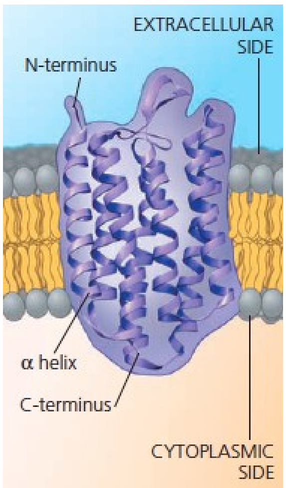
<u>Concept 7.1</u>: Cellular membranes are fluid mosaics of lipids and proteins

- <u>Lipids</u>: Non-polar substances such as fat that contain C, H, O.
- <u>Phospholipids</u>: Lipid with phosphate group, very abundant in plasma membranes, **amphipathic** (hydrophilic/hydrophobic components) → **phospholipid bilayer**.
- <u>How do we know it is fluid mosaic?</u>
  - Fluoresce proteins of mouse cell, do the same with human cell (different colour).
  - Fuse the two cells, wait, proteins get mixed up.
- Proteins embedded in bilayer.
  - <u>Integral</u>: Penetrates hydrophobic part of bilayer, usually transmembrane.
  - <u>Peripheral</u>: Loosely bound to the outside (membrane surface/external part of integral proteins).
  - Proteins are arranged purposefully. See *Figure 7.1.1.*
- Membrane is **fluid**, held by weak hydrophobic forces.
  - Temperature **low** → solidified membrane → **lower fluidity** (and v.v).
  - **Unsaturated** phospholipids → **kinks** in tail → can't pack closely → **higher fluidity**.
  - Cholesterol has different effects on membrane fluidity (**fluidity buffer**; resists changes).
    - Temperature **high** → restrains membrane movement → **lowered fluidity**.
    - Temperature **low** → increases membrane movement → **higher fluidity**.
  - Phospholipids move sideways, but rarely vertically.
- <u>Extracellular matrix</u>: Keeps the cell in place in the tissue (SUPPORT)
- <u>Cytoskeleton</u>: Gives the cell its shape (SUPPORT).
- <u>Membrane sidedness</u>: Asymmetric (different on extracellular/cytoplasmic sides) arrangement of proteins, lipids and carbohydrates.

Figure 7.1.1: Structure of Transmembrane Protein



- Non-helical hydrophilic segments are at the **ends** of the protein (near aqueous solutions).
- α-helical structure of hydrophobic segments in the **middle** of the bilayer.

Concept 7.2: Membrane structure results in selective permeability

- Selective permeability: Allows certain molecules to pass.
  - Permeable to small, non-polar molecules (O_2, CO_2, hydrocarbons), and a little water by diffusion.
  - Not permeable to ions, small hydrophilic molecules (glucose), macromolecules.

Concept 7.3: Passive Transport

- Diffusion: Random movement of particles to spread out into available space and become **equally distributed** (eliminate concentration gradients).
  - **Passive** (doesn't expend energy).
- Osmosis: Diffusion of water through selectively permeable membrane into another aqueous compartment containing solute at **higher concentration**.
  - Lots of things can't move through the membrane, so they can't diffuse to equalise concentration → water moves instead (water wants to be at equilibrium).
- Osmotica: 'Osmotically active', i.e. don't get across the membrane. Need water to move to equalise concentration.
  - Ions, sugars, proteins, nutrients.
  - For osmosis calculations, **just add up all solutes on each side** (don't think of them separately).
- Tonicity: Ability of a solution to lose or gain water.
  - **FOR ANIMAL CELLS** (no cell walls)
    - Isotonic: Solute concentration = inside the cell → **no net movement**.
    - Hypertonic: Solute concentration > inside the cell → **water exits the cell** → **cell shrivels.**
    - Hypotonic: Solute concentration < inside the cell → **water enters the cell** → **cell swells and lyses**.
  - **FOR PLANT CELLS** (cell walls)
    - Isotonic: Flaccid.
    - Hypertonic: Cell wall has no advantage, still shrinks. Membrane pulls away from the cell wall (plasmolysed).
    - Hypotonic: Water pushes against the cell, cell wall pushes back (**turgor pressure**) → very firm and turgid cell (**healthy**).
- Calculations
  1. Determine which molecules are osmotically active!
  2. Calculate osmolarity (does it split up into individual ions, e.g. NaCl, or does it remain as one molecule, e.g. glucose).
  3. Compare tonicity.
- Facilitated diffusion: Substances impeded by bilayer diffuse passively with help of **transport proteins**.
  - Channel proteins: Hydrophilic 'tunnel' that allow specific ion/molecule to cross the membrane. **FACILITATED DIFFUSION → NEVER ACTIVE TRANSPORT**. Often transmembrane proteins.
    - Include aquaporins (water), or ion channels that respond to stimulus (gate channels).
  - Carrier proteins: Attach to polar substances, change shape to 'shuttle' through membrane. **FACILITATED DIFFUSION OR ACTIVE TRANSPORT.**
  - Transport proteins are **specific** to molecule.

Concept 7.4: Active Transport

- Active Transport: Moves substances **against** concentration gradient, **uses energy** (e.g. ATP) and **carrier proteins**.
  - Allows cell to maintain internal solute concentration that differs from surroundings.
  - Example: Animal cell has **high [K^+]** and **low [Na^+]** compared to environment. Active transport allows it to pump out Na^+ and pump in K^+ against concentration gradient.
- Cotransport: Active transport of a solute indirectly drives transport of another solute.
  - Couples 'down-hill' diffusion of solute to 'uphill' active transport of second solute.
- Electrogenic pump: Transport protein that generates voltage across membrane.
  - Have to consider both electrochemical and concentration gradient. Same direction = passive, opposing direction = active.
- Sodium-potassium pump: Electrogenic pump. **3 Na^+ out, 2 K^+ in = inside is (-), outside is (+).** *See Figure 7.4.1*
  - Hydrolysis of ATP → ADP and P_1 stimulates active transport of **3 Na^+ out of the cell and 2 K^+ molecules into the cell** against both their concentration gradients.
  - Working with the sodium-glucose cotransporter: Since concentration gradient now exists for Na^+ (high outside the cell, low inside the cell), 2 Na^+ molecules **passively diffuse** into the cell, **along with the glucose** against its concentration gradient through cotransport.
- Hydrogen ion-sucrose cotransporter in plant cells: *See Figure 7.4.2*
  1. ATP drives active transport of H^+ out of the cell through proton pump.
  2. Since concentration gradient now exists for H^+ (high outside the cell, low inside the cell), hydrogen ions **passively diffuse** into the cell, **along with sucrose** against its concentration gradient through cotransport.

Figure 7.4.1

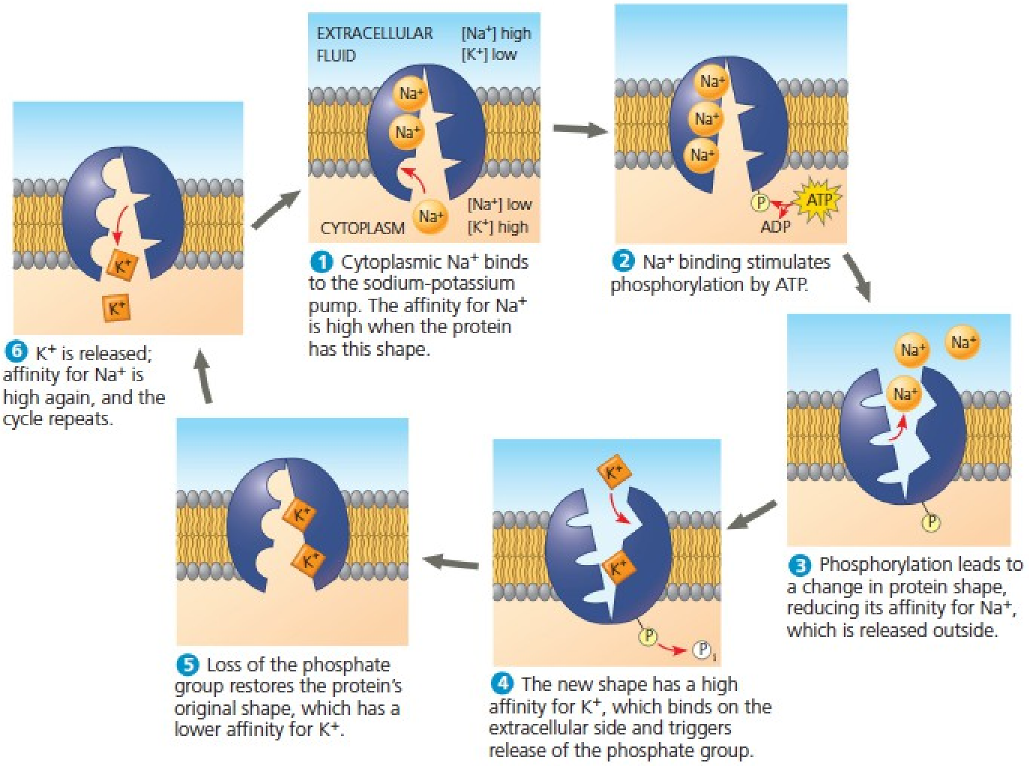
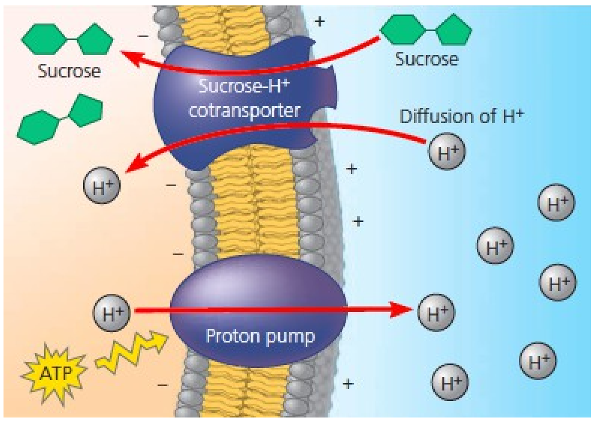


Figure 7.4.2



Concept 7.5: Bulk Transport

- Bulk Transport: Movement of macromolecules in/out of cell. Done by exocytosis or endocytosis.
  - Exocytosis: Secreting/releasing molecules by fusing existing vesicles into the plasma membrane.
  - Endocytosis: Cell engulfs molecules and particulates by forming new vesicles in the plasma membrane.
    - Phagocytosis: Cell engulfs a **particle** by extending pseudopodia around it and packaging it into a **food vacuole**.
    - Pinocytosis: Cell 'drinks' **extracellular fluid** (non-specific, takes in all solutes) into **coated vesicles**.
    - Receptor-mediated endocytosis: Specialised pinocytosis that allows the cell to take in **bulk quantities** of **specific substances** (not all solutes) using **receptor proteins**.