IGCSE BIOLOGY • EXERCISE SHEET

3.2 Osmosis

Name: ____________ Class: ________ Date: __________ **Total: 31 marks**

KEY WORDS solution 溶液 • osmosis 渗透 • water potential 水势 • turgid 膨胀 • flaccid 松软

Objective

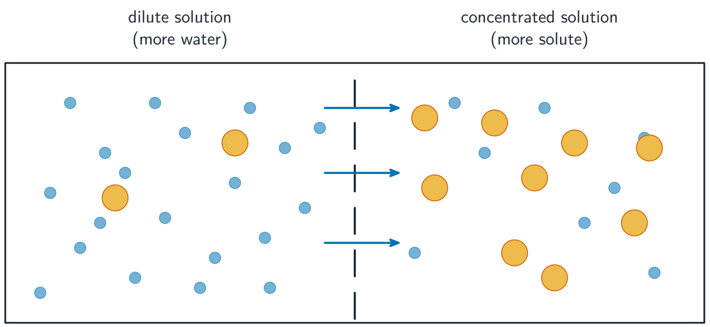
Build the skills to answer exam questions on **osmosis** 渗透 — the definition, **water potential** 水势, and the effect on plant cells (**turgid** 膨胀, **flaccid** 松软, **plasmolysed** 质壁分离).

You must be able to:

- define osmosis (net water movement across a partially permeable membrane)
- describe what happens to plant cells in dilute and concentrated solutions
- interpret a potato/dialysis-tubing experiment

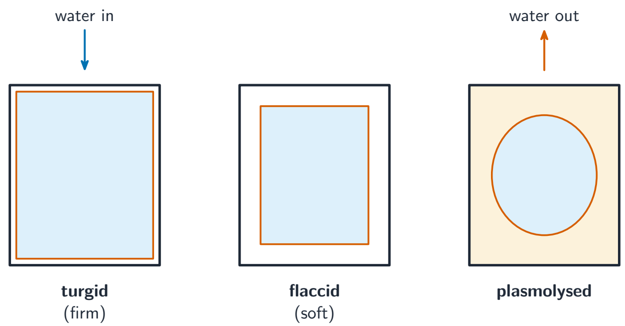
1 Worked examples

Osmosis and plant cells



water moves by osmosis to the concentrated side; solute is too big to cross

Osmosis: net movement of water from higher to lower water potential, through a partially permeable membrane



Dilute solution → water in → turgid; concentrated → water out → flaccid/plasmolysed

- potato in water → gains mass; in concentrated solution → loses mass.

Osmosis, in the words that earn the marks

Osmosis 渗透 is 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** 半透膜.

Three phrases are marks and cannot be paraphrased away: *water molecules* (not "water"), *partially permeable* (not "semi-permeable" in current specifications), and *down the water potential gradient.* Never write that water moves "to where there is more salt" — the mark scheme wants the concentration of **water**, or the **water potential**.

Water potential 水势: pure water has the **highest** water potential; adding solute **lowers** it. So a dilute solution has a higher water potential than a concentrated one, and water moves from dilute to concentrated.

What happens to a cell — and the two words differ between plant and animal:

	in a dilute solution (higher Ψ outside)	in a concentrated solution (lower Ψ outside)
plant cell	water enters, the vacuole swells, the cell becomes **turgid** 膨压 — the cell wall stops it bursting	water leaves, the protoplast shrinks from the wall: **plasmolysed** 质壁分离; before that it is **flaccid**
animal cell	water enters and the cell **bursts** (**lysis**) — no wall to resist	water leaves and the cell shrinks and **crenates**

The presence or absence of a **cell wall** is the whole explanation for the difference, and stating it is usually the mark.

The standard experiment. Cut identical potato cylinders, blot them, measure the mass, leave each in a different sucrose concentration, blot and re-weigh. Calculate the **percentage change in mass** — always dividing by the ORIGINAL mass — and plot it against concentration. Where the line crosses **zero change**, the external solution has the same water potential as the cell sap, so there is no net movement. Blotting matters: surface water counts on the balance and is not osmosis.

Worked example. A cylinder gains mass in solution A and loses mass in solution B. What does that say about the two solutions?

1. Gaining mass means water entered, so solution A has a **higher** water potential than the cell sap — it is more dilute.
2. Losing mass means water left, so solution B has a **lower** water potential than the cell sap — it is more concentrated.

2 Practice

2.1 Define osmosis. [2]

2.2 State what happens to a plant cell placed in pure water. [1]

2.3 Define osmosis, using the term water potential. [3]

2.4 Explain why a plant cell in pure water becomes turgid but does not burst. [2]

2.5 Explain why the potato cylinders must be blotted before weighing. [2]

3 Exam-style questions

3.1 A plant cell in a concentrated sugar solution becomes: [1]

- **A** turgid
- **B** flaccid (loses water)
- **C** larger
- **D** unchanged

3.2 Potato cylinders are placed in different sugar solutions and their mass measured.

(a) State what happens to the mass of a cylinder in pure water, and why. [2]

(b) State what you would observe for a cylinder in a very concentrated solution. [1]

3.3 Explain why turgid cells help support a plant. [2]

3.4 A student places identical potato cylinders in sucrose solutions of different concentrations for one hour, then blots and re-weighs them.

Sucrose concentration / mol dm^{-3}	**0.0**	**0.2**	**0.4**	**0.6**
Initial mass / g	5.00	5.00	5.00	5.00
Final mass / g	5.55	5.20	4.75	4.40

(a) Calculate the percentage change in mass for the 0.0 and the 0.6 solutions. [3]

(b) Explain, in terms of water potential, the result for the 0.0 solution. [3]

(c) Estimate the concentration at which there would be no change in mass, and state what that tells you about the cells. [2]

(d) Describe what would be seen under a microscope in a cell from the 0.6 solution, and name the condition. [3]

(e) Explain why a red blood cell placed in pure water bursts, but a plant cell does not. [2]

(f) State two variables the student must control for the comparison to be valid. [2]

Solutions

2.1 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.

2.2 water moves in by osmosis and the cell becomes turgid (firm).

2.3 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.

2.4 Water enters by osmosis and the vacuole swells, pushing the cell contents against the wall; the cell wall is strong and inelastic, so it resists further expansion and the cell becomes turgid instead of bursting.

2.5 Surface water would be included in the mass measured, which would make the change appear larger than the water actually moved by osmosis.

3.1 B. In a concentrated solution water leaves the cell, so it becomes flaccid.

3.2 (a) the mass increases; because water moves into the cells by osmosis.
(b) it loses mass / becomes shorter and floppy.

3.3 water inside makes the cells turgid and press out on the cell walls; this firmness holds the plant up straight.

3.4 (a) 0.0: $\dfrac{5.55 - 5.00}{5.00} \times 100 = +11.0\%$; 0.6: $\dfrac{4.40 - 5.00}{5.00} \times 100 = -12.0\%$.
(b) The 0.0 solution is pure water, which has a higher water potential than the cell sap; water therefore moves into the cells by osmosis, down the water potential gradient; the cells gain water and the cylinder gains mass.
(c) Between 0.2 and 0.4, at about 0.3 mol dm^{-3}; at that concentration the external solution has the same water potential as the cell sap, so there is no net movement of water.
(d) The cell contents would be shrunken and pulled away from the cell wall, with the membrane no longer pressed against it; the cell is plasmolysed.
(e) An animal cell has no cell wall, so nothing resists the swelling and the membrane bursts; a plant cell's strong cell wall resists the pressure and the cell only becomes turgid.
(f) Any two of: the temperature; the volume of solution; the time left in the solution; the size and source of the potato cylinders.