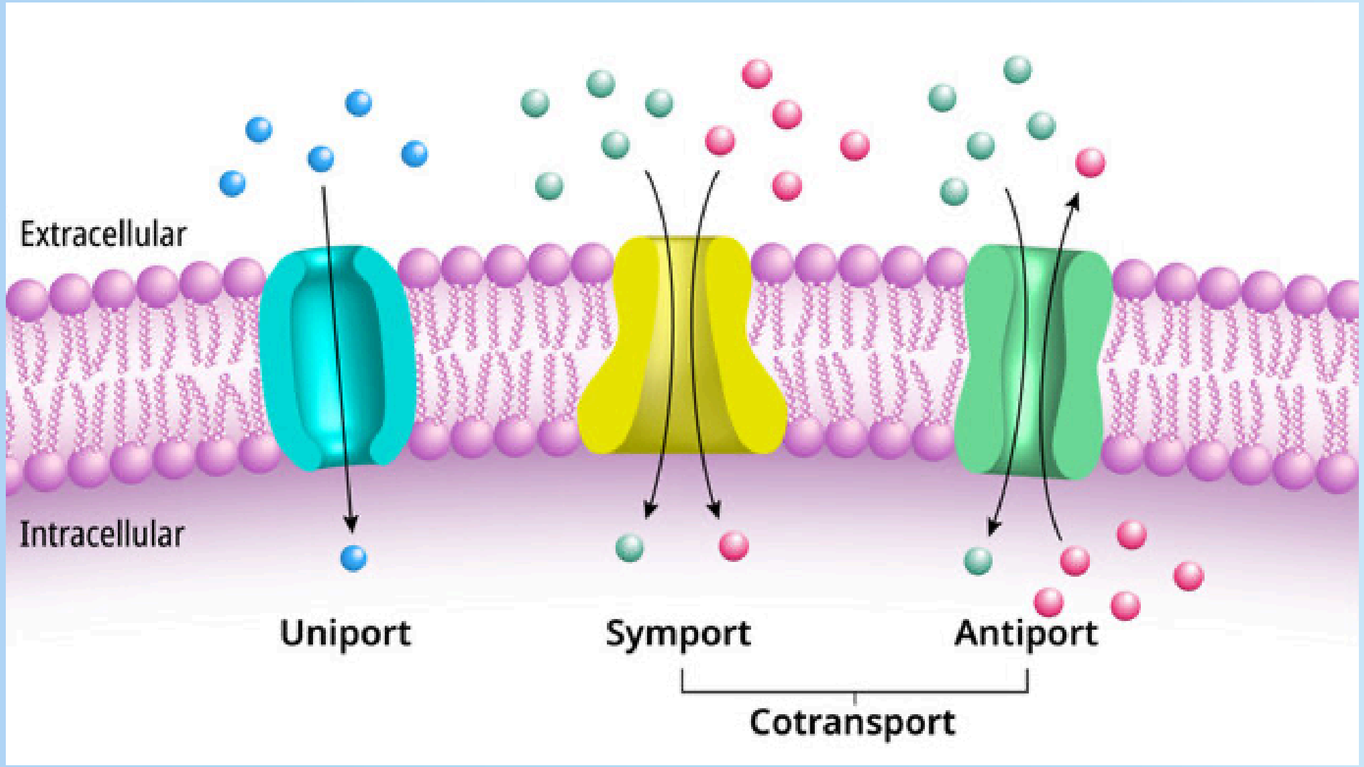
Secondary Active transport

Indirect use of ATP
Increased concentration of Na+ after primary active transport allows Na+ to travel back into the cell from the concentration gradient created

Symport
both molcules move in the same direction

Examples:
Na+/glucose co-transporter
Na+/K+/Cl- co-transporter



Antiport
molecules move in opposite directions

Examples:
Na+/H+ Pump
Na+/Ca+ exchanger

Clinical Correlation
SGLT-2 Inhibitors

Clinical Correlation:
Counteracting alkalosis

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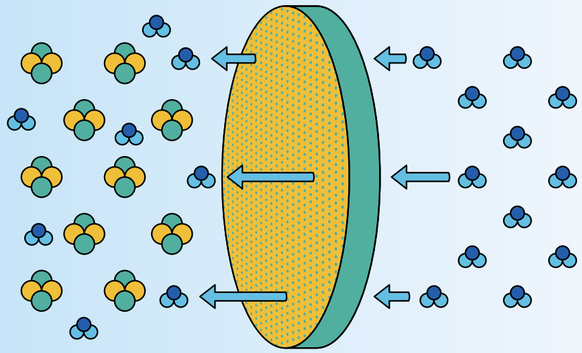

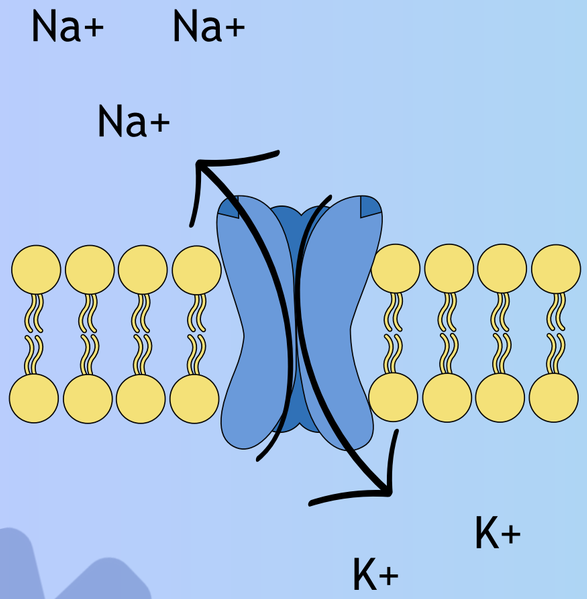

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