

Food tests

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

For AQA GCSE Biology 8461 and Combined Science: Trilogy 8464. Teacher answers start on a new page.

Name

Date

Aim

To use qualitative reagents to test food samples for sugars, starch, protein and lipids.

Background

Foods contain carbohydrates, proteins and lipids (fats and oils). A **qualitative reagent** is a chemical that changes colour in the presence of a food molecule. The test tells you whether the molecule is present, but not how much (that would be quantitative).

Benedict's solution is blue and turns green, yellow, orange or brick-red when heated with sugars.

Iodine solution is orange-brown and turns blue-black with starch. **Biuret reagent** is blue and turns purple (lilac) with protein. **Sudan III** stain dyes lipids red, which makes an oily layer form on top of the water.

Many foods are solid. To test them, they are first ground up with a little water so that the food molecules dissolve or mix into the liquid and can react with the reagent. A coloured food could hide a colour change, so a plain, pale food or a clear solution works best.

Equipment

- Food samples such as milk, egg white, vegetable oil, potato or bread, and glucose solution and starch solution for comparison
- Mortar and pestle (or a beaker and a glass rod), distilled water, filter funnel and filter paper
- Test tubes and a test tube rack
- Dropping pipettes and a 10 cm³ measuring cylinder (or graduated syringe)
- Benedict's solution
- Iodine solution
- Biuret reagent
- Sudan III stain solution (or ethanol for the emulsion test)
- Water bath at about 80 °C (or a beaker of hot water from a kettle on a heat-proof mat) and a test tube holder
- Thermometer and a timer
- Spotting tile (optional, for the iodine test)
- Marker pen and eye protection

Risk assessment

Hazard	Risk	Precaution
Hot water bath	Scalds from hot water or from tubes of boiling liquid.	Do not let the water boil. Use a test tube holder, point the tube away from your face and keep the water bath below boiling.
Biuret reagent (contains sodium hydroxide and copper sulfate)	It is corrosive and can damage the eyes and skin.	Wear eye protection. Wash splashes off the skin with plenty of water and tell the teacher at once.
Benedict's solution (contains copper sulfate)	It is harmful if swallowed and an irritant to the eyes.	Wear eye protection. Never taste or eat any of the samples.
Sudan III stain and ethanol	They are flammable and the stain irritates the eyes. It also stains skin and clothes.	Keep them away from any flames. Wear eye protection and wipe up spills.
Iodine solution	It stains skin and clothes and can irritate the eyes.	Wear eye protection and wash off splashes with water.
Food allergies	Some students have allergies, for example to milk or egg.	Do not eat or taste anything. The teacher should check for allergies before the practical and food samples must not touch the skin.

Method

1. Label four test tubes with the name of the food sample and the test. Do this for each food sample in turn.
2. If the food is solid, grind a small amount with a little distilled water using a mortar and pestle. Filter it, or let the solid settle, so that you can use the liquid.
3. Starch: put 2 cm³ of the food liquid into a test tube (or one drop on a spotting tile). Add a few drops of iodine solution and shake. Record the colour.
4. Sugars: put 2 cm³ of the food liquid into a test tube and add 10 drops of Benedict's solution. Place the tube in the hot water bath at about 80 °C for 5 minutes. Record the colour at the end.
5. Protein: put 2 cm³ of the food liquid into a test tube and add 2 cm³ of Biuret reagent. Mix gently and record the colour after about a minute.
6. Lipids: put 2 cm³ of the food (or the oil on its own) into a test tube with 2 cm³ of water and add a few drops of Sudan III stain solution. Shake gently and leave to settle. Look for a red-stained layer on top.
7. If your school uses the ethanol emulsion test for lipids instead: shake 2 cm³ of the food with 2 cm³ of ethanol, then pour the liquid into a tube of water. A cloudy white emulsion shows lipid is present.
8. Record the colour before and after for each test in the results table. Write 'present' or 'not present' next to each result.
9. Repeat steps 1 to 8 for each food sample. Test a sample of pure water as a negative control and a sample of the pure molecule as a positive control (for example glucose, starch, egg white and oil).
10. Write a conclusion for each food sample saying which food molecules it contains.
11. Wash out the test tubes, put the waste liquids down the sink with plenty of water as your teacher instructs, and wash your hands.

Results

Results of the food tests				
Food sample	Benedict's test (sugar)	Iodine test (starch)	Biuret test (protein)	Sudan III test (lipid)

Exam questions 10 questions · 26 marks

1 Name the reagent used to test for starch. State the colour change for a positive result. [2 marks]

2 Describe how you would test a food for sugar and what you would see if sugar is present. [3 marks]

3 The tube in the Benedict's test is heated in a hot water bath rather than directly in a Bunsen flame. Give two reasons. [2 marks]

- 4** A student tests a food sample. Use the results to decide which food molecules the sample contains. **[3 marks]**

Results for food sample X		
Test	Colour at the start	Colour at the end
Benedict's	Blue	Blue
Iodine	Orange-brown	Blue-black
Biuret	Blue	Purple

- 5** Before testing a solid food, it is ground up with water. Explain why. **[2 marks]**

- 6** In the Benedict's test, tube A turns brick-red and tube B turns green. What does this tell you about the two foods? **[2 marks]**

- 7** The food tests are described as qualitative. Explain what this means. **[2 marks]**

- 8** Give two safety precautions needed when carrying out the food tests. **[2 marks]**

9 A student adds Biuret reagent to a food and the solution stays blue. The student then adds the same Biuret reagent to egg white, and it turns purple. Explain why the student tested egg white. **[2 marks]**

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10 A student is given a sample of a white powder that may contain starch, sugar, protein or lipid. Describe how to test the powder to find out which food molecules it contains. Include the results the student would expect for each one. **[6 marks]**

[illegible]

Teacher answers

Required practical 4: Food tests. The example results are practice data, not real measurements.

Example results

Example results (practice data)				
Food sample	Benedict's test (sugar)	Iodine test (starch)	Biuret test (protein)	Sudan III test (lipid)
Glucose solution	Blue to brick-red	Stays orange-brown	Stays blue	No red layer
Starch solution	Stays blue	Orange-brown to blue-black	Stays blue	No red layer
Egg white	Stays blue	Stays orange-brown	Blue to purple	No red layer
Vegetable oil	Stays blue	Stays orange-brown	Stays blue	Red oily layer on top
Milk	Blue to orange	Stays orange-brown	Blue to purple	Red-stained oily layer on top

Conclusion

Glucose solution contains sugar only, starch solution contains starch only, egg white contains protein and vegetable oil contains lipid. Milk gave a positive result for sugar, protein and lipid, so it contains all three. It does not contain starch, because the iodine stayed orange-brown. The positive controls (the pure molecules) gave the expected colour changes, which shows the reagents are working.

Errors and improvements

Error	Effect on the results	Improvement
The Benedict's tube is not heated for long enough or at a high enough temperature.	A sugar may be missed, giving a false negative (stays blue).	Use a thermometer to keep the water bath at about 80 °C and a timer for 5 minutes.
Different amounts of food liquid or reagent are used in different tests.	The colours cannot be compared fairly, for example how brick-red the Benedict's test goes.	Measure the volumes with a syringe or graduated pipette and use the same number of drops each time.
The same pipette or tube is used for different foods.	Contamination can give false positive results.	Use a clean pipette and a fresh test tube for every sample.
A coloured food makes it hard to judge the colour change.	The result is a matter of opinion (subjective), so different observers could record different colours.	Compare each result against a control tube and a colour chart, or use a colorimeter.

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [2]

- iodine (solution) (1)
- orange-brown to blue-black (1) allow orange / brown / yellow for the start colour; allow black; reject blue alone

2. [3]

- add Benedict's solution (to the food solution) (1)
- heat in a hot water bath (1)
- blue changes to green / yellow / orange / brick-red (1)

3. [2]

- liquid could boil over / spit out of the tube (1)
- water bath gives a controlled temperature / safer (1)

4. [3]

- contains starch (1)
- contains protein (1)
- does not contain sugar (1)

5. [2]

- to release / dissolve the food molecules into the liquid (1)
- so they can react with the test reagents (1)

6. [2]

- both contain sugar (1)
- food A contains more sugar than B (1)

7. [2]

- they show whether a food molecule is present or not (1)
- they do not tell you how much / the amount of it (1)

8. [2]

- wear eye protection (1)
- keep flammable chemicals such as ethanol / Sudan III away from flames (1)
- do not taste or eat the food samples (1)
- use a test tube holder / do not let the water boil (1)
- Max 2

9. [2]

- egg white is known to contain protein / it is a positive control (1)
- it shows the reagent is working, so the food really contains no protein (1)

10. [6]

Level 3 5-6	A clear, logical plan covering all four food molecules, with the correct reagent, method (including heating for sugars) and positive result for each. The preparation of the sample is described and safety or controls are mentioned.
Level 2 3-4	A plan covering at least two or three tests with the correct reagent and most of the positive results. Some detail may be missing, for example heating or sample preparation.
Level 1 1-2	A few relevant points about food tests, such as the name of one or two reagents or a colour change, with little method.

Indicative content

- grind the powder with water and filter / use the liquid
- iodine solution: orange-brown to blue-black if starch is present
- Benedict's solution and heat in a water bath: blue to green / yellow / orange / brick-red if sugar is present
- Biuret reagent: blue to purple if protein is present
- Sudan III: red-stained oily layer on top if lipid is present (or ethanol emulsion test: cloudy white emulsion)
- use separate test tubes and clean pipettes for each test
- wear eye protection, use a water bath and keep ethanol or Sudan III away from flames

Exam tips

- Learn the colour changes exactly: blue-black for iodine, brick-red for Benedict's, purple for Biuret. 'Blue' for iodine or 'pink' for Biuret will not score.
- Always describe a colour change as 'from ... to ...', for example 'blue to brick-red'. A positive result is the change, not just the final colour.
- Benedict's solution needs to be heated in a hot water bath. If you forget to heat it, you lose the mark.
- Food tests are qualitative: they show whether a molecule is present, not how much. Say this if asked what the tests cannot show.
- If a test stays the same colour as the reagent, write 'not present' for that molecule.