MEMBRANE STRUCTURE

Content Statements:

B2.1.1 Lipid bilayers as the basis of cell membranes

B2.1.2 Lipid bilayers as barriers

B2.1.4 Integral and peripheral proteins in membranes

B2.1.9 Structure and function of glycoproteins and glycolipids

B2.1.10 Fluid mosaic model of membrane structure

B1.1.12 Formation of phospholipid bilayers as a consequence of hydrophobic and hydrophilic regions

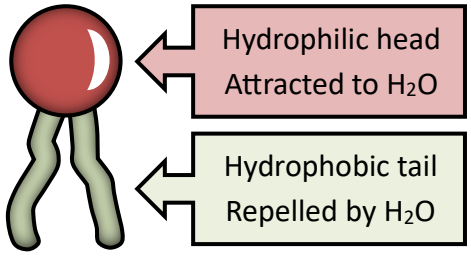
CELL MEMBRANES

Cell (plasma) membranes enclose the contents of the cell, separating intracellular components from the extracellular environment. This allows for the precise control of internal conditions (i.e. homeostasis). Cell membranes have two key properties that promote this homeostatic regulation:

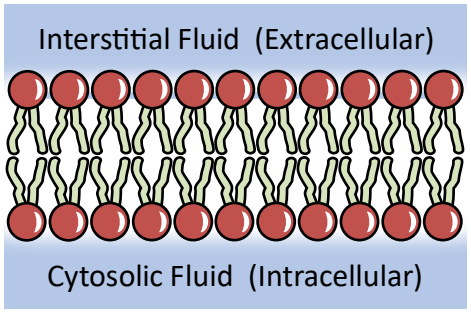
- They are **semi-permeable**, in that some material cannot cross the membrane without assistance
- They are **selective**, in that membrane scan regulate the passage of certain material according to need

PHOSPHOLIPID BILAYER

Membranes consist of a phospholipid bilayer. Each phospholipid consists of a polar phosphate head and two non-polar fatty acid tails. The phosphate head is **hydrophilic** (water-loving), while the fatty acid tails are **hydrophobic** (water-hating). This makes the phospholipid *amphipathic* (both hydrophilic and hydrophobic).



Phospholipids will spontaneously arrange into a **bilayer**, with the hydrophilic phosphate heads facing out towards the surrounding aqueous solutions (i.e. cytosolic and extracellular fluids), while the hydrophobic fatty acids face inwards to avoid exposure to the polar fluids. The bilayer is therefore held together by the **weak hydrophobic associations** between the fatty acid tails, allowing for membrane fluidity and flexibility (it can easily break and reform).



MEMBRANE PROTEINS

Phospholipid bilayers are embedded with proteins, which may be permanently or temporarily attached:

- **Integral proteins** are transmembrane (span the bilayer) and permanently attached to the membrane
- **Peripheral proteins** associate with one side of a membrane and are temporarily attached to the bilayer

Integral proteins cannot readily be dissociated from the membrane without disrupting the bilayer (such as through the use of detergents). Examples of integral proteins include ion channels, carrier proteins and protein pumps. Peripheral proteins can easily be dissociated from the membrane by using a polar solvent. Examples include receptor complexes associated with signal transduction pathways (such as G proteins).

PROTEIN FUNCTIONS

Membrane proteins serve a variety of key functions:

- **Junctions:** They can connect cells together to form tissues (tight junctions)
- **Enzymes:** Immobilising enzymes on membranes localises specific reactions
- **Transport:** Allows passage of material across the bilayer (channel proteins)
- **Recognition:** May function as markers for cell identification (e.g. antigens)
- **Adhesion:** Act as attachment points for cytoskeleton or extracellular matrix
- **Transduction:** Functions as receptors for signalling pathways (glycoproteins)

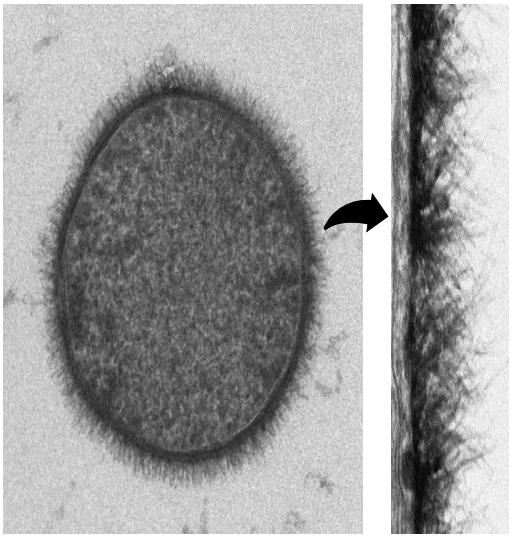
Hint: JET RAT

GLYCOSYLATION

Phospholipids and membrane proteins can have carbohydrate chains attached via the process of **glycosylation**. Glycosylation of phospholipids result in *glycolipids*, whereas glycosylation of membrane proteins produce *glycoproteins*. The carbohydrate chains are located on the extracellular side of the membrane and play important roles in cell adhesion and cell recognition.

- **Adhesion:** Surface carbohydrates can serve as attachment points for cells (glycoproteins act as sperm binding sites)
- **Recognition:** Surface carbohydrates can also act as a point of recognition between cells (ABO antigens are glycolipids)

Glycoproteins and glycolipids also play a role in maintaining the structural integrity of the extracellular matrix. The carbohydrate chains can link extracellular molecules together, helping to make the matrix a cohesive network that provides external structure.



*The **glycocalyx** is a sugar coat found in ova that mediates sperm binding*

FLUID-MOSAIC MODEL

The fluid-mosaic model of membrane structure describes two of the key qualities of a plasma membrane:

- **Fluid:** Phospholipids can move position, making membranes **amorphous** (able to change size or shape)
- **Mosaic:** The bilayer is embedded with proteins and carbohydrates, resulting in a mosaic of components

The fluid-mosaic model was proposed by Singer and Nicolson in 1972 and is the currently accepted model.