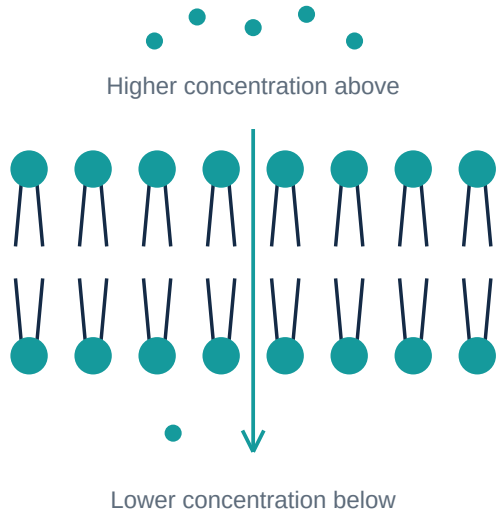
Two routes down a gradient

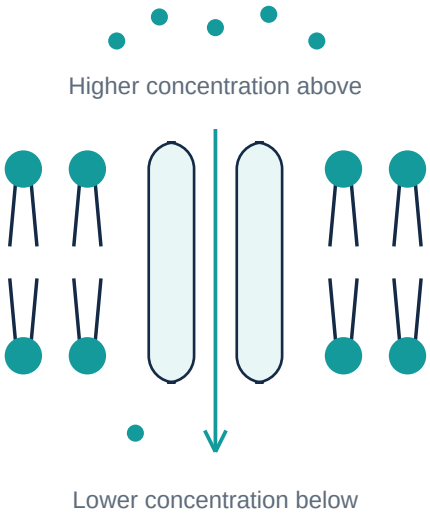
Simple and facilitated diffusion are passive: neither requires a direct input of ATP. The difference is the route through the membrane.

1. COMPARE THE ROUTES

SIMPLE DIFFUSION



FACILITATED DIFFUSION



2. SIMPLE DIFFUSION: THROUGH THE LIPID BILAYER

Small non-polar molecules such as O_2 and CO_2 dissolve in the lipid region and cross directly. Their net movement is from higher to lower concentration. No channel or carrier is needed.

3. FACILITATED DIFFUSION: THROUGH A PROTEIN

A channel provides a selective hydrophilic pore. A carrier binds a solute, changes shape and releases it on the other side. Examples include ions passing through channels and glucose moving through suitable carriers.

Particles keep moving randomly in both directions. At dynamic equilibrium there is no net movement, not no movement. For ions, electrical differences as well as concentration affect the direction of passive transport.

Diffusion, channels and carriers: OpenStax Biology 2e, section 5.2.
Permeability and transport gradients: Alberts et al., Principles of Membrane Transport.

Scope: Cambridge Biology 9700 syllabus, section 4.2, outcome 1, p. 21.

Water flow and uphill transport

Identify both the substance and its gradient. Osmosis moves water down a water-potential gradient; active transport can move a solute against its gradient.

1. OSMOSIS: WATER MOVES, NOT THE SOLUTE

Net movement of water through a partially permeable membrane from higher water potential to lower water potential. No ATP is required.



Centre line: membrane permeable to water, not the solute in this model.

2. ACTIVE TRANSPORT: AN ENERGY-COUPLED CARRIER

In an ATP-driven pump, energy from ATP hydrolysis drives changes in the carrier protein. Solute can be moved from lower to higher concentration.

A. BIND

Solute binds on the lower-concentration side.

B. CHANGE SHAPE

ATP supplies energy for the carrier cycle.

C. RELEASE

Solute is released on the higher-concentration side.

Example: the sodium-potassium pump maintains ion gradients in animal cells.

Water-potential check: -0.2 MPa is higher than -0.8 MPa. Use water potential, not solute concentration alone, when pressure differs. Aquaporins speed water movement; they do not make osmosis active.

Supporting distinction: some active carriers use an ion gradient as an indirect energy source rather than hydrolysing ATP themselves.

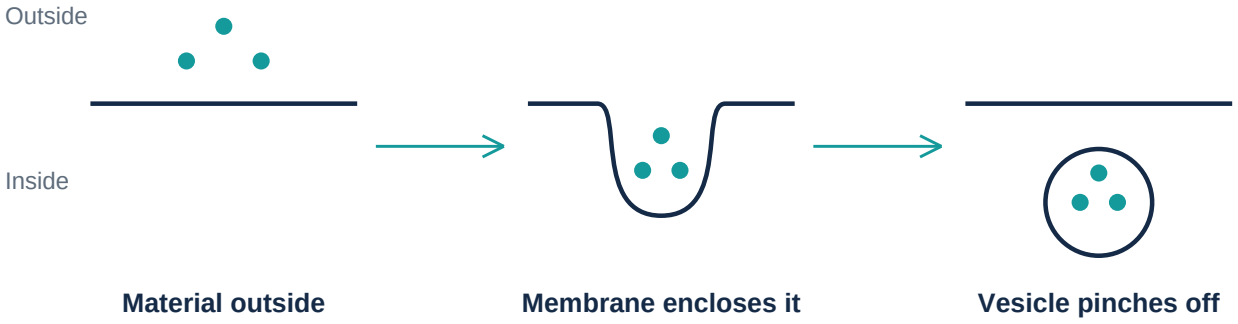
Osmosis and aquaporins: OpenStax Biology 2e, section 5.2.
ATP-driven pumps and coupled transport: OpenStax Biology 2e, section 5.3.

Scope: Cambridge Biology 9700 syllabus, section 4.2, outcome 1, p. 21.

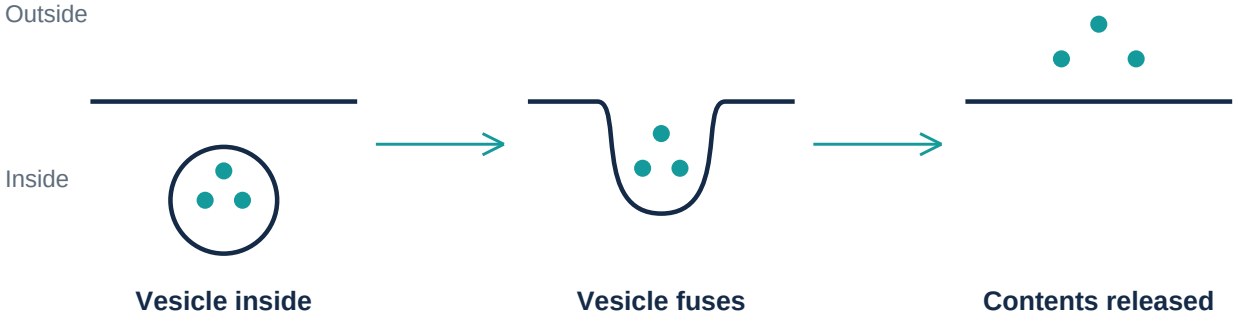
Transport in membrane sacs

Endocytosis and exocytosis use energy and vesicles. Cargo is enclosed by membrane rather than passing through a channel or dissolving in the lipid core.

1. ENDOCYTOSIS: INTO THE CELL



2. EXOCYTOSIS: OUT OF THE CELL



3. SIX PROCESSES AT A GLANCE

PROCESS	MAIN ROUTE / DIRECTION
Simple diffusion	Bilayer; down concentration gradient
Facilitated diffusion	Channel or carrier; down relevant gradient
Osmosis	Water; higher to lower water potential
Active transport	Energy-coupled carrier; against gradient
Endocytosis	Membrane encloses cargo into a vesicle
Exocytosis	Vesicle fuses with membrane; cargo exits

Diagrams are stages over time; each navy line represents a membrane bilayer.

Vesicle formation and fusion: OpenStax Biology 2e, section 5.4.
Solute transport comparison: Alberts et al., Principles of Membrane Transport.

Scope: Cambridge Biology 9700 syllabus, section 4.2, outcome 1, p. 21.