IGCSE and O Level Biology osmosis

Notes, practice questions and answers for Cambridge IGCSE Biology 0610 and O Level Biology 5090. Free from numrahedu.com.

Osmosis key words

Term	Meaning
Solvent	The liquid that dissolves a substance. In cells and organisms, the solvent is usually water.
Solute	The substance that dissolves, such as sugar or salt.
Solution	A solute dissolved in a solvent.
Dilute solution	Has less solute and more water. It has a higher water potential.
Concentrated solution	Has more solute and less water. It has a lower water potential.
Partially permeable membrane	Lets small molecules such as water pass, but stops larger molecules such as sugar.
Water potential	A measure of how readily water molecules move. Pure water has the highest water potential.
Osmosis	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.
Turgid	A plant cell that is swollen and firm because water has entered.
Turgor pressure	The pressure of the cell contents pushing outwards on the cell wall.
Flaccid	A plant cell that is soft because it has lost water, so it no longer presses on the wall.
Plasmolysis	The cell membrane and cytoplasm pull away from the cell wall after a plant cell loses a lot of water.

Why water moves

Water molecules move randomly and cross the membrane in both directions. More cross from the dilute side to the concentrated side, so the overall movement is called net movement. The energy comes from the kinetic energy of the moving molecules, so osmosis does not need energy from respiration.

Water is also the solvent in living things. Digestion, excretion and transport all depend on substances being dissolved in it.

What osmosis does to cells

Dilute solution or pure water

The solution has a higher water potential than the cell, so water enters by osmosis.

Plant cell



Turgid. The vacuole swells and the contents press on the wall. The wall stops the cell from bursting.

Animal cell



Swells and may burst, because it has no cell wall.

Same water potential as the cell

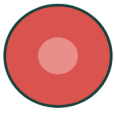
Water crosses both ways at the same rate, so there is no net movement.

Plant cell



Stays the same. No overall change in size.

Animal cell

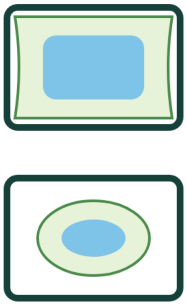


Stays the same. No overall change in size.

Concentrated solution

The solution has a lower water potential than the cell, so water leaves by osmosis.

Plant cell



Flaccid, then plasmolysed if it loses a lot of water. The membrane pulls away from the wall.

Animal cell



Shrinks. It cannot plasmolyse, because it has no cell wall.

Why this matters to plants

- Turgid cells press against each other and give soft parts of a plant their support.
- When a plant loses more water than it takes in, cells become flaccid and the plant wilts.
- Root hair cells take in water from soil by osmosis when the soil water has a higher water potential than the cell.

Osmosis experiments to know

Potato cylinders in sugar solutions

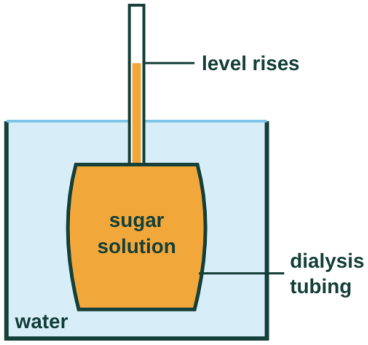
1. Cut equal potato cylinders with a cork borer, and trim them to the same length.
2. Blot each cylinder dry and measure its mass.
3. Put one cylinder in each boiling tube of a different sugar solution, plus one in distilled water.
4. Leave them for the same time, such as 30 minutes.
5. Remove each cylinder, blot it dry and measure its mass again.
6. Calculate the percentage change in mass. Repeat at each concentration and find the mean.

Fair test. Distilled water shows the largest gain. Keep the volume of solution, the temperature and the time the same.

Remember. Blot in the same way each time, since water left on the surface adds to the mass.

Dialysis tubing and sugar solution

1. Tie one end of a length of dialysis tubing and fill it with concentrated sugar solution.
2. Fix a narrow glass tube into the open end and mark the starting liquid level.
3. Stand the tubing in a beaker of distilled water.
4. Measure the liquid level in the narrow tube at regular intervals.



Fair test. Set up the same apparatus with distilled water inside the tubing. The level should not rise.

Remember. Rinse the outside of the tubing first, so that no sugar is in the beaker at the start.

Looking at plasmolysis

1. Peel a thin layer of red onion epidermis and put it on a slide.
2. Add a drop of concentrated sugar solution and a cover slip.
3. Look at the cells with a microscope, and compare them with cells in distilled water.

Fair test. Cells in distilled water stay turgid, so they can be compared with the cells in the sugar solution.

Remember. In a plasmolysed cell, the coloured contents shrink away from the cell wall.

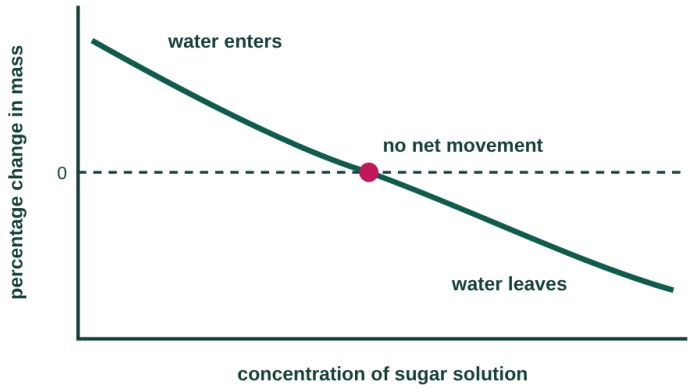
Percentage change in mass

Percentage change = (final mass - starting mass) ÷ starting mass × 100

Example with made-up values: a cylinder goes from 20.0 g to 22.5 g. The change is 2.5 g, and 2.5 ÷ 20.0 × 100 = 12.5, so it gained 12.5%. A loss gives a negative answer.

Percentage change is used because the starting masses may not be exactly the same, so it allows a fair comparison.

On a graph of percentage change against concentration, the line crosses zero where there is no net movement. At that point the solution and the potato cells have about the same water potential.



Numrahedu.com: the graph shows the shape to learn, not real data.

How to write your answers

Avoid	Write
Water moves from high to low concentration.	Water moves from higher to lower water potential, or from a dilute to a concentrated solution.
Sugar moved into the potato.	Water moved out of the potato by osmosis. Sugar molecules are too large to pass through the membrane.
Water stops moving at equilibrium.	Water still crosses both ways, but there is no net movement.
The plant cell burst.	The plant cell became turgid. The cell wall stops it from bursting.
The red blood cell was plasmolysed.	The red blood cell shrank. Plasmolysis happens only in cells with a cell wall.
The cell wall is partially permeable.	The cell membrane is partially permeable. The cell wall is fully permeable.
The cell is flaccid, so its membrane has pulled away.	A flaccid cell is soft. A plasmolysed cell has its membrane pulled away from the wall.

Fair tests and evaluation

- **Keep other variables the same.** Use cylinders from the same potato, and keep their size, the solution volume, the temperature and the time the same.
- **Blot in the same way.** Water left on the outside changes the mass, so dry each cylinder in the same way.
- **Use a range of concentrations.** Include distilled water, and use more concentrations near the point where the mass does not change.
- **Repeat and find a mean.** Repeats help you spot an anomalous result and make the results more reliable.
- **Use a precise balance.** A small change in mass needs a balance that reads to at least 0.1 g.
- **Plot a graph.** A line of best fit lets you estimate the concentration at which there is no net movement.

Hazards and precautions

What	Hazard	Precaution
Cork borer or scalpel	Can cut skin	Cut away from your hand, on a white tile or cutting surface.
Glass tubes and slides	Can break and cut	Handle with care and report any breakage.
Spilt solutions	Floors can become slippery	Wipe up spills straight away.

Osmosis questions

12 original questions, 42 marks. Answer on paper, then mark your work with the answers at the end.

Q1. Defining osmosis [3 marks]

Describe what is meant by osmosis.

Q2. Solute and solvent [2 marks]

Salt is dissolved in water. Name the solute and the solvent.

Q3. Percentage change [4 marks]

A potato cylinder of 16.0 g has a final mass of 14.0 g. (a) Calculate the percentage change in mass. [2] (b) Explain why it lost mass. [2]

Q4. Reading a graph from results [5 marks]

Made-up results for potato cylinders. Sugar concentration in mol/dm^3 and percentage change in mass: 0.0, +18. 0.2, +8. 0.4, -2. 0.6, -12. 0.8, -20. (a) Estimate the concentration with no change in mass. [2] (b) State what this shows about the potato cells. [1] (c) Explain the result at 0.8 mol/dm^3. [2]

Q5. Why use percentage change? [2 marks]

Explain why a student calculates percentage change in mass and not just the change in mass.

Q6. Plant and animal cells [4 marks]

A plant cell and a red blood cell are both put in distilled water. Describe and explain what happens to each cell.

Q7. Plasmolysis [3 marks]

Onion cells are placed in a concentrated sugar solution. Explain how they become plasmolysed.

Q8. Why plants wilt [3 marks]

A pot plant has not been watered for a week and its leaves droop. Explain why.

Q9. Dialysis tubing [4 marks]

Dialysis tubing containing sugar solution is placed in a beaker of water. (a) Predict what happens to the liquid level in a narrow tube fixed to the tubing. [1] (b) Explain your prediction. [2] (c) Describe a suitable control. [1]

Q10. Spot the mistakes [3 marks]

Read this student's account: "The sugar moved out of the solution into the potato because of diffusion, so the potato gained mass and its cell walls stretched until they burst." Give three corrections.

Q11. Evaluating a method [3 marks]

A student dries some cylinders with paper, but not others, before finding their final mass. Explain how this affects the results and suggest an improvement.

Q12. Planning [6 marks]

Plan an experiment to find the concentration of sugar solution with the same water potential as potato tissue.

Answers

Q1. Defining osmosis

- One mark for the net movement of water molecules.
- One mark for moving from higher to lower water potential, or from a dilute to a concentrated solution.
- One mark for moving through a partially permeable membrane.

Q2. Solute and solvent

- One mark for salt as the solute.
- One mark for water as the solvent.

Q3. Percentage change

- (a) One mark for working: -2.0 ÷ 16.0 × 100.
- (a) One mark for -12.5%.
- (b) One mark for the solution having a lower water potential than the potato cells.
- (b) One mark for water leaving the cells by osmosis.

Q4. Reading a graph from results

- (a) One mark for choosing a value between 0.2 and 0.4.
- (a) One mark for about 0.36 mol/dm^3.
- (b) One mark for the solution and the cells having about the same water potential.
- (c) One mark for the solution having a lower water potential than the cells.
- (c) One mark for water leaving by osmosis.

Q5. Why use percentage change?

- One mark because the cylinders may have different starting masses.
- One mark because percentage change allows a fair comparison.

Q6. Plant and animal cells

- One mark for water entering both cells by osmosis.
- One mark for the plant cell becoming turgid.
- One mark for the red blood cell swelling and possibly bursting.
- One mark because the plant cell wall stops bursting, and a red blood cell has no wall.

Q7. Plasmolysis

- One mark for the solution having a lower water potential than the cell.
- One mark for water leaving the cell by osmosis.
- One mark for the cell membrane and cytoplasm pulling away from the cell wall.

Q8. Why plants wilt

- One mark for cells losing water.
- One mark for cells becoming flaccid, or losing turgor pressure.
- One mark for cells no longer giving the leaves support.

Q9. Dialysis tubing

- (a) One mark for the level rising.
- (b) One mark for the water in the beaker having a higher water potential.
- (b) One mark for water entering the tubing by osmosis.
- (c) One mark for using distilled water inside the tubing.

Q10. Spot the mistakes

- One mark for water moving, not sugar.
- One mark for osmosis through a partially permeable membrane.
- One mark because a plant cell does not burst, since the wall stops it.

Q11. Evaluating a method

- One mark for water on the surface adding to the mass.
- One mark for the results not being a fair comparison, or the gain appearing too high.
- One mark for blotting every cylinder in the same way.

Q12. Planning

- Any six of these, one mark each:
- Prepare a range of sugar solutions, including distilled water.
- Cut potato cylinders of the same size.
- Blot and measure the starting mass of each.
- Put a cylinder in each solution, using the same volume.
- Leave for the same time at the same temperature.
- Blot and measure the final mass of each.
- Calculate the percentage change in mass.
- Repeat and calculate a mean.
- Plot a graph and read the concentration where the change is zero.

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