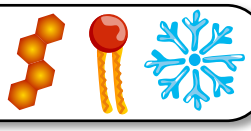
B2.1

Membrane Fluidity (HL)

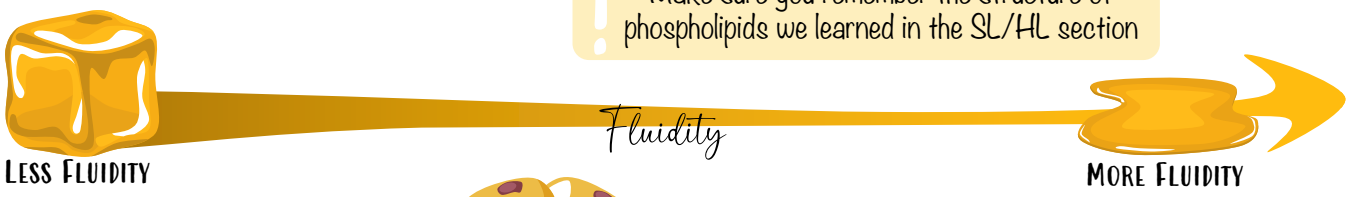
MEMBRANE FLUIDITY – The ability of the cell membrane to move and freely change shape. It is influenced by factors such as cholesterol, phospholipids and temperature.



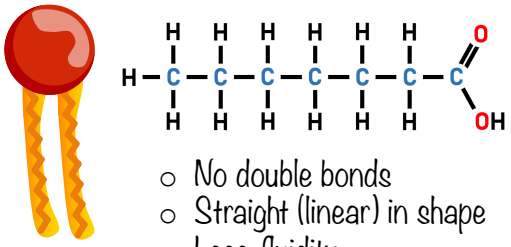
1. EFFECT OF PHOSPHOLIPIDS

NOTE!

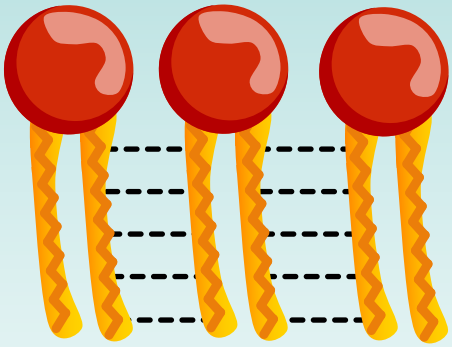
Make sure you remember the structure of phospholipids we learned in the SL/HL section



Saturated fatty acid



- No double bonds
- Straight (linear) in shape
- Less fluidity

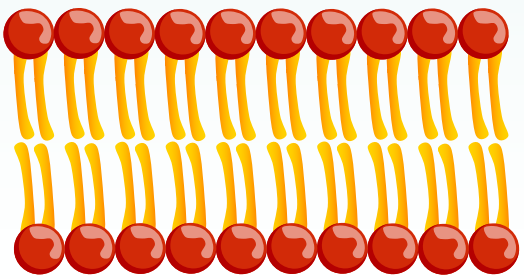


Bonding occurs between adjacent fatty acid tails, as they are **SATURATED** and **STRAIGHT** in shape, **MORE** (than in unsaturated) interactions can occur

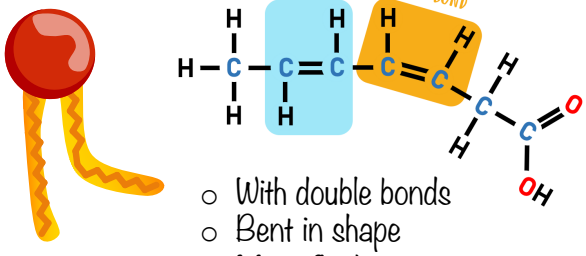
The bonding is weak and transient which still allows some movement

GOOD FOR **HIGH** TEMPERATURE

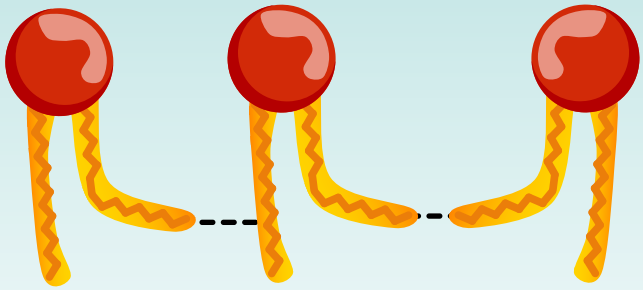
(Ensure that high temperature does not make it too fluid)



Unsaturated fatty acid



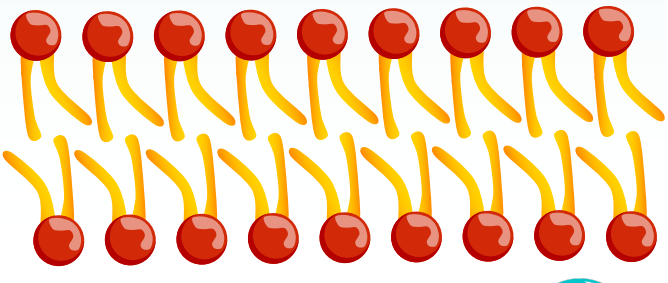
- With double bonds
- Bent in shape
- More fluidity



Bonding occurs between adjacent fatty acid tails, as they are **UNSATURATED** and **BENT** in shape, **LESS** (than in saturated) interactions can occur

GOOD FOR LOW TEMPERATURE

(Ensure that low temperatures doesn't cause too much rigidity)

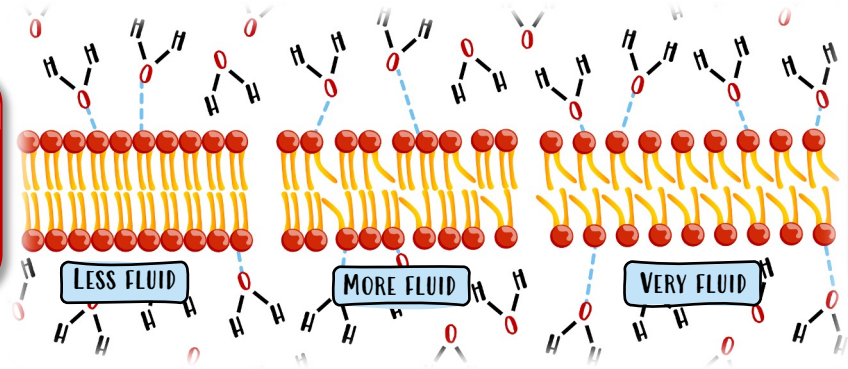


Membrane Fluidity (HL)

A cell wants to maintain **CONSTANT** membrane fluidity. Hence at different temperatures, the level of saturation changes;

At HIGH temperatures

Heat breaks the bonds between the phospholipids, therefore the cell will increase their saturation to prevent the membrane from being too fluid.



At LOW temperatures

Low temperatures reduce phospholipid movement, therefore the cell will decrease the phospholipid's saturation to prevent the membrane from being overly stiff.

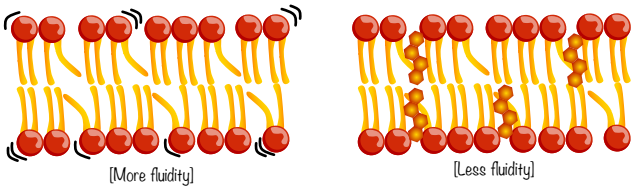
Polar heads of phospholipids are capable of **HYDROGEN BONDING** with water. This bonding is relatively weak and so the phospholipids can still move around freely. This allows **FLUIDITY**.

II. Effect of Cholesterol

CHOLESTEROL has a dual role in **REGULATING** membrane fluidity: It can stabilize the membrane at high temperatures and enhance fluidity at low temperatures.

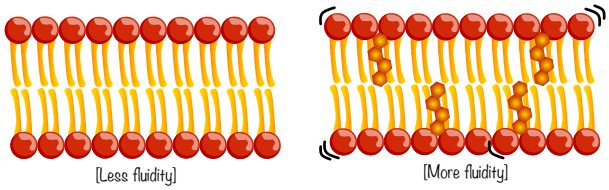
At HIGH temperatures

The heat causes a lot of phospholipid movement, so the insertion of cholesterol helps to reduce movement by serving as an **OBSTRUCTION** and thereby enhancing the stability (lower fluidity) of the membrane.

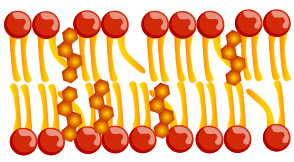


At LOW temperatures

The cold causes very little phospholipid movement, so the insertion of cholesterol helps to increase movement, and thereby membrane fluidity, by preventing bonding between adjacent phospholipids.

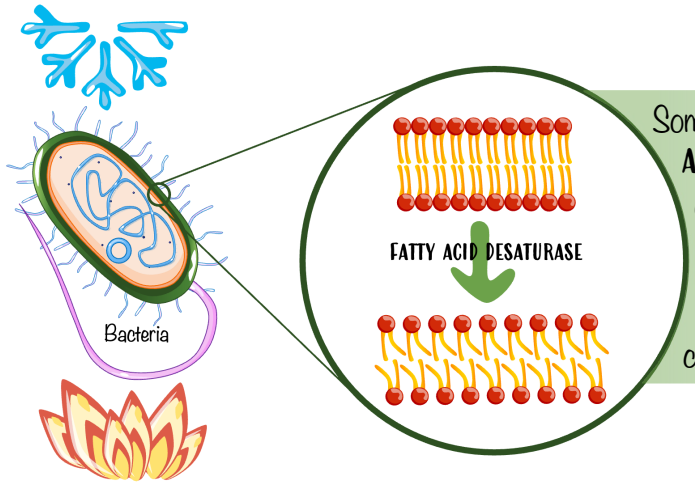


Internal **ORGANELLES** (such as the Mitochondria and Golgi apparatus) will have less cholesterol in their membrane compared to the cell membrane. This is because the internal organelles are not subject to extremes in temperatures like the cell membrane is. Therefor not required to be able to adapt as much.


Cell Membrane


Organelle Membrane

Membrane Fluidity (HL)

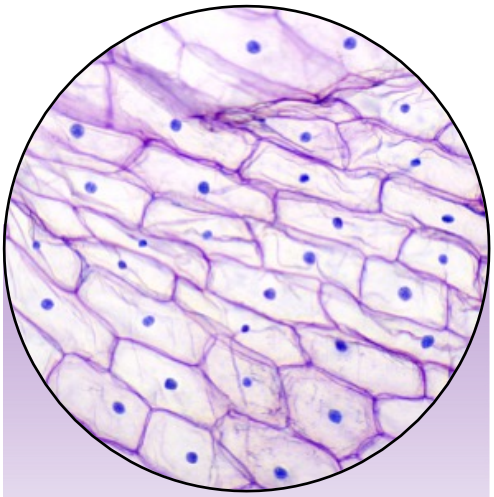


Some bacteria have an enzyme called **FATTY ACID DESATURASE** which allows them to desaturate on command the fatty acids of their cell membrane in response to temperature changes. Unfortunately human cells cannot do this.

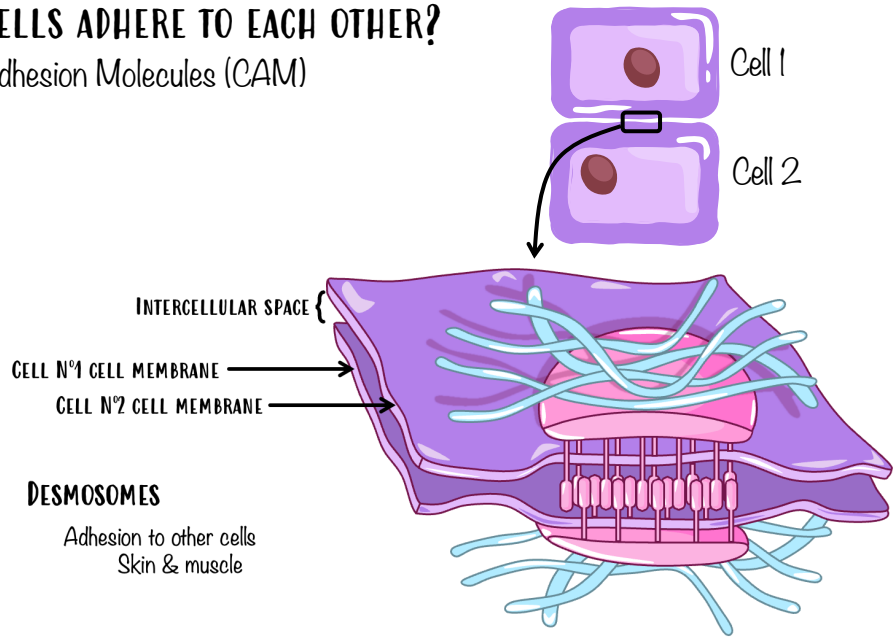
Membrane Adhesion (HL)

How DO CELLS ADHERE TO EACH OTHER?

Cell Adhesion Molecules (CAM)

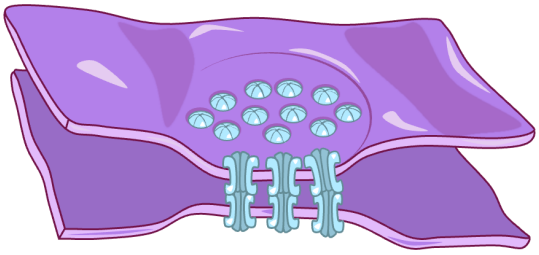


This figure shows a light microscopy image of onion skin cells. Notice how tightly packed the cells are (the dark purple circles are the nuclei and the lighter purple show the cell membranes).



DESMOSOMES

Adhesion to other cells
Skin & muscle



OTHER CONNECTIONS (CHANNELS BETWEEN CELLS)

Plasmodesmata (Plants)

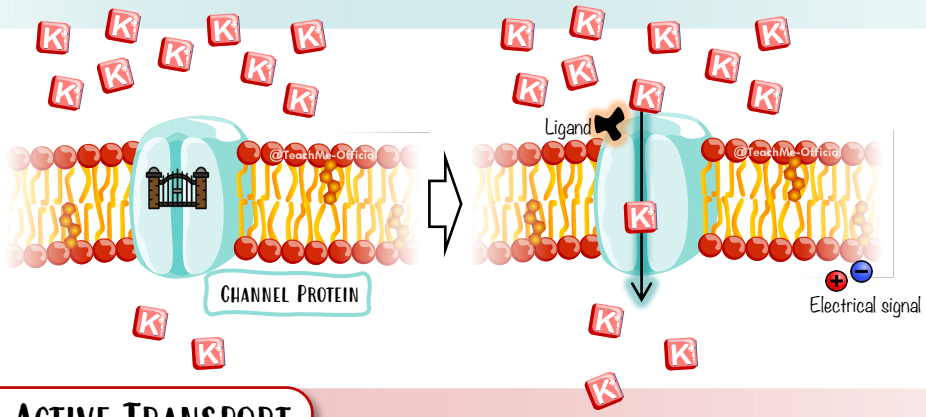
B2.1

Membrane Transport (HL)

Remember most types of transport were discussed in B2.1 SL/HL – only additional information for HL are included here

B. Facilitated Diffusion

- Channel proteins can be gated (open or closed) and respond to **CHEMICAL** or **ELECTRICAL** signals.
  - **Chemical signals** include a molecule (for example a protein or lipid) binding to the channel protein which triggers it to open – allowing molecules to be transported through (for example potassium K^+)
  - **Electrical signals** (a + or – change) can trigger the protein channel to open – allowing molecules to be transported through (for example potassium K^+)

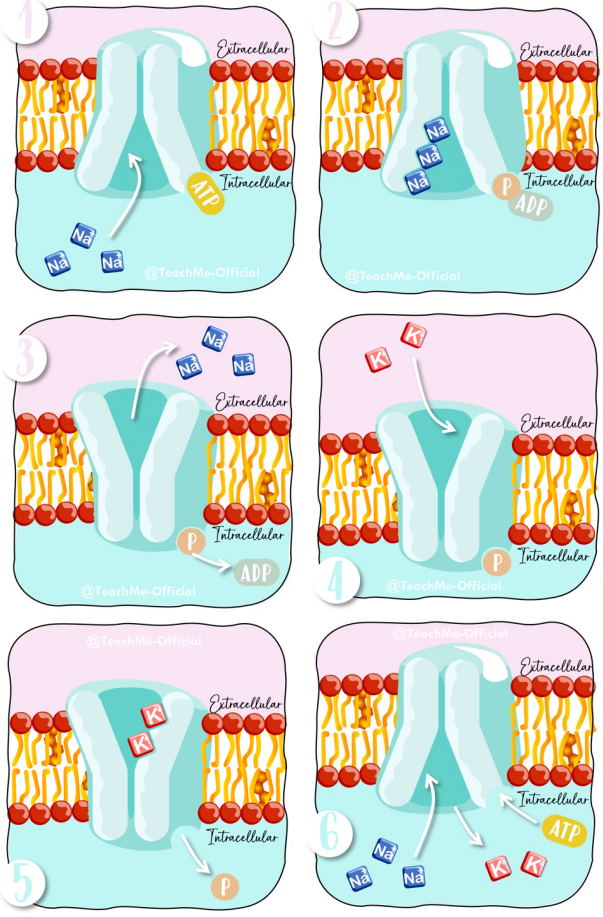


NOTE!
Chemically gated = Ligand gated (same meaning)

II. Active Transport

- The active movement of molecules from an area of **LOWER CONCENTRATION** to an area of **HIGHER CONCENTRATION** using energy (**ATP**)
- Includes (**A**) Direct and (**B**) Indirect active transport.

Sodium–Potassium Pump (Na^+/K^+ pump)

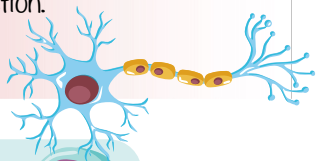


A. Direct Active Transport

An example: the **Sodium–Potassium Pump** (Na^+/K^+ pump)

- Purpose: Maintain membrane potential
  - Membrane potential is the electrical charge differential between the **INTERIOR** and **EXTERIOR** of the cell. There is a higher relative positive (+) charge on the outside compared to the inside (-).
- This is kind of carrier protein that is called an **ANTIPORTER** as it moves ions in the opposite (anti) direction.

Important for **NERVE CELLS** (see later)



BIG BRAIN TIP!
Na^+ = NAH = 3
K^+ = K (OKAY) = 2

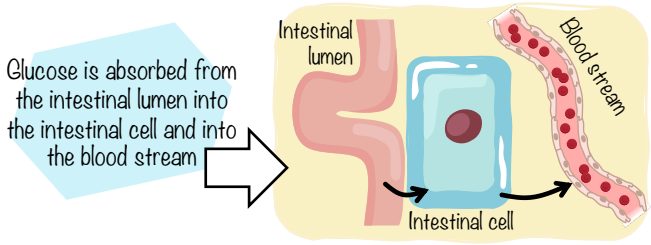
1. Once ATP (provide energy) molecule attaches, the pump will bind three intracellular sodium ions.
2. Sodium ion binding causes the pump (protein carrier) to split ATP into ADP and Pi (phosphorylation), providing usable energy.
3. Phosphorylation causes the protein to change its shape (reduce affinity/attraction for sodium), thereby expelling sodium ions into extracellular space.
4. The shape change also increases affinity for potassium ions, and hence two extracellular potassium ions bind to the protein (different site than sodium). Binding leads to phosphate release.
5. Phosphate loss restores the protein's original shape, causing release of potassium ions into the intracellular space. Now carrier is ready to repeat the cycle.

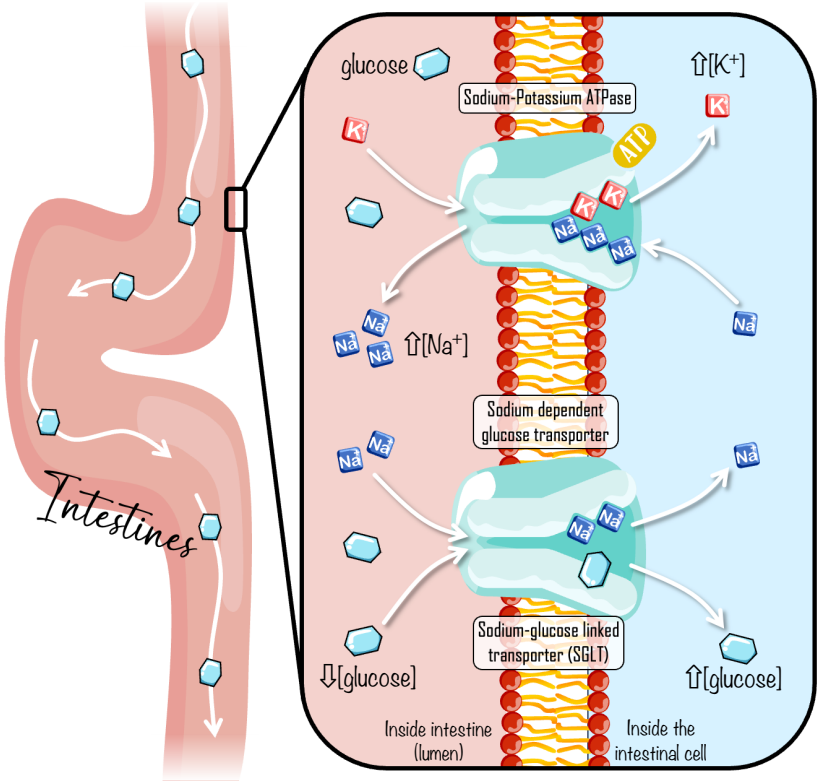
Membrane Transport (HL)

B. Indirect Active Transport

- Uses the energy produced by the movement of one molecule **DOWN** the concentration gradient to move another molecule **AGAINST** the concentration gradient. ATP is still used, but **INDIRECTLY**.

E.g., the transport of glucose from the intestinal lumen into the intestinal cells.





1. There are more sodium (Na^+) ions outside than inside the intestinal cell (due to the sodium-potassium ATPase)
2. Sodium ions and glucose bind to a specific transporter protein (SGLT) on the intestinal cell membrane
3. Sodium passes through the carrier into the inside of the cell down a concentration gradient – the carrier captures the energy relased by this movement
4. This captured energy is used to transport the glucose through the same protein into the cell against its concentration gradient.

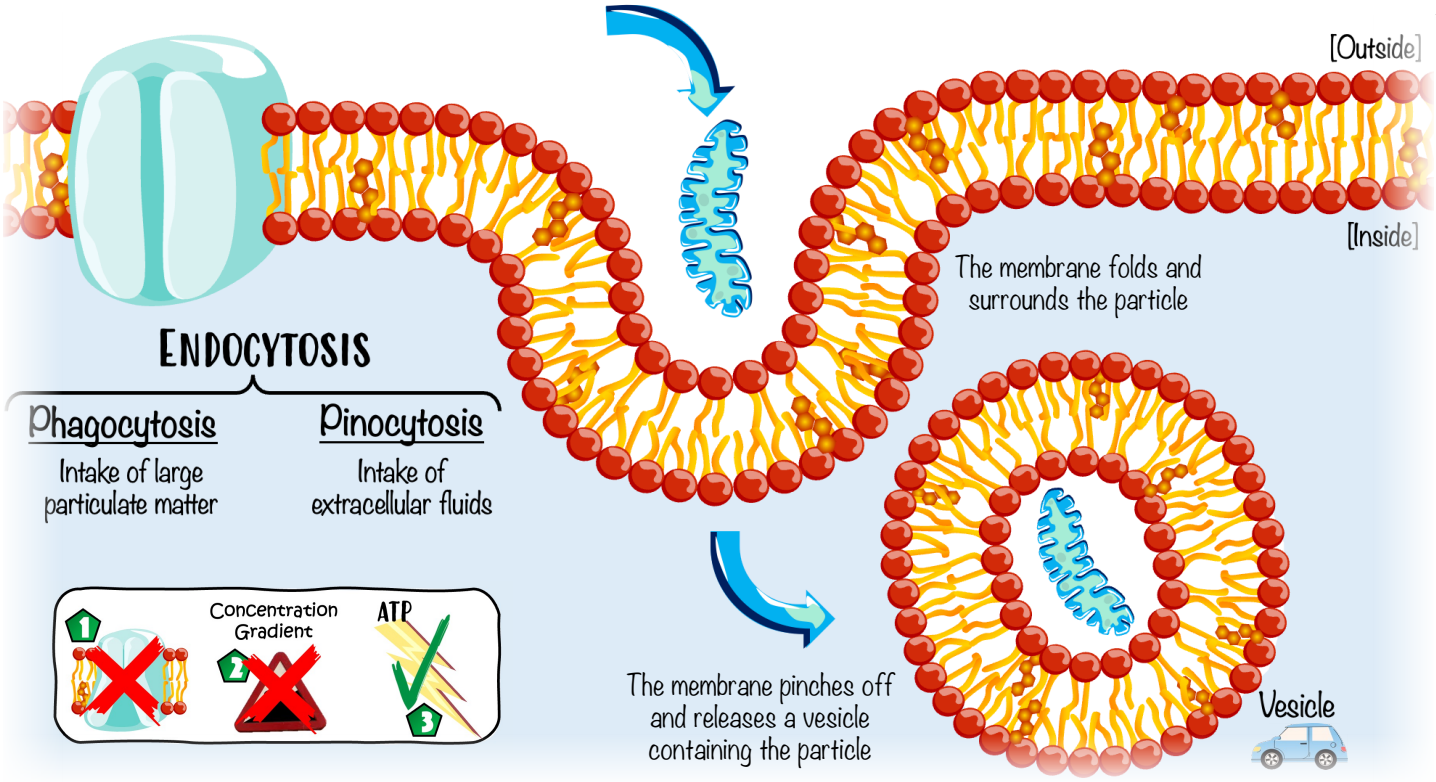
Big Brain Observation!

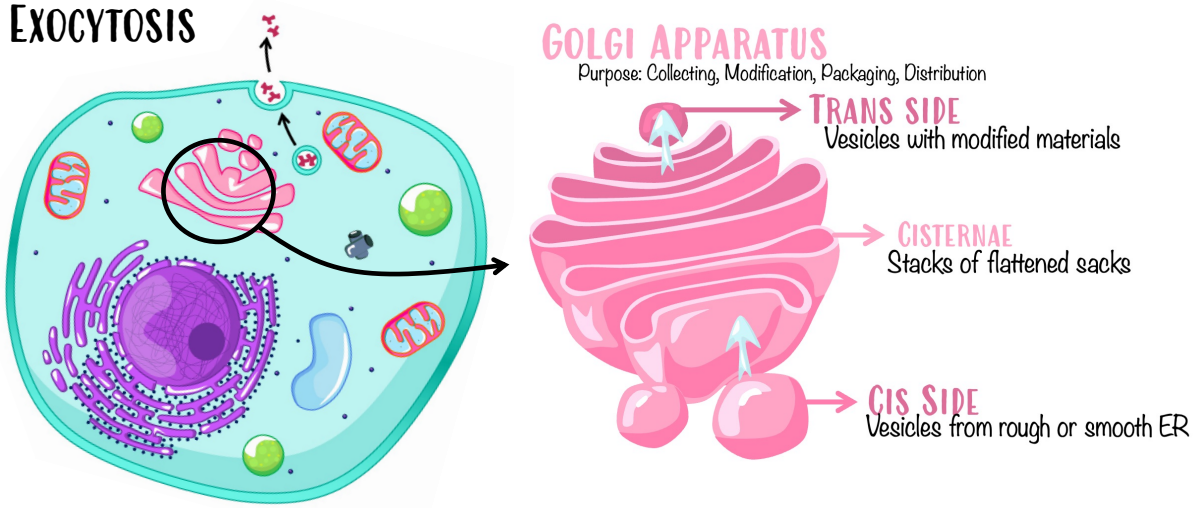
Notice how without the ATP used by the Na^+/K^+ pump, there wouldn't be a concentration gradient of Na^+ necessary to move glucose against its concentration gradient – thus why the "**INDIRECT**" use of ATP.

Membrane Transport (HL)

III. Bulk Uptake: Endocytosis & Exocytosis

- **Endocytosis** – Movement of large molecules (macromolecules) & large amount of material across plasma membrane (Inwards).
  E.g., a white blood cell taking in a bacteria to destroy it
- **Exocytosis** - Movement of large molecules (macromolecules) & large amount of material across plasma membrane (Outwards).
  E.g., the Golgi Apparatus (see below)
- Both endocytosis and exocytosis are dependent on membrane fluidity. These processes may or may not use ATP (energy).



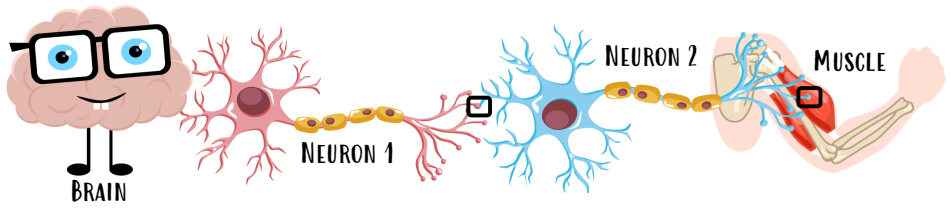


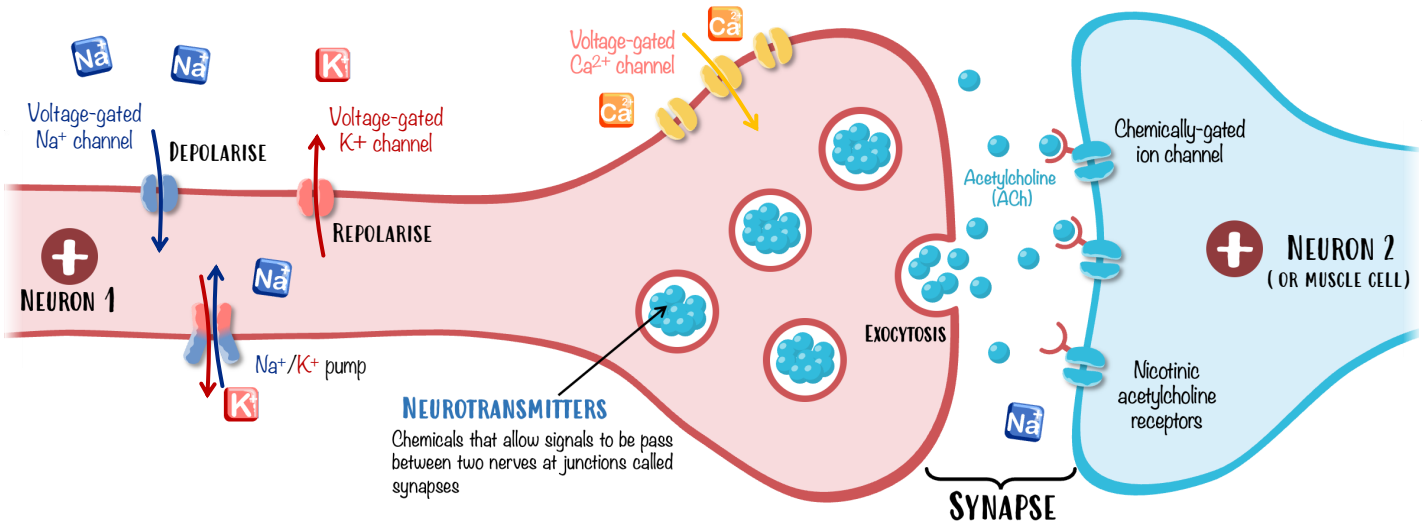
1. Protein produced by the ribosomes of the rough ER enters the lumen (inner space) of the ER. The protein is packed into a vesicle.
2. The vesicle carrying the protein fuses with the **CIS SIDE** of the Golgi apparatus.
3. As the protein moves through the Golgi apparatus, it is modified and exits on the **TRANS FACE** inside another vesicle.
4. The vesicle with the modified protein inside moves towards and fuses with the plasma membrane, resulting in the secretion of the contents from the cell by exocytosis.

Membrane Transport (HL)

Summary

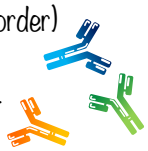
A great example to show many types of transport working together is seen in **NEURONS!**





Disease: **MYASTHENIA GRAVIS** (an Autoimmune Disorder)

Antibodies bind to nicotinic acetylcholine receptors.
Reducing response to the acetylcholine (neurotransmitter).
Muscle movement problems occur.



notes