

GCSE Biology: Required practical activities

DRAFT

Introduction

Practical work is at the heart of science – that’s why we have placed it at the heart of each of our GCSE science specifications. By carrying out carefully considered practical work, students will enhance their investigative thinking, improve their mastery of techniques and consolidate their understanding of key scientific concepts.

The assessment of practical skills is changing, so we are creating documents to help you and your students prepare for the changes including the *Required practical summary*. It provides further details on how the sample lessons in this document meet the specified practical skills, mathematical skills and Working scientifically skills.

This document contains the required practical activities for the GCSE Biology qualification. By undertaking the required practical activities, students will have the opportunity to experience all of the required apparatus and techniques needed for the qualifications. However, these activities are only suggestions and teachers are encouraged to develop activities, resources and contexts that provide the appropriate level of engagement and challenge for their own students.

These sample activities have been written by practising teachers and use apparatus and materials that are commonly found in most schools.

When planning your lessons, remember that the required practical activities listed as ‘biology **only**’ (practicals 2, 8 and 10) are only required by GCSE Biology and not for either of the combined science specifications.

Getting started

Risk assessment

These required practical activities have been suggested by teachers who have successfully carried them out in the lab. However it is the responsibility of the centre to ensure that full risk assessments have been carried out in each case.

Trialling

The practical activities should be trialled before use with students to ensure that they match the resources available within the school or college.

GCSE science practical handbook

Further guidance on carrying out effective practical work will be made available in the new AQA *Science Practical Handbook* which will be published in the spring 2016. It will provide resources for teachers and students including:

1. cross-board apparatus and techniques and Ofqual regulations
2. practical skills assessment in question papers
3. sample practical lessons
4. guidelines for supporting students in practical work
5. improving the quality of practical work
 - a. working scientifically
 - b. collecting data
 - c. graphing
 - d. glossary of terms
6. practical progression ladders
7. student resources.

GCSE Biology required practical activity 1: Microscopy

Teachers' notes

Required practical activity	Apparatus and techniques
Use a light microscope to observe, draw and label a selection of plant and animal cells. A scale magnification must be included.	AT 1, AT 7

Using a light microscope to observe, draw and label cells in an onion skin

Materials

In addition to access to general laboratory equipment, each student needs:

- a small piece of onion
- a knife or scalpel
- a white tile
- forceps
- a microscope slide
- a coverslip
- a microscope
- iodine solution in a dropping bottle.

Technical information

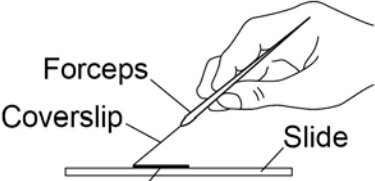
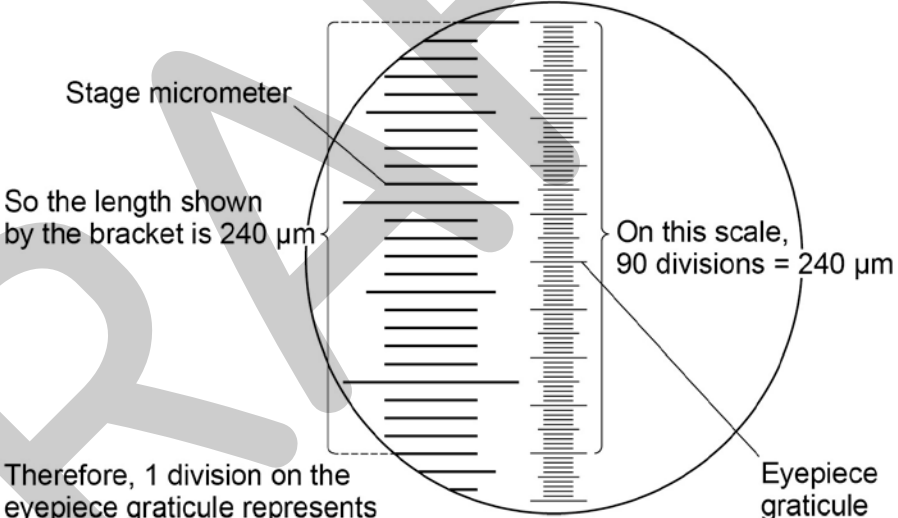
Iodine solution may be purchased ready-made or can be made up following the instructions on CLEAPSS recipe card number 50.

Additional information

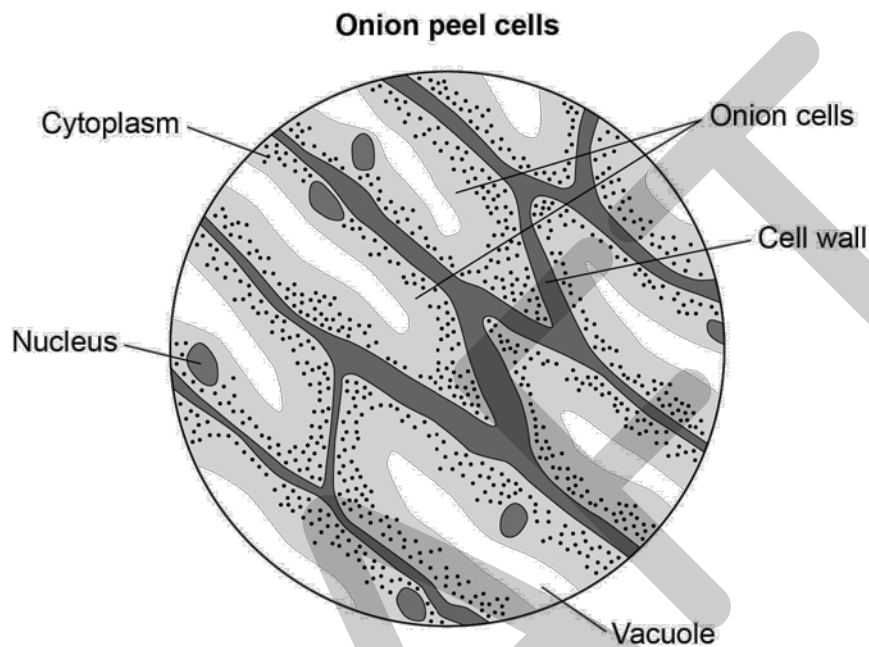
The techniques involved should be demonstrated to the students. The students should be allowed time to practice the technique of preparing a wet slide.

It is particularly important that they practise the technique of lowering the cover slip on to the slide so that no air bubbles are trapped.

Students should be familiar with the use of a microscope and how to use an eyepiece graticule.

Techniques requiring practice	Additional information
Lowering the coverslip on to the slide	 <p>Forceps Coverslip Slide Specimen in water</p>
Using the microscope	Students should be given guidance in how to use an optical microscope, with particular reference to the coarse and fine focus controls.
Using an eyepiece graticule	<p>Part of the stage micrometer viewed at x400 magnification</p>  <p>Stage micrometer</p> <p>So the length shown by the bracket is 240 μm</p> <p>On this scale, 90 divisions = 240 μm</p> <p>Therefore, 1 division on the eyepiece graticule represents $240 \div 90 = 2.67 \mu\text{m}$ at this magnification</p> <p>Eye-piece graticule</p> <p>A simple eyepiece graticule, such as the one above, could be used. Students need to appreciate that with different objective lenses the distance between the lines on the graticule changes. Unless a stage micrometer is available, students will need to be told what each division on the graticule is worth for each different objective power.</p>
Using a stage micrometer	If a stage micrometer is available students will need to be taught how to use it, using a diagram similar to the one above.

Students should be able to see the following using $\times 400$ magnification.



Risk assessment

- Risk assessment and risk management are the responsibility of the school or college.
- Care should be taken when using iodine solution to avoid staining and ingestion.
- Safety goggles should be used when handling iodine solution.

Trialling

The practical should be trialled before use with students.

GCSE Biology required practical activity 1: Microscopy

Student sheet

Required practical activity	Apparatus and techniques
Use a light microscope to observe, draw and label a selection of plant and animal cells. A scale magnification must be included.	AT 1, AT 7

Using a light microscope to observe, draw and label cells in an onion skin

In this experiment you will prepare a microscope slide to show the cells and their contents in an onion leaf.

You will use an optical microscope to observe, draw and measure the cells in the onion skin. You will also need to identify structures within the cells.

Learning outcomes
1
2
Teachers to add these with particular reference to working scientifically

Method

You are provided with the following:

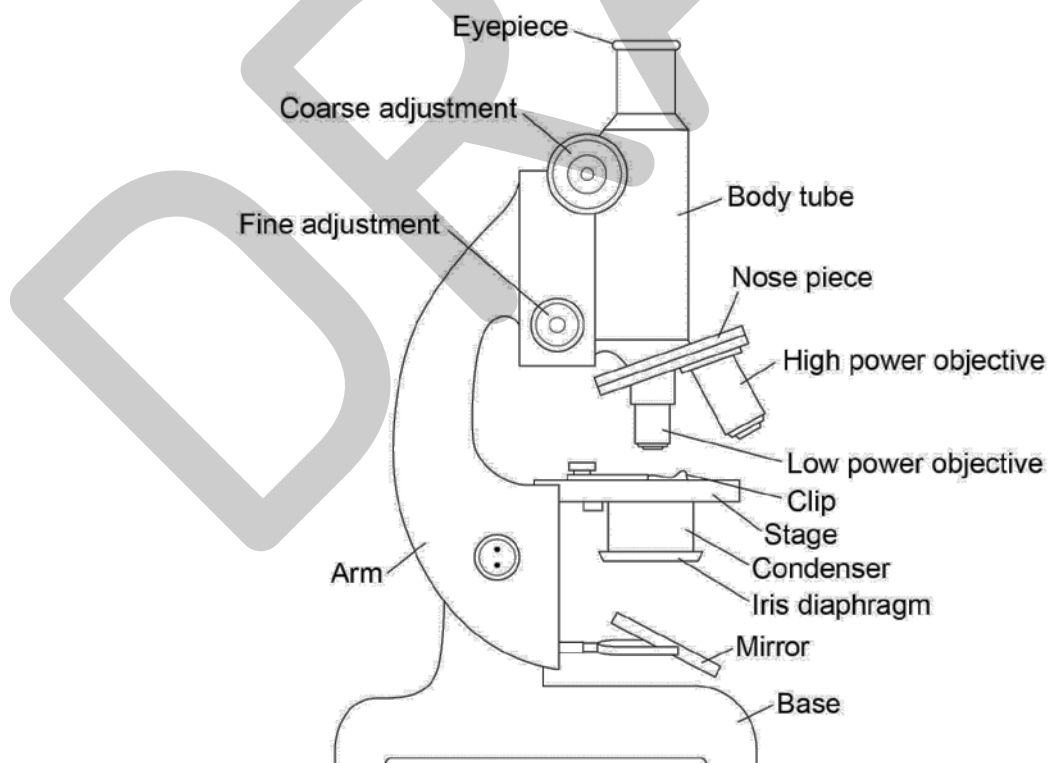
- a small piece of onion
- a knife or scalpel
- a white tile
- forceps
- a microscope slide
- a coverslip
- a microscope
- iodine solution in a dropping bottle.

You should read these instructions carefully before you start work.

1. Use a dropping pipette to put one drop of water onto a microscope slide.
2. Separate one of the thin layers of the onion.
3. Peel off a thin layer of epidermal tissue from the inner surface.
4. Use forceps to put this thin layer on to the drop of water that you have placed on the microscope slide.
5. Make sure that the layer of onion cells is flat on the slide.
6. Put two drops of iodine solution onto the onion tissue.
7. Carefully lower a coverslip onto the slide. Do this by placing one edge of the coverslip on the slide and then using a mounted needle to lower the other edge onto the slide.
8. Use a piece of filter paper to soak up any liquid from around the edge of the coverslip.
9. Put the slide on the microscope stage.

Using the microscope

The diagram shows a typical microscope.



This microscope has a mirror to reflect light up through the slide. Some microscopes have a built-in light instead of a mirror.

-
10. Turn the nosepiece to the lowest power objective lens.
 11. Looking from the side (**not** through the eyepiece) turn the coarse adjustment knob so that the end of the objective lens is almost touching the slide.
 12. Now looking through the eyepiece, turn the coarse adjustment knob in the direction to increase the distance between the objective lens and the slide. Do this until the cells come into focus.
 13. Now rotate the nosepiece to use a higher power objective lens.
 14. Slightly rotate the fine adjustment knob to bring the cells into a clear focus and use the low-power objective ($\times 40$ magnification) to look at the cells.
 15. When you have found some cells, switch to a higher power ($\times 100$ or $\times 400$ magnification).
 16. In the space below make a clear, labelled drawing of some of these cells. Make sure that you draw and label any component parts of the cell.
 17. Use an eyepiece graticule to measure the length of one of the epidermal cells that you have drawn. Remember to include the units.
 18. Now measure the same cell in your drawing.
 19. Calculate the magnification of your drawing, using the formula:

$$\text{magnification} = \frac{\text{length of drawing of cell}}{\text{actual length of cell}}$$

20. Write the magnification underneath your drawing.



GCSE Biology required practical activity 2: Microbiology (biology only)

Teachers' notes

Required practical activity	Apparatus and techniques
Investigate the effect of antiseptics or antibiotics on bacterial growth using agar plates and measuring zones of inhibition.	AT 1, AT 3, AT 4, AT 8

Investigating the effect of antiseptics on the growth of bacteria

Materials

In addition to access to general laboratory equipment, each student needs:

- a nutrient agar plate
- a Bunsen burner
- a heatproof mat
- a disposable plastic pipette
- a culture of bacteria (*E. coli*)
- a glass spreader
- filter paper discs
- three antiseptics (such as mouthwash, TCP, and antiseptic cream)
- disinfectant bench spray
- a 'discard beaker' of disinfectant
- a small beaker of ethanol
- forceps
- clear tape
- hand wash
- a wax pencil
- access to an incubator.

Technical information

Cultures of *E. coli* bacteria, nutrient agar, and suitable disinfectants for the bench spray and the 'discard beaker' can be bought from educational suppliers. The instructions, and any risk assessment information, which accompany them should be followed carefully.

Plastic petri dishes should be used as these can be destroyed by melting in an autoclave or large pressure cooker, in a specialist autoclave bag (or roasting bag), immediately after obtaining the

results. Discs can be cut from filter paper using a hole-punch. Glass spreaders are made by bending a 3–4 mm diameter glass rod into an L-shape.

Additional information

The techniques involved should be demonstrated to the students and they should be allowed time to practice the techniques. Students can use water in place of the bacterial culture, before performing this experiment.

It is important that students can work carefully but quickly to minimise contamination. The lids on the agar plates should be lifted for as short a time as possible at each step of the experiment. The lid should be replaced on the culture bottle immediately once the sample of bacteria has been removed with the pipette. At no point should any lids be placed down on the bench (it is less easy to forget the lid is off if you have it in your hands and no microorganisms are transferred to the bench).

In particular students will need to practice the following:

Techniques requiring practice	Additional information
Flaming the neck of the culture bottle	This must be done whilst still holding the pipette and the lid of the culture bottle in your other hand (neither should be placed down on the bench at any point). The bottle must not be held still in the flame as the glass will crack – it should be rotated as it is very briefly passed through the flame.
Lifting the lid of the agar plate at an angle	The lid should only be opened at the side facing the Bunsen burner to avoid contamination
Spreading the bacteria thoroughly around the agar plate right to the edges	This is best done by holding the glass spreader still up to the edge of the plate and rotating the plate. The lid of the plate must be held over it at the same time to avoid contamination.
Placing the filter paper discs onto the agar plate in the right positions	Students should hold the first disc with the forceps. They should lift the lid of the agar plate at an angle (as before) and place the disc flat onto the central dot in the first third of the plate. The lid of the agar plate should be replaced whilst the next disc is collected. This is repeated so that all three discs are in position.

Clear zones are not always perfectly circular so students should measure the diameter twice (at 90° to each other) and calculate a mean diameter for each clear zone.

Risk assessment

- Risk assessment and risk management are the responsibility of the school or college.
- Care should be taken to ensure that appropriate aseptic techniques are used when handling microorganisms.
- Care should be taken to ensure that appropriate aseptic techniques are used when handling microorganisms.
- Food for human consumption should not be kept in a refrigerator that is used to store microorganisms.
- Care should be taken with the use of ethanol and naked flames in this experiment. Refer to Hazcard 40A.
- Students should ensure that their work spaces and hands are thoroughly cleaned before and after the experiment.
- Care must be taken to ensure that the lids on the agar plates are secured in place (but not completely sealed). Students must not remove the lids when making their clear zone measurements.
- All equipment that has come into contact with the microorganisms should be suitably destroyed or sterilised immediately after the experiment.

Trialling

The practical should be trialled before use with students.

Alternative practical

Outline method	Suggested apparatus	Suggested reagents
<p>Investigating the effect of antibiotics on the growth of bacteria</p> <p>As above but use three antibiotic discs instead of the filter paper disc. These are commercially prepared – either with different antibiotics or different concentrations of the same antibiotic. Care should be taken to ensure that these discs are only handled using forceps as allergic reactions to antibiotics, such as penicillin, can occur.</p>	<p>As above but with antibiotic discs</p>	<p>As above</p>

GCSE Biology required practical activity 2: Microbiology (biology only)

Student sheet

Required practical activity	Apparatus and techniques
Investigate the effect of antiseptics or antibiotics on bacterial growth using agar plates and measuring zones of inhibition.	AT 1, AT 3, AT 4, AT 8

Investigating the effect of antiseptics on the growth of bacteria

In this experiment you will prepare a lawn plate of bacteria before testing the effectiveness of three different antiseptics.

Care must be taken when handling microorganisms such as bacteria.

You will use techniques called aseptic techniques during this experiment to avoid contamination.

Contamination can be where microorganisms from:

- the surroundings get into your experiment and spoil your results
- your experiment get into the surroundings and cause a potential health hazard.

You will measure the diameter of the 'clear zone' around the disc where there is no bacteria growing. The larger the clear zone, the more effective the antiseptic.

Learning outcomes
1
2
Teachers to add these with particular reference to working scientifically

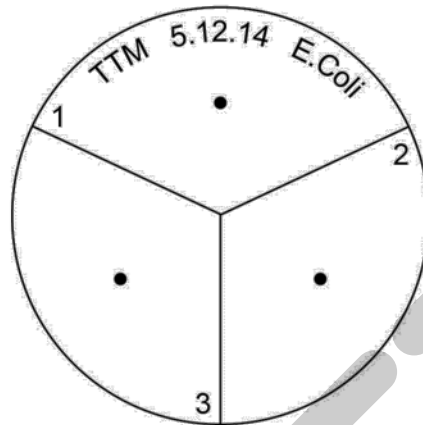
Method

You are provided with the following:

- a nutrient agar plate
- a Bunsen burner
- a heatproof mat
- a disposable plastic pipette
- a culture of bacteria (*E. coli*)
- a glass spreader
- filter paper discs
- three antiseptics (such as mouthwash, TCP, and antiseptic cream)
- disinfectant bench spray
- a 'discard beaker' of disinfectant
- a small beaker of ethanol
- forceps
- clear tape
- hand wash
- a wax pencil
- access to an incubator.

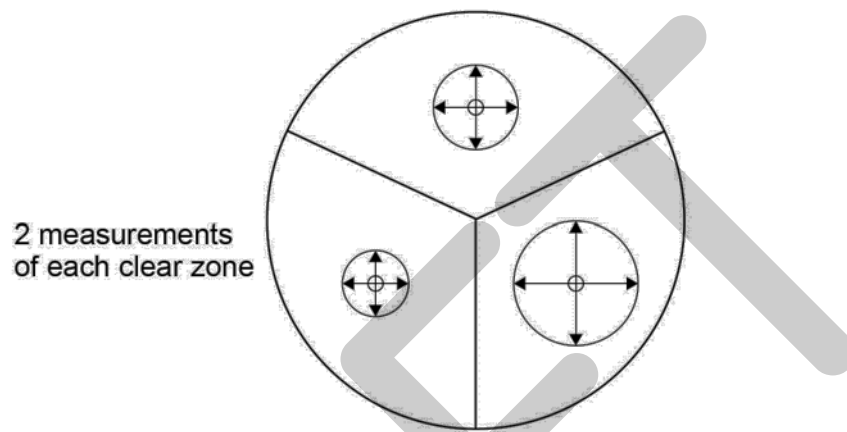
You should read these instructions carefully before you start work.

1. Set up your working area by first spraying the bench with the disinfectant spray and wiping with paper towels.
2. Place the Bunsen burner on the heatproof mat in the middle of your working area and light the Bunsen on a yellow flame.
3. Wash your hands with the antibacterial hand wash.
4. Mark the underneath of a nutrient agar plate (not the lid) with the wax pencil as follows (making sure that the lid stays in place to avoid contamination):
 - divide the plate into three equal sections as if you were cutting a pie into three and number them 1, 2 and 3 around the edge
 - place a dot into the middle of each section
 - around the edge write your initials, the date and the name of the bacteria (*E. coli*).



5. Turn the Bunsen flame to blue.
6. Remove the lid of the bottle containing the culture of bacteria (keep the lid in your hand) and flame the neck of the bottle through the Bunsen flame, quickly twisting the bottle from side to side. Using the disposable pipette, collect approximately 1 ml of the bacterial culture.
7. Quickly flame the neck of the bottle again and replace the lid.
8. Lift the lid of the agar plate at an angle so that it is only fully open on the Bunsen burner side.
9. Pipette the bacteria onto the agar plate and replace the lid.
10. Place the pipette into the 'discard beaker' and turn the Bunsen burner flame back to yellow.
11. Dip the glass spreader into the ethanol. Remove the glass spreader and tap off the excess ethanol, then pass the glass spreader through the flame (holding the glass spreader horizontally to ensure nothing drips down onto your hand).
12. Allow the flame on the glass spreader to go out and allow the spreader to cool for a count of 20.
13. Lift the lid of the agar plate, again at an angle so only the side next to the Bunsen burner is fully open, and spread the bacteria around the plate using the glass spreader.
14. Lower the lid of the agar plate and place the glass spreader into the discard beaker.
15. Place different antiseptics onto the three filter paper discs by either soaking them in the liquid or spreading the cream or paste onto them.
16. Lift the lid of the agar plate as before and, using the forceps, carefully place each disc onto one of the dots drawn on with the wax pencil.
17. Make a note of which antiseptic is in each of the three numbered sections of the plate.
18. Secure the lid of the agar plate in place using two small pieces of clear tape (do not seal the lid all the way around as this creates anaerobic conditions, which will prevent the *E. coli* bacteria from growing and can encourage some other very nasty bacteria to grow).
19. Incubate the plate at 25 °C for 48 hours.

20. Measure the diameter of the clear zone around each disc by placing the ruler across the centre of the disc. Measure again at 90° to the first measurement so that the mean diameter can be calculated.



21. Record your results in a table such as the one here.

Type of antiseptic	Diameter of clear zone in mm		
	1	2	Mean
Mouthwash (1)			
TCP (2)			
Antiseptic cream (3)			

GCSE Biology required practical activity 3: Osmosis

Teachers' notes

Required practical activity	Apparatus and techniques
Investigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue.	AT 1, AT 3, AT 5

Investigating osmosis in potato tissue

Materials

In addition to access to general laboratory equipment, each student needs:

- a potato
- a cork borer
- a ruler
- a 10 cm³ measuring cylinder
- labels
- three boiling tubes
- a test tube rack
- paper towels
- a scalpel
- a white tile
- 1 M sugar solution
- 0.5 M sugar solution
- distilled water
- a top-pan balance.

Technical information

Make up a solution of 1 M sucrose solution by adding distilled water to 342.3 g of sugar (dissolve by heating) and making up to 1 litre in a volumetric flask. Measure out 500 ml of this 1 M solution and place in a separate flask. Make the original flask up to 1 litre again by adding more distilled water to make the 0.5 M solution. This will provide enough for a class as each student needs 10 cm³ of each, in addition to 10 cm³ of distilled water.

To avoid students having to use sharp implements the potato cylinders can be prepared for them. They must be freshly prepared.

Ensure that potato cylinders do not have any skin on them as this affects the movement of water molecules.

Additional information

Other sugar concentrations could be used (eg 0.2 M, 0.4 M, 0.6 M, 0.8 M, 1.0 M and distilled water 0 M) and distributed across the class so that each student does three. The class data could then be collated before plotting the graph. Where the line of best fit crosses the x-axis is an approximation of the concentration inside the potato tissue.

The length of time that the potato cylinders are left in the sugar solutions can be adjusted to suit lesson timings. Better results are achieved if they are left for more than 30 minutes. They will start going mouldy if left for several days.

Risk assessment

- Risk assessment and risk management are the responsibility of the school or college.
- Care should be taken with the use of cork borers and scalpels when students are cutting their own potato cylinders. Small kitchen knives could be used if available.
- Care should be taken with the use of an electrical balance in the presence of water.

Trialling

The practical should be trialled before use with students.

Alternative practicals

Outline method	Suggested apparatus	Suggested reagents
<p>Using salt solutions to investigate osmosis in potato tissue</p> <p>As above but with salt solution instead of sugar solution.</p>	As above	Water, 1 M salt solution, 0.5 M salt solution
<p>Investigating osmosis in onion cells</p> <p>Place slices of red onion into sugar solutions of different concentrations and leave overnight. Prepare a slide with a piece of onion tissue from each concentration. Observe the red onion cells under the microscope. Count 100 cells and record how many of these cells show signs of shrunken cell contents.</p>	Red onion, white tile, scalpel, microscope, glass slide, cover slip, beakers	Water, 1 M sugar solution, 0.5 M sugar solution

GCSE Biology required practical activity 3: Osmosis

Student sheet

Required practical activity	Apparatus and techniques
Investigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue.	AT 1, AT 3, AT 5

Investigating osmosis in potato tissue

Osmosis is the movement of water through a selectively permeable membrane from an area of high concentration of water to an area of lower concentration of water.

Plant tissues, such as potato, can be used to investigate osmosis.

In this experiment potatoes are cut into equal sized cylinders. The changes in length and mass after leaving them overnight in sugar solution and distilled water can then be accurately compared.

Learning outcomes
1
2
Teachers to add these with particular reference to working scientifically

Method

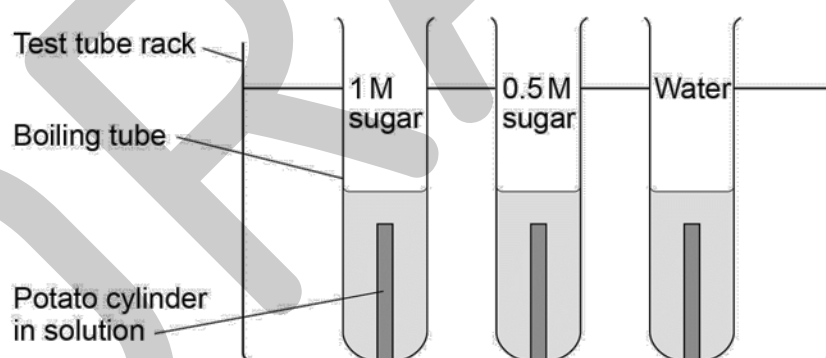
You are provided with the following:

- a potato
- a cork borer
- a ruler
- a 10 cm³ measuring cylinder
- labels
- three boiling tubes
- a test tube rack
- paper towels
- a scalpel
- a white tile

- 1 M sugar solution
- 0.5 M sugar solution
- distilled water
- a top-pan balance.

You should read these instructions carefully before you start work.

1. Using a cork borer, cut three potato cylinders of the same diameter.
2. Trim the cylinders so that they are all the same length (about 3 cm).
3. Accurately measure and record the length and mass of each potato cylinder.
4. Measure out 10 cm³ of the 1 M sugar solution and place into the first boiling tube (labelled 1 M sugar).
5. Measure out 10 cm³ of 0.5 M sugar solution and place into the second boiling tube (labelled 0.5 M sugar).
6. Measure out 10 cm³ of the distilled water into the third boiling tube (labelled water).
7. Add one potato cylinder to each tube (make sure you know which one is which in terms of the length and mass).



8. Record your lengths and masses in a table such as the one below.
9. Leave the potato cylinders in the boiling tubes overnight in the test tube rack.
10. Remove the cylinders from the boiling tubes and carefully blot them dry with the paper towels.
11. Re-measure the length and mass of each cylinder (make sure you know which is which).

	1 M sugar solution	0.5 M sugar solution	Distilled water
Initial length (mm)			
Final length (mm)			
Change in length (mm)			
Initial mass (g)			
Final mass in (g)			
Change in mass in (g)			

12. Draw a graph with 'Change in mass in g' on the y-axis against 'Concentration of sugar solution' on the x-axis.

GCSE Biology required practical activity 4: Enzymes

Teachers' notes

Required practical activity	Apparatus and techniques
Investigate the effect of pH on the rate of reaction of amylase enzyme. Students should use a continuous sampling technique to determine the time taken to completely digest a starch solution at a range of pH values. Iodine reagent is to be used to test for starch every 30 seconds. Temperature must be controlled by use of a water bath or electric heater.	AT 1, AT 2, AT 5, AT 8

Investigating the effect of temperature on the enzyme amylase

Materials

In addition to access to general laboratory equipment, each student needs:

- test tubes
- a test tube rack
- water baths (electrical or Bunsen burners and beakers)
- spotting tiles
- a 5 cm³ measuring cylinder or syringe
- a glass rod
- a stop watch
- starch solution
- amylase solution
- iodine solution
- thermometers.

Technical information

A 1% solution of amylase and a 1% suspension of starch are appropriate for this experiment.

Amylase will slowly lose activity so it is best to make up a fresh batch, using the powdered enzyme, for each lesson. Otherwise any results collected on different days will not be comparable.

Starch suspension should also be made fresh. This can be done by making a cream of 5 g of soluble starch in cold water and pouring into 500 cm³ of boiling water. Stir well and boil until you have a clear solution.

A 0.01 M solution of iodine is suitable for starch testing.

Additional information

It is best to check that the amylase breaks down the starch at an appropriate rate before students do this experiment. At around the optimum temperature, the end point should be reached within 1–2 minutes. Enzymes may degrade in storage. Testing beforehand will ensure that there is time to adjust concentrations or obtain fresh stocks if necessary.

It might be appropriate for each student to test only one or two temperatures, working in a pair or a group, so that results can be pooled. This would ensure that the tests were performed in the same lesson, and therefore are more comparable.

A wider range of temperatures could be investigated and class results could be collated. This would require more water baths, but students could make their own using beakers and Bunsen burners etc.

Risk assessment

- Risk assessment and risk management are the responsibility of the school or college.
- All solutions, once made up, are low hazard. Refer to Hazcard 33 for amylase.
- Iodine solution may irritate the eyes so safety goggles should be worn. Refer to Hazcards 54A and 54B.
- Safety goggles should be worn in the presence of hot water in water baths.
- Care should be taken with the use of naked flames in this experiment if students are using Bunsen burners to make water baths.
- Care should be taken with the presence of water and electrical equipment, if electrical water baths are being used.

Trialling

The practical should be trialled before use with students.

Alternative practicals

Outline method	Suggested apparatus	Suggested reagents
<p>Investigating the effect of pH on the enzyme amylase</p> <p>As above but using different pH rather than temperatures.</p>	<p>Test tubes, test tube rack, spotting tiles, measuring cylinders or syringes, glass rods, stopwatch</p>	<p>As above plus buffer solutions of pH 4, 7 and 10</p>
<p>Investigating the effect of temperature on the enzyme pepsin</p> <p>Place egg albumen and pepsin solution into test tubes in water baths at different temperatures. Time how long it takes for the egg albumen to change from white to colourless.</p>	<p>Test tubes, test tube rack, water-baths, measuring cylinders or syringes, stopwatch</p>	<p>Egg albumen (boiled egg white), pepsin</p>
<p>Investigating the effect of pH on the enzyme pepsin</p> <p>As above but using different pH rather than temperatures.</p>	<p>Test tubes, test tube rack, measuring cylinders or syringes, stopwatch</p>	<p>Egg albumen (boiled egg white), pepsin, buffer solutions of pH 4, 7 and 10</p>

GCSE Biology required practical activity 4: Enzymes

Student sheet

Required practical activity	Apparatus and techniques
Investigate the effect of pH on the rate of reaction of amylase enzyme. Students should use a continuous sampling technique to determine the time taken to completely digest a starch solution at a range of pH values. Iodine reagent is to be used to test for starch every 30 seconds. Temperature must be controlled by use of a water bath or electric heater.	AT 1, AT 2, AT 5, AT 8

Investigating the effect of temperature on the enzyme amylase

The enzyme amylase controls the breakdown of starch in our digestive system. We are able to simulate digestion, using solutions of starch and amylase in test tubes, and find the optimum conditions required.

The presence or absence of starch can be determined using iodine solution and, in this experiment, we can measure how long the amylase takes to break down the starch at different temperatures.

Learning outcomes
1
2
Teachers to add these with particular reference to working scientifically

Method

You are provided with the following:

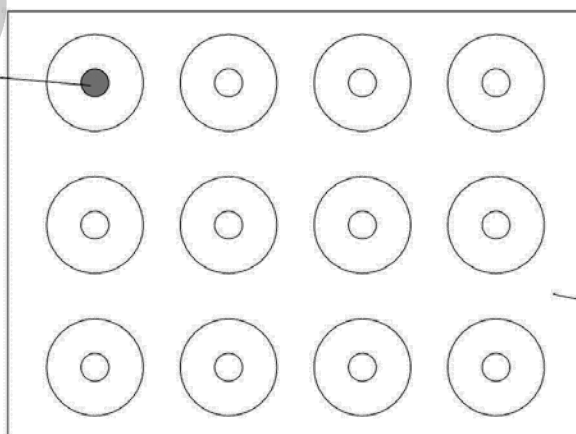
- test tubes
- a test tube rack
- water baths (electrical or Bunsen burners and beakers)
- spotting tiles

- a 5 cm³ measuring cylinder or syringe
- glass rods
- a stop watch
- starch solution
- amylase solution
- iodine solution
- thermometers.

You should read these instructions carefully before you start work.

1. Place one drop of iodine solution into each depression on the spotting tile.
2. Set up water baths for every temperature you want to test (suggest one cold with ice, one at room temperature, one around body temperature 35–40 °C and one above 50 °C).
3. Measure out 5 cm³ of starch solution, using the measuring cylinder or syringe, into 4 test tubes.
4. Place one test tube of starch solution into each water bath.
5. Measure out 1 cm³ of amylase solution, using a measuring cylinder or syringe, into 4 different test tubes.
6. Place one test tube of amylase solution into each water bath.
7. Leave the test tubes in the water baths until the contents of each test tube have reached the temperature of the water baths. Check this with a thermometer.
8. When the contents of the test tubes in one water bath have both reached the required temperature, make a note of this temperature. Then, carefully pour the amylase solution into the test tube with the starch solution and mix with the glass rod.
9. Remove one drop of the mixed solution on the end of the glass rod and place on the first depression of the spotting tile with the iodine solution. This is 'time zero'.

Drop of starch/
amylase mixture
added at zero time



Spotting tile
containing
drops of
iodine

-
10. Immediately start the stop clock.
 11. Using the glass rod, remove one drop every minute and place onto the iodine solution in the next depression on the spotting tile. Rinse the glass rod with water after each drop.
 12. Continue until the iodine solution no longer turns black. This indicates that the starch has been broken down.
 13. Record the temperature of the water bath and the time taken for the starch to be broken down in a table such as the one here.

Temperature of water bath in °C	Time taken for amylase to completely break down the starch in minutes

Repeat for the other temperatures.

GCSE Biology required practical activity 5: Food tests

Teachers' notes

Required practical activity	Apparatus and techniques
Use qualitative reagents to test for a range of carbohydrates, lipids and proteins. To include: Benedict's test for sugars; iodine test for starch; Biuret reagent for protein.	AT 2, AT 8

Using qualitative reagents to test for a range of carbohydrates, lipids and proteins

Materials

In addition to access to general laboratory equipment, each student needs:

- food to be tested
- a pestle and mortar
- a stirring rod
- a filter funnel and filter paper
- 5 × beaker, 250 ml
- a conical flask
- 4 × test tube
- Benedict's solution
- iodine solution
- Sudan III stain solution
- Biuret solution
- a Bunsen burner, tripod and gauze to heat water
- a heatproof mat
- a thermometer
- safety goggles.

Technical information

Benedict's qualitative reagent (CLEAPSS)

Benedict's solution or DNSA (see Recipe sheet 34) should be used in place of Fehling's solution to test for reducing sugars. This is because it is less hazardous.

Glucose, lactose and maltose are reducing sugars and give a positive test. Sucrose is a non-reducing sugar and does not give a positive result.

No hazard warning symbol is required on the bottle as the concentrations of each of the constituents are low.

Qualitative Biuret Reagent (CLEAPSS)

This does **not** keep so only prepare what is required.

General hazards:

- Sodium hydroxide (solid) and 2 M solution. See Hazcard 91.
- Copper sulphate, see Hazcard 27C.

Preparing 1 litre of Qualitative Biuret reagent:

- wear safety goggles
- weigh out 0.75 g of copper(II) sulfate(VI)-5 -water
- prepare 1 litre of 2 M potassium or sodium hydroxide solution
- dissolve the copper(II) sulfate(VI) in the alkali and label the solution CORROSIVE.

A purple or pink colouration indicates the presence of protein.

Iodine solution (CLEAPSS)

Iodine is only sparingly soluble in water (0.3 g/L). It is usual to dissolve it in aqueous potassium iodide solution (KI) or organic solvents such as ethanol. The procedure will take time even with stirring.

A 0.01 M solution is suitable as a test reagent for starch.

The concentration of solutions decreases with storage. Check that the solutions work before use in the laboratory.

The solution may be bought ready-made. Alternatively, use CLEAPSS Recipe card 50 to make up the solution.

Sudan III stain solution

Dissolve 0.5 g of dye in 70 ml of ethanol and 30 ml of water, using a warm water bath, and filter.

Ethanol is HIGHLY FLAMMABLE (see Hazcards 32 and 40). Label the solution HIGHLY FLAMMABLE.

Wear safety goggles.

Additional information

The techniques involved should be demonstrated to the students. Students should be allowed time to practice the techniques by testing pure substances first in order to see the expected colour change.

The following are suggested for this purpose:

- Biuret test – albumen solution
- Benedict’s solution – glucose solution
- iodine solution – starch solution
- Sudan III – any suitable oil.

In particular students will need to practice the following:

Techniques requiring practice	Additional information
Use of a pestle and mortar	When crushing the food it may help to add a small amount of sharp sand
Filtration	Students may need to be taught how to fold the filter paper correctly
Use of water bath	Students may need to learn how to use a beaker of hot water as a water bath

Risk assessment

- Risk assessment and risk management are the responsibility of the school or college.
- Biuret solution contains copper sulfate, which is poisonous, and sodium hydroxide, which is caustic.

Suggested foods for testing

Proteins: milk, yogurt, cheese, meat, tofu, apple, potato, yeast, cooked beans, eggs.

Lipids: olive oil, sesame seed oil, grape seed oil, margarine, butter, lard, milks (full fat, semi-skimmed, skimmed), egg white solution, egg yolk solution.

Carbohydrates: potato, bread, cooked noodles, biscuits, sugar, apples, flour, corn starch.

Trialling

The practical should be trialled before use with students.

GCSE Biology required practical activity 5: Food tests

Student sheet

Required practical activity	Apparatus and techniques
Use qualitative reagents to test for a range of carbohydrates, lipids and proteins. To include: Benedict's test for sugars; iodine test for starch; Biuret reagent for protein.	AT 2, AT 8

1. Testing for sugars

In this experiment you will test one or more foodstuffs for the presence of carbohydrates.

Learning outcomes
1
2
Teachers to add these with particular reference to working scientifically

Method

You are provided with the following:

- food to be tested
- a pestle and mortar
- a stirring rod
- filter funnel and filter paper
- 2 × beaker, 250 ml
- a conical flask
- 2 × test tube
- Benedict's solution
- iodine solution
- a Bunsen burner, tripod and gauze to heat water
- a heatproof mat
- a thermometer
- safety goggles.

2. Testing for lipids

In this experiment you will test one or more foodstuffs for the presence of lipids (fats).

Learning outcomes
1
2
Teachers to add these with particular reference to working scientifically

Method

You are provided with the following:

- food to be tested
- a pestle and mortar
- a stirring rod
- a filter funnel and filter paper
- 2 × beaker, 250 ml
- a test tube
- Sudan III stain solution.

Risk assessment:

- *Wear safety goggles.*
- *Sudan III contains ethanol, which is highly flammable. Keep the solution away from naked flames.*

You should read these instructions carefully before you start work.

1. Use a pestle and mortar to grind up a small sample of food.
2. Transfer the ground up food into a small beaker and add distilled water.
3. Stir in order to allow some of the food content to dissolve in the water.
4. Use a filter funnel and filter paper to obtain as clear a solution as possible.
5. Half fill a test tube with some of this solution.
6. Add 3 drops of Sudan III stain to the solution in the test tube. Shake gently to mix.
7. A red-stained oil layer will separate out and float on the water surface if fat is present.

GCSE Biology required practical activity 6: Photosynthesis

Teachers' notes

Required practical activity	Apparatus and techniques
Investigate the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed.	AT 1, AT 3, AT 4, AT 5

Investigating the effect of light intensity on photosynthesis in pondweed

Materials

In addition to access to general laboratory equipment, each student needs:

- a boiling tube
- freshly cut 10 cm piece of pondweed (*Cabomba* or *Elodea*)
- a light source
- a ruler
- a test tube rack
- a stop watch
- 0.2% solution of sodium hydrogen carbonate solution
- a glass rod

Technical information

Cabomba or *Elodea* could be used as the pondweed in this investigation. Both can be bought from tropical fish shops and some large garden centres.

Cabomba is recommended as it is the most reliable as it produces the most bubbles. *Cabomba* should be kept in a well aerated tank prior to its use. If *Elodea* is used, it is suggested that the plant is placed in a beaker of water in front of a lamp for 2–3 hours before starting the investigation.

It is best to use an LED light source as they give off less heat. If these are not available, use a normal light bulb but place a beaker of water in between the boiling tube and the light source to reduce the chance of temperature affecting the results. Low energy light bulbs should not be used as the light intensity may be too low to promote measurable photosynthesis.

Additional information

Graphs can be drawn of number of bubbles per minute against distance from light source.

Light intensity is proportional to $1/\text{distance}^2$. Higher attaining students may want to draw their graphs of number of bubbles against light intensity instead.

If no bubbles appear from the cut end of the pondweed when placed closest to the light source, cut a few millimetres off the end or, if necessary, use a new freshly-cut piece of pondweed.

Students could work within a group in order to investigate a wider range of distances and with increments of 5 cm instead of 10 cm. Group results could be collated.

Risk assessment

- Risk assessment and risk management are the responsibility of the school or college.
- 0.2% sodium hydrogen carbonate solution is low hazard. Refer to Hazcard 95C.
- Care should be taken when handling glassware.
- Care should be taken with the use of lamps that may get hot.
- Care should be taken with the presence of water and the electrical power supply for the lamp.

Trialling

The practical should be trialled before use with students.

Alternative practicals

Outline method	Suggested apparatus	Suggested reagents
<p>Investigating the effect of light wavelength on photosynthesis in pondweed</p> <p>As above but keep the distance from the light the same and place different coloured filters between the test tube and the light.</p>	<p>As above plus coloured filters or coloured cellophane</p>	<p>As above</p>
<p>Investigating the effect of carbon dioxide concentration on photosynthesis in pondweed</p> <p>As above but keep distance from the light the same and place the pondweed in different concentrations of sodium hydrogen carbonate.</p>	<p>As above</p>	<p>Increments of 0.05g of sodium hydrogen carbonate powder added to distilled water will increase the available carbon dioxide</p>

GCSE Biology required practical activity 6: Photosynthesis

Student sheet

Required practical activity	Apparatus and techniques
Investigate the effect of a factor on the rate of photosynthesis.	AT 1, AT 3, AT 4, AT 5

Investigating the effect of light intensity on photosynthesis in pondweed

Plants use carbon dioxide and water to produce glucose and oxygen during the process of photosynthesis. Many factors, such as light intensity and light wavelength, affect the rate at which photosynthesis occurs.

Aquatic plants, such as pondweed, produce visible bubbles of oxygen gas into the surrounding water when they photosynthesise. These bubbles can be counted as a measure of the rate of photosynthesis.

The effect of light intensity can be investigated by varying the distance between pondweed and a light source. The closer the light source the greater the light intensity.

Learning outcomes
1
2
Teachers to add these with particular reference to working scientifically

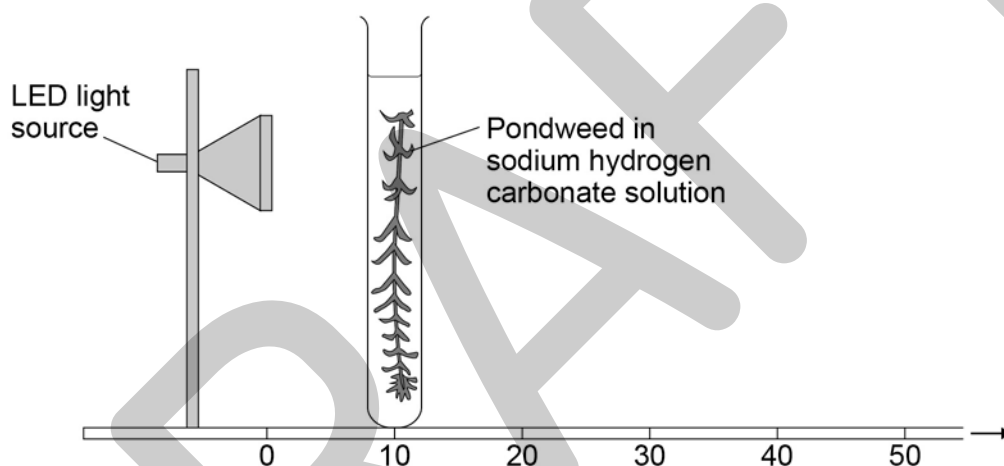
Method

You are provided with the following:

- a boiling tube
- freshly cut 10 cm piece of pondweed (*Cabomba* or *Elodea*)
- a light source
- a ruler
- a test tube rack
- a stop watch
- 0.2% solution of sodium hydrogen carbonate
- a glass rod.

You should read these instructions carefully before you start work:

1. Set up a test tube rack containing a boiling tube at a distance of 10 cm away from the light source
2. Fill the boiling tube with the sodium hydrogen carbonate solution.
3. Place the piece of pondweed into the boiling tube with the cut end uppermost. Gently push the pondweed down with the glass rod.
4. Leave the boiling tube for 5 minutes.
5. Start the stop watch and count the number of bubbles produced in one minute.



6. Record the results in a table such as the one here.

Distance between pondweed and light source in cm	Number of bubbles per minute			
	1	2	3	Mean
10				
20				
30				
40				

7. Repeat the count twice more so that the mean number of bubbles per minute can be calculated.
8. Move the test tube rack to a distance of 20 cm from the light source and repeat steps 4–6.
9. Repeat using distances of 30 cm and 40 cm between the test tube rack and the light source.

GCSE Biology required practical activity 7: Reaction Time

Teachers' notes

Required practical activity	Apparatus and techniques
Plan and carry out an investigation into the effect of a factor on human reaction time.	AT 1, AT 3, AT 4

Investigating whether practice reduces human reaction times

Materials

In addition to access to general laboratory equipment, each student needs a:

- metre ruler
- chair
- table
- partner.

Technical information

Students should use their weaker hand for the ruler drop test. They should ensure that they have not done any practicing before the start of the experiment but start taking measurements immediately so that the effects of any practicing can be seen.

Ruler measurements can be converted to reaction times using the conversion table below.

Additional information

The following conversion table can be given to students in order to determine reaction times.

Graphs of reaction time against attempt number can be drawn.

Reading from ruler (cm)	Reaction time (s)	Reading from ruler (cm)	Reaction time (s)	Reading from ruler (cm)	Reaction time (s)	Reading from ruler (cm)	Reaction time (s)	Reading from ruler (cm)	Reaction time (s)	Reading from ruler (cm)	Reaction time (s)	Reading from ruler (cm)	Reaction time (s)	Reading from ruler (cm)	Reaction time (s)	Reading from ruler (cm)	Reaction time (s)	Reading from ruler (cm)	Reaction time (s)	
1	0.05	21	0.21	41	0.29	61	0.35	81	0.41											
2	0.06	22	0.22	42	0.29	62	0.36	82	0.41											
3	0.08	23	0.22	43	0.30	63	0.36	83	0.41											
4	0.09	24	0.22	44	0.30	64	0.36	84	0.41											
5	0.10	25	0.23	45	0.30	65	0.36	85	0.42											
6	0.11	26	0.23	46	0.31	66	0.37	86	0.42											
7	0.12	27	0.23	47	0.31	67	0.37	87	0.42											
8	0.13	28	0.24	48	0.31	68	0.37	88	0.42											
9	0.14	29	0.24	49	0.32	69	0.38	89	0.43											
10	0.14	30	0.25	50	0.32	70	0.38	90	0.43											
11	0.15	31	0.25	51	0.32	71	0.38	91	0.43											
12	0.16	32	0.26	52	0.33	72	0.38	92	0.43											
13	0.16	33	0.26	53	0.33	73	0.39	93	0.44											
14	0.17	34	0.26	54	0.33	74	0.39	94	0.44											
15	0.18	35	0.27	55	0.34	75	0.39	95	0.44											
16	0.18	36	0.27	56	0.34	76	0.39	96	0.44											
17	0.19	37	0.28	57	0.34	77	0.40	97	0.45											
18	0.19	38	0.28	58	0.34	78	0.40	98	0.45											
19	0.20	39	0.28	59	0.35	79	0.40	99	0.45											
20	0.21	40	0.29	60	0.35	80	0.40	100	0.45											

Risk assessment

- Risk assessment and risk management are the responsibility of the school or college.
- It is advisable for the students who drop the ruler to wear goggles to avoid the possibility of the ruler hitting the floor and bouncing back up to hit the eyes.
- Care should be taken to ensure that students do not experience any discomfort when being used as the subjects of investigation.

Trialling

The practical should be trialled before use with students.

Alternative practicals

Outline method	Suggested apparatus	Suggested reagents
Investigating whether caffeine affects human reaction times As above but after the first test drink a cup of coffee (or caffeinated cola drink) before the second test. Drink a further cup of coffee before the third test.	As above plus coffee or cola	As above
Investigating whether aerobic exercise affects human reactions times As above but do the drop test before and after a period of exercise and then again after rest.	As above	As above

GCSE Biology required practical activity 7: Reaction Time

Student sheet

Required practical activity	Apparatus and techniques
Plan and carry out an investigation into the effect of a factor on human reaction time.	AT 1, AT 3, AT 4

Investigating whether practice reduces human reaction times

Messages travel very quickly around your body through the nervous system. This is so that you are able to respond to changes in the environment. The time it takes for you to respond to such a change is called your reaction time.

Athletes spend hours practicing to try to reduce their reaction time in order to improve performance in their particular sport. Responding quicker to the starter's pistol in a race can gain you the advantage over other runners.

In this investigation you will conduct a simple, measurable experiment called the ruler drop test to determine whether your reaction time can be reduced with practice.

Learning outcomes
1
2
Teachers to add these with particular reference to working scientifically

Method

You are provided with the following:

- a metre ruler
- a chair
- a table
- a partner

You should read these instructions carefully before you start work:

1. You should use your weaker hand for this experiment. If you are right handed then your left hand is your weaker hand.
2. Sit down on the chair with good upright posture and eyes looking across the room.
3. Place the forearm of your weaker arm across the table with your hand overhanging the edge of the table.
4. Your partner will hold a ruler vertically with the bottom end (the end with the 0 cm) in between your thumb and first finger. Practice holding the ruler with those two fingers.
5. Your partner will take hold of the ruler and ask you to remove your fingers.
6. Your partner will hold the ruler so the zero mark is level with the top of your thumb and tell you to prepare to catch the ruler.
7. Your partner will then drop the ruler without telling you.
8. You must catch the ruler as quickly as you can when you sense that the ruler is dropping.
9. After catching it, look at the number level with the top of your thumb on the ruler. Record this as a measure of how fast you caught it in a table such as the one here.

Drop test attempts	Ruler measurements in cm		Reaction times in seconds	
	Person 1	Person 2	Person 1	Person 2
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

10. Have a short rest and then repeat the drop test. Record the number on the ruler as attempt 2.
11. Continue to repeat several times.
12. Swap places with your partner and repeat the experiment to get their results.
13. Use a conversion table to convert your ruler measurements into reaction times.

GCSE Biology required practical activity 8: Germination (biology only)

Teachers' notes

Required practical activity	Apparatus and techniques
Investigate the effect of light or gravity on the growth of germinating seeds. Record results as both length measurements and as careful, labelled biological drawings to show the effects.	AT 1, AT 3, AT 4, AT 7

Investigating the effect of light intensity on the growth of mustard seedlings

Materials

In addition to access to general laboratory equipment, each student needs:

- white mustard seeds
- petri-dishes
- cotton wool
- a ruler
- water
- access to a light windowsill and a dark cupboard.

Technical information

Cotton wool should be damp but not in excess water. The amount of cotton wool and water needed should be determined before students do the experiment.

Seeds will require a day or so to germinate (depending on how warm it is). Alternative seeds, such as cress or *Brassica rapa*, could be used instead of white mustard seeds. However, white mustard seeds are bigger and easier to handle so these are recommended.

Partial light can be achieved by alternating a day on the windowsill with a day in the dark cupboard.

Additional information

To measure the height of the seedlings students should rest the ruler on the cotton wool and then gently hold the seedling to its full height against the ruler. Care should be taken to ensure the seedlings are not damaged during measuring.

Risk assessment

- Risk assessment and risk management are the responsibility of the school or college.
- The equipment and techniques used in this experiment are not hazardous.

Trialling

The practical should be trialled before use with students.

Alternative practical

Outline method	Suggested apparatus	Suggested reagents
Investigate the effect of light wavelength on the growth of mustard seedlings As above but place the petri-dishes in boxes with a window cut out and coloured filters or coloured cellophane covering the window.	As above plus coloured filters or coloured cellophane	As above

GCSE Biology required practical activity 8: Germination (biology only)

Student sheet

Required practical activity	Apparatus and techniques
Investigate the effect of light or gravity on the growth of germinating seeds. Record results as both length measurements and as careful, labelled biological drawings to show the effects.	AT 1, AT 3, AT 4, AT 7

Investigating the effect of light intensity on the growth of mustard seedlings

Germination is the start of growth in a seed. Water, oxygen and warmth are required for the seed to germinate. Once germinated, the shoots will only continue to grow if placed into the correct conditions.

Mustard seeds germinate easily and quickly when placed on damp cotton wool. The effect of light on the growth of the newly germinated shoots can be determined by measuring their height with a ruler.

Learning outcomes
1
2
Teachers to add these with particular reference to working scientifically

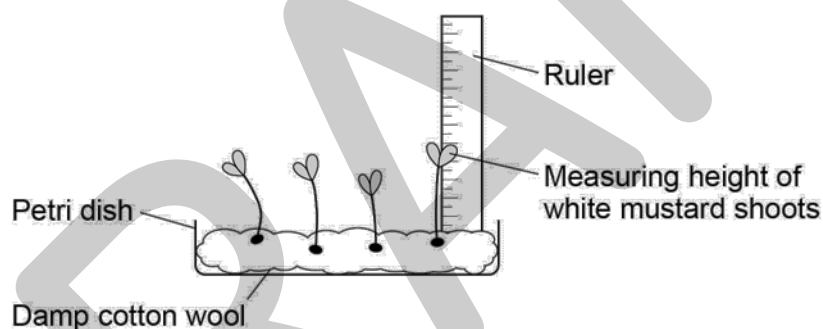
Method

You are provided with the following:

- white mustard seeds
- petri-dishes
- cotton wool
- a ruler
- water
- access to a light windowsill and a dark cupboard.

You should read these instructions carefully before you start work:

1. Set up three petri dishes with cotton wool soaked in equal amounts of water.
2. Place ten mustard seeds in each petri dish.
3. Place the petri dishes in a warm place where they will not be disturbed or moved.
4. Allow the mustard seeds to germinate, adding more water if the cotton wool gets dry (equal amounts to each dish).
5. Once the mustard seeds have germinated, make sure that the number of seedlings in each dish is the same. Remove excess seedlings from any dish that has too many. For example, one dish has eight seedlings which is the fewest compared to the other petri dishes. Therefore remove seedlings from the other dishes so that each dish has eight.
6. Move the petri dishes into position. One should be placed on a windowsill in full sunlight. One should be placed in a dark cupboard. The third should be placed in partial light.
7. Every day, for at least a week, measure the height of each seedling and record in a table such as the one here. You will need one table for full sunlight, one for partial light and one for darkness.



Day	Height of seedling in full sunlight in mm								Mean
	1	2	3	4	5	6	7	8	
1									
2									
3									
4									
5									
6									
7									

8. Calculate the mean height of the seedlings each day.
9. Compare the mean heights in full sunlight, partial light and darkness by drawing a graph of 'mean height' against 'time' for each.

GCSE Biology required practical activity 9: Field investigations

Teachers' notes

Required practical activity	Apparatus and techniques
Measure the population size of a common species in a habitat. Use sampling techniques to investigate the effect of a factor on the distribution of this species.	AT 1, AT 3, AT 4, AT 6, AT 8

Investigating the population size of daisies in trampled and un-trampled parts of a school field

Materials

In addition to access to general laboratory equipment, each student needs:

- a 1 m² quadrat
- a 30 m tape measure
- a clipboard
- a pen
- paper.

Technical information

A good trampled area of the field might be a football pitch, and the un-trampled area could just be along the very edge of the field where the grass has not been cut or not cut as often.

A shorter transect line could be used if space is limited and quadrats could be placed closer together. A 0.5 m² quadrat could be used instead if more appropriate or if a 1 m² quadrat is not available.

Several students can work independently along one transect line if the number of tape measures is limited. Alternatively string or rope can be used as the transect line by marking 5 m intervals along it with a marker pen.

Additional information

Exactly what counts as a daisy plant should be demonstrated to students to ensure they are counting whole plants (rosettes) and not just counting flowers. Students will need to kneel or

crouch down and may need to use their hands to determine how many plants are within the quadrat (especially in the longer grass of the un-trampled area).

Risk assessment

- Risk assessment and risk management are the responsibility of the school or college.
- It is advisable not to undertake this experiment if the conditions are very wet as students may slip on wet grass.
- The areas to be used should be checked beforehand to ensure that no hazardous materials, such as broken glass, are present. This is especially necessary where items could be hidden in the longer grass.
- Care should be taken when using tape measures that may recoil back if not carefully locked in place.
- Care should be taken to ensure that students place the quadrats carefully along the transect line and do not throw them around, as this could cause injury to other students.
- If during the course of this experiment students get soil on their hands, they should wash hands thoroughly afterwards.

Trialling

The practical should be trialled before use with students.

Alternative practical

Outline method	Suggested apparatus	Suggested reagents
<p>Using the capture-mark-recapture technique to estimate population size</p> <p>Place about five large handfuls of dried beans into a container to represent the animals. Capture ten of the 'animals' and mark them with a marker pen. Place them back into the container and stir them around. Recapture a handful of beans without looking.</p> <p>Perform the recapture ten times, each time recording how many you have captured and how many are marked.</p> <p>Use the total number recaptured and the total number that were marked to estimate the population size. Count the beans in the bag and compare estimate with the actual number.</p> <p>Perform a further ten recaptures and add the totals to the first set to see whether a larger sample size increases accuracy of estimate.</p>	<p>Container such as bag or box, dried beans, marker pen</p>	<p>n/a</p>

GCSE Biology required practical activity 9: Field investigations

Student sheet

Required practical activity	Apparatus and techniques
Measure the population size of a common species in a habitat. Use sampling techniques to investigate the effect of a factor on the distribution of this species.	AT 1, AT 3, AT 4, AT 6, AT 8

Investigating the population size of daisies in trampled and un-trampled parts of a school field

The size of a population of animals or plants in a habitat can be estimated by taking samples of the organisms from the habitat. The larger the sample, the more accurate your estimate of the population size is likely to be.

Plants can be sampled more easily than animals because they are unable to move around within the habitat. By sampling, population sizes can be compared between different areas.

In this experiment, you will compare the population sizes of daisies in trampled and un-trampled parts of your school field using a transect line and a quadrat.

Learning outcomes
1
2
Teachers to add these with particular reference to working scientifically

Method

You are provided with the following:

- a 1 m² quadrat
- a 30 m tape measure
- a clipboard
- a pen
- paper.

You should read these instructions carefully before you start work:

1. Place the 30 m tape measure across a well-trampled part of the school field to form a transect line.
2. Place the 1 m² quadrat against the transect line so that one corner of it touches the 0 m mark on the tape measure.
3. Count the number of daisy plants within the quadrat.
4. Record the number of daisies counted within the quadrat in a table such as the one here.

Distance along the transect line in m	Number of daisy plants per 1 m ² quadrat	
	Trampled	Un-trampled
0		
5		
10		
15		
20		
25		
30		
Mean number of daisy plants per m ²		

5. Move the quadrat 5 m up the transect line and count the number of daisy plants again. Record in the table.
6. Continue to place the quadrat at 5 m intervals and count the number of daisy plants in each quadrat.
7. Calculate the mean number of daisy plants per m² for the trampled area.
8. Move the 30 m tape measure to an un-trampled part of the school field to form the new transect line.
9. Place the quadrat at 5 m intervals as before and count the number of daisy plants in each quadrat. Record in the table.
10. Calculate the mean number of daisy plants per m² for the un-trampled area.
11. Compare the population size of daisies in the well-trampled and un-trampled parts of the field.

GCSE Biology required practical activity 10: Decay (biology only)

Teachers' notes

Required practical activity	Apparatus and techniques
Investigate the effect of temperature on the rate of decay of fresh milk by measuring pH change.	AT 1, AT 3, AT 4, AT 5

Investigating the effect of temperature on the rate of decay of fresh milk by measuring pH change

Materials

In addition to access to general laboratory equipment, each student needs:

- a small beaker containing milk (full fat or semi-skimmed, but not UHT)
- a small beaker containing sodium carbonate solution (0.05 mol dm^{-3})
- a small beaker containing 5% lipase solution
- 250 cm^3 beakers, to be used as water baths
- test tubes
- a test tube rack
- a marker pen
- 10 cm^3 plastic syringes
- a stirring thermometer
- stop clock / stopwatch
- phenolphthalein in a dropper bottle
- an electric kettle, for heating water
- ice, for investigating temperatures below room temperature.

Technical information

Sodium carbonate solution, 0.05 M. Make with 5.2 g of anhydrous solid or 14.2 g of washing soda per litre of water. See CLEAPSS Hazcard; it is an IRRITANT at concentrations over 1.8 M.

Phenolphthalein solution contains methanol which is highly flammable and should be kept away from naked flames.

Lipase solution is should be freshly made, but it can be kept for a few days in a refrigerator.

Additional information

If electric water baths are available this would be preferable to using hot water in beakers.

Ideally, at least five different temperatures should be investigated, ranging around 60 °C.

If timer is short, class results may be pooled rather than individual students carrying out a number of different temperatures and repeats.

Risk assessment

- Risk assessment and risk management are the responsibility of the school or college.
- Phenolphthalein is described as low hazard on CLEAPSS Hazcard 32. Refer to Recipe card 33 (acid-base indicators).
- Sodium carbonate solution, 0.05 M. Make with 5.2 g of anhydrous solid, or 14.2 g of washing soda per litre of water. See CLEAPSS Hazcard; it is an IRRITANT at concentrations over 1.8 M.
- Ethanol (IDA) in the phenolphthalein indicator is described as HIGHLY FLAMMABLE on the CLEAPSS Hazcard (flash point 13 °C) and HARMFUL (because of presence of methanol).

Trialling

The practical should be trialled before use with students.

Alternative practical

Outline method	Suggested apparatus	Suggested reagents
Investigating the effect of temperature on the rate of decay of fresh milk by measuring pH change As above but using a pH probe connected to a data logger instead of phenolphthalein.	As above but using a pH probe connected to a data logger instead of phenolphthalein	As above but without phenolphthalein

GCSE Biology required practical activity 10: Decay (biology only)

Student sheet

Required practical activity	Apparatus and techniques
Investigate the effect of temperature on the rate of decay of fresh milk by measuring pH change.	AT 1, AT 3, AT 4, AT 5

Investigating the effect of temperature on the rate of decay of fresh milk by measuring pH change

In this experiment you will use an alkaline solution of milk. When lipase is added the fat in the milk is broken down into fatty acids. This makes the pH of the solution lower.

Phenolphthalein is an indicator that is pink in alkaline solutions of about pH 10. When the pH drops below pH 8.3 phenolphthalein becomes colourless.

Learning Outcomes
1
2
Teachers to add these with particular reference to working scientifically

Method

You are provided with the following:

- a small beaker containing milk
- a small beaker containing sodium carbonate solution
- a small beaker containing lipase solution
- 250 cm³ beakers, to be used as water baths
- test tubes
- a test tube rack
- a marker pen
- 10 cm³ plastic syringes
- a stirring thermometer
- a stop clock / stopwatch

- phenolphthalein in a dropper bottle
- an electric kettle, for heating water
- ice, for investigating temperatures below room temperature.

You should read these instructions carefully before you start work.

1. Set up a water bath by half filling one of the 250 cm³ beakers with hot water from the kettle.
2. Label two test tubes: one 'lipase' and the other 'milk'.
3. In the first test tube put 5 cm³ of lipase solution.
4. In the other test tube put five drops of phenolphthalein solution.
5. Use a calibrated dropping pipette to add 5 cm³ of milk to the tube containing the phenolphthalein.
6. Use another pipette to add 7 cm³ of sodium carbonate solution to this test tube. The solution should be pink.
7. Put a thermometer into this test tube.
8. Put both test tubes into the water bath and wait until the contents reach the same temperature as the water bath.
9. Use another dropping pipette to transfer 1 cm³ of lipase into the tube containing the milk and phenolphthalein. Immediately start timing.
10. Stir the contents of the test tube until the solution loses its pink colour.
11. Record the time taken for the pink colour to disappear.
12. Repeat the above steps for different temperatures of water bath. You can obtain temperatures below room temperature by using ice in the beaker instead of hot water.
13. Record your results in a table such as the one here and plot a graph of your results.

Temperature of milk in °C	Time taken for pink colour to disappear in seconds			
	Trial 1	Trial 2	Trial 3	Mean