Bio CP4 Transporting substances

Objectives

B1.15 Explain how substances are transported by diffusion, osmosis and active transport.

B1.16 *Investigate osmosis in potatoes.*

B1.17 Calculate percentage gain and loss of mass in osmosis.

Maths requirements

1c Use percentages.

2b Find arithmetic means.

4a Translate information between graphical and numeric forms.

Learning outcomes

7th **SB1.15** State that substances are transported by diffusion, osmosis and active transport.

7th **SB1.15** Describe how substances are transported by active transport (including the need for energy).

6th **SB1.15** Explain how substances are transported by diffusion.

9th **SB1.15** Explain how substances are transported by osmosis.

9th **SB1.15** Explain the effects of osmosis on cells and tissues.

8th **SB1.16** Investigate osmosis in potatoes.

9th **SB1.17** Calculate percentage gain and loss of mass in osmosis.

Exploring

1. Diffusion and osmosis – Core practical

Students' sheet CP4(Osmosis in potatoes) provides support for the core practical on osmosis in potato slices (specification statement B1.16), and Worksheet SB1i.2 supports the optional suggested practical on diffusion using agar. Both practicals include calculations that some students may have problems with. In the osmosis practical, results from different groups are collated and compared to check for outliers, then mean values calculated for each solution. It may help to prepare a class spreadsheet for displaying all the results for discussion. The identification of outliers may provide useful information for the evaluation of the investigation. If students need further practice in calculating means, this can be added to the diffusion practical by comparing groups' results in a similar way.

Osmosis: The osmosis practical measures the percentage change in mass of strips of potato placed in different concentrations of solution. Using a coloured sugar syrup, such as blackcurrant squash (not sugar-free), makes it easier for students to see that the solutions are of different concentrations. However, a concentrated sucrose solution with added food colouring, which is then used to produce different dilutions, is also suitable.

Note that some students may be confused by the idea that a more concentrated solution contains proportionately fewer water molecules than a weaker or more dilute solution. So it may be worth checking understanding of this when students are carrying out this practical. If needed, talk in terms of a higher concentration of solute containing fewer water molecules.

The following table starts with a sucrose or blackcurrant squash concentration of about 550 g/dm^3 of sucrose.

Concentration of initial solution (%)	Volume of blackcurrant squash needed to make 30 cm^3 of solution	Volume of water needed to make 30 cm^3 of solution	Final volume of solution made (cm^3)
0 (pure water)	0	30	30
40	12	18	30
80	24	6	30
100	30	0	30

Cut the potato strips as near to lesson time as possible using a cork borer or potato chipper to get identical diameters/widths. Then cut them all to the same length. Make sure this length will fit inside a boiling tube if that is what students will be using. Wrap the strips in a damp cloth or plastic film until the lesson. This means that the strips placed in pure water should gain mass during the experiment, as the cells will not be fully turgid at the start.

The **ALDS** spreadsheet *SB1i Percentage change in osmosis* contains data that could be used with students if they have not been able to collect their own results. The spreadsheet then guides students through plotting the data and analysing it.

Support: Students may need help in drawing up their table and completing the calculations. They may also need help working out how to record negative numbers on their chart.

Stretch**:** Ask students how they could adapt this practical to find the concentration inside potato cells.

⚠ Safety

Students should be warned not to taste or drink any of the solutions, or taste the potato.

Expected results

Students should find that the potato strip in pure water gains mass, while the rest lose mass in relation to how much water was in the solution (i.e. the potato in the solution with least water (100% solution) loses most mass).

Diffusion (optional): For the agar cube practical, the agar will need preparing ahead of the lesson to give it time to set. Use 2 g plain agar powder in 100 cm^3 water, with added 0.01 mol/dm^3 sodium hydroxide and either universal indicator or phenolphthalein, enough to colour the agar to indicate alkalinity. Place the container in a water bath of boiling water until the solution boils. Agar cubes of side length 2 cm, 1 cm and 0.5 cm can either be cut before the lesson or students could be given a larger block from which to cut their own cubes. In the latter case, tell students the dimensions to cut. Explain to students that the agar contains indicator that will change colour in the presence of the acid, and that this change will be used to measure how far the acid has diffused into each cube.

Support: Work with students to complete the calculations of volume and rate of diffusion.

Stretch: Ask students to consider how good a model they think agar cubes are for investigating diffusion into cells, using similarities and differences between agar and cells to help them answer the question.

⚠ Safety

Wear eye protection and rinse splashes from skin when preparing the agar cubes and hydrochloric acid, as well as during the practical.

Expected results

Students should find that most, if not all, of the smallest cube will have changed colour due to the diffusion of the acid through the block. In the other cubes, it is unlikely that the acid will have diffused to the centre. This suggests there is a physical limit to cell size, as beyond a certain size substances take too long to diffuse in and out from the centre of a cell to support life processes effectively.

Course resources

Bio Students' sheet CP4

Equipment (per group)

Osmosis: four potato strips of identical size, accurate balance, four boiling tubes and rack (or beakers), waterproof pen, four labelled solutions containing different concentrations of initial (approx. 550 g/dm^3) sucrose solution (0%, 40%, 80%, 100%), forceps, paper towels

Diffusion: agar cubes containing sodium hydroxide and universal indicator or phenolphthalein (one cube each of side lengths 2 cm, 1 cm and 0.5 cm or an agar block large enough for students to cut their own cubes), 20 cm^3 0.1 mol/dm^3 hydrochloric acid, 100 cm^3 beaker, forceps, paper towel, rinsing water, white tile, knife, stopclock or watch, eye protection