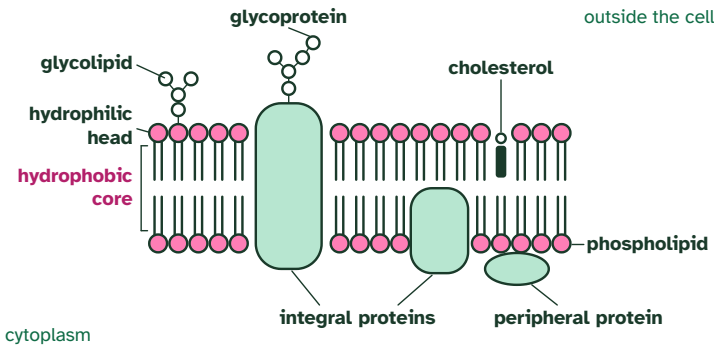
A *barrier* with doors

What to know, what to draw and what to say. Nothing else.

THE ONE IDEA

The lipid bilayer keeps out ions and polar molecules. Its proteins decide what else crosses, and whether that costs ATP.



Draw it like this. Sugars on the outside only; cholesterol among the tails (animal cells).

B2.1.9 and 10 START HERE

The *fluid mosaic* model

- **Fluid:** phospholipids and many proteins **drift sideways** within their layer. **Mosaic:** proteins are scattered through the bilayer like tiles.
- **Glycoproteins** and **glycolipids** carry short, branched sugar chains, always on the **outer side** of the plasma membrane.
- The sugars are identity tags, for **cell recognition** (the ABO blood groups; immune cells telling self from non-self) and **cell adhesion**.
- **Draw it with** the bilayer, integral and peripheral proteins, a glycoprotein and cholesterol; label the **hydrophilic** and **hydrophobic** regions.

B2.1.1

A bilayer that *builds itself*

- A phospholipid is **amphipathic**: it has a hydrophilic part and a hydrophobic part.
- In water they form a **bilayer** by themselves: heads face the water, tails face each other.
- The sheet closes on itself, so it is **continuous**: no tails are left touching water.

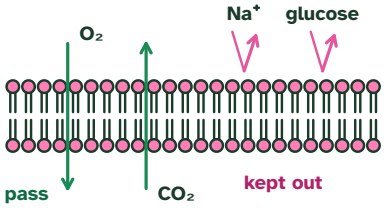
Head hydrophilic
A phosphate group, attracted to water.

Two tails hydrophobic
Fatty acids, squeezed together by the water round them, not by a bond.

B2.1.2 and 3

A barrier with gaps for *small* things

- The hydrophobic core of hydrocarbon tails has **low permeability** to ions, polar molecules and large molecules: a barrier between two watery solutions.
- **Simple diffusion:** small, uncharged O_2 and CO_2 slip **between the phospholipids**, down their gradient, with no energy spent.



B2.1.4

Proteins *in* it and *on* it

- Membrane proteins vary in **structure, position and function**: channels, pumps, enzymes, receptors, anchors for the cytoskeleton.
- Only a detergent that breaks up the bilayer frees an integral protein.

Integral embedded
In **one or both** layers, held by a hydrophobic part among the tails. Channels and pumps cross both.

Peripheral attached
On the inner or outer **surface**, to the heads or to an integral protein.

B2.1.5

Osmosis and *aquaporins*

- **Osmosis:** the net movement of water **towards the higher solute concentration**.
- **Why:** water moves **at random**, both ways, but the membrane holds back solutes. On the concentrated side more water is held round solute particles, so fewer cross back.
- **Aquaporins:** integral proteins with a **narrow hydrophilic pore**. Water passes in single file; ions are kept out by size and charge.

Through the bilayer slow
Small, but polar: few squeeze between the phospholipids.

Through aquaporins fast
Billions a second through each. Many in kidney collecting ducts and plant roots.

B2.1.6 to 8

Channels open, *pumps* push

- **Channel protein:** a hydrophilic pore whose width and charges fit **one kind of ion**. Gate open, ions diffuse through; shut, none pass.
- **Pump protein:** binds a specific particle and uses **energy from ATP** to change shape, moving it **against the gradient**.

	SIMPLE DIFFUSION	FACILITATED DIFFUSION	ACTIVE TRANSPORT
Route	Through the bilayer	Channel protein	Pump protein
Energy	None: passive	None: passive	**ATP**
Direction	Down the gradient	Down the gradient	Can go against it
Selective	No: size and polarity only	Yes: one kind of ion	Yes: specific particles
Example	O_2 in, CO_2 out	Na^+ channel	Na^+ pumped out

Proteins make a membrane **selectively permeable**.

Remember: *Down needs no ATP*

Fluid membranes, *gates* and pumps

B2.1.11 and 12 HIGHER LEVEL

Not too stiff, not too *runny*

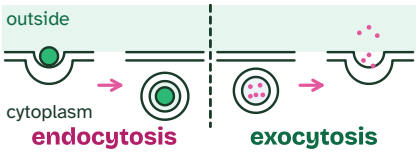
- **Saturated** tails are straight and pack tightly: **higher melting points**, so stronger at high temperatures.
- **Unsaturated** tails kink and pack loosely: **lower melting points**, so fluid at the cell's temperature.
- **Habitat:** Antarctic icefish (water at about −2 °C) have many unsaturated fatty acids.
- **Cholesterol** (animal cells) sits among the tails, its OH by the heads. A **modulator**: less fluid when warm, less stiff when cold.



B2.1.13 HIGHER LEVEL

Vesicles form and fuse

- Fluidity lets a membrane **pinch off a vesicle** or fuse with one, leaving no hole. Both use ATP.
- **Endocytosis:** the membrane folds in round material. Phagocytes take in bacteria; a newborn calf's gut cells, antibodies from milk.
- **Exocytosis:** a vesicle **fuses with the plasma membrane**, releasing digestive enzymes from gland cells or neurotransmitters from neurons.



B2.1.17 HIGHER LEVEL

Cells held in *tissues*

- **Cell-adhesion molecules** (CAMs) are membrane proteins that bind CAMs on the next cell. **Different forms** make different junctions.

SEAL
Gut lining
Nothing leaks between cells.

ANCHOR
Skin, heart muscle
Holds when stretched.

SIGNAL
Other junctions
Cells pass signals.

B2.1.14 and 15 HIGHER LEVEL

Gates and a *pump* in neurons

- **Neurotransmitter-gated:** acetylcholine binds the **nicotinic acetylcholine receptor**; it opens and Na^+ diffuses in.
- **Voltage-gated:** **Na^+ and K^+ channels** open or close as the membrane voltage changes, carrying the nerve impulse.
- **Na^+/K^+ pump**, an **exchange transporter**: 3 Na^+ out, 2 K^+ in per ATP, both against their gradients. With K^+ leaking out, the inside is negative: the membrane potential, about −70 mV.

STEP 1
Na^+ bind
Three Na^+ bind from the cytoplasm.

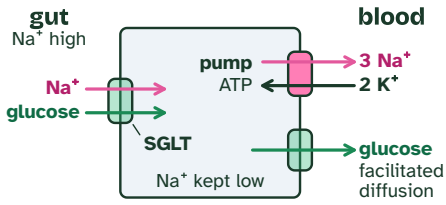
STEP 2
ATP
Phosphorylated, it changes shape and releases Na^+ outside.

STEP 3
K^+ bind
Two K^+ bind; phosphate off, shape back, K^+ released inside.

B2.1.16 HIGHER LEVEL

Glucose *hitches a ride*

- The **Na^+/K^+ pump** on the blood side uses ATP to keep **Na^+ low inside** the gut lining cell.
- The **SGLT** on the gut side lets Na^+ in only with glucose: Na^+ moving down its gradient carries **glucose up its gradient**.
- **Indirect active transport**: the cotransporter spends no ATP. Used in the **small intestine** and the **nephron**, so no glucose is lost in urine.



WATCH OUT

Six mistakes that *cost marks*

- ✕ **Facilitated diffusion is passive.** It uses a protein but no energy.
- ✕ **Small is not enough.** Na^+ is smaller than O_2, but its charge keeps it out of the bilayer.
- ✕ **Aquaporins do not pump water.** Water goes through by osmosis, whichever way the solutes decide.
- ✕ **Integral does not mean "crosses the membrane".** One layer is enough, if part is among the tails.
- ✕ **Cholesterol does not just stiffen.** Give both ends: less fluid when warm, less stiff when cold.
- ✕ **The SGLT spends no ATP.** Stop the pump and it stops too, as the Na^+ gradient runs down.

COVER THE SHEET

Can you *answer these?*

1. Explain why phospholipids form a bilayer in water.
2. Explain why O_2 crosses the bilayer but Na^+ does not.
3. Distinguish integral from peripheral proteins.
4. Explain osmosis, and the role of aquaporins.
5. Compare facilitated diffusion with active transport.
6. Draw the fluid mosaic model; state two roles of its sugars.
7. Explain how fatty acids and cholesterol set fluidity. HL
8. Distinguish endocytosis from exocytosis. HL
9. Outline the gated channels and the pump in a neuron. HL
10. Explain why the SGLT is indirect active transport. HL
11. Outline the role of CAMs in tissues. HL

IN THE EXAM

Name the method, then the protein, the direction and the energy: "facilitated diffusion through a channel protein, down the concentration gradient, no ATP".

GO FURTHER

Animated figures, a dry lab and a marked Check are in the full guide online.