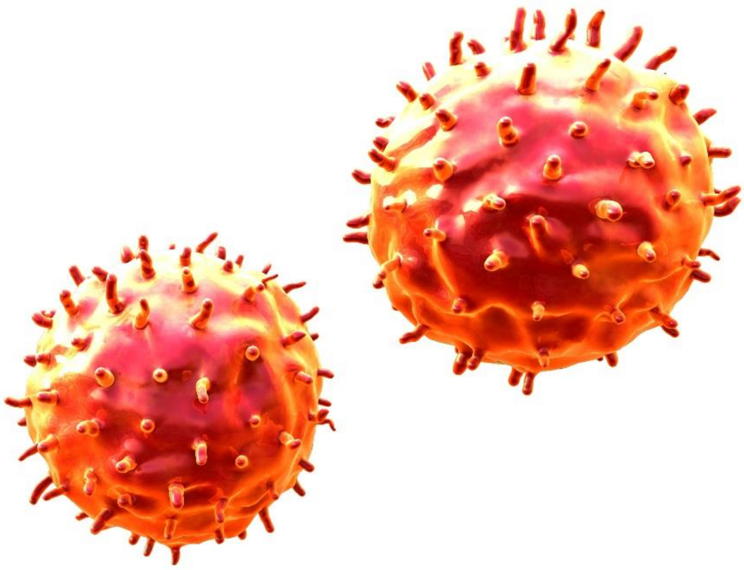
Teaching pack

Digestion: model gut

Cambridge IGCSE™

Biology 0610

This *Teaching pack* can also be used with the following syllabuses:
- Cambridge IGCSE™ (9–1) Biology **0970**
- Cambridge IGCSE™ Biology (US) **0438**
- Cambridge IGCSE™ Combined Science **0653**
- Cambridge IGCSE™ Co-ordinated Sciences (Double Award) **0654**
- Cambridge IGCSE™ (9–1) Co-ordinated Science (Double Award) **0973**
- Cambridge O Level Biology **5090**
- Cambridge O Level Combined Science **5129**



Version 2.0

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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 *Teaching 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 5 (Practical Test) or Paper 6 (Alternative to the Practical Test).

There are two options for practising experimental skills. If you have laboratory facilities this pack will support you with the logistics of running the experiment. If you have limited access to experimental equipment and/or chemicals, this pack will help you to deliver a virtual experiment.

This is one of a range of *Teaching packs*. Each pack is based on one experiment with a focus on specific experimental techniques. The packs can be used in any order to suit your teaching sequence.

The structure is as follows:

Briefing lesson (1 hour*)
This lesson introduces the focus experimental skills to be developed. It also introduces any content needed for your learners to understand the experiment being carried out in the *Lab lesson*.

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Lab lesson (1 hour*)	
Option 1 – run the experiment	**Option 2 – virtual experiment**
This lesson allows the experiment to be run with your learners, providing an opportunity to practise the experiment skills introduced in the *Briefing lesson*.	This lesson allows your learners to complete a virtual experiment, providing an opportunity to practise the experiment skills introduced in the *Briefing lesson*.

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Debriefing lesson (1 hour*)
This lesson consolidates and builds on the progress learners have made. In some cases, it will also provide the opportunity to practise extended writing skills.

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

In this *Teaching pack* you will find the lesson plans, worksheets for learners and teacher resource sheets you will need to successfully complete this experiment.

Experiment: Digestion – model gut

This *Teaching pack* focuses on the need for digestion.

Digestion involves the breaking down of large molecules into smaller ones. In this experiment, you will demonstrate that only small molecules can be absorbed into the blood via the small intestine.

This experiment has links to the following syllabus content:

- 7.2 Digestive system

The experiment covers the following experimental skills, adapted from **AO3: Experimental skills and investigations** (see syllabus for assessment objectives):

- safely using techniques, equipment and materials including following a sequence of instructions
- planning an experiment
- evaluating a method and suggest possible improvements

Prior knowledge

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

- 7.2 Digestive system
- 7.4 Chemical digestion
- 7.5 Absorption
- 3.1 Diffusion

Going forward

The knowledge and skills gained from this experiment can be used for when you teach learners about enzymes.

Briefing lesson: Safety and planning

Resources	• Worksheets A and B
Learning objectives	By the end of the lesson: • ***all*** learners should know what safety is and be able to select appropriate equipment. • ***most*** learners should be able to suggest how to make experimental work safe, and how to outline an experimental plan. • ***some*** learners will be able to plan an experiment including the safety considerations.

Timings	Activity
5 min	**Starter/introduction** Ask learners to think of places where it is important to have safety rules, e.g. a swimming pool; hygiene in the kitchen of a restaurant; X-ray machines in a hospital. Discuss these as a group. You could talk about any school rules, such as what happens during a fire drill. Ask learners why these rules are important and what the consequences of not following them might be. Make sure they understand that safety is important and why they need to work safely in a laboratory.
15 min 10 min	**Main lesson** Give learners Worksheet A and ask them to write down a list of all the safety hazards they can see in the picture. Ask them to think what might happen to each person shown in the picture and why it is not a good idea for them to be doing the various activities shown. Learners to discuss their ideas in pairs. Ask learners to write their own list of laboratory rules stating why each rule is important. Examples might include prevention of the hazards seen in Worksheet A. Other could include: not touching chemicals or equipment unless told to do so; not inhaling gases (waft them to smell, don't breathe them in); not entering the lab without permission; not starting lab work without an adult present; taking note of safety signs on bottles; inform a teacher in case of accident or spillage; place lids on bottles when not in use; keeping the stool tucked under the bench when working standing up; disposing of waste appropriately; reporting any breakages immediately; avoiding wearing baggy clothing; not wearing open-toed shoes; only mixing chemicals in the way described; wearing gloves when handling biohazards such as bacteria; if anything gets on the skin or in the eyes telling the teacher immediately for the correct first aid treatment; keeping the lab bench neat and tidy; never returning unused chemicals to the original container; tying back long hair; not using broken or chipped glassware; and washing hands after doing laboratory work. *Continues on next page …*

Timings	Activity
25 min	**Main lesson continued …** Explain that safety is an important aspect to consider when designing an experiment and that they are now going to consider how to plan an experiment. Divide learners into small groups (2–4) and give them a few minutes to discuss what they think makes a good experimental design. You could ask them to think back to any previous experimental work they may have completed or seen demonstrated in lessons. Ask some learners to share their ideas with the whole class, explaining why each point is important. Give learners Worksheet B, which contains a list of important considerations when planning an experiment. Learners spend a few minutes looking at the statements in column **A** to tick off the ones they had thought of, and to acknowledge the ones they missed. If appropriate, have a quick discussion on the ones that were missed and make sure learners appreciate their importance. Learners now have to order the statements to form a 'good' plan, and then match the definitions/examples in column **B** to each step of their plan. Learners should cut out the statements to help ordering. This allows changes following discussion in pairs or as a class. Once the class agrees on the best order and can justify it, learners stick down the statements. Ask them to think about where the safety considerations come in to the plan, and why they might come in at that point. Could they be positioned anywhere else?
5 min	**Plenary** Drawing on the previous activity, ask learners to consider the importance of following a sequence of instructions. You could give them a set of instructions for a simple daily activity they are all familiar with, such a cleaning their teeth or getting dressed, and discussing what would happen if the order was changed. Does it matter? Learners should appreciate that in many cases a set of instructions is given in a particular order for a reason and should be followed if they want to get the desired end outcome. You could also incorporate safety in here, by including a set of instructions relating to safety and the order in which they are followed.

Lab lesson: Option 1 – run the experiment

Resources	• Worksheets C, D, E and F • Learners' completed Worksheet B • *Teacher method*, *Teacher notes, Teacher walkthrough video* • Equipment as indicated in the *Teacher notes* • *Virtual experiment* video (optional)

Learning objectives	By the end of the lesson: • ***all*** learners should know how to work safely in the laboratory and follow instructions with help from the teacher. • ***most*** learners should know how to work safely in the laboratory following written instructions to obtain some results. • ***some*** learners will know how to work safely in the laboratory following written instructions, and be able to design a table to record their results.

Timings	Activity
10 min	**Starter/introduction**

Explain that they will carry out an experiment to demonstrate that large molecules, such as starch, cannot pass through the wall of the small intestine but small molecules, such as glucose, can.

Give learners Worksheet C and Worksheet D, which contain the equipment set-up and method that they will use. Explain that a risk assessment always needs to be done before an experiment can be run. Ask learners for suggestions of the potential safety hazards of using the equipment and the given method, and how they can prevent any problems. You might need to explain that Benedict's solution is a low hazard in the concentrations used but it should not be swallowed and contact with the skin and eyes should be avoided as it can be an irritant. Iodine solution is a moderate hazard. If there is ethanol in the solution, it is flammable. It is toxic if swallowed. Contact with skin can cause dryness and cracking. It can be an irritant to the eyes and airways.

You should end up with the following risk assessment:

Hazard	Risk	Prevention
Iodine solution	Could be spilt onto skin, clothes or get into the eyes. It could be inhaled.	• Take care not to spill any. • Wear eye protection. • Wear lab coats or other protective clothing. • Wash hands after the practical. • Tell the teacher immediately if spillage occurs. • Tell the teacher immediately if any gets on the skin or in eyes to seek the correct first aid treatment. • Do not inhale fumes from the bottle.
Benedict's solution	Could be spilt onto skin, clothes or get into the eyes. Could spit out of samples during heating.	• As above. • Do not point the open end of the boiling tubes towards anyone's face. • Do not look down the boiling tube or beaker whilst being heated.
Starch and glucose solution	Could cause discomfort if swallowed.	• Do not consume. • Wear gloves if you have allergies.
Hot water	If split on the skin or in the eye could cause burns.	• Take care not to spill any. • Wear eye protection. • Wear lab coats or other protective clothing.
Hot test-tubes	When transferring the hot test-tubes to a rack, there is a risk of burning.	• Transfer the test-tubes using test-tube holders so that the hot glass does not come into contact with skin.

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Timings	Activity
	Main lesson
40 min	You might need to explain that Visking tubing is an artificial selectively permeable membrane that can be used to represent the wall of the small intestine, which is also a selectively permeable membrane. If required, make sure all learners are familiar with the concept of a partially permeable membrane and the process of diffusion. You could play the introduction of the *Virtual experiment* video; it will pause automatically at experiment set-up. If necessary, explain that iodine solution is used to test for starch: turns from an orange-brown colour to a blue-black colour in the presence of starch. And that Benedict's solution is used to test for glucose: it changes colour from blue to green/yellow/orange/red when glucose is present; the different colours represent different concentrations of glucose. Demonstrate how to wet the piece of Visking tubing under tap water and then how to tie a knot in one end, without tearing it. Show learners how to use a syringe to fill the bag with the starch solution and glucose solution mixture. Request the help of one learner to hold the tubing whilst you tie the top of the bag. Stress to be careful so as not to tear the Visking tubing and the need to make the knots tight to avoid leakage of any solution. Learners carry out the experiment in groups of 2–4. Give learners Worksheet E to record their results. Abler learners can be challenged to design their own table. If necessary, remind them of the requirements of a good table: a title that relates to the data being recorded; ruled lines; enough rows and columns for the required data; column/row headers; suitable headings including units; record the data in the correct cells. **Safety** Circulate the classroom at all times during the experiment so that you can make sure that your learners are safe and that the data they are collecting is accurate. Remind learners to: • wear eye protection and lab coats when handling Benedict's solution and iodine solution • be careful when handling hot water and hot test-tubes Learners should complete Worksheet F, which asks them questions about the method; these are related to the prompts in the grey panels provided throughout the method. If there is not time in the lesson, this should be set as homework.
5 min	If there is time at the end of the experiment, ask one or two groups to share the results they obtained with the class. Discuss if these results were as expected, i.e. starch is absent from the water in the test-tube (shown by an orange-brown colour when tested with iodine solution) but glucose is present (shown by colour change when heated with Benedict's solution). Discuss any unexpected results and why they might have occurred.
	Plenary
5 min	Ask learners to discuss if the method they just followed was the result of good planning. Tell them to refer back to their answers to Worksheet B (and Worksheet F if completed) as guidance; for example, they should think about what the variables were, what they wanted to measure and how they measured it; what they kept the same, etc. Was it all appropriate, or could it have been improved?

Teacher notes

Watch the *Teacher walkthrough* video and read these notes.

Each group will require:

- Visking tubing approximately 15 cm long (diameter is typically 15 mm)
- a boiling tube
- thread approximately 10 cm long × 2 (optional)
- starch and glucose solution (5% glucose and 2% starch should result in the desired colour changes, alternatively use 10% glucose and 5% starch solution)
- 10 cm^3 syringe
- 250 cm^3 beaker (large enough to stand the boiling tube in)
- a clamp
- glassware pen (not water soluble)
- timer
- Benedict's solution
- iodine solution
- test-tubes × 8
- dropper pipette
- 250 cm^3 beaker of boiling water (or water bath set at 80 °C)
- test-tube racks × 2
- test-tube holder

Safety

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

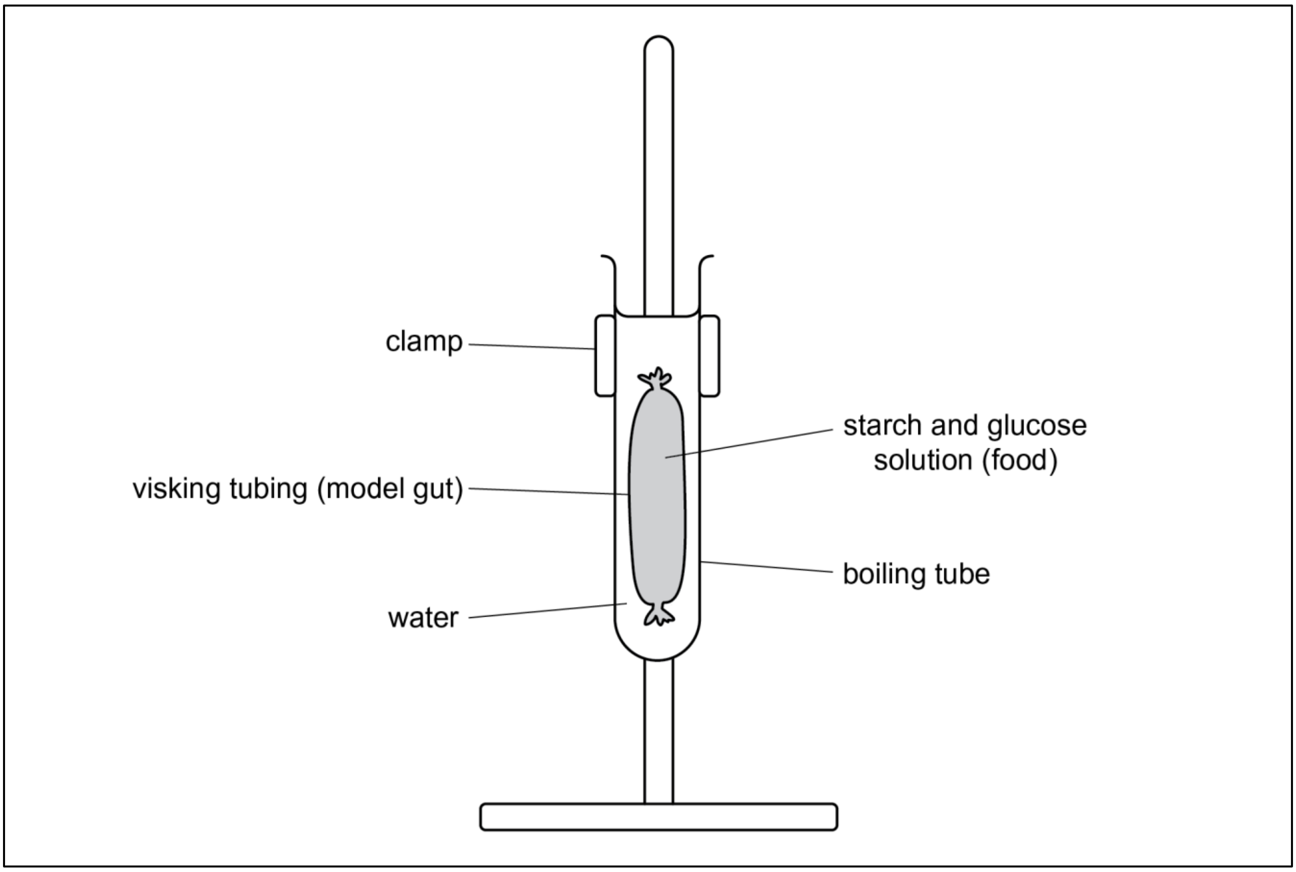
Some associated safety precautions include:

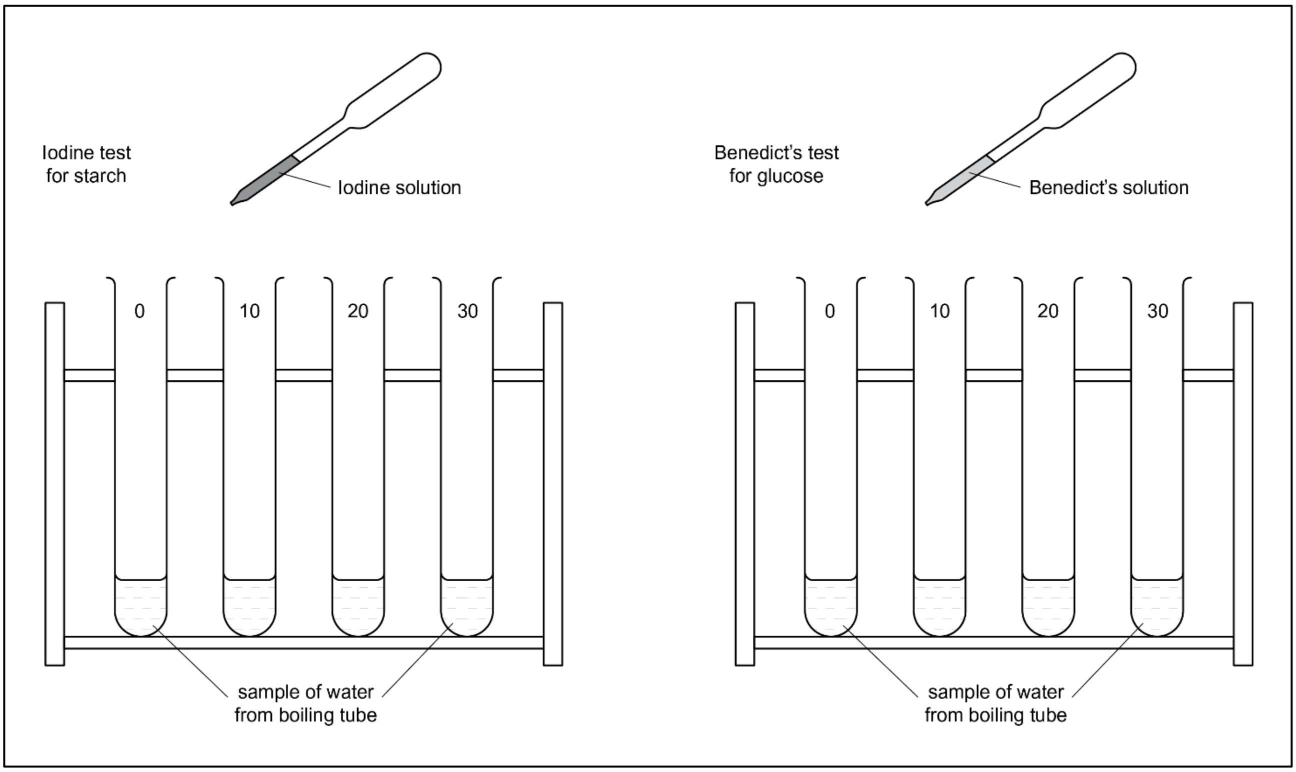
1. Learners must wear eye protection when using the starch and glucose solution, iodine solution and Benedict's solution.
2. During the Benedict's test, learners need to be careful when handling hot water to avoid scalding; learners must only pick up test-tubes following heating using the test-tube holders.
3. At the end of the experiment, the contents of the test-tubes should be emptied into a sink and disposed of with plenty of running water.

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

Substance	Hazard	First aid
Iodine solution [0.1 mol/dm^3]	 GHS09 (*hazardous to the aquatic environment* **N**)	**In the eye:** flood the eye with gently-running tap water for 15 minutes; see a doctor. **Vapour breathed in:** remove the casualty to fresh air; call a doctor if breathing is even slightly affected. **Swallowed:** do no more than wash out the mouth with water; do not induce vomiting; sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** remove contaminated clothing; drench the skin with plenty of water; if a large area is affected or blistering occurs, see a doctor. **Spilt on the floor, bench, etc.,:** ventilate the room; for small amounts, use a damp cloth and rinse well; for larger amounts, cover with mineral absorbent (e.g. cat litter) and scoop into a bucket.
Benedict's solution	LOW HAZARD	**In the eye:** flood the eye with gently-running tap water for 15 minutes; see a doctor. **Vapour breathed in:** ventilate the room; remove the casualty to fresh air; call a doctor if breathing is even slightly affected. **Swallowed:** do no more than wash out the mouth with water; do not induce vomiting; sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** remove contaminated clothing; drench the skin with plenty of water; if a large area is affected or blistering occurs, see a doctor. **Spilt on the floor, bench, etc.:** wipe up small solution spills with cloth and rinse well; for larger spills, cover with a mineral absorbent (e.g. cat litter); neutralise alkali with citric acid and rinse with water.
Starch [1% w/v solution]	LOW HAZARD	**In the eye:** flood the eye with gently-running tap water for at least 10 min. See a doctor. **Swallowed:** do no more than wash out the mouth with water. Do not induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** remove contaminated clothing and rinse it. Wash off the skin with plenty of water. **Spilt on the floor, bench, etc.:** wipe up small solution spills with cloth and rinse well. For larger spills use mineral absorbent (e.g. cat litter).
Glucose	LOW HAZARD	**In the eye:** flood the eye with gently-running tap water for at least 10 minutes. See a doctor if pain persists. **Swallowed:** do no more than wash out the mouth with water. Do **not** induce vomiting. Sips of water may help cool the throat and help keep the airway open. See a doctor. **Spilt on the skin or clothing:** brush solid off contaminated clothing. Rinse clothing or the skin as necessary. **Spilt on the floor, bench, etc.,:** brush up solid spills, trying to avoid raising dust, then wipe with a damp cloth. Wipe up solution spills with a cloth and rinse well.

Experiment set-up





Teacher method

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

Do not share this method with learners. Give them Worksheet D.

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

Think about:

- the number of groups you will need (group size 2–4 learners)
- the amount of equipment/chemicals required
- decide if equipment will be laid out on work spaces at the start or if learners will collect their equipment from the front of the class

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

Step	Notes
1. Learners should open the piece of tubing by holding it under tap water and gently rubbing it between thumb and forefinger.	*Some learners might find this difficult; make sure the tubing is thoroughly moistened.*
2. Learners tie a knot at one end of the tubing; they check that it is tight to avoid leakage.	*Learners should take care to avoid tearing; thread can be used instead.*
3. Learners should fill a 10 cm^3 syringe with the starch and glucose solution. Then gently fill the Visking tubing with the mixture until it is approximately two thirds full.	*Glucose solution can be sticky and should be cleaned from the work space with a damp cloth; filling could be done over a tray to collect any spillage. One learner can hold the tubing whilst the other fills it with solution.*
4. Learners tightly tie the top of the filled tubing to make a small 'bag'. They make sure that the tubing is tightly sealed and ensure that none of the mixture leaks out.	*This can also be done with thread. Leakage will invalidate the results. Some learners may struggle to do this. One learner could hold the tubing whilst the other ties the end.*
5. Learners gently rinse the tubing with water under a tap to wash off any spillages of the starch and glucose solution on the outside that would contaminate the results.	

Step	Notes
6. Learners label two sets of test-tubes: 0, 10, 20 and 30. They line these up into two test-tube racks.	*Remind learners to be careful when handling glassware. The labels should be at the top of the test-tube so that it can easily be seen and will not wash off when placed in a hot water bath during the Benedict's test. If the rack has different sized holes, make sure the test-tubes are placed in the correct holes to avoid them slipping out and breaking.*
7. Learners place the Visking tubing into a boiling tube, clamp the tube in place and fill the boiling tube with distilled water. The tubing should be fully covered with water. This is all done at room temperature.	*If you use a beaker of water instead of a boiling tube, then you will need to use a higher concentration of the starch-glucose solution (otherwise the concentration of glucose diffused into the beaker of water will be too dilute to detect efficiently). You might have to try different concentrations before running the experiment with the class.*
8. Learners immediately start the timer and remove a small sample of the water from the boiling tube using the dropper pipette	*The sample volume must be small enough so that after the 8 samples have been taken across the 30 minutes, the water level in the boiling tube does not go below the top of the Visking tubing.*
9. Learners place 4 drops of the sample into each of the test-tubes labelled '0'.	
10. After 10 minutes, they take another sample from the boiling tube (of the same volume) and add 4 drops to each of the two test-tubes labelled '10'.	
11. After 20 minutes, learners take another sample (of the same size) from the boiling tube and add 4 drops to each of the test-tubes labelled '20'.	
12. After 30 minutes, learners take a final sample and add 4 drops to each of the test-tubes labelled '30'.	

13. Learners now test each sample, one at a time, for the presence of starch and then glucose.

Ask learners what safety precautions they should take before carrying out tests for starch and glucose.

14. To test for starch, learners add 4 drops of iodine solution to one of the test-tubes labelled '0'. They gently swirl the contents being careful not to break the test-tube or spill the contents. Then they add 4 drops to each of the other test-tubes in the same test-tube rack.

Use about as much iodine solution as there is sample. Adjust the volume of iodine if a different volume of sample is used. If the iodine solution is too diluted in the sample, the distinct orange-brown colour is difficult to see.

15. Learners record their observations on Worksheet E or in their own table.

16. To test for glucose, learners use the other rack of samples (that have not been used for the starch test) and add 4 drops of Benedict's solution to each test-tube.

Use about as much Benedict's solution as there is sample. Adjust the volume of Benedict's solution if a different sample size is used.

17. They place the test-tubes into a beaker of hot water, start the timer and leave for 2 minutes.

The water needs to be very hot (80°C) in order for Benedict's solution to be activated. Use a water bath or use a kettle to fill beakers with hot water when it is needed

18. After 2 minutes, they remove the test-tubes from the beaker using test-tube holders. They place them in a dry rack, in the same order as before.

Ask learners how they will remove the test-tubes safely: using test-tube holders, they carry the tube by the top of the test-tube, taking care not to drop hot water onto skin.

19. Learners record their observations on Worksheet E or in their own table.

Clean-up

After the experiment learners should:

- return all equipment and any unused chemicals to you
- tidy up their work space
- ensure any spillages have been mopped up by you

The test-tube contents should be flushed down the sink with plenty of water.

Lab lesson: Option 2 – virtual experiment

Resources

- Learners' completed Worksheet B
- Worksheets C, D, E and F
- *Virtual experiment* video

Learning objectives

By the end of the lesson:

- ***all*** learners should know how to work safely in the laboratory and follow instructions with teacher help.
- ***most*** learners should know how to work safely in the laboratory following written instructions to obtain some results.
- ***some*** learners will know how to work safely in the laboratory following written instructions, and be able to design a table to record their results.

Timings	Activity
10 min	**Starter/introduction**

Starter/introduction

Explain that they are going to watch an experiment which demonstrates that large molecules, such as starch, cannot pass through the wall of the small intestine but small molecules, such as glucose, can. Play the start of the video to introduce the experiment; it will automatically pause on the equipment set-up (Worksheet D). Make sure learners understand what will be done (you could give them Worksheet C), particularly the tests for starch (iodine solution) and glucose (Benedict's solution), which include heating the Benedict's solution to 80°C in order to activate it.

Explain that a risk assessment always needs to be done before an experiment can be run. Ask learners for suggestions of the potential safety hazards of using the equipment and the proposed method, and how they can prevent any problems. You might need to explain that Benedict's solution is a low hazard in the concentrations used but it should not be swallowed and contact with the skin and eyes should be avoided as it can be an irritant. Iodine solution is a moderate hazard. If there is ethanol in the solution, it is flammable. It is toxic if swallowed. Contact with skin can cause dryness and cracking. It can be an irritant to the eyes and airways.

You should end up with the following risk assessment:

Risk	Hazard	Prevention
Iodine solution	Could be spilt onto skin, clothes or get into the eyes. It could be inhaled.	• Take care not to spill any. • Wear eye protection. • Wear lab coats or other protective clothing. • Wash hands after the practical. • Tell the teacher immediately if spillage occurs. • Tell the teacher immediately if any gets on the skin or in eyes to seek the correct first aid treatment. • Do not inhale fumes from the bottle.
Benedict's solution	Could be spilt onto skin, clothes or get into the eyes. Could spit out of samples during heating.	• As above. • Do not point the open end of the boiling tubes towards anyone's face. • Do not look down the boiling tube or beaker whilst being heated.
Starch-glucose solution	Could cause discomfort if swallowed.	• Do not consume. • Wear gloves if you have allergies.
Hot water	If split on the skin or in the eye could cause burns.	• Take care not to spill any. • Wear eye protection. • Wear lab coats or other protective clothing.
Hot test-tubes	When transferring the hot test-tubes to a rack, there is a risk of burning.	• Transfer the test-tubes using test-tube holders so that the hot glass does not come into contact with skin.

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Timings	Activity
5 min 30 min 10 min	**Main lesson continued…** Explain that they will now watch someone carry out the experiment. Tell them to write down anything about the method that they think is important. Resume the video. The video will pause automatically on the results from the starch test. Ask learners to record their observations on Worksheet E. Abler learners can be challenged to design their own table. If necessary, remind them of the requirements of a good table: a title that relates to the data being recorded; ruled lines; enough rows and columns for the required data; column/row headers; suitable headings including units; record the data in the correct cells. Resume the video; learners can check that their results match those described in the audio. The video will pause automatically after about 3 minutes, this time on the results of the glucose test. Learners record their results as before. Watch the end of the video. Learners can check their results match those in the audio of the video. Learners answer the questions on screen either as a class discussion or in pairs first. Hand out Worksheet F and ask learners to answer each question about the method using the notes they made from the video. Have a discussion about if they were able to answer all of the questions; are there differences/similarities between their notes; does this say something about their understanding of the method? Had they made notes on safety considerations; instructions that seem important; variables that are controlled; variables that are changed, and so on?
5 min	**Plenary** Ask learners to discuss if the method used in the video was the result of good planning. Tell them to refer back to their answers to Worksheet B as guidance; for example, they should think about what the variables were, what they wanted to measure and how they measured it; what they kept the same, etc. Was it all appropriate, or could it have been improved?

Debriefing lesson: Planning and evaluating methods

Resources	• Learners' completed Worksheet E • Worksheets G, H, I, J and K

Learning objectives	By the end of the lesson: • ***all*** learners should be able to plan an experiment including an equipment list and some safety precautions. • ***most*** learners should be able to plan an experiment including an equipment list and safety precautions, and be able to compare different methods. • ***some*** learners should be able to plan an experiment including a full equipment list and safety precautions, based on an evaluation of different methods.

Timings	Activity
5 min	**Starter/introduction** Ask learners to think back to the end of the last lesson, where they compared the method in the experiment to their answers to Worksheet B to determine if the method had been well planned. Hand out Worksheet G and ask learners to write down any problems they noticed with the experiment and to think of an example of how to improve the experiment for each problem they found.
10 min 20 min	**Main lesson** Explain to learners that starch is broken down into maltose, a simple sugar, by the enzyme amylase. This process happens inside the small intestine. Arrange learners in groups (2–4) and ask them to discuss how they could plan an experiment to show that amylase breaks down starch into simple sugars. They should use what they have learnt from the model gut experiment to help them; they can reuse and adapt parts of the method as appropriate. Explain that they will now write out their plan using Worksheet H and Worksheet I. On Worksheet H they need to fill out an equipment list and justify the use of each item. Tell them that they can use any standard laboratory equipment and solutions; some examples are given on page 2 of Worksheet H (it is advised **not** to produce Worksheet H double-sided). Remind learners to include as much detail as possible, such as the number of each item they will use. On Worksheet I, they have to write a step-by-step method. Encourage them to include as much detail as possible, such as the frequency of any measurements they want to make. They should also include safety precautions. *Continues on next page …*

Timings	Activity
20 min	**Main lesson continued …** Give learners Worksheet J and explain that they will now compare two experimental methods. Both methods are designed to determine if different types of biscuit contain different concentrations of reducing sugar. Learners compare and evaluate the two methods shown. Ask them to discuss which method would provide the most accurate results and to explain their reasoning. Ask them to suggest any further improvements that could be made to the methods. Explain that you want them to write up their plan as a piece of extended writing. They should use Worksheet K to support their writing skills, and Worksheets H and I as reminders for the things they should consider. For example, a list of all the equipment they would need; how much of each equipment; what variables there are and how they will control or change them. As before, they can use any standard laboratory equipment or solutions. They should also include safety precautions, including general practice such as wearing eye protection and lab coats, and not eating or drinking in the lab.
5 min	**Plenary** Groups of learners share their methods and critique them. They should consider if the instructions are easy to follow; if the proper safety precautions have been made; and if the method is likely to produce valid results.

Worksheets and suggested answers

Worksheet A: Safety

Look closely at the picture. Make a list of all the safety hazards you can see.

Worksheet B: Planning an experiment

The list of statements in column **A**, are important steps when planning an efficient experiment. Cut out the statements and order them on page 2 of the worksheet to create a good plan.

The statements in column **B** are definitions or examples in context of each step in the plan. Cut out the statements and match these to the appropriate steps in **A**, on page 2.

A	B
Identify which variable(s) you will change	The number of times a sample is tested and results recorded; at least three is best
Decide how many repeats to make	Draw a results table, then decide if a graph will help show any trends in the data
List any variable(s) that need to be controlled	Factors that should be kept the same so that they do not make the results invalid
Write down required safety precautions	For example, count the number of bubbles of gas given off in 1 minute
Identify the variables	A picture that shows how to arrange the equipment during the experiment
Draw a diagram of the equipment set-up	For example, observing a colour change or measuring the volume of gas produced
Decide how you will take measurements	This is the independent variable; for example, how often a measurement will be
Decide how you will control variables	Choose equipment that allows the most efficient and accurate measurement of data
Describe how you will present your data	The suggested explanation/prediction/theory that is to be tested
State a hypothesis	The factors that can change during an experiment
List suitable equipment to use	For example, wear safety goggles and a lab coat
Decide what you will measure	For example, use the same volume of solution each time

Put the statements in the correct order, then add the correct definitions/examples.

A	B

Worksheet C: Method

Use the following method to find out whether starch and/or glucose molecules can diffuse through Visking tubing.

1. Open the piece of Visking tubing by holding it under a running tap and gently rubbing the tubing between your thumb and forefinger.
2. Tie a knot at one end of the tubing; handle carefully to avoid tearing.
3. Fill a $10cm^3$ syringe with the starch and glucose solution mixture. Then gently fill the Visking tubing with the mixture until it is approximately two thirds full.
4. Now tightly tie the top of the filled tubing with a knot or a piece of thread to make a small 'bag'. Make sure that the tubing is tightly sealed and that none of the mixture leaks out.
5. Gently rinse the tubing with water under a tap.

> *Why is it important for there to be no leaks?*
> *Why do you need to rinse the tubing under a tap?*

6. Label two sets of test-tubes: 0, 10, 20, 30. Add the label at the top so that it's easy to see and doesn't get washed off later.
7. Place the Visking tubing into a boiling tube and fill the tube with distilled water. Ensure that the tubing is fully covered with water.

> *Why is it important for the tubing to be fully covered with water?*

8. Immediately start the timer and remove a small sample of the water from the boiling tube using the dropper pipette.
9. Place 4 drops of the sample into each of the test-tubes labelled '0'.

> *Why is a sample taken at time 0 minutes? What does this represent?*

10. After 10 minutes, take another sample from the boiling tube and add 4 drops of the sample to each of the two test-tubes labelled '10'.
11. After 20 minutes, take another sample from the boiling tube and add 4 drops to each of the test-tubes labelled '20'.
12. After 30 minutes, take a final sample from the boiling tube and add 4 drops to each of the test-tubes labelled '30'.

> *Why are samples of water taken every 10 minutes? What variable is this?*
> *Why do you think an interval of 10 minutes was used?*
> *Why was the same volume of sample added to each test-tube?*

13. Now test each sample, one at a time, for the presence of starch and then glucose.

> *What safety precautions do you need to consider when handling iodine solution and Benedict's solution?*

14. **To test for starch:**

  i. Add 4 drops of iodine solution to one of the test-tubes labelled '0'.

  ii. Gently swirl the contents being careful not to break the test-tube or spill the contents.

  iii. Add 4 drops of iodine solution to each of the other test-tubes in the same test-tube rack.

  iv. Record your observations. Has there been a colour change? Record the colour of the solution, not just 'change' or 'no change'.

> *Why is the same number of drops of iodine solution added to each sample?*

15. **To test for glucose:**

  i. Use the other set of test-tubes that have not had iodine solution added.

  ii. Add 4 drops of Benedict's solution to each test-tube.

> *Why is the same number of drops of Benedict's solution added to each sample?*

  iii. Benedict's solution needs to be warmed to at least 80°C to become active. Place all of the test-tubes into a water bath set at 80°C, or a beaker of hot water.

  iv. Start the timer and leave the test-tubes for 2 minutes.

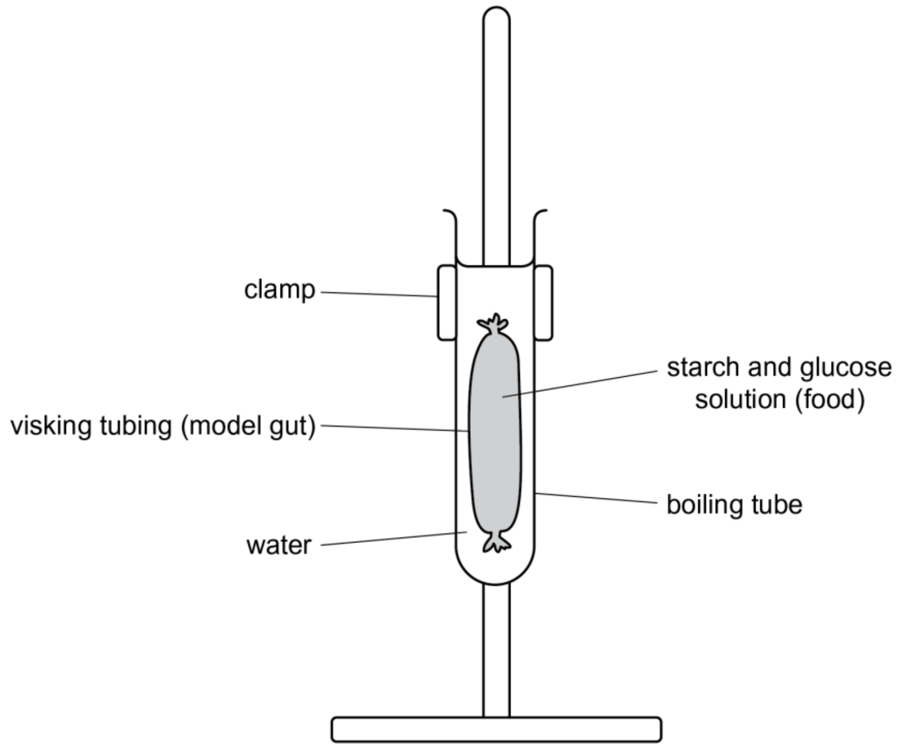
  v. After 2 minutes carefully remove the test-tubes from the beaker using the test-tube holders. Hold the test-tubes by the rim. Handle glassware carefully to avoid breakage.

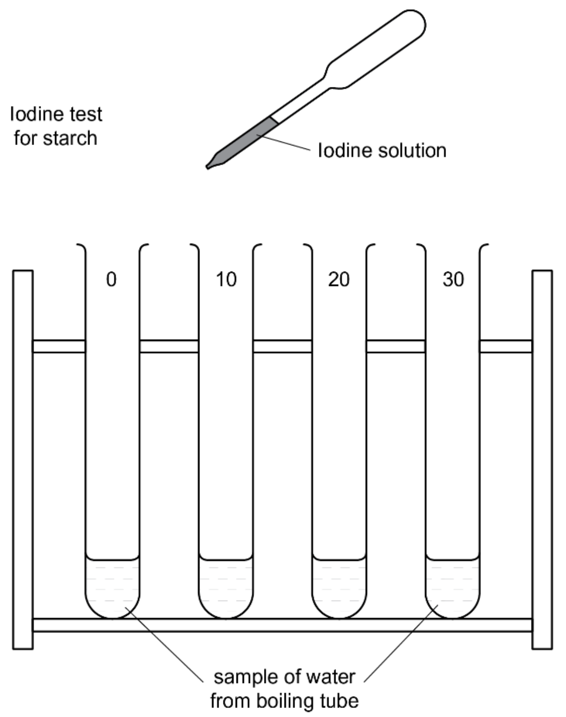
> *What safety precautions do you need to take when heating liquids and handling hot water?*

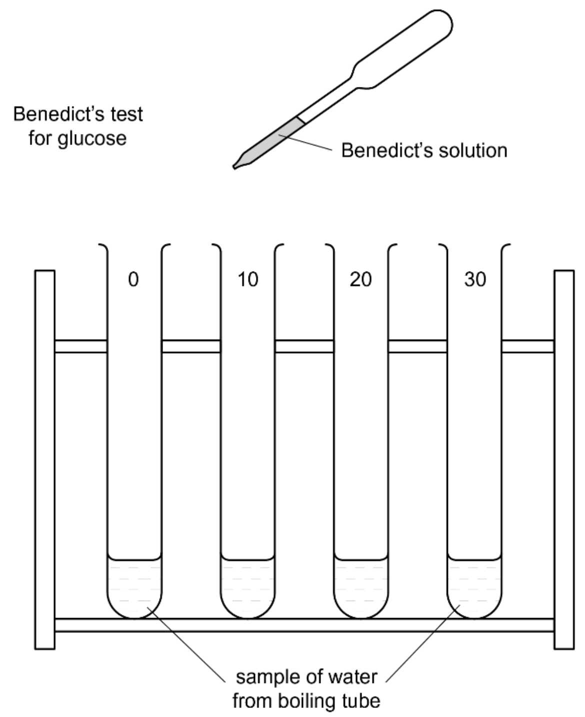
  vi. Place the test-tubes into a dry test-tube rack. Put the test-tube labelled zero in the first slot, and the rest in order from 0 to 30 as before.

  vii. Record your observations. Has there been a colour change? Record the colour of the solution, not just 'change' or 'no change'.

Worksheet D: Experiment set-up







Worksheet E: Results table

Time (minutes)	Colour observed	
	Iodine solution	**Benedict's solution**
0		
10		
20		
30		

Worksheet F: Looking at the method

Answer the following questions about the method used in the experiment.
Use your answers to Worksheet E to help.

1. Samples of water were taken every 10 minutes. What sort of variable is this? Why do you think this length of time was chosen?

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2. What control measures were taken in the method? Why was each needed?

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3. Using your knowledge of diffusion, why might it have been important to ensure the Visking tubing was completely submerged in the container of water **throughout** the experiment?

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4. Why was a sample taken at 0 minutes? What does this represent?

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5. Does the method allow you to make a valid comparison between all of the samples? Why?

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Worksheet G: Evaluating the method

List some problems with the method and suggest a way to improve each.

Your answers to Worksheets E and F might be useful.

Problem with method	Improvement

Worksheet H: Starch-amylase demonstration

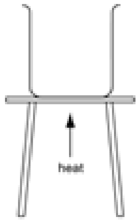
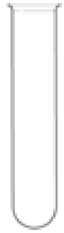
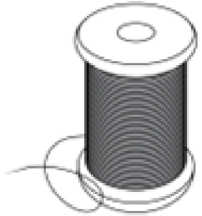
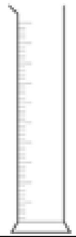
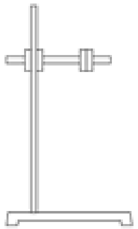
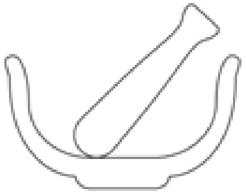
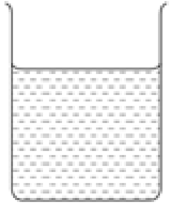
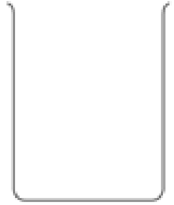
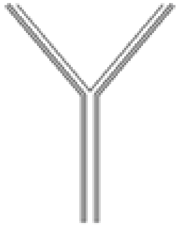
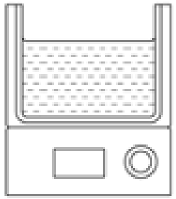
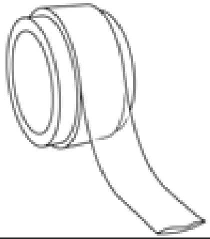
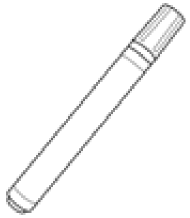
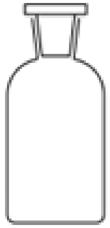
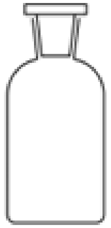
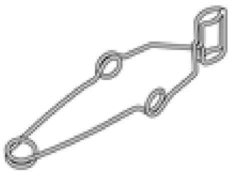
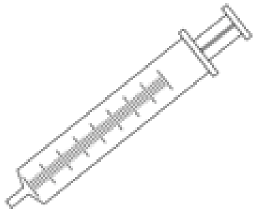
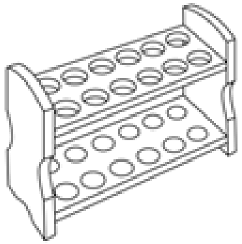
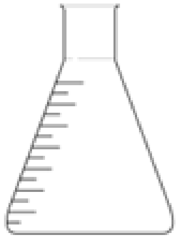
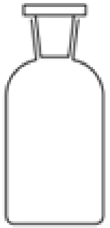
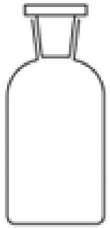
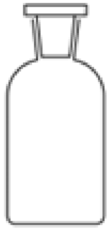
Plan an experiment to demonstrate that amylase digests starch into maltose.

You can use any equipment usually found in lab, some examples can be found on page 2 of this worksheet. Write your equipment list here and state why each piece is needed.

An example has been done for you.

Equipment	Use
10 cm^3 5% amylase solution	To digest starch into maltose sugar

Here is some typical laboratory equipment.

						
dropper pipette	distilled water	timer	Bunsen burner & tripod	boiling tubes / test-tubes	thread	measuring cylinder
						
clamp	pestle & mortar	spatula	beaker of water	glass rod	beakers	balance
						
thermometer	funnel & filter paper	water bath	Visking tubing	glassware pen	5% amylase	starch suspension
						
test-tube holders	syringe	rack	conical flask	starch & glucose solution	Benedict's solution	iodine solution

Worksheet I: Starch-amylase method

Draw a labelled diagram to show how you would set up your experiment.

Write a step-by-step plan for a method that would allow you to carry out your experiment. Think about what variables there are, which ones you want to change and which you want to control; how you will measure them and how you will keep safe.

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What results would you expect to see at the end of your experiment? Why?

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Worksheet J: Testing biscuits

Methods A and B are both designed to test if one type of biscuit contains more reducing sugar than another type of biscuit.

Compare and evaluate the two different methods.

Method A	Method B
1. Put a small piece of biscuit into a test-tube. Add some water using a dropping pipette.	1. Add a small amount of crushed biscuit to a test-tube and add 1 cm^3 of water using a syringe.
2. Shake the test-tube to mix the contents.	2. Shake the test-tube to mix the contents.
3. Add 5 drops of Benedict's solution to the test-tube.	3. Add 0.5 cm^3 of Benedict's solution to the test-tube.
4. Put the test-tube in a beaker of hot water for 1 minute.	4. Place the test-tube in a water bath set at 80°C for 2 minutes.
5. Observe any colour change.	5. Observe any colour change.
6. Repeat for other types of biscuit for comparison.	6. Repeat the procedure one more time using the same type of biscuit.
	7. Repeat for other types of biscuit for comparison.

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Which method do you think would provide the most accurate results?
Explain your reasoning.

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Can you suggest any improvements to either method?

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Worksheet K: Writing up

Here are some ideas and techniques you might find helpful when writing a plan for a scientific method. You can use this as a checklist.

1. Use a sequence of steps to explain how the experiment should be carried out; make sure these are in the order you want them to be completed. ☐

2. Each step should be a detailed command of what needs to be done, e.g. ‘gently swirl the contents of the test-tube to mix’ rather than ‘mix’. ☐

3. Include safety. ☐

4. Identify the variables (control, independent and dependent). ☐

5. Make sure you explain (or draw) the equipment and materials needed, including how many of each item is needed. ☐

6. Your vocabulary should be precise and you should use relevant technical words. ☐

7. Your language should be impersonal. Do not use words like ‘I’ or ‘we’. ☐

8. State what you want to achieve, e.g. To test for starch, add … ☐

9. You should use direct language such as ‘**add** 2 cm^3 of Benedict’s solution to the test-tube’. ☐

10. Use numbers or temporal connectives to show the stages involved. For example, ‘next’, ‘now’, ‘after’, ‘first’, ‘second’, ‘third’, ‘20 minutes later’ and ‘meanwhile’. ☐

11. Your language should be clear so that someone could repeat the experiment without mistakes. ☐

Worksheet A: Suggested answers

The following are some suggestions of the answers that learners might provide.

Hazard	Possible effects and ways to avoid harm
Eating	Could ingest harmful or toxic chemicals. Food should not be eaten in a lab.
Drinking	Could ingest harmful or toxic chemicals. Drinks should not be consumed in a lab.
Throwing objects	Could cause an accident (another learner to drop equipment) or a fire (if object landed near a lit Bunsen burner) or hurt another learner if object hits them. Learners should never throw things in the lab or play around.
Long hair near a Bunsen burner	Untied hair could easily catch fire, burning the learner. Long hair should always be tied up.
Not wearing eye protection when heating liquids	The solution could spit out of the test-tube and burn the learner's eyes, causing serious injury and even blindness. Eye protection should always be worn when heating solutions.
Spilling water over an electrical item	Could cause an electric shock to the learner and even death. Work with liquids should be away from electrical items.
Inserting items into electrical sockets	Could cause an electric shock to the learner and even death. Items should never be inserted into electrical sockets.
Tilting back on a lab stool	Learner might fall backwards and hurt themselves or another learner standing nearby, or cause a neighbouring learner to have an accident (they might drop equipment or spill hot/hazardous liquids). Learners should stand whilst carrying out practical work and stools should be pushed under the bench out of the way.
Bags on the floor	Learners could trip over bags and this can lead to injury or accidents, especially if the learner is carrying equipment such as chemical solutions or hot test-tubes. Bags should be left outside of the lab or in a safe designated area.
Knocking over a beaker of liquid	If spills are not cleaned up immediately, toxic or harmful reagents might come into contact with the learner's skin and cause harm. They could spill onto the floor and increase the chances of someone slipping over and hurting themselves. All spills should be cleared up immediately.
Pool of spilt liquid on the floor	A learner might slip over and hurt themselves. This would be especially dangerous if they were carrying glassware or chemicals, which could break or spill the chemical solutions. All spills should be cleared up immediately.
Pointing a test-tube at another learner whilst heating a solution	The solution could spit out of the test-tube and onto a nearby learner causing them harm. Test-tubes should always be pointed away from other learners when heating solutions.
Filling a test-tube from a large container	The chance of spillage is much greater, so a smaller container and a funnel should be used when dispensing liquid.
Not wearing a lab coat	Hazardous chemicals, such as acids, could get onto clothing and either burn holes in the clothing and damage the skin, or soak through to the skin and cause irritation. Lab coats should always be worn.
Moving beaker from a water bath with hands	Hot glassware and hot water can burn the skin. Hot glassware should always be transferred using a suitable tool, such as a test-tube holder, to prevent burning.
Flammable liquid next to a lit Bunsen burner	The flammable liquid might catch fire, burning a nearby learner or setting the room on fire. Flammable liquids should always be kept in containers with a lid, away from open flames.
Conical flask balancing on the edge of a work bench	The beaker could be knocked onto the floor and break, and spill any chemicals it contains. Broken glassware can cause cuts, learners could slip on the liquid, or get chemical burns from the liquid. Always keep glassware away from the edges of the work space.
Pouring a liquid irritant without wearing eye protection or gloves	Some of the liquid might spill or spit out during pouring and go into the learner's eyes, causing severe irritation and possibly even blindness. Eye protection must always be used when handling irritants.

Worksheet B: Suggested answers

The following is a suggested order for a good plan, along with the correct definitions/examples.

A	B
State a hypothesis	The suggested explanation/prediction/theory that is to be tested
Identify the variables	The factors that can change during an experiment
List any variable(s) that need to be controlled	Factors that should be kept the same so that they do not make the results invalid
Decide how you will control variables	For example, use the same volume of solution each time
Identify which variable(s) you will change	This is the independent variable; for example, how often a measurement will be
Decide what you will measure	For example, observing a colour change or measuring the volume of gas produced
Decide how you will take measurements	For example, count the number of bubbles of gas given off in 1 minute
Decide how many repeats to make	The number of times a sample is tested and results recorded; at least three is best
List suitable equipment to use	Choose equipment that allows most efficient and accurate measurement of data
Draw a diagram of the equipment set-up	A picture that shows how to arrange the equipment during the experiment
Describe how you will present your data	Draw a results table and decide if a graph will help show any trends in the data
Write down required safety precautions	For example, wear safety goggles and a lab coat

Worksheet E: Suggested answers

These are the results from the experiment carried out in the *Virtual experiment* video.

Time (minutes)	Colour observed with	
	Iodine solution	Benedict's solution
0	orange-brown	blue
10	orange-brown	green
20	orange-brown	yellow
30	orange-brown	orange

Worksheet F: Suggested answers

1. Independent variable; 10 gives time for the glucose molecules to diffuse through the tubing.

2. The same volume of water was sampled each time; this ensures that the results for each test are comparable. If one sample was a larger volume, then it would contain comparatively more glucose whereas a smaller volume sample would contain less glucose. This would lead to inaccurate results.

   The same volume of Benedict's solution and iodine solution was used each time; again this ensures that the results are accurate and comparable.

   The time in the water-bath was the same for each sample; again, this ensures that the results are accurate and comparable. For example, if the time was shorter than 2 minutes then not all of the Benedict's solution will have reacted with the sample leading to an inaccurate colour change for the true concentration of glucose in the sample.

   The temperature of the water-bath was the same for each sample; at temperatures below 80^{o}C the Benedict's solution will not react with the glucose and a false negative result could be obtained. Higher temperatures are unnecessary and could pose a higher hazard of scalding. The temperature was constant to ensure the results are accurate and comparable.

   The Visking tubing was rinsed under a running tap after filling with starch and glucose solution, to prevent contamination of the water, which would make the results invalid as the glucose in the water would not be a result of diffusion through the tubing.

   Making sure the Visking tubing bag is tightly sealed so that the starch and glucose solution cannot leak and contaminate the water, which would make the results invalid as the glucose in the water would not be a result of diffusion through the tubing.

3. So that diffusion can happen along the full length of the Visking tubing; thus allowing for the maximum diffusion of glucose out of the tubing. This is particularly important as only low concentrations of glucose are present to be detected by the Benedict's solution. If the volume of the water in the beaker changed significantly between each sample, this would also affect the concentration of glucose in the water and make the results inaccurate.

4. To show that no starch or glucose was present in the water at the start of the experiment. This is the control experiment.

5. Yes, because the samples were all tested in exactly the same way and all variables were kept the same.

Worksheet G: Suggested answers

The following are example answers only.

Problem with method	Improvement
The experiment was only done once.	Repeating the experiment at least two more times would improve the reliability of the results.
When removing 4 drops of the sample the drop size may vary, meaning sample sizes are not exactly the same.	Remove a fixed volume, e.g.1 cm^3 using a syringe.
Drop sizes of iodine solution and Benedict's solution might vary between samples meaning not every sample got exactly the same volume.	Add a fixed volume, e.g.1 cm^3 using a syringe.
After iodine solution and Benedict's solution were added, the test-tubes were gently swirled.	A more even and thorough mix would occur if the samples were stirred using a glass rod.

The answers might lead to a discussion whereby learners agree that overall, the method was relatively well planned. There were three main issues when comparing against the steps in Worksheet C (issues listed above), however, they might agree that given the required degree of accuracy, i.e., simply to demonstrate that starch cannot pass through the tubing but glucose can, the degree of accuracy supplied by the points above are unnecessary in this instance although good practice in general.

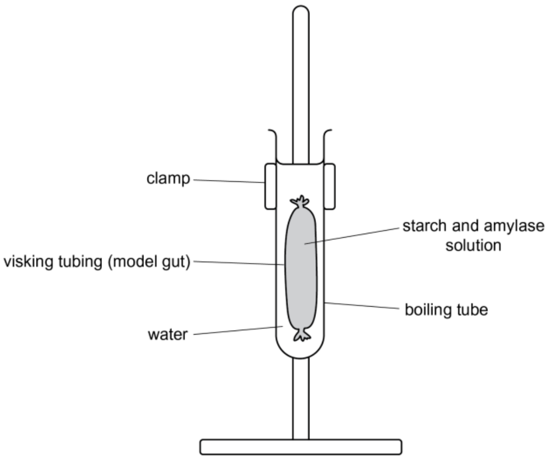
Worksheet H: Suggested answers

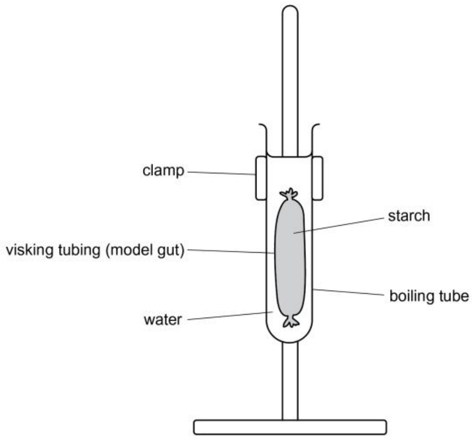
The following is one suggested answer only. You should acknowledge all valid choices based on reasonable justifications.

Equipment	Use
10 cm^3 amylase solution	To digest starch into maltose sugar.
20 cm^3 starch solution	For the amylase to act on, i.e. the substrate to digest into sugar.
Benedict's solution	To test for the presence of reducing sugar.
10 cm^3 syringes × 3	To measure the volume of starch, amylase and Benedict's solutions.
Visking tubing (15 cm lengths) × 2	To represent the wall of the small intestine.
Thread × 2	To tie the Visking tubing into a bag.
Test-tubes × 8	To put samples into.
Boiling tubes × 2	To put Visking tubing into.
Dropper pipette × 2	To remove samples from boiling tube.
Timer	To measure time intervals for removing samples, and time the test-tubes when they are heated during the Benedict's test.
Electronic water bath set at 80°C	To activate the Benedict's solution.
Marker pen or labels	To label test-tubes so the samples do not get mixed up and make the results invalid.
Test-tube holder	To remove test-tubes from hot water bath after the Benedict's test.
Test-tube rack × 2	To hold test-tubes; one per biscuit type.
Eye protection	For eye protection when using Benedict's solution and heating liquids.

Worksheet I: Suggested answers

The following is one suggested answer only. You should acknowledge all valid choices based on reasonable justifications.





Make sure eye protection and lab coats are worn.

1. Label a set of test-tubes: '0', '10', '20' and '30'. (Samples taken every 10 minutes is the **independent variable**.)
2. Place them in a test-tube rack in numerical order.
3. Open the piece of tubing by holding it under tap water and gently rubbing the tubing between thumb and forefinger.
4. Tie one end of the tubing using a piece of thread, being careful not to tear it.
5. Fill a 10 cm^3 syringe with the starch suspension and place it into the tubing.
6. Using a syringe, gently add 10 cm^3 amylase solution to the tubing.
7. Avoid getting starch or amylase solutions on the skin as they might irritate. Rinse off immediately if they do come into contact with skin and report to the teacher. (**Safety**)
8. Tightly tie the top of the filled tubing with a piece of thread to make a small 'bag'.
9. Make sure that the tubing is tightly sealed and that none of the mixture leaks out. (**Control variable**).
10. Gently rinse the tubing with water under a tap to remove any starch or amylase that might be on the outside of the tubing. (**Control variable**).
11. Place the Visking tubing into a boiling tube and fill the boiling tube with distilled water.
12. Ensure that the tubing is fully covered with water. (**Control variable**).
13. Immediately start the timer and remove a small sample of the water from the boiling tube using the dropper pipette (**Control experiment**).
14. Place 4 drops into the test-tube labelled '0'.
15. After 10 minutes, take another sample from the boiling tube and add 4 drops of the sample to the test-tube labelled '10'.

16. After 20 minutes, take another sample from the boiling tube and add 4 drops to the test-tube labelled '20'.
17. After 30 minutes, take a final sample from the boiling tube and add 4 drops to the test-tube labelled '30'.

(All sample sizes are the same as a **control variable**.)

18. Now test each sample, one at a time, for the presence of glucose.
19. Add 4 drops of Benedict's solution to each test-tube. (**Control variable**)
20. Take care not to spill any Benedict's solution on the skin. Inform the teacher immediately if this happens and wash skin under running water. (**Safety**)
21. Place all of the test-tubes containing Benedict's solution, into the beaker of hot water.
22. Start the timer and leave the test-tubes for 2 minutes.
23. After 2 minutes, carefully remove the test-tubes from the beaker using the test-tube holders. Hold the test-tubes by the rim. Handle glassware carefully to avoid breakage. (**Safety**)
24. Place the test-tubes back into a new rack. (**Safety**)
25. Put them in the same order as before.
26. Record the colours of the Benedict's solution in each test-tube. (**Dependent variable**)

    Then, repeat the whole experiment but do not add amylase solution to the tubing bag. (**Control experiment**).

Note: Alternatively, some learners might simply put starch solution into one test-tube and starch and amylase solutions into another test-tube (bypassing the need for Visking tubing) and then remove a sample from each test-tube at 10-minute intervals for a total of 30 minutes. The same results should be obtained, i.e. that amylase breaks starch down into maltose.

Expected results might include:

Time (minutes)	Colour after heating with Benedict's solution	
	Starch only	Starch and amylase
0	blue	blue
10	blue	green
20	blue	yellow
30	blue	orange/red

The amylase breaks down the starch into reducing sugar, as shown by the change in colour of the Benedict's solution from blue to orange/red. The longer the starch and amylase are left together the more starch is broken down and so more sugar is produced indicated by the change in colour from green to yellow to orange/red.

Worksheet J: Suggested answers

The following is one suggested answer only. You should acknowledge all valid choices based on reasonable justification.

Example comparison might include:

1. In Experiment A, the volume of water is not specified and could vary between samples leading to inaccurate results. Experiment B is more accurate as it specifies the volume to be used. Experiment B also uses biscuits crumbs, which makes the sugar more available to the Benedict's solution. However, neither experiment uses a fixed amount of biscuit, so sample sizes will vary and make it invalid to compare the results.
2. Both experiments shake the tube but neither say for how long, or if they should be shaken vigorously or gently.
3. Both experiments A and B control the volumes of Benedict's solution to be added, which would lead to comparable results. However, Experiment B does this more accurately as it uses a fixed volume, rather than a number of drops. Drop sizes might vary so the volume might not be consistent across all samples.
4. Whilst Experiment A places the test-tube into hot water the temperature is not stated and therefore it may not be sufficiently hot to activate the Benedict's solution and may lead to a false negative result. 1 minute is also too short a time. Experiment B uses the correct temperature to activate the Benedict's solution and uses a sufficient time to do this.
5. Observing colour change is fine for this test.
6. There is no repeat in Experiment A, which would not give very reliable results, whereas Experiment B uses two repeats, which would give more reliable results.
7. Both test other biscuits using the same method, so that comparisons are valid.

Experiment B would provide the most accurate results because it:

- controls more variables (volume of water and volume of Benedict's solution) so the results would be more comparable between samples
- uses the correct incubation temperature and period for the Benedict's test
- repeats the test so the results are more reliable

Possible improvements include:

- a fixed surface area of biscuit, e.g. crush using a pestle and mortar
- a fixed quantity of biscuit e.g. use 1 g of crushed biscuit
- a volume of Benedict's solution equal to that of the water to give a more visible colour change, i.e., 1 cm^3
- stirring using a glass rod so that the Benedict's solution is evenly distributed
- collect quantitative data rather than qualitative
- carry out at least three repeats to increase the reliability of the results.

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