

Cell membranes and transport

A-Level Biology 9700 · Topic 4 revision notes

Everything from the 3 lessons of this topic on a few pages: the key idea of each lesson, the diagram to remember, the points to learn and the traps examiners set. Read it, cover it, test yourself.

1. The fluid mosaic model

2. Diffusion, active transport and bulk transport

3. Osmosis and water potential

1 The fluid mosaic model

Syllabus 4.1

A cell surface membrane is a **phospholipid bilayer**: the hydrophilic phosphate heads face the watery cytoplasm and tissue fluid, while the hydrophobic fatty acid tails point inward, away from water. It is **fluid** because the phospholipids and many proteins move sideways within their layer, and a **mosaic** because proteins are scattered through it. Cholesterol regulates fluidity and stability, channel and carrier proteins transport polar substances and ions, and the carbohydrate chains of **glycoproteins and glycolipids** act as receptors and recognition markers. In **cell signalling** a cell secretes a ligand, the ligand is transported to target cells, and it binds to a complementary receptor, which triggers a response inside the cell.

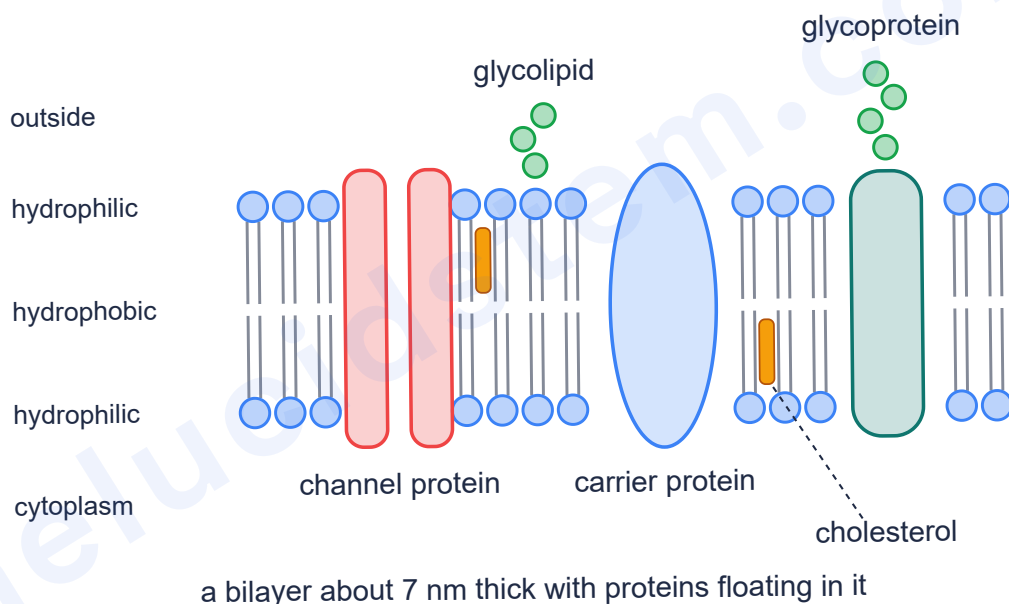


Fig. 1: a section through a cell surface membrane, showing the fluid mosaic model

Structure explains function.

- ✓ **Heads** hydrophilic, face water; **tails** hydrophobic, face inward.
- ✓ **Fluid** = molecules move sideways; **mosaic** = scattered proteins.
- ✓ **Carbohydrate chains** face outward: receptors and recognition.
- ✓ **Signalling:** secrete, transport, bind a complementary receptor, respond.

Watch out!

The hydrophobic core is what makes the membrane a barrier: ions and polar molecules such as glucose cannot pass through it easily. Say "hydrophobic core" or "hydrophobic fatty acid tails" in your answer, not just "the membrane is in the way".

Carbohydrate chains are found only on the **outer** surface of the cell surface membrane, facing the tissue fluid. A diagram with glycoproteins pointing into the cytoplasm will lose the mark.

2 Diffusion, active transport and bulk transport

Syllabus 4.2

Diffusion is the net movement of molecules or ions from a region of higher concentration to a region of lower concentration, down a concentration gradient, as a result of their random motion. It is passive. Small non-polar molecules such as O_2 and CO_2 diffuse straight through the bilayer (**simple diffusion**); ions and polar molecules need channel or carrier proteins (**facilitated diffusion**). Larger organisms and cells have a smaller **surface area to volume ratio**, so diffusion alone serves them less well. **Active transport** moves ions or molecules against their concentration gradient through carrier proteins, using energy from ATP made in respiration. Large particles and liquids cross in bulk inside vesicles: **endocytosis** into the cell and **exocytosis** out of it, both also using ATP.

rate of movement into the cell

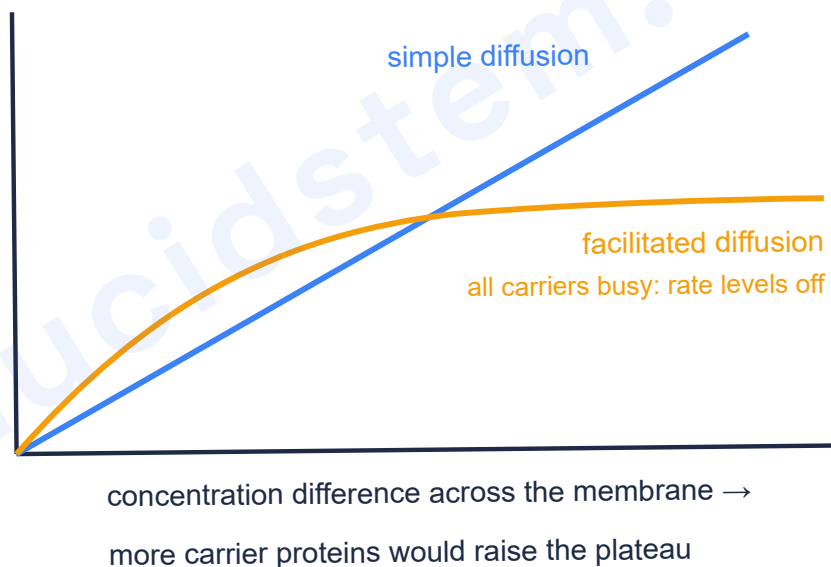


Fig. 1: how the rate of entry changes with the concentration difference for simple and facilitated diffusion

Route, gradient, energy.

- ✓ **Simple diffusion:** small, non-polar, through the bilayer.
- ✓ **Facilitated:** channel or carrier protein, still down the gradient, no ATP.
- ✓ **Active:** carrier protein, against the gradient, ATP.
- ✓ **SA : V** falls as size rises; give it as a ratio to 1.

Watch out!

Facilitated diffusion is still **passive**. The protein helps the substance across, but it only moves down its concentration gradient and no ATP is used. Do not write that carrier proteins always mean active transport.

The ratio **decreases** as size increases; it does not increase. And quote SA : V as a ratio to 1 (for example 3 : 1), showing the surface area and volume you used to get it.

3 Osmosis and water potential

Syllabus 4.2

Water potential (ψ) is the tendency of water to move out of a solution, measured in kPa. Pure water has the highest water potential, **0 kPa**; dissolving solutes lowers it, so all solutions have negative values. **Osmosis** is the net movement of water molecules from a region of higher water potential to a region of lower water potential, through a partially permeable membrane. An animal cell in a solution of higher water potential gains water and may burst; in a lower one it loses water and shrinks. A plant cell's wall stops it bursting, so it becomes **turgid**; in a solution of lower water potential the protoplast pulls away from the wall: **plasmolysis**. Soaking plant tissue in a range of solutions and finding where there is **no change in mass** gives the water potential of the tissue.

percentage change in mass

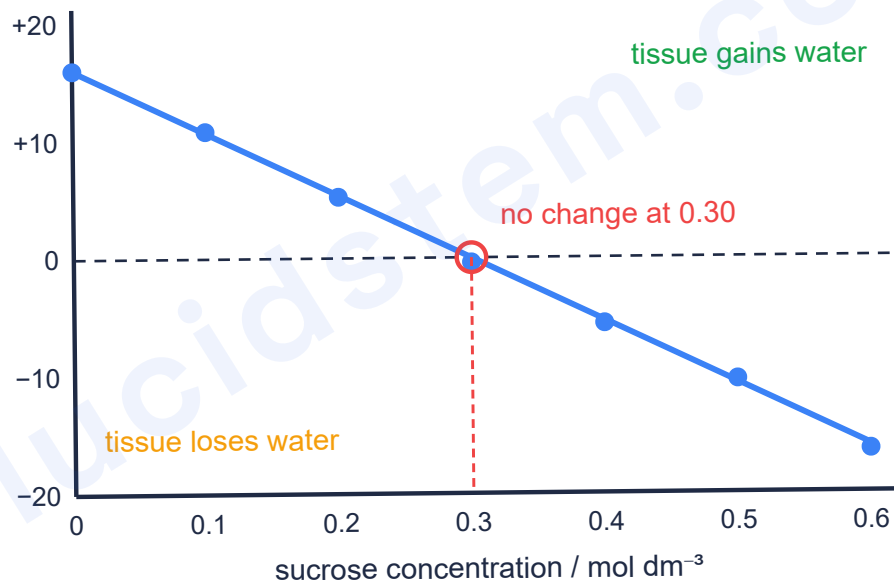


Fig. 1: percentage change in mass of potato cylinders after soaking in sucrose solutions; the line crosses zero at 0.30 mol dm^{-3}

Think in water potential.

- ✓ **Pure water** = 0 kPa; solutions are negative.
- ✓ **Osmosis:** water moves from higher to lower ψ across a partially permeable membrane.
- ✓ **Animal cells** burst or crenate; **plant cells** become turgid or plasmolysed.
- ✓ **No change in mass** = solution ψ equals tissue ψ .

Watch out!

Say "from a higher water potential to a lower water potential", not "from a high concentration to a low concentration". "Concentration" is ambiguous (of water or of solute?), and AS mark schemes expect osmosis to be explained in terms of water potential.

A cylinder that gains mass was in a solution of **higher** water potential than its cells. Do not say the potato "absorbed sucrose"; the membrane is partially permeable, and the mass change is due to water moving by osmosis.