4 Cell Membranes and Transport

4.1 Fluid mosaic membranes

Fluid mosaic model

- 'fluid' refers to the movement of phospholipids while 'mosaic' refers to the scattered proteins (and glycoproteins) in the phospholipid bilayer

1) Phospholipids

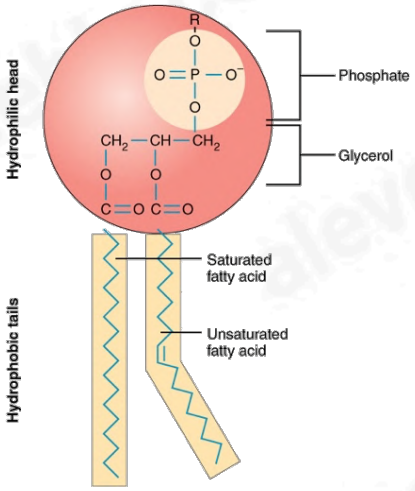


Image: https://courses.lumenlearning.com/

- phospholipids are arranged so that hydrophobic, non-polar tails do not face water. Water is on both the intracellular and extracellular sides
- therefore, tails point inwards, and hydrophilic heads face the aqueous medium

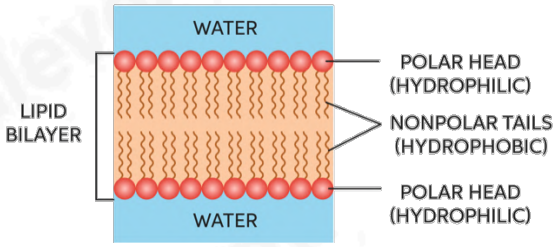


Image: https://www.chegg.com/

Membrane fluidity

Membrane fluidity refers to the viscosity of the lipid bilayer of a cell membrane.

Membrane fluidity is affected by:

1) **tail length** – longer the tail, the less fluid the membrane
2) **saturation of fatty acid** – the more unsaturated they are, the more fluid the membrane. This is as unsaturated fatty acid tails are bent and fit together more loosely

3) cholesterol

- regulates the fluidity of membrane
- at low temperatures, cholesterol increases the fluidity of the membrane preventing it from being too rigid, this is because it prevents close packing of phospholipid tails
- at high temperatures, cholesterol decreases the fluidity of membrane and stabilises the cell

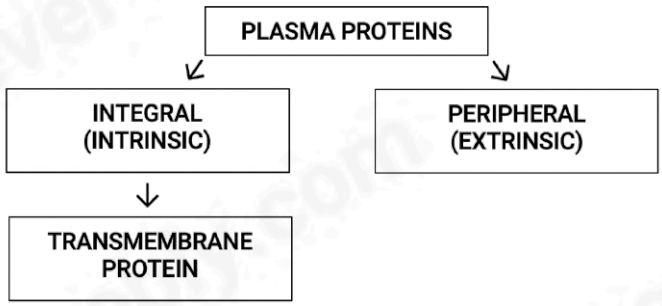
2, 3) Glycolipids and glycoproteins

Lipid and protein molecules on the outer surfaces of cell membrane have carbohydrate chains attached to them forming glycolipids and glycoproteins

These carbohydrate chains projecting out like antennae:

- stabilise the membrane structure by forming hydrogen bonds with water molecules surrounding the cell
- **glycocalyx** – sugary cell coating formed by carbohydrate chains
- act as receptor molecules:
  - ⇒ **signalling receptors** – recognise messenger molecules like hormones and neurotransmitters
  - ⇒ **endocytosis** – bind to molecule to be engulfed by membrane
- act as cell markers/antigens allowing cell-cell recognition

4) Proteins



- proteins that are found embedded within the membrane
- may be found in inner layer, outer layer or spanning the whole membrane (these are transmembrane proteins)
- helps in movement in and out of cell

- can be present inside or outside of the cell membrane i.e., intracellular, and extracellular
- extracellular peripheral proteins – communication, receptors, and recognition proteins
- intracellular peripheral proteins- structural support, attached to the cytoskeleton of the cell

Function of transmembrane proteins

- act as gateways and can transform, helping in facilitated diffusion and active transport

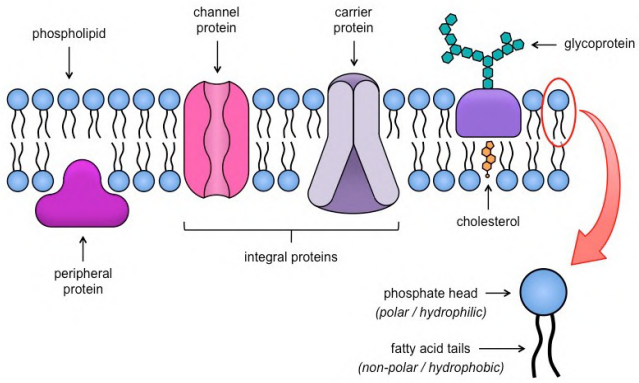


Image: https://o.quizlet.com/MZFY3U-L4j6xL86C4rWTOQ_b.jpg

Channel proteins

- do not require energy
- transport substances through membrane passively, along their concentration gradient
- used for both active transport and facilitated diffusion

Carrier proteins

- require energy
- go against the concentration gradient
- take substances from outside and pumps it inside or vice versa
- used for active transport

Cell surface receptors

- present in membranes and binds with particular substances
- used for signalling, endocytosis, cell adhesion, cell markers

Cell surface antigen

- acts as cell identifying markers
- each type of cell has its own antigen
- this enables cells to recognise other cells and behave in an organised way

Cell signalling

- cells detect signals with cell receptors, i.e., glycoproteins and glycolipids, present on their membrane
- the signalling molecule binds to the receptor as their shapes are complementary to each other
- this creates a chain of reactions in the cell, leading to a response

a) If the signalling molecules are hydrophobic (e.g., steroid hormones such as oestrogen)

- they can diffuse directly across the cell membrane and bind to receptors in the cytoplasm or nucleus.

b) If the signalling molecule is water-soluble

1) signal arrives at protein receptor in cell membrane
2) the receptor's shape is complementary to the ligand
3) the signal brings about a change in the receptor's shape
4) changing the shape of the receptor allows it to interact with the next component of the pathway so the message gets transmitted
5) binding triggers/stimulates reactions within the cell
6) cell signalling results in a response which may be intracellular or extracellular

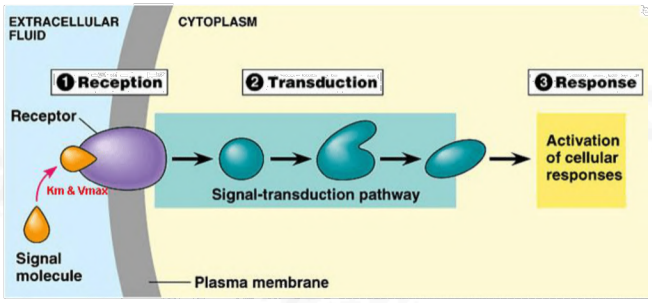


Image: https://croteaubio.wordpress.com/

4.2 Movement of substances into and out of cells

a) Diffusion

> Net movement of molecules or ions from a region of higher concentration to a region of lower concentration down a gradient, as the result of the random movement of particles.

- passive process
- molecules tend to reach an equilibrium situation

Factors affecting diffusion

- as steepness of gradient increases, diffusion increases
- as temperature increases, diffusion increases
- as surface area increases, diffusion increases
- as distance increases, diffusion decreases
- smaller and non-polar molecules like fats diffuse much easily across the cell surface membrane as they're soluble in phospholipid tails

b) Facilitated diffusion

> Diffusion of a substance through transport proteins in a cell surface membrane.

- the proteins provide hydrophilic areas that allow the molecules or ions to pass through the membrane which would otherwise be less permeable to them

Channel proteins

- allow charged substances, usually ions to diffuse
- can move to open or close the pore, like a gate controlling ion exchange

Carrier proteins

- flip between 2 shapes, as a result, the binding site opens alternatively to each side

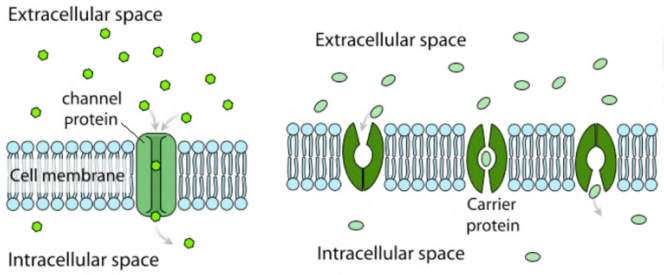


Image: https://www.khanacademy.org/

c) Osmosis

> Net movement of water molecules from a region of higher water potential to a region of lower water potential through a partially permeable membrane as a result of their random motion.

Water potential

> Tendency of water to move out of solution.

- water always moves down a water potential gradient, this happens until water potential is the same throughout the solution
- denoted by psi (Ψ)
- water potential becomes negative if the solute concentration is very high

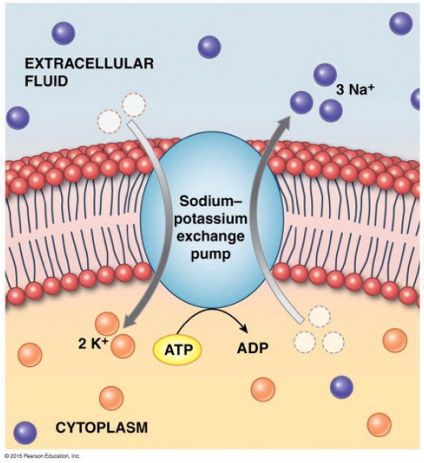
	RBC /ANIMAL CELLS	PLANT CELLS
WATER LOSS	crenated	plasmolysed, flaccid
WATER GAIN	haemolysed / lysed	turgid

d) Active transport

> Movement of molecules or ions through transport proteins, across a cell membrane, against their concentration gradient, using energy from ATP.

- achieved by carrier and channel proteins
- these are specific to the type of molecule they're transporting
- requires energy; supplied by ATP
- energy is used to make the channel/carrier proteins change shape, transferring molecules/ions across the membrane in the process

Sodium/Potassium pump



FOR EVERY ATP MOLECULE USED
$3Na^+$ - given out the cell
$2K^+$ taken in the cell

e) Bulk transport

> A type of active transport where large molecules are transported across the cell surface membrane, using energy from ATP.

ENDOCYTOSIS (INSIDE) | **EXOCYTOSIS (OUTSIDE)**

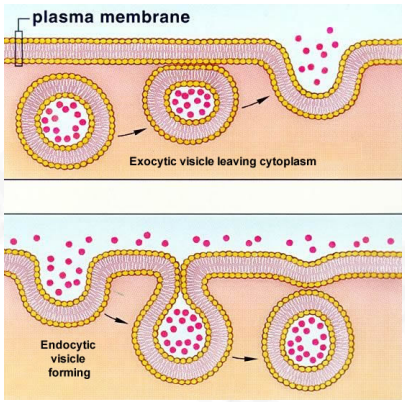


Image: http://lifeofplant.blogspot.com/

1) Endocytosis

> Bulk movement of liquids (pinocytosis) or solids (phagocytosis) into a cell by the infolding of the cell membrane to form vesicles containing the substance.

2) Exocytosis

> Bulk movement of liquids or solids out of a cell by the fusion of vesicles containing the substance with the cell surface membrane.