

Osmosis

4.1.3.2 · Cell biology · revision notes

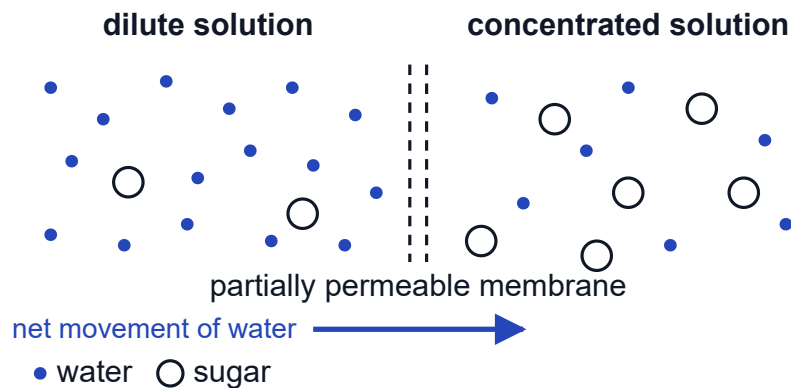
Osmosis is the diffusion of water across a partially permeable membrane. Questions ask you to define it, predict and explain the movement of water into or out of cells, and use the results of the osmosis required practical, including percentage change in mass calculations and graphs.

Key facts

- Osmosis: diffusion of water from a dilute to a concentrated solution through a partially permeable membrane
- Partially permeable membrane: lets water through, but not larger solute molecules
- Rate of change in mass = $\text{change in mass} \div \text{time}$
- Loss in mass: solution more concentrated than the cell contents
- Dilute solution: lots of water, little solute; concentrated solution: more solute, less water
- % change in mass = $(\text{final mass} - \text{starting mass}) \div \text{starting mass} \times 100$
- Gain in mass: solution more dilute than the cell contents
- 0% change: solution has the same concentration as the cell contents

What osmosis is

- **Osmosis** is the diffusion of water from a **dilute solution** to a **concentrated solution** through a **partially permeable membrane**.



Osmosis: water moves from the dilute solution to the concentrated solution. The sugar molecules are too big to pass through the membrane.

- A dilute solution has a lot of water and little dissolved solute. A concentrated solution has more solute and less water.
- A partially permeable membrane, such as the cell membrane, lets small molecules like water through but not larger molecules like sugar.
- Water molecules move both ways, but the net movement is into the more concentrated solution. Osmosis is passive: it needs no energy from respiration.

Osmosis in cells

- If the solution outside a cell is more dilute than the cell contents, water moves into the cell.
- If the solution outside is more concentrated than the cell contents, water moves out of the cell.
- If the concentrations are the same, there is no net movement of water.
- Animal cells have no cell wall: in pure water they swell and may burst; in a concentrated solution they shrivel.
- Plant cells in water swell and become firm (turgid), but the cell wall stops them bursting. In a concentrated solution they lose water and become soft (flaccid).

Required practical: osmosis in plant tissue

- Cut potato cylinders of the same size (e.g. with a cork borer), blot them dry and record the starting mass of each.
- Put one cylinder in each of a range of sugar or salt solutions (e.g. 0.0 to 1.0 mol/dm³), with the same volume, for the same time and at the same temperature.
- Remove the cylinders, blot them dry to remove surface solution, and reweigh them.
- Calculate the percentage change in mass. Use percentage change because the cylinders start with different masses.

How to answer each type of question

Predict and explain the movement of water

2 marks

Grade 4

1. Decide which solution is more dilute and which is more concentrated.
2. Water moves from the dilute solution to the concentrated solution.
3. Name the process (osmosis) and the partially permeable membrane.

Example. The contents of a plant cell have a solute concentration of 0.3 mol/dm^3 . The cell is placed in a sugar solution with a concentration of 0.5 mol/dm^3 .

Describe and explain the movement of water.

Model answer. Water moves out of the cell (1), by osmosis from the more dilute solution inside the cell to the more concentrated solution outside, through the partially permeable cell membrane (1).

Calculate percentage change and rate of change in mass

2 to 3 marks

Grade 5

1. Change in mass = final mass – starting mass (negative for a loss).
2. Divide by the STARTING mass and multiply by 100.
3. For a rate, divide the change in mass by the time taken.

Example. A potato cylinder had a mass of 2.50 g. After 30 minutes in a salt solution its mass was 2.20 g.

- (a) Calculate the percentage change in mass.
- (b) Calculate the mean rate of mass loss in g per minute.

Model answer. (a) $2.20 - 2.50 = -0.30 \text{ g}$ (1)

$-0.30 \div 2.50 \times 100 = -12\%$ (1)

(b) $0.30 \div 30 = 0.01 \text{ g per minute}$ (1)

Don't lose marks

- ✗ Saying water moves 'from high concentration to low concentration' without saying of what. Say from a dilute solution to a concentrated solution.
- ✗ Saying sugar or salt moves by osmosis. Only water moves by osmosis.
- ✗ Dividing by the final mass instead of the starting mass in a percentage change.
- ✗ Leaving the minus sign off a loss in mass.
- ✗ Saying plant cells burst in water. The cell wall stops this.
- ✗ Not blotting the tissue before weighing, so surface liquid adds to the mass.

More tips

Memory tricks

- Water follows the solute: water moves towards the side with more dissolved substance.
- Positive % change = water moved in; negative = water moved out; zero = no net movement.
- Osmosis is just the diffusion of water, so it is also passive and a net movement.
- Sense check: potato in pure water should gain mass; in a strong sugar solution it should lose mass.

Exam technique

- Always give the full definition: diffusion of water, dilute to concentrated, partially permeable membrane.
- In the practical, say why each step is done: same size pieces for a fair test, blotting to remove surface solution, percentage change because starting masses differ.
- To find the concentration of the cell contents, draw a line of best fit and read where it crosses 0% change in mass.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3

Define osmosis

The diffusion of water from a dilute solution to a concentrated solution through a partially permeable membrane.

Grade 4

Predict the direction of water movement

Water moves from the more dilute solution into the more concentrated solution.

Grade 5

Describe the osmosis required practical

Weigh pieces of plant tissue, leave them in a range of concentrations, then reweigh them.

Grade 5

Calculate percentage change in mass

$\text{Change in mass} \div \text{starting mass} \times 100$; a loss in mass gives a negative answer.

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