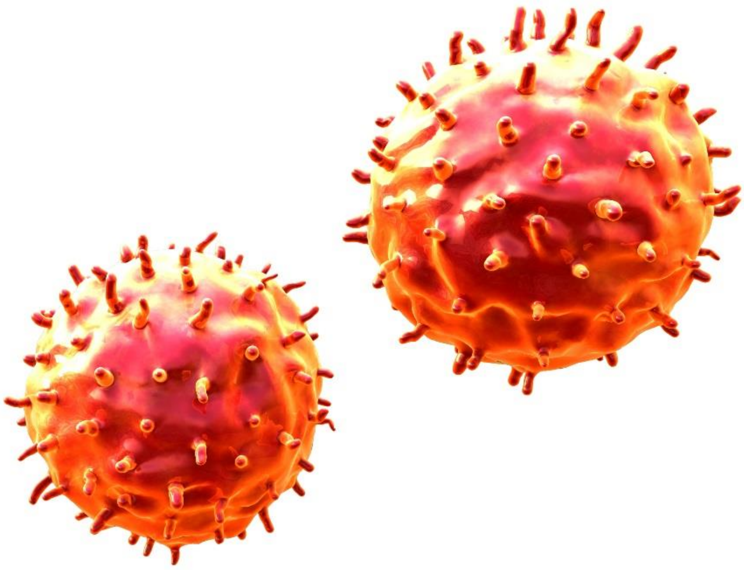
Cambridge Assessment International Education

Teaching Pack

Food tests

Cambridge O Level Biology 5090



Version 2.0

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Icons used in this pack:

Briefing lesson

Lab lesson: Option 1 – run the experiment

Lab lesson: Option 2 – virtual experiment

Debriefing lesson

Introduction

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

> **Important note**
> Our *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*.

↓

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 experimental skills introduced in the *Briefing lesson*.	This lesson allows your learners to complete a virtual experiment, providing an opportunity to practise the experimental skills introduced in the *Briefing lesson*.

↓

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: Food tests

This *Teaching Pack* focuses on testing for the presence of nutrients in a variety of foods.

Qualitative food tests can be used to identify what nutrients are present in food. This pack covers five such tests: DCPIP test for vitamin C; the iodine test for starch; the biuret test for proteins; the Benedict's test for non-reducing sugars; and the emulsion test for fats.

This experiment has links to the following syllabus content (see syllabus for detail):

- 5.1 Nutrients

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

- make and record observations, measurements and estimates
- interpret and evaluate experimental observations and data
- plan experiments and investigations

Prior knowledge

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

- 5.1 Nutrients
- 5.2 Diet
- 5.4 Human alimentary canal
- 5.5 Chemical digestion

Going forward

The knowledge and skills gained from this experiment will be useful for when you teach any of the prior knowledge topics and absorption.

Briefing lesson: Planning an investigation

Resources needed

- Worksheets A and B

Learning objectives

By the end of the lesson:

- ***all*** learners should be able to describe the difference between an observation and a measurement.
- ***most*** learners should be able to identify what variables could be measured, changed or controlled to test the hypothesis
- ***some*** learners will be able to evaluate the effectiveness of data collection methods.

Timings	Activity
10 min	**Starter/introduction**

Arrange learners in groups of 2–4. Ask them to think of what data could be collected during a chemical reaction in an experiment. Ask them to be more specific than ‘*What a sample looks like*’; challenge them to think of specific examples of what could be observed or measured. To support learners, give them an example of a change in colour of a sample, or a change in temperature.

After group discussion time, draw a table with the headings ‘observation’ and ‘measurement’ for the whole class to see (for example on a central whiteboard). Review learners’ ideas as a whole class and discuss which column their data would fit into. Learners should justify their choices, using what they know about observation and measurement. Possible suggestions might include:

Observation	Measurement
Change in colour	Change in mass of a sample
Fizzing	Temperature change
Gas given off	Length of a substance or organisms
Bubbles	Heart rate
Smell	Number of bubbles
Change in appearance	Distance travelled
Movement of an organism	Volume of a liquid
Steam being given off	Time taken
	Volume of gas

Timings	Activity
10 min	**Main lesson**

Ask learners to use their ideas from the starter to suggest what is meant by the terms ‘measurement’ and ‘observation’. Give learners a minute to discuss these terms and then review their ideas as a class.

Learners should be able to describe a measurement as involving numbers or exact readings. Discuss the idea that a measurement is the collection of quantitative data.

Learners should be able to describe an observation as a description of something they can see, smell or hear. Discuss the idea that an observation is the collection of qualitative data. Introduce the idea that observations are subjective and therefore based on opinion.

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Timings	Activity
	Main lesson continued …
	Ask learners what is meant by the term ‘valid data’. Give them a moment to discuss and then review their ideas. Learners should understand that valid data is the collection of data that is suitable to investigate the purpose of the experiment. For example, if they were investigating how the concentration of glucose changes over time, they would not measure the temperature over the different time periods.
	Challenge learners to discuss whether observations or measurements are more valuable in forming a valid conclusion or if it should be a combination of the two. Learners should be able to suggest that, if possible, a combination of the two would lead to more valid data being collected. This would provide as much data as possible to either prove or disprove a hypothesis. For example, when investigating if a reaction is exothermic or endothermic, learners could record a measurement of the temperature change and the observation of the presence or absence of steam. Learners should be able to appreciate that it is not always possible to collect both types of data if the experiment does not allow it.
10 min	Give learners Worksheet A and ask them to suggest what data could be collected in each experiment; is the experiment one where an observation, measurement or both could be collected? Reiterate that their suggestions should allow the collection of valid data and therefore be suitable for the investigation. Challenge learners to identify the equipment they would need in order to record this data. Review and discuss learners’ ideas as a class.
	Ask what variable they have identified when considering what data could be collected. Learners should be able to suggest that this is the dependent variable. Set learners the challenge of identifying the independent and control variables as well. Discuss with learners that unless there is a clear independent variable and conditions that are kept the same throughout, valid data cannot be collected and therefore valid conclusions cannot be made.
	Give learners another 5 minutes to complete the final column in the table on Worksheet A. Support learners by reminding them that an independent variable is what is changed, dependent variable is what is measured and the control variables are kept the same.
	Review learners’ ideas as a whole class, discussing their suggestions and if everyone agrees. Prompt discussion and evaluation of the learners’ ideas, asking if their suggestions are suitable for investigating the aim of each investigation.
15 min	Ask what they could do in order to improve the accuracy of the data collection in the investigations on Worksheet A. Learners should be able to suggest repeating the experiment three times to calculate a mean, which will help to eliminate anomalies; they could also compare results with others. Ask them how a mean is calculated. Recap that a mean is calculated by adding all of the values together and dividing by how many values there are. Ask learners *how* this improves accuracy. Learners should be able to say that calculating a mean gives an average value that is close to the actual value; taking into consideration lots of values helps to reduce the impact of variation. Discuss with learners that when calculating a mean they should not include any significantly different values that do not fit the general trend. This is because this data point was probably caused by a mistake in the method or human error, and would skew the calculated mean.
	Continues on next page …

Timings	Activity
	**Main lesson continued …** Give learners Worksheet B and ask them to review the data and calculate the mean. Review learners work. Discuss what should have been done and why. Learners should be able to suggest that the anomalies should not have been included in the mean calculation because this can distort the mean. Ask learners to suggest what this could be caused by; ideas should include human error, random error or a problem with the method. Ask learners why, in this example, the mean should be rounded to 3 significant figures. They should suggest that in this scenario, a standard thermometer is used which measures temperature to an accuracy of 0.5°C, so the temperatures can only be measured to the nearest half a degree. Learners should understand that including a mean to more than 3 significant figures would suggest that the accuracy of data collection is higher than it actually was. So, including more significant figures would introduce error as the equipment does not measure to that degree of accuracy.
	**Plenary** Ask learners what conclusions can be drawn from the data on Worksheet B. They should be able to suggest that as the fat content increases, the energy released also increases. Challenge learners to evaluate whether the data collected is valid to support this conclusion. What would they need to assume in order for this conclusion to be valid? Ideas should include that: • the control variables were managed; for example, the mass of the samples were all the same. • the repeats were conducted in the same conditions as the original experiment. • an accurate thermometer was used. Ask learners what else could be done in order to improve the accuracy of the results. Learners should be able to suggest that more tests are conducted and their results should be compared with others.

Lab lesson: Option 1 – run the experiment

Resources needed	• Worksheets C, D, E, F and G. • Worksheet E printed in colour or projected on a whiteboard • *Teacher notes*, *Teacher method, Teacher walkthrough* video • Equipment as listed in the *Teacher method* • A blank results table

Learning objectives	By the end of the lesson: • ***all*** learners should be able to record data from an investigation. • ***most*** learners should be able to interpret their findings in order to form a conclusion. • ***some*** learners should be able to evaluate their experiment to suggest the suitability of the method.

Timings	Activity
15 min	**Starter/introduction** Arrange learners into small groups (2–4) and give each group a tray with the equipment required to carry out a single nutrient test (alternatively give them each Worksheet F). The Benedict's test should be completed by abler learners, whereas the iodine and biuret tests could be completed by less able learners. Explain the purpose of the experiment: to test different food samples for the presence of 5 nutrients (carbohydrates in the form of starch and glucose, protein, fat, and vitamin C). Briefly explain that each group will prepare some food samples and add a testing reagent that will allow them to collect qualitative data. Give learners Worksheet C and ask them to plan their experiment. They need to consider the type of data they can record from this practical; telling them that the reagents test qualitatively should lead them to assume that they will record observations such as a change in appearance, smell or consistency. They are asked to consider the problems with this type of data collection; they should suggest that it's based on opinion so results will vary. They are challenged to identify the variables that will need to be controlled in order for valid data to be collected. They should be able to suggest: adding the same volume of reagent; leaving each sample with the reagent for the same amount of time; same mass or volume of food samples; same temperature of water for each sample in the Benedict's test. Suggestions of how to control the variables might include: use a graduated pipette or count the number of reagent drops; record the time using a stopwatch; use a balance or a ruler to measure the food samples; use a thermometer to record and monitor the temperature. Discuss that controlling these conditions allows for valid comparisons to be made and therefore accurate and meaningful conclusions gathered. Learners suggest how they could improve the reliability of their results. They should be able to suggest that they repeat the test or compare their results with others. Make it clear that learners will be swapping results so it is essential that they all follow the same standards so that valid comparisons can be made. Learners predict the outcome of their test for each food sample as positive or negative. They base this on prior knowledge. Learners can suggest that more than one food group would be found in a food item. Challenge those doing the Benedict's test to suggest foods with the highest and lowest concentration of reducing sugar. *Continues on next page …*

Timings	Activity
5 min 30 min	**Main lesson** Give learners Worksheet E. Ask them to use the descriptions on page 2 to label each reagent with the nutrient it is used to test for. Design a blank results table appropriate for the number of experiments set up in your classroom and give this to each learner; it should include space for them to write down their observations, as well as a column for stating if the result is positive or negative. (An example table is provided on Worksheet G; if used, learners can write the test the results are for in the title). You could challenge some learners to create their own; they will need space for their observations as they will use these to determine the result as positive or negative. Give learners the appropriate method for their experiment (Worksheet D). Instruct learners to begin their experiment. They should follow the method on Worksheet D and record their observations in the table provided, using Worksheet E for reference of a positive and negative result. Some tests will take longer than others. To make sure that the time is roughly the same, make sure that the water baths are set to 80°C before the lesson or that a kettle is boiled during the starter. Make sure that learners have clearly labelled their samples and that they are displayed clearly on the tables. If time and equipment allows, learners could repeat their experiment in order to improve the reliability of their results. **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. Once learners are finished with their observations, ask them to move to a different experiment. This could be done as a carousel. Learners can move in a clockwise direction from table to table recording the results from the experiment on that table. Learners should record what they *see* in as much detail as possible, as they will be using these written observations to identify a positive and negative result. Learners should then compare their results with their hypothesis. Was it correct? Challenge abler learners to consider what they would change about the method to investigate the concentration of the nutrients, rather than just present or not. Discuss the results as a class. Learners offer their results in a 'hands up' activity, and then the class discusses and agrees if the sample tested positive or negative.
10 min	**Plenary** Ask learners to discuss their results as a group. Were there any results that were difficult to identify as either positive or negative? Challenge learners to identify the problem with the data collected. For example, learners should be able to suggest that in some cases it was hard to identify whether the test was positive or negative as the colour change was not clear or conclusive; or the starting colour of the food sample made it difficult to detect the colour of the reagent; some people view colours differently. The discussion should also include that the collected data was qualitative and therefore based on opinion, which is a weakness because it means the results are not absolute or precise. The purpose of the experiment was to determine if each nutrient was in the food sample and if the results were valid; ask if their data collection method was accurate enough for the aim of the experiment and to obtain valid results.

Teacher notes

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

Food samples that work well include: cooked chicken thigh (this is fattier than breast), tomato sauce, cooking oil, whole milk, white bread, honey, orange juice, avocado and potato.

Each group will require:

- food samples
- distilled water
- test-tubes (2 for each food solid sample, 1 for each liquid food sample and 1 for the control; boiling tubes could be used for the Benedict's solution test as the glassware will be heated to 80°C)
- a test-tube rack / boiling-tube rack
- a sharp knife or scalpel
- a white tile
- graduated pipette (1 for each liquid food sample and 1 for distilled water)
- dropper pipette (1 for each solid food sample)
- glass rod (1 for each food sample or wash between uses)
- a glassware pen, or sticky labels
- a timer
- a pestle and mortar (optional for starch test as iodine can be added directly to solid samples)
- a ruler
- antibacterial spray (to clean surfaces following food spillage)
- folder paper (to transfer food crumbs from pestle and mortar to test-tube)

Groups doing the iodine solution test will also require:
- iodine solution

Groups doing the vitamin C test will also require:
- DCPIP

Groups doing the biuret test will also require:
- biuret solution

Groups doing the Benedict's test will also require:
- Benedict's solution
- a water-bath set at 80°C with test-tube/boiling-tube racks inside (or a kettle to boil water, and a beaker to create the water-bath to put the tubes into, and a thermometer to monitor the temperature)
- a test-tube holder

Groups doing the Emulsion test will also require:
- neat / pure ethanol

Safety

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

Some safety precautions include:

1 The use of food could cause an allergic reaction in some learners; allergies should be checked before the experiment to ensure that the samples are safe for use.
2 Eye protection must be worn when handling all reagents; be aware that Benedict's solution can spit during heating.
3 Ethanol is highly flammable, so Bunsen burners should not be used in the room.
4 Test-tubes should be removed from hot water-baths using test-tube holders.
5 Sharp knives / scalpels should be counted out and in; learners must be instructed on how to use and carry them safety.

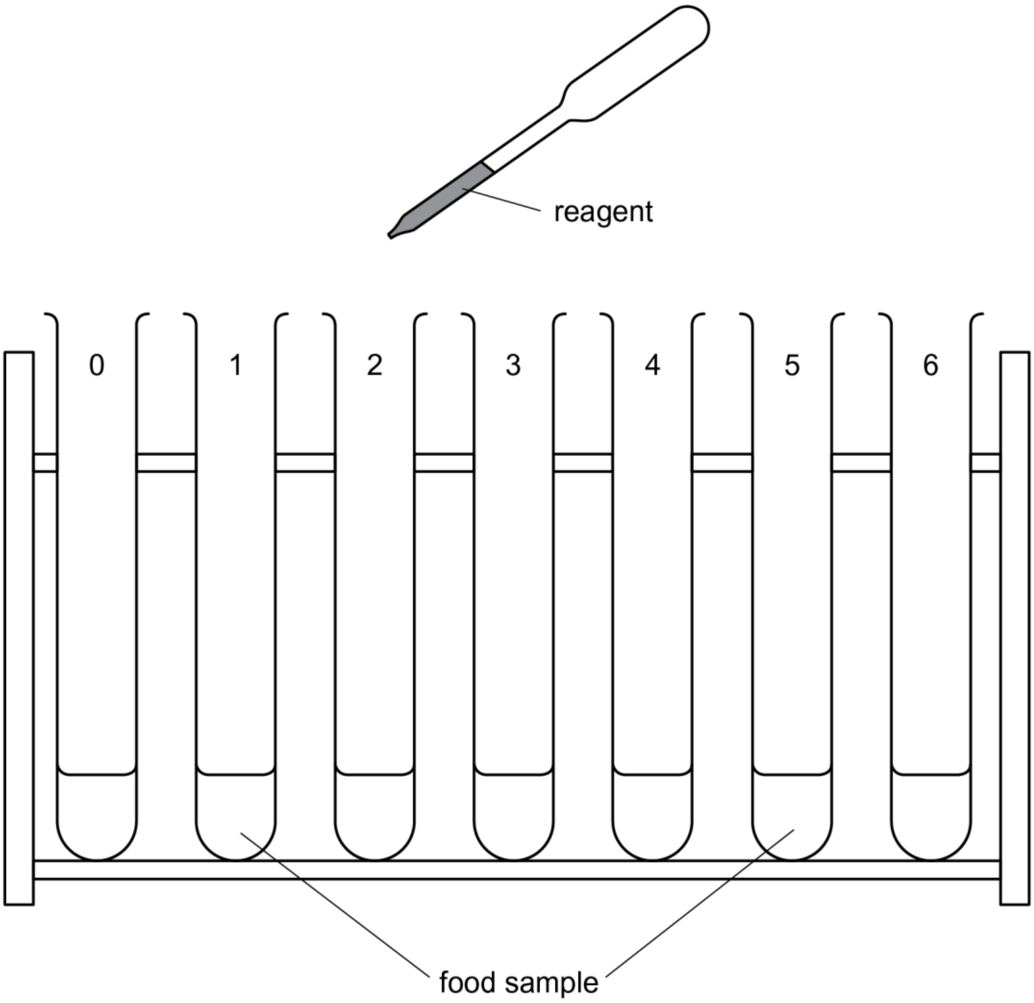
At the end of the experiment test-tube contents should be emptied into a sink and disposed of with plenty of running water.

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. 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. **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 amounts with a damp cloth and rinse it well. For larger amounts, cover with mineral absorbent (e.g. cat litter) and scoop into a bucket. Neutralise alkali with citric acid. Rinse with water. **Breathed in:** Ventilate the room, remove the casualty to fresh air; call a doctor if breathing is even slightly affected.
Biuret solution (dilute: less than 0.5 M)	LOW HAZARD	**In the eye:** flood the eye with gently running tap water for 10 minutes. 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 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 floor, bench, etc.:** For small amounts, use a damp cloth. Rinse well. For larger amounts, cover with mineral absorbent (e.g. cat litter) and scoop into a bucket.

Substance	Hazard	First aid
Ethanol (pure)	MODERATE HAZARD  **GHS02 (*flammable* F)**  **GHS08 (*health hazard* HH)**	**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. Note: the casualty may show signs of drunkenness. **Spilt on the skin or clothing:** remove contaminated clothing and rinse it. Wash the skin and clothing with plenty of water. If a large area is affected or blistering occurs, see a doctor. **Spilt on the floor, bench, etc.:** Extinguish all Bunsen-burner flames. Wipe up small amounts with a cloth and rinse it well. For larger amounts, open all windows, cover with mineral absorbent (e.g. cat litter), scoop into a bucket and add water. **Clothing catches on fire:** Push the casualty to the floor, roll the body or smother flames on clothing or the skin with a fire blanket or other material. Cool any burnt skin with gently running tap water for 10 minutes. **Other ethanol fires:** Allow fires in sinks, etc., to burn out. Fires at the top of test-tubes, beakers, etc., should be smothered with a damp cloth or heat-proof mat.
DCPIP	LOW HAZARD	**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. Rinse well. For larger amounts, cover with mineral absorbent (e.g. cat litter) and scoop into a bucket.
Food	Allergies	Do not consume any foodstuffs in the labs. If discomfort persists see a doctor.
Latex gloves	Allergic reaction	Remove the gloves and wash hands under water. Look out for severe allergic reactions such as difficulty breathing and/or swelling of the face, body or tongue. Seek emergency medical attention immediately.
Sharps (e.g. scalpels, knives, cork borers, mounted needles, broken glassware)	Risk of cuts or puncture wounds due to sharps. Wounds can lead to infection, especially if the blade or point is contaminated.	**Minor cuts:** Rinse the wound with water. Get the casualty to apply a small, sterile dressing. **Severe cuts**: Lower the casualty to the floor. Raise the wound as high as possible. If feasible, ask the casualty to apply pressure on or as close to the cut as possible, using fingers, a pad of cloth or, better, a sterile dressing (adding further layers as necessary). If the casualty is unable to do so, apply pressure yourself, protecting your skin and clothes from contamination by blood if possible. Leave any embedded large bodies and press around them. Send for a first aider.
Hot (80°C) water-bath	Burns	Flood burnt area with water for at least 10 minutes. For serious injuries see a doctor.

Experiment set-up



Teacher method

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

Do not share this method with learners. Give learners the appropriate pages of Worksheet D.

Before you begin

This is a very large experiment that requires a lot of equipment and organisation. Consider how you will run the lesson given your class size, the ability of the learners and the availability of equipment. It is recommended that you run this lesson with each table or small group of learners doing an individual test. Learners then move between tables to observe and record the results on other tables. Have the equipment laid out for each experiment in separate trays so that it is easy to sort. It is recommended that you provide learners with at least 5 food samples to test.

Think about:

- if you will get all learners to perform each test, or if you will split the class into groups who each carry out just one test and learners circulate the room to see other groups' results
- size of groups; groups of 2–4 would work well
- if you have enough test-tubes; you might need to wash them between tests using tap water
- what foods you will supply; consider any food allergies of your learners
- what sort of blank results table you need to supply your learners with (this will depend on how the tests are split across the class and the number of food samples used); you could challenge learners to create their own
- how the equipment will be laid out; as this is a large practical with multiple elements it might be more efficient to organise the equipment according to the test so that learners can just collect the relevant equipment
- how you will differentiate the tasks; abler learners could do the Benedict's test or emulsion test whilst less able learners could do the biuret, iodine or DCPIP tests.
- the DCPIP test for vitamin C requires the DCPIP to be refrigerated and then removed for the experiment; if not in use this should be returned to the refrigerator; you could create an ice-water bath in the classroom to store the DCPIP whilst being used by the class to make sure that it remains useable
- if you will let learners use sharp knives or if you will have the food pre-cut
- how you will collate the class results; options are discussed in the *Debriefing lesson* plan
- if you have access to electronic water-baths or will be using beakers with boiled water; Bunsen burners should **not** be used to warm the solution for the Benedict's test as ethanol is in the room for the emulsion test.

Experiment

Circulate during the experiment in case learners encounter any difficulties.

Step	Notes
1. For the Benedict's test, make sure all water-baths are set to 80°C ahead of the start of the session, or that water is pre-boiled in kettles, ready for use.	
2. Learners should collect their equipment.	*Equipment could be arranged according to the tests so learners just collect what they need in order to minimise confusion. Or, to reduce the risk of spillage or accidents, the equipment can already be laid out on the work benches.*
3. Learners label their test-tubes according to the key on their method sheet. The labels should be at the top of the test-tube so they are easily visible, and in the case of the Benedict's test, do not get washed off by water.	
4. Each group will need to prepare liquid food extracts for any solid foods. They do this by cutting a 1 cm by 1 cm piece of food, breaking it into smaller pieces using a pestle and mortar, transferring the pieces to a test-tube, then adding 1 cm^3 of distilled water and finally mixing until the solid looks roughly evenly distributed in the water. They then use a dropper pipette to collect the liquid (leaving behind the solid) and add the liquid to the labelled test-tube for testing later. Note that for the iodine test, the iodine solution can be added directly to solid food samples without the need to create liquid food extracts; starch is only slightly soluble in water so making the liquid extract has little benefit.	*If you want to use a different volume of food sample, then when the liquid food extract is prepared make sure learners add a volume of water equal to the volume of solid.* *Ask learners why a liquid food extract is needed. The cells are broken open to release the nutrients into solution; they dissolve in the water, where they can be accessed more easily by the reagents.* *Explain that for the emulsion test, ethanol is used instead of water to create the liquid food extracts because fats are insoluble in water but soluble in alcohol.*
5. Learners should then add 1 cm^3 of liquid food samples to the appropriate test-tubes. 6. Once food samples are prepared, learners should add the reagents. They do so using a graduated pipette. (See Worksheet D for more detailed instructions for each test.)	*Learners are not investigating the concentration of each nutrient, so the general guidelines are that only approximately the same volume of food sample is required each time; and, learners should add approximately the same volume of reagent as there is food sample. Use this rule if you wish to change the volume of food sample used.* *You might want to explain to learners that the emulsion test works because fats are soluble in ethanol but not in water, so when the water is added, the fats dissolved in the ethanol form a white precipitate in the water, that makes it look cloudy.* *You might want to create an ice-water bath to keep the DCPIP cold when not in use.*

Step	Notes
7. Learners carrying out the Benedict's test will need access to a water-bath. They incubate the test-tubes in the racks within the water-bath; or directly in the beaker, for 2 minutes.	*Make sure learners use test-tube holders to remove the test-tubes from the water-bath, holding them just under the rim. The racks in the water-bath should be left there; the test-tubes should be transferred to a new rack.*
8. Learners record their results in their table.	*See detailed notes below*.*
9. When instructed by you, they should move to a different table to observe any colour changes in the test-tubes on that table.	

** Things to note about the results:*

Note that the strength of the colour changes will depend on the volume of reagent used and / or its concentration, so you might need to explain this to learners in case they do not see colours as strongly as they expect. For instance, the negative blue colour of the biuret solution can fade over time; make it clear to learners that they should watch the samples closely to see if there are any immediate colour changes as soon as the reagent is added. If the reagent stays blue but the blue colour fades and the solution hasn't turned purple, then the result is negative.

Similarly, with the other reagents, the 'negative' colour might be barely visible, but they should conclude that as the 'positive' colour change has not occurred, the result can be assumed to be negative. If you do not get decisive results, more of each reagent can be added. You might want to test your chosen food samples ahead of the lesson to adjust the volumes of reagents / sample required to get the expected results.

Note that the DCPIP might not go colourless if the concentration of vitamin C in the sample is not sufficiently high; if using orange juice, more expensive brands tend to contain a higher concentration of vitamin C. Once DCPIP is added, the colour may fade to a light pink. This could be considered a positive result if you agree that vitamin C would be present in that food; the pink colour is an indication that the content of vitamin C isn't high enough to turn the solution colourless.

For the emulsion test, the milky white emulsion might not form a distinct layer; it might only be possible to see that the solution has gone cloudy. For solid food samples, if the liquid food extract was not separated from the solid food, or there are still some pieces of solid food present, it could look like the solution is cloudy. In these circumstances, look closely at the layer at the meniscus. If it looks as though solid particles are falling then any the cloudiness is likely to be due to the solid separating out from the liquid, rather than a positive emulsion result.

Clean-up

At the end of the practical, learners should:

- clean all glassware
- tidy up their work space
- ensure any spillages have been mopped up (if reagents are spilt, learners must inform you immediately and you must clean it up)
- return all equipment and any unused chemicals to you
- put any food waste into the bin
- leave the Benedict's water-bath equipment to cool as this will still be hot.

Lab lesson: Option 2 – virtual experiment

Resources needed	• *Virtual experiment* video • Worksheet E, printed in colour or displayed on a whiteboard • Worksheets C, F and G.

Learning objectives	By the end of the lesson: • ***all*** learners should be able to record data from an investigation. • ***most*** learners should be able to interpret their findings in order to form a conclusion. • ***some*** learners should be able to evaluate their experiment to suggest the suitability of the method.

Timings	Activity
15 min	**Starter/introduction** Arrange learners into small groups (2–4) and give each group Worksheet F, which shows the equipment required to carry out each nutrient test. Allocate each group a different test. The Benedict's test should be given to abler learners, whereas the iodine and biuret tests could be given to less able learners. Explain the purpose of the experiment: to test different food samples for the presence of 5 nutrients (carbohydrates in the form of starch and glucose; protein; fat; and vitamin C) by adding a testing reagent to the food samples. The testing reagent will lead to qualitative data. Now give learners Worksheet C and ask them to plan their experiment. They need to consider the type of data they can record from this practical; telling them that the reagents test qualitatively should lead them to assume that they will record observations such as a change in appearance, smell or consistency. They are asked to consider the problems with this type of data collection; they should suggest that it's based on opinion so results will vary. They are challenged to identify the variables that will need to be controlled in order for valid data to be collected. They should be able to suggest: adding the same volume of reagent; leaving each sample with the reagent for the same amount of time; same mass or volume of food samples; same temperature of water for each sample in the Benedict's test. Suggestions of how to control the variables might include: use a graduated pipette or count the number of reagent drops; record the time using a stopwatch; use a balance or a ruler to measure the food samples; use a thermometer to record and monitor the temperature. Discuss that controlling these conditions allows for valid comparisons to be made and therefore accurate and meaningful conclusions gathered. Learners suggest how they could improve the reliability of their results. They should be able to suggest that they repeat the test or compare their results with others. Learners predict the outcome of their test for each food sample as positive or negative. They base this on prior knowledge. Learners can suggest that more than one food group would be found in a food item. Challenge those doing the Benedict's test to suggest foods with the highest and lowest concentration of reducing sugar. *Continues on next page …*

Timings	Activity
5 min 30 min	**Main lesson** Give learners Worksheet E. Ask them to use the descriptions on page 2 to label each reagent with the nutrient it is used to test for. Explain that they will watch a video that shows each of the nutrient tests being carried out and you want them to record the results. Give them Worksheet G to record their observations and results, or challenge more able learners to create their own results table. They will need a column for their observations as they will use these to determine if the result is positive or negative. Play the video; it will automatically pause after they have seen how to prepare each food sample ready for testing. At this point, tell learners that they will see each test in turn and be asked to record their observations before moving on to the next test. As the video plays, you can click on the 'Pause for discussion' and 'Video question' buttons to reveal questions for the learners to answer. These can be answered using a class discussion, or set as a task for pairs or small groups (2–4) to discuss and agree on an answer before discussing as a whole class. Each test is carried out and then the results are immediately shown so that learners can make their observations. There is no audio for the results (see the master version for audio or read the transcript); the visual moves to each sample in turn so that learners can write down what they observe. The tests are done in the following order: iodine test for starch (3:33); biuret test for protein (5:30); DCPIP test for vitamin C (8:05); Benedict's test for reducing sugars (9:55); and emulsion tests for fats (12:27). For each test, you can pause the video before the results are shown by pressing on the 'Pause for discussion' button to discuss their hypothesis for each food sample, and/or by pressing on 'Data collection' button, which will explain that the learners will see the results in the next shot and will need to make observations. Ask learners to write down in detail what they observe in each sample and to determine if the result is positive or negative using Worksheet E as a reference. If they find it difficult to determine the result, they should write this down as this will form part of their evaluation later. Reassure learners that it doesn't matter if they are unsure or if they miss some samples, everything will be discussed later. Make sure that they are clear that they will be discussing how easy / difficult it was to reach their results from their observations in the plenary, so it's important for their observations to be as detailed as possible. Make sure that learners are describing what they *see*. Note that for some of the more difficult samples, there will be visual cues for support, including arrows pointing at layers, or visuals of other samples/colours for comparison. For support, you could pause the video on each sample to allow time for pair / group / class discussion about what the observations and results are (see the master video transcript for the discussions of the results to help you). It is likely that learners will need more time to discuss how to describe their observations for the emulsion test, as a few of the samples are already white to begin with. The end of the video summarises that the food we eat contains lots of different nutrients. Learners should compare their results with their hypotheses. Were they correct? When learners are finished with their observations, ask them to swap results with a partner. Were their observations and conclusions the same? If not, why not? *Continues on next page …*

Timings	Activity
	Main lesson continued … Discuss the results as a class. Review as a 'hands up' activity, if a sample was positive or negative for a given nutrient. Discuss any differences in opinion and why they might have occurred given that they were all looking at the same samples.
10 min	**Plenary** Ask learners to discuss their results as a group (2–4). Were there any results that were difficult to identify as either positive or negative? Challenge learners to identify the problem with the data collected. For example, learners should be able to suggest that in some cases it was hard to identify if the result was positive or negative as the colour change was not clear or conclusive; or the starting colour of the food sample made it difficult to detect the colour of the reagent; some people view colours differently. The discussion should also include that the collected data was qualitative and therefore based on opinion, which is a weakness because it means the results are not absolute or precise. The purpose of the experiment was to determine if each nutrient was in the food sample and if the results were valid; ask if their data collection method was accurate enough for the aim of the experiment and to obtain valid results.

Debriefing lesson: Reviewing the experiment

Resources	• Learners' results • Worksheets D, E and H.

Learning objectives	By the end of the lesson: • ***all*** learners should be able to describe what is meant by interpretation and evaluation. • ***most*** learners should be able to interpret data from the investigation in order to form a conclusion. • ***some*** learners will be able to evaluate data to suggest how the validity of the data collected could be improved.

Timings	Activity
	**Starter/introduction** Ask learners what is meant by the terms 'interpret' and 'evaluate' and to give examples of what these words mean using their data and results. Learners should be able to suggest that 'interpret' means reviewing the results and explaining them. This would be a summary of the food groups contained in the food samples tested and why this food contains that group. For example, in the biuret test, the milk was slightly purple and therefore tested positive for protein. Milk is a source of protein as it is an animal product. Learners should be able to suggest that 'evaluate' means to review what went well and not so well, and how the method of data collection could be improved so that the results are more reliable and / or valid. The purpose of their experiment was to determine if the nutrients were present or not in the food sample, so evaluating their data would mean asking if their data was accurate enough for those conclusions to be found with confidence; was their data valid? How could they improve the method to ensure that the results were more definite, and thus improve the validity of their results? Learners should be able to suggest that they could review how the experiment went, what they did well in terms of following the method and how this could be improved. Explain that they will interpret and evaluate their data in this lesson.
	**Main lesson** Give learners Worksheet H and ask them to use this to help them interpret and evaluate their data. This starts off by reviewing some of the questions asked during the practical session, to get them to think about the reasons why certain steps were taken. This will help them to evaluate the method. You can give them the appropriate version of Worksheet D, and Worksheet E to help them think of each step in the method and their results. Whilst learners are completing Worksheet H ask them periodically to have a class discussion about their answers (see next page); this should become a discussion on the interpretation and evaluation of the data. Learners can self-assess by marking their answers as the discussion proceeds and making comments or adjustment where necessary. *Continues on next page …*

Timings	Activity
	Main lesson continued … Start by asking learners to summarise their results; where any of their results difficult to categorise as either positive or negative? Why? They should be able to suggest that some observations were not clear. For example, milk turned slightly purple in the biuret test. It was not clear if there was a definite purple colour and so learners may have classified this differently from one another. Ask learners how they came to make decisions as to whether they classified the results as either positive or negative. They should be able to suggest that they used their prior knowledge to guide their interpretation of the results. For instance, learners will know that proteins are found in animal products and that milk is an animal product and so is likely to contain protein. This should lead into a discussion on the problems of collecting qualitative data, i.e. different learners had different opinions on what was positive or negative. It comes down to different individuals' interpretation of their results. Some learners may have looked at a given sample and determined it to be an obviously negative result whilst another individual might decide that there is a slight colour change and determine it to be a positive result. Support learners in forming a conclusive summary table by producing a table for the whole class to see (on a whiteboard for example). Discuss each result in turn as a class by collating each group's results and using discussion of the observations and prior knowledge to determine a result that the whole class agrees on. Learners might need to refer back to Worksheet E in order to compare their observations and their results. Discuss with learners what a 'limitation' in an experiment might be. Ask learners to share their ideas as to what this means. Learners should be able to describe a limitation as a factor that limits the wider application of the results. It might be that there was a problem in the methodology or in the accuracy of the controls. Ask learners to review the methods and suggest any problems. For example, the number of drops of solution may not have been added equally; perhaps the solid food wasn't left in the water for long enough or stirred properly and the liquid food extract did not contain all the dissolved nutrients it should have; the samples were only tested once rather than a number of times to eliminate any anomalies. Although in the *Lab lesson Option 1* they collated their data, each test was carried out by different individuals who could have introduced different errors. Discuss the views as a class and ask learners how they could improve the experiment. Learners should be able to suggest the same individuals repeating the test multiple times in order to get conclusive results. Repeating the test would eliminate any anomalies or rule out human error in the experiments, however this would also take a long time. Learners should also be able to suggest that exact volumes of reagents are added rather than drops as different drops may contain different volumes of solutions. Perhaps in cases where the qualitative test was unclear, they should have added more reagent, or perhaps a larger sample of the food was required if the nutrient is present but in low concentrations. *Continues on next page …*

Timings	Activity
	Main lesson continued … Some learners might suggest that quantitative data could have been collected and this could have allowed more accurate results to be obtained; it would tell them more information about the relative concentrations of the different nutrients in the different foods. Discuss whether this degree of accuracy is needed for the aim of their investigation; they might suggest that they don't need to know the relative concentrations for the aim but if the tests are more accurate and more sensitive they might make it easier to determine a true positive or negative result but they would likely be more complicated and take more time to do.
15 min	**Plenary** Ask learners what makes an effective conclusion. Learners should be able to suggest that it summarises their interpretation of the results from their collected data and often suggests the wider implications of their results. Learners should also be able to suggest that data should be used to support their conclusions. Ask learners to review the conclusion they wrote on Worksheet H, does this confirm what they've all agreed makes an effective conclusion? Review the conclusions as a whole group. Ask a selection of learners to share their ideas as a class. Promote evaluation of each-other's conclusion by asking learners if they agree or disagree and why. Make sure that learners are referring to their observations in their conclusions in order to back up their suggestions. Have a discussion on what makes a balanced diet. Prompt learners by asking what nutrients are contained in the different foods that they tested and their recommendations of what people should eat in order to have a balanced diet. Learners should be able to suggest that a balanced diet might vary for different individuals depending upon a number of variables such as level of physical activity, age, gender, height, geographical location or health. For example, people with very high levels of physical activity should consume more carbohydrate-rich foods than those who are sedentary. Very young children and very old adults might need to eat more protein to help with muscular growth. Individuals living in colder climates might need more fatty foods. Ask learners to review their conclusion of the experiment and to amend as / if necessary following the class discussions.

Worksheets and suggested answers

	Worksheets	Suggested answers
For use in the *Briefing lesson:*		
A: Identifying data	**25**	**44**
B: Interpreting results	**26**	**45**
For use in *Lab lesson: Option 1:*		
C: Planning the food test	**27**	**46**
D: Method	**28–33**	**—**
E: Qualitative tests for nutrients	**34–35**	**47**
F: Equipment for food tests	**36**	**—**
G: Results table for …	**37**	**—**
For use in *Lab lesson: Option 2:*		
E: Qualitative tests for nutrients	**34–35**	**47**
F: Equipment for food tests	**36**	**—**
G: Results table for …	**37**	**—**
For use in the *Debriefing lesson:*		
H: Interpreting and evaluating	**38–43**	**48**

Worksheet A: Identifying data

Complete the table for each investigation.

Investigation	What data could be collected?	What equipment is needed?	Variables
A student wants to investigate the effectiveness of different catalysts in breaking down hydrogen peroxide into water and hydrogen. The catalysts include: - liver - celery - potato - manganese dioxide			Independent: Dependent: Control:
A student wants to investigate the energy transferred when heating water by burning different foods. The foods to be burned include: - cookies - crisps - cereal - pasta			Independent: Dependent: Control:
A student wants to investigate what different drinks are composed of in order to categorise them. The drinks to be tested are: - orange juice - lemon - coffee - tea - soda			Independent: Dependent: Control:

Worksheet B: Interpreting results

The data below was collected by a student investigating the energy transferred when heating water by burning different foods.

1. Calculate the mean temperature rise of the water for each food.

Food item	Temperature rise of water / °C			Mean (3 sf)
	Test 1	Test 2	Test 3	
Cookie	65	47	64	
Plain biscuit	41	38	44	
Pasta	28	19	22	
Whole grain cereal	40	41	37	
Sugar cereal	55	62	30	
Full fat crisps	86	82	77	
Reduced fat crisps	59	54	48	

2. What two things should be done with the above data in order to calculate an ***accurate*** mean?

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Worksheet C: Planning the food test

The data I could collect is:

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The disadvantage of using this type of data is:

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The variables I need to control in order to collect valid data are:

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……………………………………………………………………………………

I plan to control these variables by:

……………………………………………………………………………………

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……………………………………………………………………………………

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To increase accuracy, I will also:

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……………………………………………………………………………………

……………………………………………………………………………………

The food that I will be testing and my hypothesis for which nutrient(s) each will contain:

Worksheet D: Method – test-tube set-up for all methods

Write down your food samples next to the numbers in the box below. Then label your test-tubes with a number to identify what food sample is in each test-tube. You will not use all the numbers if you are testing less than 6 food samples.

Test-tube labels:

0 = control

1 = ...

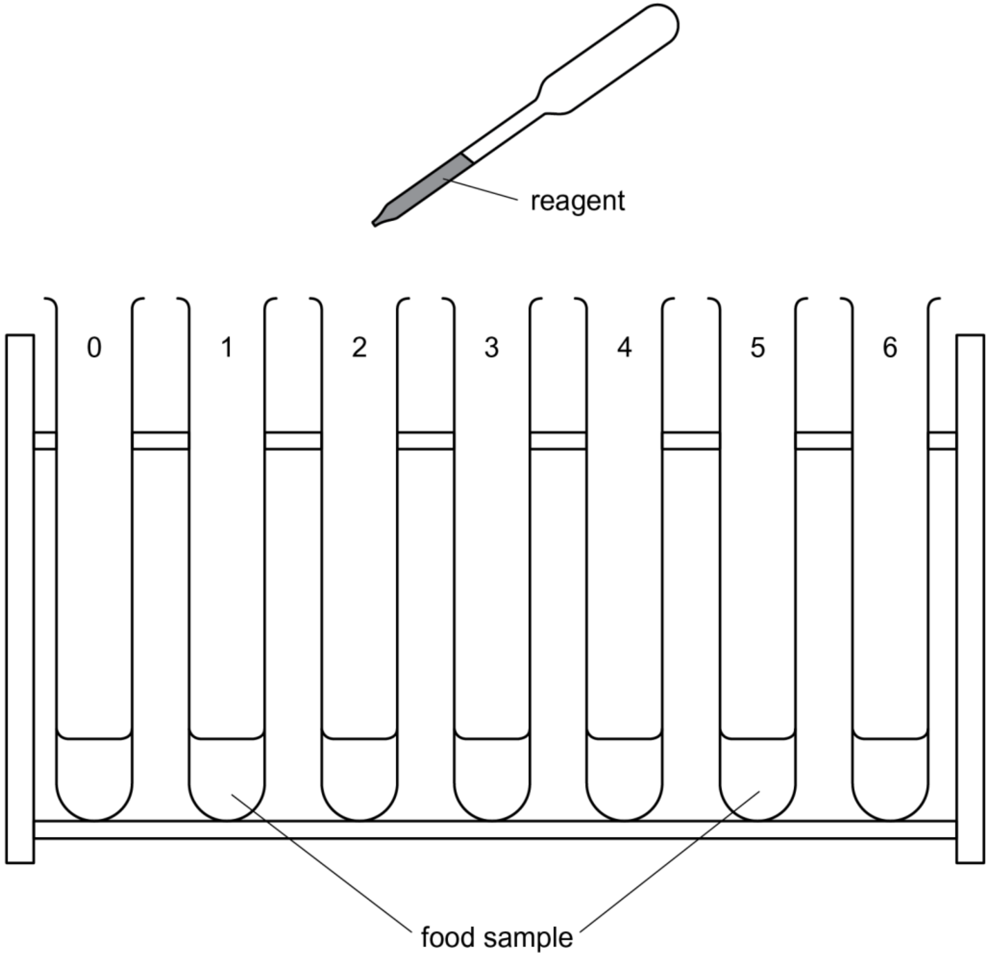
2 = ...

3 = ...

4 = ...

5 = ...

6 = ...



Worksheet D: Method – Benedict's test for sugars

Follow the instructions below.

1. Collect your equipment and label the tubes according to your completed Worksheet F, using adhesive labels.

> *Where should you position your adhesive labels and why is this important?*

2. Set up a water-bath at 80°C. Monitor the temperature throughout the experiment.

> *Why should the temperature be monitored throughout?*

3. Use a graduated pipette to add $1cm^3$ of distilled water to tube '0'. This is the control.

> *Why is it important to have a control sample?*

4. Separate the food into solid or liquid samples.
5. Put a solid food item onto a white tile.
6. Use a scalpel or knife to cut the food into 1 piece that is about 1 cm by 1 cm in size.
7. Use a pestle and mortar to grind this piece into small crumbs.
8. Place the crumbs into an **unlabelled** tube; you can use a piece of folded paper to help. Pour the crumbs onto the folded paper and collect them in the fold; then use the folded paper to funnel the crumbs into the tube.
9. Use a graduated pipette to add $1cm^3$ of distilled water to the crumbs and stir using a clean glass rod until the crumbs look roughly evenly distributed in the water.
10. Use a dropper pipette to extract the liquid and leave the solid behind.
11. Place the liquid into the correctly **labelled** tube; you have created a liquid food extract.

> *Why is a liquid food extract made? Hint: reducing sugars are soluble in water*

12. Follow **steps 5** to **11** for all solid food samples.
13. Use a graduated pipette to add $1cm^3$ of the liquid food samples to the correctly labelled tubes.
14. Use a graduated pipette to add $1cm^3$ of Benedict's reagent to each sample. Stir the samples using a clean glass rod for each sample.

> *Why is it important to add the same volume of reagent to each sample? Why do you need to stir the samples? Why is it important to use a clean glass rod?*

15. Put the samples into the water-bath and leave for 2 minutes.

> *Why do you think the samples should be left in the water-bath for 2 minutes?*
>
> ***Take care** when viewing the samples as they could spit.*

16. Remove the samples from the water-bath using test-tube holders and put them into a rack.

> *Do **not** touch the hot tubes with your hands.*

17. Record your observations. Compare your sample with the control, what changes can you see? What has happened? What does this suggest?

Worksheet D: Method – biuret test for protein

Follow the instructions below.

1. Collect your equipment and label the test-tubes according to your completed Worksheet F, using adhesive labels.

Where should you position your adhesive labels and why is this important?

2. Use a graduated pipette to add 1 cm^3 of distilled water to test-tube ‘0’. This is the control.

Why is it important to have a control sample?

3. Separate the food into solid or liquid samples.
4. Put a solid food item onto a white tile.
5. Use a scalpel or knife to cut the food into 1 piece that is about 1 cm by 1 cm in size.
6. Use a pestle and mortar to grind this piece into small crumbs.
7. Place the crumbs into an **unlabelled** tube; you can use a piece of folded paper to help. Pour the crumbs onto the folded paper and collect them in the fold; then use the folded paper to funnel the crumbs into the tube.
8. Use a graduated pipette to add 1cm^3 of distilled water to the crumbs and stir using a clean glass rod until the crumbs look roughly evenly distributed in the water.
9. Use a dropper pipette to extract the liquid and leave the solid behind.
10. Place the liquid into the correctly **labelled** tube; you have created a liquid food extract.

Why do you think a liquid food extract is made from the solid food samples?
Hint: protein is soluble in water

11. Follow **steps 4** to **10** for all solid food samples.
12. Use a graduated pipette to add 1cm^3 of the liquid food samples to the correctly labelled tubes.
13. Use a graduated pipette to add 1 cm^3 of biuret reagent to each sample. Stir the samples using a clean glass rod for each sample.

Why is it important to add the same volume of reagent to each sample?
Why do you need to stir the samples?
Why is it important to use a clean glass rod to stir each sample?

14. Leave the samples for 2 minutes.

Why do you think the samples should be left for 2 minutes?

15. Record your observations. Compare your sample with the control, what changes can you see? What has happened? What does this suggest?

Worksheet D: Method – iodine test for starch

Follow the instructions below.

1. Collect your equipment and label the test-tubes according to your completed Worksheet F, using adhesive labels.

Where should you position your adhesive labels and why is this important?

2. Use a graduated pipette to add 1cm^3 of distilled water to tube ‘0’. This is the control.

Why is it important to have a control?

3. Separate the food into solid or liquid samples.
4. Put a solid food item onto a white tile.
5. Use a scalpel or knife to cut the food into 1 piece that is about 1 cm by 1 cm in size.
6. Place the solid food piece into the correctly **labelled** test-tube.

*A liquid food extract is made from solid foods when testing for other nutrients but it is not needed when testing for starch because starch is not very soluble in water. Why might a liquid food extract be needed when testing for **other** nutrients?*

7. Repeat **steps 4** to **6** for all solid food samples.
8. Use a graduated pipette to add 1 cm^3 of the liquid food samples to the correct test-tubes.
9. Use a graduated pipette to add 1 cm^3 of iodine to each sample.
10. Stir the liquid samples gently using a clean glass rod for each sample.

Why is it important to add the same volume of reagent to each sample?
Why do you need to stir the samples?
Why is it important to use a clean glass rod to stir each sample?

11. Leave the samples for 2 minutes.

Why do you need to leave the samples for 2 minutes?

12. Record your observations. Compare your sample with the control, what changes can you see? What has happened? What does this suggest?

Worksheet D: Method – emulsion test for fats

Follow the instructions below.

1. Collect your equipment and label the test-tubes according to your completed Worksheet F, using adhesive labels.

Where should you position your adhesive labels and why is this important?

2. Use a graduated pipette to add $1cm^3$ of ethanol to tube '0'. This is the control.

Why is it important to have a control sample?

3. Separate the food into solid or liquid samples.
4. Put a solid food item onto a white tile.
5. Use a scalpel or knife to cut the food into 1 piece that is about 1 cm by 1 cm in size.
6. Use a pestle and mortar to grind this piece into small crumbs.
7. Place the crumbs into an **unlabelled** tube; you can use a piece of folded paper to help. Pour the crumbs onto the folded paper and collect them in the fold; then use the folded paper to funnel the crumbs into the tube.
8. Use a graduated pipette to add $1cm^3$ of ethanol to the crumbs and stir using a clean glass rod until the crumbs look roughly evenly distributed.
9. Use a dropper pipette to extract the liquid and leave the solid behind.
10. Place the liquid into the correctly **labelled** tube; you have created a liquid food extract.

Why do you think a liquid food extract is made from the solid food samples?
For other nutrients, distilled water is used to make the food extract.
Why might ethanol have been used for fat? Hint: other nutrients are soluble in water.

11. Follow **steps 4** to **10** for all solid food samples.
12. Use a graduated pipette to add $1\,cm^3$ of the liquid food samples to the correct test-tubes.
13. Use a graduated pipette to add $1\,cm^3$ of ethanol to each liquid food sample.
14. Stir all the samples using a clean glass rod for each sample.

Why is it important to add the same volume of reagent to each sample?
Why do you need to stir the samples?
Why is it important to use a clean glass rod to stir each sample?

15. Leave the samples for 2 minutes.

Why do you need to leave the samples for 2 minutes?

16. Use a graduated pipette to add $1\,cm^3$ of distilled water to each sample.
17. Record your observations. Compare your sample with the control, what changes can you see? What has happened? What does this suggest?

Worksheet D: Method – DCPIP test for vitamin C

Follow the instructions below.

1. Collect your equipment and label the test-tubes according to your completed Worksheet F, using adhesive labels.

Where should you position your adhesive labels and why is this important?

2. Use a graduated pipette to add 1 cm^3 of distilled water to test-tube ‘0’. This is the control.

Why is it important to have a control sample?

3. Separate the food into solid or liquid samples.
4. Put a solid food item onto a white tile.
5. Use a scalpel or knife to cut the food into 1 piece that is about 1 cm by 1 cm in size.
6. Use a pestle and mortar to grind this piece into small crumbs.
7. Place the crumbs into an **unlabelled** tube; you can use a piece of folded paper to help. Pour the crumbs onto the folded paper and collect them in the fold; then use the folded paper to funnel the crumbs into the tube.
8. Use a graduated pipette to add 1cm^3 of distilled water to the crumbs and stir using a clean glass rod until the crumbs look roughly evenly distributed.
9. Use a dropper pipette to extract the liquid and leave the solid behind.
10. Place the liquid into the correctly **labelled** tube; you have created a liquid food extract.

Why do you think a liquid food extract is made from the solid food samples?
Hint: vitamin C is soluble in water

11. Follow **steps 4** to **10** for all solid food samples.
12. Use a graduated pipette to add 1cm^3 of the liquid food samples to the correctly labelled tubes.
13. Add 5 drops of DCPIP to each sample. Stir the samples using a clean glass rod for each sample.

Why is it important to add the same volume of reagent to each sample?
Why do you need to stir the samples?
Why is it important to use a clean glass rod to stir each sample?

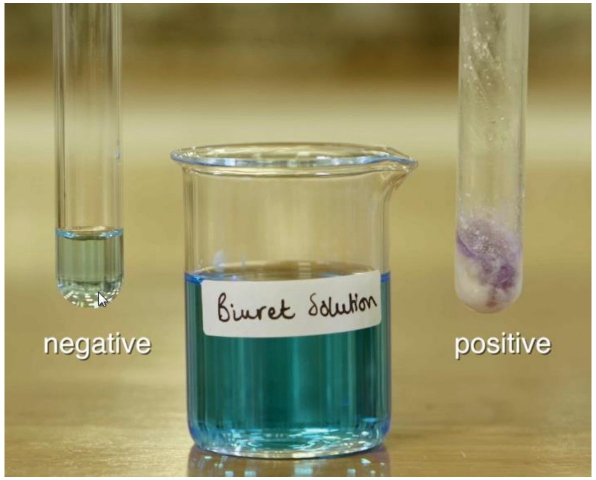
14. Leave the samples for 2 minutes.

Why do you think the samples should be left for 2 minutes?

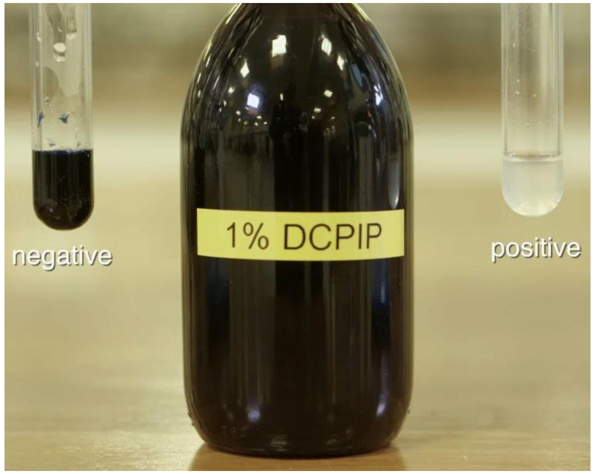
15. Record your observations. Compare your sample with the control, what changes can you see? What has happened? What does this suggest?

Worksheet E: Qualitative tests for nutrients

Iodine solution tests for: …………………….

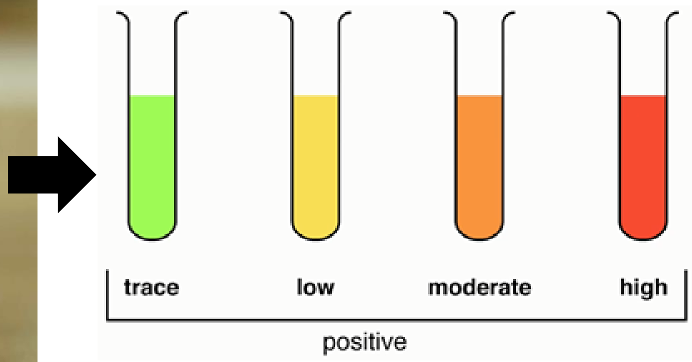


Biuret solution tests for: …………………….



DCPIP solution tests for: ……………………

Ethanol emulsion test, tests for: ………………



Benedict's solution tests for: …………………….

Observations following reaction with testing reagents

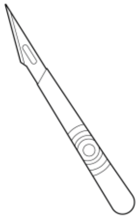
Nutrient	Observation following addition of testing reagent	
	Positive result	**Negative result**
Fat	The formation of a milky-white solution, often in a layer.	A milky-white solution does not form.
Glucose (and other reducing sugars)	The reagent changes colour from blue to a range of different colours, depending on the concentration of the nutrient.	The reagent remains a blue colour.
Protein	The reagent changes colour from blue to purple.	The reagent remains a blue colour.
Starch	The reagent changes colour from orange-brown to blue-black.	The reagent remains an orange-brown colour.
Vitamin C	The reagent decolourises, going from a very dark blue colour to colourless.	The reagent remains a very dark blue colour.

Worksheet F: Equipment for food tests

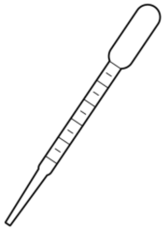
For all tests:

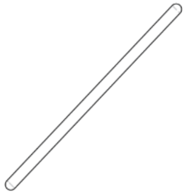

dropper pipette

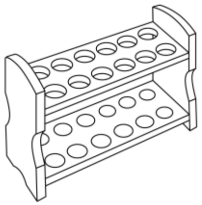

distilled water

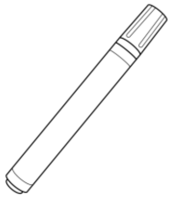

scalpel or knife

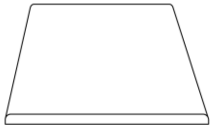
timer

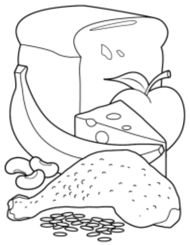

graduated pipette


glass rod

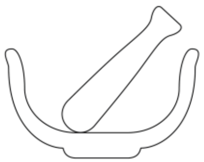

rack


glassware pen


white tile


food samples

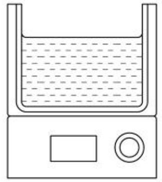

boiling tubes & test-tubes

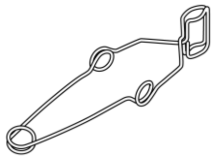

pestle & mortar

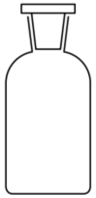

ruler

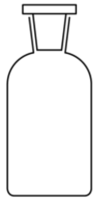

antibacterial spray

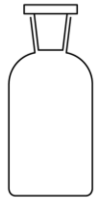
Each box below contains the additional equipment needed for each of five nutrient tests:

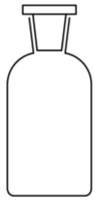

water bath

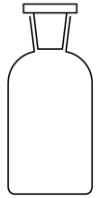

test-tube holders


Benedict's solution


iodine solution


biuret solution


DCPIP


ethanol

Worksheet G: Results table for ……………………………..

Sample	Observation	Result
Control (O)		

Worksheet H: Interpreting and evaluating

Interpreting your results

1. Look at your hypothesis. Was it correct? Use data from your results to support your answer.

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2. Were there any surprises in your results? Refer to your observations in your answer.

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3. Were there any samples where it was not clear if the result of the test was positive or negative? Refer to your observations and describe the tests and foods that had unclear results. How did you decide if the result was positive or negative?

4. Summarise your results into the table below.

Food sample	Nutrients that sample tested positive for

5. What can you conclude from your results? Use data to support your answer.

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Evaluating the data collection

1. Why is the position of the test-tube labels important?

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2. Why is it OK to only use roughly the same volume of food sample each time?

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3. Why is it important to clean the pestle and mortar and glass rod between uses?

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4. Why is it important to add the same number of drops of reagent to each sample?

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5. Why do samples need to be mixed / stirred after the reagents have been added?

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6. Why does Benedict's solution need to be heated? Why must each sample be incubated at the same temperature?

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7. Why do you need to leave each sample with the reagent for two minutes?

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8. What is a control sample and why is it important to have one in the investigation? Explain your answer.

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9. Using your answers to the above question, can you identify any limitations to the data you have collected? How might the limitations in the data collection have affected your results?

HINT: Look at the method and write down any issues that you can identify that would make the results less meaningful.

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10. How could the method be improved to reduce the limitations? Suggest any adaptations that would make the data more valid. Explain your suggestions.

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11. Use examples from your results to suggest what is meant by the term 'balanced diet'. Is it the same for everyone? Give examples of when it might be different.

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Worksheet A: Suggested answers

Investigation	What data could be collected?	What equipment is needed?	Variables
A student wants to investigate the effectiveness of different catalysts in breaking down hydrogen peroxide into water and hydrogen. The catalysts include: - liver - celery - potato - manganese dioxide	Volume of gas produced Appearance of reaction Volume of water produced Temperature of the reaction	Delivery tube and gas syringe Thermometer Conical flask Measuring cylinder	Independent: types of catalysts Dependent: volume of gas; temperature rise; volume of water Control: mass off catalyst; volume of hydrogen peroxide
A student wants to investigate the energy transferred when heating water by burning different foods. The foods to be burned include: - cookies - crisps - cereal - pasta	Mass of food items Temperature rise of water Appearance of the food	Balance Thermometer Timer Ruler	Independent: food items Dependent: temperature rise of water Control: mass of food samples; distance to the thermometer; time left to heat sample
A student wants to investigate what different drinks are composed of in order to categorise them. The drinks to be tested are: - orange juice - lemon - coffee - tea - soda	pH of the drinks Boiling points of the drinks Sugar concentration of the drinks Appearance of drinks	pH meter or universal indicator Thermometer Colorimeter Measuring cylinder Timer	Independent: types of drink Dependent: pH; boiling point; sugar concentration Control: same volume of drink, same time

Worksheet B: Suggested answers

1. Red numbers are anomalies that should be omitted from the calculation of the mean.

Food item	Temperature rise of water / °C			Mean (3 sf)
	Test 1	Test 2	Test 3	
Cookie	65	47	64	64.5
Plain biscuit	41	38	44	41.0
Pasta	28	19	22	23.0
Whole grain cereal	40	41	37	39.3
Sugar cereal	55	62	30	58.5
Full fat crisps	86	82	77	81.7
Reduced fat crisps	59	54	48	53.7

2. What two things should be done with the above data in order to calculate an ***accurate*** mean?

In order to calculate an accurate mean the values for each of the three tests should be added together and divided by how many tests there are. Anomalies should **not** be included when calculating the mean as they can skew the mean. Anomalies are numbers that are much larger or smaller than the other results.

The results should also be rounded to a set number of significant figures and kept the same for each calculation. This makes sure that the results are comparable. If the results are not rounded this would suggest that the method of measuring the results was more accurate than it actually was. This is the 'resolution' of the experiment.

Worksheet C: Suggested answers

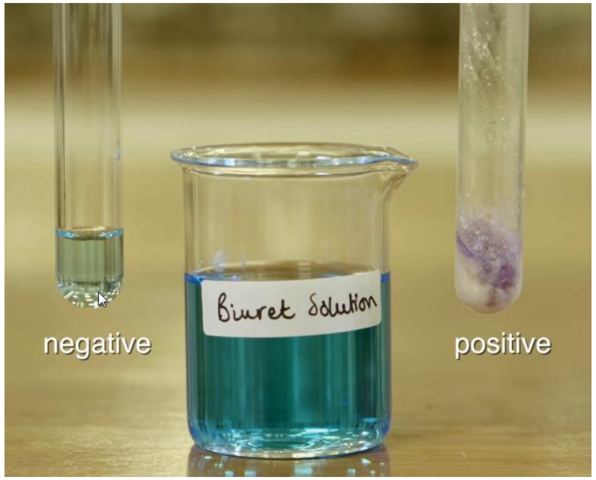
An example answer might include:

The data I could collect is: qualitative observations The disadvantage of using this type of data is: it is subjective and based on opinion. What one person observes may not be the same as someone else, which could make distinguishing a positive or negative result difficult.	The variables I need to control in order to collect valid data are: size of food sample; volume of reagent; time for the reaction. I plan to control these variables by: using the same volume of liquid food products or size of solid sample; add the same number of drops of reagent; record the time between adding the reagent and viewing the sample. To increase accuracy, I will also: compare my results with others. Use a control sample to compare the results with.

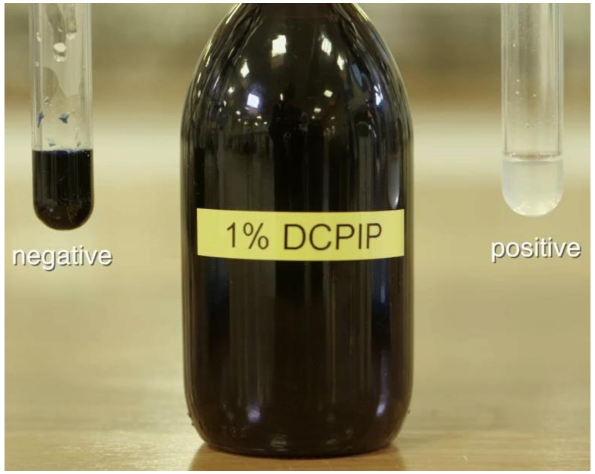
Learners' own hypothesis.

Worksheet E: Qualitative tests for nutrients

Iodine solution tests for: *starch*

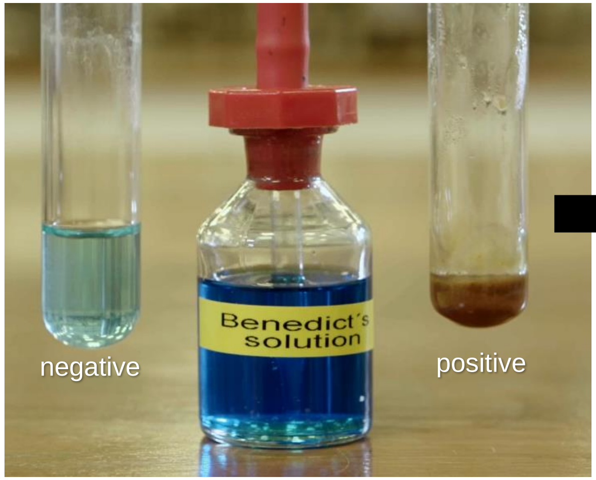


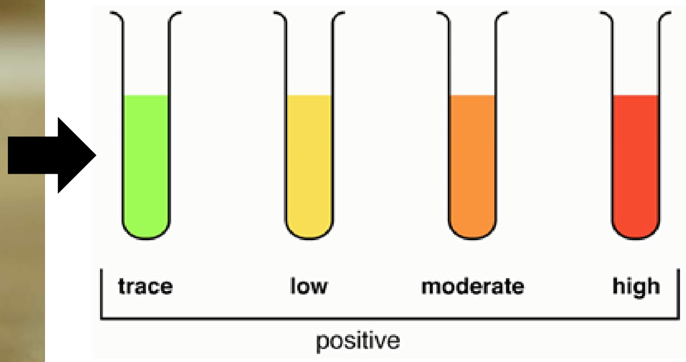
Biuret solution tests for: *protein*



DCPIP solution tests for: *vitamin C*

Ethanol emulsion test, tests for: *fats*





Benedict's solution tests for: *reducing sugars, such as glucose*

Worksheet H: Interpreting and evaluating

Below are some exemplar answers taken from the results for the Benedict's test for reducing sugars, recorded in the *Virtual experiment* video. The exemplar answers have only been provided for one food sample and one nutrient; learners would obviously be expected to provide answers for all their samples.

Interpreting your results

1. Look at your hypothesis. Was it correct?
   Use data from your results to support your answer.

   My hypothesis was mostly correct as I thought that the tomato sauce and orange juice would test positive for sugars. The tomato sauce became a red-brown colour compared to its starting colour, and the orange juice turned a darker shade of orange compared to its starting colour, indicating the presence of sugars. I also predicted that cooking oil would test negative for sugars. This was correct, as the oil sample had micelles of a light blue colour, matching the control.

   However, I predicted that the chicken, milk and bread would all test negative for the presence of sugar. However, the chicken turned a blue-purple colour, which was much darker than the control and looked like a distinct colour change, suggested there was a small concentration of sugars present. The milk and bread also tested positive for sugar, as the reagent turned a yellow colour.

2. Were there any surprises in your results? Refer to your observations in your answer.

   I was surprised that sugar was present in the chicken, bread and milk. They turned a light yellow colour indicating the presence of sugars. However, the colours suggest they do not contain as high a concentration of sugar as the tomato sauce or orange juice, which changed to darker yellow/red- red colours.

3. Were there any samples where it was not clear if the result of the test was positive or negative? Refer to your observations and describe the tests and foods that had unclear results. How did you decide if the result was positive or negative?

   It was difficult to determine whether the orange colour of the orange juice and the brick red of the tomato sauce was a positive test or not as the samples were originally an orange and red colour, respectively. In order to decide if they were a positive or negative result, I compared the colour of the sample after conducting the Benedict's test with the colour of original sample. It was clear that there was a colour change that corresponded with the colour changes seen in a Benedict's test.

4. Summarise your results into the table below. Answers here are from the *Virtual experiment* video.

Food sample	Nutrients that sample tested positive for
Bread	Starch, sugar and fat.
Chicken	Fat, sugar and protein
Tomato Sauce	Starch, sugar and fat
Oil	Fat
Milk	Sugar, protein, fat, and vitamin C
Orange juice	Sugars and vitamin C

5. What can you conclude from your results? Use data to support your answer.

This experiment shows that a variety of food groups that are essential for good health can be found in food. For example, chicken contains fat and protein, as does milk. Bread contains starch and some sugars. Some food items contain lots of sugar, such as orange juice or tomato sauce but little Vitamin C. This suggests that these food items should not be consumed in excess unless the person is doing lots of exercise in order to burn the excess energy. The positive result for sugar in the chicken suggests that the chicken was cooked in something containing sugar or was highly processed as you would not expect to find sugar in the chicken sample.

Evaluating the data collection

1. Why is the position of the test-tube labels important?

   It is important so that it doesn't obscure the results. If the label is positioned near the sample, it will make viewing any results difficult. The label should be positioned near the top of the sample so that it can be clearly identified but doesn't restrict the view of the sample. It also prevents the label being washed off during the Benedict's test.

2. Why is it alright to only use roughly the same volume of food sample each time?

   We are recording qualitative tests so slight variations in the volume of food samples are not likely to significantly affect the results. We are observing changes in colour and as long as the volumes are very similar then we will still be able to distinguish colour changes. If we were doing quantitative tests, then it would be essential to record the exact volumes to compare results validly and accurately.

3. Why is it important to clean the pestle and mortar and glass rod between uses?

This is to prevent cross contamination of the samples. Food particles could be left on the pestle and mortar or glass rod and then be transferred to another test. This could make forming observations difficult and cause a false-positive or false-negative result.

4. Why is it important to add the same number of drops of reagent to each sample?
   Keeping the number of drops the same within each test means that any colour changes are comparable and the results are valid. Adding too many or too little would affect whether the colour change forms and the strength of the colour change.

5. Why do samples need to be mixed / stirred after the reagents have been added?
   This is to ensure that the reagent is evenly distributed within the food extract; if it was not, you might obtain false-negatives. This makes sure the reagent has the opportunity to react with the nutrient in the sample.

6. Why does Benedict's solution need to be heated? Why must each sample be incubated at the same temperature?
   This reagent requires energy in order to react. Heating the sample provides energy in the form of heat. The samples must be incubated at the same temperature so that each reagent has the same amount of energy applied. If too much or too little is given to different samples, then this would mean the results cannot be compared with each other.

7. Why do you need to leave each sample with the reagent for two minutes?
   This allows time for the samples to react with the reagent and for any possible colour change to occur.

8. What is a control sample and why is it important to have one in your investigation? Explain your answer.
   A control sample is one where the independent variable (in this case the type of food) is not added but all other conditions are controlled; this shows you what the result would be in the absence of the independent variable, and therefore confirms that any recorded changes are due to the presence of the independent variable. It is important to have a control to demonstrate what a negative test will show. This can then be used to compare tests with an independent variable to determine whether or not there was a positive test.

9. Using your answers to the above question, can you identify any limitations to the data you have collected? How might the limitations in the data collection have affected your results?

   HINT: Look at the method and write down any issues that you can identify that would make the results less meaningful.

- A limitation of this experiment could have been that the conditions were not adequately controlled. For example, there may have been large differences in the volume of reagent added or the mass of the food samples. This could mean that the colour change is not comparable between the samples and the control. Another limitation could be that the amount of time left before viewing the sample may have been too long and any possible colour change may have faded.
- The data collected in this investigation was qualitative and is therefore based on opinion. It may be that a result that looks positive or negative to one person may not to someone else, and so cause differences in results.
- Also, some colour changes were only very slight. This could have been due to differences in the amount of food items tested.

10. How could the method be improved to reduce the limitations? Suggest any adaptations that would make the data more valid. Explain your suggestions.

- Record any colour changes 30 seconds, 1 minute and 2 minutes after the test. This could eliminate the possibility that any colour changes have faded.
- Record the mass of the food samples to ensure the same mass is being used in each investigation.
- Compare results with others to discuss identification of positive and negative results.
- Repeat the test at least 3 times to eliminate anomalies.
- A wider sample of food items could be tested to compare food groups.
- Use exactly the same volume of food sample.

11. Use examples from your results to suggest what is meant by the term 'balanced diet'. Is it the same for everyone? Give examples of when it might be different.

A balanced diet contains a variety of different types of food without any in excess. This provides the necessary nutrients for good health. Diets should be high in protein, carbohydrates and healthy, natural fats. Elderly or children should eat a diet high in protein for growth and therefore eat foods such as chicken. Very active people can eat foods high in sugars such as orange juice and starchy foods such as pasta or potato.

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