2-Transport mechanisms (requiring energy from cells)

The cell needs to transport molecules against their concentration gradient and that needs energy which provide by ATP hydrolysis and that's form what is called **ion pumps** which are responsible for maintaining gradients of ions. This type is also termed primary type of active transport.

a- Active transport is the movement of substances like ions against its concentration gradient (from low to high concentration) by carrier proteins.

1-Primary active transport

Certain ions like potassium are pumped into cells while sodium ions are pumped out of cells by primary active transport ,so potassium is found at higher concentration inside of cells than outside while sodium is found at higher concentrations of the cells than inside because of primary active transport.

The tendency of these ions will be move down their concentration gradients and can be used to power the transport of other solutes against their own concentration gradient.

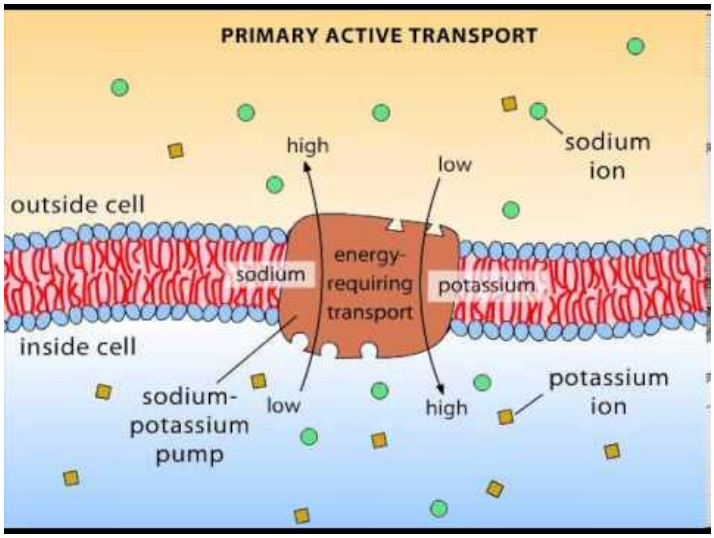
Types of primary active transport

Sodium –potassium ATPase, present in plasma membranes of all animal cells .It functions to maintain extracellular and intracellular potassium concentrations. Three ions of sodium are pumped out of the cell and potassium ions are pumped in for each ATP hydrolyzed by the Sodium –potassium ATPase, resulting in a net transfer of positive charge outside the membrane

Calcium ATPase, pump calcium out of the cytosol into the extracellular environment or intracellular storage locations, so the calcium ATPase maintaining the concentration of free calcium ions in cytosol at a low level.

Hydrogen-ATPase

Move H^+ ions out of cells, so the extracellular fluids contains large quantities of Na+ and Cl^- but only small quantities of K^+ and Cl intracellular. Phosphates and proteins are greater in quantities intracellular than in extracellular.



2-Secondary active transport

Is the process by which ion gradients generated by ATP powered pumps are used to power transport of other molecules and ions against their own concentrations gradients .

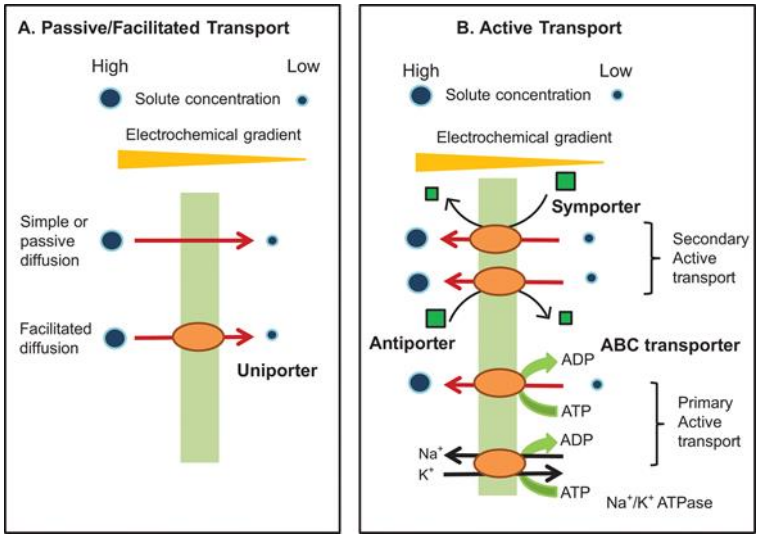
There are two types of secondary active transport:

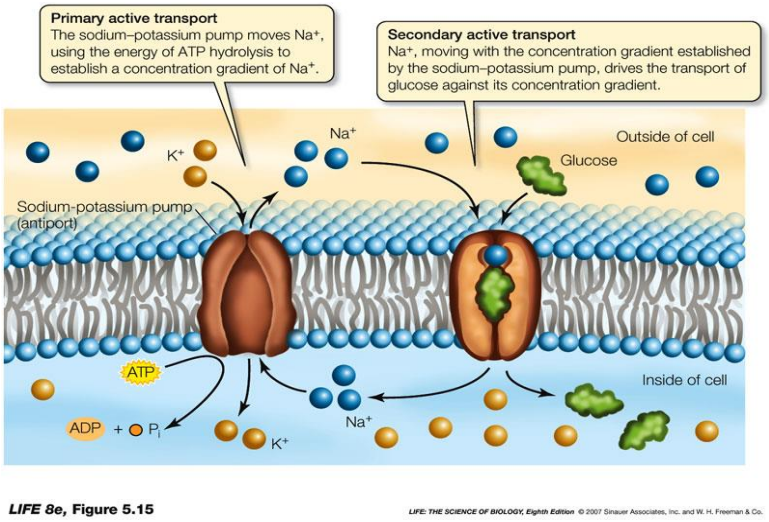
1-symporters

Can allow substrates to cross the membrane in the same direction as each other like the movement of amino acids using sodium ions

2-Antiporters

Entry one substrate and exit of another like the movement of Calcium ions using sodium ions.





LIFE 8e, Figure 5.15

b- Bulk transport is the movement of substances or macromolecules across membrane within a small vacuole that's mean that the large molecules and particles move through membrane enclosed by vesicles formed by parts of cell membrane.

These processes are grouped according to whether materials are moved into or out of the cells in which both needs energy as follows:

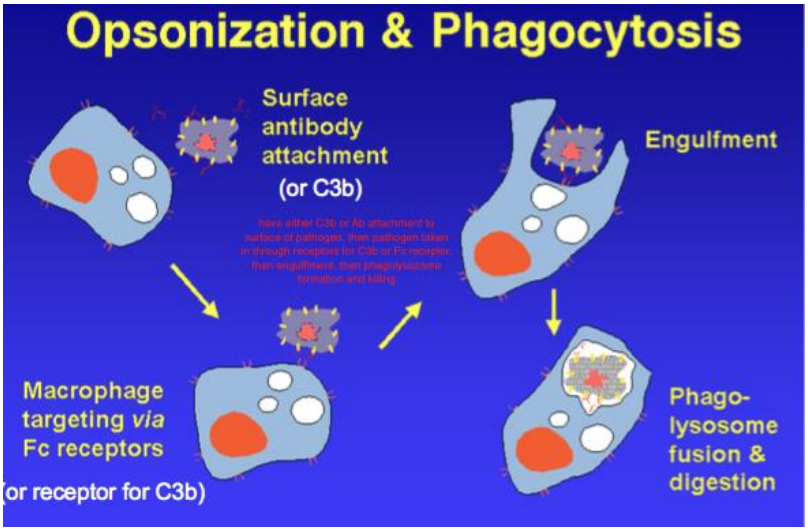
1-Endocytosis

Cells uptake molecules and particles from surrounding media through plasma membrane to inside the cytoplasm in which material a cross through plasma membrane invigilates to inside the cell to form vesicle containing ingested material . Endocytosis occurs in one of three ways

Phagocytosis (cell eating)

Occurs when the dissolved materials enter the cell in which cells engulf large particles like bacteria and debris. The particles bound to the receptors on the surface of phagocytic cells , cytoplasmic process (pseudopodia) of the cell are extended and surround the particles and form vesicle called **phagosome.** Phagosomes then fuse with lysosome to form phagolysosome or secondary lysosome. Lysosomal enzymes digest the content and the indigested particles are retained within vacuoles which termed residual bodies

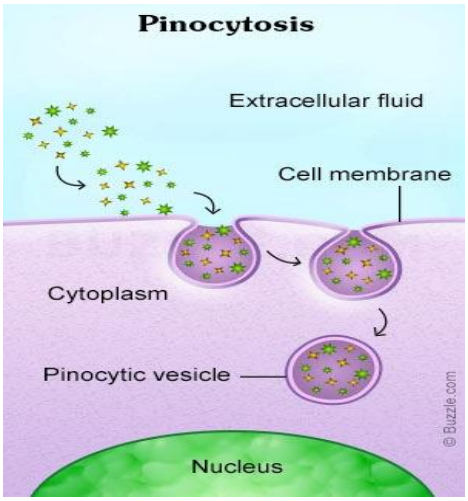
Certain white blood cells like neutrophil and macrophage are specialized for engulfing and removing particles like bacteria and dead cells.



Pinocytosis (cell drinking)

Occurs when the plasma membrane folds inward to form a channel allowing dissolved substances to enter the cell.

When the channel is closed, the liquid is encircled within a pinocytic vesicle, these pinocytotic vesicles subsequently fuses with lysosomes to hydrolyze (break down) the particles and may move to the cell surface opposite their origin , they fuse with the plasma membrane and release their contents outside the cell. This process is termed **transcytosis** and requires energy in the form of adenosine triphosphate (ATP), the chemical compound mostly used as energy in the majority of animal cells.



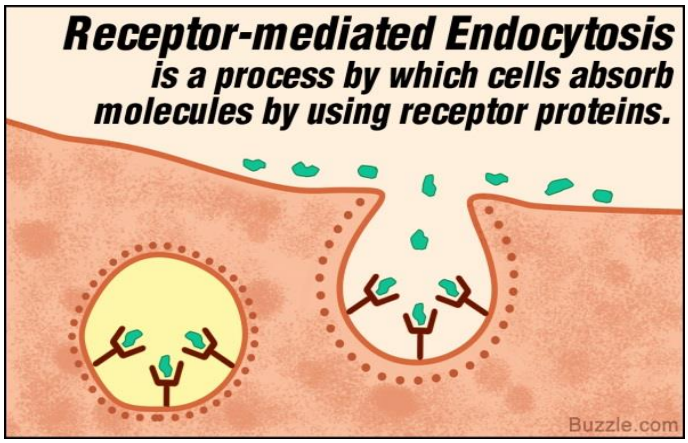
Receptor mediated endocytosis

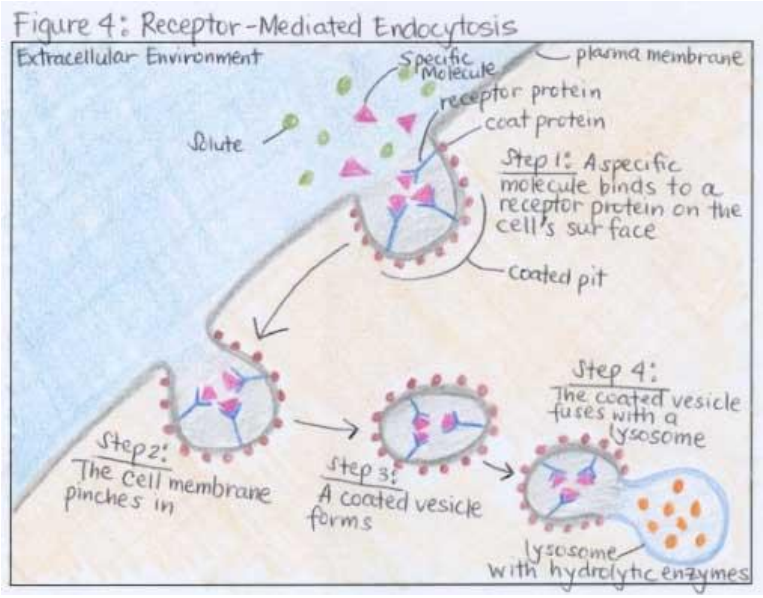
Receptor mediated endocytosis is the process by which the material like absorb metabolites, hormones, other proteins – and in some cases viruses (ligands, molecules with high affinity for a receptor) binds directly onto the receptor protein of the cell-membrane(integral proteins) . These receptor sites are located around the membrane of the cell in small clusters called **coated pits**, which is initiates the process of invagination as well as the formation of a protein-covering layer known as the coated vesicles .

Receptor mediated endocytosis is mediated by the cytoplasmic peripheral membrane protein clathrin (fibrous protein found in cytosolic side) or other proteins which promote invagination and temporarily the newly.

When many receptors are bound by their ligands they aggregate in one membrane region which then invaginates and pinches off into cytoplasm, forming **coated vesicles** that containing both receptors and its bound ligands , these are termed clathrin coated vesicles. The vesicles that produced quickly enter and fused with one or more vesicle of the endosomal compartment (a dynamic system of vesicles and tubules) ,the early endosome found near to the surface and the late endosome located deeper in cytoplasm.

The acidic PH (because endosome contains ATP-H^+ driven pumps) of early endosome makes many ligand separate from their receptors and sorted into other vesicle, vesicles that empty from receptors return to the cell surface and the receptors may be reunited to the cell membrane to be reused, for example , low density lipoproteins are recycled many times.
Ligands are typically transferred to late endosome, some ligands with their receptors are returned to the surface and both are used again like iron transport protein transferrin : ferric atoms separate from carrier at low PH and both return to the surface. Late endosome fuse with lysosomes for digestion of their contents.

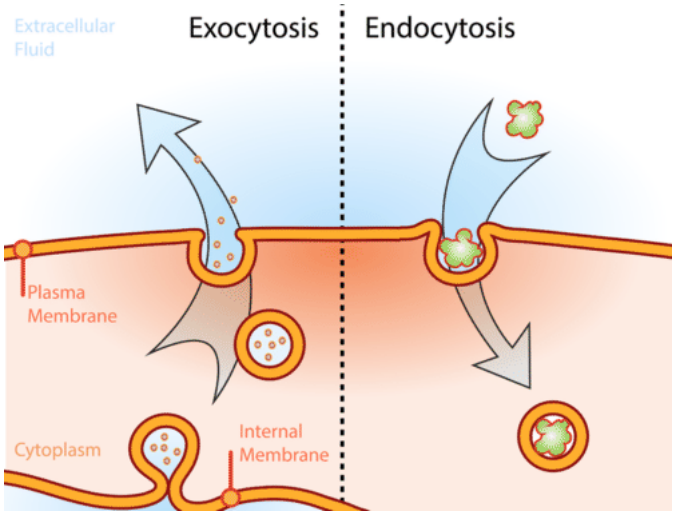




Exocytosis

Exocytosis is that process of vesicles fusing with the plasma membrane and releasing their contents to the outside of the cell like waste products or molecules for export like hormones and proteins. Newly made membrane proteins and membrane lipids are moved on top the plasma membrane by exocytosis.

Exocytosis is the opposite of endocytosis in which substances are taken into cells. In exocytosis, membrane-bound vesicles containing cellular molecules are transported to the cell membrane. The vesicles fuse with the cell membrane and expel their contents to the exterior of the cell.
In endocytosis portions of cell membrane become endocytotic vesicles while in exocytosis the membrane is returned to the cell surface, this movement of plasma membrane and recycling is called **membrane trafficking** .This process of trafficking membrane usually found in most cells.



Modes of fluid transport

Passive Transport

- High -> Low Concentration
- No ATP needed
- Towards equilibrium

1. Simple diffusion
2. Facilitated diffusion
   a. Transport proteins
   b. Ion channels
3. Osmosis

Active Transport

- Low -> High Concentration
  ie;Against concentration gradient
- ATP needed

1. Cell membrane pumps
   a. Transport proteins
   b. Ion channels
2. Movement in vesicles
   a. Endocytosis
      - ***Pinocytosis***
      - ***Phagocytosis***
   b. Exocytosis