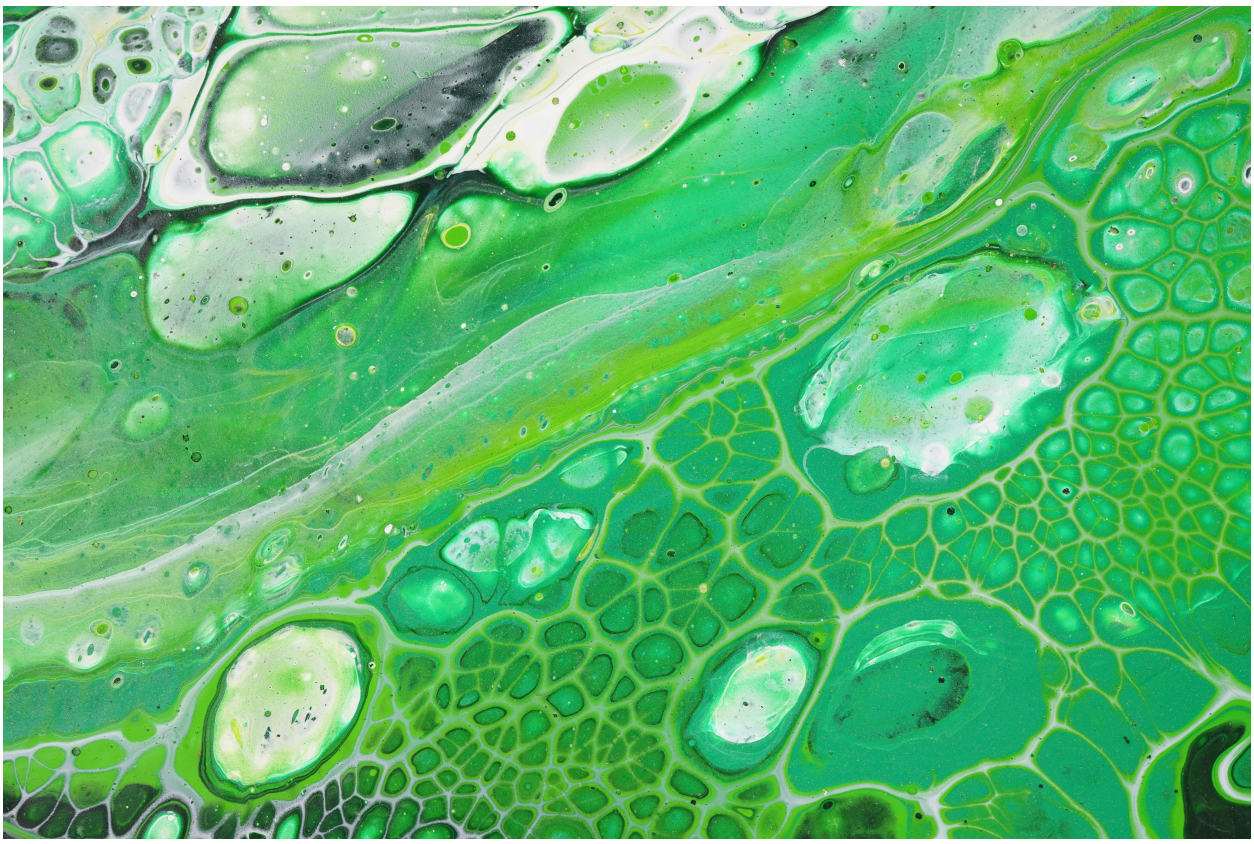
Transport and Cell membrane

Created	@June 13, 2025 1:32 AM
Tags	



Describe how the carrier protein works

(c) explain how glucose is transported across the plasma membrane by GLUT4.

.....

.....

.....

..... [2]

1. Glucose **binds** to the **binding site of GLUT4**, **explanation:** glucose has a shape / structure that is complementary to the binding site of GLUT4.
2. Glucose is taken into GLUT4 and is released to the other side across the plasma membrane, **explanation: GLUT4** undergoes **conformation change**.

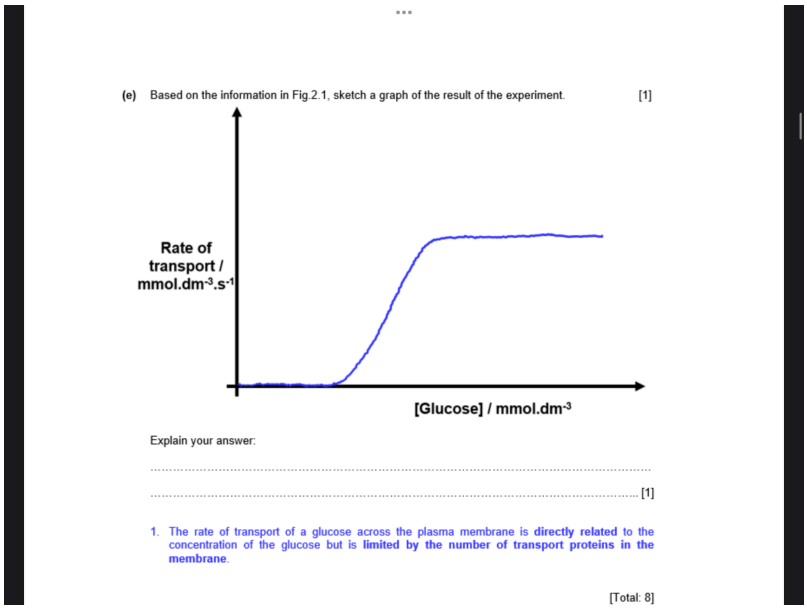
▼ Notes

- molecule to be transported is complementary to binding site of carrier protein and will bind to binding site of carrier protein
- This induced a conformational change on the carrier protein and hence molecule is taken into carrier protein and released to other side of plasma membrane
- Channel proteins are constantly open

---

the rate of transport of molecules across plasma membrane with increasing concentration of molecules

- The rate of transport increases with increasing concentration
- However, it is limited by the number of transport proteins embedded in cell membrane
- Note that rate of transport by carrier protein is lower than channel protein due to limited number if channel protein being saturated with ions



(e) Based on the information in Fig.2.1, sketch a graph of the result of the experiment. [1]

Rate of transport / $mmol.dm^{-3}.s^{-1}$

[Glucose] / $mmol.dm^{-3}$

Explain your answer:

.....

..... [1]

1. The rate of transport of a glucose across the plasma membrane is **directly related** to the concentration of the glucose but is **limited by the number of transport proteins in the membrane**.

[Total: 8]

Significance of transport proteins

- To transport charged, hydrophilic and polar molecules that are unable to transverse the hydrophobic core of phospholipid bilayer and hence interior of channels are lined with hydrophilic residues for transport of these molecules across cell membrane

Why is the rate of transport (that involves ATP hydrolysis) expected to stay constant, even if the concentration difference changes?

(d)
- Hydrolysis of **ATP provides energy** for the transport of molecules; [2]
- Molecules **transported against concentration gradient** does not require consideration of the concentration gradient;
- **Bulk transport of molecules into or out of the cell** does not take into account the concentration gradient;

▼ Notes

1. **ATP provides energy:** The process uses energy from ATP hydrolysis (breaking ATP into ADP + Pi) to power the transport. **This energy input is fixed and doesn't depend on how much more or less concentrated the molecules are outside/inside the cell.**

2. **Works against the gradient:** This type of transport (e.g., active transport) moves molecules *against t*heir natural concentration gradient (from low to high concentration). Since the energy comes from ATP (not the gradient), the rate stays steady regardless of how big the concentration difference is.
3. **Bulk transport exception:** For processes like endocytosis/exocytosis (where large amounts are moved at once), the **concentration gradient doesn't matter because the cell "decides" to move a set amount**

- **Passive Transport:** Rate depends on gradient (e.g., diffusion).
- **Active Transport:** Rate depends only on ATP availability (fixed speed).
- **Bulk Transport:** Gradient irrelevant; cell decides how much to move.

Features of active transport

- Requires ATP to provide energy for reaction to occur
- Requires a carrier protein
  - Note that channel protein is used in facilitated diffusion as no confrontational change is needed to open the gate of protein
- Carrier protein has specific binding sites
- Binding causes conformational changes in carrier proteins

Function of hydrocarbon tails in phospholipid bilayer of cell membrane

- Provides a hydrophobic core which acts as a selective barrier, restricting movement of charged ions, polar or hydrophilic molecules across membrane into cell

---

Describing and explaining the process of endocytosis

- Endocytosis is a process of bulk transport which involves bringing in macromolecules or molecules in large quantity into a cell and ATP is needed for this due to the rearrangement of cytoskeleton that causes infolding of cell membranes , forming an invagination of cell surface membrane forming

endosome/vesicle contains proteins formed within the cell from the infolding of cell surface membrane

- Substance taken up by cell via phagocytosis which involves the rearrangement of cytoskeleton forming pseudopodia which extend outwards to engulf the large insoluble macromolecule and solids.
- The ends of pseuodopia fuse, pinching off the cell surface membrane to form vesicles contains the foreign material
- A lysosomes then fuse with phagosome forming phagolysosome amd the hydrolytic enzymes in lysosome digest the contents into soluble products
- Useful products absorbed into cytoplasm while unwanted products are released out the cell via exocytosis
- There is also pinocytosis which is to bring in tiny vesicle of liquid when a small area of the plasma membrane invaginates
- For transport of molecules in large quantity against concentration gradient, receptor-mediated endocytosis occurs where specific ligands bind to receptor proteins in membrane causing invagination of membrane

---

Role of membrane

- Due to the hydrophobic core of phospholipid bilayer, membranes serve as a selectively permeable barrier to movement of ions, polar, charged and large molecules

this is for when question ask role of membranes WITHIN cells and not cell surface membrane:

- **Within a cell**, membrane allows compartmentalisation to occur allowing formation of unique environments for specialised activities such as enzyme reactions in lysosomes where an optimal pH is required, **For establishment of proton gradients within specialised organelles such as mitochondria and chloroplasts for chemiosmosis and formation of ATP**
- allow localisation of proteins of related function together so that sequential biochemical processes are facilitated for example enzymes and proteins are

grouped together into photosystems II and I on thylakoid membranes of chloroplasts facilitating electron energy transfer

- Increase surface area for chemical reactions such as highly folded cristae of mitochondria increases surface area for chemical reactions such as **highly folded cristae of mitochondria increases surface area for insertion of electron transport carriers and ATP synthase complexes for oxidative phosphorylation to take place**
- Site for protein synthesis at rough endoplasmic reticulum where translation takes place at ribosomes at RER membrane
- Allows storage of molecules within a separate environment to prevent degradation by other enzymes such as starch in amyloplasts

Transport of ATP and H+ ion

(d) ATP synthase facilitates both the transportation of H^+ ions and the production of ATP.

Describe two features that are similar between the processes. [2]

1. Specificity of channel of ATP synthase to H+ ions and active site of ATP synthase to ADP::
2. The higher the concentration of substance, i.e. proton or ADP, the higher the rate of transport across membrane and rate of ATP synthesis respectively::
3. AVP::

▼ Notes

How a phospholipid bilayer is formed

(a) Explain how the molecular structure of the phospholipid allows for the formation of the phospholipid bilayer.

.....[2]

1 Phospholipid molecule consists of (one) hydrophilic / polar phosphate head (of phospholipid) ; (two) hydrophobic / non-polar fatty acid tails;

2 Ref. ionic bonds or hydrogen bonds between phosphate heads or between phosphate heads and aqueous medium of the cytoplasm **and** the external environment

/ hydrophobic interactions between fatty acid tails; (facing away from the aqueous medium)

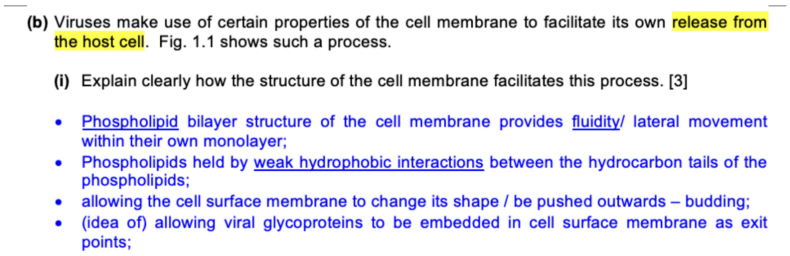
▼ Notes

- Describe structure of a phospholipid molecule + bonds
    - Consists of one polar, hydrophilic, charged phosphate head held by ionic & hydrogen bonds between phosphate head and aqueous medium of cytoplasm and external environment and two hydrophobic, non-polar fatty acid tails which are held by hydrophobic interactions between fatty acid tails
    - Phosphate heads faces outwards which is the aqueous medium and fatty acid tails faces inwards to shield itself from the aqueous environment forming a phospholipid bilayer

How a molecule travels across membrane by simple diffusion

- Diffuse directly across the phospholipid bilayer by interacting with hydrophobic fatty acids via hydrophobic interactions

How structure of cell membrane and aquaphorin channels facilitates movement of particles /water



(b) Viruses make use of certain properties of the cell membrane to facilitate its own release from the host cell. Fig. 1.1 shows such a process.

(i) Explain clearly how the structure of the cell membrane facilitates this process. [3]

- Phospholipid bilayer structure of the cell membrane provides fluidity/ lateral movement within their own monolayer;
- Phospholipids held by weak hydrophobic interactions between the hydrocarbon tails of the phospholipids;
- allowing the cell surface membrane to change its shape / be pushed outwards – budding;
- (idea of) allowing viral glycoproteins to be embedded in cell surface membrane as exit points;

- Two layers of amphitatic phospholipid molecules with hydrophilic phosphate heads facing the aqueous extracellular and intracellular medium of the cell and hydrophobic fatty acids tails facing inwards away from the aqueous medium forms hydrophobic core of the bilayer, adjacent phospholipid held by weak hydrophobic interactions between fatty acids tails
- Hydrophobic core restricts the free movement of hydrophilic,polar and charged substances across the membrane

- Fluid nature of membrane due to lateral movement of phospholipids contributes to slight permeability to water
- Aquaphorin channels have hydrophilic amino acid residues lining the pore or channel allowing passage of polar, hydrophilic and charged molecules down/against the concentration gradient and also have hydrophobic a,into acid residues forming hydrophobic interactions with the fatty acids tails to embed in the membrane

---

describing exocytosis

- secretory vesicles containing protein substances bud off from cisternae at trans face of Golgi body and move towards the cell surface membrane
- The membrane of the secretory vesicles fuses with CSM amd moved by microtubules to CSM
- ATP required
- Releasing protein out of cell via exocytosis

Explain why a CSM is described as a fluid mosaic?

- Fluid refers to phospholipids and proteins (state what protein on the CSM) being able to move laterally within a phospholipid bilayer
- If diagram shows cholesterol: cholesterol within the phospholipid molecule further increases the fluidity of the CSM
- Phospholipids are also being able to flip flop between a layer
- Mosaic refers to protein molecules embedded and scattered among the phospholipids, causing a random arrangement of proteins embedded amongst the phospholipid, resembling a mosaic pattern

---

Describe the structure of cell membrane including roles of constituent Biomolecules of cell membrane

- membrane is made up of 2 layers of phospholipids with hydrocarbon tails facing inside the membrane and phosphate heads facing outside next to the aqueous medium (describe arrangement of phospholipids in cell membranes)

- Constituents:
    - Cell membranes contain phospholipids, cholesterol and proteins
- Phospholipid: (explain how the structure of phospholipids is related to arrangement of cell membranes/how a phospholipid bilayer is formed)
    - Each phospholipid is made up of 2 hydrophobic hydrocarbon tails and a hydrophilic phosphate head attached to a glycerol
    - Phosphate head is charged and hydrophilic and will interact with water by hydrogen bonds hence facing outwards to the aqueous medium of the intracellular and extracellular environment
    - Hydrocarbon tails are non-polar and hydrophobic and arranged away from aqueous medium, forming hydrophobic interactions with each other forming a hydrophobic core in a phospholipid bilayer, serving as a barrier to movement of polar, charged, hydrophilic and large molecules
    - As hydrophobic interaction between the phospholipid are weak, phospholipids are able to move laterally in the bilayer contributing to fluidity of the membrane
- Cholesterol: (note that this is not a protein)
    - It is an amphipathic molecule with hydrophobic four ringed structure and a hydrophilic hydroxyl group
    - The OH group interacts with the phosphate heads of phospholipids while the 4 ring structures form hydrophobic interactions with the hydrophobic core of the membrane in order to be embed in the membrane
    - It is involved in regulation of membrane fluidity, prevents membrane from being overly fluid at high temperature by restricting phospholipids lateral movement with cholesterols rigidity and also prevents membrane from being overly firm at lower temperatures by preventing close packing of phospholipids
    - It also provides mechanical stability as it forms weak hydrophobic interactions with neighbouring hydrophobic chains of phospholipids
    - It also prevents entry of hydrophillic/ polar substances

- Glycolipids:
    - Acts as markers for cell-to cell recognition to distinguish cells as self or non self as the basis of immune system
    - Also results in cell adhesion allowing cells to be attached to one another to form tissues and organs
    - Acts as Recep for certain pathogens and toxins to bind to host cells and gain entry into the cell

If Question asks for proteins on cell membrane only:

- Transport proteins:
    - Proteins that are transmembrane as they are Embedded in membranes and control movement of polar charged and large molecules that are unable to diffuse through the hydrophobic core of the phospholipid bilayer. It has amino acid residues with non-polar R groups to form a hydrophobic region that interacts with the hydrophobic core of the membrane via hydrophobic interactions, allowing it to be embedded in the membrane.
    - Allow facilitated diffusion of polar or charged molecules or ions across a membrane via a transmembrane channel proteins that provide a hydrophilic channel, lined with amino acids with polar R groups, which allows for the diffusion of polar and charged molecules across the membrane
    - or via a carrier proteins where changes in conformation upon solute binding results in the solute being transported to other side of membrane and released.
    - Carrier proteins also assist in active transport of polar or charged molecules or ions across membranes via pimple against concentration gradient using ATP to driven active process
    - For transport of molecules in large quantity against concentration gradient, receptor-mediated endocytosis occurs where specific ligands bind to receptor proteins on membrane causing invagination of membrane
- Membrane proteins interact with the extracellular matrix on the exterior side and the cytoskeleton on the cytoplasmic side, maintaining shape of cell-and to

fix the location of some membrane proteins such as receptors and transport proteins

- Receptor proteins has a specific ligand it will bind to. The formation of ligand-receptor complex will initiate an intracellular signalling cascade for signal transduction and signal amplification
- Some proteins which are enzymes that carry out catalytic at cell membrane such as adenyl Cyclase that catalyses conversion of ATP to CAMP
- when combined with carbohydrates, glycoproteins are markers for cell to cell recognition due to their diversity, enabling distinguishing self from non-self is crucial for immune cell recognition and immune responses amd for cell to cell adhesion where cells of the same type to form tissues

Why do some molecules require transport proteins to travel across cell surface membrane?

- The molecule is polar and thus hydrophilic/ charged
- The molecule is too large and hence unable to pass through the transient pores of phospholipid bilayer
- Hydrophobic core of phospholipid bilayer would repel the molecule and hence transport proteins provide a hydrophilic channel

Functions of protein that forms the membrane channel

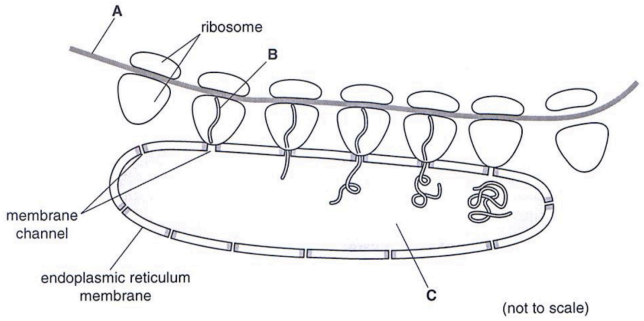


Fig. 1.1

- It functions as a receptor to bind to the signal peptide on the polypeptide

- It allows large molecules (e.g. polypeptide synthesised by the ribosome) to cross the membrane by binding to them / providing a polar channel through which they can pass;
- It holds the ribosome to the outer surface of the endoplasmic reticulum membrane while the polypeptide is being synthesised;

Explain effect of increasing external concentration of glucose on the rate of uptake of glucose into a cell

- As external concentration increases, the rate of uptake increases steeply but eventually the increase slow down and reaches maximum rate at a plateau
- As glucose is polar and hydrophilic, it would be repelled by the hydrophobic core of the phospholipid bilayer and hence require carrier proteins to transport across the membrane via facilitated diffusion
- But at high external concentration, carrier proteins become saturated and due to limited number of carrier proteins, they become a limiting factor and hence rate of uptake plateaus
- As external concentration increases, concentration gradient is steeper and increasing rate of uptake

Why is there no movement of substances despite it being present

- No concentration gradient/ diffusion gradient between two environments, concentration remains the same

Explain why inner mitochondrial membrane has more area than outer mitochondrial membrane

- Inner membrane is highly folded to increase surface area
- Allow more electron carriers of electron transport chain and ATP synthase to be embedded in it
- To increase rate if oxidative phosphorylation
- Outer mitochondria membrane is not folded and hence smaller area

Application question such as how gaseous exchange occur in plants (usually photosynthesis or respiration)

Common keywords:

- Gas dissolved in film of water surrounding cell wall and diffuses into cytoplasm DOWN a concentration gradient/ actively transported into cytoplasm AGAISNT concentration gradient (depending on context of question, need to figure out if gas is lower in concentration inside or outside the cell)
- Dissolved gas then further diffuses into organelles across single/double membrane
    - For photosynthesis, diffuses into stroma across double membrane of chloroplast where carbon fixation takes place via Calvin Cycle of photosynthesis