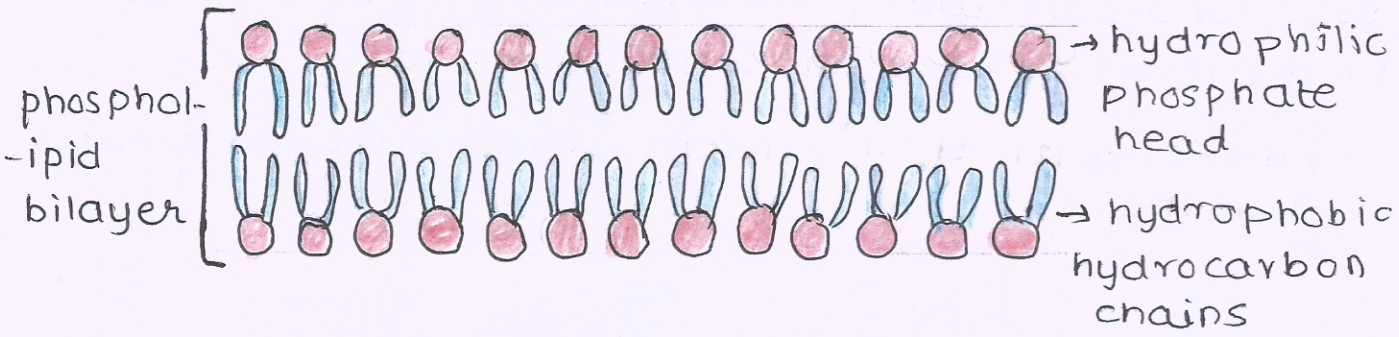
1.3. MEMBRANE STRUCTURE

PHOSPHOLIPID BILAYERS



→ attracted to water

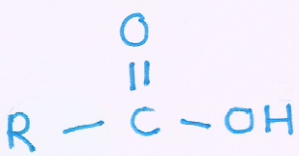
→ repell water

They are **amphipathic**.

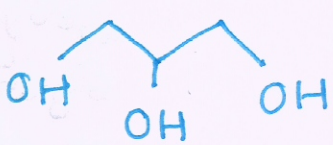
Form the base of all cell membranes

Structure

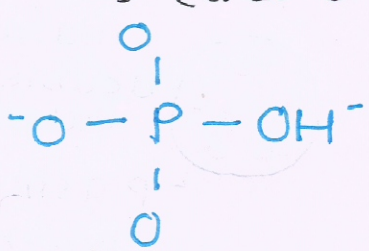
Fatty acids - carboxylic acid attatched to a long carbon chain



Glycerol - three carbons attatched to three hydroxyl groups (alcohol groups).



Phosphate group - phosphorous attatched to 3 oxygens and one hydroxyl (alcohol) group.

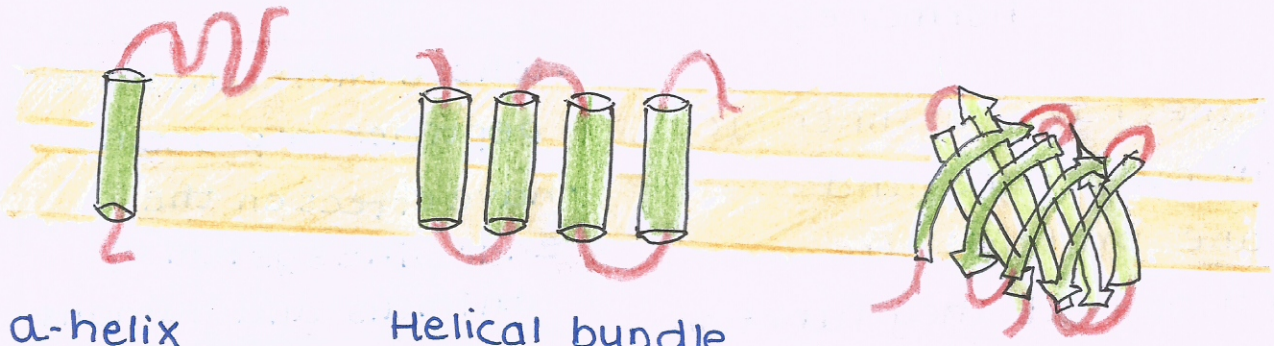


MEMBRANE PROTEINS

Membrane proteins are diverse in terms of structure, position in the membrane and function.

Integral proteins

- permanently attatched to the membrane and are typically transmembrane (they span across the bilayer).
- hydrophobic
- embedded in the hydrocarbon chains in the centre of the membrane.



α-helix
Recognition, Receptors

Helical bundle
Enzymes, Transport, Receptors

β - barrel
Transporters (channel proteins)

Peripheral proteins

- temporarily attatched to the surface of integral proteins.
- this arrangement is reversible.
- some have a single hydrocarbon chain attatched to them which is inserted into the membrane, anchoring the protein to the membrane surface.

Transporters

Enzymes
Anchorage

FUNCTIONS OF MEMBRANE PROTEINS

- **Junctions:** serve to connect and join two cells together
- **Enzymes:** fixing to membranes localises metabolic pathways
- **Transport:** responsible for facilitated diffusion and active transport
- **Recognition:** may function as markers for cellular identification
- **Anchorage:** attatchment points for cytoskeleton and extra cellular matrix.
- **Transduction:** function as receptors for peptide hormones

membranes have an inner face and an outer face and membrane proteins are oreinted so that they function correctly.

- whose molecules are peptides or proteins
- have effect on the endocrine system of animals and humans

Protein content of membranes

- variable functions
- the more active the membrane is, the higher its protein content.
- membranes in the myelin sheath around nerve fibres just act as insulators and have a protein content of only 18%.
- membranes around the cell - plasma membranes have a protein content of 50%.
- highest protein contents are in the mitochondria and chloroplast membranes

↓

active in photosynthesis and respiration and have a protein content of 75%.

CHOLESTROL

The two main components of cell membranes are phospholipids and proteins. Animal cell membranes also contain cholestrol.

Cholestrol

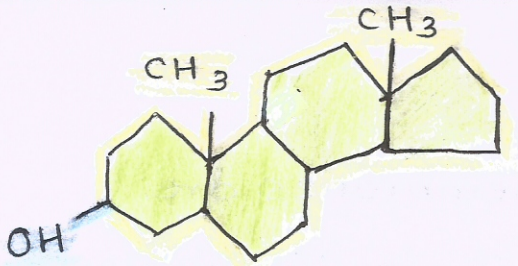
- It is a type of lipid but it is not a fat or an oil.
- belongs to a group called steroids.
- most of a cholestrol molecule is hydrophobic which helps itself attach to the hydrocarbon chain.
- One end of the cholestrol molecule is hydrophillic (OH^-) which gets attracted to the phosphate heads on the periphery of the membrane.
- they are positioned between the phospholipids in the membrane.

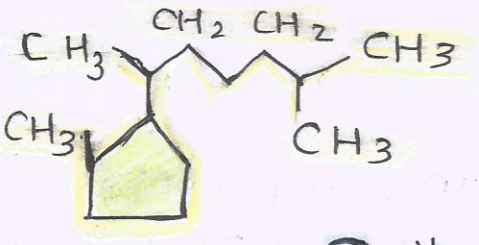
Amount of cholestrol:

- it varies in a cell membrane.
- the membranes that hold neurotransmitters at synapses have 30% cholestrol in the membrane.

Functions:

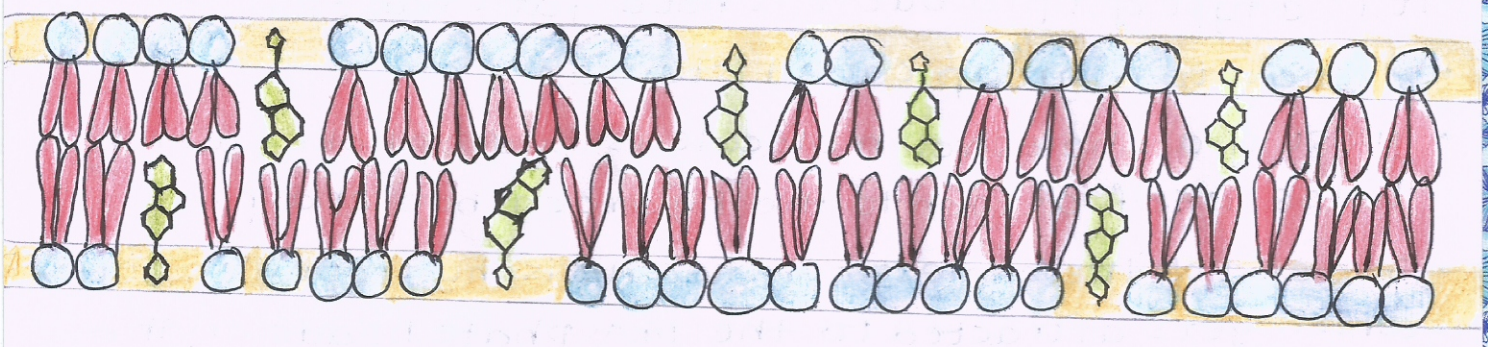
- It interacts with the fatty acids of phospholipids to moderate some functions
- Functions to immobilize the outer surface of the membrane, reducing fluidity.
- makes the membrane less permeable to very small water soluble molecules that would otherwise cross freely.
- seperates the phospholipid tails and prevent crystallisation of the membrane.
- helps secure peripheral proteins by forming high density lipid rafts capable of anchoring the protein.





- Hydrophilic
- Hydrophobic

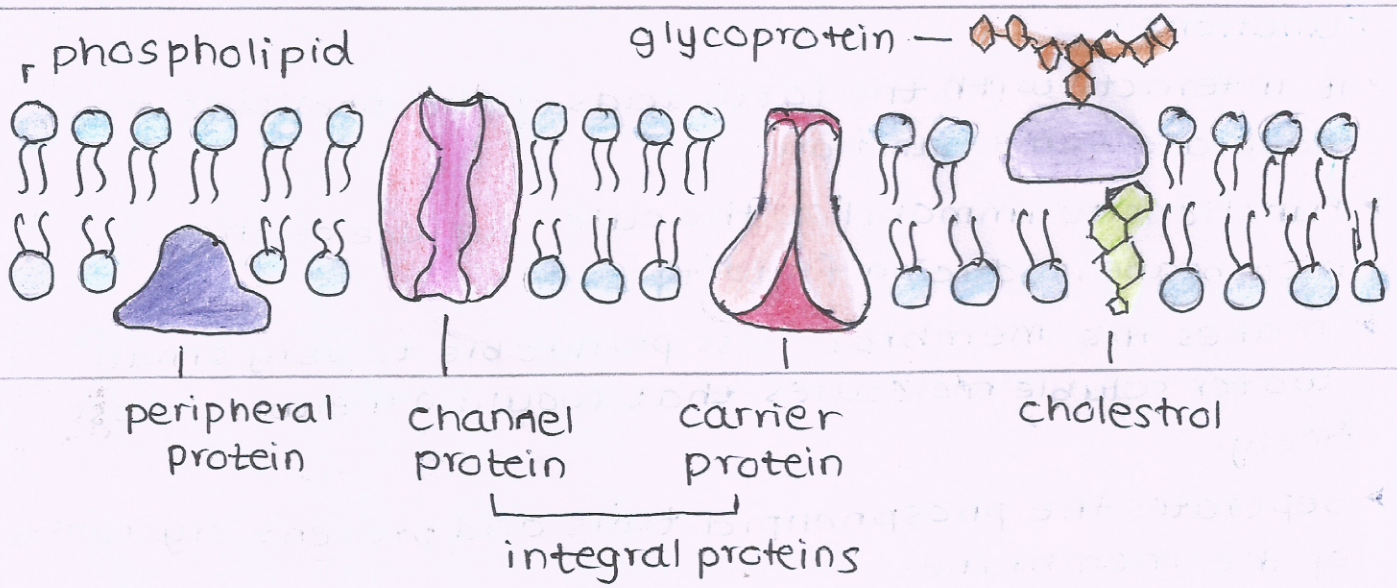
Diagram: → Cholestrol in mammal membrane



FLUID-MOSIAC MODEL

- **Fluid** - the phospholipid bilayer is viscous and it can move positions.
- **Mosiac** - the layer is embedded with proteins, resulting in a mosiac of components.

It was proposed by singer and Nicolson in 1966.



Phospholipids: form a bilayer with heads facing outwards & tails facing inwards.

cholestrol: improve stability and reduce fluidity

Proteins: either integral or peripheral → variety of roles

MEMBRANE MODELS

The first model that attempted to describe the position of proteins within the bilayer was proposed by Hugh Davson and James Danielli in 1935.

Under the electron microscope, the membranes exhibit a characteristic 'trilaminar' appearance.

Trilaminar → 3 layers two dark outer layers and a lighter inner region.

Davson-Danielli model

- It was described as a 'lipo-protein sandwich' as the lipid layer was sandwiched between two protein layers.
- The dark segments seen under the microscope were wrongly identified as representing two protein layers.

Drawbacks with this model

- assumed all membranes were of a uniform thickness and would have a constant lipid-protein ratio.
- assumed that all membranes would have symmetrical inner and external surfaces. (not bifacial).
- did not account for the permeability of certain substances. (did not recognize the need for hydrophillic pores).
- temperatures at which membranes solidified did not co-relate with those expected under the proposed model.

Falsification Evidence

Membrane proteins were discovered to be insoluble in water indicating hydrophobic surfaces and varied in size.

- Such proteins would not be able to form a uniform and continuous layer around the outer surface of a membrane.

Fluorescent anti-body tagging of membrane proteins showed they were mobile and not fixed in place.

- membrane proteins from 2 different cells were tagged with red and green fluorescent markers respectively
- when the 2 cells were fused, the markers became mixed throughout the membrane of the fused cell.
- This demonstrated that the membrane proteins could move and did not form a static layer.

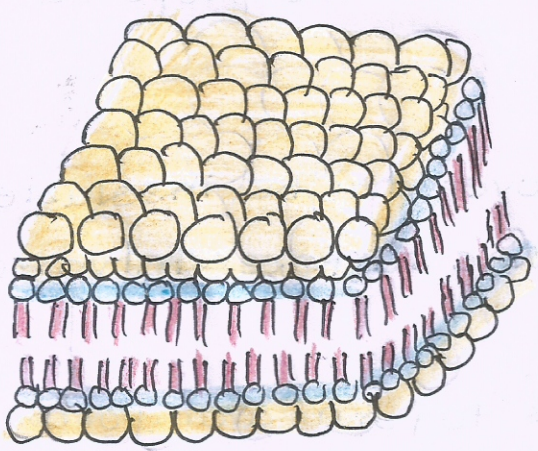
freeze fracturing was used to split open the membranes and revealed irregular rough surfaces within the membrane.

- These rough surfaces were interpreted as being transmembrane proteins, demonstrating that proteins were not soley localized to the outside of the membrane structure.

NEW MODEL

Due to the limitations of the previous model, seymour Singer and Garth Nicolson proposed the new model.

- According to this model, proteins were embedded within the lipid layer rather than existing in a seperate layer.
- This is the fluid-mosiac model and is used by scientists even today.



Dawson-Danielli model
proteins form distinctive layers (like a sandwich)