Discovering digestion

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Learning objectives

- Identifying the main food groups present in different types of food
- Explaining why each of the main food groups is needed in our diets
- Discussing the importance of a balanced diet
- Understanding how to test foods for the presence of starch, sugar and protein

Curriculum links

- Science (Biology
  - Structure and function of living organisms
  - Nutrition and digestion
  - Working scientifically

Resources required

- Discovering digestion slides
- Experimenting with energy student sheet
- Testing your food student sheet

Equipment needed

For the **Experimenting with energy** activity, you will need (per group):

- A variety of food samples (in small pieces) with nutritional information labels. E.g. sugar, pulses, bread, biscuits, pasta, crisps, cereal, cheese, chocolate. If the food does not have labels with nutritional information search for the food on a major supermarket online shopping website. They will have clear nutritional information for most foods
- Boiling tube
- Clamp stand, boss and clamp
- Weighing scale
- Bunsen burner
- Heatproof mat
- Tripods and pipe clay triangles
- Crucibles
- Measuring cylinders (to measure 20cm^3)
- Thermometer or temperature probe
- Safety goggles

Time needed: 60+ minutes

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Equipment needed Continued…

For the **Testing your food** activity, you will need:

- A range of food samples. E.g. cooked pasta, honey, fizzy drink, butter, baked beans, yoghurt, chocolate, cooked potato. Sticky foods should be chopped or separated into smaller pieces. Dry foods like rice and pasta should be cooked
- Clinistix® test strips and colour chart
- Albustix® test strips and colour chart
- Iodine solution
- 5% glucose solution
- Spatula
- Dropping pipette
- Beaker
- Test tubes
- Test tube rack

Lesson plan
Resources needed: Slides

20 mins

Preparation

Safety: All activities should only be undertaken if a suitably qualified adult is on hand to supervise. Risk assess the activities in line with the requirements of your setting and have a look at the **CLEAPPS website** for further guidance.

Slide 1
Discovering digestion

- Explain to students that today's lesson is about food and digestion, the body's process to get useful things from food

Slide 2
What is your favourite food?

- Ask students to talk about their favourite foods, and why they love them. If their favourite foods were all they ate, would that make a balanced diet?
- Ask the class what they think a balanced diet looks like
- Explain that a balanced diet describes the amounts of the seven food groups that a person should eat to be healthy
- It contains nutrients our bodies need in the right amounts to keep us healthy
- In extreme cases, imbalanced diets can lead to obesity, starvation and nutritional deficiencies
- Ask students if they can name the different groups. You may wish to write them on the board, or students can record their answers themselves

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Slide 3
The seven food groups

- Reveal the answers one at a time and explain how the body uses different kinds of nutrients for different things. Ask students if they can think of examples of food in each group as you go through each one, explaining what they're for and providing the examples below
- Carbohydrates provide energy for the body
  - Good sources include cereals, bread, pasta, rice and potatoes
- Proteins are used for growth and repair. That's why people trying to build muscle (like athletes) need to eat more protein
  - Good sources include fish, meat, eggs, beans, pulses and dairy products
- Lipids (fats and oils) also provide energy. This energy can be stored in the body and used to insulate it against the cold
  - Good sources include butter, oil and nuts
- Vitamins are also needed in small amounts to maintain health. E.g. vitamin B12 is needed to make DNA and vitamin C helps with eye health
  - Good sources include fruits, vegetables, grains and dairy foods
- Minerals are needed in small amounts to maintain general health. For example, calcium helps with bone strength and iron helps with transporting oxygen around the body
  - Good sources include salt, milk (for calcium), liver (for iron), nuts and vegetables
- Dietary fibres provide roughage to help to keep the food moving through the gut, supporting healthy digestion
  - Good sources include vegetables, cereals and bran. Many breakfast cereals have added fibre
- Water is needed for cells and body fluids
  - Good sources include water, fruit juice and milk

Slide 4
How much energy do we need?

- Ask the students if they think we all need the same amount of energy
- Click through the slides animations to reveal and explain that factors like gender, age, height and activity level all affect how much energy we need
- Explain that the energy content of food is normally measured in kilojoules (kJ)
  - E.g. a one-year-old baby needs an average of 3850 kJ each day, whereas an adult Olympic swimmer needs an average of 15,600 kJ each day
- Ask the students if they think all types of food contain the same amount of energy. Explain that they are going to be conducting some experiments to find out

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Slide 5
Experimenting with energy

- Tell students to read through the instructions in full before beginning
- Split the class into small groups and hand out the **Experimenting with energy student sheet**, then ask the students to predict which foods they think will have the highest energy content on their sheet
- Distribute or lay out the food samples for the experiment. You will need to make sure groups are testing different types of food
- Ask students to let you know about any food allergies they have

Activity 1
Experimenting with energy

30 mins

1. Explain that this experiment focuses on the three biggest food groups: fats (lipids), carbohydrates and proteins. These all contain chemical energy
2. If you like, you can demonstrate this by setting a piece of food on fire, or explaining that, for example, a single peanut can release enough heat to boil water in a test tube
3. Tell students to put on safety goggles
4. They will then measure out 20cm^3 of water into the boiling tube and then clamp the tube to the clamp stand
5. When safely attached, tell students to measure the temperature of the water with the thermometer and record the results in the table on the **Experimenting with energy student sheet**
6. Students can now choose a piece of food and find its mass using the weighing scale and record its mass in the table
7. Once they have placed the food into a crucible on a tripod, they can light the Bunsen burner and hold the food in the flame until it catches alight
8. When the food is aflame, students should put it under the boiling tube, so the flames heat the water
9. Tell students to hold the food in place until the food has burnt completely
   a. If the flame goes out before the food burns, students can light it again using the Bunsen burner and reposition the food beneath the tube
10. As soon as the food has burned away completely and the flame has gone out, students should stir the water carefully with the thermometer and measure the temperature of the water again, noting the highest temperature reached in the results table
11. Next, calculate the rise in temperature each time and note it down
12. Then calculate the energy released from each food by using this formula on **Slide 5**: energy (J) per gram of food = mass of water (g) × temperature rise (°C) × 4.2/ mass of food (g)
13. 4.2 is the value of the specific heat capacity of water, in joules per gram per degree Celsius: the number of joules taken to raise the temperature of water by 1°C. 1cm^3 of water has a mass of 1g
14. The groups can repeat steps 5-15 for other food types, ideally using one from each category of fats, carbohydrates and protein, based on how much time you have

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Safety notes:

Students will be working with small flames and hot equipment. Check all students are wearing eye protection during the procedure.

Food allergies: avoid nuts as foods for this investigation. Check with the students if they have any known allergies and ask them to avoid the foods to which they are sensitive.

Fatty foods especially burn with a very smoky flame. Students can reuse the same boiling tube repeatedly in this practical, but the washing up might be quite difficult.

Discussing the energy content of food can lead to discussion of body mass and weight loss which is a sensitive area for many students.

Slide 6

Which food has the highest energy content?

- Tell students to look back at their predictions at the start of the activity and ask which foods have the highest energy content
- Reveal the answer by moving to **Slide 6**. Explain that fats (lipids) have the highest energy (or "calorific") value. Let students know that fats release more than two times the energy per gram than carbohydrates
  - A typical fat may release 40kJg-1, compared to around 18kJg-1 for a carbohydrate
- Tell students that ideally about 60% of energy intake should come from carbohydrates, which provide energy quickly
- Fats are a slow release store of energy, and should be around 25% of your energy intake
- Ask the students to look at whether the food energy content they calculated was the same as on the nutritional label? Are their values higher or lower? Why?
- Explain that some energy might have been lost heating the water, and the moisture in the food itself absorbs heat released by combustion as it warms up, which can lead to an underestimate of the food's energy content

Slide 7

Releasing energy

- Briefly recap learning from the first activity, asking students to recall which types of food had higher energy content
- Ask students if they think some foods might give you an energy boost faster than others and why
- Explain that living things don't have little fires burning inside their cells. Instead, energy is released by a process called respiration
  - Students will have some awareness of this process if they have completed the **How we breathe** module
- Explain that foods rich in fats or carbohydrates first need to be broken down into sugars to release their energy
- Foods that already contain sugars skip this step, providing really rapid energy

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Slide 8
Glucose: The fastest energy

- Explain that glucose is the simple sugar $C_6H_{12}O_6$ (students may have come across it when learning about photosynthesis)
- It is the fuel for our bodies, and it is made by digesting carbohydrates
- Blood carries glucose and oxygen to all our cells, and cells get the energy they need from glucose during respiration

Slide 9
Protein: Medium term energy

- Remind students that we use proteins for growth, replacement and repair of worn out or damaged body tissues
- This is because all cells are made mainly from protein. Explain to students that the body needs protein to make new cells when you grow and to replace old or damaged cells
- Tell students that the enzymes controlling the body's chemical reactions are also proteins, so they are essential in everyone's diet even when they have stopped growing. Proteins cannot be stored in the body, so they're used straight away (though not as fast as glucose)

Slide 10
Starch: Slow release energy

- Explain that starch is a type of carbohydrate. Starch is a white solid at room temperature and does not dissolve in cold water
- Tell students that the digestion of starch makes glucose
  - Most plants store their energy as starch
- Explain to students that as starch takes longer to digest than glucose, the sugar loading into the blood is more gradual, avoiding a spike in blood sugar level
- You can use iodine to test foods for starch. If starch is present, the orange-yellow iodine solution becomes blue-black

Slide 11
Testing your food

- Remind students to read the instructions in full before beginning the experiment
- Tell students they are going to be conducting three experiments to find out which foods release energy the fastest, by finding out about their glucose, protein and starch content
- Give out the **Testing your food student sheet**, and ask the students to predict which foods they think will be the highest in glucose, proteins and starch

Additional information: **Clinistix® test strips** are designed for testing for glucose in urine as a sign of diabetes and can detect it at very low concentrations. This method of testing for glucose avoids the heating stage needed when using Benedict's reagent. This makes it quick and safe.

Clinistix® use an enzyme that is specific to glucose rather than just reducing sugars in general, so students may find that some foods containing a high 'sugar' content are nonetheless low in glucose. This is a good chance to explain how 'sugar' is a general term for the group of compounds that includes glucose. The 'sugar' crystals that students will be familiar with from their kitchens is actually sucrose.

Albustix® test strips are designed for testing for proteins in urine and can detect them at very low concentrations. This method of testing for protein avoids the use of irritant sodium hydroxide solution used in the Biuret test. Students will have to be careful to avoid false positive results caused by cross-contamination.

Care should be taken with **iodine solution**, which will stain skin or clothing if spilled. The test is quite sensitive, but the starch needs to be in an aqueous suspension (watery) for the iodine solution to react with it. That's why things like rice or pasta need to be cooked first.

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Activity 2
Testing your food

30 mins

1. If food is solid tell students to grind or crush it in a pestle and mortar
2. Students should put half of each food sample in a test tube (to a depth of 2cm) and the other half in a petri dish
   - Once prepared, remind students to clean the pestle and mortar thoroughly to prevent contamination for each food sample
3. Tell students to add distilled water to each test tube so the mixture is half food, half distilled water and stir well with the glass rod, leaving to stand for 2-3 minutes
   - This is to ensure any glucose or proteins can dissolve into the water
4. Using a dropping pipette, students should transfer a few drops of the liquid above the food to an Albustix® test strip to test for protein
5. Tell students to do the same to a Clinistix® test strip to test for glucose
6. Now they can hold the strip horizontally over a beaker and drip test liquid onto the test area until it is thoroughly wet, shaking any excess off and leaving for 10 seconds
7. They can now compare the colour of the test area with the colours shown on the side of the Clinistix® and Albustix® containers and record the results
8. Dispose of the used test strips carefully
9. Add a few drops of iodine solution to the food samples in the petri dishes
10. Let students know that starch is present if a blue or blue-black colour appears and record the results on the **Testing your food student sheet**

Slide 12
Evaluate results

- Tell the class to look back at their predictions and see how accurate their predictions were about which foods had the most of each food type. Ask them to name foods that had the most glucose, then protein, then starch as you click through the slide animations on **Slide 12**
- Explain to students that starches provide energy over a longer period of time
- Remind students that although a sweet snack or drink does provide quick energy, they also result in significant dips because they don't last very long
  - Excessive sugary foods and drinks also have serious drawbacks like causing tooth decay and other health problems

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Slide 13 and 14
Quiz

- Once you have completed both activities, let students know you're going to do a quiz to check what they've learnt about food and digestion
- Either in their groups or as individuals, ask the students to note down their answers to the 10 questions
- Go over the answers, to the right and on **Slide 15**, recapping your answers as you go

Q: What is the main reason why we need protein in our diet?

A: Growth and repair

Q: Name two factors that affect how much energy someone needs

A: Height, age, physical activity and gender

Q: What nutrient is found in pasta and rice?

A: Carbohydrate

Q: $C_6H_{12}O_6$ is the chemical symbol for what?

A: Glucose

Q: Which of these contains the most protein?

A: Fish

Q: Through which process is energy released in the body?

A: Respiration

Q: Which of these contains the most fibre?

A: Carrots

Q: Name all seven food groups

A: Carbohydrates, lipids, proteins, vitamins, minerals, fibre and water

Q: Albustix® strips can be used to test for what?

A: Protein