Cambridge Assessment International Education

Skills Pack

Investigating the water potential of onion cells by determining the rate of incipient plasmolysis

Cambridge International AS & A Level

Biology 9700

Version 0.1

Cambridge Pathway

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Icons used in this pack:

Briefing lesson

Planning lesson

Lab lesson

Debriefing lesson

Introduction

This pack will help you to develop your learners' experimental skills as defined by assessment objective 3 (AO3 Experimental skills and investigations) in the course syllabus.

Important note
Our *Skills Packs* have been written by **classroom teachers** to help you deliver topics and skills that can be challenging. Use these materials to supplement your teaching and engage your learners. You can also use them to help you create lesson plans for other experiments.

This content is designed to give you and your learners the chance to explore practical skills. It is not intended as specific practice for Paper 3 (Advanced Practical Skills) or Paper 5 (Planning, Analysis and Evaluation).

This is one of a range of *Skills Packs* and each pack is based on one experiment. The packs can be used in any order to suit your teaching sequence.

The structure is as follows:

Briefing lesson (1 hour*)
This lesson reinforces the key concepts, relevant skills, knowledge and understanding linked to the experiment.

↓

Planning lesson (1 hour*)
This lesson focuses on planning an experiment.
It ends with a demonstration video of the experiment.

↓

Lab lesson (1 hour*)
This lesson focuses on carrying out the experiment including the collection and recording of observations, measurements and estimates.

↓

Debriefing lesson (1 hour*)
This lesson focuses on the analysis and interpretation of data.
This includes making conclusions, evaluating methods and the quality of data and how improvements could be made.

** the timings are a guide only; you may need to adapt the lessons to suit your circumstances.*

In this pack, you will find lesson plans, worksheets and teacher resource sheets.

Experiment: Investigating the water potential of onion cells by determining the rate of incipient plasmolysis

This *Skills Pack* focuses on an investigation into the water potential of onion cells by determining the rate of incipient plasmolysis.

Plasmolysis occurs when plant cells begin to lose water from their cytoplasm and vacuole, which causes the cell surface membrane to pull away from the cell wall. In this experiment, you will investigate the water potential of onion cells by determining the rate of incipient plasmolysis.

This experiment has links to the following syllabus content (2025–2027 syllabus):

- **4.2.5.** investigate the effects of immersing plant tissues in solutions of different water potentials, using the results to estimate the water potential of the tissues.
- **4.2.6.** explain the movement of water between cells and solutions in terms of water potential and explain the different effects of the movement of water on plant cells and animal cells (knowledge of solute potential and pressure potential is not expected)

The experiment covers the following experimental skills, as listed in **AO3: Experimental skills and investigations:**

- plan experiments and investigations
- collect, record and present observations, measurements and estimates.
- analyse and interpret data to reach conclusions.
- evaluate methods and quality of data and suggest improvements.

Prior knowledge

Knowledge from the following syllabus topics is useful for this experiment.

- **4.2.1.** describe and explain the processes of simple diffusion, facilitated diffusion, osmosis, active transport, endocytosis and exocytosis.

Briefing lesson: Cell structure review

Resources	• Teacher Instructions • Worksheets A, B and C • Computer display or overhead projector
Learning objectives	By the end of the lesson: • **all** learners will be able to describe the effects of immersing plant tissues in solutions of different water potentials. • **most** learners will be able to explain the effects of immersing plant tissues in solutions of different water potentials. • **some** learners will be able to suggest how to use the results of an experiment in which plant tissues are immersed in solutions of different water potentials to estimate the water potential of those tissues.

Timings	Activity
20 minutes	**Starter/Introduction** Share **Worksheet A** with learners. This shows a series of true / false statements about cell structure. After they have read the article, instruct learners to engage in a think, pair, share activity to make collective decisions about whether the statements are true or false. Learners initially work in pairs to brainstorm key words related to the five discussions, and then after 2–3 minutes, the pairs join into 4s and then 8s to engage in deeper analysis. Learners record any new key words that arise during these wider discussions. Ask one or two learners from each group to then write their key words on the class board and then host a class discussion to join the key terms into a mind map to help learners make meaning of them. Finally, learners copy down the mind map with things 'I knew' in green and things that 'are new' in red. This can be referred to at the end of the lesson to show learners how much progress they have made.
30 minutes	**Main lesson** Refer to **Teacher Instructions** for this activity. This is a task called 'jigsaw reveal.' A diagram of a plasmolysed cell is obscured by nine jigsaw pieces. Inform learners that during this series of lessons they will have the opportunity to explore the process of plasmolysis in plant cells (onion epidermis). Provide **Worksheet B**, which contains the fully-obscured jigsaw. Display this on the board and ask one learner to choose a numbered jigsaw piece at random. Display the image with this piece removed. Challenge learners to infer what has been revealed, and what is happening in this section of the cell. If the revealed image is difficult to interpret, provide learners with an opportunity to discuss their ideas as you circulate to provide prompts to guide them towards the correct answer. Encourage learners to make rough notes on the jigsaw piece on **Worksheet B**. Help learners understand what has happened – refer to terms such as solution, solute, solvent, dehydration, plasmolysis, net osmosis and shrinking. Through this discussion gain a good idea of what vocabulary learners already have, and what

	understanding needs to be further developed during the lesson.
10 minutes	**Plenary** Ask learners to write the shortest paragraph possible using all the following key terms: ‘shrink’, ‘pull away’, ‘plasmolyse’, ‘net’, ‘water potential’ and ‘osmoses. This is a good way to focus learners on developing their higher-order thinking skills to make sense of the meaning of these terms, rather than simply recall them. To scaffold this activity for some learners, provide the first and final sentences, or reduce the number of words that they are expected to use. Collect learners’ work as they leave the room, so that their understanding can be formatively assessed in advance of the *Planning lesson*.

Planning lesson: Digital recording

Resources	• Worksheets C and D • 100 cm^3 distilled water in a beaker. • Coverslips x 4 • Dropping pipette (plastic) • Forceps (blunt) • Fresh white onion • Glass marker pen (permanent) • Microscope slides x 4. • Mobile phone • Mounted needle • Paper towels • Safety eyewear • Scalpel • White tile • Microscope with: - an eyepiece lens, ×10 magnification - a low-power objective lens, ×10 magnification - a high-power objective lens, ×40 magnification - an eyepiece graticule fitted into the eyepiece lens
Learning objectives	By the end of the lesson: • **all** learners will be able to outline how to carry out an investigation into the solute potential of onion cells by determining the rate of incipient plasmolysis. • **most** learners will be able to describe some of the problems associated with carrying out an investigation into the solute potential of onion cells by determining the rate of incipient plasmolysis . • **some** learners will be able to suggest how to overcome some of the problems encountered when an investigation into the solute potential of onion cells by determining the rate of incipient plasmolysis is carried out.

Timings	Activity
10 minutes	**Starter/Introduction** Refresh learners' knowledge of key terms related to osmosis by hosting a think, pair, share discussion. Provide the practical-focused questions on **Worksheet C** to pairs of learners, who should think about their initial answers, discuss them in pairs, and then submit them to a class discussion. This activity encourages pair and whole-class discussion and reinforces key terminology and concept from the *Briefing lesson*.
40 minutes	**Main lesson** Inform learners that they are going to undertake a series of activities that will refresh their understanding and skills related to the use of a microscope. The task involves a 'circus' in which three 'stations' are arranged around the room. Leaners work in pairs or small groups to undertake the four tasks that require them to practice the steps involved in setting up and then using a microscope for the purpose of this investigation. Set up the workstations and provide **Worksheet D** to your learners. Circulate the room as learners work in pairs or small groups to conduct the tasks listed at each station. Allow learners ten minutes to work at each station and sound an alarm or

	similar when the time is up. Many students will find it challenging to carry out these activities properly to begin with. It can be helpful to pair more confident learners with those needing more help and employ them as demonstrators. Both 'learner' and 'demonstrator' benefit, the 'demonstrator' by reinforcing their communication skills and developing communication skills, and the 'learner' by having more detailed and personalised help. During the activities, reinforce the names of the different parts of the microscope, including the stage micrometer and eyepiece graticule, by displaying on the board a labelled diagram of the equipment. Insist that learners use the terms during the lesson in their discussions. This helps learners become familiar with the terms. Discuss aspects of the method with learners and how before the investigation these can be explored to enhance the quality of the data obtained. For example: • why a range of five different concentrations of salt solutions would give more accurate results (a line graph could be plotted to show an accurate trend) • how reliability could be improved (by repeating the experiment three times and calculating a mean value or pooling the class results for the same purpose).
10 minutes	**Plenary** This activity introduces many of the skills that learners will require during this topic. Encourage learners to reflect on their experiences and make some recommendations for the *Lab lesson*. These could be of the structure '*The next time I do … I must remember to …*' If there is time, ask learners to write these on post-it notes, which they must stick to the class board or wall. Ideally, leave these sticky notes in place until the *Lab lesson*.

Lab lesson: Getting practical

Resources	• 10 cm^3 syringes x 2 • 100 cm^3 distilled water in a beaker. • 200 cm^3 1.00 mol dm^{-3} sodium chloride solution in a beaker • Boiling tubes x 3 in a holder • Bungs to fit boiling tubes x 3. • Coverslips x 4 • Dropping pipette (plastic) • Forceps (blunt) • Fresh white onion • Glass marker pen (permanent) • Microscope slides x 4. • Mobile phone • Mounted needle • Paper towels • Safety eyewear • Scalpel • Timer • White tile • Microscope with: - an eyepiece lens, ×10 magnification - a low-power objective lens, ×10 magnification - a high-power objective lens, ×40 magnification - an eyepiece graticule fitted into the eyepiece lens

Learning objectives	By the end of the lesson: • **all** learners will be able to outline how to carry out an investigation into the solute potential of onion cells by determining the rate of incipient plasmolysis. • **most** learners will be able to describe some of the problems associated with carrying out an investigation into the solute potential of onion cells by determining the rate of incipient plasmolysis . • **some** learners will be able to suggest how to overcome some of the problems encountered when an investigation into the solute potential of onion cells by determining the rate of incipient plasmolysis is carried out.

Timings	Activity
10 minutes	**Starter/Introduction** Ask learners to reflect on their answers to **Worksheet D** from the *Planning lesson*. Engage learners in a 'think, pair, share' activity with a partner for a few minutes, and then choose learners at random to offer their answers to inform a class discussion.
45 minutes	**Main lesson** Inform learners that they will now undertake the practical activity. Ask learners to use their completed **Worksheet D** from the *Planning lesson* to help them. Note that the procedure followed in this investigation requires at least one hour. Therefore, it is important that the lesson is structured carefully so that the opportunities for teaching and learning are maximised. Suggestions include: • Providing onion pieces, so that learners do not need to cut the onion themselves.

	• Provide solutions that have been pre-prepared and stores in a fridge. **Safety** Always circulate the classroom during the experiment so that you can make sure that your learners are safe and that the data they are collecting is accurate.
5 minutes	**Plenary** Host an 'open board' to allow learners to list key words related to the method which illustrate some of the difficulties they encountered. These may include 'filming,' 'subjective' and 'inaccurate.' Ask learners to record these key terms and in advance of next lesson, prepare a summary of the problems and how they could be overcome.

Teacher notes

Watch the video (teacher version) and read these notes.

Each group will require:

- 10 cm^3 syringes x 2
- 100 cm^3 distilled water in a beaker
- 200 cm^3 1.00 mol dm^{-3} sodium chloride solution in a beaker
- Boiling tubes x 3 in a holder
- Bungs to fit boiling tubes x 3
- Coverslips x 4
- Dropping pipette (plastic)
- Forceps (blunt)
- Fresh white onion
- Glass marker pen (permanent)
- Microscope slides x 4
- Mobile phone
- Mounted needle
- Paper towels
- Safety eyewear
- Scalpel
- Timer
- White tile
- Microscope with:

- an eyepiece lens, ×10 magnification
- a low-power objective lens, ×10 magnification
- a high-power objective lens, ×40 magnification
- an eyepiece graticule fitted into the eyepiece lens

Safety

The information in the table below is a summary of the key points you should consider before undertaking this experiment with your learners.

It is your responsibility to carry out an appropriate risk assessment for this experiment.

Substance	Hazard	First aid
scalpel	sharp	Cut material away from the body and on a cutting tile.
onion tissue	allergen	Beware of possible allergic reactions. Wear gloves when handling onion tissue.

How to make the stock solutions of sodium chloride

The stock solution of 1.00 mol dm^{-3} sodium chloride solution can be prepared by putting 11.7 g of sodium chloride in 100 cm^3 of distilled water and making up to 200 cm^3 with distilled water.

Teacher method

This is your version of the method for this experiment that accompanies the *Teacher walkthrough* video.

Do not share this method with learners.

Before you begin

Plan how you will group your learners during the experiment session.

Think about:

- whether there is enough time for all learners to conduct the full investigation, or if different learners could investigate different concentrations of sodium chloride solution.
- the number of groups you will need (group size 2–4 learners) or how you will host the demonstration.
- the amount of equipment/chemicals required.

Experiment

Walk around the learners during the experiment in case they encounter any difficulties.

Steps	Notes
1. To prepare the first dilution, 5 cm3 distilled water is put into a test tube using a syringe.	*Rationale for step 1: N/A*
2. Next, 15 cm3 of the sodium chloride stock solution labelled sodium chloride solution (1.00 mol dm–3) is transferred from the stock beaker into the same test tube using the other syringe.	*Rationale for step 2:* *This solution, which is now three quarters as concentrated as the stock solution, should inverted to mix.*
3. To prepare the second dilution, 10 cm3 distilled water is put into a test tube using a syringe.	*Rationale for step 3: N/A*
4. Next, 10 cm3 of the sodium chloride stock solution labelled sodium chloride solution (1.00 mol dm–3) is transferred from the stock beaker into the same test tube using the other syringe.	*Rationale for step 4:* *This solution, which is now half as concentrated as the stock solution, is inverted to mix.* *This process, called proportional or simple dilution, is repeated to form another solution of sodium chloride, of the lowest concentration for this investigation.*
5. The objective lens is set to x 10. This achieves a combined magnification of x 100.	*Rationale for step 5:* *You may need to reduce the amount of light entering the microscope to observe the cells clearly. It might be useful at this stage to make and use a 'test slide' of onion epidermis to help identify the focus point in the field of view.*
6. Five microscope slides should be labelled with the concentrations of the four solutions and distilled water.	*Rationale for step 6: N/A*

7. Using a dropping pipette, a few drops of the most concentrated solution are added to the middle of the first microscope slide.	*Rationale for step 7: N/A*
8. A small piece of onion epidermis is removed using the blunt forceps.	*Rationale for step 8: N/A*
9. This epidermis is carefully cut to prepare a piece of onion epidermis approximately in the shape of a small square.	*Rationale for step 9: N/A*
10. The epidermis square is then carefully placed using the mounted needle into the middle of the microscope slide.	*Rationale for step 10:* *If the piece of epidermis is folded, you may need to add more drops of the appropriate solution so that it floats and can be unfolded. It is important to prevent the epidermis from drying out.* *A couple of extra drops of the appropriate solution is then added to the epidermis and the mounted needle is used to gently lower the cover slip on top.* *A paper towel can be used to remove any excel solution that is outside the cover slip.* *It is important to immediately transfer to the microscope stage.* *The inner epidermis may start to separate or have become separated from the rest of the onion tissue, so the epidermis may be floating in the sodium chloride solution.*
11. This epidermis is carefully cut to prepare a piece of onion epidermis approximately in the shape of a small square.	*Rationale for step 11: N/A*
12. The timer is started, and a video is recorded for ten minutes.	*Rationale for step 12:* *Alternatively, set up a boss and clamp to hold the phone.* *This is repeated in the same way for the other solutions.* *Replaying the video can help identify the time point at which 50 % of the cells begin to show plasmolysis. This is called incipient plasmolysis.*

(Continued for remaining steps if necessary)

Clean-up

After the experiment learners should:

- clean all glassware.
- tidy up their workspace.
- ensure any spillages have been mopped up.
- return all equipment and any unused chemicals to you.

Debriefing lesson: Cell behaviour

Resources	• Worksheets E and F
Learning objectives	By the end of the lesson: • **all** learners will be able to outline how to carry out an investigation into the solute potential of onion cells by determining the rate of incipient plasmolysis. • **most** learners will be able to describe some of the problems associated with carrying out an investigation into the solute potential of onion cells by determining the rate of incipient plasmolysis. • **some** learners will be able to suggest how to overcome some of the problems encountered when an investigation into the solute potential of onion cells by determining the rate of incipient plasmolysis is carried out.

Timings	Activity
10 minutes	**Starter/Introduction** At the end of the *Lab lesson*, learners were asked to list key words related to the method which illustrate some of the difficulties they encountered. Allow learners to review the post-it notes and consider the recommendations of others, and highlight common mistakes that learners made.
35 minutes	**Main lesson** Give learners 2–3 minutes to discuss with a partner one aspect of the method that presented an obstacle during the last lesson. Choose one learner at random (or ask for a volunteer) and ask for a contribution to get the class discussion started. Ask the other learners in the class '*Who else encountered this problem?*' and elicit various solutions that were used to overcome it. Hand out **Worksheet E** if learners was unable to obtain their own data.
15 minutes	**Plenary** Refer learners to **Worksheet F**, which provides a written text that summarises the experience of a class that has undertaken a similar practical investigation. However, there are 5–10 conceptual and terminology errors. Encourage learners to spot and circle as many mistakes as possible and offer corrections in the margin. Provide learners with 5 minutes to compare and contrast their work with that of a partner and add any points they missed. This activity could be made into a competition, with the first pair of learners who identifies all mistakes deemed the winner.

Worksheets and answers

	Worksheet	Answers
For use in *Briefing lesson*:		
Teacher instructions: Jigsaw reveal	**17**	**N/A**
A: True or false?	**18**	**28**
B: Observing cells	**19**	**29**
C: Think, pair, share	**22**	**N/A**
For use in *Planning lesson*:		
D: Method circus	**25**	**N/A**
For use in *Evaluation lesson*:		
E: Sample results	**26**	**N/A**
F: Critiquing a report	**27**	**30**

Teacher instructions: Jigsaw reveal

As different jigsaw pieces are removed, encourage learners to record the key points from the discussion on **Worksheet B**, on top of the blank jigsaw pieces. Suggestions may include:

1. The cell membrane is attached to the cell wall.
2. The cell membrane is not attached to the cell wall.
3. The vacuole is turgid.

Worksheet A: True or false?

Statement 1
The net movement of water molecules across a semi-permeable membrane occurs from a solution of low water potential to a solution of high water potential.

Statement 2
Net osmosis into the cytoplasm is responsible for plasmolysis in plant cells.

Statement 3
The cell wall prevents a plant cell from bursting when placed into a hypertonic solution.

To help you with your discussions about these statements, record key words from your studies in the table below.

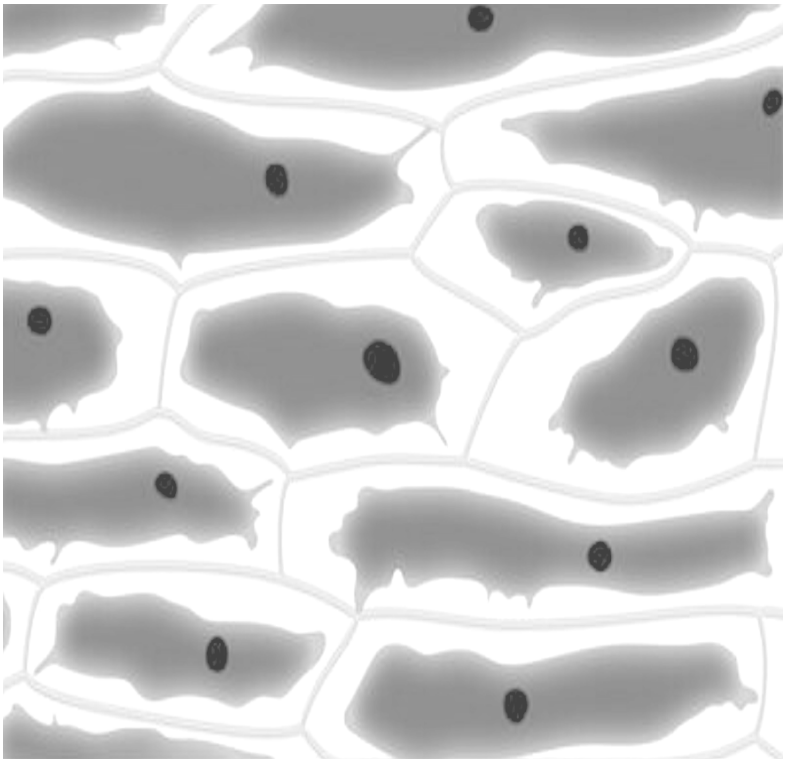
Discussion topics

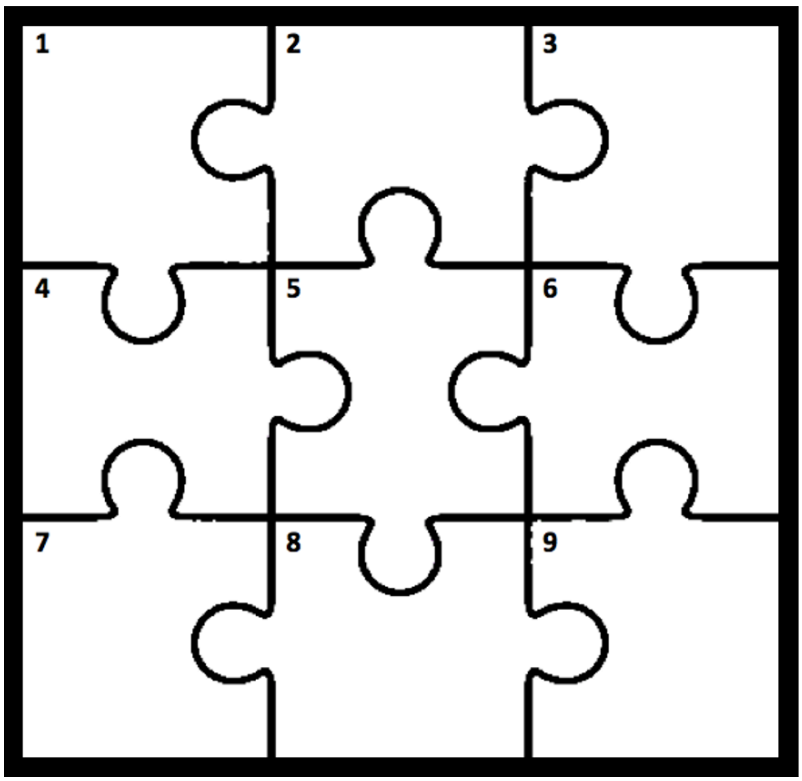
1. What is a good definition of osmosis?
2. How can we describe and explain the process of plasmolysis?
3. Why do plant cells, but not animal cells, have a cell wall?

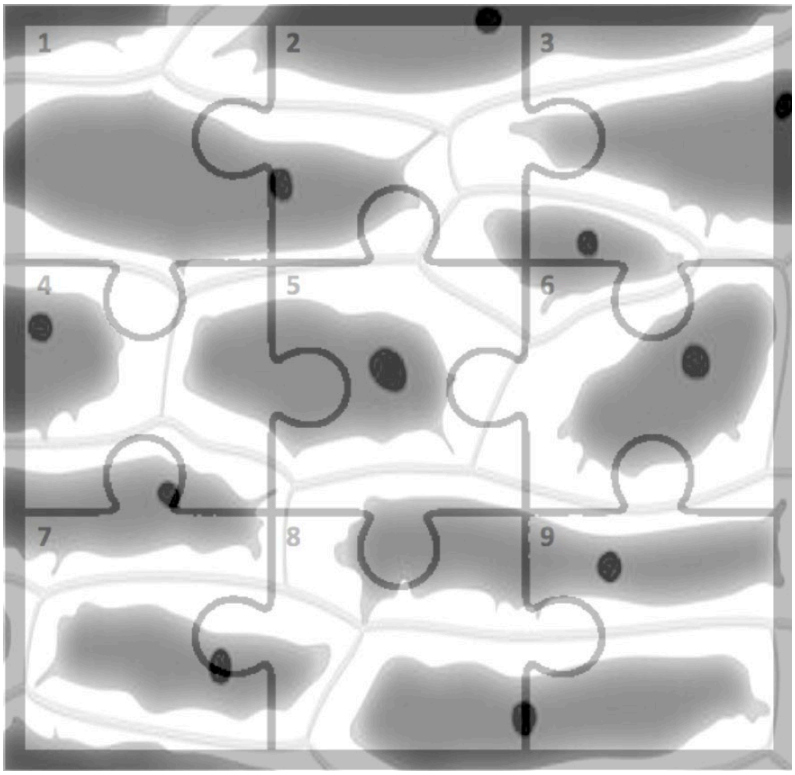
discussion	key words to use in your discussion	key words that arise during your discussion
1		
2		
3		

Worksheet B: Observing cells

As your teacher reveals the different jigsaw pieces, record your observations in the missing piece.







Extra notes

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Worksheet C: Think, pair, share

Here is a practical-focused question that requires learners to use higher-order thinking skills and their knowledge of osmosis.
Learners will need to discuss their thoughts with a partner before submitting their answers.

Visking tubing can be used to investigate the properties of cell membranes.

A student carried out an experiment to investigate osmosis using Visking tubing. An outline of the investigation is shown in Fig. 3.1.

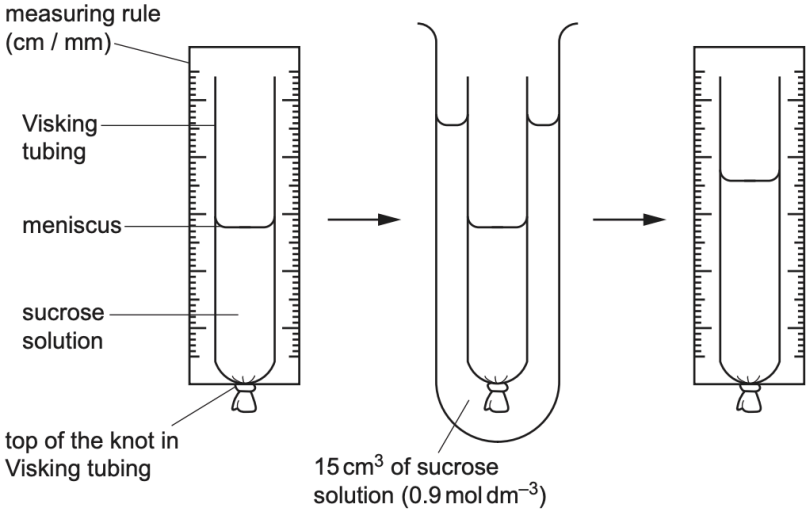

Fig. 3.1

- Six pieces of Visking tubing were filled with 10 cm^3 of different concentrations of sucrose solution: 0.0, 0.4, 0.8, 1.2, 1.6 and 2.0 $mol\,dm^{-3}$.
- The height of the meniscus of each solution in the Visking tubing was measured.
- The pieces of Visking tubing were put into test-tubes containing 15 cm^3 of 0.9 $mol\,dm^{-3}$ sucrose solution.
- After 20 minutes, the pieces of Visking tubing were removed from the test-tubes and the height of the meniscus in each was measured.

The results are shown in Table 3.1.

Table 3.1

concentration of sucrose solution inside Visking tubing / $mol\,dm^{-3}$	difference in height of meniscus after 20 minutes / mm
0.0	–12
0.4	–4
0.8	–2
1.2	+1
1.6	+6
2.0	+11

(a) The Visking tubing used by the student was **not** permeable to sucrose.

Explain the results shown in Table 3.1.

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..... [3]

(b) When red blood cells are placed in water they are destroyed by bursting.

The student also investigated how red blood cells are affected by immersion in solutions of sodium chloride of different concentration. Blood samples of the same volume were added to solutions of sodium chloride in separate test-tubes.

After 10 minutes, the student took 0.1 cm^3 of the blood samples from the test-tubes and estimated the percentage of red blood cells that had burst in each blood sample.

Fig. 3.2 shows the student's results.

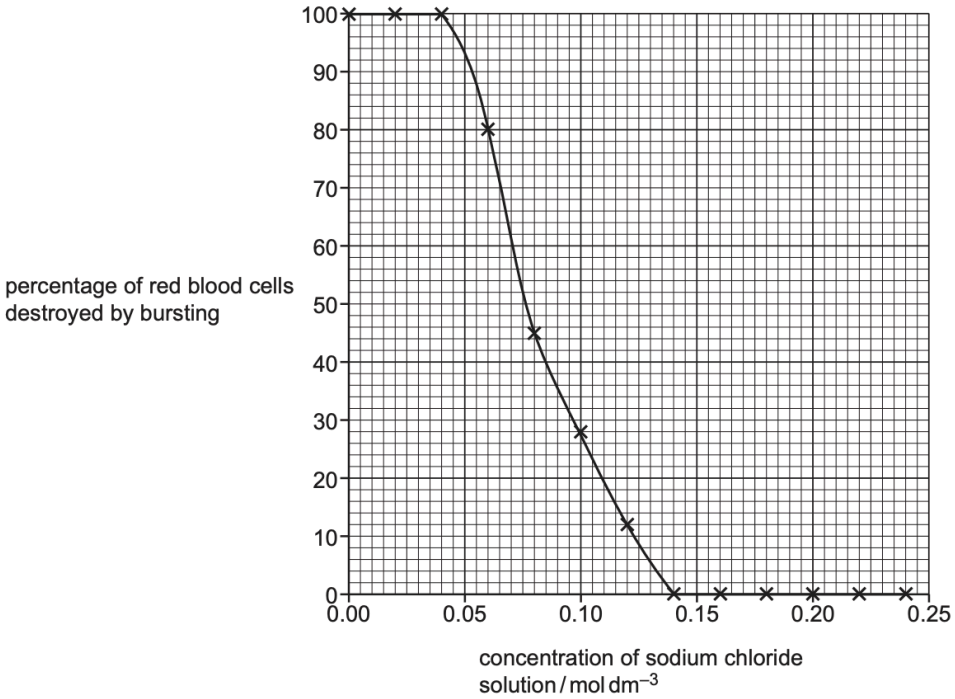

Fig. 3.2

Describe **and** explain the effects on red blood cells of immersion in different concentrations of sodium chloride as shown in Fig. 3.2.

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..... [4]

[Total: 7]

Worksheet D: Method circus

During this activity, you will practice the skills required to undertake this investigation, how to effectively use a light microscope, stage micrometer and an eyepiece graticule. Your teacher will provide you with 15 minutes to engage with each of three different tasks.

TASK 1. Setting up a microscope (15 minutes)

Problems encountered and expected safety precautions:

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TASK 2. Using a stage micrometer and eyepiece graticule (15 minutes)

Problems encountered and expected safety precautions:

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TASK 3. Recording video clips using a mobile phone attached to a microscope (15 minutes)

Problems encountered and expected safety precautions:

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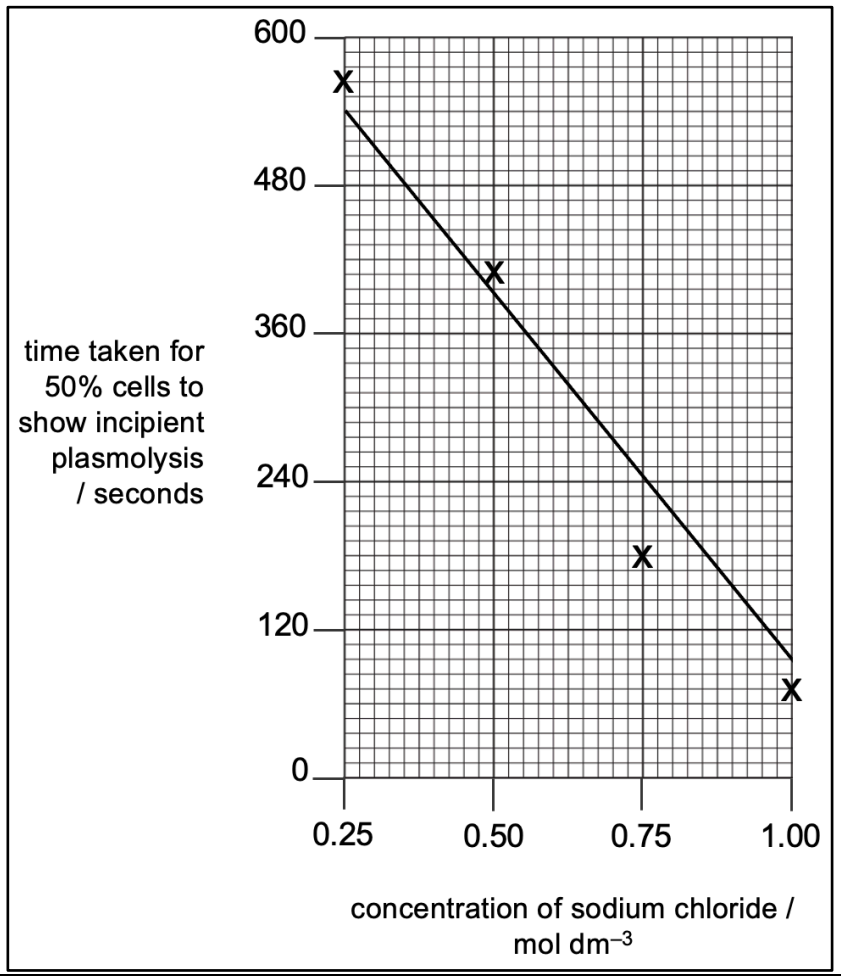
Worksheet E: Sample results



Worksheet F: Critiquing a report

The plan below was written by a student in response to the following question:

"*How does changing the temperature of a hypertonic solution affect the rate at which plant cells lose water to that solution?*"

Circle any parts of the student's plan that you would change and add sections that are missing. Add annotations in the margins to explain how you would do things differently – and why.

I would use three solutions of the same water potential, but at three different temperatures: room temperature, 50°C and 90°C. I would put a whole onion into the solutions and then wait for 1 hour. I would need to keep the time of incubation of the onion in the solution the same for all solutions. After this time, I would peel the onion and place some epidermis onto the microscope slide. Viewing the cells at x400, I would then use a timer to measure the time taken for 50% of cells to show some sign of plasmolysis.

Worksheet A: Answers

Statement 1
The net movement of water molecules across a semi-permeable membrane occurs from a solution of low water potential to a solution of high water potential.

This is false. The net movement of water is from a high to a low water potential.

Statement 2
Net osmosis into the cytoplasm is responsible for plasmolysis in plant cells.

This is false. Plasmolysis is caused by net osmosis out of the cytoplasm (and vacuole).

Statement 3
The cell wall prevents a plant cell from bursting when placed into a hypertonic solution.

This is false. It is in hypotonic solutions that the cell wall prevents a plant cell from bursting.

Worksheet B: Answers

Part (a)

any three from

1 *differences in height show that*
concentrations of sucrose, 0, 0.4 and 0.8 (mol dm^{-3}) *or* ⩽ / less than, 0.8 / 0.9, water moves out of Visking tubing ;
A one of 0, 0.4 or 0.8 **R** sucrose moving

2 concentrations of sucrose 1.2, 1.6, 2.0 (mol dm^{-3}) *or* ⩾ / more than, 0.9 /1.2, water moves into Visking tubing ;
A one of 1.2, 1.6 or 2.0 **R** sucrose moving

3 *ref. to* net water movement ;

if water enters Visking tubing – **A ora** *for water leaving*

4 external solution has higher water potential (than contents of Visking tubing) ;
A high water potential to low water potential

5 water moves, down, water potential / Ψ, gradient ;

Part (b)

mark whole question to a max of four marks
descriptions

1 at concentrations, less than / ⩽, 0.04 mol dm^{-3} all cells, burst / AW ;
2 at concentrations between 0.04 and 0.14 mol dm^{-3} decreasing percentage of cells burst / AW ; **A** use of percentages
3 at concentrations, greater than / ⩾, 0.14 mol dm^{-3} no cells, burst / AW ;

explanations to max 3

4 in low concentrations / ⩽ 0.04, of sodium chloride water moves into cells down water potential gradient / from high Ψ to low Ψ ;

5 cells increase in, volume / size / internal pressure ;

6 *either*
cell membranes are not strong enough to withstand increase in volume / pressure
or
red blood cells burst because they have no cell wall ;

7 between 0.04 and 0.14 (mol dm^{-3}) water potential gradient into cells, decreases / becomes less steep / AW ;

8 above 0.14 (mol dm^{-3}) / in high concentrations, water potential inside cells is the same or higher than the sodium chloride solution ;

9 at high concentration / ⩾ 0.14, water leaves cells / cells shrink / cells shrivel / cells show crenation ;

Worksheet F: Answers

Here is the student's plan.

I would use three solutions of the same water potential, but at three different temperatures: room temperature, 50°C and 90°C. I would put a whole onion into the solutions and then wait for 10 minutes. I would need to keep the time of incubation of the onion in the solution the same for all solutions. After this time, I would peel the onion and place some epidermis onto the microscope slide. Viewing the cells at x400, I would then use a timer to measure the time taken for 50% of cells to show some sign of plasmolysis.

Suggested changes to the plan are provided below.

- More than three solutions should be used – at least five. This is because any graph that will be plotted using this data could not show an accurate trend with so few values of the independent variable, which would be separated by large increments.
- The range of temperatures included is not appropriate: 'room temperature' is not a quantitative value, and at 90°C, the plant tissue would be killed, and cell surface membranes would not be present. A range of values between 10°C and 60°C could be appropriate, with solutions at 10°C intervals.
- Although the time of incubation is correctly stated as being the same between solutions, the value provided (10 minutes) would be too small to see the effect of net osmosis of the cells in the onion epidermis.
- The onions should be peeled before putting them into the solutions. This is because the movement of water by osmosis would not be possible across the hard outer skin of the onions.
- The magnification x400 would allow only a limited number of cells to be viewed. A magnification of x100 would be more appropriate.
- Because the onion tissue is being incubated for a period in the solutions, measuring the rate of osmosis using the 50% plasmolysis method is not appropriate. Instead, measuring the diameter or area of the cytoplasm in cells could be a possible alternative.

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