# Biology PAG 8: Transport in and out of cells

# Suggested Activity 1: Transport in and out of cells

## Instructions and answers for teachers and technicians

These instructions cover the learner activity section which can be found on [page 11](#_Student_Activity). This Practical activity supports OCR GCSE Biology.

**When distributing the activity section to the learners either as a printed copy or as a Word file you will need to remove the teacher instructions section.**

|  |
| --- |
| This is a **suggested** practical activity that can be used as part of teaching the GCSE (9-1) Gateway Science (A) and Twenty First Century Science (B) specifications.  These are **not controlled assessment tasks**, and there is **no requirement to use these particular activities**.  You may modify these activities to suit your learners and centre. Alternative activities are available from, for example, [Royal Society of Biology](https://www.rsb.org.uk/education/teaching-resources/secondary-schools), [Royal Society of Chemistry](http://www.rsc.org/learn-chemistry), [Institute of Physics](http://www.iop.org/education/teacher/resources/index.html), [CLEAPSS](http://science.cleapss.org.uk/) and [publishing companies](https://global.oup.com/education/content/secondary/key-issues/gcse_science_2016/?region=uk), or of your own devising.  Further details are available in the [specifications](http://www.ocr.org.uk/science) (Practical Skills Topics), and in these [videos](https://www.youtube.com/playlist?list=PLBD9B84FF4BD54AA4). |

**OCR recommendations:**

**Before carrying out any experiment or demonstration based on this guidance, it is the responsibility of teachers to ensure that they have undertaken a risk assessment in accordance with their employer’s requirements, making use of up-to-date information and taking account of their own particular circumstances. Any local rules or restrictions issued by the employer must always be followed.**

**CLEAPSS resources are useful for carrying out risk-assessments: (**<http://science.cleapss.org.uk>**).**

**Centres should trial experiments in advance of giving them to learners. Centres may choose to make adaptations to this practical activity, but should be aware that this may affect the Apparatus and Techniques covered by the learner.**

### Introduction

There are many activities that can be used as demonstrations and class practicals to help learners to understand about the movement of molecules, including water, into and out of cells.

A number of them are classic experiments that have common procedures including:

* Investigating osmosis in chicken eggs
* Investigating the effect of different concentrations of sucrose / salt concentrations on osmosis in potato chips
* The effect of size on uptake by diffusion using agar cubes
* Observing osmosis, plasmolysis and turgor in plant cells using microscopy
* Investigating ‘creaming yeast’ to show osmosis.

Learners need to be fully prepared for the practical questions in the written examinations so a rich and varied practical experience will help them with this preparation.

These instructions describe a possible procedure for investigating the effect of different solute concentrations on osmosis in potato chips. It is going to consider the way to measure the effect on mass and offer the opportunity to consider some related mathematical skills.

This has been chosen as it is a commonly used experiment with many schools having the required apparatus. There are many possible variations on this method and if you use a variation in your school that is successful, please continue to use that as long as the same skills and techniques are covered.

### DfE Apparatus and Techniques covered

The codes used below match the OCR Practical Activity Learner Record Sheet ([**Biology**](http://www.ocr.org.uk/Images/-295601-gcse-biology-learner-record-sheet.doc) / [*Combined Science*](http://www.ocr.org.uk/Images/304431-gcse-combined-science-learner-record-sheet.doc)) and Trackers ([**Biology**](http://www.ocr.org.uk/Images/323480-gcse-biology-practical-tracker.zip) / [*Combined Science*](http://www.ocr.org.uk/Images/323483-gcse-combined-science-practical-tracker.zip)) available online. **There is no requirement to use these resources.**

**1** *[1]***:** Use of appropriate apparatus to make and record a range of measurements accurately, including: **i**[*i*]) length**; iii**[*iii*]) mass**; iv**[*iv*]) time**; vi**[*vi*]) volume of liquids

**3** *[3]*: Use of appropriate apparatus and techniques for the: i) observation of biological changes and/or processes; ii) measurement of biological changes and/or processes

**5** *[5]*: Measurement of rates of reaction by a variety of methods including: ii) uptake of water

**8**: Use of appropriate techniques and qualitative reagents to identify biological molecules and processes in more complex and problem-solving contexts including: **i**) continuous sampling in an investigation

### Aims

To use appropriate apparatus and techniques to observe and measure movement of molecules into and out of cells.

To calculate the percentage change in mass of plant tissue.

To use apparatus to measure length, mass, time, temperature and the volume of a liquid.

### Intended class time

This activity will take 60 minutes.

### Links to Specifications:

### Twenty First Century

B3.2.2a Explain how substances are transported into and out of cells through diffusion, osmosis and active transport.

B3.2.2b Describe practical investigations into the processes of diffusion and osmosis.

B3.2.3 Explain how the partially-permeable cells membranes of plant cells and prokaryotic cells are related to diffusion, osmosis and active transport.

B5.1.2 Explain how the partially-permeable cell membranes of animal cells are related to diffusion, osmosis and active transport.

B5.4.4 Explain the effect on cells of osmotic changes in body fluids.

### Gateway

B2.1a Explain how substances are transported into and out of cells through diffusion, osmosis and active transport.

B2.2a Explain the need for exchange surfaces and a transport system in multicellular organisms in terms of surface area : volume ratio.

B3.3f Explain the effect on cells of osmotic changes in body fluids.

### Mathematical Skills covered

M1a Recognise and use expressions in decimal form

M1c Use fractions, ratios and percentages

M2b Find arithmetic means

M2f Understand the terms mean, mode and median

M4a Translate information between graphical and numeric form

M4b Understand that y = mx + c represents a linear relationship

M4c Plot two variables from experimental and other data

M4d Determine the slope and intercept of a linear graph

### Twenty First Century IaS references covered

IaS2.1 Present observations and other data using appropriate formats

IaS2.2 When processing data use SI units where appropriate

IaS2.4 Be able to translate data from one form to another

IaS2.6 When processing data use an appropriate number of significant figures

IaS2.7 When displaying data graphically select an appropriate graphical form, use appropriate axes and scales, plot data points correctly, draw an appropriate line of best fit and indicate uncertainty (e.g. range bars)

IaS2.8 When analysing data identify patterns / trends, use statistics (range and mean) and obtain values from a line on a graph (including gradient, interpolation and extrapolation)

### Gateway Working scientifically references covered

WS1.3a – presenting observations and other data using appropriate methods

WS1.3b – translating data from one form to another

WS1.3c – carrying out and representing mathematical and statistical analysis

WS1.3e – interpreting observation and other data

WS1.4a – use scientific vocabulary, terminology and definitions

WS1.4c – use SI units

WS1.4f – use an appropriate number of significant figures in calculation

WS2a – carry out experiments to include due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations, and following written instructions

WS2b – make and record observations and measurements using a range of apparatus and methods to include keeping appropriate records

WS2c – presenting observations using appropriate methods to include methods to include descriptive, tabular diagrammatic and graphically

### Equipment (all equipment in this section is per group)

* Potato / potato chips
* Cork borer
* Knife
* White tile
* Ruler
* Measuring cylinder
* Distilled water
* Sucrose solutions – 0.1M, 0.2M, 0.3M, 0.4M, 0.5M and 0.6M
* 7 small beakers (or equivalent)
* Marker pen / labels for beakers
* Balance that weights to 0.1 g
* Paper towel
* Forceps

### Health and Safety

Care should be taken when using the cork borer and knife to cut / trim the pieces of potato and when handling glassware.

### Method

This is a fairly straightforward procedure so it is unlikely that learners will need any part of it demonstrating. They need to be reminded to take care to label their beakers of solution carefully and to keep track of which potato chip is which in order to ensure correct results are recorded.

A table for learners to complete is provided on the learner activity sheet but this could be removed for a higher ability group and then learners asked to design a table for the activity themselves.

1. Collect seven small beakers (or equivalent) and label them ‘0.0M’, ‘0.1M’, ‘0.2M’, ‘0.3M’, ‘0.4M’, ‘0.5M’ and ‘0.6M’ using a marker pen or labels.
2. Use a cork borer and a knife to cut seven potato chips to a length of 50 mm. Use a ruler to measure the length of the potato chips.
3. It is important that each potato chip ‘belongs’ to a particular concentration of sucrose so decide this by placing one chip in each beaker. Take care to always keep each chip with the same concentration / beaker.
4. One by one, weigh each potato chip on a balance and record the mass in the table, to one decimal place. Remember to replace each chip into the correct beaker.
5. Add 50 ml of the correct solution to each beaker – 50 ml distilled water to the ‘0.0M’ beaker, 50 ml 0.1M sucrose to the ‘0.1M’ beaker etc. Ensure that the potato chips are submerged in the solutions.
6. Leave the potato chips in the solutions for 30 minutes or a time determined by your teacher.
7. Remove the chips one by one with forceps and blot dry using paper towel.
8. Re-weigh each chip, carefully keeping track of which chip came from which solution, and record the new mass in the table.

### Notes

There is likely to be support for learners required with the data processing that follows the practical activity, depending on the ability of the learners. The processing carried out or the scaffolding provided can be determined depending on the ability of the group or on small groups within a larger class.

The most able should find it fairly straightforward to measure the mass of the potato chips at the start and end of the procedure and then calculate the percentage change in mass. Weaker learners will need support with all or parts of this in varying ways.

The drawing of a graph naturally follows the collection of percentage change data of this type and this is an important part of the process, though not directly related to practical skills. Learners may well be presented with a set of data generated in a similar way in an examination and so they need to be prepared and to have had plenty of opportunities to develop a range of graph drawing skills. The learner activity sheet suggests that learners follow up their calculations with the drawing of a graph of these data. These instructions can be modified or added to depending on the ability of the group or the time allowed for the activity.

A possible set of data, using 50 mm long potato chips and mass as the dependent variable can be found below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sucrose molarity (M)** | **Initial mass (g)** | **Final mass (g)** | **Change in mass (g)** | **Percentage change in mass (%)** |
| 0.0 | 4.5 | 5.0 | + 0.5 | + 11.1 |
| 0.1 | 4.2 | 4.6 | + 0.3 | + 7.1 |
| 0.2 | 3.9 | 4.0 | + 0.1 | + 2.6 |
| 0.3 | 4.5 | 4.3 | - 0.2 | - 4.3 |
| 0.4 | 4.3 | 3.7 | - 0.6 | - 14.0 |
| 0.5 | 4.4 | 3.6 | - 0.8 | - 18.2 |
| 0.6 | 4.2 | 3.2 | - 1.0 | - 23.8 |

The rate of water uptake can be calculated using the following equation:

|  |  |
| --- | --- |
| rate of water uptake = | final mass – initial mass |
| time |

Students could use this experiment to evaluate the usefulness of the rate calculation. This can be used to reinforce that the potato chips will reach an equilibrium point where there is no net movement of water. If that equilibrium point is reached after ten minutes then a measurement at an hour would not provide a reliable rate. Students could use this as an opportunity to plan then do a practical to effectively calculate rate (e.g. place the chips in water and at sample various time intervals – and plot a change in mass time graph). Technician Notes

For this practical the teacher will require for a class of 30:

* 15 × potatoes
* 15 × cork borers
* 15 × knives
* 15 × white tiles
* 15 × forceps
* 15 × rulers
* 15 × measuring cylinders (100 ml)
* 15 × distilled water bottles
* 105 × small beakers (or equivalent) ×7 per pair
* 15 × marker pens or sets of labels for the beakers
* 2 or 3 balances that weigh to 0.1 g
* Paper towel

### Mark scheme for quiz questions

|  |
| --- |
| **1.** Different molecules move in and out of potato cells by various processes, including osmosis.  What is **osmosis**?  Complete the sentence. **[1 mark]**  Osmosis is the overall movement of water molecules from a dilute to a more |
| concentrated solution across a membrane that is partially / selectively permeable ✓ |
|  |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.** | Sarah is investigating how plant tissue takes up water.  She uses four potato chips, **A**, **B**, **C** and **D**. The chips are all cut to the **same length**.  Sarah places the four chips into a range of sugar concentrations.  The diagram below shows the original length of the chips and the length of each chip **after** soaking for 30 minutes in the sugar solutions.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Original** | **A** | **B** | **C** | **D** | |  |  |  |  |  | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Write the letters **A**, **B**, **C** and **D** in the table to show which chip was in each solution.  **[2 marks]**   |  |  | | --- | --- | | **Concentration of solution (M)** | **Potato chip** | | **0.0** | C | | **0.3** | B | | **0.6** | A | | **0.9** | D |   4 correct ✓✓, 2 or 3 correct ✓, 1 or 0 correct 🗶 | | | |
|  |  | | | |
| **3** | **(a)** | The table below shows data from an investigation into the effect of different salt concentrations on cells. Pieces of potato are weighed and placed in five different salt concentrations. After 20 minutes, they are removed and re-weighed.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Concentration of salt solution (M)** | **Starting mass (g)** | **Final mass (g)** | **Difference in mass (g)** | **Percentage change in mass (%)** | | 0.1 | 2.2 | 2.5 | + 0.3 | + 13.6 | | 0.2 | 2.4 | 2.5 | + 0.1 | + 4.17 ✓✓ | | 0.3 | 3.0 | 3.1 | + 0.1 | + 3.33 | | 0.4 | 2.1 | 1.9 | - 0.1 | - 4.76 | | 0.5 | 2.4 | 2.2 | - 0.2 | - 8.33 |   Calculate the percentage change for the piece of potato placed in the 0.2 M salt solution and complete the table. Give your answer to two decimal places. **[2 marks]** | | |
|  |  |  | | |
|  | **(b)** | Why is it better to calculate the percentage change rather than using the difference in mass as measure of the change in the potato chips? **[2 marks]** | | |
|  |  |  | Potato pieces had a different mass / weight (at the start of the experiment) ✓  *Idea that* it allows comparison of the potato pieces / the results are comparable✓ |  |
|  |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **(c)** | The data in the table can be used to work out the concentration of the cells in the potato chips.  What is the range of the concentration of the cells? Use the data to work this out. **[2 marks]**  Range ……………0.3 ✓……………. (M) to …………0.4 ✓…………….. (M) | | |
|  |  |  | | |
|  | **(d)** | What are **three** improvements to the procedure used that could improve the quality of data and confidence in conclusions? **[3 marks]** | | |
|  |  |  | **Any three from**  Repeats ✓  (More) tests between 0.3 and 0.4 ✓  Keep surface area the same ✓  Keep temperature the same ✓  Leave the chips in the solutions for longer ✓  Make sure the starting mass / weight is the same ✓  Same age / variety of potato OR use the same potato ✓  Removal of excess solution by blotting ✓  Ensure potato chips are totally immersed in solution / prevent evaporation of water ✓ |  |

### Document updates

v1 Published on the qualification pages

v1.1 January 2017 Consolidated labelling and formatting of activities

v1.2 February 2017 Updated to include rate of water update calculation

v1.3 June 2021 Update to meet digital accessibility standards



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# Biology PAG 8: Transport in and out of cells

# Suggested Activity 1: Transport in and out of cells

## Learner Activity

### Introduction

There are many activities that can be used as demonstrations and class practicals to help learners to understand about the movement of molecules, including water, into and out of cells.

A number of them are classic experiments that have common procedures including:

* Investigating osmosis in chicken eggs
* Investigating the effect of different concentrations of sucrose / salt concentrations on osmosis in potato chips
* The effect of size on uptake by diffusion using agar cubes
* Observing osmosis, plasmolysis and turgor in plant cells using microscopy
* Investigating ‘creaming yeast’ to show osmosis.

Learners need to be fully prepared for the practical questions in the written examinations so a rich and varied practical experience will help them with this preparation.

### Aims

To use appropriate apparatus and techniques to observe and measure movement of molecules into and out of cells.

To calculate the percentage change in mass of plant tissue.

To use apparatus to measure length, mass, time, temperature and the volume of a liquid.

### Intended class time

60 minutes.

### Method

1. Collect seven small beakers (or equivalent) and label them ‘0.0M’, ‘0.1M’, ‘0.2M’, ‘0.3M’, ‘0.4M’, ‘0.5M’ and ‘0.6M’ using a marker pen or labels.
2. Use a cork borer and a knife to cut seven potato chips to a length of 50 mm. Use a ruler to measure the length of the potato chips.
3. It is important that each potato chip ‘belongs’ to a particular concentration of sucrose so decide this by placing one chip in each beaker. Take care to always keep each chip with the same concentration / beaker.
4. One by one, weigh each potato chip on a balance and record the mass in the table, to one decimal place. Remember to replace each chip into the correct beaker.
5. Add 50 ml of the correct solution to each beaker – 50 ml distilled water to the ‘0.0M’ beaker, 50 ml 0.1M sucrose to the ‘0.1M’ beaker etc. Ensure that the potato chips are submerged in the solutions.
6. Leave the potato chips in the solutions for 30 minutes or a time determined by your teacher.
7. Remove the chips one by one with forceps and blot dry using paper towel.
8. Re-weigh each chip, carefully keeping track of which chip came from which solution, and record the new mass in the table.

### Results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sucrose molarity (M)** | **Initial mass (g)** | **Final mass (g)** | **Change in mass (g)** | **Percentage change in mass (%)** |
| 0.0 |  |  |  |  |
| 0.1 |  |  |  |  |
| 0.2 |  |  |  |  |
| 0.3 |  |  |  |  |
| 0.4 |  |  |  |  |
| 0.5 |  |  |  |  |
| 0.6 |  |  |  |  |

* Calculate the change in mass and the percentage change in mass.
* Plot a graph of percentage change in mass against sucrose molarity.

### Conclusion

Use your graph to determine the sucrose concentration of the potato chips and explain how you decided.

Use scientific knowledge about osmosis and transport in and out of cells to write a paragraph to explain your data.

### Quiz – test your knowledge and understanding

|  |
| --- |
| **1.** Different molecules move in and out of potato cells by various processes, including osmosis.  What is **osmosis**?  Complete the sentence. **[1 mark]**  Osmosis is the overall movement of ………………………….. molecules from a dilute to a more |
| concentrated solution across a membrane that is ………………………………………………… |
|  |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **2.** | Sarah is investigating how plant tissue takes up water.  She uses four potato chips, **A**, **B**, **C** and **D**. The chips are all cut to the **same length**.  Sarah places the four chips into a range of sugar concentrations.  The diagram below shows the original length of the chips and the length of each chip **after** soaking for 30 minutes in the sugar solutions.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Original** | **A** | **B** | **C** | **D** | |  |  |  |  |  | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Write the letters **A**, **B**, **C** and **D** in the table to show which chip was in each solution. **[2 marks]**   |  |  | | --- | --- | | **Concentration of solution (M)** | **Potato chip** | | **0.0** |  | | **0.3** |  | | **0.6** |  | | **0.9** |  | | | | |
|  |  | | | |
| **3** | **(a)** | The table below shows data from an investigation into the effect of different salt concentrations on cells. Pieces of potato are weighed and placed in five different salt concentrations. After 20 minutes, they are removed and re-weighed.   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Concentration of salt solution (M)** | **Starting mass (g)** | **Final mass (g)** | **Difference in mass (g)** | **Percentage change in mass (%)** | | 0.1 | 2.2 | 2.5 | + 0.3 | + 13.6 | | 0.2 | 2.4 | 2.5 | + 0.1 |  | | 0.3 | 3.0 | 3.1 | + 0.1 | + 3.33 | | 0.4 | 2.1 | 1.9 | - 0.1 | - 4.76 | | 0.5 | 2.4 | 2.2 | - 0.2 | - 8.33 |   Calculate the percentage change for the piece of potato placed in the 0.2 M salt solution and complete the table. Give your answer to two decimal places. **[2 marks]** | | |
|  |  |  | | |
|  | **(b)** | Why is it better to calculate the percentage change rather than using the difference in mass as measure of the change in the potato chips? **[2 marks]** | | |
|  |  |  |  |  |
|  |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **(c)** | The data in the table can be used to work out the concentration of the cells in the potato chips.  What is the range of the concentration of the cells? Use the data to work this out.  **[2 marks]**  Range ……………………………. (M) to ………….…………….. (M) | | |
|  |  |  | | |
|  | **(d)** | What are **three** improvements to the procedure used that could improve the quality of data and confidence in conclusions? **[3 marks]** | | |
|  |  |  |  |  |

### DfE Apparatus and Techniques covered

If you are using the OCR Practical Activity Learner Record Sheet ([**Biology**](http://www.ocr.org.uk/Images/-295601-gcse-biology-learner-record-sheet.doc) / [*Combined Science*](http://www.ocr.org.uk/Images/304431-gcse-combined-science-learner-record-sheet.doc)) you may be able to tick off the following skills:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Biology** | | | |  | ***Combined Science*** | | | |
| 1-i | 1-iii | 1-iv | 1-vi |  | *1-i* | *1-iii* | *1-iv* | *1-vi* |
| 3-i | 3-ii | 5-ii | 8-i |  | *3-i* | *3-ii* | *5-ii* |  |