WJEC Wales Biology A Level

SP 1.3a: Determination of water potential by measuring changes in mass or length

Practical notes

Introduction

Osmosis is the movement of **water molecules** down their **water potential** (Ψ) gradient, from an area of high Ψ to an area of low Ψ, across a **partially permeable membrane**. It can be investigated by placing a potato in solutions of different sucrose concentration.

Equipment

- Potato
- Sucrose solutions: 0.2, 0.4, 0.6, 0.8, 1.0 mol dm^{-3}
- Distilled water
- 6 boiling tubes
- 6 bungs
- Boiling tube rack
- 50 cm^3 measuring cylinder
- Cork borer
- Ruler
- Scalpel
- Forceps
- White tile
- Stopwatch
- Balance

Risk assessment

Hazard	Risk	Precaution	Emergency
Broken glass	Cuts	Keep glassware away from the edge of the desk	Dispose of broken glassware carefully; elevate cuts and apply pressure; do not remove glass from cuts; seek medical assistance
Scalpel	Cuts	Direction of cut away from the body; do not attempt to change blade; keep scalpel away from the edge of the desk	Elevate cuts and apply pressure; wash minor cuts in cold water; seek medical assistance

Method

1. Using the cork borer, scalpel and ruler, prepare **six** potato chips **50 mm** long. *Ensure that there is no potato skin present (contains suberin, a waterproof layer that prevents osmosis).*
2. Dry each potato chip by rolling it over a paper towel **three times.**
3. Measure the **starting mass** of each potato chip using a **balance**. Record your results.
4. Fill six boiling tubes with **30 cm^3** 1.0, 0.8, 0.6, 0.4, 0.2 and 0.0 (distilled water) mol dm^{-3}.
5. Using the forceps, place a potato chip into each boiling tube. *Add a bung to prevent the evaporation of water.* Set a stopwatch for **60 minutes**.
6. After 60 minutes remove each potato chip from the boiling tubes.
7. Dry each potato chip by rolling it over a paper towel **three times.**
8. Use the **balance** to measure the **final mass** of each potato chip. Record your results.
9. **Repeat** three times and calculate the **mean % change in mass** for each concentration of sucrose solution. Record you results (see below).

$$\% \text{ change in mass} = \frac{\text{change in mass}}{\text{original mass}} \times 100$$

10. Plot a **graph** of **mean % change in mass** of potato against **sucrose solution concentration.**
11. **Estimate** the water potential of the potato. *The sucrose solution in which there is no change in the mass of the potato chip should have the same Ψ as the potato.*

Variables

Independent variable

The variable that is **changed**
i.e. the concentration of sucrose solution.
Dependent variable

The variable being **measured** whose value depends on the independent variable
i.e. mean % change in mass of potato chip.

Controlled variables

The variables that are kept **constant** during the experiment:

- Surface-area-to-volume ratio of the potato chip
  Controlled using a cork borer (same circumference) and ruler (same length).
- Length of time left in the sucrose solution
  Controlled using a stopwatch to time 60 minutes.
- Volume of water on the surface of the potato chip
  Controlled by rolling over a paper towel three full times.
- Volume of sucrose solution
  50 cm^3 measuring cylinder using to measure 30 cm^3 of each sucrose solution.
- Same type and age of potato
  Potato chips should be from the same potato or the same type of potato.

Results

Sucrose concentration (mol dm^{-3})	Mass of potato chip (g)									% change in mass			Mean % change in mass
	Initial			Final			Change						
	1	2	3	1	2	3	1	2	3	1	2	3	
0.0													
0.2													
0.4													
0.6													
0.8													
1.0													

Conclusion

The **more concentrated the sucrose solution** the **more negative the mean % change in mass** of the potato chip (mass is lost).

This is because the **more concentrated** the solution, the **lower the water potential** (Ψ). Water moves out of the potato chip by osmosis from an area of high Ψ to an area of low Ψ, down its water potential gradient into the surrounding solution.