Sourcing Sugars

Aim: This hands-on workshop is designed to help students to investigate which foods and drinks contain simple carbohydrates (e.g.glucose).

WORDS OF ADVICE:
Because this demonstration requires a water bath or hot plate, you may not feel comfortable allowing your students to take part. An alternative would be to do this as a demonstration with your class and then allow them to use glucose test strips to test some liquids (see Sourcing Sugars I)

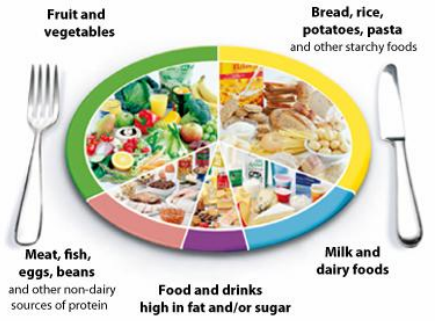
Curriculum Links:

By investigating some body systems and potential problems which they may develop, I can make informed decisions to help me to maintain my health and wellbeing. ***SCN 2-12a***

I have collaborated in activities which safely demonstrate simple chemical reactions using everyday chemicals. I can show an appreciation of a chemical reaction as being a change in which different materials are made. ***SCN 2-19a***

Background Info

There are many different kinds of nutrients our bodies need to stay healthy. These include vitamins, proteins, fats and carbohydrates. We get these from eating a variety of different foods.



In order for our body to operate efficiently we have to give it energy and **carbohydrates** supply this. There are two types of carbohydrates – simple carbohydrates and complex carbohydrates.

Simple carbohydrates are sugars including glucose (see further details later), fructose (the sugar found in fruits), sucrose (table sugar) and lactose (the sugar found in milk). These carbohydrates are easy to digest and provide a quick energy source. Simple carbohydrates are single-chain sugars.

Complex carbohydrates are also sugars but are long chains of simple sugar molecules joined together to form complex chemical structures. Complex carbohydrates are things like starches found in grains, some vegetables and legumes. They require more digestion than simple carbohydrates and are the body's best source of energy because they are burned in a constant, time-release manner. They provide sustained energy for athletic events and can help keep blood sugar levels steady.

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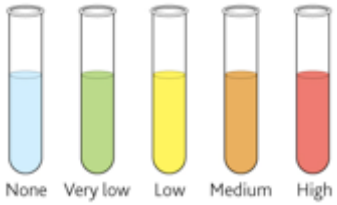
When carbohydrates, both simple and complex, are eaten, the digestive process transforms these into **glucose**. This is the fuel for all the body's cells. The body will either use the glucose immediately or, if there is too much, store it in the body as fat. The liver converts glucose to fat.

In this experiment we are going to look at some everyday foods and drinks to see if we can find out which, if any, contain a high amount of simple carbohydrates.

We can use a special reagent called **Benedict's solution** to test for simple carbohydrates like glucose. Benedict's solution is blue but, if simple carbohydrates are present, it will change colour – green/yellow if the amount is low and red if it is high.



A precipitate will also form if the sugars are present and the quantity of this gives an indication as to the quantity of sugars in the test sample.

Benedict's solution contains **copper (II) sulphate** and the Cu^{2+} ions are what give the solution its blue colour. If simple carbohydrates are present these sugars will, when the mixture is heated, reduce the copper and cause a red **copper (I) oxide** precipitate to form. For this reason, these sugars are known as **reducing sugars**.

Setting up the workspace for the experiment

Because this experiment involves a lot of liquids, spillages may occur so consider covering the tables or conducting the experiment on trays.

Although none of the substances being used are very harmful, participants should wear personal protective equipment of some sort to protect clothes and skin. For example, disposable aprons or lab coats, gloves (if available) and eye protection (if available). Students with long hair should tie it back.

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Equipment Required

- Benedict's Reagent[1]
- Test tubes (as many as you have samples)
- Test tube rack
- Water bath or hotplate
- Beaker
- Thermometer
- Food and drink samples
  e.g. Tap water, mineral water, flavoured mineral water, orange squash, fresh orange juice, flavoured yoghurt, natural yoghurt, Coke, Diet Coke, whole milk, semi-skimmed milk, flavoured milk.
- 5ml droppers / plastic pipettes (**NB** droppers must allow you to measure the volume of sample)
- Timer
- Tongs

What to do

1. **BEFORE STARTING THE EXPERIMENT** turn on the waterbath and set to 70°C. If using a hot plate, place a beaker of water on the hotplate and heat to 70°C.

NB This experiment is quite time-consuming therefore, if the students are doing it, it may be best to split them into small groups with a couple of test solutions each and then collate results as a class.

2. Label each of the test tubes with a number.

3. Place 1ml of each sample into a separate test-tube using a new dropper each time. Note in the table overleaf which sample is in which numbered tube.

4. Place the tubes in the test-tube rack when complete.

5. Note the colour of the samples in the table overleaf.

6. Add 3ml of Benedict's solution to each of the test tubes. Make sure the dropper does not touch the test solution.

7. Note the colour of the samples in the table overleaf.

8. Place all of the test tubes in the waterbath/beaker of water for 5 minutes.

9. Carefully remove the tubes and, on the table overleaf, note the colours and if any solid was formed on the table overleaf.

[1] If your school doesn't have Benedict's reagent, check the suppliers list provided on our website.

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Results

NB Your results may differ from those below depending on the exact brands etc. you use.

Test-tube number	Sample	Colour before Benedict's	Colour after Benedict's	Colour after heating	Solid formed?
1	Tap water	Colourless	Blue	Blue	×
2	Mineral Water	Colourless	Blue	Blue	×
3	Flavoured Mineral Water	Colourless	Blue	Dark Red	×
4	Orange squash	Yellow	Turquoise	Turquoise	×
5	Fresh orange juice	Yellow	Green	Orange	×
6	Natural yoghurt	White	Cloudy Blue	Orange	×
7	Flavoured yoghurt	Pink	Cloudy Turquoise	Orange/Brown	✓
8	Coke	Brown	Turquoise	Brick-red	×
9	Diet Coke	Brown	Turquoise	Turquoise	×
10	Whole Milk	White	Cloudy Blue	Orange	×
11	Semi-skimmed milk	White	Cloudy Blue	Brown	×
12	Flavoured milk (chocolate)	Brown	Cloudy Turquoise	Brown	✓

Conclusions

Why did the colour of the indicator in some tubes stay the same?

If the test solution contained no glucose the colour of the indicator would stay the same.

Which drink(s) contained the most sugar?

Flavoured Mineral Water, Coke.

What was the solid that gathered in some of the tubes?

The solid was red copper oxide.

Why did this form?

This formed when the copper sulphate in the indicator was reduced by/reacted with the (reducing) sugars in the test solution.

Why do we need to heat the solutions?

We need heat to provide the energy for the reaction.

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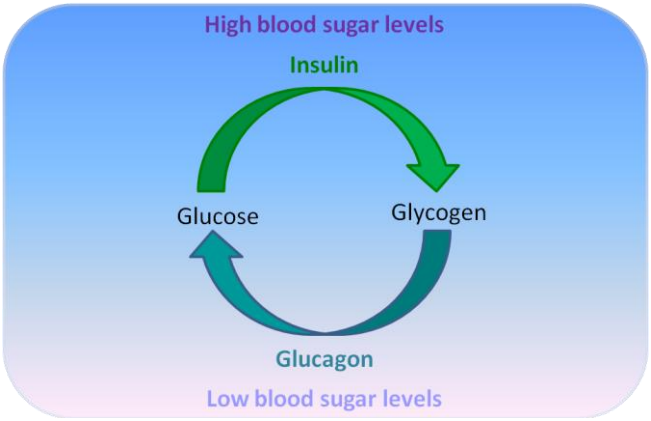
Exploring the Science

The human body needs glucose as a fuel for all the cells.

Ideally, the levels of glucose in the blood (blood sugar level) should be kept within a very narrow range. If blood sugar levels remain high in the body for long periods of time this can damage the blood vessels that supply vital organs, which can increase the risk of heart disease and stroke, kidney disease, vision problems, and nerve problems. If blood sugar levels are too low you might feel hungry and shaky. You may get a headache, feel drowsy or even pass out.

There are two special chemicals (hormones), insulin and glucagon which have the job of keeping blood sugar levels balanced. These hormones are made in the pancreas. When blood glucose levels are too high, insulin is produced by the body to reduce the levels. When blood glucose levels are too low, glucagon is produced by the body to increase the levels.



A disease called **diabetes** causes the amount of glucose in the blood to be too high because the body cannot use it properly. This can be for one of two reasons;

1. The pancreas does not produce any insulin, or not enough (Type 1 Diabetes)
2. The body cannot properly use the insulin that is produced (Type 2 Diabetes)

More than two million people in the UK have the condition and more than three-quarters of these have Type 2 diabetes. The number of people with type 2 diabetes is rapidly increasing because it more common in those who are overweight and the level of obesity in the population is rising all the time.

Why not make this the introduction to a healthy living project?

In the past, Benedict's reagent was used to test a patient's urine. If glucose is present in urine it may mean the patient is diabetic. Nowadays, instead of using Benedict's test, we can use test sticks which have special chemicals on them. They are dipped in the urine and, if glucose is present, the stick will change colour (see more information in Sourcing Sugars I)

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Risk Assessment

Brief Description of Experiment

Test various food and drinks for glucose by adding Benedict's solution to 1ml of the test liquid. Heat the solutions for 5 minutes.

Risks	Action to be taken to minimise risks	Action to be taken in the event of an accident
Hot water / hot plate could cause burns.	– Only demonstrators to use water bath/hot plate.	– Run affected area under cold water and call first aider.
Benedict's reagent irritant to eyes and skin.	– Use small amounts of the chemicals. – Use minimum strength of the chemicals. – Make sure all spills are cleaned up immediately. – Make sure all participants wear appropriate PPE. – Supervise students at all times. – Make sure participants wash hands after the experiment.	– Flush affected skin or eye under running water. – Cover the affected area with an emollient. – See medical attention if the above actions have been taken and irritation persists.
Benedict's reagent irritant if inhaled.	– Use small amounts of the chemicals. – Use minimum strength of the chemicals. – Supervise students at all times.	– Remove to fresh air. – If not breathing or breathing is difficult seek medical attention.
Benedict's reagent dangerous if swallowed.	– Use small amounts of the chemicals. – Use minimum strength of the chemicals. – Supervise students at all times. – Make sure participants wash hands after the experiment.	– If large quantities of this material are swallowed seek medical attention. – Do not induce vomiting unless directed to do so by medical personnel.