5 Food for life

Planning page

Getting started

5.1 The need for food page 88
- Activity page 89
- Skillbuilder page 91 Heating a liquid in a test tube
- Investigate 11 Testing foods

5.2 Digesting food page 96
- Experiment Enzyme action
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- Animation Enzyme action
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- Investigate 13 The blood system
- Activities page 107
- Animation The heart

Main ideas
- Chapter 5 crossword

Review
- Chapter 5 test

Essential Learnings for Chapter 5

Essential Learnings	References		
	Student book (page number)	**Workbook (page number)**	**Teacher Edition CD (Assessment task)**
Knowledge and understanding ***Life and living*** Complex organisms depend on interacting body systems to meet their needs internally and with respect to their environment	pp. 96–109	pp. 37–40	Assessment task 5 An energy budget
Ways of working Draw conclusions that summarise and explain patterns, and that are consistent with the data and respond to the question	Experiment p. 98 Investigate 12 p. 100	p. 36	Assessment task 5 An energy budget
Evaluate data, information and evidence to identify connections, construct arguments and link results to theory	Activity p. 89 Investigate 11 pp. 91–93		
Communicate scientific ideas, explanations, conclusions, decisions and data, using scientific argument and terminology, in appropriate formats		p. 41	Assessment task 5 An energy budget

QSA Science Essential Learnings by the end of Year 9

Vocabulary

alveoli
amino acid
artery
bronchi
capillaries
carbohydrates
cellular
chlorophyll
diaphragm
digestion
excretion
faeces
glucose
intestine
iodine
nutrients
oesophagus
proteins
respiratory
trachea
urine
vein
villi

Focus for learning

Check their knowledge of food webs and parts of the body (page 87).

Equipment and chemicals (per group)

Skillbuilder page 91	test tube (in test tube rack), test tube holder, 10% glucose solution in dropper bottle, Benedict's solution in dropper bottle, Bunsen burner
Investigate 11 pages 91–93	glucose solution, starch suspension (20 g starch/L), protein solution (10% gelatine solution), butter or dripping, Benedict's solution or glucose teststrips, iodine solution (5 g I_2 in 100 mL 10% KI), copper sulfate solution (0.1M) and sodium hydroxide solution (2M) or Uristix, brown paper, spotting tile, 4 test tubes, a stopper and rack, test tube holder, burner and heatproof mat, small pieces of foods
Experiment page 98*	starch suspension, iodine solution, glucose solution, Benedict's solution or Clinistix, amylase solution, test tubes, large beaker, spotting tile, long dropper
Investigate 12 page 100	3 lengths of cellophane tubing (15 cm), three 250 mL beakers, 3 twist-ties, 3 droppers, small funnel, spotting tile or test tubes, 3 rubber bands, glucose solution, starch suspension, protein solution, iodine solution, Benedict's solution or Clinistix, copper sulfate solution (0.1M) and sodium hydroxide (2M) or Uristix
Activity page 102	stick of celery with a few leaves, beaker, food colouring, single-edged razor blade (or scalpel), microscope and slide
Investigate 13 page 105	digital watch, small aquarium fish (eg guppy), microscope and slide, cotton wool, aquarium or pond water, video microscope (optional)
Activities page 107	**Part A:** pair of sheep's lungs **Part B:** sheep's kidney, single-edged razor blade (or scalpel), scissors, disposable gloves

Special preparations

Skillbuilder page 91	If commercially prepared Benedict's solution is not available, prepare it as follows. To 800 mL of hot water, add 173 g of sodium citrate and 100 g of anhydrous Na_2CO_3. Separately, dissolve 17.3 of $CuSO_4.5H_2O$ in 100 mL of H_2O and slowly add it to the first solution, stirring constantly. Make up to 1000 mL with H_2O. The solution is stable and can be kept for years.
Investigate 11 page 91	Add a small amount of cold water to 10 g of starch powder and stir until a smooth paste. Pour this paste into 500 mL of boiling water and stir rapidly. The starch suspension will form immediately.

* Students to list equipment they will need, which may be different from what is listed here.

5 Food for life

Getting Started

Work in a small group to discuss the following tasks.

- You have just prepared a ham, tomato and cheese omelette. You are pleased with it because the eggs came from your own hens which forage in a large paddock, and the tomatoes you grew in your garden. Draw a food web to show the source of the foods that made your omelette.
- How much do you know about your body? Draw an outline of a body on a piece of A4 paper. Mark on the paper the positions of the following parts of the body: heart, liver, stomach, kidneys, oesophagus, salivary glands, intestines, anus, lungs and brain. Then briefly list the functions of each part.

Starting point

1 The first Getting Started point is a great activity connecting energy, food and everyday life. Revise how to draw a food web (*ScienceWorld 1* Chapter 7). You may choose to draw some food chains before introducing the food web.

2 In their health and personal development, food technology or physical education classes, students have probably gone over some topics about health, nutrition and the human body. Give the class a pre-test to see what they know and if they have any misconceptions. The second Getting Started point can form part of the pre-test.

3 Alternatively, join sheets of butcher's paper together, so each sheet is big enough for the students to trace the full body outlines of their classmates. (This is an ideal activity for small groups.) Arrange them into groups, then ask them to trace around the outline of one group member. They can then draw in the positions of the body parts listed in the second Getting Started point. Ask them to add a description of each organ's function. You may be quite surprised to discover where some students think the organs are located.

4 Ask the students to construct a KWHL chart. The chart helps the students organise and identify what they know and want to learn about a topic:

- **K**: what you already *know* about the topic (under the heading 'What I Know')
- **W**: what you *want* to learn ('What I Want to Learn')
- **H**: *how* you can learn more about the topic ('How I Can Learn More')
- **L**: what you *learnt* about the topic ('What I Have Learnt').

KNOW WANT HOW

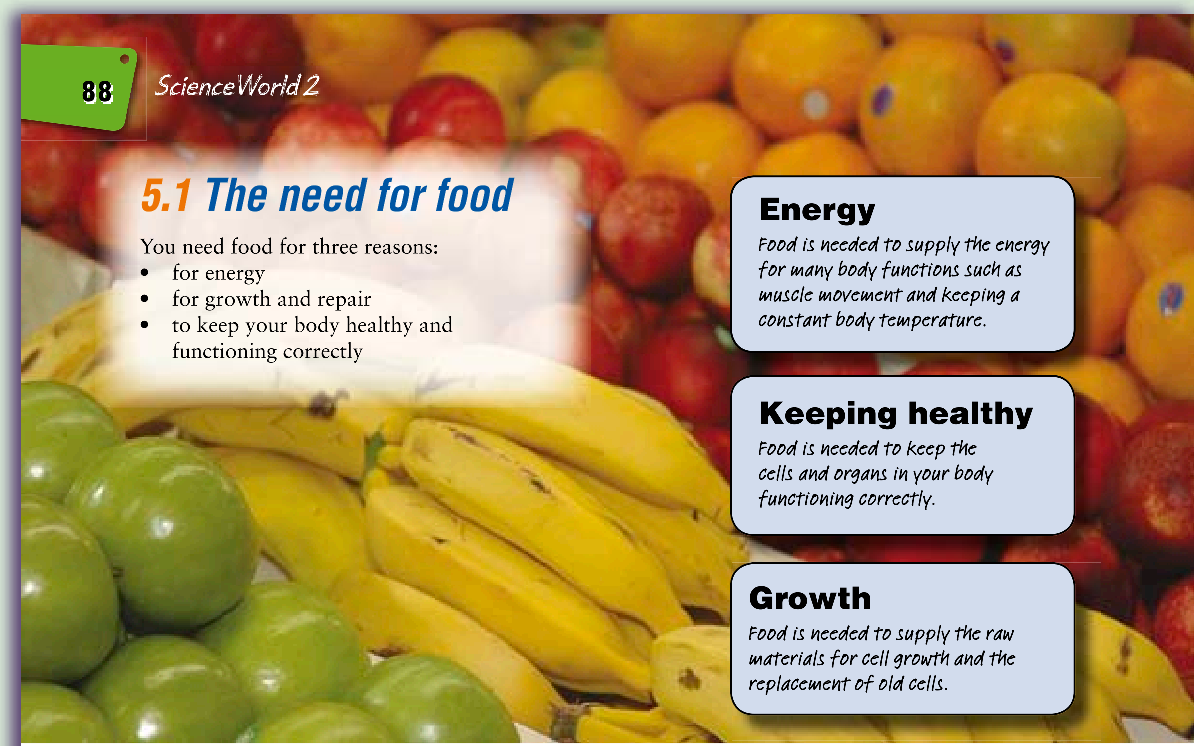
LEARNT

Doing an activity like this promotes self-learning and evaluation as students will want answers to the questions they have listed. At the end of the chapter they can fill in the last section detailing what they have learnt. This encourages self-assessment and critical thinking.

5 While working through this topic, be aware of any student or student's family member who may be suffering from a life-threatening illness. Sensitivity is the key, as the student may not know how they might react when presented with facts or concepts about the human body.

Hints and tips

- ESL students or students with language difficulties may be challenged with spelling and remembering words in this chapter. Be mindful of this when setting assessment tasks. Encourage ESL students to write the words in their native language as well as in English.
- Revise the concept of energy and ask the students to explain its association with this topic. The cartoon on this page should be a good discussion starting point.



5.1 The need for food

You need food for three reasons:

- for energy
- for growth and repair
- to keep your body healthy and functioning correctly

Energy

Food is needed to supply the energy for many body functions such as muscle movement and keeping a constant body temperature.

Keeping healthy

Food is needed to keep the cells and organs in your body functioning correctly.

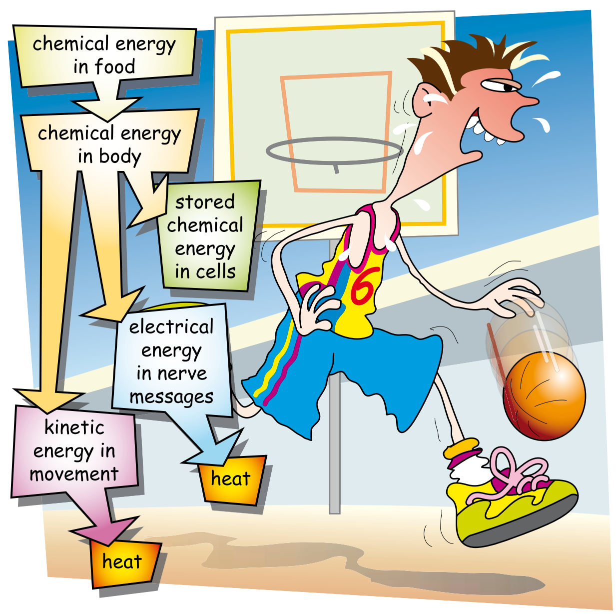
Growth

Food is needed to supply the raw materials for cell growth and the replacement of old cells.

The energy in food

When a nut or piece of spaghetti burns, the chemical energy stored in the food is converted to heat energy. A similar process occurs in your body, but the energy is not released in one chemical reaction. Instead, the food is broken down in a number of steps in chemical reactions in the cells of your body. This process of obtaining energy from food in your body is called **cellular respiration**, or simply, *respiration*.

The chemical energy in the food molecules is converted to chemical energy in other molecules or transformed into other forms of energy. Some of this energy is used in sending nerve messages along nerves, and to supply energy for muscle activity. In all these energy transformations the final energy product is heat, which is eventually given off to your surroundings.



Homework

Ask students to collect current media articles relating to the human body and health. For each article, they should write its date, a summary outlining its main points, an explanation of how it relates to the chapter and their own viewpoint. They could listen to or watch programs like *The Health Report* (Radio National) and *Catalyst* (ABC TV). Transcripts of these programs, and audio and video files, are also available online.

This is an excellent ongoing weekly task that can be done for the duration of the chapter. It promotes science awareness, literacy and critical thinking.

Learning experience

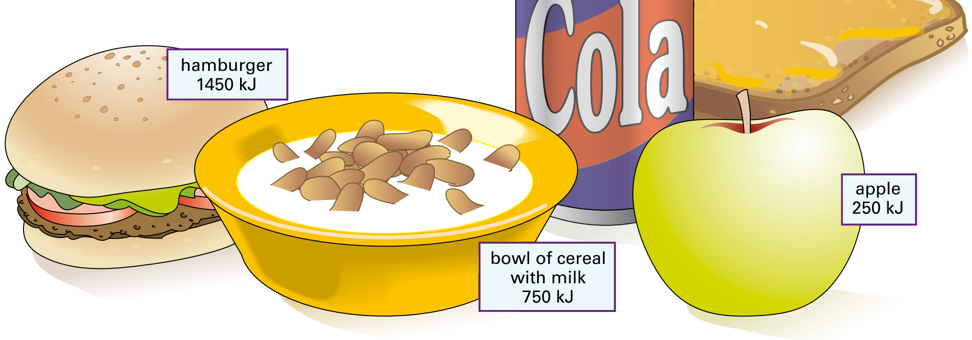
Ask the students to list a series of 'why' and 'what' questions relating to our need for food. Examples include:

- *Why do we need food?* and *What is its link to energy?*
- *Why is it important to have a balanced diet?* and *What is a balanced diet?*
- *Why is it important to exercise?* and *What are some forms of exercise you do?*

Learning experience

Ask the class to draw a flow diagram of how our body uses food energy and how this energy is transformed until the final energy product is heat (given off to our surroundings). The cartoon will help here.

The energy in food is measured in *kilojoules* (kJ). A kilojoule is quite a small amount of energy. It takes about 80 kJ of heat energy to boil a cup of water. The amounts of energy in some common foods are shown below.



Activity

How much energy do you use?

The amount of energy you use each day depends on three factors: how much you are growing, how active you are and how much you weigh.

The table shows the approximate amounts of energy used per hour by a 60 kg person doing various activities.

- List the activities that you did yesterday and the amount of time you spent doing each of them. Then, using the table as a guide, work out yesterday's energy usage over 24 hours. (Assume that you are 60 kg.)
- Calculate how much energy you would use on a very active day. Do the same for a very inactive day. On which day should you eat more? Why?
- Work out how much energy you would use if you stayed in bed all day? Suggest how this energy is used. Would you use more energy standing up? Why?

Activity	Energy used (kJ per hour)
aerobics	7 000
cycling, slow	700
cycling, fast	1 500
dancing	1 000
doing homework	500
housework	600
jogging	2 500
lying still	300
playing ball games	2 800
running fast	10 000
sitting in class	500
sleeping	250
standing	400
using computer	350
walking, slow	600
walking, fast	2 000
watching TV	350

Hints and tips

Be sensitive and aware of any students with weight issues. Remind the students not to make judgments, form opinions or hold prejudices about others in the class. Encourage empathy and understanding.

It is important, however, to discuss health issues relating to weight, and the importance of eating a balanced diet and exercising regularly.

Activity notes

Pose some thinking questions around the activity. Some examples are:

- A handful of nuts and a chocolate bar can give you about the same amount of energy, but why is it better for your health to eat the nuts?
- If you ate a wholemeal bread tuna sandwich, which is about 1200 kJ, what exercise(s) could you do to use up the energy? Why is the sandwich a better alternative than the hamburger?

Learning experience

Ask students to list and discuss some weight-related diseases/disorders. Possible discussion points are:

- Who is more at risk of getting the disease and why?
- How can you minimise your risk?
- As a country, are we doing enough to educate the population and targeting the right people? What would you do?

Learning experience

Do a class survey to see how much exercise the students do per week. Positively affirm those who take the initiative to exercise even if they do not belong to a sporting club or team.

Hints and tips

Students often find facts like these interesting.

- An average loaf of bread is more than one-third water.
- Milk is an excellent source of protein and calcium—a cow produces about 40 glasses of milk a day.
- Vitamin C is essential for maintaining a healthy body, and strawberries contain more vitamin C than oranges.

Homework

Ask the students to construct a food pyramid of the food they eat in an average day. Discuss and show what a healthy food pyramid should look like. Alternatively, ask students to do their own research and find a nutritionally balanced food pyramid, either in books or on the internet. Ask the students to draw a third pyramid showing a more healthy version of their own food pyramid. Get them to indicate where they need to make changes to their own diets, and how they can make these modifications.

Homework

Ask students to develop a food journal of what they eat each day, listing the group(s) each food belongs to and the approximate energy it contains per serve. The energy per serve is listed on the packaging of most processed foods. The internet will have a list of the energy content for unprocessed foods such as fruit and vegetables.

Food types

There are various substances in the food you eat. But the one thing that all food contains is water. For example, potatoes contain 77% water, lettuce 93% and eggs 75%, while peanuts contain only 5% water. The dry matter in foods is made of four main food types:

- **carbohydrates** (sugars, starch and cellulose)
- **proteins**
- **fats**
- **vitamins and minerals.**

Proteins

Proteins provide the materials for the growth and repair of cells. They cannot be stored in the body, so some protein must be eaten regularly. Meat, fish, chicken, nuts, cereals, eggs and cheese are high in protein.

Vitamins and minerals

These are found in very small quantities in foods, but are as important as the other food types. They are used in various cell reactions in the body. Vitamins are found in all fresh fruit, vegetables, beans, nuts and meats.

Carbohydrates

(sugars, starch and cellulose)

Sugars and starch are used for energy. Sugars are found in fruits, honey and sweets. Starch is found in rice, potatoes, bread and pasta.

Cellulose is also called fibre and is found mostly in fruit, vegetables and cereals. It helps keep the food moving in your gut.

Fats

Fats are high in energy, producing about 2.5 times more energy per gram than carbohydrates. Fats are stored by your body as an energy reserve and also to insulate your body from heat loss. Animal fats (eg butter) are usually solid at room temperature, while vegetable fats are usually oils (eg olive oil).

Skillbuilder

Heating a liquid in a test tube

In Investigate 11 you might do a chemical test for glucose. In this test you use a Bunsen burner to heat a liquid in a test tube. This sounds simple, but it is a very difficult laboratory skill.

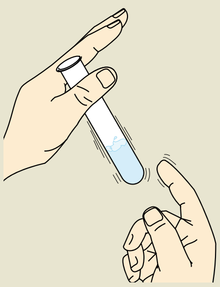
For this Skillbuilder your teacher will give you the following equipment:

- test tube (in a test tube rack)
- test tube holder
- glucose solution in dropper bottle
- Benedict's solution in dropper bottle
- Bunsen burner
- matches

Wear safety glasses.

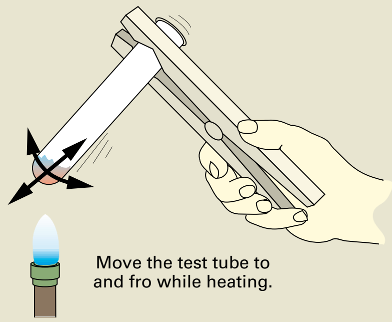
Method

1 Wear safety glasses.
2 Add 2 dropperfuls of glucose solution to a test tube. Then add the same amount of Benedict's solution.
3 Use the technique shown in the diagram to mix the two liquids.



4 Light a burner and turn the collar so that the flame is just off the yellow flame and turning blue.
5 Turn the gas down at the tap to give a small flame.
6 Hold the test tube with a test tube holder and heat the liquid gently. Remember to point the mouth of the test tube away from you and other people.
7 Move the test tube to and fro while you are heating. Don't heat the tube too strongly, otherwise the liquid will quickly boil and splash out of the tube.

Record the colour change.



Move the test tube to and fro while heating.

Investigate
11 TESTING FOODS

Aim

To test various foods for glucose, starch, protein and fat.

Materials

- glucose solution (10% glucose solution)
- starch suspension (20 g starch/L)
- protein solution (10% gelatine solution)
- butter or dripping
- Benedict's solution or Clinistix
- iodine solution (5 g I_2 in 100 mL 10% KI)
- copper sulfate solution (0.1M) and **sodium hydroxide** (2M) solution or Uristix
- brown paper
- spotting tile
- test tube holder
- 4 test tubes, a stopper and a rack
- burner and heatproof mat (or a boiling water bath for the class)
- small pieces of foods, eg cooked rice, fruit, bread, chicken, egg white

Corrosive

Skillbuilder notes

- Be vigilant in checking that students are wearing safety glasses.
- Remind them to turn the burner on to the safety flame when they are not heating the test tube.

Lab notes

- It may take about four lessons to do this investigation and write a full report.
- Clinistix and Uristix are available from local chemists but they are quite expensive. Laboratory suppliers may have them but order beforehand, since they are not always in stock.

Lab notes

Part A

- Insist that students prepare and use tables to record their data. It may be necessary to show them how to construct appropriate tables—this can save time.
- Spotting tiles are ideal but they must be cleaned and the risk of contamination must be managed.
- Iodine stains paper, clothes and skin, so the usual precautions with clothing and bench mats apply (lab coats and newspaper).
- It may be fun for students to test parts of their lunch, although encouraging them to bring food into the lab may be rather tempting and they may find themselves unable to resist eating it. Alternatively, the canteen might have some scraps available.

Planning and Safety Check

- Read each of the 4 food type tests in Part A very carefully.
- Using diagrams and labels only, describe what you have to do in each of the four tests.

SAFE USE OF CHEMICALS

1 **Protein testing solution**
The sodium hydroxide solution is very corrosive. Take care not to splash or drop any on your skin. If you do, wash it immediately with water and tell your teacher. Always wear safety glasses.

2 **Testing glucose with Benedict's solution**
If you are going to heat a test tube containing Benedict's solution with a burner, you **must first do the Skillbuilder** on the previous page. Alternatively, your teacher may set up a boiling water bath for the test tubes.

PART A
Tests for food types

Testing for glucose

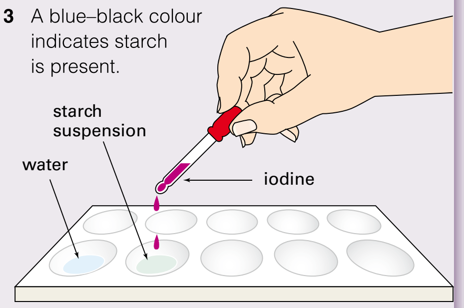
Dip a Clinistix strip into the glucose solution and watch for a colour change, or do the chemical test as follows:

1. Add 2 dropperfuls of glucose solution to a test tube and 2 dropperfuls of water to another test tube (this is the *control tube*).
2. Then add 2 dropperfuls of Benedict's solution to each test tube. Shake each tube to mix.
3. Use a test tube holder to heat each test tube very carefully over a small flame until it boils. Remember to constantly move the test tube to and fro while heating it.
   If your teacher has set up a boiling water bath for the class, place the test tubes in the water bath.
4. A red precipitate will form if glucose is present.

Testing for starch

Use a spotting tile for this test.

1. Add 5 drops of starch suspension to a spot on the tile. Add 5 drops of water to another spot.
2. Then add 2 drops of iodine solution to the starch and to the water.
3. A blue–black colour indicates starch is present.



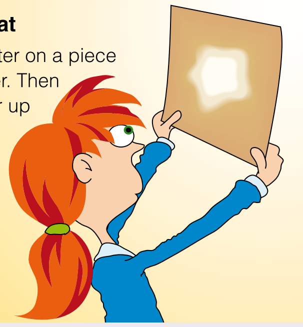
Testing for protein

Dip a Uristix strip into the protein solution and watch for a colour change, or do the chemical test as follows:

1. Add a dropperful of protein solution to a test tube, and a dropperful of water to a second test tube.
2. Add a dropperful of sodium hydroxide solution (take care) to each test tube.
3. Then add 2 dropperfuls of copper sulfate solution to each tube.
4. The blue solution will turn pink if protein is present.

Testing for fat

Rub some butter on a piece of brown paper. Then hold the paper up to the light. Fat leaves a see-through mark on the paper.



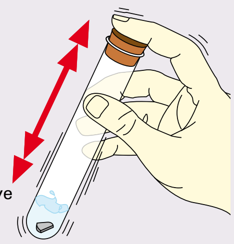
PART B
Testing foods

Method

1 Wash and clean the four test tubes from Part A.

2 Select a piece of food and mash it up. Keep a little of it for the fat test, and add the rest to a clean test tube containing about 5 mL of warm water.

3 To dissolve as much of the food as possible, you need to add a stopper to the test tube and shake vigorously.



Shake to dissolve the food.

4 Pour equal amounts of the mixture into three clean test tubes.

5 Test for glucose, starch and protein as you did in Part A. Test the solid piece of food for fat.

Record your results.

6 Select another food and repeat the above steps.

Discussion

1 Without looking at your book, briefly describe how you tested for glucose, starch, protein and fat.

2 The water test that you used for each food type in Part A is called an *experimental control*. What was the purpose of this?

3 What food types were found in the foods you tested in Part B?

science bits

You are what you eat!

If you need food for energy, why can't you just eat fatty food, which is high in energy? The answer is that your body needs many different nutrients in foods to supply a variety of needs in addition to its energy needs.

If you have a *balanced diet*, you are supplying your body's needs by eating foods in the correct proportions. The table on the right shows an example of a balanced diet with the recommended amounts of foods to be eaten each day.

What's wrong with processed foods?

Processed foods are ones that are manufactured and they include biscuits, pies, chips and most fast foods. The table includes few processed foods; bread and cereals are the only ones. Processed foods often contain a high proportion of fats and very little protein. Always check the packaging for information about the fat and sugar content.

Foods	Daily amount
Lean meat/chicken/fish/eggs	1-2 serves
Dairy foods	2 serves
Wholegrain bread/crispbread	2-3 serves
High-fibre cereal	1 serve
Fresh fruit	2 serves
Vegetables	1-2 cupfuls
Fats and oil (added to food)	3 teaspoons

Questions

Work in a small group to discuss the following questions.

1 Use the table to plan your food intake for a day.

2 What foods have you eaten in the last few days that are not included in the table? Would you consider these foods to be high in fat or sugar?

3 Suggest how your plan from question 1 would change if you were an athlete in training.

Lab notes

Part B

- Insist and check that food scraps are disposed of properly and are not put down the sink.
- Avoid any food containing nuts because of food allergies. Remind students not to taste any food pieces as the science rooms are working laboratories and there are a range of contaminants present.

Hints and tips

If you haven't already done so, show the students an example of a healthy food pyramid. Explain how useful it is in planning nutritionally balanced meals.

Learning experience

Ask the students to devise a weekly menu using the information in the table above (or using a food pyramid). Students should write a balanced dietary menu, but allow for creativity, and encourage neat presentation as well. Keen students could assign the energy content per serving for each food item in their menu.

Doing an application task like this helps the student connect what they have learned with the real world. When you collect and review the menus, they will give you a sense for how well the students have understood the concepts involved.

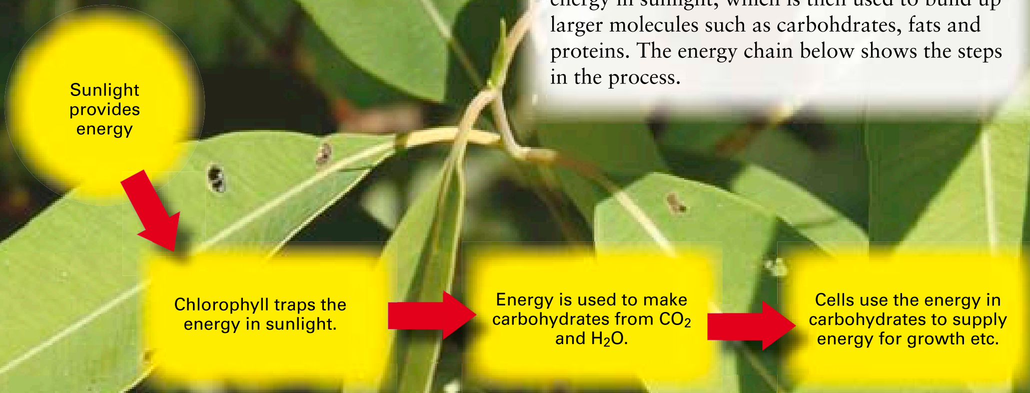
Hints and tips

- Explain why there is an increasing awareness of organic farming practices. Why shouldn't we keep adding fertilisers to the soil if they are supposed to improve its fertility? What sorts of natural fertilisers are being used?
- Make a list of what our body's average daily vitamin and mineral intake should be, and list which foods these nutrients can be found in.

Where does food come from?

Look back at your Getting Started notes. Notice in the food webs you constructed, green plants are at the beginning of each of them. This is because green plants make their own food by the process of *photosynthesis*, and supply food to all the other organisms in the food web.

The chlorophyll in green plants absorbs the energy in sunlight, which is then used to build up larger molecules such as carbohdrates, fats and proteins. The energy chain below shows the steps in the process.



The foods plants make

Carbohydrates contain carbon, hydrogen and oxygen atoms. These are made from carbon dioxide (CO_2) and water (H_2O).

Fats also contain carbon, hydrogen and oxygen atoms. But the atoms are arranged in different ways from those in the molecules of carbohydrates.

Proteins contain nitrogen as well as carbon, hydrogen and oxygen. Plants absorb nitrogen from the soil in the form of compounds called *nitrates*, which are soluble in water. These nitrates are absorbed by the roots and are transported to those cells which are photosynthesising. Here they are made into proteins.

Many other elements, such as phosphorus, calcium, potassium, sulfur and magnesium, are also absorbed by the plant's roots. For example, magnesium is needed in quite large quantities since it is part of the chlorophyll molecule. Other elements, such as boron, are needed in very small amounts. Fertile soil contains an abundance of the elements needed for plant growth. These elements are called *soil nutrients*.

In natural environments, animal wastes and dead organisms are decomposed by bacteria and fungi in the soil. The resulting nutrients dissolve in water and increase the fertility of the soil. These processes form a nutrient cycle. On the other hand, where farmers harvest plant crops before they die and decay, there is much less nutrient recycling. For this reason, fertilisers have to be added to the soil.

Homework

Ask students to imagine they have just acquired a fertile piece of land and wish to farm it. They are not sure whether to go organic, or farm using the non-organic methods of everyone else around them. Ask them to prepare a report detailing the pros and cons of organic farming. How will they decide to farm (organic or not organic) and why?

Learning experiences

Try one or more of the following activities:

1. Ask the students to explain to a partner what this week's lessons in science were about. Give a time limit of no more than 5 minutes.
2. Ask a set of 'quick questions' at the start of the lesson on the material already covered. Students only need to record answers. Spend no more than 5 to 10 minutes on this.
3. Ask some students to read one of their reports, or a media article, aloud to the class. (See the Homework note on page 88.)
4. See if the students are able to put the following question in context with everyday life and this chapter:

   Legumes, such as beans and peas, are grown not only for eating, but also for improving the soil. Why?

Check!

1 For each of the words below, write a sentence to show that you understand its meaning.

respiration proteins
nutrients carbohydrates

2 Some of the sentences below are incorrect. Choose the incorrect ones and rewrite them to make them correct.

- **a** Vitamins and minerals are needed in large amounts by your body.
- **b** Vitamins and minerals are found in fresh fruit and vegetables, nuts and meats.
- **c** Proteins are used to supply your body with energy. They can be stored by the body.
- **d** Plants absorb all of the raw materials for growth and energy from the soil.
- **e** Cellulose is called fibre and helps keep the food moving in your gut.
- **f** Dead organisms and wastes decompose and are a source of soil nutrients.

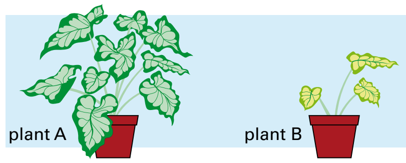
3 Write a paragraph to explain to someone a couple of years younger than you why we need food.

4 Draw a table with 3 columns and label the columns Carbohydrates, Proteins, Fats. In each column list at least 4 foods that would contain a high proportion of the food type. For example, eggs would go in the protein column.

5 Bronwyn and Leong sit down together to eat lunch. Bronwyn eats a roast chicken leg and two chocolate biscuits. Leong eats an apple, a banana, and some sultanas.

- **a** Whose lunch contains more protein?
- **b** Whose lunch contains more fibre?
- **c** What does nutritious mean? Who is eating the more nutritious lunch?

6 Plant A in the diagram below was grown in fertile soil. Plant B, on the right, was grown in soil poor in nitrates. Suggest why the plants are different.



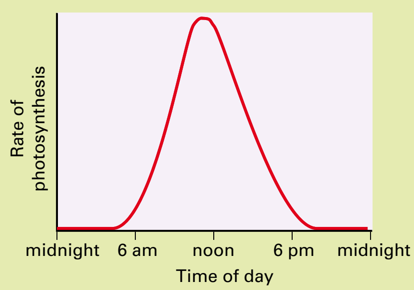
challenge

1 Tan Long weighs 60 kilograms. She works as a computer operator from 8 am to 4 pm. To get to and from work, she walks for 30 minutes to get to the train, has a 30-minute train ride, then walks for another 15 minutes. She does aerobics for an hour on the way home from work, does housework for an hour, eats dinner and watches TV between 7.15 pm and 8.30 pm, reads until 10, then sleeps till 6 am. She sits and has breakfast until 6.45 am.

Use this information and the table in the activity on page 89 to estimate the amount of energy Tan Long uses each day.

2 Draw an energy chain to show what happens to the energy in sunlight that is absorbed by a plant leaf and eventually stored as chemical energy in an animal's body.

3 The graph below shows the rate of photosynthesis occurring in a leaf over 24 hours. In terms of energy, explain the shape of the graph.



Check! solutions

1
- Respiration is the process in living things in which the food which is eaten and the oxygen which is breathed in combine to release energy which is necessary for life.
- Proteins are an important food type which we eat. They are important for growth and repair.
- Nutrients include all of the chemicals which are needed by a living thing. Plants and animals have quite different nutrients.
- Carbohydrates include sugars, starch and cellulose. They are very important as a source of energy for most living things.

2
- a False. Vitamins and minerals are needed in *small* amounts by your body.
- b True.
- c False. Proteins are *not* used to supply your body with energy. They *cannot* be stored by the body.
- d False. Plants absorb all of the raw materials for growth from the soil and the *air*, and obtain the energy they need from the *sun*.
- e True.
- f True.

3 We need to eat food so that our bodies can work properly. Food helps us to grow and move around. Eating food is like putting petrol in a car. When it is burned it produces heat and allows movement.

4 An example of a correct table is:

Carbohydrates	*Proteins*	*Fats*
bread	eggs	olive oil
fruits	meat	butter
honey	nuts	margarine
cellulose	cereals	fried foods

5
- a Bronwyn's lunch contains more protein.
- b Leong's lunch contains more fibre.
- c Nutritious means the best balance of nutrients. Leong's lunch is more nutritious because it contains a good mixture of carbohydrates, fibre, vitamins and minerals, with very little sugar.

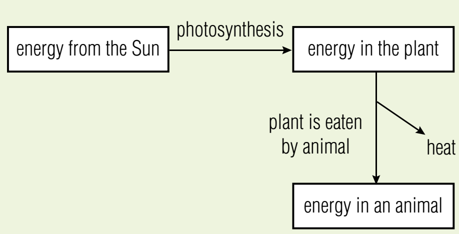
6 The plants are different because the plant on the right does not have enough nitrate. Nitrogen is very important because the plant needs it to make proteins which are used for growth.

Challenge solutions

1 The energy used is as follows:

Computing	8 hr @ 500	4000 kJ
Walking	1.5 hr @ 600	900 kJ
Aerobics	1 hr @ 7000	7000 kJ
Sitting on train	1 hr @ 500	500 kJ
Watching TV	1.25 hr @ 350	440 kJ
Reading	1.5 hr @ 500	750 kJ
Sleeping	8 hr @ 250	2000 kJ
Housework	1.75 hr @ 600	1050 kJ
Daily total		**16 640 kJ**

2 An energy chain would look like this:



3 The amount of photosynthesis which occurs in a plant depends mainly on the amount of light available. No photosynthesis will occur at night and most will occur in the middle of the day when the sun is shining most brightly.

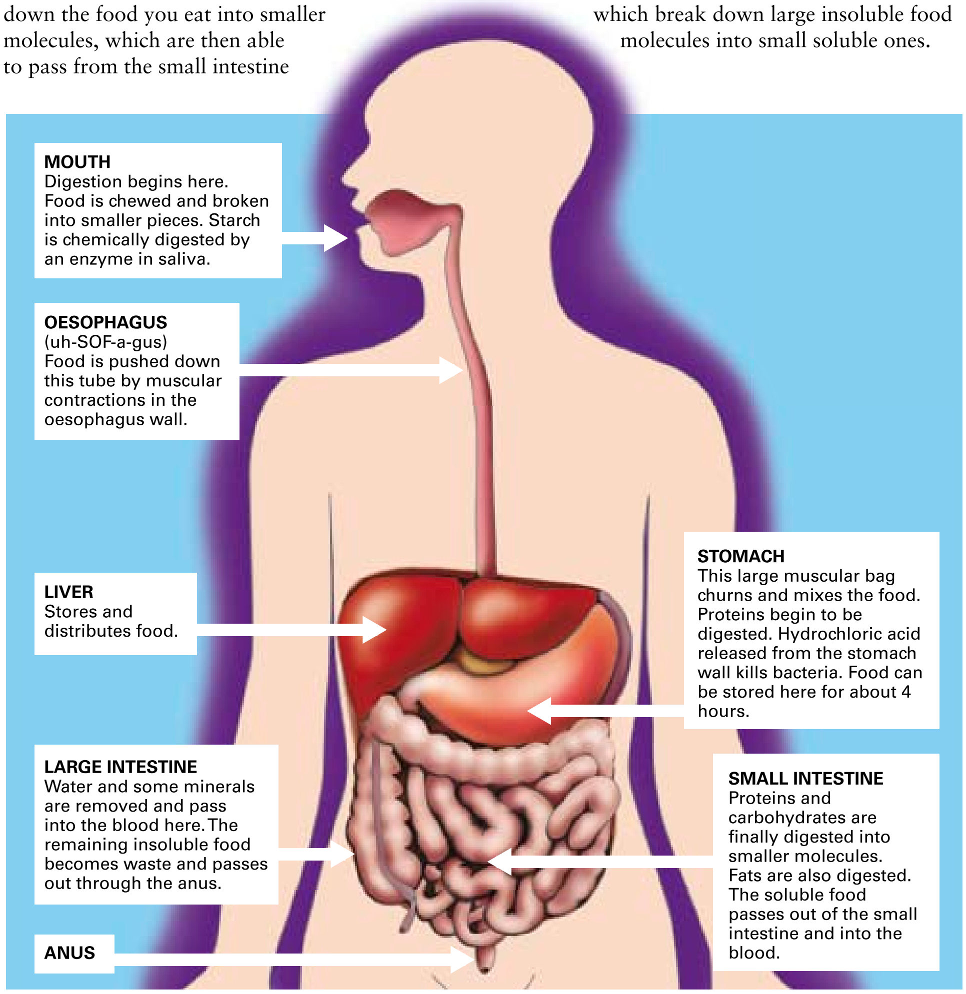
Hints and tips

- Students tend to forget that digestion begins in the mouth and is both the physical and chemical breakdown of food—keep reinforcing this information.
- Revise the role of enzymes (page 34). Enzymes in the human body are proteins which are catalysts. Nearly all enzymes are highly specific in their action and therefore enormous numbers of them are found in nature. (Often a co-enzyme is required so the enzyme can carry out its proper function.) A catalyst alters the rate of a reaction (ie speeds it up or sometimes slows it down) but is itself unchanged (page 32).

5.2 Digesting food

When you take a bite out of a hamburger, you chew the mouthful of food a few times, then swallow it. That is the last you see of the hamburger. How is the hamburger digested? The diagram of the *digestive system* or *gut*, will help answer this question.

The job of the digestive system is to break down the food you eat into smaller molecules, which are then able to pass from the small intestine into your blood. **Digestion** is both the physical breakdown of large lumps of food into smaller ones, and the chemical breakdown of food. The chemical breakdown occurs with the help of substances called enzymes (EN-zimes), which are made in special cells in your body. These substances speed up chemical reactions, which break down large insoluble food molecules into small soluble ones.



Learning experiences

- Devise a 'What am I?' quiz about the digestive system. Get the students to guess if you are describing the large or small intestine, photosynthesis, an enzyme and so on.
- A very worthwhile activity is making playdough models of the human digestive system. The model should be less than the size of an A4 piece of paper and constructed on large tiles or plastic wrap (cling wrap or GLAD® Wrap).
- Ask the students to write and act out a role play about the digestive system. They will find it great fun, but limit the time spent on this activity.
- The students could write a creative yet scientifically accurate story about the journey of a hamburger or apple being eaten and digested by a human. Start them off with an opening sentence or story title: 'Chomp, chomp, chomp … oh, and to think I once was a beautiful …' is one example!

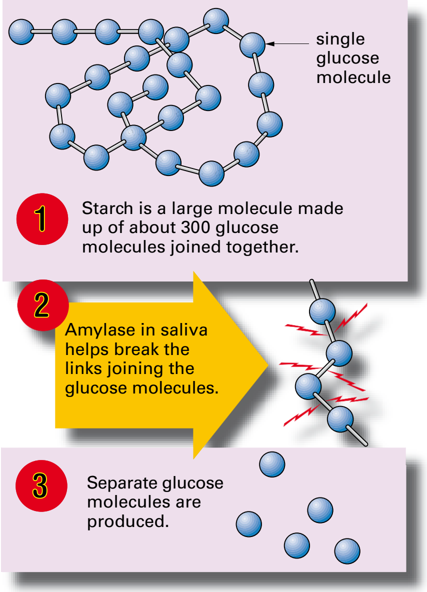
Digestive enzymes and food

Enzymes that break down carbohydrates into sugars such as glucose are called *amylases* (AM-ill-AY-zes). Amylases are made in the salivary glands in the mouth and in other glands in the digestive system. The diagram on the right shows how amylase helps break down starch to glucose.

Enzymes called *proteases* (PRO-tee-AY-zes) break down proteins into amino acids. These molecules are essential for your body to build structures such as cell membranes. Proteases are made in glands in the stomach and the small intestine.

The enzymes that break down fats (lipids) are called *lipases* (LIE-pazes). Fats are broken down to fatty acids.

Working with technology: To see how a model explains how enzymes work, open the **Enzyme action** animation on the CD.



science bits

Enzymes in detergents

Some washing detergents contain enzymes. They are added to the detergent to remove stains made by proteins such as blood and eggs, and stains from other biological sources.

Proteins are very large molecules, and many are insoluble in water. They are made up of many smaller units called amino acids. All amino acids are soluble in water.

The enzymes in detergents work by attacking the protein in the stain and breaking it down into smaller, soluble amino acids. The stain gradually fades as the smaller particles are removed from the fabric by the agitation of the washing machine and dissolved in the washing water.

try this

Design a test to show the effectiveness of enzyme-containing detergents on pieces of cloth stained by fresh meat, egg, grass or other plants.

To make it a fair test, you will have to control a number of variables. Check the instructions on the packets of detergents and discuss your design with your teacher. (See Chapter 1 for designing fair tests.)

Hints and tips

- Get students to compile a dot-point summary of the chapter so far. This can be added to later and used as a revision tool for tests or examinations.
- Ask a set of 'Quick Questions' at the start of the lesson on the material already covered. Frequently asking questions helps reinforce concepts and definitions. It also helps them to identify the key points.

Animation

Students should view the animation *Enzyme action* on the CD.

Research

Ask students to research a disease of the digestive system and present the information as a pamphlet similar to those available in chemists' shops. Their pamphlet needs to include the disease's symptoms, its causes, how the disease affects the digestive system and how it's treated.

Learning experience

If the students have not already done so, get them to investigate how many different enzymes there are in the human body. Construct a table with the enzyme's name, its purpose, if it speeds up or inhibits a reaction, and where it functions in the body. Revisit this activity if students have already done it.

Learning experience

It is best if the students work in groups for the Try this in 'Enzymes in detergents'. The students' experimental designs will determine how much powder is required and if different types are needed. Washing powder is expensive to purchase, so ask each group member to bring in a small amount from home, with the washing instructions. Remind them to make sure the powder contains enzymes.

Lab notes

- Saliva will work but there are a number of issues with it, such as:
  - —health concerns about producing and using saliva
  - —low concentration of enzyme and therefore a slow reaction
  - —possible contamination of saliva with food in the mouth.
- The use of saliva is therefore NOT recommended. Go through the issues with the class and explain why saliva should not be used.
- Amylase powder is available from laboratory suppliers (eg Southern Biological). It is usually mixed with water and acts much more reliably than saliva. It is a good idea to make up a fresh mix and keep it in the fridge.
- Allocate planning time to the students. Encourage them to think about the concepts they have covered in the last few lessons and approach the experiment in an informed way. Check their planning and method before they attempt to perform the experiment.

Experiment
ENZYME ACTION

The enzyme amylase (found in saliva) breaks down starch into glucose. This reaction occurs in the mouth and in the small intestine. Can the reaction be demonstrated in the laboratory?

The problem to be solved

Your task is to work in a small group to design a test to show that amylase acts on starch to produce glucose.

Designing your experiment

1. Read the information in the Hints and tips box. Then work in your group to design tests.
2. Make a list of the equipment you will need.
3. Discuss how you are going to record your observations.
4. Discuss your draft design with your teacher. When you and your teacher are happy with it, get started.

Writing your report

1. Write a full report of your experiment, using the headings: Title, Aim, Materials, Method, Results, Discussion and Conclusion.
2. Your discussion should contain an inference that tries to explain your observations.
3. You might like to take a digital photo of your set-up and include it in your report.

Hints and tips

1. You will need the following chemicals for your experiment.
   - starch suspension (20 g starch/L)
   - iodine solution
   - glucose solution (10%)
   - Benedict's solution or glucose test strips (Clinistix)
   - amylase solution (your teacher will prepare this from amylase powder)

   Check with your teacher if you think you need other chemicals.
2. The action of amylase occurs in the body at about 35°C. You will need to sit your test tubes in a container of water at about this temperature to get reliable results.
3. You must include control tubes in your tests. Remember you have to compare the colours of your tests with the control tubes.
4. Use a long dropper to take out samples of liquids in the test tubes and test them on a spotting tile or in small test tubes as shown in the photo.

Food for cells

When it reaches the small intestine, the food is like thick, creamy soup. The soluble food is made up of small molecules that are able to pass through the small intestine wall. From here they pass into the blood in the many blood vessels that surround the small intestine. This dissolved food travels to the liver and is then distributed to cells in all parts of the body. Here the soluble food particles leave the blood and pass through the cell membrane into the cytoplasm of the cell.

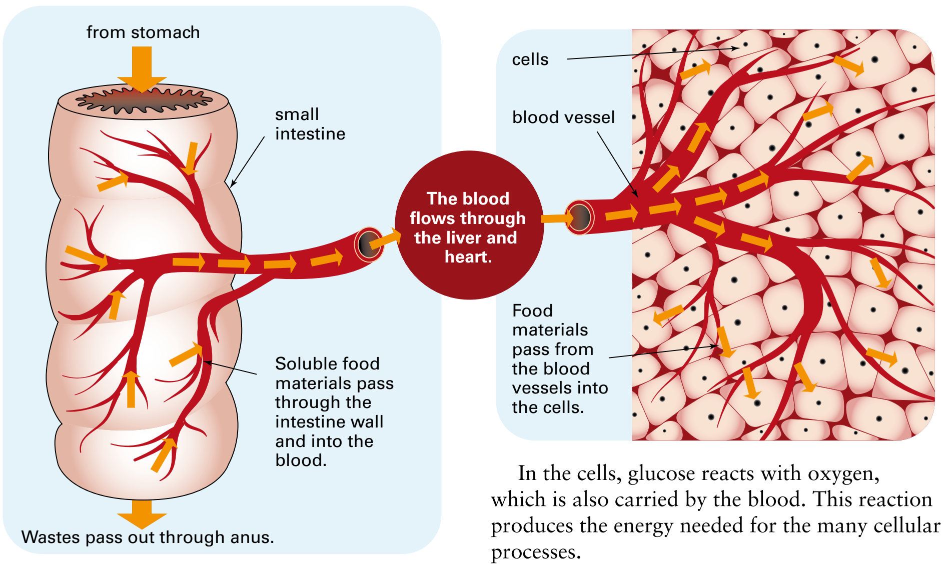
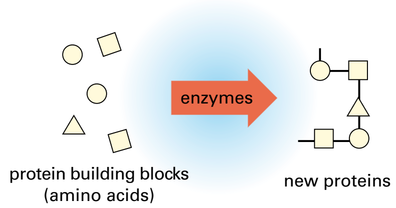


Fig 16 The inside of the small intestine has many tiny projections called villi (VIL-ee) to increase its surface area. This allows more food to come in contact with the intestinal wall.

In the cells, glucose reacts with oxygen, which is also carried by the blood. This reaction produces the energy needed for the many cellular processes.

glucose + oxygen ➡ carbon dioxide + water + ENERGY

The energy produced during cellular respiration is used for many body processes and for the growth and repair of cells. For example, the small molecules from the digested protein molecules are joined together to make new proteins, which are used to make membranes, organelles and other cell structures. Enzymes are required for these reactions.



Hints and tips

- Remind students not to write the word *sugar* instead of *glucose*. Glucose $C_6H_{12}O_6$ occurs in honey and sweet fruits. Other carbohydrates and sugars are converted into glucose in the human body before being used as an energy source.
- You may wish to refer to page 115 to show students the structure of a cell.

Homework

Set students the task of finding out what the chemical equation (unbalanced) for glucose reacting with oxygen is, in symbols.

Learning experience

As the students enter the room, hand them a card containing a word relating to the chapter (*mouth*, *stomach*, *enzyme*, *photosynthesis*, *respiration*, etc). When seated, randomly ask some students to read out the word and in one minute describe where it is located or where it occurs, its function and any other useful information they can remember.

Lab notes

- Watch for students with long fingernails and warn all students about the danger of damaging the tubing.
- Highlight the importance of step 3. Remind the students about cross-contamination. They need to be very careful not to get any glucose, starch or protein solution into the beakers containing water.
- It is a good idea to leave the tubes and beakers in a tray in case some fluid overflows onto the bench, and for easy storage if they are left overnight.
- Put the beakers on a piece of scrap paper with the names of the students, or initial each beaker label to avoid disputes.

Assessment task

This would be a good place to set *Assessment task 5: An energy budget*, found on the CD.

Investigate 12 MODEL INTESTINES

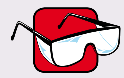
Aim

To investigate the sort of molecules that can pass through membranes.

Materials

- 3 lengths of cellophane tubing (15 cm)
- three 250 mL beakers
- 3 twist-ties
- 3 droppers
- small funnel
- spotting tile or test tubes
- 3 rubber bands
- glucose solution (10%)
- starch suspension (20 g starch/L)
- protein solution (10% gelatine solution)
- iodine solution
- Benedict's solution or Clinistix
- copper sulfate solution (0.1M) and **sodium hydroxide** (2M) solution or Uristix

Wear safety glasses.

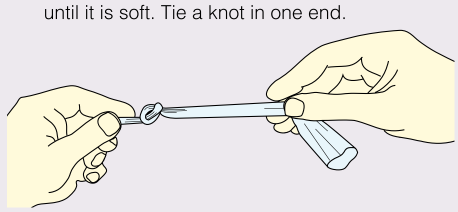


Corrosive

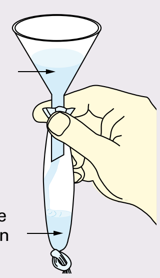
Method

1 Pour about 150 mL of distilled water into one of the beakers.

2 Hold a piece of cellophane tubing under water until it is soft. Tie a knot in one end.



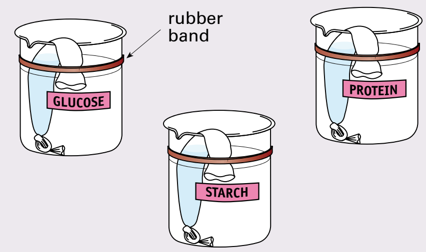
3 Rub your fingers back and forth on the other end until the tubing opens. Use a small funnel to three-quarters fill the tubing with glucose solution. Then rinse the outside of the tubing with water.



4 Place the tubing in a beaker and label it Glucose. Secure the open end of the tubing with a rubber band on the outside of the beaker.

5 Repeat Steps 1 to 4 for the second piece of tubing, but this time use starch instead of glucose.

6 For the third piece of tubing use protein solution.



7 Leave the beakers for at least 15 minutes (better if left overnight).
Transfer a drop of the water surrounding the tubing in the first beaker to a spotting tile or test tube. Test it for glucose (see page 92). Test the water in the second beaker for starch and the third one for protein (see page 92).
Record your results in a data table.

Discussion

1 What do your results suggest about the sizes of the molecules that can pass through the cellophane tubing?

2 If the cellophane tubing behaves in the same way as your small intestine wall, what can you infer about the passage of substances across the small intestine wall?

3 Use this investigation to explain why food has to be digested before it is used by your body.

try this

Does salt (sodium chloride) pass across membranes? Design a test to investigate this.

Challenge solutions

1 a You would expect that the amount of starch would slowly decrease as time progressed.
b The purpose of sampling at intervals is to learn more about the rate of reaction and to find the time when all of the starch disappears.

2 Everyone's fantasy story will be different, but there should be mention of the ham sandwich containing the three major food groups. These are carbohydrates, fats and proteins. For each of these the student should say where digestion and absorption occurs.

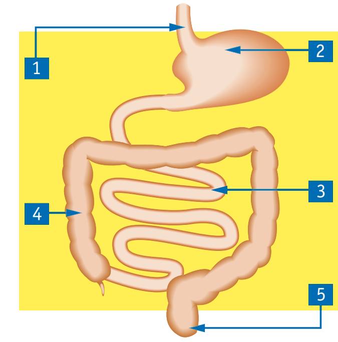
Check!

1 Copy and complete the following sentences.
- **a** The speed of breakdown of foods into smaller particles is increased by ______.
- **b** Digested food passes through the ______ ______ wall and into the blood.
- **c** The oesophagus joins the ______ to the ______.
- **d** In the large intestine ______ and ______ are removed and absorbed by the blood.

2 What is cellular respiration? In your description, list the substances that are used and produced. Then write a word equation.

3 Look at the simple diagram of a human gut on the right. In which numbered part:
- **a** does protein digestion first occur?
- **b** is most of the digested food absorbed by the blood?
- **c** do wastes and insoluble material pass out of the body?
- **d** does food enter from the mouth?
- **e** is acid released to kill bacteria?
- **f** are fats digested?
- **g** is food stored for short periods?
- **h** are water and some minerals removed?

(You may have to use some numbers more than once.)



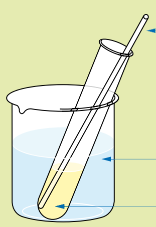
4 The inside of the small intestine is not smooth but is folded and contains many tiny projections. What is the reason for this?

5 How does the function of the stomach differ from that of the small intestine?

6 Describe two functions of the mouth in digestion.

challenge

1 In an experiment on starch and saliva, the equipment below was set up.



A drop was removed from the test tube using the glass tubing and placed on a spotting tile. Iodine was added to this drop. This procedure was repeated every 10 minutes for one hour.
- **a** What results would you expect?
- **b** What was the purpose of sampling at 10-minute intervals?

2 Suppose you were a ham sandwich. Write a fantasy story of what would happen to you if you were eaten and digested by a human.

3 When a piece of bread is placed on your tongue, nothing can be tasted. After a short while, a sweet taste can be detected. Infer the reason for this.

4 Suppose you wanted to test the effect of temperature on the activity of the amylase enzyme in saliva. Describe how you would do this.

5 Some cells in your body, eg muscle cells, use more digested food materials than others. Explain why this is so.

6 There is an increase in the amount of materials carried away from muscle cells during exercise. Suggest what materials these are, and explain the reason for the increase.

Check! solutions

1 These are the completed sentences.
- a The speed of breakdown of foods into smaller particles is increased by *chewing*.
- b Digested food passes through the *small intestine* wall and into the blood.
- c The oesophagus joins the *mouth* to the *stomach*.
- d In the large intestine *water* and *some minerals* are removed and absorbed by the blood.

2 Cellular respiration is the process in the cells of your body that produces the energy you need to live and move. The substances used in this process are the food you eat and the oxygen that you breathe. The substances produced are carbon dioxide and water.

The word equation is:

food + oxygen → carbon dioxide + water

3
- a Protein digestion occurs first in organ number 2.
- b Most digested food is absorbed by organ number 3.
- c Wastes and insoluble material pass out of the body through organ number 5.
- d Food enters organ number 1 from the mouth.
- e Acid is released to kill bacteria in organ number 2.
- f Fats are digested in organ number 3.
- g Food is stored for short periods in organ number 2.
- h Water and some minerals are removed in organ number 4.

4 The folds and tiny projections provide a much greater surface area for absorption of soluble foods after digestion has occurred.

5 The stomach is concerned mainly with the storage of food and digestion of proteins. The small intestine is mainly concerned with the digestion of fats and carbohydrates and absorption of digested food into the blood stream.

6 Two important functions of the mouth are to chew the food into smaller pieces and also to produce saliva which acts as a lubricant and starts the digestion of starch.

The student could also mention the sensations involved in travelling through the dark, slippery and twisty gut.

3 A likely inference is that the bread is slowly digested by an enzyme in your saliva. When this happens some of the starch is changed to glucose. This explains the sweet taste after a short while in your mouth.

4 One way to do this would be to set up four test tubes. Into each test tube place the same amount of starch and saliva. After about 20 minutes take a few drops from each test tube and test for the presence of glucose. Now place one of the tubes in the fridge (about 4ºC), one in a cupboard at room temperature (about 20ºC), one in an oven or water bath at about 37ºC and the other in an oven at about 50ºC. You could record your results in a table and then possibly draw a graph.

5 Some cells use more energy than others because they have different functions. For example, muscle cells move your limbs and need much more energy than, say, liver cells or skin cells.

6 When muscle cells are active they produce waste products. These are carbon dioxide, which is carried away in the blood, and water, which is usually used in the cell. These are produced as waste products of cell respiration.

Hints and tips

Set aside some time for the students to reflect on the concepts they have learnt so far in this topic. See how many of the KWHL questions (see 'Starting points' at the beginning of the chapter) have been investigated or answered.

Activity notes

- Revise how to use a microscope (*ScienceWorld 1* page 184).
- It is worth demonstrating to the class how to use a microscope. Turn it into a quiz to make it more interesting or ask the students to instruct you how to use it.
- Make sure the students take great care with the scalpel or razor blade. Make sure they use a cutting board.

5.3 Using food

In large multicellular organisms food has to be transported to all cells. These cells may be quite a distance from the places where the food was made or digested. For example, in a large eucalypt tree, the food that is made in the leaves may be as far as 30 metres from the cells in the roots. In a blue whale, the food digested in its intestine may have to be transported 20 metres to its brain cells.

How do plants transport food? The photo of a leaf below shows the **veins**. These are the structures which transport materials around the plant.

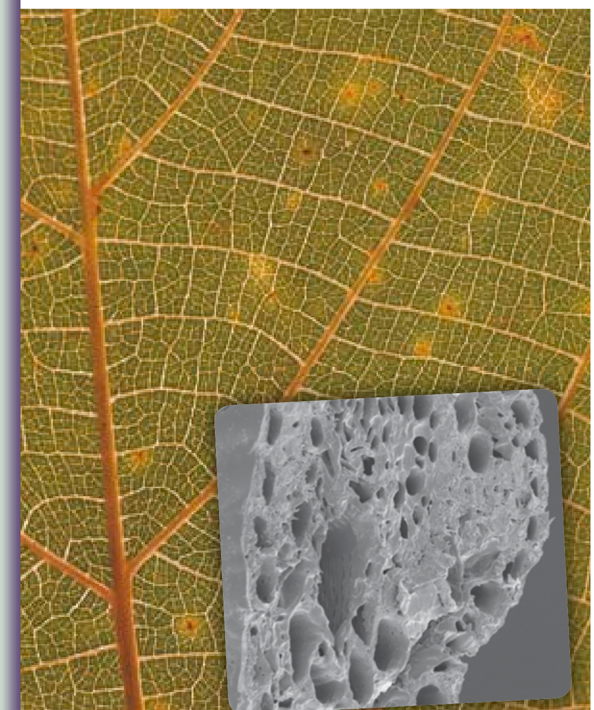


Fig 23 A leaf showing the veins. The small photo, taken using an electron microscope, shows how the veins are made up of many microscopic tubes called conducting vessels.

Activity

In this activity you will observe the conducting vessels in the stem of a plant.

You will need a soft stem with a few leaves (celery works well), a beaker, food colouring, a single-edge razor blade (or scalpel) and a microscope and slide.

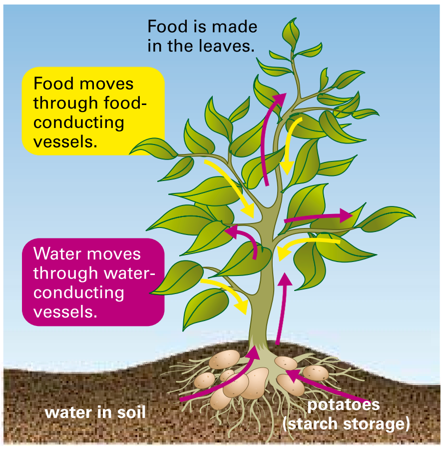
1. Half fill the beaker with water and add some food colouring.
2. Cut the end off the plant stem and immediately place the stem in the beaker of coloured water. Leave it there for a few hours or overnight.
3. Take the stem out of the water and hold it up to the light.
   Can you see the colouring in the stem?
4. Use the razor blade to carefully cut a very thin cross-section of the stem. (This may take a bit of practice.)
5. Set up a microscope and view the cross-sections.
   Draw a sketch of your stem cross-section.

Learning experience

Pose some higher-order thinking questions where the students have to apply the knowledge from this chapter to a real-world situation. Ask them to make an inference to answer each question. They may like to devise a way of testing the question. Consider questions such as:

- In autumn, some plants lose all their leaves (ie deciduous plants). If plants require energy from the sun for photosynthesis, does this still happen if there are no leaves?
- How does the plant transport materials around it? What 'pumps' the materials around the plant?

The conducting vessels you saw in the activity on the previous page were water-conducting vessels. Food-conducting vessels transport materials such as glucose and proteins.



The glucose that is made in photosynthesis is stored in the form of insoluble starch in the leaves. In some plants, such as carrots, sweet potatoes and turnips, a large amount of starch is stored in the main root, which swells as it stores the starch. Potatoes, yams and ginger store food in special underground stems called *tubers*.

Fig 26 Carrots store food in the form of starch.

Transport in humans

Blood carries food and oxygen to all cells in your body and carries wastes away from them. Blood looks like a red liquid, but it is actually a suspension of **red blood cells** in a pale yellow liquid called **plasma.** Plasma is mainly water, but also contains dissolved food (mainly glucose), waste products, and minerals. The red blood cells carry oxygen from the lungs to the cells to be used in cellular respiration.

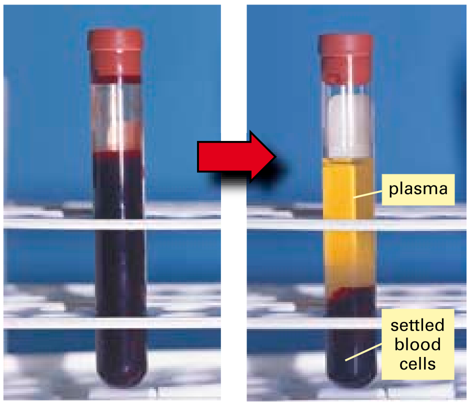


Fig 27 Blood is a suspension of blood cells in plasma. When left, the blood cells settle out leaving the pale yellow plasma.

After the food has been digested in the small intestine and absorbed into the blood, it is carried to the **liver**. This is the largest organ in your body and functions as a warehouse and sorting-out or distribution centre for foods.

When a meal is eaten and digested, a large quantity of glucose, amino acids and fatty acids is carried to the liver. Some of the glucose molecules are joined together with the help of enzymes to form a large molecule called *glycogen*, which can be stored in the liver.

Some fats can be stored in the liver, but most are stored in special fat cells in tissue under the skin and around essential organs such as the heart and kidneys.

Hints and tips

Check that ESL students or students with language difficulties are keeping up with new words and terms.

Homework

Explain to students that carrots store food in the form of starch. Ask them to obtain a carrot top (top 1–2 cm of the carrot). Put some damp/wet cotton wool onto a plastic lid. Now place the piece of carrot (top up) onto the cotton wool. Position the carrot on a windowsill and keep the cotton wool damp. Students should predict what they think is likely to occur and why. They should then note what happens over the next few weeks.

Learning experience

Students could develop a flow diagram of energy processes in the human body. Ask them to link it with the digestive process and the human transport system. Alternatively, they could develop a concept map and illustrate it with pictures.

Hints and tips

- One way for students to remember that arteries carry blood *away* from the heart is to remind them that **a** is for artery and **a** is also for away. Then they need to remember veins do the opposite.
- Photocopy worksheets which include diagrams of the circulatory system that students can colour in. Students should be able to recognise the main arteries/blood vessels, lungs and heart.

Animation

Students should view the animation *The heart* on the CD.

The heart and blood vessels

Your heart is a muscular organ that keeps pumping blood to your body about 70 times a minute for the whole of your life.

The blood vessels that carry blood away from the heart are called **arteries**. **Veins** carry blood back to the heart. Arteries and veins have the same layers of elastic and muscular tissue, but the layers in the arteries are much thicker (see Fig 28). As the heart contracts, blood is forced through the arteries. The heartbeat can be felt as a pulse near your wrist and in your neck.

The large arteries and veins form many branches throughout the body. The narrowest arteries and veins branch into microscopic vessels called **capillaries**, which are very thin, usually only one cell thick. Food, oxygen and water pass through the capillaries to the cells, and wastes pass back as shown in the diagram below right.

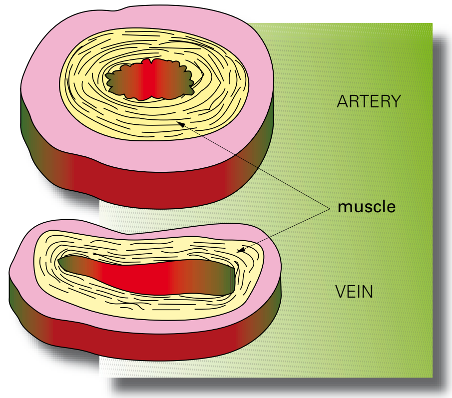
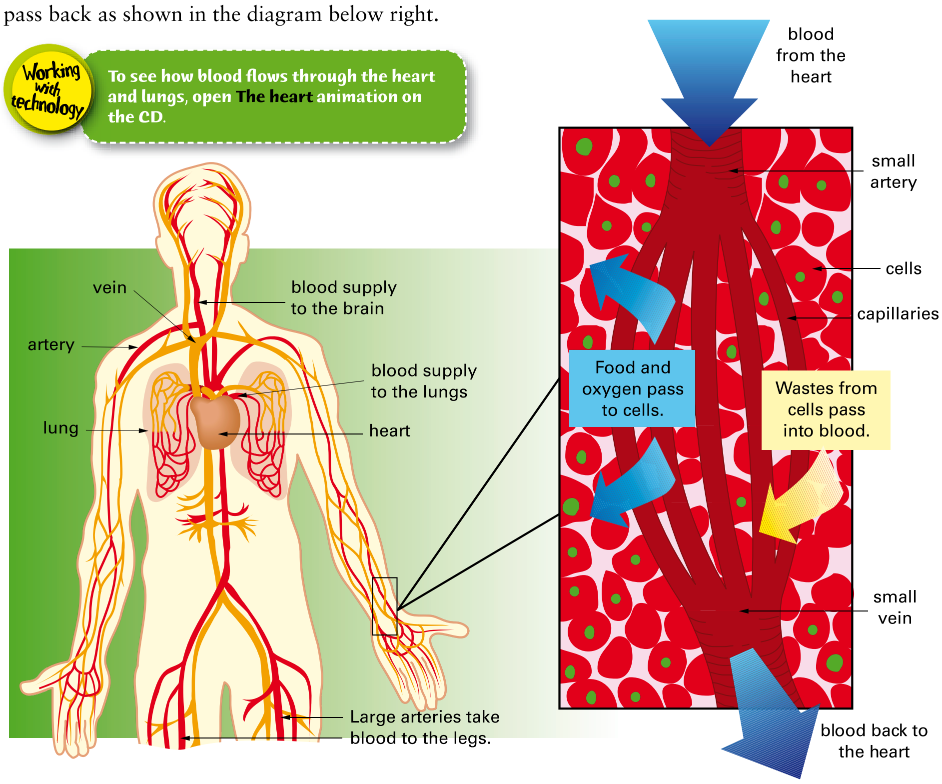


Fig 28 Arteries have thick muscular and elastic walls and carry blood away from the heart. Veins have thinner walls and take blood back towards the heart.

Working with technology To see how blood flows through the heart and lungs, open **The heart** animation on the CD.



Learning experience

A worthwhile activity is for the students to make playdough models of blood vessel cross-sections. This way they can vary the thickness and shape of the vessel walls. 3D models could also be attempted. Use tiles or plastic wrap as a base for the models.

Learning experience

Ask the students to write and act out a role play about the human transport system. Limit the time spent on this activity.

Investigate 13 THE BLOOD SYSTEM

Aim

To investigate your pulse and observe the blood capillaries in a fish's tail.

Materials

- a watch with a second hand, or digital watch
- small aquarium fish, eg guppy
- microscope and microscope slide
- cotton wool
- aquarium or pond water

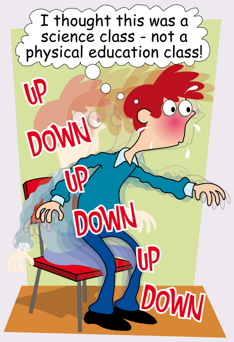
Planning and Safety Check

- Read through Part A and decide who is going to do what sort of exercise. Design a data table for the results.
- Make a list of all the precautions you will take to make sure the fish in Part B is not harmed in any way.

PART A Measuring pulse

1 Use your index finger to find your partner's pulse in the artery in their wrist.
Record the number of beats per minute and call this the resting pulse rate.

2 Have your partner exercise (eg by standing and sitting rapidly) for 2 minutes. Immediately after the exercise, take their new pulse rate.
Record your results.



3 Record how long it takes for the pulse rate to return to the resting rate.

Working with technology: You might like to use a datalogger to measure and record your pulse rates using a pressure probe.

PART B Capillaries

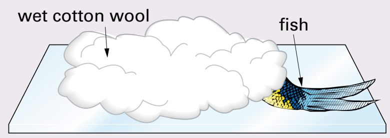
Your teacher will do this part of the investigation as a class demonstration.

Working with technology: You can view the capillaries on a computer or TV monitor via a video camera fitted to a microscope.

1 Soak some cotton wool in pond water, squeeze out most of the water and lay it on a microscope slide.

2 Carefully lay the fish on the cotton wool and place some more wet cotton wool on top of the fish. This will hold the fish in place and stop it from drying out.

3 Make sure the tail is sticking out of the cotton wool, as shown.



4 Look at the tail through low power on a microscope. Then switch to higher power to observe the capillaries and blood cells.
Use a diagram to record your observations.

Note: Take care of the fish and return it to the aquarium immediately after use.

Discusssion

1 How does your heart (pulse) respond to a change in activity in your body?

2 Suggest why there is a change in the pulse rate with exercise. Include the needs of the body cells in your explanation.

3 Why is it necessary for your heart to continue beating when you are asleep?

4 Does a fish have a pulse? Suggest reasons for your answer.

Lab notes

Part A

- Be aware of any student with a heart condition. If there is a student who should not attempt Part A, they could become your assistant and help organise Part B while the others are measuring their pulses. This way, without drawing attention to their condition, they are still actively participating in the investigation and the other students will hardly notice.
- The pulse is in the radial artery which is not near the skin but deep between the radius and the ulna bones. It will be difficult to find in students who have a lot of subcutaneous adipose tissue (ie who are overweight). Show the class where to find their pulse on their neck (carotid artery) so they can choose from the two options.
- If available, let students use stethoscopes to hear the sounds of the heart.
- Your class may be able to use a corridor or nearby stairs for their exercise.

Part B

- Keep the cotton wool and fish quite wet and be patient.
- If you have the equipment, use a video microscope (Video Flex or ProScope) or similar device to put it on a screen or wall for all to see.
- Emphasise that the fish is unharmed and will recover fully!

Hints and tips

If you have access to a model of the human torso, bring it into class and get some students to 'dissect' it. It is a very good tool to show where the organs are located. When some students have finished 'dissecting' it, organise another team to reassemble it. This can be done throughout the lesson in conjunction with board work or completion of exercises.

Getting rid of wastes

Your body is like a factory. It takes in raw materials (food, water and air) and produces new products (cells and parts of cells). It uses energy in these processes and it also produces wastes. The wastes are gases, liquids and solids.

Gaseous wastes—carbon dioxide

The most important cell reaction in your body is respiration, which produces carbon dioxide and water. Much of the water is reused by the body, but carbon dioxide is not used and has to be removed through your **lungs**. The two lungs are part of your respiratory system, and are large pink-coloured organs found inside the chest cavity. The lungs appear solid but are soft and sponge-like. The pink colour is due to the many blood capillaries in the lung tissue.

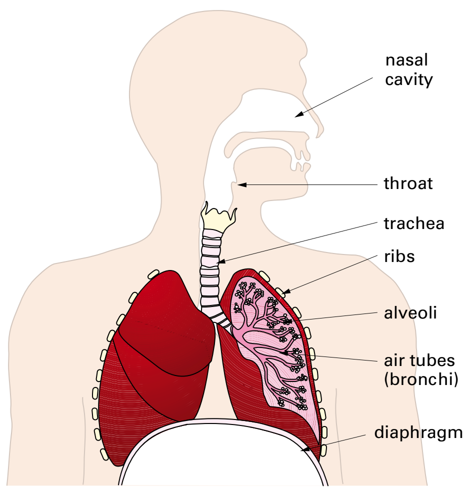


Fig 32 Oxygen from the air passes into the blood in the lungs, and waste carbon dioxide passes from the blood and is breathed out.

Air enters the lungs from the nose or mouth and then the **trachea** (track-EE-a) or windpipe. The air is moved in and out of the lungs by the movements of the muscles around the ribs and the large muscular diaphragm. The air moves through the trachea and into smaller air tubes called *bronchi* (BRONK-ee), which end in minute air sacs called **alveoli** (AL-vee-OH-lee). The total surface area of the alveoli in the lungs is enormous—about 80 m^2, or about half the size of a tennis court.

The oxygen in the air breathed in passes through the thin walls of the alveoli and into the blood in the capillaries. From here the blood is pumped to cells throughout the body. The blood coming into the lungs from the body contains a lot of carbon dioxide. This passes from the blood into the alveoli and is breathed out.

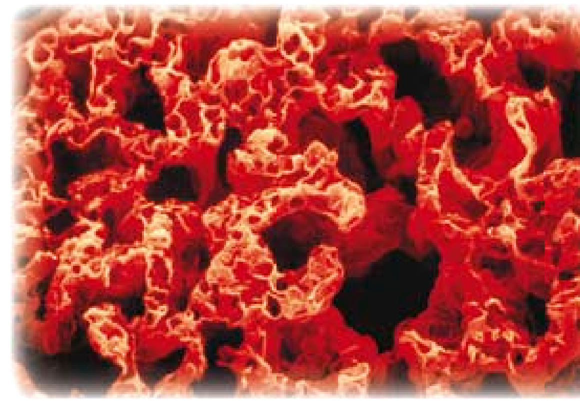


Fig 33 A microscope view of lung tissue showing many thin-walled alveoli

Liquid wastes—urine

Most of the wastes produced by cell reactions are soluble in water and are therefore able to be transported away by the blood. Many of these waste products are taken to the liver for processing.

The liver is a very important organ in the body. It not only stores and distributes digested food, but it also breaks down many substances including amino acids and harmful substances such as alcohol.

Urea is one of the substances produced by the liver when it breaks down amino acids. Urea is soluble and so is carried in the blood from the liver to the **kidneys** where it is then removed.

Learning experience

Turn what the students have learned from this chapter into a fun activity and devise a Human Body Board Game. Give sufficient brainstorming time for creative thought and planning. Divide the allocated time for this activity into five stages:

1 brainstorming
2 planning and designing
3 constructing
4 testing the game
5 making modifications (if necessary).

A task like this allows students to construct a substantial, tangible product that reveals their understanding of concepts and skills related to the human body, and their ability to apply those concepts and skills.

Blood is supplied to each of the two kidneys by a large artery called the *renal artery* (*renal* means 'of the kidney'). About one litre of blood passes through the kidneys each minute. This blood is filtered, and the wastes and some water pass out of the kidney to the bladder. The liquid waste is called *urine*.

The removal of wastes from the body is called **excretion** (ex-KREE-shun). The kidneys and liver are part of the excretory system. Sweat on your skin also removes salts and other soluble substances. But the skin is not considered part of the excretory system because the main purpose of sweat is to lower your body temperature.

Solid wastes–faeces

The solid wastes are called **faeces** (FEE-seas) and consist of leftover material from the food you eat (mainly fibre), as well as bacteria (about 30% of the mass), water and other products of cell reactions. The faeces pass out of your body through the anus. The brown colour of faeces is due to substances produced in the liver when blood is broken down.

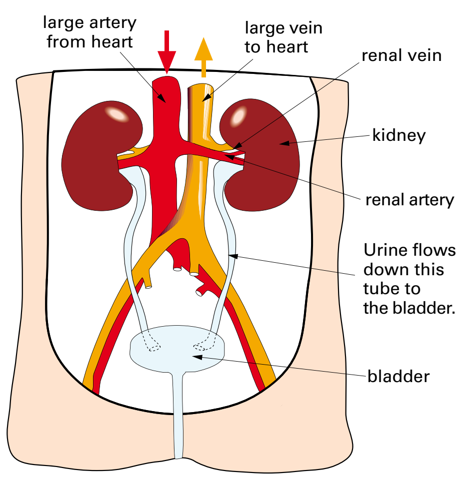


Fig 34 Kidneys are the main organs of excretion—the removal of wastes which are dissolved in water.

Activities

Part A Looking at lungs

Your teacher will show you a pair of sheep's lungs attached to the trachea.

Observe the colour and texture of the lungs and the trachea.

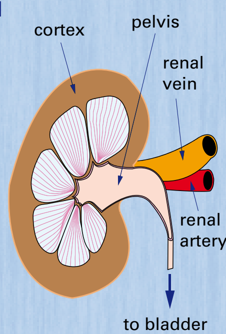
Infer the function of the bands of cartilage in the trachea.

Observe what happens when the lungs are inflated with air.

Part B Looking at kidneys

You will need a sheep's kidney, a single-edge razor blade (or scalpel), scissors and gloves.

1. Peel off the fat around the kidney and look for the blood vessels attached to the concave side of the kidney.
2. Use the razor blade to cut the kidney in half.



The outer dark red region is called the *cortex* and is where the wastes are filtered. The light-coloured inner region is the *pelvis* and is where the urine collects.

Infer the function of the fat around the kidney.

Use a library to find out the names of the various parts of the kidney, and how the kidney filters the blood.

Your teacher may supply you with a microscope. If so, cut a very thin piece of tissue from the lung and from the kidney and look at them under the microscope.

Note: Your teacher will tell you how to clean up and prepare the remains of the lungs and kidneys for disposal.

Hints and tips

Some students in the class may become a little silly reading this section. Allow only a few minutes of general question time and make sure there is no unnecessary sidetracking.

Activity notes

- Check regulations about handling animal organs and insist on good hygiene, no mutilation and proper disposal of waste.
- Check with your local butcher or abattoir for availability—you may need to order the lungs and kidneys.
- You could also bring a sea sponge into class to show the students how similar it is to a microscopic view of lung tissue.

Learning experience

If the students constructed a KWHL chart at the beginning of the chapter, ask them to fill in the 'What I Have Learnt' section of the chart during the chapter. Allow time for critical thinking and reflecting—students are required to construct new knowledge, not just select a response.

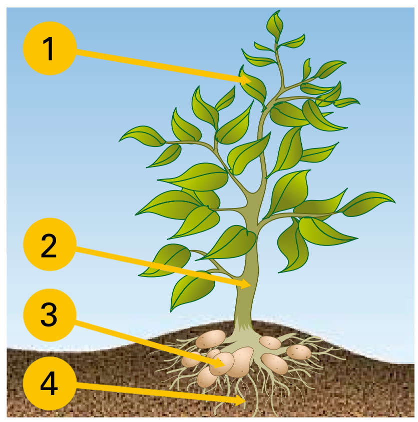
Learning experience

Ask students to compile a dot-point summary of the chapter. This can be used as a revision tool for tests or examinations. (You may suggest they do this before they devise their Human Body Board Game on page 106.)

Check!

1 Some of the sentences below are false. Select the ones that are false and rewrite them to make them correct.
 a Blood consists of blood cells suspended in plasma.
 b Lung tissue has very few blood vessels.
 c During exercise the amount of blood flowing to the body cells decreases.
 d Arteries have the same structure but much thicker walls than veins.
 e Urine is produced by the liver and is collected in the bladder.

2 Match the statements with the numbers on the diagram of the plant below.
 a This transports food and water to all cells in the plant.
 b Water and nutrients are absorbed here
 c Food and oxygen are made here.
 d This is where starch is stored.



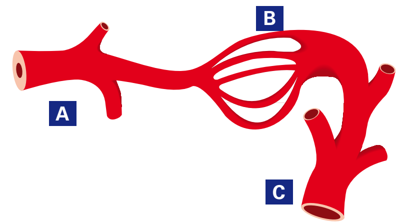
3 What is a pulse? Why does the pulse rate vary? What actions do you have to take to lower your pulse rate?

4 Suppose you analysed the blood in an artery in your arm. You then did the same to the blood in a nearby vein. Which substances would you find more of in the artery than in the vein?
Which substances would you find more of in the vein than in the artery?

5 What is urine? Where is it made and what happens to it in the body?

6 Bonnie had a pot plant that she kept in a sunny place on a veranda. She noticed that the plant had started to wilt.
 a What conditions made the plant wilt?
 b How could Bonnie save the plant?

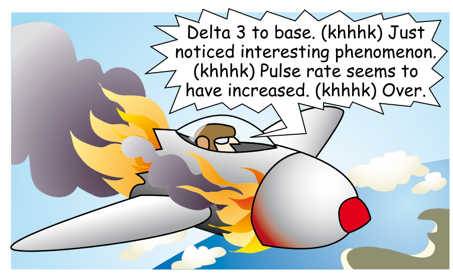
7 The diagram below shows simplified blood vessels.
 a Match veins, arteries and capillaries to A, B, and C on the diagram. Explain your choices.
 b In which direction does the blood flow? How do you know?



8 What is the advantage to a plant such as a potato plant of storing food?

9 Why does the air you breathe out contain less oxygen and more carbon dioxide than the air you breathe in?

10 Suggest why your pulse rate increases when you see signs that you are in danger.



11 During exercise your heart rate increases. Suggest why your breathing rate also increases during exercise.

Check! solutions

1 a True.
 b False. Lung tissue has *many* blood vessels.
 c False. During exercise the amount of blood flowing to the body cells *increases*.
 d True.
 e False. Urine is produced by the *kidneys* and is collected in the bladder.

2 a Structure 2
 b Structure 4
 c Structure 1
 d Structure 3

3 A pulse is a sudden increase in blood pressure caused by the contraction of the heart. It varies because your heart contracts at different rates depending on the activity of your body. To lower your pulse rate you should sit or lie down quietly so that your muscles do not need much oxygen or produce much carbon dioxide.

4 You would expect to find more dissolved food and oxygen in the artery compared with the vein. You would expect to find more dissolved carbon dioxide and other wastes in the vein, compared with the artery.

5 Urine is a waste liquid produced by the body. It is made in the kidney and is stored in the bladder before urination.

6 a The hot and sunny conditions caused the plant to wilt because they caused a loss of water from the leaves.
 b Bonnie can save the plant by moving it back to a cooler spot and adding water to the soil.

7 a Part A represents the arteries because it has a smaller internal diameter. Part B represents the capillaries because they are much smaller blood vessels. Part C represents the veins because it has a larger internal diameter.
 b Blood flows from the arteries through the capillaries to the veins. On the diagram it is from left to right.

8 Plants such as potatoes need to store food in case they cannot always make food throughout the year. Most plants grow very slowly or become dormant in the winter months and use the stored food to keep alive.

9 This is because your body uses oxygen from the air and produces carbon dioxide which you breathe out.

10 Your pulse rate increases because when you see danger your body is getting ready for a sudden effort. It is actually caused by the release of a hormone called adrenalin which prepares you for emergencies.

11 Your breathing rate also increases because your body is producing more carbon dioxide and also requires more oxygen for respiration.

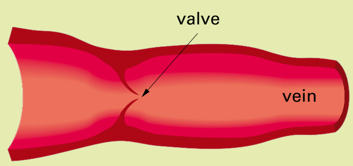
challenge

1 When a tree is ringbarked, a groove about 2 cm deep is cut all the way around the trunk. Use your knowledge of the plant transport system to suggest why a ringbarked tree eventually dies.

2 Your body contains about 5 litres of blood.
  - a If the kidneys filter one litre of blood in one minute, how much blood is filtered in a day?
  - b How many times is the 5 litres of blood filtered in a day?
  - c You produce about 1500 mL of urine each day. Express the amount of urine produced as a percentage of the total amount of blood filtered in a day.

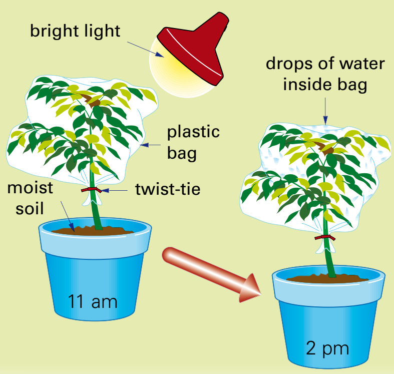
3 Your heart pumps about 70 mL of blood with each beat. Estimate the volume of blood it would pump in 24 hours. What assumptions have you made in your calculations?

4 The veins in your body have valves that allow blood to flow in one direction only.



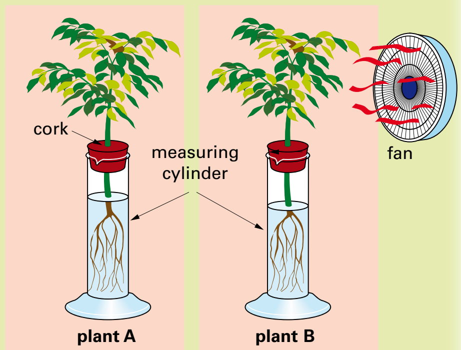
  - a In which direction would the blood flow in the diagram above? How do you know?
  - b Suggest why arteries do not have valves.

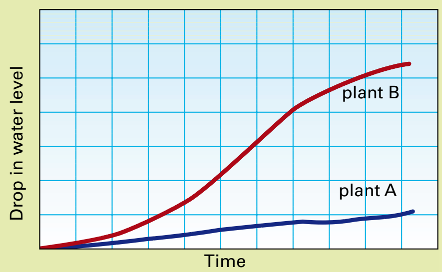
5 A plant experiment was set up as shown in the diagram below.



  - a What was the aim of the experiment?
  - b What equipment was needed for this experiment?
  - c For how long did the experiment run?
  - d Describe the results of the experiment.

6 In a follow-up experiment for the one in Challenge 5 a plant was placed in a measuring cylinder of water. The top was sealed by a cork. The drop in the level of water in the measuring cylinder was recorded every 30 minutes. A similar plant was set up but this time a fan was directed at the leaves of the plant. The graph shows the results of the experiment.





  - a What was the purpose of the cork in the measuring cylinder?
  - b What variables were controlled?
  - c Could the number of leaves on each plant affect the results? How?
  - d Write a conclusion for this experiment.

Challenge solutions

1 The ringbarked tree eventually dies because the food-conducting vessels which are on the outside of the trunk are cut. This means that the roots will not receive food from the leaves and will die. When the roots die the plant will be unable to absorb water from the soil.

2 a The volume is about 1 × 60 × 24 = 1440 L per day.

b $\frac{1440\,\text{L}}{5\,\text{L}} = 288$ times

c $\frac{1.5}{1400} \times \frac{100}{1} = 0.1\%$

3 The average pulse rate for Year 8 students is about 70 beats per minute. Multiplying 70 × 60 × 24 × 70 mL = 7 056 000 mL = 7056 L = 7.056 kL (We have assumed an average pulse rate of 70 beats per minute.)

4 a The blood would flow from left to right in the diagram because the valve does not allow the blood to flow backwards.

b Arteries do not have valves because the blood is under high pressure continuously and valves may restrict the flow of the blood.

5 a The aim of the experiment was to see whether a bright light changed the rate of water loss (transpiration) of a plant.

b The equipment needed was a plant in a pot, a plastic bag with a tie and a bright light.

c The experiment ran for three hours between 11 am and 2 pm.

d The results of the experiment were that droplets of water were observed inside the bag surrounding the plant.

6 a The cork is to prevent evaporation of the water from the measuring cylinder.

b Variables that were controlled were the apparatus, the starting volume of water, the time and the plant.

c Yes, because the water actually escapes from tiny pores in the surface of the leaf. So the more leaves, the greater the water loss.

d The conclusion is that the air movement caused by the fan increases the water loss from a plant.

Main ideas solutions

1 growth, energy
2 carbohydrates, fats
3 sugars and starch, repair
4 chlorophyll
5 digestion
6 transport, photosynthesis
7 blood
8 carbon dioxide, kidneys

Review solutions

1 C
2 D—Photosynthesis needs the energy from sunlight, so it stops at night.
3 B—see page 90
4 D

MAIN IDEAS

Copy and complete these statements to make a summary of this chapter. The missing words are on the right.

blood
carbohydrates
carbon dioxide
chlorophyll
digestion
energy
fats
growth
kidneys
photosynthesis
repair
sugars and starch
transport

1 All organisms need food for _____, for _____ and to keep their bodies healthy and functioning correctly.
2 Foods contain four main food types: _____, proteins, _____, and vitamins and minerals.
3 Carbohydrates include _____ and are used for energy. Fats are also an energy source, while proteins provide materials for the growth and _____ of cells.
4 Plants contain _____ and are able to make carbohydrates in photosynthesis.
5 _____ is a process that breaks down large lumps of food into soluble materials containing small molecules which can dissolve in the blood.
6 Plants _____ food, water and other materials in conducting vessels in stems, roots and leaves. Food made by _____ is stored as starch.
7 In humans, food, oxygen, water and wastes are carried to and from cells by the _____.
8 _____ is removed from the blood by the lungs, dissolved wastes are filtered from the blood in the _____, and solid wastes pass out of the body through the anus.

Try doing the Chapter 5 crossword on the CD. Working with technology

REVIEW

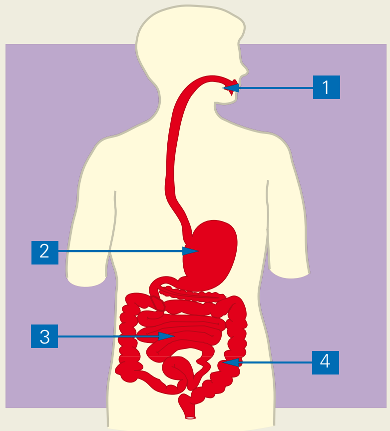
1 Which one of the following statements about respiration in animals and plants is *incorrect*? Respiration:
A releases energy in cells.
B requires oxygen.
C needs sunlight.
D uses up food.

2 Which one of the following statements about photosynthesis is *incorrect*? Photosynthesis:
A uses up carbon dioxide and water, and gives off oxygen.
B makes carbohydrates.
C takes place in cells containing chlorophyll.
D occurs 24 hours of the day.

3 Which of the following food types is used mainly for the growth of cells?
A fats
B proteins
C vitamins and minerals
D carbohydrates

4 Brad was testing various foods in an investigation. He added a few drops of a brown liquid to pieces of rice, chicken, bread and butter. He observed the rice and bread turn a blue-black colour. What substance was he testing for?
A sugar
B protein
C fat
D starch

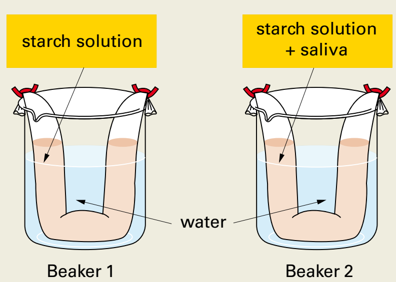
5 The following questions refer to the diagram below.



a Where are most substances absorbed into the blood?
b Where is food first acted on by enzymes?
c Where is food stored for short periods of time?
d Where are carbohydrates first digested?
e Where are water and some minerals absorbed into the blood?

6 Which organs are responsible for the removal of solid, liquid and gaseous wastes from the body.

7 An experiment was set up using cellophane tubing.

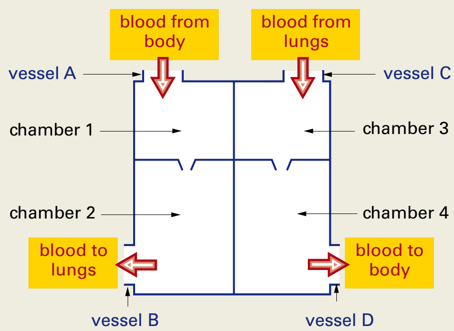


The water in each of the beakers was tested for glucose at the start of the experiment and then after 30 minutes. The results are shown in the table below.

	Beaker 1	Beaker 2
At the start	no glucose	no glucose
After 30 mins	no glucose	glucose

a Where did the glucose come from?
b What was the aim of the experiment?
c Why was beaker 1 included in the experiment?
d Which variables were controlled?

8 The diagram below shows a simple model of a human heart.



a Which blood vessel, A or B, would have the thicker walls? Explain your answer.
b Does the blood in chamber 1 contain more or less oxygen than the blood in chamber 3? Explain your answer.
c Write a paragraph describing the flow of blood through the four chambers and four blood vessels of the heart.

Check your answers on pages 319–320.

5 a 3—the small intestine (see page 96)
b 1—enzymes start digesting starch in the mouth
c 2—the stomach
d 1—the mouth
e 4—the large intestine

6 Solid wastes (faeces) pass out of the gut through the anus. Liquid wastes are removed by the kidneys through the bladder. Gaseous wastes are removed by the lungs and breathed out through the trachea. (See pages 106 and 107.)

7 a The glucose came from the breakdown of starch by the enzyme in saliva. The glucose passed through the cellophane tubing and into the water in beaker 2.
b The aim of the experiment was to test whether glucose is produced when saliva and starch are mixed together.
c Beaker 1 was used as a comparison, and to check that glucose did not come from other sources such as the cellophane bag. It is called an *experimental control*.
d The volume of water in each beaker, the volume of starch solution in each piece of tubing, and the time each was left.

8 a Vessel B contains blood which is being pumped *away* from the heart. Therefore, it would have thicker walls.
b The blood in Chamber 1 would have less oxygen since the blood has come from the body and is being pumped to the lungs to receive more oxygen.
c The blood flows through vessel A into chamber 1, then into chamber 2. It is pumped from chamber 2 to the lungs in vessel B. It then returns from the lungs to chamber 3 in vessel C, and finally is pumped from chamber 4 to the body in vessel D.