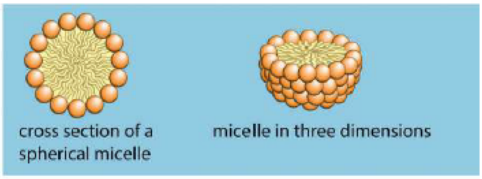
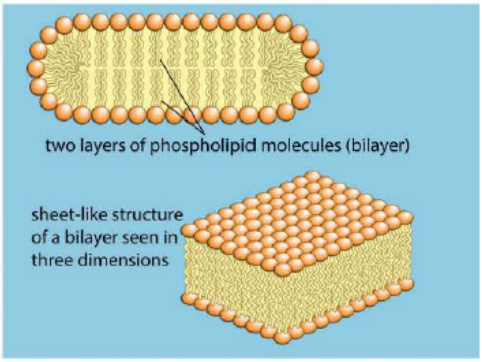
UNIT 4 - CELL MEMBRANES





- Cell membranes surround every cell. Even most of the organelles within a cell are completely covered by a semi-permeable membrane. Cell membranes are made of phospholipids and have 4 main functions:
- They act as barriers between the interior of the cell and the rest of the environment. They also keep organelles separate from one another to keep the cell interior organised and functional.
- Cell membranes control movement into and out of the cell. They are semi-permeable (thanks to membrane proteins) and only allow certain molecules across through diffusion, osmosis or active transport.
- Cell membrane have special receptors on which hormones can bind and allow cells too signal each other e.g. insulin.
- Plasma membranes have specialised structure on their surface that allow for cell recognition.
- Since membranes are made of phospholipids, they have what is called a phospholipid bilayer. The hydrophilic phosphate heads point towards the watery exterior (cytoplasm and outside the cell), and the hydrophobic tails point inwards, away from the watery environment.
- Phospholipids alone can also be mixed with water to form spherical structures called micelles

The Fluid Mosaic Model

- The Fluid Mosaic model was proposed by Singeer and Nicolson
- The cell surface membrane, according to the model, is:
  - A bilayer of phospholipis molecules. The individual phospholipid molecules move about by diffusion within their layers
  - The hydrophobic tails point inwards, forming a non-polar, hydrophobic interior
  - *Some of the phospholipids are UNSATURATED, and so contain double bonds*

Structure and function of the cell membrane components:

- Glycoproteins - recognition sites, act as antigens
- Phospholipids - form a bilayer and make membrane fluid. They are non-polar tails and hydrophilic heads, thus forming a barrier to most water soluble substances.
- Cholesterol - waterproof the membrane & control its stability. They also have hydrophilic heads and hydrophobic tails.
- Intrinsic proteins - pass through membranes. Some form channels or carriers for water-soluble molecules.
  - Channel proteins - a hydrophovic channel where diffusion of polar molecules and ions happens
  - Carrier proteins - allow active and passive transport. They change shape when the molecule enters the protein
- Extrinsic proteins - found on the surface only; some act as enzymes
- Glycolipids - short carbohydrate chains that help make membranes stable by forming hydrogen bonds with water. Help cells attach to one another

Fluidity of the membrane is affected by:

- Saturated vs. unsaturated fatty acid tails - unsaturated fatty acids pack loosely so more unsaturated tails make a membrane more fluid
- Long vs. short fatty acid tails - shorter tails means more fluidity
- Cholesterol - lipid that provides mechanical stability and acts as a buffer against temperature changes. Cholesterol mke membranes less fluid
- Temperature - higher temperatures mean more fluid membranes

Glycoproteins, glycolipids and proteins

- Receptor molecules
  - Bind with specific substances at the cell surface. Different cells have different receptors, depending on their function
  - "Signalling receptors" coordinate the activity of the cell by recognising chemical messengers like hormones and neurotransmitters
- Cell-to-cell recognition
  - Some glycolipids and glycoproteins act as cell markers and allow cells to recognise each other. The carbohydrate chains bind to complimentary sites on the other cell
- Transport proteins
  - Channel and carrier proteins have polar insides and allow water-soluble substances to enter and exit the cell
- Enzymes
  - Some membrane proteins (extrinsic) are enzymes e.g. enzymes on the cell surface of cells in the small intestine that catalyse the hydrolysis of molecules such as disaccharides

- The cytoskeleton
    - Some proteins on the inside of the cell membrane are attached to the cytoskeleton which keeps the cells shape and overall structure stable

Cell Signalling

1) A stimulus causes cells to secrete a ligand e.g. in the pancrease the hormone glucagon is secrete as a response to dropping sugar levels
2) The ligand is transported to target cells. In the case of hormones, the transport system is the blood
3) The ligand binds to cell surface receptors on the target cells. The receptors are protein molecules

Ligand - a biological molecule that binds specifically to another molecule such as a cell surface membrane receptor during cell signalling

Transduction - occurs during cell signalling and is the process of converting a signal from one method of transmission to another.

The stimulation of one receptor molecule results in many second messenger molecules being made, resulting in an amplification of the response. This causes a change in the cell metabolism.

- This is called a signalling cascade
- Direct contact is another form of cell signalling, like when lymphocytes detect foreign antigens on other cells

Movement of substances across the cell membrane:

- Diffusion - relevant for uncharged molecules that can diffuse directly across the the phospholipid bilayer e.g. oxygen or carbon dioxide

Diffusion - the net movement of molecules or ions from a regions of higher concentration gradient to regions of lower concentration gradients, as a result of the random movement of particles.

- Facilitated diffusion - relevant for polar molecules that cannot pass directly through the bilayer, and requires channel carrier proteins.

Osmosis - the net diffusion of water molecules from a region of higher water potential to a region of lower water potential through a partially permeable membrane.

Water potential - a measure of the tendency of water to move from one place to another; water potential can be decreased (becomes more negative) by the addition of solutes and increased by the removal of solutes (less negative). It can be represented by the symbol Ψ_w.

Active transport - the movement of molecules or ions through transport proteins across a cell membrane AGAINST the concentration gradient, using energy from ATP

Endocytosis & Exocytosis

Endocytosis - the bulk movement of liquids (pinocytosis) or solids (phagocytosis) into a cell by the infolding of the cell surface membrane to form vesicles containing the substance; endocytosis in an active process requiring ATP.

Exocytosis - the bulk movement of liquids or solids out of a cell bu the fusion of vesicles with the cell surface membrane; exocytosis also requires ATP. Exocytosis can be used for the excretion of waste or the secretion of substances (e.g. mucus from goblet cells is secreted via exocytosis)