1.4 Membrane Transport

Types of Transport

Outline the two key qualities of plasma membranes

1. Semi-permeability (some things can cross the membrane, other things can't cross)
2. Selectivity (cells can control the passage of certain materials across the membrane)

Distinguish between passive transport and active transport

Passive Transport	Active Transport
Movement from a region of high concentration to a region of lower concentration (along a gradient)	Movement from a region of low concentration to a region of higher concentration (against a gradient)
Does not require the expenditure of ATP	Requires the expenditure of ATP
E.g. simple diffusion, facilitated diffusion, osmosis	Also requires membrane proteins (protein pumps)

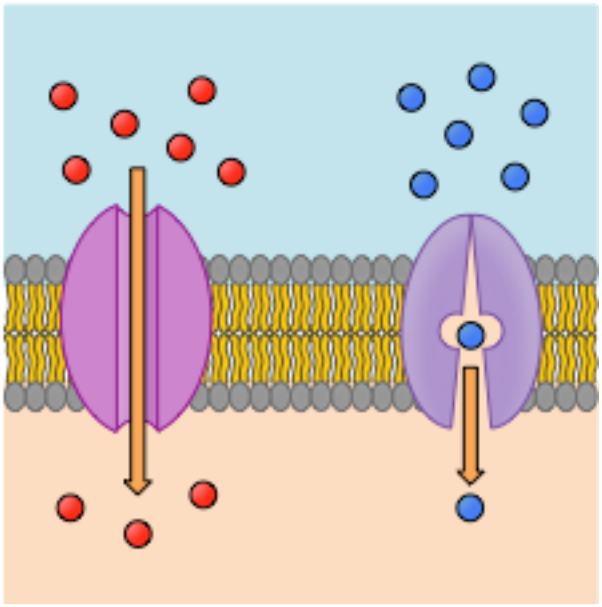
Passive Transport

Define simple diffusion

The net movement of particles from a region of high concentration to a region of low concentration (until equilibrium is reached)

Describe the process of facilitated diffusion

- Facilitated diffusion is a passive transport mechanism for materials that cannot freely cross the membrane
- Large and charged substances cannot freely cross the hydrophobic bilayer (e.g. ions, macromolecules)
- Membrane proteins may include:
  - Channel proteins (form a hydrophilic pore)
  - Carrier proteins (translocate substances)



List three molecules that are transported by simple diffusion and facilitated diffusion

Simple Diffusion: oxygen, carbon dioxide, lipophilic substances (e.g. steroids)

Facilitated Diffusion: Ions (e.g. sodium, potassium, etc.), macromolecules (glucose, starch, etc.)

Describe how the structure of the potassium channel facilitates diffusion in nerve cells

Integral proteins with a hydrophilic inner pore via which potassium ions may be transported

Inner pore contains a selectivity filter in order to restrict the passage of alternative ions

Channels adopt an open / closed conformation based on:

- Membrane polarity (voltage-gated)
- Binding of neurotransmitter (ligand-gated)

Osmosis

Describe the relationship between solutes and solvents in a solution

A solute is a substance that is dissolved in a solvent

Due to it's polarity, water is often termed the 'universal solvent' (but won't dissolve non-polar molecules)

Define osmosis

The net movement of free water molecules across a semi-permeable membrane from a region of low solute concentration to a region of high solute concentration, until equilibrium is reached

Differentiate between hypertonic, hypotonic and isotonic solutions

	Solute Concentration	Effect on Cell
Hypertonic	Higher solute concentration (relatively)	Water flows out of cell (into hypertonic)
Hypotonic	Lower solute concentration (relatively)	Water flows into cell (from hypotonic)
Isotonic	Equal solute concentration (relatively)	No net water movement

Define osmolarity

Osmolarity is a measure of solute concentration, as defined by osmol/L

Explain why the osmolarity of a solution affects animal cells and plant cells differently

- Plant cells have a rigid cell wall which prevents uncontrolled osmosis
- Plant cells may swell (become turgid), but they cannot burst or rupture (lyse) like animal cells
- Equally, the cell membrane may shrink from the cell wall (plasmolysis), but overall structure remains intact

Active Transport

Distinguish between primary (direct) active transport and secondary (indirect) active transport

Direct Active Transport (Primary): ATP hydrolysis is used to mediate transport by causing a conformational change in the protein pump (thereby translocating the molecule against the gradient)

Indirect Active Transport (Secondary): Transport is coupled to another molecule moving along an electrochemical gradient (cotransport)

Describe how the structure of the sodium-potassium pump enables active transport in nerve cells

Three sodium ions attach to intracellular binding sites on the protein pump

ATP hydrolysis phosphorylates the pump and changes its conformation

Sodium ions are translocated and released from the cell, exposing extracellular binding sites for potassium

Two potassium ions attach to these sites and the pump is dephosphorylated

This returns the pump to its original conformation, internalising the potassium ions

Vesicular / Bulk Transport

Outline the role of vesicles in the transport of materials between organelles

Polypeptides destined for secretion are synthesised by ribosomes on rough ER

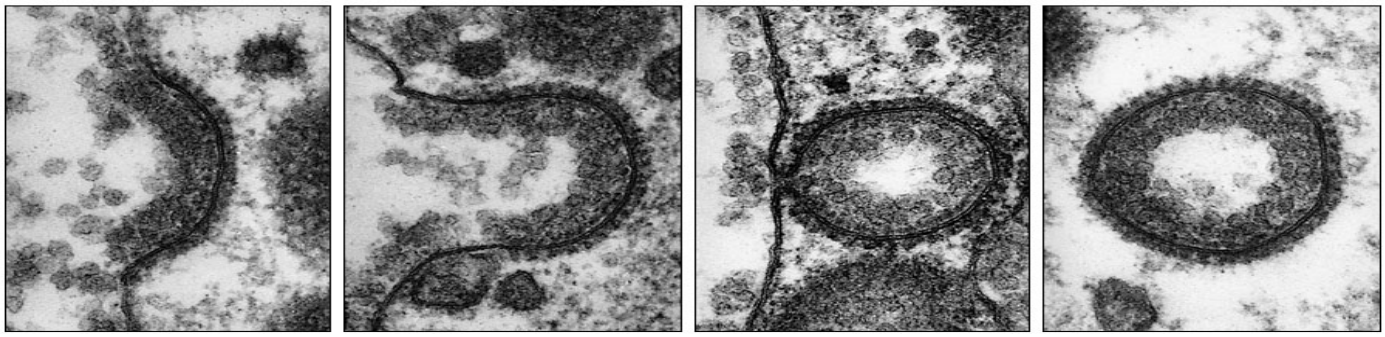
They are transported to the Golgi body via vesicles (formed from the ER membrane)

The Golgi body will potentially sort, store and modify these secretory products

The proteins are then transported by another vesicle to the cell membrane for secretion (exocytosis)

External materials can be internalised into cellular vesicles via endocytosis (for digestion by lysosomes)

Use the diagram below to explain the process of endocytosis



Endocytosis is the process by which large substances (or bulk amounts of smaller substances) enter the cell without crossing the membrane

An invagination of the membrane forms a flask-like depression which envelopes the extracellular material

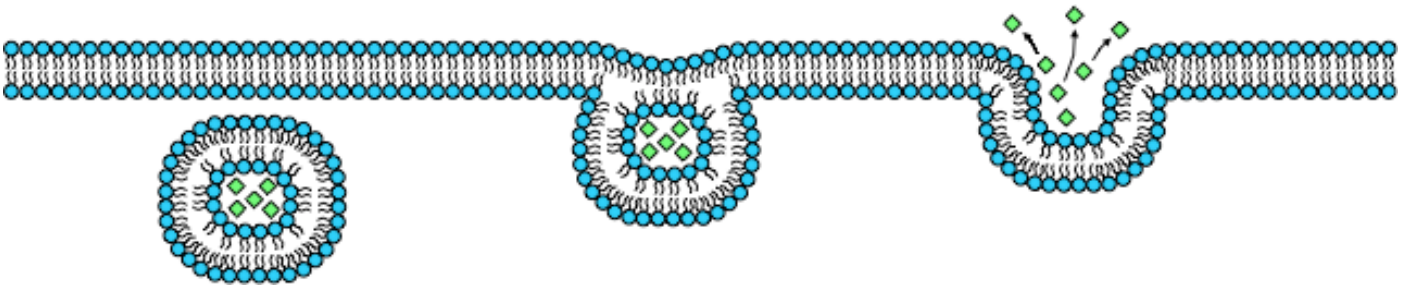
The invagination is then sealed off to form an intracellular vesicle containing the material

Differentiate between phagocytosis and pinocytosis

Phagocytosis: The process by which solid substances (e.g. food particles, foreign pathogens) are ingested (usually to be transported to the lysosome for break down)

Pinocytosis: The process by which liquids / solutions (e.g. dissolved substances) are ingested by the cell (allows quick entry for large amounts of substance)

Use the diagram below to explain the process of exocytosis



The process by which large substances (or bulk amounts of small substances) exit the cell without crossing the membrane

Vesicles fuse with the plasma membrane, expelling their contents into the extracellular environment

Exocytosis adds vesicular phospholipids to the cell membrane, replacing those lost via endocytosis