

3 Systems working together

Your body systems work together to keep you alive. Each of these systems is made up of organs with specific functions. An important function of your body systems is to supply your cells with energy and nutrients, and to remove wastes that are produced. From early times, the study of anatomy has added to knowledge about the human body. This painting by Rembrandt depicts an anatomy lesson given by Dr Nicolaes Tulp in 1632.

Think about body systems

- Is it the amount of oxygen or carbon dioxide in your blood that influences your breathing rate?
- In what form are old red blood cells excreted in faeces?
- Which vitamin deficiency may result in poor blood clotting?
- Why is being slimy a good thing for a bolus?
- What's the link between your urethra and your ureter?
- What's wrong with glucose in your urine?
- Does eating food stop you from getting drunk?
- What's the link between cocaine and neurotransmitters in the brain?
- What's the difference between your oesophagus and your trachea?
- Which is better, high or low GI?
- Which type of blood vessels take blood to the heart?
- Is chicken soup good for fevers?
- Should the government be able to control what and how much you eat and drink?

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YOUR QUEST

Ingredients for life?

Have you ever wondered what the recipe for life is? Which ingredients would you blend together to make up a living thing? How could this mixture result in life?

Many of the mysteries of life are being explored. Scientists have developed a whole range of different instruments and technologies to discover more about life processes. This has helped develop our knowledge and understanding of the structure of living things and how they work. Investigations provide us with more information about chemical processes that occur in cells and keep living things alive.

Scientists from different fields study the ingredients for life in different ways. Biologists may be interested in the cells that make up the organism and how these help the organism to grow, maintain itself and respond to internal and external environments. Chemists may see the organism as an amazingly complicated combination of atoms and molecules that are involved in millions of chemical reactions every second. Physicists and engineers, however, may see organisms as incredibly sophisticated self-controlling and self-repairing machines.

Your quest — Recipe for life

- 1 (a) Identify an environment in which your organism will live.
 (b) Describe the temperature, light intensity, water availability, food sources and other factors that you consider to be important to the survival of your organism.
- 2 Design your organism.
 - (a) Identify how your organism obtains (i) nutrients and (ii) oxygen, and (iii) how its wastes will be removed.
 - (b) Identify how nutrients, oxygen and its wastes are transported within its body.
 - (c) Identify how the organism senses and responds to its environment.
- 3 Draw labelled diagrams of your organism's cells, tissues, organs and systems. Remember to take the function of each of these into account when you are designing its structure.
- 4 Describe how each of your organism's systems work together to keep it alive.
- 5 Construct a model of your organism.
- 6 Construct an electronic or hard-copy brochure that advertises what a magnificent life form your organism is.



Respiratory and circulatory systems

Although you don't have to think about breathing, it is essential for your survival. It is a necessary function so that you can meet oxygen requirements for cellular respiration and for the removal of waste products such as carbon dioxide.

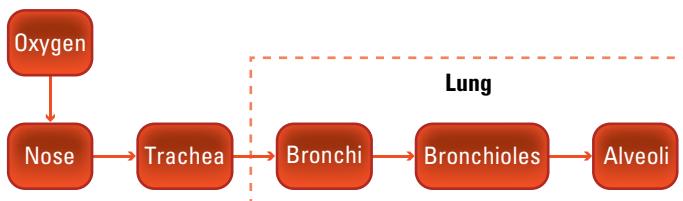
Cells need energy!

Your circulatory and respiratory systems work together to provide your cells with **oxygen** which is essential for **cellular respiration**. This process involves the breaking down of **glucose** so that energy is released in a form that your cells can then use. As can be seen in the cellular respiration equation below, **carbon dioxide** is produced as a waste product. The carbon dioxide then needs to be removed from your cells or it would cause damage or death to them.

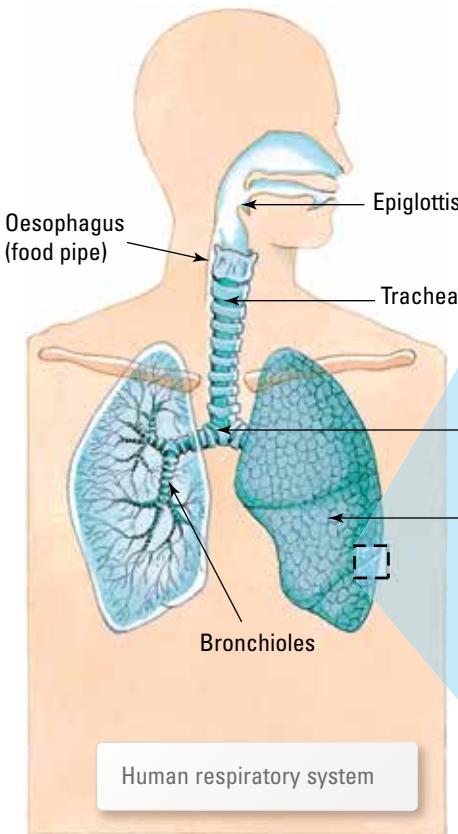


Getting oxygen into your respiratory system

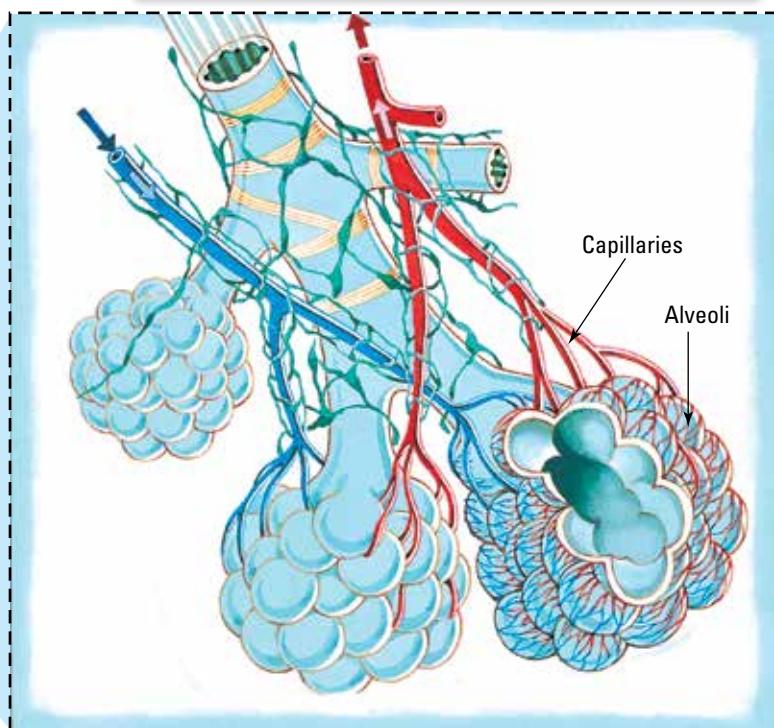
Your **respiratory system** is responsible for getting oxygen into your body and carbon dioxide out. This occurs when you inhale (breathe in) and exhale (breathe out).



When you breathe in, you actually take in a mixture of gases (of which about 21 per cent is oxygen) from the air around you. The air moves down your **trachea** (or windpipe), then down into one of two narrower tubes called **bronchi** (bronchus), then into smaller branching tubes called **bronchioles** which end in tiny air sacs called **alveoli** (alveolus).

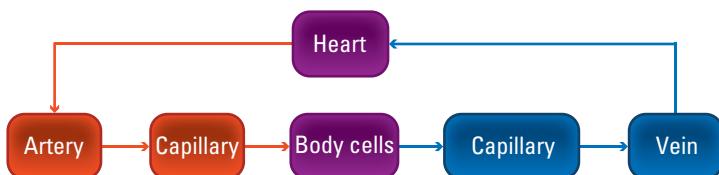


Organs of the respiratory system, expanded to show details



Transporting around

Your **circulatory system** is responsible for transporting oxygen and nutrients to your body's cells, and wastes such as carbon dioxide away from them. This involves blood cells that are transported in your blood vessels and heart. The three major types of blood vessels are **arteries**, which transport blood from the heart, **capillaries**, in which materials are exchanged with cells, and **veins**, which transport blood back to the heart (as shown below).



Getting oxygen into your circulatory system

Your alveoli are surrounded by a network of capillaries. These capillaries contain **red blood cells** (or **erythrocytes**) that contain **haemoglobin**, an iron-based pigment that gives your blood its red colour. Oxygen moves from the alveoli into the red blood cells in the surrounding capillaries and binds to the haemoglobin to form oxyhaemoglobin. It is in this form that the oxygen is transported to your body cells.

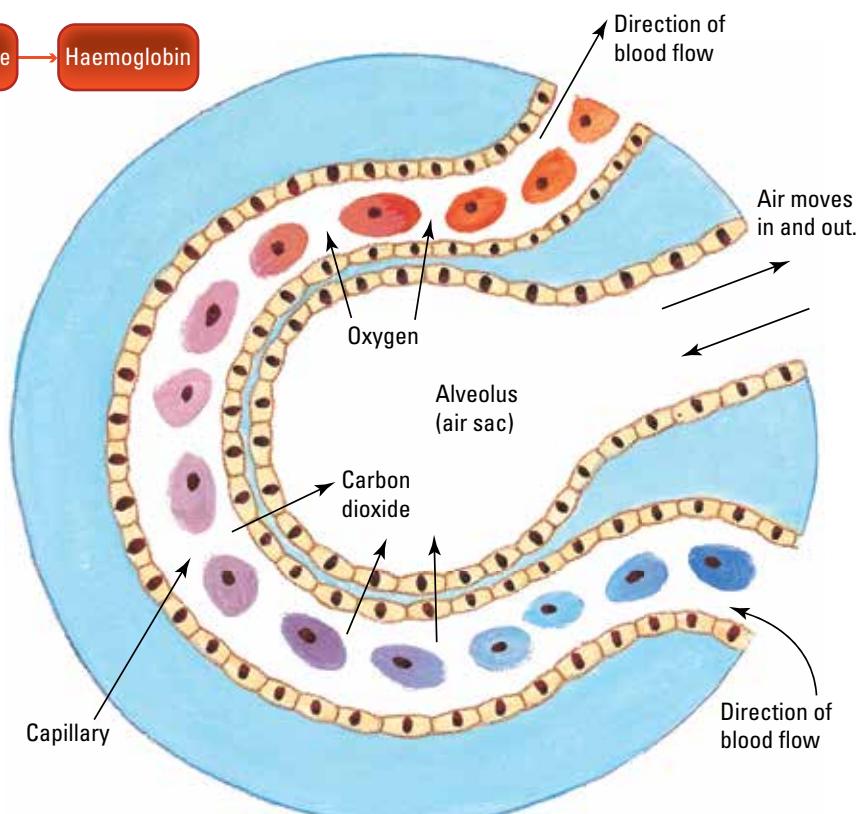
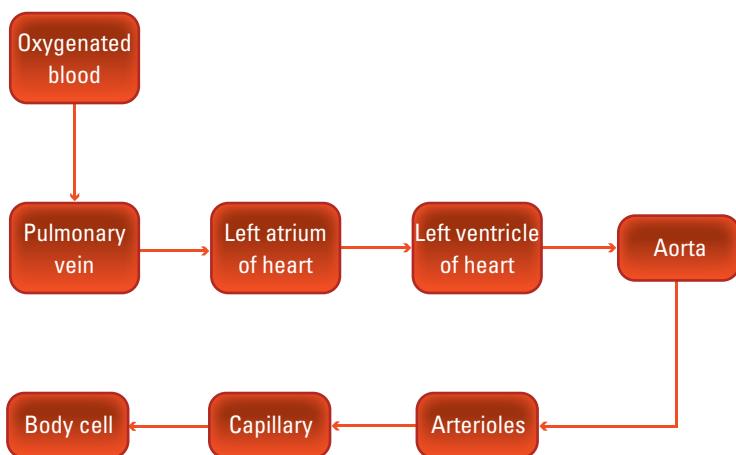


In an alveolus, oxygen diffuses into the blood and carbon dioxide diffuses out of the blood.

Getting oxygen to your cells

Oxygenated blood travels from your lungs via the **pulmonary vein** to the **left atrium** of your **heart**. From here, it travels to the **left ventricle** where it is pumped under high pressure to your body through a large artery called the **aorta**.

The arteries transport the oxygenated blood to smaller vessels called **arterioles** and finally to capillaries through which oxygen finally diffuses into body cells for use in cellular respiration.



Getting carbon dioxide away from your cells

When oxygen has diffused into the cell and the waste product of cellular respiration, carbon dioxide, has diffused out of the cell into the capillary, the blood in the capillary is referred to as **deoxygenated blood**. This waste-carrying blood is transported via capillaries to **veins** (small veins) to large veins called **vена cava**, then to the **right atrium** of your heart. From here it travels to the **right ventricle** where it is pumped to your lungs through the **pulmonary artery**, so called because it is associated with your lungs. The pulmonary artery is the only artery that does not contain oxygenated blood.

The movement of blood through the heart

Deoxygenated blood

Capillary

Venules

Vena cava

Right atrium of heart

Right ventricle of heart

Pulmonary artery

Lungs

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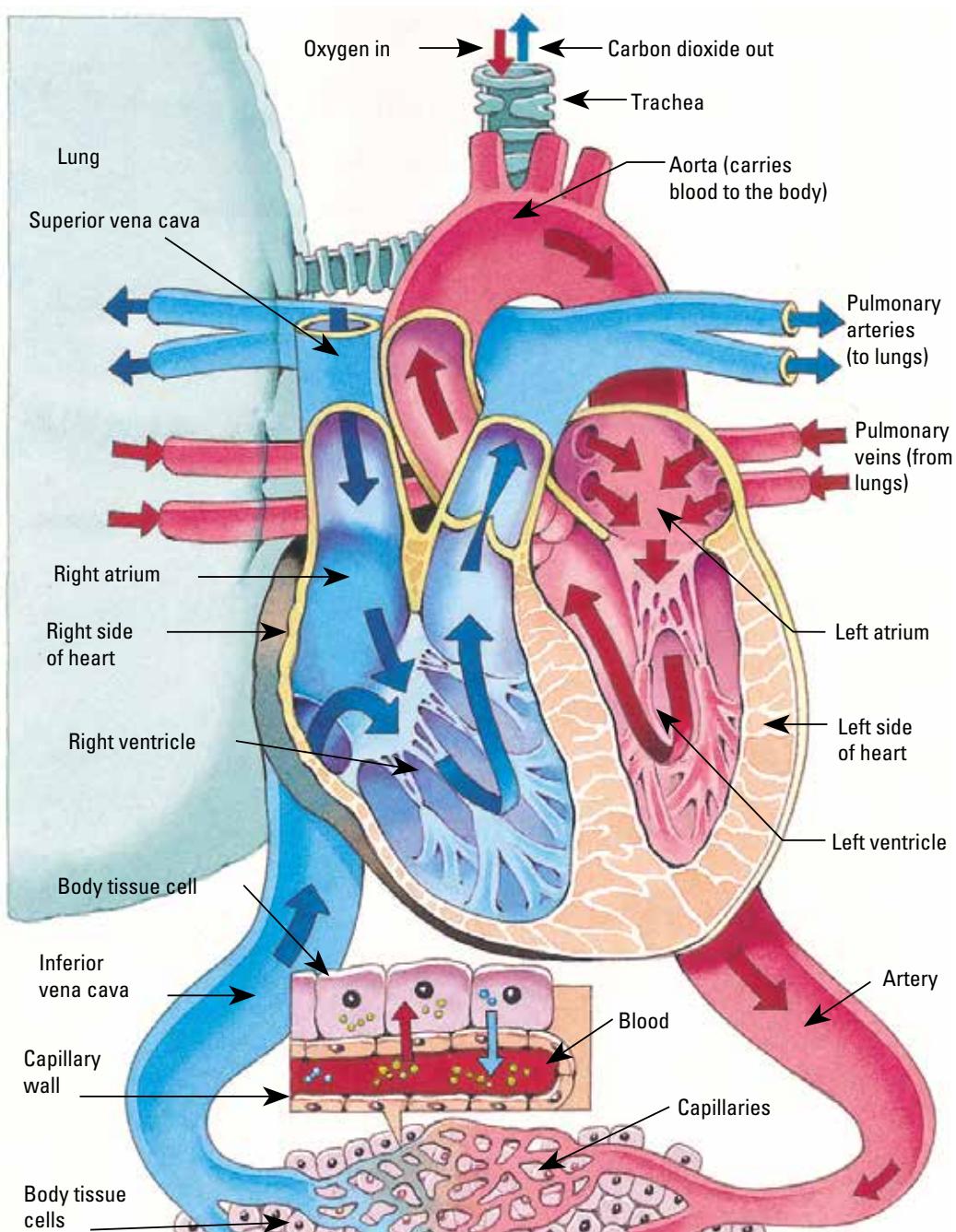
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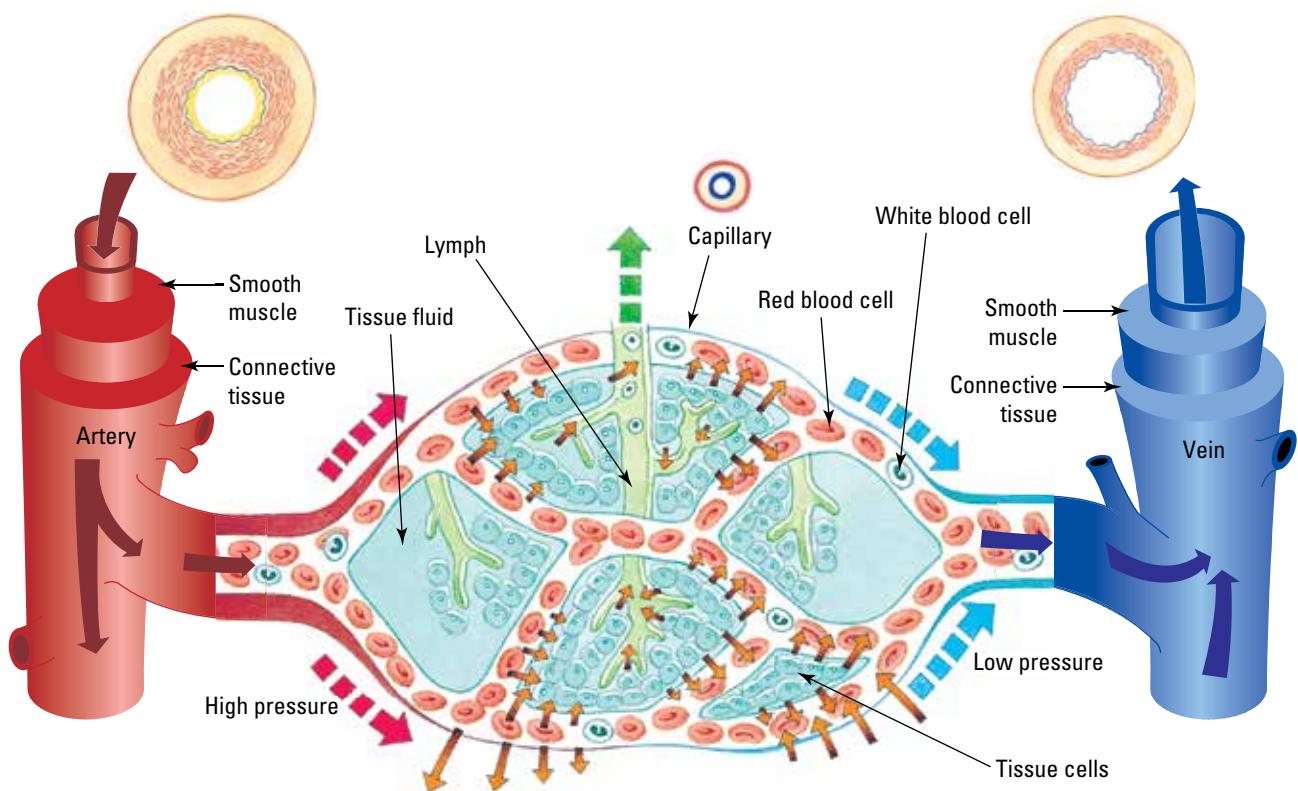


Robotic heart surgery

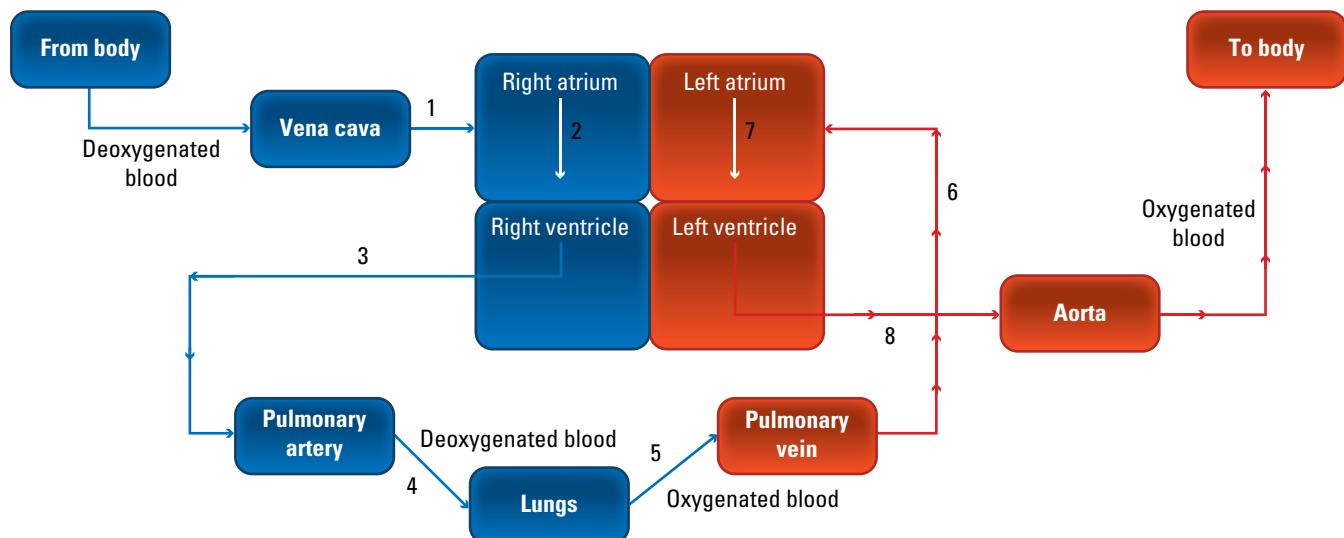
Watch an ABC Catalyst report to find out how the treatment of the heart condition atrial fibrillation is being revolutionised by the use of robotic systems.

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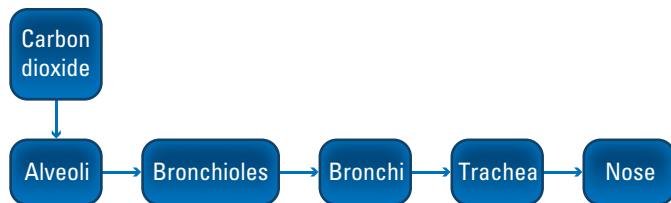
Your circulatory system consists of your heart, blood vessels and blood. Arteries, capillaries and veins are the major types of blood vessels through which your blood travels.



The heart is actually two pumps. One side pumps oxygenated blood and the other deoxygenated blood.

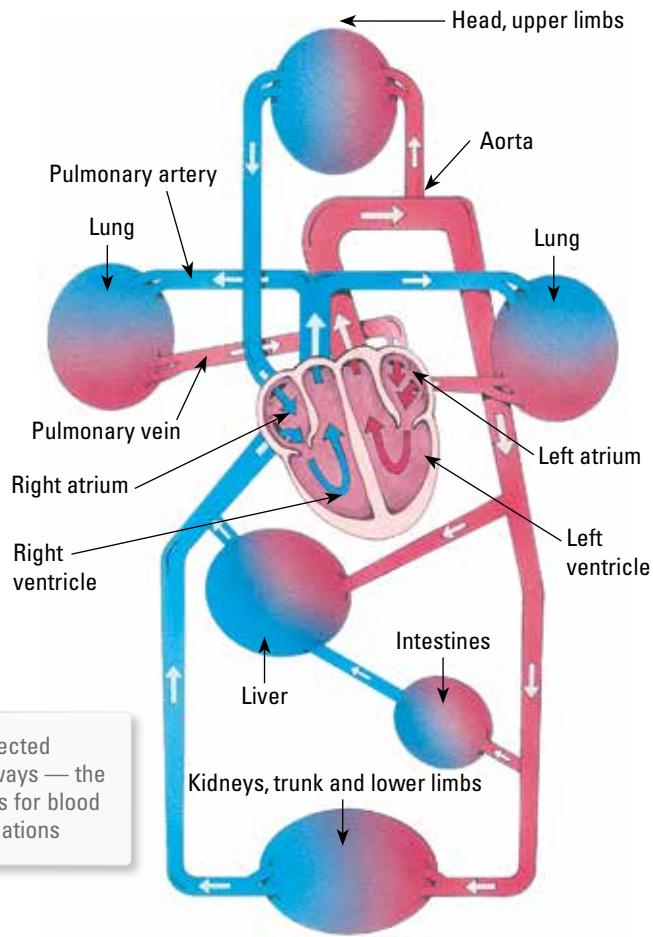
Getting carbon dioxide into your respiratory system

Carbon dioxide from the deoxygenated blood in your capillaries diffuses into the alveoli in your lungs. It is then transported into your bronchioles, then your bronchi, and then into your trachea. From here, carbon dioxide is exhaled through your nose (or mouth) when you breathe out.



Putting it all together

Your body systems do not work in isolation. They work together to supply your cells with nutrients and to remove waste products that may otherwise be harmful. The transport of oxygen and carbon dioxide described here is merely an outline of the process. It is actually much more complex and is regulated by your nervous and endocrine system. Later in this chapter you will find out more about how these other systems are involved in keeping you alive.



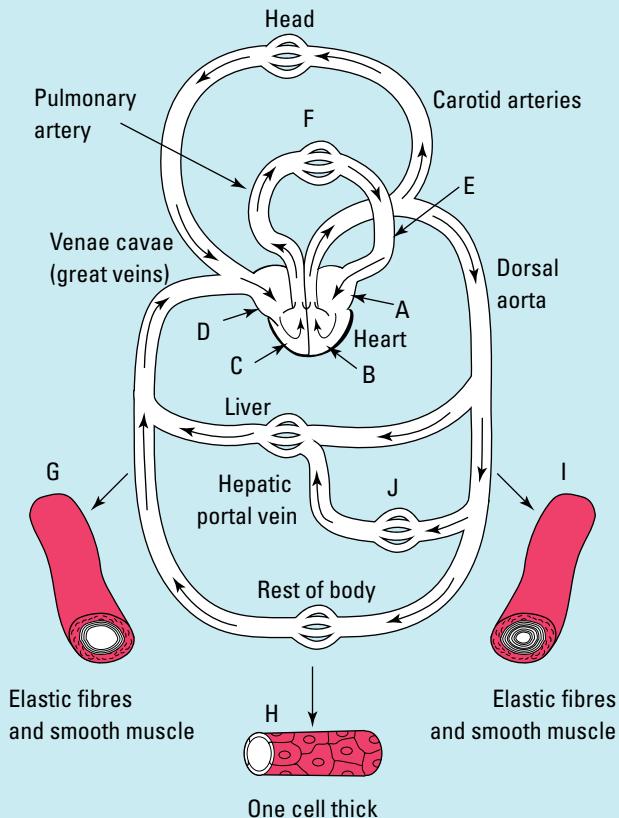
UNDERSTANDING AND INQUIRING

REMEMBER

- 1 State the word equation for cellular respiration.
- 2 Identify the molecule that the respiratory system and circulatory system work together to:
 - (a) supply to your cells
 - (b) remove from your cells.
- 3 Construct a flowchart to show the transport of:
 - (a) oxygen from your nose to your alveoli
 - (b) oxygen from your lungs to haemoglobin in your red blood cells
 - (c) oxygenated blood from your lungs to your body cells
 - (d) deoxygenated blood from your body cells to your lungs
 - (e) carbon dioxide from your lungs to your nose.
- 4 Construct a diagram to show the interactions between your heart, body cells and blood vessels.

THINK AND DISCUSS

- 5 Label the lettered parts (A–J) in the figure below.



- 6** Identify which of the following statements are true and which are false. Justify your response.
- Oxygen is a product of cellular respiration.
 - Arteries have thicker, more muscular walls than veins.
 - Blood travels to the heart in arteries.
 - Blood in the aorta is oxygenated.
 - Deoxygenated blood travels from your heart to your lungs in your pulmonary vein.
- 7** Use Venn diagrams to compare:
- the right atrium and left atrium of the heart
 - the right ventricle and left ventricle of the heart
 - the left atrium and left ventricle of the heart
 - oxygenated blood and deoxygenated blood
 - arteries and veins
 - oxygen and carbon dioxide
 - the pulmonary artery and pulmonary vein
 - the aorta and vena cava.

INVESTIGATE, THINK AND CREATE

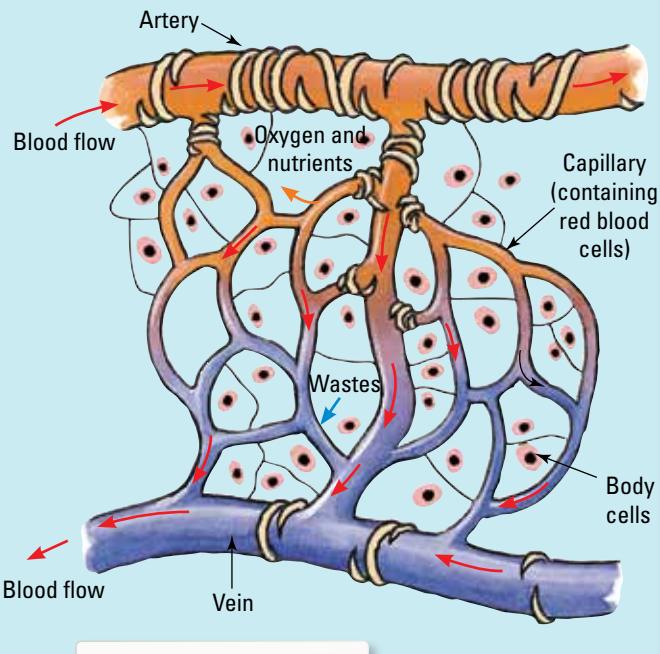
- 8** (a) Search the internet for animations or simulations showing how the circulatory or respiratory systems function.
- (b) Select your favourite animation or simulation.
- (c) Construct a PMI chart that outlines what you liked about the animation, what you didn't like and how it could be improved.
- (d) Create your own multimedia version on the circulatory system and/or respiratory system.
- (e) Share your creation with the class.

| Topic/theme/idea | | |
|------------------|-------|-------------|
| Plus | Minus | Interesting |
| • | • | • |
| • | • | • |
| • | • | • |
| • | • | • |
| • | • | • |

- 9** Find out more about the structure and function of either the circulatory or respiratory system and create a model that helps you to explain why the system is so important to survival.
- 10** Find examples of how developments in imaging technologies have improved our understanding of the functions and interactions of our body systems. Share your findings with others.

11 Investigate how technologies using electromagnetic radiation are used in medicine; for example, in the detection and treatment of cancer of the circulatory or respiratory system.

- 12** (a) Find examples of scientific research on either the circulatory or respiratory system.
- (b) Create a poster, PowerPoint presentation or podcast on the research that interests you most and present your findings to the class.
- 13** (a) Use the internet to identify problems relating to either the circulatory or respiratory system.
- (b) Select one of these problems and construct a model or animation to demonstrate its effect on normal body function.



In the capillaries, oxygen diffuses out of the blood and waste produced by cells diffuses into the bloodstream.

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work sheet

3.1 Cells, tissues, organs and systems

Essential intake

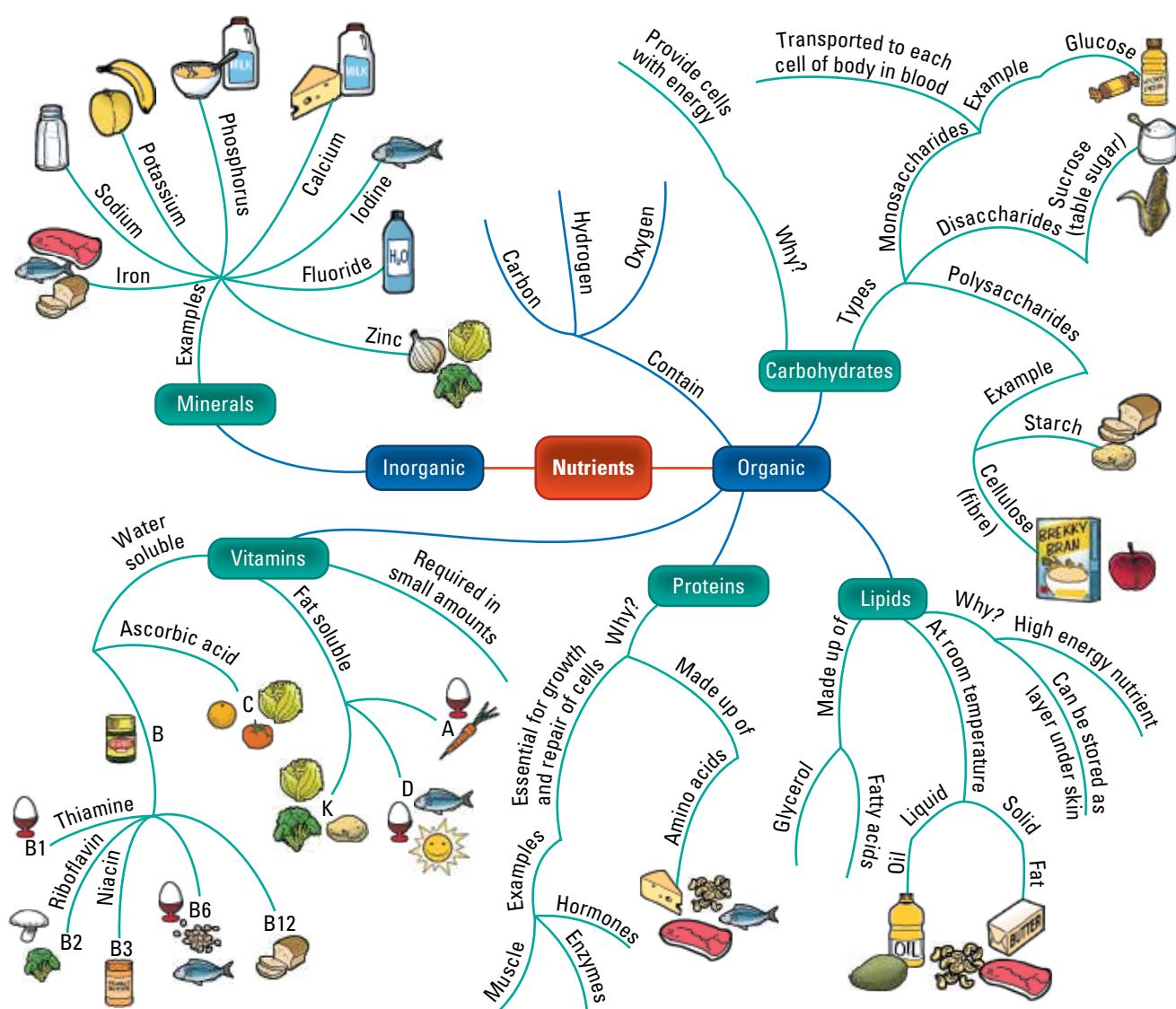
Feeling hungry? Tummy rumbling? You need to eat to provide your body with nutrients.

Essential nutrients

Nutrients are substances needed for energy, cell functioning and for your body's growth and repair. The five main groups of nutrients that your body needs to stay alive are:

- carbohydrates
- proteins
- lipids
- vitamins
- minerals.

Mind-mapping your essential nutrients



All of these except minerals are called organic nutrients because they contain carbon, hydrogen and oxygen.

Carbohydrates and **lipids** are nutrients that provide you with an immediate source of energy and a back-up supply. While **proteins** can supply some energy, their key role is as bodybuilding compounds. They provide the raw materials required for cell growth and the repair of damaged and worn-out tissues. They are also involved in many other activities in your body; important chemicals such as enzymes and hormones are made of protein. Although vitamins have no energy value, they are needed in small amounts to keep you healthy and to speed up a variety of chemical reactions in your body.

Feeding your emotions

Your body also needs the raw materials from nutrients to make neurotransmitters that can affect your emotions. For example, dopamine and norepinephrine are made up of three amino acids. These are tryptophan, tyrosine and phenylalanine. Tryptophan can be obtained from food sources such as cottage cheese, peanuts, red meat and brown rice, tyrosine from foods such as almonds, avocados, bananas and dairy products, and phenylalanine from meat, fish, eggs and soy products. Tryptophan is also important in the synthesis of another neurotransmitter called serotonin. For more information on these neurotransmitters see page 131.

Small but important

Even though **vitamins** and **minerals** are required in only small amounts, they are very important to your health. They are both needed to control chemical changes in your body. Your **endocrine system** and **nervous system** also require a number of these to be able to effectively function and maintain a healthy environment for your cells.



Nutrient requirements
change during pregnancy.



A lack of any of the 13 vitamins can cause disease. Diseases caused by a lack of vitamins are called **vitamin-deficiency diseases**. Diseases such as scurvy, rickets and beriberi have become less common as people have become more aware of the importance of vitamins. Deficiencies of minerals can also cause a number of significant problems.

Essential non-nutrients

Foods contain other important substances that are not nutrients. They are not used for energy or for growth and repair, but they are still essential to your health. Two of these substances are water and fibre.

Essential water

Did you realise that about two-thirds of your body is water? Water is another essential substance that you need to stay alive. Many of the chemical reactions that take place inside you use water. Your blood is 90 per cent water — the fluid part (plasma) is mostly water. Blood helps carry nutrients around your body and wastes away from it. You may be able to survive 40 days without food, but no more than 3 days without water.

How much water have you drunk today? Each day you lose water when breathing out (0.5 litres), sweating (0.5 litres) and urinating (1.5 litres). Have you replaced water that you have lost today? If you lose too much water, you may become **dehydrated**. A dry throat and mouth and dark-coloured urine are signs of mild dehydration. If you lose more than 20 per cent of your body's water volume, you could die!

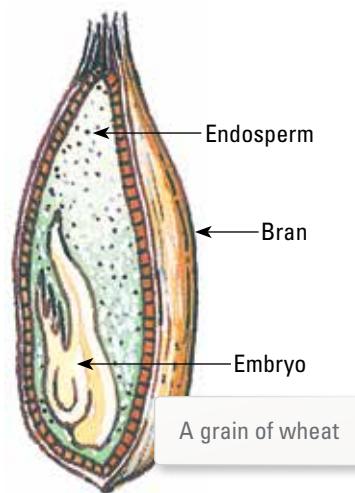
In one end and out the other

Fibre is found in the walls of plant cells. It is only partially broken down by your digestive system.

Although it really does go 'in one end and out the other', it serves a very useful purpose and is an essential part of your diet. It provides bulk to your food, allowing it to move properly through your intestines. Without fibre, undigested food travels too slowly through the large intestine, losing too much water. The result is difficulty in releasing the solid food waste from the body, a condition called **constipation**. Lack of fibre in the diet can also lead to haemorrhoids (varicose veins around the anal passage, also known as piles), bowel cancer and several other diseases.

Fibre can be found only in foods that come from plants — foods such as fruits and vegetables, wholegrain breads and cereals, nuts and seeds.

Wholegrain products are higher in dietary fibre because they contain the outer covering, or bran, of the grain. When grains are highly processed, as they are in the production of white bread, white flour and many breakfast cereals, the bran is removed.



A grain of wheat



These foods contain fibre.

INVESTIGATION 3.1

Essential testing

AIM To investigate the nutrients found in foods

Materials:

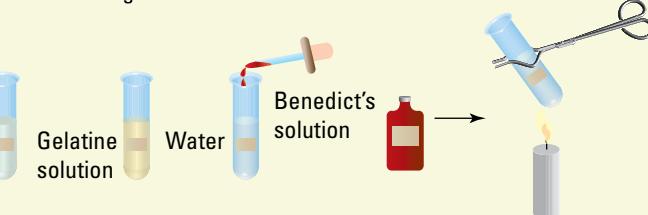
test-tube rack
4 test tubes
safety glasses
glucose solution
starch solution
gelatine solution
distilled water
iodine solution
test-tube holder
Benedict's solution
tongs
candle or Bunsen burner
matches

heatproof mat
0.01 M copper sulfate solution
1.00 M sodium hydroxide solution
food samples



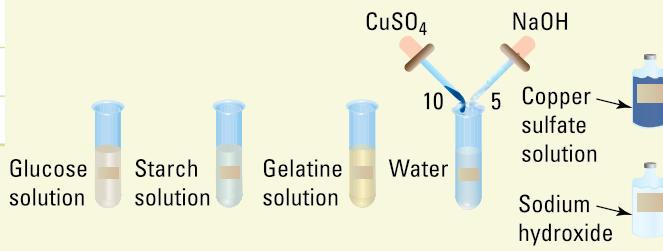
GLUCOSE TEST

- Add four drops of Benedict's solution to each of the four test tubes. Gently heat each test tube over the candle or Bunsen burner flame. Observe any colour change and record the results.



PROTEIN TEST

- Add ten drops of copper sulfate solution to each of the four test tubes. Then add five drops of sodium hydroxide solution to each test tube. Observe any colour change and record the results.



METHOD AND RESULTS

- Copy and complete the table below for recording the test results.

| Test results | Water | Glucose solution | Starch solution | Gelatine solution |
|--------------|-------|------------------|-----------------|-------------------|
| Starch test | | | | |
| Glucose test | | | | |
| Protein test | | | | |

From your kitchen cupboards, select five foods to test. If they are solid, you may need to use a mortar and pestle to grind them into a 'mash' with a small amount of water before testing.

- Predict which of your food samples will contain starch, glucose and/or protein.

ESSENTIAL STANDARDS

- For each of the tests in this experiment, set up the four test tubes as shown below. After each test, clean the test tubes by rinsing with water. Make sure a fresh sample of each liquid is used for each test.



STARCH TEST

- Add two drops of iodine solution to each of the four test tubes. Observe any colour change and record the results.

ESSENTIAL FOOD TESTS

- Using the three tests above, investigate the food samples for the presence of starch, glucose and protein. (Note: Add *only* your food samples to these tests, *not* the glucose, starch or gelatine solutions.)

DISCUSS AND EXPLAIN

- Suggest why you set up standard tests and added the same volumes of solutions to each test tube.
- Which foods contain two or more of the nutrients tested for?
- Were your predictions supported by your results?
- Comment on your overall findings.
- If you were to do the food testing again, suggest how you might improve the procedure.

INVESTIGATION 3.2

What's in your kitchen cupboard?

AIM To investigate the nutrients found in foods

METHOD AND RESULTS

- Find ten food items in your kitchen that have the nutrients listed on the packaging.

- 1 Draw up a table like the one below to summarise your findings.

DISCUSS AND EXPLAIN

- 2 Which of the foods was highest in:

- (a) energy
- (b) protein
- (c) fibre
- (d) sodium?

- 3 Rank the foods in order from highest to lowest for:

- (a) fat
- (b) fibre
- (c) energy.

Are your results what you expected? Why?

- 4 The recommended daily fibre intake is 30–40 g. On the basis of your findings, put together a meal of your packaged foods that would meet this requirement.

- 5 Draw a bar graph of your results for your foods and their fat content.

- 6 (a) Compare your results with those of two other students.
(b) How were they similar and how were they different?
(c) Select foods from your group to put together a meal. Using the nutrient tables, calculate the amount of each nutrient in your designed meal.

- 7 (a) Suggest three questions that you could research on the topics of nutrients or packaging labels.
(b) Collate the questions from the whole class and select one of these questions to research.
(c) Report your findings back to the class.



| Name of food | Nutrients per 100 grams | | | | | | |
|--------------------------------------|-------------------------|-------------|---------|------------------------|-----------|-------------------|-------------|
| | Energy (kJ) | Protein (g) | Fat (g) | Total carbohydrate (g) | Sugar (g) | Dietary fibre (g) | Sodium (mg) |
| 'Light'n'tasty' cereal | 1540 | 8.7 | 3.1 | 71.3 | 23.6 | 7.7 | 225 |
| Potato chips | 2130 | 8.5 | 31.9 | 46.1 | 1.8 | 3.0 | 518 |
| Apricot jam | 1140 | 6.4 | 0.1 | 66.6 | 59.4 | — | 17 |
| Barbecue-flavoured 'Shapes' biscuits | 2184 | 10.2 | 25.2 | 63.3 | 1.4 | — | 752 |
| Multigrain corn thins | 380 | 9.5 | 3.0 | 77.6 | 0.7 | 8.5 | 201 |

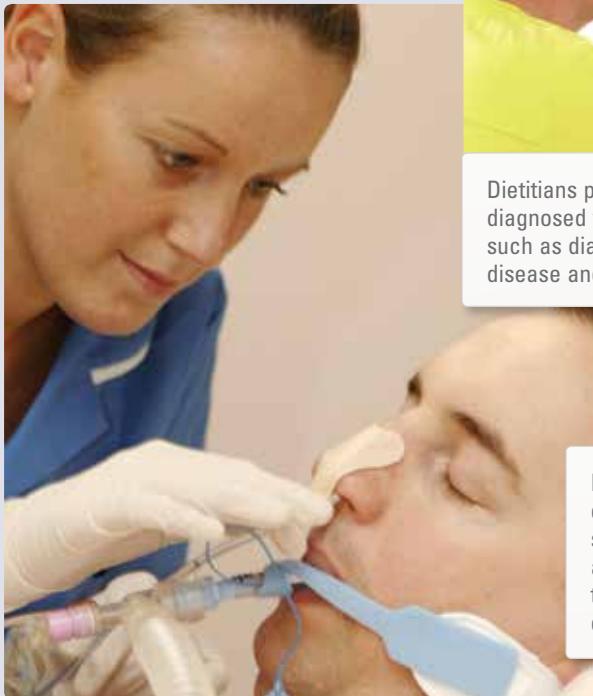
HOW ABOUT THAT!

Nutrient careers

Nutritionists and dietitians are examples of two careers with a focus on nutrition. These careers may involve communication of nutrition messages to individuals or to various groups within the community.

These careers may be in private, public or community health, in the food industry or in various types of research.

Clinical nutritionists may have face-to-face consultations and discussions with their clients about dietary changes that may be required. While clinical nutritionists approach issues from a 'nutrient' perspective, dietitians may be working in a hospital or private practice to advise their clients about food and lifestyle changes.



Dietitians provide advice to people diagnosed with diet-related diseases such as diabetes, coeliac disease, heart disease and certain types of cancers.

Dietitians may also be involved in determining the appropriate food solution for patients who require a drip or nasogastric tube (a tube that goes through the nose and down into the stomach).

UNDERSTANDING AND INQUIRING

REMEMBER

- 1 Give two reasons why you need to eat.
- 2 (a) List the five main groups of nutrients.
(b) Which of these are organic nutrients?
- 3 Identify shared features for the following pairs.
 - (a) Carbohydrates and lipids
 - (b) Cellulose and starch
 - (c) Fats and oils
 - (d) Iron and potassium
 - (e) Hormones and enzymes
- 4 How do cells get the energy that they need?
- 5 (a) What are proteins made of?
(b) Why are they important?
- 6 List some ways you can lose water.
- 7 Explain why it is important to drink water.
- 8 Describe the symptoms of dehydration.
- 9 What is fibre?
- 10 Why is it important to eat fibre even though the chemicals in it are not used by your body?

- 11 List the types of food you would recommend to a person lacking:
 - (a) vitamin C
 - (b) calcium
 - (c) iron.
- 12 Explain why the following vitamins are important to your health.
 - (a) A
 - (b) C
 - (c) K
- 13 Describe the deficiency signs of:
 - (a) calcium, zinc and magnesium
 - (b) vitamins A, B2 and D.
- 14 (a) Which amino acids are required for the synthesis of dopamine and norepinephrine? Name some foods that these are found in.
(b) Which amino acid is important for the synthesis of serotonin? Name some foods that it can be found in.

THINK AND INVESTIGATE

- 15 Suggest why pregnant women, children and adolescents need more protein than other adults.

- 16** Milk and other dairy products are well known as good sources of calcium. Which nutrients would be missing from the diet of someone whose food intake consisted mainly of dairy products?
- 17** Too much salt (sodium chloride) in your diet is not healthy. Why do we need salt at all?
- 18** Find out more about pregnancy and folate deficiencies.
- 19** Select a vitamin or mineral, find out details about it that interest you and then create a brochure to advertise it to others.
- 20** Suggest ways to encourage people to drink more water.
- 21** (a) An increased number of Australian women are being diagnosed as deficient in vitamin D. Suggest possible reasons for this situation.
 (b) List the symptoms associated with vitamin D deficiency.
 (c) Other than vitamin supplements, suggest ways in which this deficiency can be treated.
 (d) Design an investigation to test the effectiveness of your suggested treatments.
- 22** The addition of fluoride to our water supplies has caused much controversy. Find out and report on the key arguments for and against fluoridation.
- 23** Suggest how science can help individuals and communities make choices about their diet in terms of vitamins and minerals that they require.
- 24** Predict the relationship between darker skin and the amount of sunlight required for vitamin D production. Research and record information about the link, citing your references. Pose three questions that could be used to guide further research.
- 25** What do the results in the graph below suggest?
-
- | Food Item | Fibre content (grams) |
|----------------------------------|-----------------------|
| 1 cup boiled wholemeal spaghetti | ~6.2 |
| 1 cup boiled white spaghetti | ~3.0 |
| 1 slice wholemeal bread | ~1.8 |
| 1 slice white bread | ~0.7 |
- 26** Wholegrain products are high in fibre. Why do you think the word 'wholegrain' is used?
- 27** Some high-fibre breakfast cereals have more sugar added to them than some of the more highly processed breakfast cereals. Why do you think this is so?
- INVESTIGATE, REPORT OR CREATE**
- 28** Create your own vitamin and mineral learning tool to teach younger children the benefits of these nutrients to their health. This may be in the form of a song, play or poem, colourful flash cards with text and pictures, poster, brochure or booklet.
- 29** Construct your own vitamin or mineral wheel that is made up of two layers with a cut-out section in one area that allows the second layer to appear at the right time. One of the following formats should be used.
 - One layer with questions and the other with answers to the questions
 - One layer with types of foods and the other with vitamins or minerals found in those foods
 - One layer with types of vitamins or minerals and the other with diseases that can be caused by a deficiency in that vitamin or mineral and the types of foods in which it can be found
- 30** Prepare an advertisement to promote increasing fibre in people's diets. Your aim is to make high-fibre foods attractive to consumers. Your advertisement could be in the form of a poster, a dramatic performance, or a TV or radio commercial.
- 31** (a) In your team, brainstorm questions about proteins, lipids, vitamins and minerals.
 (b) Select one of these questions and suggest five further questions that you could use to find out more about it.
 (c) Use your questions to structure your research.
 (d) Organise your findings into a format that you will be able to share with others.
 (e) Report your findings back to your team or class.
- 32** A high-carbohydrate meal can increase your brain's tryptophan levels.
 - (a) What effect might this have on your mood?
 - (b) Which neurotransmitter is likely to be involved?
 - (c) At what time of the day would it be a good idea to have such a meal? Why?
- 33** A high-protein meal can raise tyrosine levels in your blood and brain.
 - (a) What effect might this have on your mood?
 - (b) Which neurotransmitter(s) is/are likely to be involved?
 - (c) At which time of the day would it be a good idea to have such a meal? Why?
 - (d) If tyrosine is also needed to make active thyroid hormones, what may result if there are insufficient levels of this amino acid in your blood?

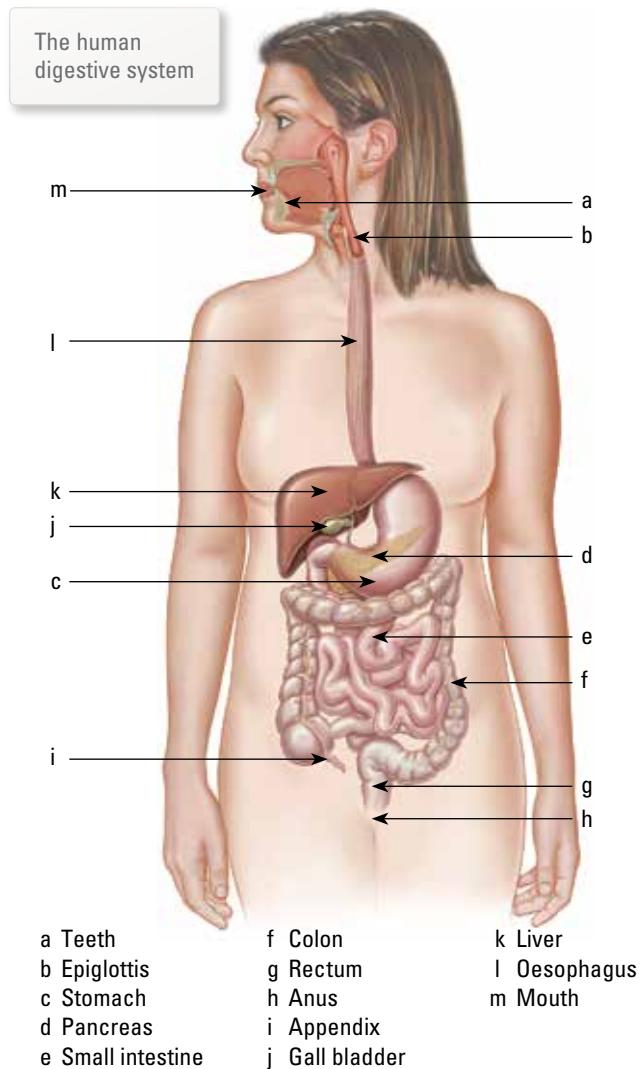
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work sheet

3.2 The digestive system

Digestive and excretory systems

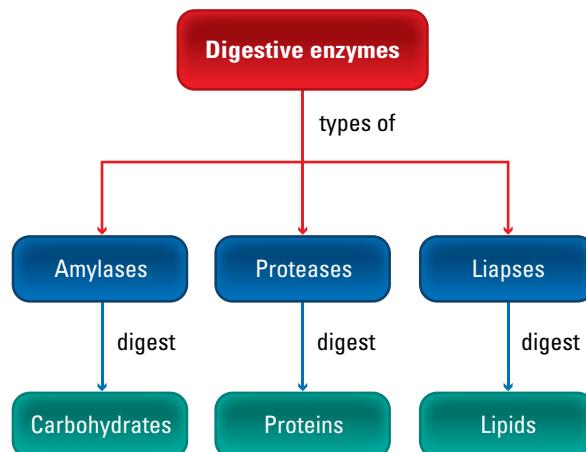
The key role of your **digestive system** is to supply your body with the nutrients it requires to function effectively. It is then up to your **excretory system** to remove wastes, such as those not digested or the waste products of a variety of necessary chemical reactions.



Digestive system — down we go

Mouth

You ingest food, digest it, then egest it. The whole process of **digestion** starts with you taking food into your mouth. **Enzymes** (such as amylases) in your **saliva** are secreted by your **salivary glands** begin the process of **chemical digestion** of some of the carbohydrates. Your teeth physically break down the food in a process called **mechanical digestion**, then your tongue rolls the food into a slimy, slippery ball-shape called a **bolus**.

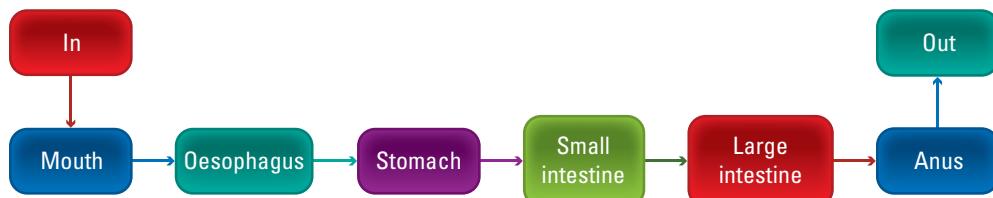


Oesophagus to stomach

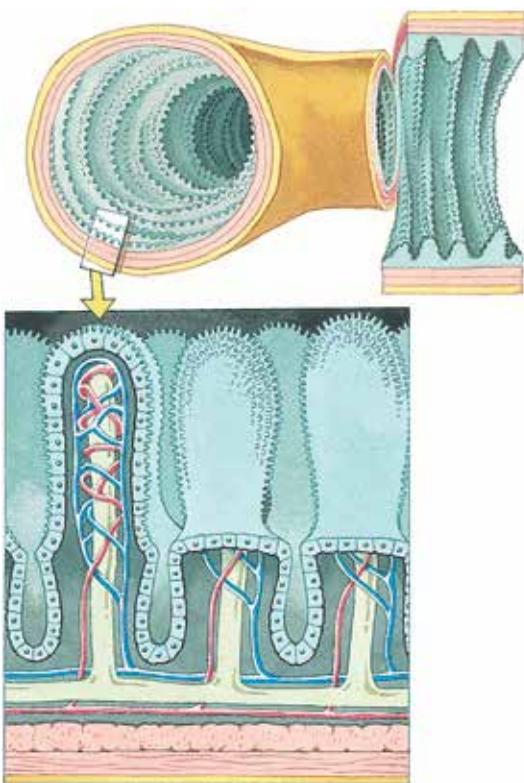
The bolus is then pushed through your **oesophagus** by muscular contractions known as **peristalsis**. From here it is transported to your stomach for temporary storage and further digestion.

Stomach to small intestine

Once the food gets from your stomach to your **small intestine**, more enzymes (including amylases, proteases and lipases) turn it into molecules that can be absorbed into your body. The **absorption** of these nutrient molecules occurs through finger-shaped **villi** in the small intestine. Villi are shaped like fingers



to maximise surface area to increase the efficiency of nutrients being absorbed into the surrounding capillaries. Once absorbed into the capillaries (of your circulatory system) these nutrients are transported to cells in the body need them.



The absorption of most nutrients into your body occurs in the ileum, the last section of the small intestine. The finger-like villi on its walls give it a large surface area that speeds up nutrient absorption. Many tiny blood vessels called capillaries transport the nutrients from the villi into your bloodstream. Undigested material continues on to the large intestine where water and vitamins may be removed, and then the remainder is pushed out through the anus as faeces.

Liver

Your liver is an extremely important organ with many key roles. One of these is the production of **bile** which is transported to your gall bladder via the bile ducts to be stored until it is needed. Bile is transported from the **gall bladder** to the small intestine where it is involved in the mechanical digestion of lipids such as fats and oils.

Pancreas

Enzymes such as **lipases**, **amylases** and **proteases** (which break down lipids, carbohydrates and proteins respectively) are made by the **pancreas** and secreted

into the small intestine to chemically digest these components of food materials.

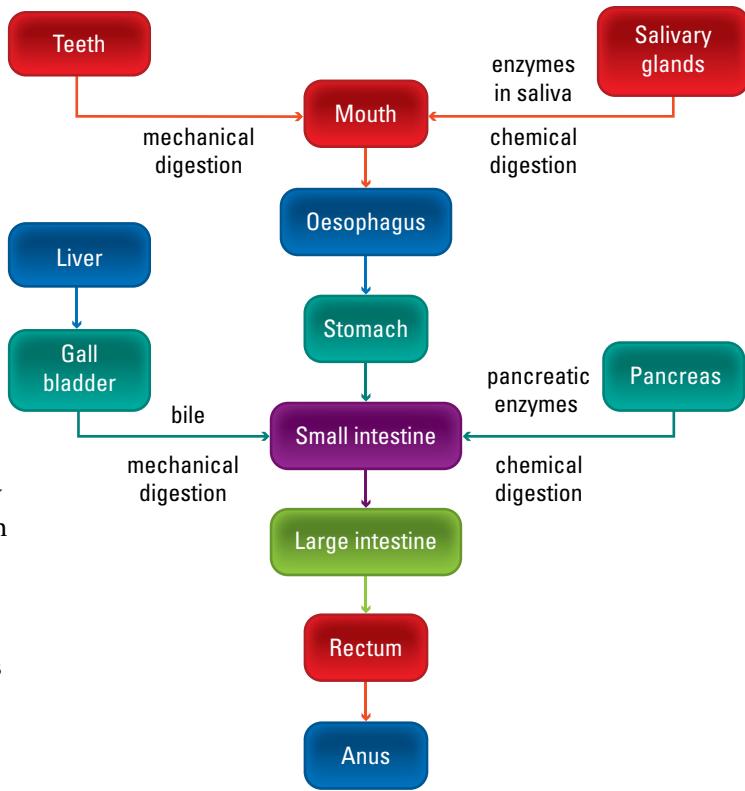
Large intestine

On its way through the digestive tract (alimentary canal), undigested food moves from the small intestine to the **colon** of the **large intestine**. It is here that water and any other required essential nutrients still remaining in the food mass may be absorbed into your body. **Vitamin D** manufactured by bacteria living within this part of the digestive system is also absorbed. Any undigested food, such as the **cellulose** cell walls of plants (which we refer to as fibre) also accumulate here and add bulk to the undigested food mass.

The **rectum** is the final part of the large intestine and it is where faeces is stored before being excreted through the **anus** as waste.

Excretory systems — out we go

Excretion is any process that gets rid of unwanted products or waste from the body. The main organs involved in human excretion are your **skin**, **lungs**, **liver** and **kidneys**. Your skin excretes salts and water as sweat and your lungs excrete carbon dioxide (produced by

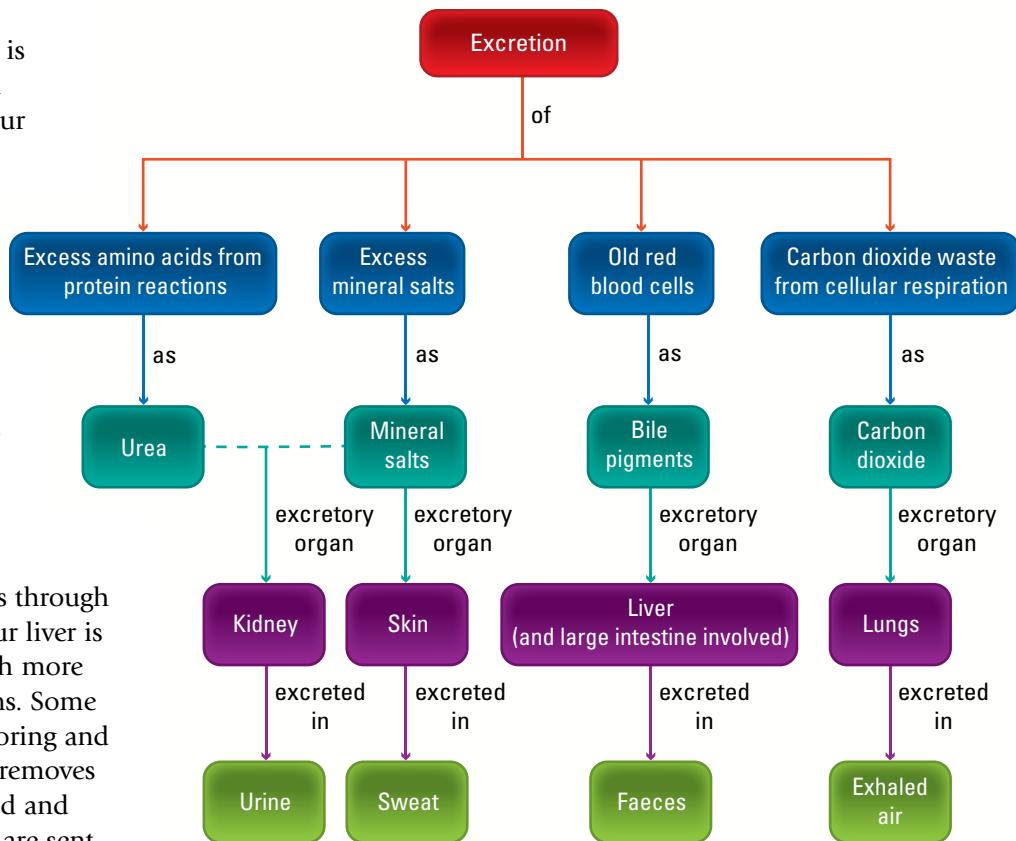
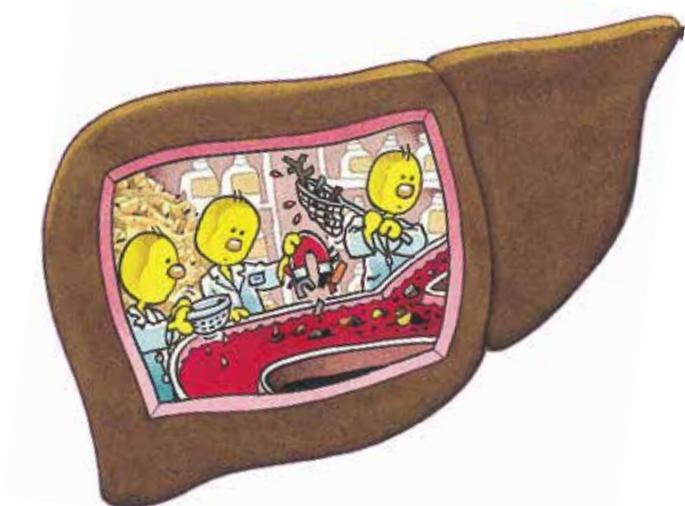


Digestion occurs within your digestive system in a systematic and organised manner.

cellular respiration) when you breathe out. Your liver is involved in breaking down toxins for excretion and your kidneys are involved in excreting the unused waste products of chemical reactions (e.g. urea) and any other chemicals that may be in excess (including water) so that a balance within our blood is maintained.

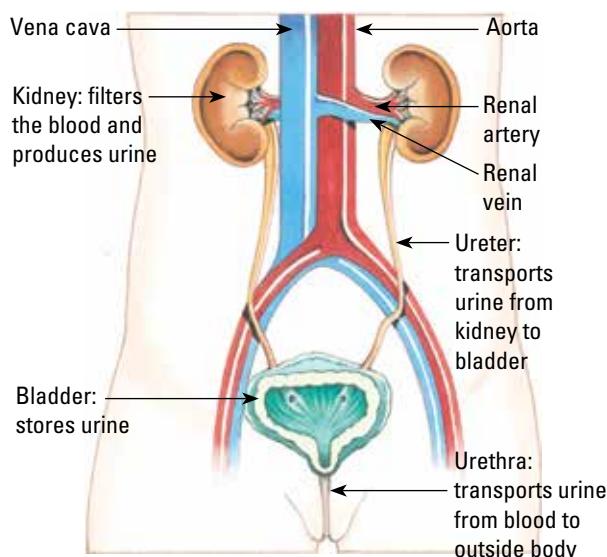
Liver

Over a litre of blood passes through your liver each minute. Your liver is like a chemical factory, with more than 500 different functions. Some of these include sorting, storing and changing digested food. It removes fats and oils from the blood and modifies them before they are sent to the body's fat deposits for storage. It also helps get rid of excess protein, which can form toxic compounds dangerous to the body. The liver converts these waste products of protein reactions into urea, which travels in the blood to the kidneys for excretion. It also changes other dangerous or poisonous substances so that they are no longer harmful to the body. Your liver is an organ that you cannot live without.



Kidneys

Your kidneys play an important role in filtering your blood and keeping the concentration of various chemicals and water within appropriate levels. Each of your kidneys is made up of about one million **nephrons**.



Your kidneys have an important role in the excretion of wastes from your body.

These tiny structures filter your blood, removing waste products and chemicals that may be in excess. Chemicals that are needed by your body are reabsorbed into capillaries surrounding them. The fluid remaining in your nephrons at the end of its journey then travels through to your **bladder** via your **ureters** for temporary storage until it is released as **urine**.

Blood, water and urine

Both blood and urine are mostly made up of water. Water is very important because it assists in the transport of nutrients within and between the cells of the body. It also helps the kidneys do their job because it dilutes toxic substances and absorbs waste products so they may be transported out of the body.

HOW ABOUT THAT!

Fish maintain their salt and water balance in different ways. Saltwater fish, such as snapper, drink sea water constantly and produce a small volume of urine. Freshwater fish, such as Murray cod, however, rarely drink, but make lots of urine.

Too much or too little?

The concentration of substances in the blood is influenced by the amount of water in it. If you drink a lot of water, more will be absorbed from your large intestine, and the kidneys will produce a greater volume of dilute urine. If you do not consume enough liquid you will urinate less and produce more concentrated urine.

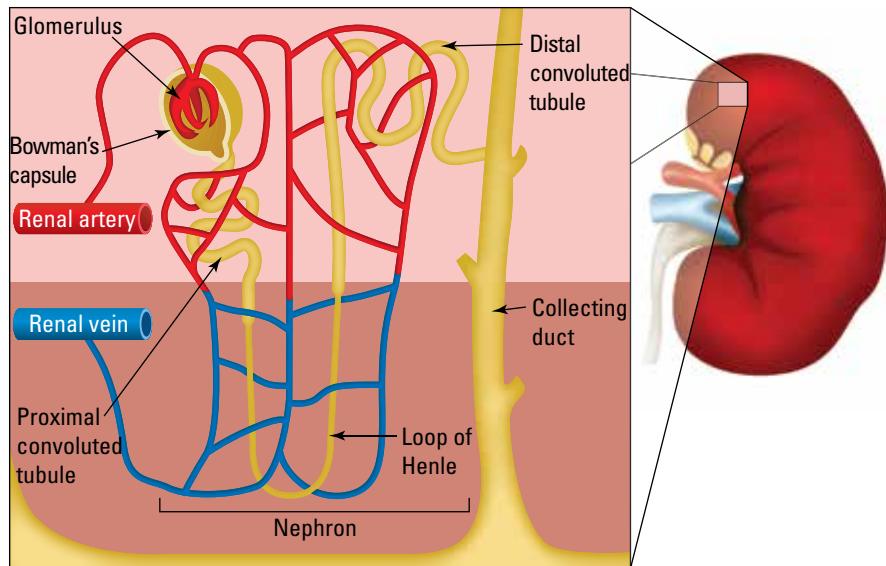
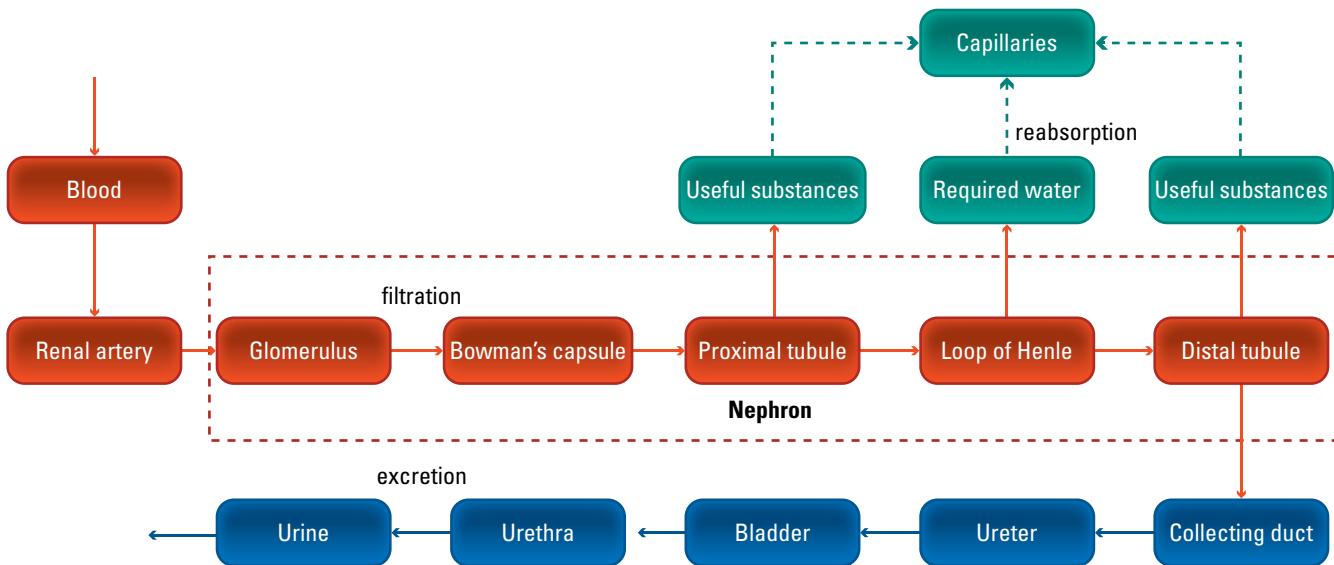


Diagram of a nephron.
Each of your kidneys
is made up of about a
million nephrons.



Lungs

Did you know that your body is more sensitive to changes in levels of carbon dioxide than oxygen? If there is too much carbon dioxide in your body, it dissolves in the liquid part of blood and forms an acid. The resulting acidic blood can affect the functioning of your body.

HOW ABOUT THAT!

The amount of oxygen carried by haemoglobin varies with altitude. At sea level, about 100 per cent of haemoglobin combines with oxygen. At an altitude of about 13 000 metres above sea level, however, only about 50–60 per cent of the haemoglobin combines with oxygen.

Blood and carbon dioxide

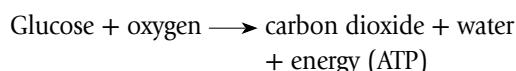
The amount of carbon dioxide in your blood influences your breathing rate. The level of carbon dioxide in the blood is detected by **receptors** in the walls of some arteries and in the brain. If the levels of carbon dioxide in your blood increase, your breathing rate will be increased so that carbon dioxide can be exhaled from your lungs and passed out of your body.

If you were to climb up high on a mountain, you would need time for your body to adjust. Initially you would feel tired and out of breath because you would be restricted by the limited amount of oxygen available to your cells. Your breathing and heart rate would increase in an effort to get more oxygen around

your body. In time, your body would begin to produce more red blood cells and hence more haemoglobin. After this, your breathing and heart rate would return to normal.

Cellular respiration

Glucose is an example of a nutrient that may be released from digested food. It is absorbed in your small intestine and then taken by the capillaries to cells for use in **cellular respiration**. In this process the glucose is combined with oxygen, and is then broken down into carbon dioxide (a waste product that needs to be removed from the cell) and water. During this reaction energy, in the form of **ATP** (adenosine triphosphate), is also released. ATP provides the cells with the energy needed to perform many of its activities, and is essential to life.



This is an example of systems working together. Glucose is supplied via the digestive system and oxygen is supplied via the **respiratory system**. The **circulatory system** transports nutrients (such as glucose) and oxygen to your cells and removes wastes (such as carbon dioxide) from your cells. These wastes are then removed from your body by your excretory systems. Without a supply of glucose and oxygen, cellular respiration could not occur. Without removal of wastes, your cells may die. If your systems did not work together like they do, you would not be able to stay alive.

UNDERSTANDING AND INQUIRING

REMEMBER

- 1 Outline why the digestive system and the excretory system are important to the survival of your cells.
- 2 Identify examples of types of enzymes involved in the digestion of:
 - (a) carbohydrates
 - (b) proteins
 - (c) lipids.
- 3 Explain why the villi in the small intestine are the shape that they are.
- 4 Describe how and where the nutrients are absorbed into your body from your digestive system.
- 5 Outline a way in which the liver is involved in digestion.

- 6 Identify the part of the digestive system in which water is absorbed into your body.
- 7 Construct a flowchart to show the route that undigested food material travels from your mouth to your anus.
- 8 Is cellulose digested? What happens to it?
- 9 Define the term *excretion*.
- 10 List examples of organs that are involved in human excretion.
- 11 Describe what happens when you drink a lot of water.
- 12 Describe one way in which excess salt is removed from your body.
- 13 Suggest reasons why you can't live without your liver.
- 14 Identify the name given to the:
 - (a) tiny structures that make up the kidney
 - (b) fluid that travels from your kidneys to your bladder for excretion.

- 15** Construct flowcharts to show the route travelled from the:
 (a) renal artery, through the nephron to the collecting duct
 (b) collecting duct to the urethra.
- 16** Suggest why a supply of water is important to your cells.
- 17** Is your body more sensitive to changes in carbon dioxide or oxygen levels? Explain.
- 18** Explain why mountain climbers sometimes find it difficult to breathe during a climb.
- 19** Explain how your cells obtain glucose and why it is important to survival.

THINK AND DISCUSS

- 20** Use Venn diagrams to compare:
 (a) the digestive system and excretory system
 (b) the small intestine and large intestine
 (c) ingestion and egestion
 (d) proteases and lipases
 (e) cellulose and glucose
 (f) bile and enzymes
 (g) ureter and urethra
 (h) nephron and villi
 (i) the digestive system and respiratory system
 (j) the excretory system and circulatory system.

ANALYSE AND EVALUATE

- 21** Use the table and the other information on these pages to answer the following questions.
 (a) Draw two bar graphs to show the quantity of water, proteins, glucose, salt and urea in blood and in urine.
 (b) Which substance is in the greatest quantity? Suggest a reason for this.
 (c) Which substances are found only in blood?
 (d) Which substances are found in urine in a greater quantity than in blood? Suggest a reason for this.
 (e) When would the amount of these substances in the urine become greater or less than in the blood?

| Substance | Quantity (%) | |
|-----------------|--------------|----------|
| | In blood | In urine |
| Water | 92 | 95 |
| Proteins | 7 | 0 |
| Glucose | 0.1 | 0 |
| Chloride (salt) | 0.37 | 0.6 |
| Urea | 0.03 | 2 |

INVESTIGATE, THINK AND CREATE

- 22** (a) Search the internet for animations or simulations that show how the excretory or digestive systems function.

- (b) Select your favourite animation or simulation.
 (c) Construct a PMI chart that outlines what you liked about the animation, what you didn't like and how it could be improved.
 (d) Create your own multimedia version on the circulatory system and/or respiratory system.
 (e) Share your creation with the class.

- 23** Find out more about the structure and function of either the digestive or excretory system and create a model that helps you to explain why the system is so important to our survival.

- 24** (a) Find examples of scientific research on either the digestive or excretory system.
 (b) Create a poster, PowerPoint presentation or podcast on the research that interests you most and present your findings to the class.

- 25** Imagine that you are a scientist working in a field related to the study of the circulatory or excretory system. Propose a relevant question or suggest a hypothesis for a scientific investigation and outline how you would design your investigation. Search the internet for relevant research or information.

- 26** Find examples of how developments in imaging technologies have improved our understanding of the functions and interactions of the digestive and excretory systems. Share your findings with your class.

- 27** Investigate how technologies using electromagnetic radiation are used in medicine; for example, in the detection and treatment of cancer of the digestive or excretory system.

- 28** There are often claims made in the media about particular products relating to the digestive and excretory systems. Examples include indigestion tablets, laxatives and weight loss tablets. Select one of these examples or one of your own to evaluate and/or test the claims being made in advertising or in the media.

- 29** Research and report on one of these conditions: urinary incontinence, kidney stones, dialysis, kidney transplants, cystitis.

- 30** Find out:
 (a) the differences between the urethra in human males and females
 (b) why pregnant women often need to urinate more frequently
 (c) how the prostate gland in males may affect urination in later life
 (d) which foods can change the colour or volume of urine
 (e) which tests use urine in the medical diagnosis of diseases.

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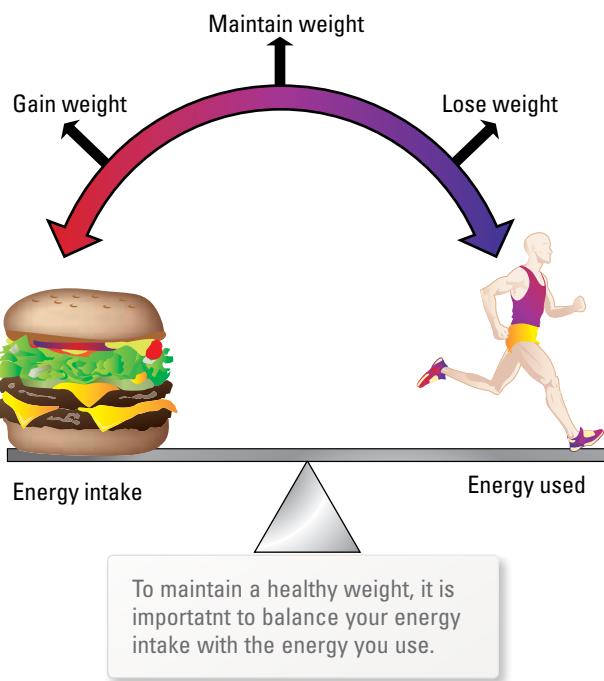


3.3 Removing waste from the blood

Living warehouses

It can be confusing trying to figure out what a healthy diet is when you are bombarded by so many different fad diets!

Many of these diets eliminate whole food groups and may put you at risk of developing a nutritional deficiency. Knowing how your body stores and uses energy — like a living warehouse — may help you to weigh up the risks and benefits of these ‘wonder diets’.



How much energy do you need?

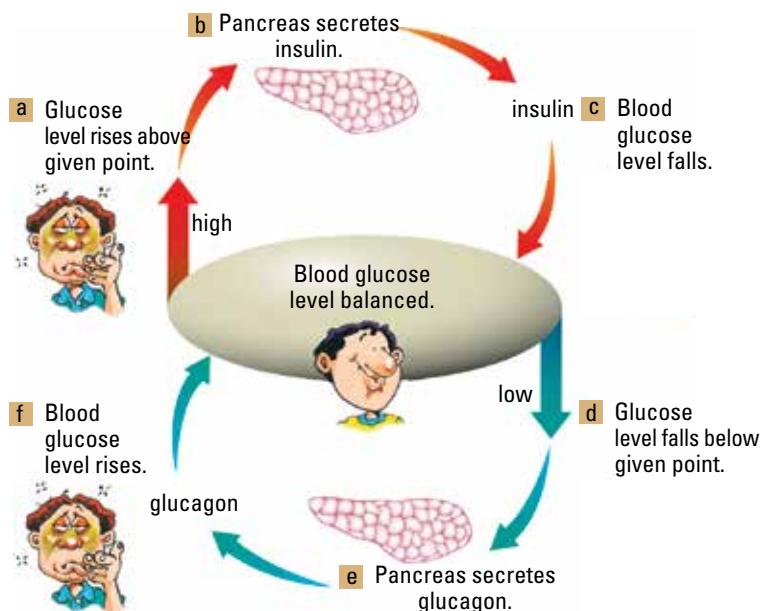
To function effectively, your body needs energy. We gain energy from the foods that we eat. The amount of energy stored in this food is measured in kilojoules (kJ) or calories.

The amount of energy that you need depends on how big and active you are, how quickly you are growing and how fast your body uses it.

Balancing blood glucose

Your cells need **glucose** to use in the process of **cellular respiration** to make **ATP** (adenosine triphosphate) molecules. ATP is used by cells in reactions that require energy. This glucose is obtained from the food that you eat. Glucose molecules are transported in blood in your circulatory system to cells throughout your body.

If you have high levels of glucose in your blood, special cells in your **pancreas** detect this and release **insulin** into your bloodstream. Target cells in your muscles and liver receive this chemical message and glucose is taken out of the blood and converted into the storage polysaccharide **glycogen**. If the levels of blood glucose are too low, then another hormone, **glucagon** is released by the pancreas. Glucagon triggers the breaking down of glycogen into the monosaccharide glucose. This is how the glucose levels in the blood can be kept within a narrow range.



The hormones insulin and glucagon are secreted by the pancreas to control glucose levels in your blood.

Diabetes

Diabetes mellitus is an endocrine disorder that is caused by a deficiency of insulin or a loss of response to insulin in target cells (such as those in liver and muscle tissue). This results in high blood glucose levels. Glucose levels can become so high that it is excreted by your kidneys and hence found in urine. Glucose in urine is one of the tests that are indicative of diabetes. The higher the glucose levels, the more water will be excreted with it. This results in the loss of large volumes of urine, which leads to persistent thirst; this is one of the warning signs for diabetes mellitus.



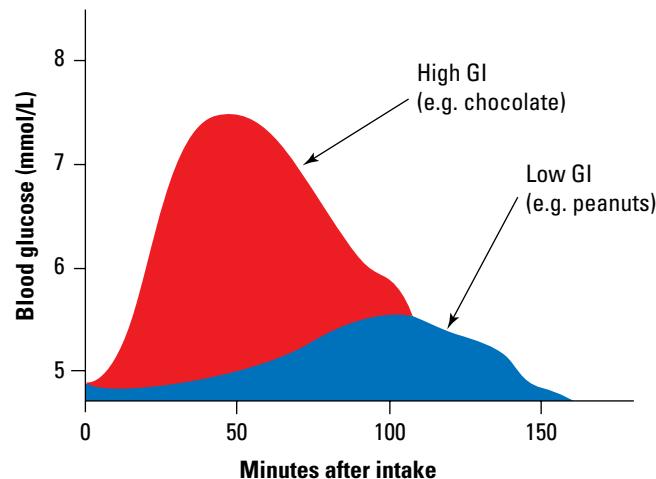
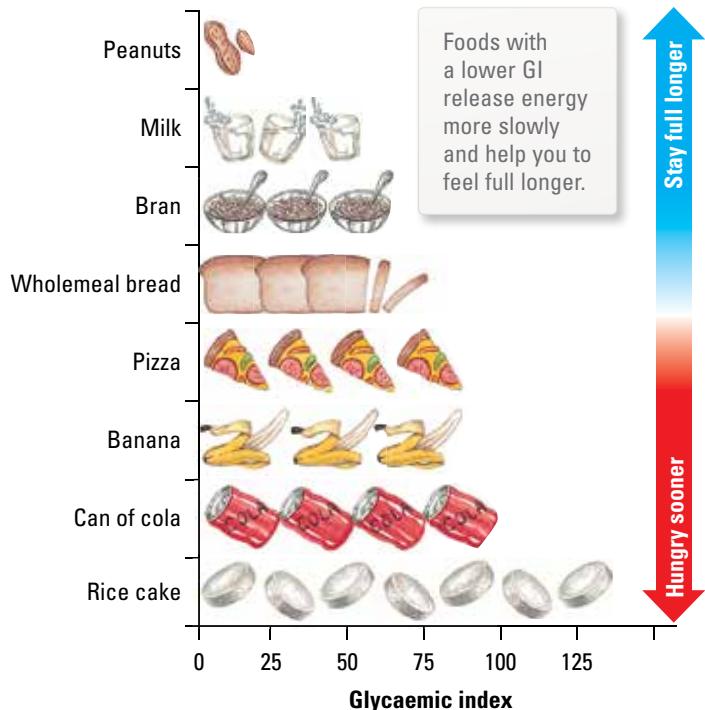
There are two main types of diabetes. **Type 1 diabetes mellitus** usually starts in childhood and is an autoimmune disorder. In this case, the immune system mounts an attack against cells in the pancreas, destroying their ability to produce insulin. This type of diabetes requires treatment with insulin injections. **Type 2 diabetes mellitus** usually starts later in life and is the most common form. It is characterised by either a deficiency of insulin or target cells that do not respond effectively to insulin. Type 2 diabetes has been linked to hereditary factors and obesity. It is usually controlled through exercise and diet.

GI: high or low?

You may have noticed that some foods are labelled as 'low GI' or 'high GI'. This refers to the **glycaemic index** of the food. This is a measure of the time it takes for your blood sugar level to rise after you have eaten it. Foods that are considered to be low GI are digested more slowly than those that are high GI. This means that blood glucose levels will rise more slowly and over a longer period of time. This will mean that you will feel fuller for longer. High GI foods provide a short burst of glucose and you may start to feel hungry as your blood glucose levels drop.

Foods with a high GI

Foods such as white bread, rice and mashed potatoes contain starch and sugar, which are porous and have a high surface-to-volume ratio. This means that they can be digested easily by the enzyme amylase. Such foods have a high glycaemic index and can cause a sharp rise in blood sugar.



Foods with a high GI, such as chocolate, cause a sharp rise in blood sugar. Foods with a low GI, such as nuts, result in a more moderate but longer lasting rise in blood sugar.

These foods are very good if you have been active and need to replenish energy stores quickly. The chart above and table at the top of the next page show some foods that will supply energy quickly and some that will help you to feel full longer.

Foods with a low GI

Foods rich in fibre, such as wholemeal bread and thick pasta like spaghetti, are digested more slowly.

| Glycaemic index | Extremely high | High | Moderately high | Moderately low | Low |
|----------------------|--|--|---|--|---|
| Grains | Puffed rice Cornflakes White bread | Wholemeal bread Muesli Brown rice Porridge oats | Bran Rye bread White pasta Brown pasta | Tomato soup Lima beans | Barley |
| Fruit and vegetables | Parsnip Baked potato Carrot | Sweetcorn Mashed potato Boiled potato Apricots Bananas | Sweet potato Peas Baked beans grapes Orange juice | Pears Apples Orange Apple juice | Red lentils Soybeans Peaches Plums |
| Sugar | Glucose Honey | Sucrose | | | |
| Snacks | | Corn chips Chocolate Crackers Biscuits Low-fat ice-cream | Potato chips Sponge cake | Yoghurt High-fat ice-cream | Peanuts |

This is because the more compact physical form of these foods makes it harder for the enzyme amylase to reach its substrate. These foods cause only a moderate change in your blood sugar level, so can help provide you with lasting energy throughout your day.

The table above indicates the glycaemic index of a range of foods. The graph opposite shows the energy spike and drop that occurs after eating high GI foods, and the more moderate, longer lasting rise in blood sugar level after eating low GI foods.

HOW ABOUT THAT!

When food supplies are scarce, or during hibernation, an animal's ability to store energy reserves greatly assists its chances of survival. Penguins, for example, use their fat reserves to provide them with energy when required. Male emperor penguins are able to keep eggs warm for nine weeks at a time without any food. Animals that live in cold regions also use their fat storage ability to insulate themselves against the very cold weather conditions.

Whales and seals have a thick layer of fat cells called blubber, which serves as an insulation layer in their cold, watery habitats.



Fats, feasts and famines

The ability of your ancestors to store high-energy molecules may be how you got to be here today. Fats are especially rich in energy, providing about twice as much energy as the equivalent amount of carbohydrate or protein.

When more kilojoules of energy are consumed than required, the body tends to store the excess energy in the liver and muscle cells as glycogen. If glycogen stores are full and the energy intake still exceeds that required, the excess may be stored as fat in the form of fat cells just beneath the skin.

When extra energy is required, the liver glycogen is used first, then the muscle glycogen and finally the fat. Most people have enough fat cells stored to provide energy for 3–7 weeks. The human body tends to hoard fat, immediately storing fat molecules obtained from food.

Most people should consume about 30–40 g of fat a day.

The amount of fat in your diet can have a more direct effect on weight gain than carbohydrates. Although fat hoarding can be a liability today, it may have increased the chances of survival of your hunting and gathering ancestors. Recent discoveries suggest that the regulation of fat storage may be controlled by a hormone called leptin and several genes inherited from your parents.

Banned! It's for your own good!

Imagine being told 'No treats for you! You will have spinach, capsicum and tomato on wholegrain bread and no butter!' Who tells you what to eat? Should

you listen? Do others really care what you put into your mouth?

In 2006, the Victorian government decided to address the types of food that are available to school students. One of the reasons for this was the growing

concern about the number of obese children in the state. Soft drinks containing sugar were the first to be on their no-go list. Do you think the government has the right to make such a decision? What is your opinion on this issue?

INVESTIGATION 3.3

Measuring the energy in food

AIM To compare the amounts of energy stored in a range of foods

Materials:

| | |
|--|----------------------------------|
| small metal basket (used to fry food) | thermometer |
| samples of small biscuits, potato chips, uncooked pasta, crouton or small piece of toast | retort stand, bosshead and clamp |
| | large test tube |
| | Bunsen burner |
| | measuring cylinder |
| safety glasses | |

CAUTION Before starting this experiment, read all the steps below and make a list of the risks associated with this activity and how you plan to minimise these risks.

METHOD AND RESULTS

1 Copy and complete the table below.

| Food | Biscuit | Chip | Pasta | Crouton/toast |
|---|---------|------|-------|---------------|
| (a) Mass of food (g) | | | | |
| (b) Volume of water (mL) | | | | |
| (c) Initial temperature of water ($^{\circ}\text{C}$) | | | | |
| (d) Final temperature of water ($^{\circ}\text{C}$) | | | | |
| (e) Increase in temperature ($= d - c$) | | | | |
| (f) Energy in food (J) $(= 4.2 \times 30 \times e)$ | | | | |
| (g) Energy in food (kJ) $(= f \div 1000)$ | | | | |
| (h) Energy per gram of food (kJ/g) ($= g \div a$) | | | | |

- Use the clamp to attach the test tube to the retort stand.
- Measure 30 mL of water and pour it into the test tube.

2 Measure the temperature of the water.

3 Weigh the biscuit.

4 Place the small biscuit in the wire basket and set fire to it using the Bunsen burner. When the biscuit is alight, put the basket containing the biscuit underneath the test tube. The heat released from the burning biscuit will heat the water. Hold the basket under the test tube until the biscuit is completely burned. You can tell that the biscuit is completely burned if it is all black and will not re-ignite in the Bunsen burner flame.

5 Measure the temperature of the water again.

6 Calculate the amount of energy that was stored in the biscuit, using the following equation.

$$\text{Energy (in joules)} = 4.2 \times \text{volume of water (in mL)} \\ \times \text{increase in temperature (in } ^{\circ}\text{C})$$

7 Calculate the amount of energy per gram of food by dividing the amount of energy by the mass of the food.

8 Repeat the steps above using the other food samples.

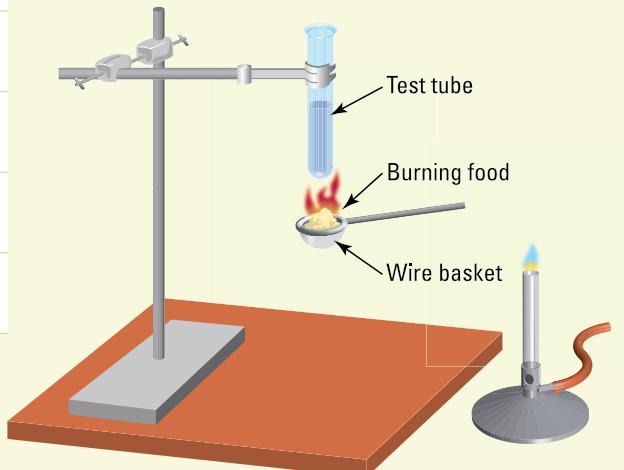
DISCUSS AND EXPLAIN

9 Copy and complete the aim of this experiment:
'To compare the amount of _____ contained in a range of foods'.

10 Copy and complete the conclusion: 'The food that contained the most energy per gram was _____'.

11 Why was it necessary to calculate the amount of energy per gram of food?

12 Did all the heat from the burning food go into heating the water? Explain how this might have affected the validity of this experiment.



CHILDHOOD OBESITY ON THE RISE

Jacqueline Freegard

Obese primary school children are showing signs of diseases normally only seen in overweight adults, research has revealed.

High levels of hyperinsulinism, fatty liver and other complications have been found in children as young as six.

Obese and overweight children were also found to suffer from sleeping disorders, depression, bullying and muscle pain.

Dr Zoe McCallum from the Murdoch Childrens Research Institute said increasing numbers of overweight children were presenting with the early stages of serious diseases, including type 2 diabetes.

'We know there is increasing liver disease, increasing hyperinsulinism

and increasing raised blood fats,' Dr McCallum said.

'And we know that there are children being diagnosed with type 2 diabetes at a younger age, which is traditionally seen in the adult population.'

Dr McCallum said the incidence of childhood obesity in Victoria has tripled in the past 15 years.

One-in-four Victorian children is overweight or obese, with 5 to 6 per cent classified as obese.

Australia now matched US rates of childhood obesity.

'We are following our American cousins and getting fatter faster than America,' she said.

'There are more obese children and they are carrying much more weight than they ever have.'

The study found overweight and obese children were unlikely to show symptoms of underlying diseases.

'These children on the whole, apart from the fact they are clearly carrying too much weight, will actually be

quite healthy and may not suffer any ill effects from having these abnormal blood tests,' she said.

Dr McCallum said the study, from Perth's Princess Margaret Hospital, found parents were generally unaware of the problems associated with obesity.

'It won't be until 10 or 20 years later that there will be an impact,' she said.

'Children who have raised insulin, raised blood fats and elevated liver enzymes have hard evidence of future risks of diseases that do shorten life.'

Detecting the diseases early meant young children could be cured.

'The beauty of detecting it in kids is you can actually do something about it,' she said.

'If we slow the rate at which a child puts weight on then we can reverse some of those results.'

But she said even very young obese children suffer from the stigma associated with the disease.

Source: Herald Sun

How much sugar?

To calculate how much sugar is in a can or bottle of drink you must first find the nutrition information section on the label. A typical non-diet soft drink might contain 11.04 grams in 100 mL.

To calculate the mass of sugar in one 375 mL can of drink, use the formula below:

$$\text{Mass of sugar} = \frac{11.04 \times \text{volume}}{100}$$

$$\text{So, mass of sugar} = 11.04 \times \frac{375}{100} = 41.4 \text{ g}$$

Since one teaspoon of sugar has a mass of approximately 4 grams, divide the mass of sugar in one can of drink by 4.

$$\frac{41.4}{4} = 10.35 \text{ teaspoons}$$

Therefore, one can of soft drink might contain over 10 teaspoons of sugar.

| SUGAR CONTENT | PEPSI | COKE | SUNKIST | SCHWEPPES LEMONADE | SOLO |
|-------------------|--|--|---|--|--|
| BANNED | | | | | |
| | PEPSI 11.04g sugar per 100mL; 186.5kJ per 100mL | COKE 10.8g sugar per 100mL; 180.5kJ per 100mL | SUNKIST 13.5g sugar per 100mL; 232.4kJ per 100mL | SCHWEPPES LEMONADE 11.3g sugar per 100mL; 195.8kJ per 100mL | SOLO 12.1g sugar per 100mL; 212kJ per 100mL |
| HEALTHIER CHOICES | | | | | |
| SR content | COKE ZERO Nil sugar; 1.4kJ per 100mL | PEPSI MAX Nil sugar; 1.29kJ per 100mL | WATER Nil sugar; Nil kJ | REV low-fat milk 4.5g sugar (naturally occurring lactose or milk sugars); 10.7kJ per 100mL | POPPER JUICE, AP No added sugar; 10.5g sugar (naturally occurring fructose) per 100mL |

INVESTIGATION 3.4

Energy for living

AIM To increase awareness of energy intake from food and energy output during different types of activities

METHOD AND RESULTS

- Table 1 below provides an approximate amount of energy used for a variety of activities.

| Activity | Approximate energy use (kJ) per hour |
|---|--------------------------------------|
| Sleeping | 250 |
| Very light: sitting, reading, watching television, driving | 450 |
| Light: leisurely walking, washing, shopping, light sport such as golf | 950 |
| Moderate: fast walking, heavy gardening, moderate sports such as cycling, tennis, dancing | 1800 |
| Heavy: vigorous work, sports such as swimming, running, basketball and football | 3500 |

- 1 Construct a table (Table 2) with the headings shown below.
- 2 Record all the activities which you have been involved in over a 24-hour time period.

| Activity | Time spent on activity in hours or part of an hour | Energy use (kJ) per hour (from table opposite) | Total energy used (in kJ) |
|----------|--|--|---------------------------|
| | | | |
| | | | |

- 3 Complete the table by calculating the energy used for each activity.
- 4 Calculate your total energy (kJ) used during the 24-hour period.

- Select a two-course lunch and a drink from Table 3 shown below.

- 5 Calculate the energy (kJ) and fat (g) in your selected lunch.

| Food | Energy (kJ) | Fat (g) |
|--------------------------|-------------|---------|
| Pizza (two slices) | 2060 | 20 |
| Hamburger | 1900 | 20 |
| Salad sandwich | 940 | 9 |
| Chocolate eclair | 1320 | 15 |
| Fresh fruit salad | 290 | 0.3 |
| Apple pie with ice cream | 2310 | 26 |
| Medium cola | 384 | 0 |
| Strawberry thick shake | 1230 | 15 |
| Medium orange juice | 530 | 0 |

DISCUSSION AND EVALUATION

- 6 Which activity used the most energy?
- 7 Subtract the total energy used (kJ) from the energy calculated in your lunch (kJ).
- 8 Based on the value calculated in question 7, how many kilojoules could you eat for breakfast and dinner to balance the rest of the energy used that was calculated in question 4? Comment on this amount.
- 9 Comment on the amount of fat (g) calculated in your selected meal.
- 10 Suggest why the values of energy used in daily activities are only approximate.
- 11 On the basis of your data, write a conclusion.
- 12 Identify the strengths and limitations of this investigation and suggest how it could be improved.
- 13 Propose a related research question that could be explored.
- 14 Suggest a hypothesis relevant to your research question.
- 15 Design an investigation that could test your hypothesis.

INVESTIGATION 3.5

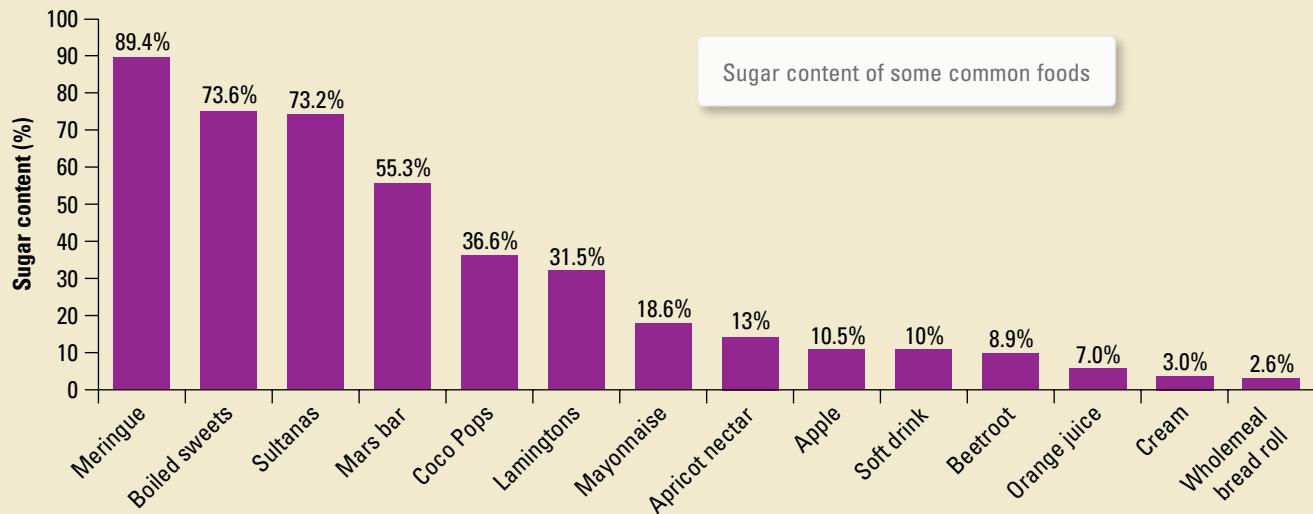
Fizz and tell

AIM To increase awareness of the amount of sugar in soft drinks and the amount consumed in a week, and to analyse data

METHOD AND RESULTS

- 1 Survey the class to find out:
 - (a) how much soft drink they consume in a week (in millilitres)
 - (b) which types of soft drinks are consumed.

- 2 Present your results in a format that can be shared with others.
- 3 Comment on your results. Were they what you expected or were you surprised? Were there patterns? What other sorts of information would you like to know to further analyse the data?
- 4 Comment on whether your data support the following statement: 'Almost 80 per cent of teenagers consume soft drinks weekly, with 10 per cent drinking more than one litre per day.'



Sugar content of some common foods

INVESTIGATION 3.6

More fizz and tell

AIM To increase awareness of attitudes and opinions about the relationship between soft drink consumption and teenage obesity

METHOD AND RESULTS

Consider the following statement:

'Sugar-loaded soft drinks should be banned from all Australian schools to reduce teenage obesity.'

- 1 Construct a PMI chart on the statement.
- 2 Do you agree with this statement?
- 3 In the classroom, construct a human graph to show people's opinions on the statement. Stand in positions to indicate your feelings about the statement.

For example:

Strongly disagree (0) — stand next to the left-hand wall Agree (2) — stand in the centre of

the room Strongly agree (4) — stand next to the right-hand wall.

- 4 Have a discussion with students standing near you to find out the reasons for their opinion.
- 5 Listen to the discussions of students in other positions.
- 6 Construct a SWOT diagram to summarise what you have found out.
- 7 Record the results of the human graph.
- 8
 - (a) What was the most popular attitude? Suggest a reason for this.
 - (b) What was the least popular attitude? Suggest a reason for this.
 - (c) Do you think this attitude pattern is representative of other Australians your age? Explain.
- 9 On the basis of your discussions, have you changed your attitude since the start of this activity? If so, how is it different and why?

UNDERSTANDING AND INQUIRING

REMEMBER

- 1 Name the unit in which energy is often measured.
- 2 Explain why your cells need glucose.
- 3 Describe how your:
 - (a) cells obtain glucose
 - (b) blood glucose levels are kept within a narrow range.
- 4 Explain why a person with diabetes type 1 needs insulin injections.
- 5 Distinguish between:
 - (a) high GI foods and low GI foods

- (b) diabetes type 1 and diabetes type 2
- (c) carbohydrate storage and fat storage.
- 6 Outline two ways in which fat storage assists the survival of animals.
- 7 Explain what happens when we eat more kilojoules than we use.
- 8 How can you eat a diet high in kilojoules and not put on weight?
- 9 Describe the relationship between:
 - (a) insulin and glucagon
 - (b) glycaemic index of foods and sugar levels.
- 10 When would it be a benefit to eat high GI foods?

- 11 List examples of:
 (a) high GI foods
 (b) low GI foods.

USING DATA AND CALCULATIONS

- 12 Use the table in this section that shows recommended energy intakes to answer the following questions.
- Plot a graph to show how energy needs change with age. You will need to plot two lines: one for males and one for females. The age should be on the horizontal axis. (If a computer is available, you could use a spreadsheet.)
 - Suggest why females seem to need less energy.
 - Suggest why you need more energy as you approach your late teens.

| | | Recommended daily energy intake (kJ) | |
|------------------------|---------|--------------------------------------|--------|
| Group | Age | Male | Female |
| Children | 1 | 5 000 | 4 800 |
| | 5 | 7 600 | 6 800 |
| | 9 | 9 000 | 7 900 |
| Adolescents | 12 | 9 800 | 8 600 |
| | 13 | 10 400 | 9 000 |
| | 14 | 11 200 | 9 200 |
| | 15 | 11 800 | 9 300 |
| Adults (height 190 cm) | 18–30 | 12 000 | 10 600 |
| | 30–60 | 11 400 | 9 500 |
| | over 60 | 9 700 | 8 800 |

ANALYSE AND EVALUATE

- 13 (a) What types of drinks may be banned from Victorian state schools?
 (b) How much sugar do most non-diet soft drinks contain?
 (c) Calculate the mass of sugar in a two-litre bottle of Coke.
 (d) Calculate the number of teaspoons of sugar in a two-litre bottle of Coke.
 (e) Calculate and graph the amount of sugar in a 375 mL can or bottle of each of the drinks in the table at the beginning of this section.

THINK AND DISCUSS

- 14 Do you think that too much soft drink is being drunk by people your age? Should it be changed or monitored? What are some implications about the amount of soft drink consumed?
- 15 What are your opinions on the state government being able to dictate the types of foods that are available to children in schools?
- 16 Do you think the Victorian government's ban on soft drinks in schools will help reduce obesity in teenagers? Give reasons to support your opinion.
- 17 What other lifestyle habits should the government be involved in? How should they approach this? Provide reasons why you think they should be involved.

THINK AND INVESTIGATE

- 18 Read the article *Childhood obesity on the rise* on page 123 and answer the following questions.
- How much has the incidence of childhood obesity in Victoria increased in the last 15 years in the article?
 - Create a mind map on the problems that have been found in obese primary school children.
 - Brainstorm ways to reduce the incidence of obesity in Australia.
 - Since this article was written in 2005, find out if childhood obesity has increased over the last ten years. Support your response with information from at least three different sources. Share and discuss your findings with others.

INVESTIGATE AND SHARE

- 19 Is childhood obesity a real issue in Australia? Research various resources to gather as much relevant information as you can. On the basis of your research and personal beliefs, construct an argument to prepare for a debate with someone who has an opposing view.
- 20 Use the nutrition information in section 3.2 and other sources to put together a menu for a day that has the recommended daily kJ for your age. Find out and report on diabetes research.

eBookplus

- 21 Use the **Kilojoule Burn calculator** weblink in your eBookPLUS to learn how many calories you will burn from performing a number of common exercises.

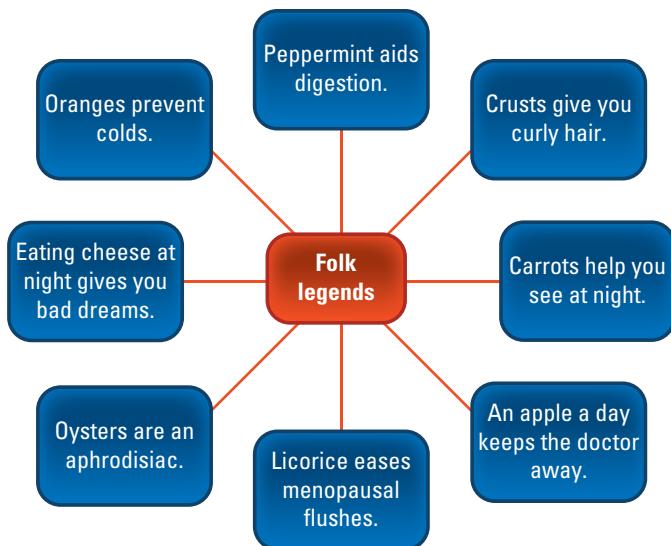
Myths, moods and foods

Folk legends

Knowledge often passes from one generation to the next through stories and tales. Some old-fashioned remedies have been passed on in this way. The truth of some of these folk legends may have altered or disappeared along the way, while others may have a sound basis.

For instance, is chicken soup good for fevers? Yes; but this is also true for many other protein-rich foods. Although your body produces about 2000 immune cells per second, many of these can be lost when you are feverish. The amino acids in proteins help you to reinforce and rebuild new immune cells and molecules.

There are many folk legends related to food, and some of these are shown in the bubble map at right.



DIET TO LIFT SPIRITS

Fay Burstin

We know them as comfort foods — those warm hearty meals or rich treats — because the mere act of eating them makes us happy.

But research suggests that consuming the right foods could make us feel so good they could even relieve depression.

Two key nutrients in fish, nuts and beets have been found to work just as well as prescription antidepressants in preventing depression in laboratory rats.

Harvard University researchers in the US found omega-3 fatty acids and uridine, both linked to improved brain function, affected the rats' behaviour during a standard depression test.

Rats forced to swim in chilled water with no way to escape will normally become hopeless and float motionlessly. But when treated with antidepressants, they remain active for longer, searching for an escape.

A team led by neurobiologist William Carlezon at Harvard-affiliated McLean Hospital found rats whose diets were

supplemented with high levels of omega-3 fatty acids for at least 30 days stayed active and focused on escape.

Similarly, the study published in *Biological Psychiatry* found rats injected with high levels of uridine were equally tenacious.

And combined doses of omega-3 oil and uridine were just as effective as three different antidepressants in prompting the rats to start swimming again, Dr Carlezon said. But they didn't see the same results in untreated rats.

Dr Carlezon speculated that the drugs and dietary supplements acted on brain cells' mitochondria, the power source that produces energy for cells.

'Imagine what happens if your brain does not have enough energy,' he said.

'Basically, we were giving the brain more fuel on which to run.'

Associate Professor Luis Vitetta, from Swinburne University's Graduate School of Integrative Medicine, said major medical advances had been made in recent years linking illnesses such as cancer and cardiovascular disease to diet.

Now, similar links were being drawn between nutrition and brain function disorders such as dementia,

ADHD, depression and bipolar disorder, he said.

'We're starting to put the pieces of the puzzle together, based largely on why some cultures with certain diets suffer less from these disorders than others,' he said.

'Japan had one of the world's lowest rates of depression and we're beginning to think it's because they eat oily fish like salmon every day that's rich in omega-3 essential fatty acids.'

Dr Vitetta said at least 50 per cent of our brain was made up of essential fatty acids (EFAs).

But our brain can't manufacture EFAs itself so we need to get them from our diet.

Dr Vitetta said research showed anyone (or anything, including lab rats) fed omega-3 fatty acids performed better on brain function tests.

Studies show dyslexic children given an omega-3 dietary supplement can make two years' reading progress in six months and 70 per cent of kids diagnosed with ADHD no longer met the clinical criteria after four months of taking an EFA supplement.

But it's not just EFAs we need to lift our mood and brain power.

Dr Vitetta said good nutrition, including at least five or six portions of fresh fruit and vegetables a day, could ultimately have the same effect on the brain as antidepressant drugs.

'The vitamins and minerals in fresh fruit and vegetables are crucial for

every bodily function, including the heart, the liver and the gastrointestinal system,' he said.

'When your body is working well, your weight is healthy and your skin looks good, all of which have a positive effect on your self-image.'

'And if you feel good about yourself, you're less likely to feel anxious and depressed, which is reflected in good mental health.'

Source: Herald Sun

Mood food

Ever heard of 'mood food' or comfort food? Do you crave particular foods when you are in a particular mood? Some foods don't just make you feel happy, but actually affect your brain. The article *Diet to lift spirits* discusses some recent research on the antidepressant properties of two key nutrients.

Seeing

Dr Lisa Smithers won the 2008 South Australian Young Investigators Award for her research on omega-3 oils, tuna oil and premature babies.

DHA (docosahexaenoic acid) is an omega-3 oil important for brain, nerve and eye tissue development. The highest concentration of omega-3 DHA in the human body is in the retina of the eye. Premature babies may have low levels of DHA and rely on milk to supply it to them after their birth.

Dr Smithers's PhD research at the University of Adelaide involved a clinical trial. One group of breastfeeding mothers ingested tuna oil capsules with DHA. This raised the levels of DHA in the milk to four times higher than would normally be present. The DHA-enriched milk was provided until the premature

babies reached their full-term date. The other group of mothers received placebo capsules that did not contain DHA.

Testing the babies at four months of age showed that those who were fed higher levels of DHA were able to visually detect a finer pattern than those who had not. This suggests that the addition of DHA to the milk assisted in their visual development.



Dr Lisa Smithers. Although they may look like jelly beans, these are omega-3-oil supplements.

Mood food

Dark chocolate (at least 70 per cent cocoa solids) contains catechins, strong antioxidants which enhance endorphins, the brain's natural feel-good chemicals, and increase libido.

Seafood and oily fish contain high levels of omega-3 essential fatty acids, nerve and brain cells' building blocks that will ultimately improve mood more than any other food.

Nuts and seeds, emu meat and other wild game also contain high levels of EFAs.

Chicken, turkey and legumes such as beans and lentils contain tryptophan, a protein converted into the brain chemical serotonin, usually low in people with depression.

Caffeine boosts mental alertness and concentration. But many regular tea and coffee drinkers confuse this effect with the unpleasant symptoms of caffeine withdrawal when they don't get their daily cuppa.

Carbohydrate cravings may be a subconscious attempt to raise levels of serotonin, as tryptophan is absorbed more quickly into the brain after eating carbohydrate 'comfort' food such as potatoes.

Junk food has high levels of sugar and animal fats, which send blood sugar and endorphin levels soaring, giving you an instant hit. But the effect is short-lived, quickly plunging blood sugar and energy levels downward, sending you into depression, so the overall effect is bad.

HOW ABOUT THAT!

In your great-grandparents' days, many children were given a daily dose of cod-liver oil to maintain good health. It turns out that your great-grandparents may have been right about the benefits of fish oil. Fish oil is rich in omega-3 fatty acids. These fatty acids are being investigated as a possible treatment for conditions including rheumatoid arthritis, depression, attention deficit disorder and heart disease.

A number of scientific studies have shown that omega-3 fatty acids affect behaviour and mood. For example, Bernard Gesch carried out an experiment involving British prison inmates. He gave half the people who had volunteered for his study a daily supplement that contained omega-3 fatty acids and other vitamins and minerals. The other prisoners were given a placebo (a tablet that looked just like the supplement but did not contain fatty acids, vitamins or minerals). Over time, he found that the prisoners taking the supplement were involved in a lot fewer violent incidents. The prisoners taking the placebo showed no significant change in their behaviour.



Omega-3 fatty acids are found in oily fish (for example, tuna), some seeds and vegetable oils, and supplements.

UNDERSTANDING AND INQUIRING

REMEMBER

- 1 Read through the text entitled *Diet to lift spirits* and respond to the following questions.
 - (a) Identify in which foods you would find the two key nutrients that act as antidepressants in depressed laboratory rats.
 - (b) State the names of these antidepressant-type nutrients.
 - (c) Identify which part of the brain cells Dr Carlezon suggested the drugs acted on.
 - (d) List some links that were drawn between nutrition and brain function disorders.
 - (e) Suggest why it is thought that Japan may have one of the world's lowest rates of depression.
 - (f) What does EFA stand for?
 - (g) State the percentage of our brain that is made up of essential fatty acids.
 - (h) Describe the results of studies on dyslexic children given an omega-3 dietary supplement.
- 2 Suggest why you might get cravings for carbohydrates.
- 3 What are the benefits of ingesting caffeine?
- 4 Describe the effect of junk food on your endorphin and sugar levels.
- 5 Suggest why chicken and lentils might be good to eat when you are depressed.

THINK AND DISCUSS

- 6 Construct a bubble map on the benefits of eating portions of fresh fruit and vegetables each day.

- 7 Suggest why coffee and tea drinkers may crave more each day.

- 8 With a partner, read through the article Diet to lift spirits in this section. Outline the experiments performed on rats at Harvard University. How do you feel about this treatment of the rats? How do you think others may view these experiments and their outcomes?

THINK, DISCUSS AND INVESTIGATE

- 9 Select one of the folk legends from the bubble map at the beginning of this section. Using one of the visual thinking tools from section 2.10 to organise your thinking:
 - outline the history of the legend
 - make your own decision about the truth of the legend. What are your reasons for making this decision?
 - Share your findings with your partner, team or class.

- 10 Search for other folk legends that relate to food. Present your findings in the form of flash cards, with the legend on the front of the flash cards and the information on the back.

- 11 Research the following chemicals.

- (a) Omega-3 fatty acids
- (b) Endorphins
- (c) Uridine
- (d) Tryptophan
- (e) Catechins
- (f) Serotonin

Summarise your findings in a mind map. With a partner, discuss your combined findings. Add any more relevant information to your mind map as you chat.

- 12 Investigate the history, manufacturing, composition and biological effects of dark chocolate.

- 13** Read through the text on the research by Dr Lisa Smithers and respond to the following questions.
- Which of the two groups in her clinical trial were the control group? Why?
 - State the independent and dependent variables in her clinical trial.
 - Suggest which variables she would have needed to control.
 - In the clinical trial, some of the mothers were not breastfeeding. Find out or suggest how they could still be a part of the trial.
 - Suggest how Dr Smithers may have decided which mothers received DHA and which did not. How would you have decided? Why?
 - Discuss issues related to the decision of who gets the ‘test drug/chemical’ and who doesn’t. If you had the choice, which group would you like to be in? Are there any other factors that may change your response? Discuss and explain.
 - State what the findings of this research suggested.
 - Suggest a myth that could result from this research.
- 14**
- Formulate your own questions about one of the folk legends shown in the bubble map at the beginning of this section.
 - Research and report on relevant information or research on these.
- 15** *Not all chocolate is created equal.* Suggest what this statement may mean and how it could relate to the myths and truths about the benefits of eating chocolate.
- 16** In a 2010 newspaper there was an article labelling some foods as superfoods. The table below provides some examples of these and the suggested implications of chemicals that they contain.
- Research the active chemical in each of these ‘superfoods’.
 - Find out whether there is any other scientific data to support:
 - the suggestion that these foods are high in these chemicals
 - the implied effect of these chemicals on our health.
 - Summarise your findings and discuss these with others in your class.
 - Decide whether you think each of these foods deserves being labelled a superfood. Provide reasons for each decision.

| Food | 'Super' property | Active chemical | Examples of other foods with high levels of this chemical | |
|--------------|---|-----------------|---|------------------------------------|
| Watermelon |  | Sun protection | Lycopene | Red capsicums, tomatoes, green tea |
| Coriander |  | Anti-ageing | Beta-carotene and vitamin C | Berries, broccoli, carrots |
| Onions |  | Cancer fighting | Quercetin | Apples, oranges, parsley |
| Mussels |  | Metabolism | Selenium | Tuna, eggs, Brazil nuts |
| Black pepper |  | Antidepressant | Piperine | Salmon, dark chocolate, bananas |

Drugs on your brain?

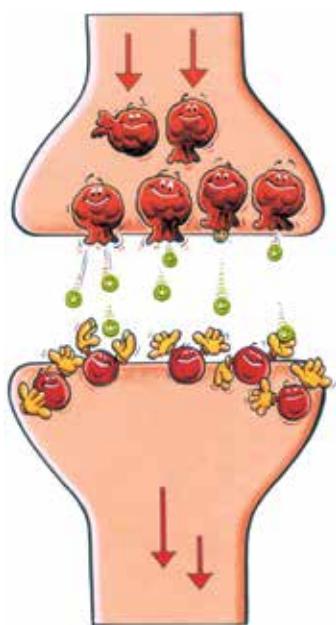
Popping a pill or taking something that you shouldn't? Are you aware of the short- and long-term effects of your actions?

Introducing various chemicals into your body can have both beneficial and terrifying consequences. After all, we all need to eat and drink to obtain our nutrients. But there are some chemicals that can cause you great damage.

Passing the message

Neurotransmitters are key players in our memory, learning, mood, behaviour, sleep and pain perception. These chemicals pass a message from one neuron (pre-synaptic neuron) to another (post-synaptic neuron) across a gap between them called a synapse.

Although there are many different neurotransmitters, only one is used at each synapse. The type of neurotransmitter that is released at the synapse can be used to classify them into groups. For example, in your brain some synapses release acetylcholine, whereas others may release noradrenaline, dopamine or enkephalins. The effect that these neurotransmitters have depends on the type of receptor that is present on the membrane of the neuron that receives it. Once the message has been received, enzymes break the neurotransmitter down.



Neurotransmitters carry the message from one neuron to the next. They are stored in sacs called vesicles. When neurotransmitters are released from the vesicles of one neuron, they travel across the synapse to bind to specific receptors on the membrane of the next neuron.

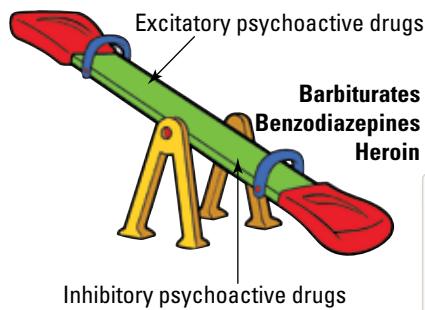
Uppers and downers

Some drugs can affect your brain or personality by either increasing or decreasing transmission of messages across the synapse. These are collectively known as **psychoactive drugs**. These drugs can bind to the receptors, mimic the neurotransmitter or block the binding of the neurotransmitter to its receptor. Nicotine is an example of a drug that mimics the working of acetylcholine.

Some examples of **excitatory psychoactive drugs** include nicotine, caffeine, cocaine and amphetamines ('speed'). Many of these drugs come from natural sources. They all stimulate or increase the synaptic transmission. Like many other drugs of abuse, these stimulants activate your brain's reward circuit.

Excitatory psychoactive drugs can be thought of as **stimulants** or 'uppers', while **inhibitory psychoactive drugs** can be considered as **depressants** or 'downers'. As their name implies, they work by inhibiting or decreasing synaptic transmission. Barbiturates, benzodiazepines (such as Valium), alcohol and cannabis (marijuana) are examples of drugs that decrease the activity of your nervous system.

Nicotine Cocaine
Caffeine Amphetamines



Examples of excitatory psychoactive drugs and inhibitory psychoactive drugs

Caffeine

What do coffee, tea, cocoa, chocolate and some soft drinks have in common? They all contain **caffeine**. In moderate doses, this central nervous system stimulant can increase alertness, reduce fine motor coordination, and cause insomnia, headaches, nervousness and dizziness. In massive doses it is lethal.

One effect of caffeine is to interfere with adenosine at multiple sites in your brain, but this drug also acts on other parts of your body. It increases your heart rate and urine production.



| Substance | Quantity of caffeine (mg) |
|-------------------------|---------------------------|
| Filter coffee (200 mL) | 140 |
| Instant coffee (200 mL) | 80 |
| Tea (200 mL) | 80 |
| Dark chocolate (30 g) | 35 |
| Typical cola (330 mL) | 32 |
| Milk chocolate (30 g) | 15 |

An adult's average daily consumption of caffeine is about 280 mg.
A fatal dose is about 10 g.

Cocaine

Cocaine (coke, snow, crack, gold dust or rock) works by inhibiting or blocking the uptake of neurotransmitters — dopamine, norepinephrine or serotonin — in a synapse, prolonging effects within the central nervous system. This results in elevated heart rate and body temperature, increased alertness and movement, and dilation of pupils. High levels of norepinephrine may result in strokes, organ failure and heart attacks.

Large doses of cocaine can cause heart attacks, strokes, paranoia and hallucinations.



Amphetamines

Amphetamines (speed, ice, ecstasy, meth, pep pills or fast) are synthetic chemicals that affect levels of neurotransmitters — dopamine, norepinephrine or serotonin. Long-term use can result in insomnia, hallucinations, tremors, and violent and aggressive behaviour. Some amphetamines are **neurotoxic** and cause neuron death.



While the short-term effects may be a dry mouth, enlarged pupils, headaches and increased confidence, frequent use of amphetamines may result in psychosis.

Ecstasy

Ecstasy or MDMA is distributed in small tablets, capsules or powder form. Short-term effects include increased blood pressure, body temperature and heart rate. Larger doses can result in convulsions, vomiting and hallucinations. There is also a risk of heart attack or brain haemorrhage and swelling, and there is evidence that it causes long-term damage to the neurons in your brain.

Barbiturates

Barbiturates are often taken to calm someone down and are used as sedatives. Sleeping pills are one such example. One key problem is that they may lead to tolerance and dependence. A key danger associated with barbiturates is that there is only a small difference between a dose that produces sedation and one that may cause death.

Marijuana

In 1964, the psychoactive ingredient in **marijuana** (also known as grass, pot, reefer or weed) was identified as a **THC** (delta-9 tetrahydrocannabinol). This chemical comes from a plant called *Cannabis sativa*. THC activates cannabinoid receptors in your brain located on neurons in your hippocampus (memory), cerebral cortex (concentration), sensory portions of your cerebral cortex (perception) and your cerebellum (movement). High doses of this drug may cause hallucinations, delusions, impaired

memory and disorientation. As it is one of the world's most commonly used illegal drugs, there has been a great deal of research into how it works and the consequences of using it.

GHB

GHB (gamma hydroxybutyrate, sodium oxybate, also known as liquid E, fantasy or gamma-OH) is an odourless, colourless, salty liquid that acts as a depressant on your nervous system. One of the dangers of this drug is the difficulty of determining a safe dosage. Although a small amount may have a euphoric effect, more can lead to amnesia, respiratory difficulties, delirium, loss of consciousness and possibly death. Likewise, combining GHB with alcohol can also lead to deep unconsciousness and may cause coma or death. GHB also has the reputation of being used as a 'date-rape' drug.

Heroin

Diacetylmorphine or **heroin** (also known as smack, jive, horse or junk) is an illegal opiate drug that contains morphine as its active ingredient. Its source is the opium poppy, *Papaver somniferum*. **Opiates** stimulate a pleasure system in your brain that involves the neurotransmitter dopamine.

In 1973, scientists found neurons in the brain that have receptors for opiates. These are located in areas involved in pain, breathing and emotions. The discovery of these receptors led to further research about their purpose. Two years later, scientists discovered that the brain manufactures its own opiates known as **endorphins**. Although endorphins are always present in the brain, when you are in pain or stressed they are released in larger amounts.

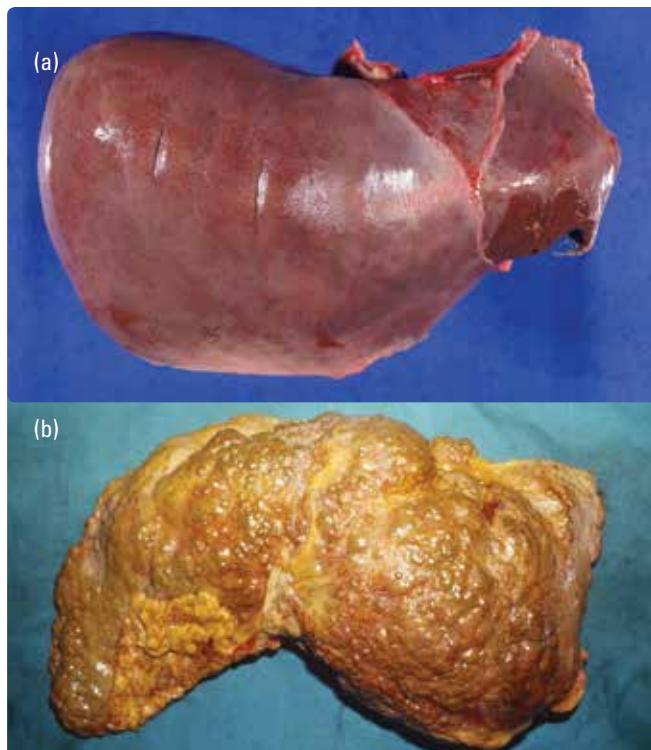
Blood and alcohol

Unlike water, some drinks can have a negative effect on your health. One such drink is **alcohol**.

Alcohol is a depressant and can alter your mood, thinking and behaviour. Many parts of your body are affected by alcohol, as shown on the next page.

Alcohol and the digestive system

Alcohol is a substance that is directly absorbed into your bloodstream through your stomach and small intestine. It irritates your stomach and causes more stomach acid to be produced, which can result in painful heartburn and stomach ulcers. Alcohol is also linked to mouth, oesophagus, stomach and intestinal cancers. The part of the digestive system that is affected most is the liver. Alcohol can destroy liver cells and can cause fat to accumulate around the liver, resulting in a fatal condition known as cirrhosis.



(a) A healthy liver and (b) a liver from a person with cirrhosis caused by excess alcohol consumption. Alcohol is an example of a toxin broken down by the liver — excess consumption of alcohol can cause extra strain on liver tissue and damage to liver cells.

Alcohol and the brain

Did you know that alcohol slows down your brain activity by interfering with your cerebellum? This may affect your coordination and perception and cause memory blackouts. When alcohol reaches your midbrain, your reflexes diminish, confusion and stupor follow, and then you may lapse into a coma. When the alcohol reaches your medulla, your heart rate may drop and your breathing may stop, possibly resulting in death.

HOW ABOUT THAT!

Australian scientists are currently in the race to develop 'smart' drugs through research on neurotransmitters. Smart drugs belong to a class of drugs called ampakines. These drugs work by boosting chemicals that allow information to flow from one part of the brain to another. Our scientists are also discovering neurotransmitters that were previously unknown, and are trying to find out about the cause and effects of imbalances of brain chemicals and drug addiction.



Alcohol affects all parts of your body.

Some common questions

Does eating food stop you from getting drunk?

The rate at which alcohol is absorbed may be slowed by the presence of food in your stomach but it won't prevent you getting drunk or intoxicated.

How can you sober up more quickly?

Your liver works at a fixed rate. It will detoxify or clear about one standard drink each hour (see the standard drinks guide opposite). So, black coffee, cold showers, fresh air and vomiting won't speed up the process of getting rid of alcohol from your body.

Why do people who drink too much alcohol smell?

Although the liver breaks down about 90 per cent of the alcohol, the rest leaves the body in urine, sweat and breath.

Should pregnant women drink alcohol?

During the first three months of pregnancy, alcohol interferes with the migration and organisation of brain cells. Heavy drinking during the next trimester, particularly between 10 and 20 weeks after conception, can have the biggest impact on the baby, leading to fetal alcohol syndrome (FAS). Drinking during the last trimester may affect the baby's hippocampus, which may reduce the child's future ability to encode visual and auditory information (reading and maths).

Brain of normal 6-week-old baby



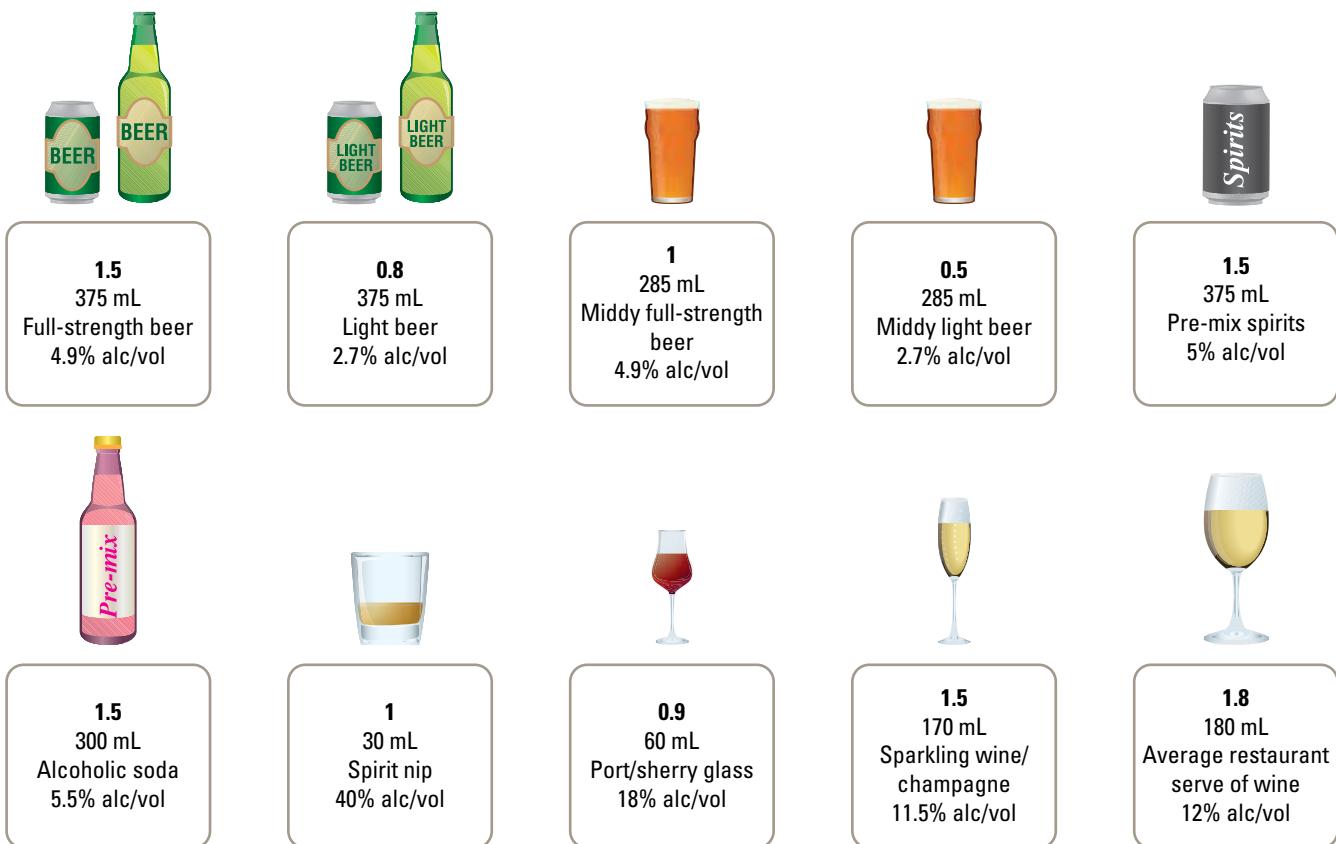
Brain of 6-week-old baby with fetal alcohol syndrome



Heavy drinking during pregnancy can damage the baby's brain.



Drinking coffee does not increase the speed at which the body processes alcohol.



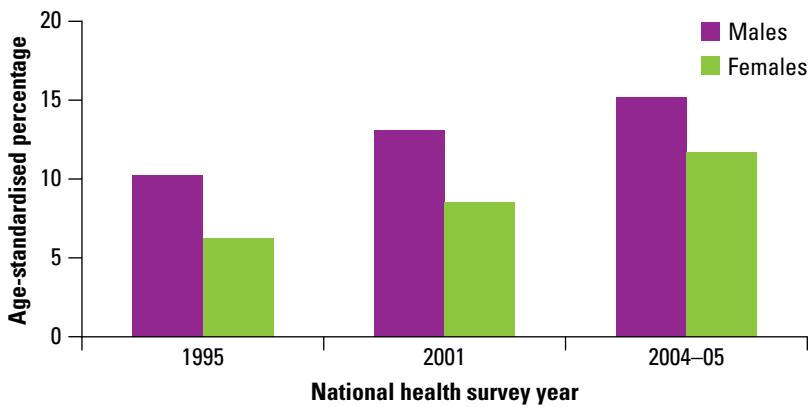
A standard drink contains about 10 grams of alcohol. It takes the liver about an hour to break down the alcohol in one standard drink.

Australia and alcohol

Headlines in Australian news stories increasingly relate alcohol abuse to accidents or violence which result in injury or death. There are data to suggest that drinking at dangerous levels is increasing within our culture.

Over the last decade, there has also been an increase in the number of women drinking at risky or high levels. This has implications not just for the woman and those close to her, but potentially to the health of an unborn child.

While some Australians believe that they have a right to drink and eat whatever, whenever and however they wish, the government is not of the same belief. There are already restrictions on the amount of alcohol in your blood when you are driving and in a number of public places



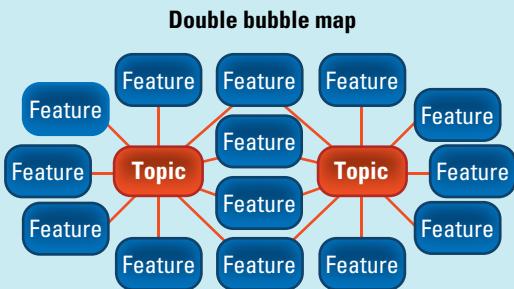
This graph indicates that the proportion of adults in Australia drinking at a risky or high level is increasing. Suggest what the percentage of risky or high alcohol consumption may look like for 2015–16.

the consumption of alcohol is illegal. With increasing evidence of the dangers of alcohol not just to ourselves but also to others, where will the line be drawn and how will it be implemented?

UNDERSTANDING AND INQUIRING

REMEMBER

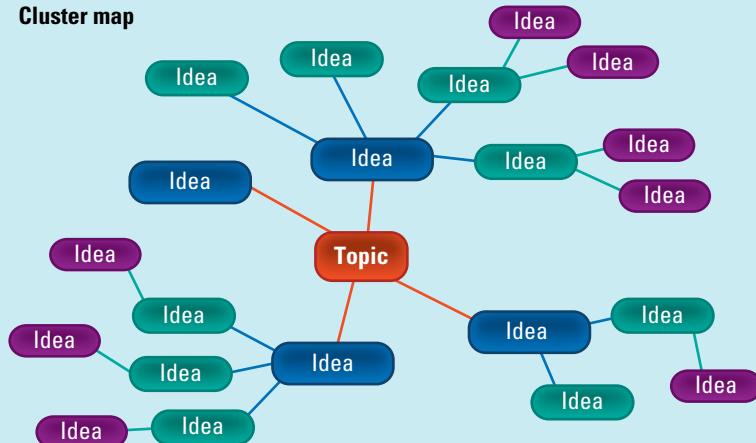
- 1 State the name of the gap across which neurotransmitters pass.
 - 2 Use a flowchart to show the links between a pre-synaptic neuron, a neurotransmitter and a post-synaptic neuron.
 - 3 List three examples of neurotransmitters.
 - 4 What do the vesicles in neurons contain?
 - 5 What are psychoactive drugs?
 - 6 What is the key difference between excitatory and inhibitory psychoactive drugs?
 - 7 State other names for:
 - (a) inhibitory psychoactive drugs
 - (b) excitatory psychoactive drugs.
 - 8 Construct a double bubble map to show the similarities and differences between excitatory and inhibitory psychoactive drugs.



- 9 Use a cluster map to show examples of the effects of the following drugs.

 - (a) Caffeine
 - (b) Cocaine
 - (c) GHB
 - (d) Heroin
 - (e) Ecstasy

Cluster map



- 10** What is meant by the term neurotoxic?

THINK AND EVALUATE

INVESTIGATE. THINK AND CREATE

- 15** Create a song that can be used to persuade people to reduce alcohol abuse.
 - 16** Suggest ways in which young people can become more aware of alcohol abuse.
 - 17** What is fetal alcohol syndrome? Find out about some other effects of alcohol on the developing fetus.
 - 18** Construct graphs that show the different amounts of alcohol in different types of alcoholic drinks.
 - 19** Find out how an alcohol breathalyser works.
Construct a model.
 - 20** *In Australia, increased abuse of alcohol is directly linked to increased drownings, violence, accidents and death.*
 - (a) Research various sources to see whether there is evidence to support this claim.
 - (b) Using a matrix table, summarise your findings for and against the statement.
 - (c) Discuss your findings with those of others, adding comments that you may have missed in your own research.
 - (d) Do you agree with the statement? Explain.
 - (e) In your team, construct a priority grid on 'Australia and alcohol'.
 - (f) Share your team's grid with other teams and discuss similarities and differences.

- 21** Research and report back to your team, for discussion, on one of the following.

- The caffeine content in a variety of foods, including different brands of coffee, tea, cola drinks, cocoa drinks and chocolates
 - The history of coffee
 - The symptoms of caffeine addiction
 - The effects and dangers of inhalants and methods of prevention
 - The connection between morphine, opium, codeine and heroin

- 22** The barbiturate sodium pentothal is also known as 'truth serum'. Find out how it works.

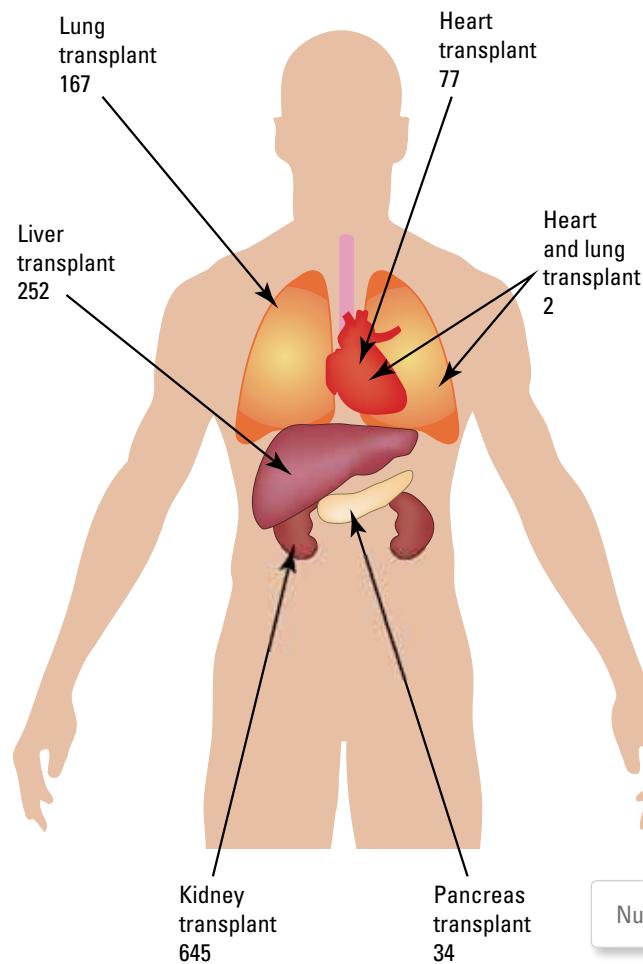
Wanted! Need an organ?

Organs within your body systems play an important role in keeping you healthy — and alive. But what if one of them fails? What if an organ with a critically important function could no longer do its job and needed to be replaced?

There are some organs that you just cannot live without. For example, if you didn't have a heart, what would pump the blood around your body? Without lungs, how could you obtain the oxygen that you need and remove the carbon dioxide that you don't?

Organ transplants

A solution to having a faulty organ is to replace it with another one that works. This may be achieved by transplanting a healthy organ from another person. In many cases, the source of the replacement organ is a recently deceased person. Organ transplantation presents a variety of medical challenges and raises a number of ethical issues.



Wait in line for an organ ...

There is a shortage of organs for transplantation and, depending on the organ, there are usually long waiting lists and times. Most essential organs cannot be obtained from live donors. Kidneys are an exception. As you have two kidneys and can live with only one, one of these can be donated while you are alive.

Patients who are on life support in hospitals are also a source of some organs for transplantation. These patients may have no brain function, or very limited, if any, chance of recovery. Another source of organs may be those harvested from people in car accidents. When applying for a driver's licence, some people register as a donor, so that their organs may be transplanted into others when they die.

Is it a match?

Even when an organ becomes available for transplant, it needs to match the recipient's blood type and have a reduced chance of being rejected by the recipient's immune system. There needs to be a matching of special proteins called **antigens** between the donor and the recipient. Even so, the recipient's immune system will still attack the transplanted organ as a foreign 'non-self' invader, so drugs are required to suppress this response.

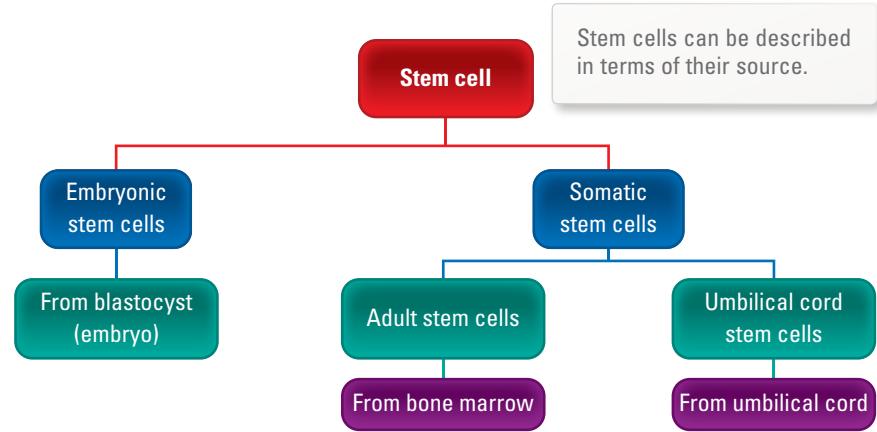
Growing body parts in labs Scaffolded or printed?

Researchers are investigating the construction of skin, cartilage, heart valves, breast, ears and other body tissues in tissue-engineering laboratories. Some of these technologies involve injection of synthetic proteins to induce tissues to grow and change; some use scaffolding techniques; and some even use 3D printers to print out tissues such as blood vessel networks.

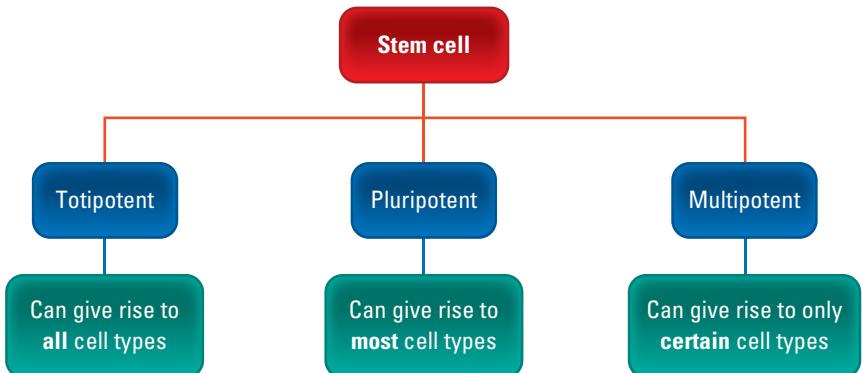
Number of transplants performed in Australia in 2013



Cardiac researcher Doris Taylor has revived the dead. The process involved rinsing rat hearts with a detergent solution to strip the cells, until all that remained was a protein skeleton of translucent tissue — a 'ghost heart'. She then injected this scaffold with fresh heart cells from newborn rats and waited. Four days later, she saw little areas beginning to beat. After eight days, the whole heart was beating. Could this research lead to new transplant technologies for use in humans?



Stem cells can be divided into categories on the basis of their ability to produce different cell types.



Stem cells

Stem cells are also being investigated as a possible solution to the shortage of donor organs. While stem cell research is showing great promise, it is also linked to considerable debate.

What are stem cells?

Stem cells are unspecialised cells that can reproduce themselves indefinitely. They have the ability to differentiate into many different and specialised cell types. Stem cells in a fertilised egg or zygote are **totipotent** — they have the ability to differentiate into *any* type of cell. The source of the stem cell determines the number of different types of cells that it can differentiate into.

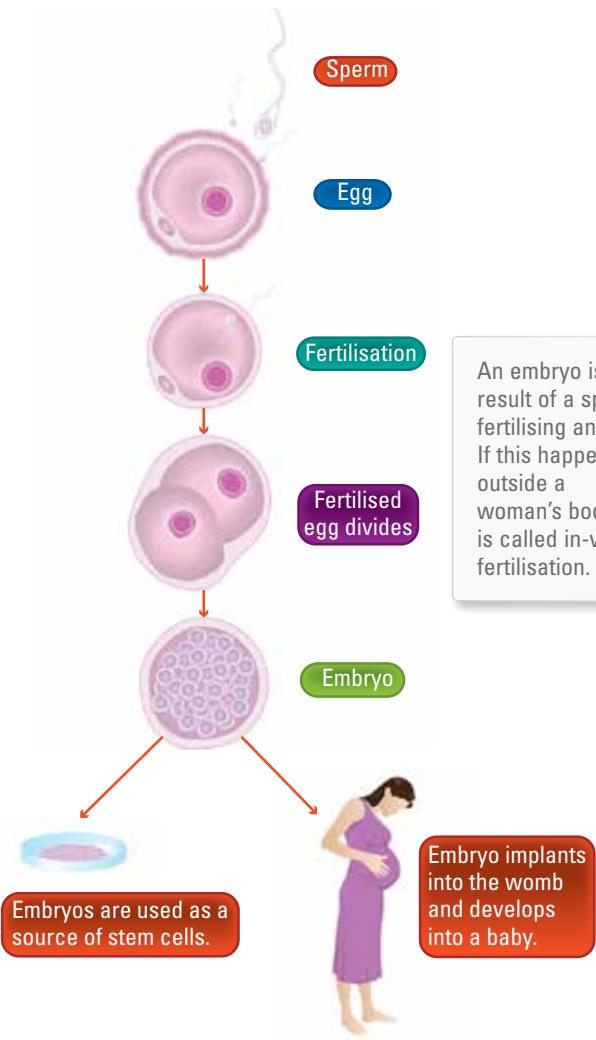
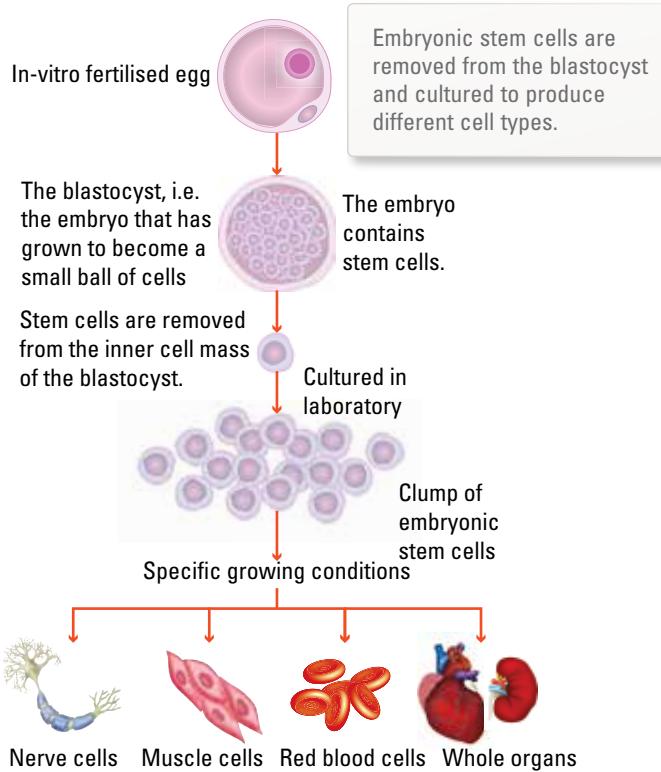
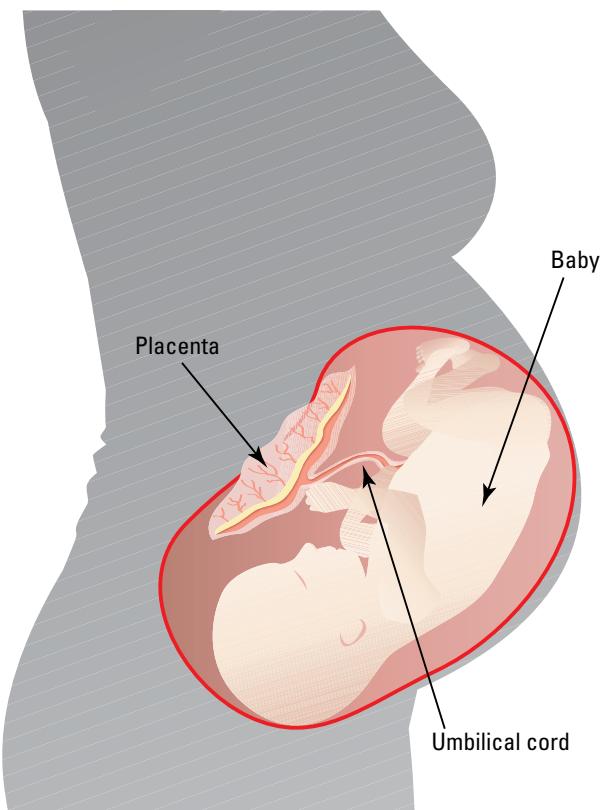
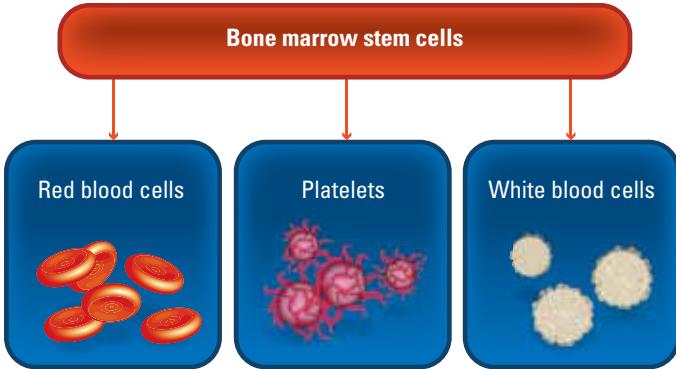
The ability to differentiate into specific cell types makes stem cells invaluable in the treatment and possible cure of a variety of diseases. For example, they may be used to replace faulty, diseased or dead cells. The versatility of stem cells is what makes them very important.

What are the sources of stem cells?

Embryonic stem cells can be obtained from the inner cell mass of a blastocyst. The blastocyst is the term used to describe the mass of cells formed at an early stage (5–7 days) of an embryo's development. Embryonic stem cells are **pluripotent** and can give rise to most cell types; for example, blood cells, skin cells, nerve cells and liver cells.

Somatic stem cells can be obtained from bone marrow and umbilical cord blood. Stem cells obtained from the bone marrow are often referred to as **adult stem cells**. These cells are **multipotent** and can develop into many kinds of blood cells.

The umbilical cord is the cord that connects the unborn baby to the placenta. This is how the baby gets nutrients and oxygen while it is still inside the mother's body. This cord contains stem cells that can develop into only a few types of cells, such as blood cells and cells useful in fighting disease. **Umbilical cord stem cells** can be taken from this cord when the baby is born.



Stem cells — made to order?

While the information in your genetic instructions tells your cells which types of cells they should become, scientists have also been able to modify the 'future' of some types of cells. By controlling the conditions in which embryonic stem cells are grown, scientists can either keep them unspecialised or encourage them to differentiate into a specific type of cell. This provides opportunities to grow replacement nerve cells for people who have damaged or diseased nerves. Imagine being able to cure paralysis or spinal cord injury. In the future, stem cells may also be used to treat and cure Alzheimer's disease, motor neurone disease, Parkinson's disease, diabetes and arthritis.

RADICAL BID TO GROW NEW BONE

STEM CELL THERAPY A WORLD FIRST

Michelle Pountney

Health reporter

A MELBOURNE man is the first person in the world whose own stem cells are being used to try to mend a broken leg.

The cutting-edge stem-cell technology has helped Jamie Stevens, 21, back on his feet.

A motorcycle crash nine months ago left him with a severely broken left thigh bone. Part of the femur stuck through his leg, and other parts of the bone were missing.

The bone failed to heal and Mr Stevens's leg was held together by a large titanium plate.

Royal Melbourne Hospital orthopedics director Richard de Steiger decided Mr Stevens was the ideal first patient for a revolutionary stem-cell trial at the hospital.

About seven weeks ago, Mr de Steiger harvested bone marrow from Mr Stevens' pelvis. The adult stem cells were then separated from the other cells. A sub-group of stem cells called mesenchymal precursor cells — those that can transform into tissues including bone cartilage and heart — were isolated and grown.

Last week about 30 million of these cells were implanted into the 5 cm × 3 cm hole in Mr Stevens' thigh bone. The cells are expected to regenerate new bone and grow through the calcium phosphate.

Yesterday, just four days after surgery, Mr Stevens went home.

'It's good to be part of something that is on the brink,' he said. 'I wouldn't say I understand it. It's all pretty cool.'

It will be three to four months before the result of the operation is known.

'This is radical and the first procedure in the world to use a patient's own stem cells and make them turn into bone-forming cells that are the patient's own cells, to stimulate healing of a fracture,' Mr de Steiger said.

The cells are harvested, cultured and expanded using Australian biotechnology company Mesoblast's specialist adult stem-cell technology.

Mr de Steiger hopes that eventually the technique will be refined to a simple injection, avoiding further surgery.

Using a patient's own cells avoids the potential problem of the body's rejection of foreign cells.

The only other alternative to repair Mr Stevens' leg would have been a painful bone graft, taking a chunk of bone from his hip and plugging it into the hole in his thigh.

'The conventional way used over many years involves a large incision at the pelvis and taking out quite a large amount of bone in Jamie's case,' Mr de Steiger said.

'In this situation there is the risk of a separate incision, reported continuing pain from that incision, and separate infection risk at that site.'

Mr de Steiger said orthopedic specialists at the Royal Melbourne hospital treated about 200 fractures of the long leg bones each year.

About 19 per cent become 'non-union' fractures that fail to heal; 10 of these patients will be recruited to be part of the year-long trial.

Mr Stevens said he was no more nervous about being the first patient in the world to have the procedure than he would have been having a graft.

'I think the benefit outweighs the old procedure, and being able to avoid having a big chunk of bone taken out of the hip . . . the recovery period of it was a lot quicker.'

After living in limbo for nine months, Mr Stevens said he was looking forward to resuming the life he enjoyed before his accident.



Jamie Stevens prepares to leave Royal Melbourne Hospital. Pictured with his surgeon Richard de Steiger. If there are too many arguments about using someone else's stem cells, why not grow your own to mend, replace and renew?

HOW ABOUT THAT!

Professor Alan Trounson is an Australian scientist who has spent a great part of his working life perfecting the technique for creating embryos outside the human body. He was part of the team that produced the first test-tube baby in Australia in 1980. He has also done a lot of work on embryonic stem cells. In 2000, his team showed that it was possible to produce nerve cells from embryonic stem cells, which meant that stem cells could potentially be used to cure diseases that have up to now been incurable. This has led to a surge of interest in the field of stem cell research.

In 2003, he was named the Australian Humanist of the Year. In 2007, he was appointed as the president of the California Institute for Regenerative Medicine, which specialises in stem cell research. It is the best-funded facility of its kind in the world, so Trounson will have the best facilities at his disposal to move stem cell research forwards.

Alan Trounson, an Australian scientist and one of the world's top stem cell research scientists



So what's the problem?

It is the source of embryonic stem cells that raises so many issues. Embryonic stem cells can be taken from spare human embryos that are left over from fertility treatments or from embryos that have been cloned in the laboratory. Some argue that this artificial creation of an embryo solely for the purpose of obtaining stem cells is unethical. There has also been concern about the fate of the embryo. In the process of obtaining stem cells, the embryo is destroyed.

Some parents have decided to have another child for the sole purpose of being able to provide stem cells for a child who is ill or has a disease. In this case, the blood from the umbilical cord or placenta is used as the source. Some suggest that this is not the 'right' reason to have a child and that they should not be considered to be a 'factory' for spare parts for their siblings.

Grow it for me!

There is also research into growing human organs in other animals, such as pigs. Once these 'pre-matched' organs have grown, they could then be transplanted into humans.

While such a technology brings with it many benefits, it also is associated with a variety of issues and possible future consequences.

Open minds are crucial in the debate on stem cell research

Politicians who decide on issues involving complex science need to be thoroughly briefed . . .

Sydney Morning Herald

We must move ahead on stem cells

To maintain its world-leading reputation, Australia needs to change the law to allow the therapeutic cloning of cells.

The Age

Discovery offers hope on cancer

Melbourne researchers have taken a giant step towards understanding the genesis of breast cancer by inducing female mice to grow new mammary glands from stem cells.

The Age

Constructing synthetic replacement parts?

Synthetic materials can be used to construct some replacement body parts. Artificial joints made of plastic and titanium or ceramic can be used to replace a damaged joint. A variety of prosthetic limbs have also been developed that are suited to different types of activities.



Artificial hip joint



INVESTIGATION 3.7

What's your stance on organ transplants?

AIM To increase awareness of attitudes and opinions on organ transplants

METHOD AND RESULTS

Consider the following statement:

'Should it be legal to buy transplant organs from either a live donor or from the family of a deceased donor in Australia?'

- 1 Construct a PMI chart for the statement.
- 2 Do you agree with the statement?
- 3 In the classroom, construct a human graph to show people's opinions about the statement. Stand in positions to indicate your feelings about the statement. For example:

Strongly disagree (0): stand next to the left-hand wall

Agree (2): stand in the centre of the room

Strongly agree (4): stand next to the right-hand wall

- 4 Have a discussion with students standing near you to find out the reasons for their opinion.
- 5 Listen to the discussions of students in other positions.
- 6 Construct a SWOT diagram to summarise what you have found out.
- 7 Record the results of the human graph and examine them to answer the questions in your discussion.

DISCUSS AND EXPLAIN

- 8 (a) What was the most popular attitude? Suggest a reason for this.
(b) What was the least popular attitude? Suggest a reason for this.
(c) Do you think this attitude pattern is representative of other Australians your age? Explain.
- 9 On the basis of your discussion, have you changed your attitude since the start of this activity? If so, how is it different and why?

UNDERSTANDING AND INQUIRING

REMEMBER

- 1 What are stem cells?
- 2 Distinguish between the terms 'totipotent', 'pluripotent' and 'multipotent'.
- 3 Outline the importance of stem cells.
- 4 List sources of stem cells.
- 5 Outline issues regarding stem cell research.
- 6 Describe a scientific contribution made by the Australian scientist Professor Alan Trounson.

INVESTIGATE, SHARE AND DISCUSS

- 7 Investigate some of the following questions.
 - (a) Which inherited genetic diseases are potentially treatable with stem cells?
 - (b) How many different kinds of adult stem cells exist and in which tissues can they be found?
 - (c) Why have the adult stem cells remained undifferentiated?
 - (d) What are the factors that stimulate adult stem cells to move to sites of injury or damage?
- 8 View an animation about stem cells by going to the **Genetic Science Learning Center** weblink in your

eBookPLUS. Use these ideas to construct your own story, cartoon, PowerPoint presentation or animation on stem cells.

eBook plus

- 9** Use the **Stem cell** weblink in your eBookPLUS to investigate the views of the major world religions on stem cell research.
- 10** In your team, discuss the following questions to suggest a variety of perspectives.
- Is it morally acceptable to produce and/or use living human embryos to obtain stem cells?
 - Each stem cell line comes from a single embryo. A single cell line allows hundreds of researchers to work on stem cells. Suggest and discuss the advantages and disadvantages of this.
 - If the use of human multipotent stem cells provides the ability to heal humans without having to kill another, how can this technology be bad?
 - Parents of a child with a genetic disease plan a sibling whose cells can be used to help the diseased child. Is it wrong for them to have another child for this reason?
- 11** Find out how stem cell research is regulated in Australia and in one other country. What are the similarities and differences of the regulations? Discuss the implications of this with your team-mates.
- 12** Investigate aspects of stem cell research and put together an argument for or against the research and its applications. Find a class member with the opposing view and present your key points to each other. Ask questions to probe any statements that you do not understand or would like to clarify. Construct a PMI to summarise your discussion.
- 13** Investigate and report on research at the Australian Stem Cell Centre.
- 14** (a) Use a bubble map or mind map to summarise the key points in the article *Stem cell therapy a world first*.
(b) As a team, discuss the article and construct a PMI.
(c) Formulate questions that may help you to develop an informed opinion.
(d) Research your questions.
(e) State your opinion on the use of stem cell therapies like the one in the article. Give reasons for your opinion.
(f) Do you have the same opinion about other types of stem cell therapies? Explain.

INVESTIGATE, DISCUSS AND DEBATE

- 15** Recent scientific and technological advances are associated with some very complex and difficult decisions, responsibilities and ethical issues.
- On your own, score each of the statements below on a scale of 0–4, where 0 = strongly disagree and 4 = strongly agree.

- Animals such as pigs should be used to grow organs for human transplants.
 - The creation of human embryos for stem cell research in Australia is acceptable.
 - Doctors should be allowed to harvest the organs of a deceased patient for organ transplants without the permission of the patient's relatives.
 - It should be compulsory for all Australians over the age of 18 to sign the donor register.
 - Smokers, heavy drinkers and drug users should be further down the organ transplant waiting list than those with a healthy lifestyle.
 - Close relatives of humans, such as monkeys and apes, should not be used as animals in scientific research testing the effectiveness of treatments against various diseases.
- (b) Research two of these issues above. Construct a table with reasons FOR and AGAINST. Compare and discuss your table with others. Organise a class debate on one of the issues.
- (c) For at least two of the statements, share your opinions by being involved in constructing a class 'opinionogram' such as in the '*What is your stance on organ transplants?*' investigation 3.7.
- Suggest questions that could be used to probe students in different opinion zones.
 - Share reasons for your opinion with students in other zones and listen to their reasons for their stance.
 - Reflect on what you have heard from others. Decide if you want to change positions, and if so, change. Give a reason why you are changing.
 - Have a member of the class record the number of students at each point of the scale.
 - Reflect on what you have learnt about the opinions and perspectives of others.
 - Construct graphs showing the opinion scales for each statement and comment on any observed patterns.
 - Construct a PMI on each statement based on opinions and statements made by others in the class.
 - Select one of the statements and organise a class debate (different from the statement in (b)).

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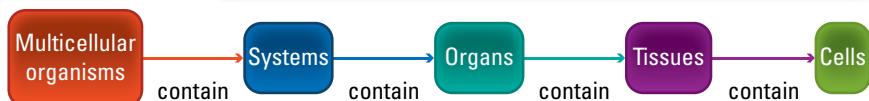
Use the following weblinks in your eBookPLUS to find out more:

- **Organ printing**
- **Kidney transplant**
- **Religious ruling**
- **Organ donor register**

Systems working together

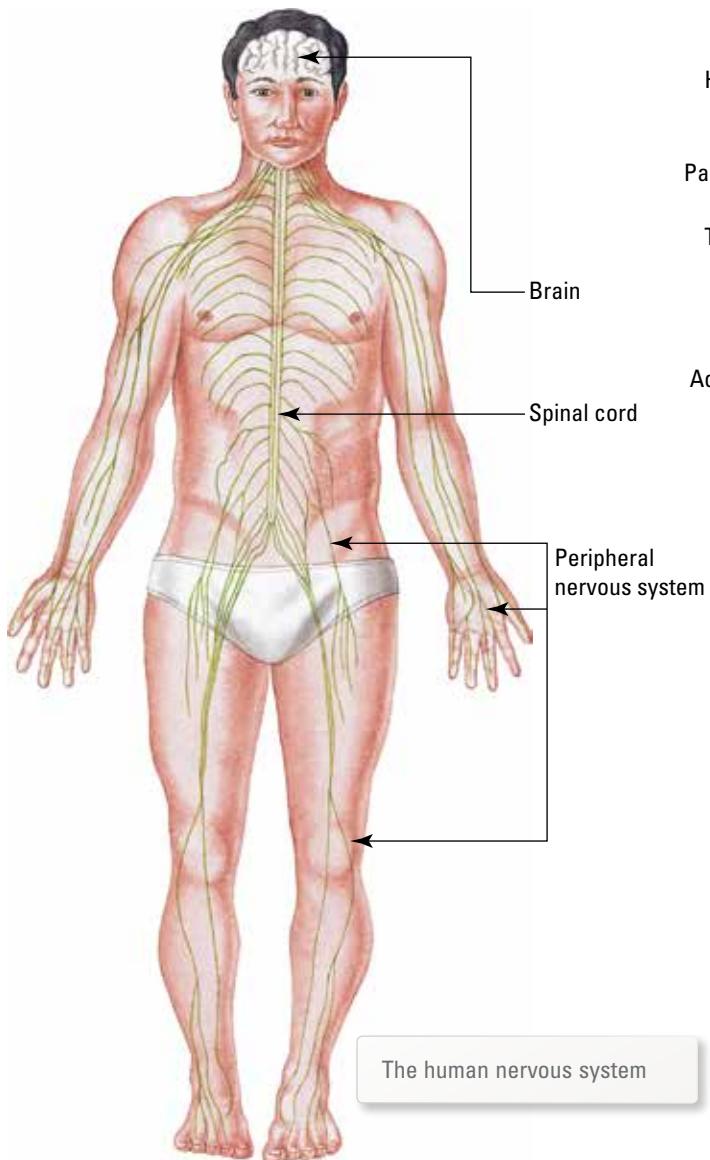
Multicellular organisms contain systems that perform particular jobs. The cells within these systems depend on each other and work together; they cannot survive independently of each other. Working together requires organisation, coordination and control.

Multicellular organisms show a pattern of organisation in which there is an order of complexity.

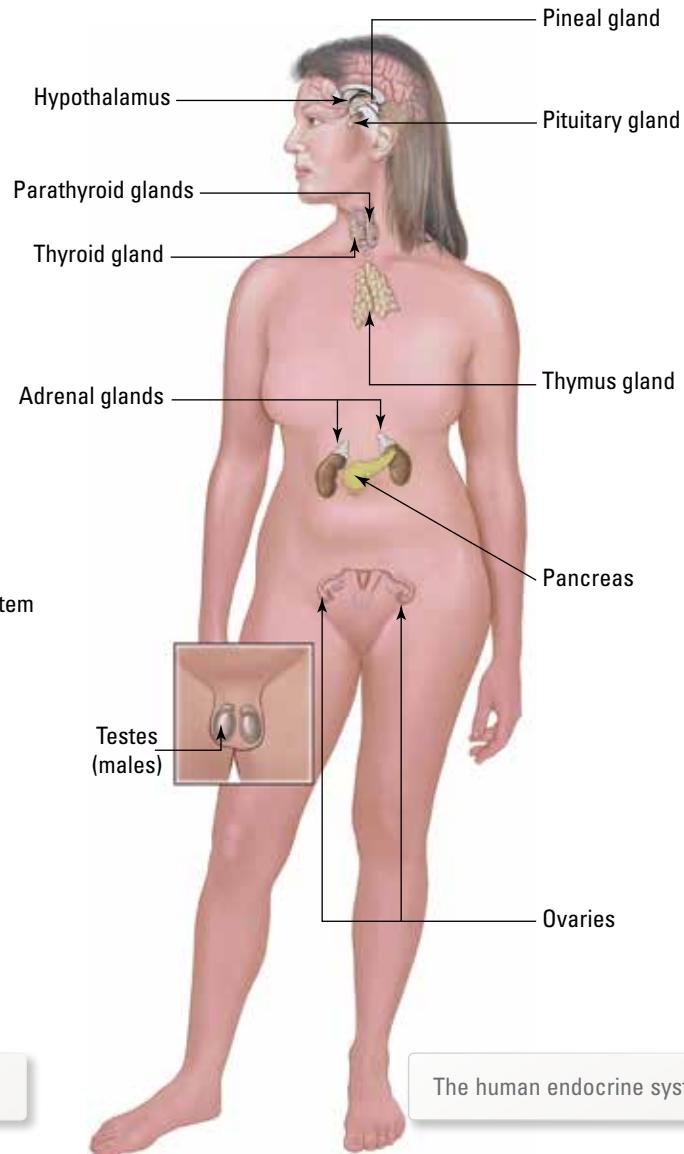


Control and coordination

Within your body, your nervous and endocrine systems play key roles in the coordination and control of the body systems. These systems also work together to keep your cells functioning, and they also provide a balanced internal environment that is essential to their survival.



Your **nervous system** is composed of the **central nervous system** (brain and spinal cord) and the **peripheral nervous system** (the nerves that connect the central nervous system to the rest of the body). Messages are sent as **electrical impulses** along neurons and then as a chemical message in the form of **neurotransmitters** between them.



Your **endocrine system** is composed of **endocrine glands** that secrete chemical substances called **hormones** into the bloodstream. These chemical messages are transported throughout the circulatory system to specific target cells in which they bring about a specific response.

Feeding cells within systems

Cells within systems are alive. They require energy, oxygen and nutrients to function. They also need wastes that have been produced by the chemical reactions of life to be removed. The **digestive, respiratory, circulatory** and **excretory systems** work together to achieve this.

Your brain has a very important role in the control and coordination of other body systems. It is also involved in coordinating both the nervous system and the endocrine system.

The brain needs to be 'fed' and 'watered'. Other body systems work together to provide cells in your brain with what they need and what they don't.

Need gas?

Like other organs of your body, your brain needs oxygen and glucose to use in cellular respiration. Breathing helps you to feed your brain oxygen. Your **respiratory system** enables you to bring oxygen into your body through your **nose** and **trachea** to your **lungs**. Within your lungs, it passes through **bronchi** and **bronchioles** to finally reach your **alveoli**.

It is at the alveoli that oxygen enters the **capillaries** to be transported via your **circulatory system** to cells throughout your body, such as those in your brain. The circulatory system also transports carbon dioxide (a waste product of cellular respiration) back to your lungs. Carbon dioxide is then

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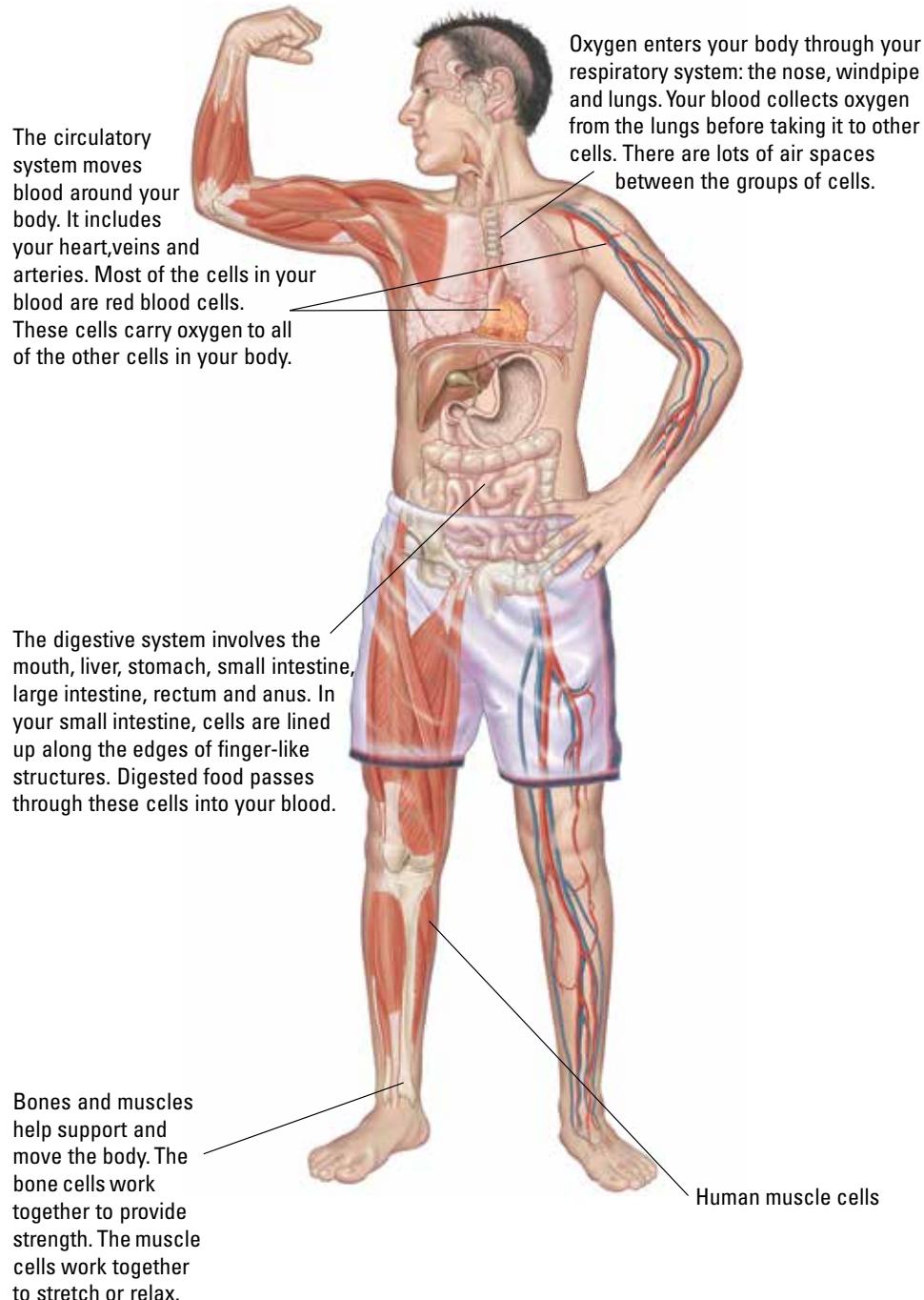
eLesson



The nervous system and neurons

Watch a video from *The story of science* about early research about the brain.

eles-1770



exhaled via the respiratory system. The rate at which these gases are exchanged is increased during exercise. The breathing rate is regulated by the brain to ensure that your cells get the oxygen they need, and that carbon dioxide is removed.

Sweet stuff

Eating helps feed your brain glucose. Some of this glucose may have been digested or broken down from a more complex form such as starch in potatoes or bread. This process of digestion occurs in the **digestive system** and is aided by biological catalysts called **enzymes**. Glucose is transported to your cells in your body by the **circulatory system**. The levels in your blood are kept within a narrow range. Your **endocrine system** uses hormones such as insulin and glucagon, which are released by your pancreas to maintain glucose blood levels.

Protein alert!

Your brain also needs nutrients such as amino acids to make **neurotransmitters**. The proteins eaten in food may need to be broken down into their component amino acids by your digestive system. Your brain uses the amino acid tyrosine to make neurotransmitters such as dopamine and **norepinephrine**.

Norepinephrine enables your body to 'get up and go' when action is required. When norepinephrine is released throughout your body, it increases the blood flow to your brain, which increases your alertness. This neurotransmitter is also very useful when you are doing maths calculations, maintaining your attention span and increasing your conscious awareness. Too much norepinephrine can make you feel 'hyper' and

stressed; too little can cause drowsiness and make you feel 'out of it'. Foods with tyrosine include meat, fish, eggs, tofu and milk products. If you want to get your day going, a 'thinking breakfast' including any of these would be a great start!

Water me

Your brain can also get thirsty. When you feel thirsty, it means that the amount of water in your body has dropped and that salt concentration in your blood is increasing. Such an increase in blood salt levels can lead to fluids leaving your cells and moving into your bloodstream. This can result in an increase in your blood pressure and an increase in stress. Drinking water can reduce these effects within five minutes.

Telling the 'story'

No matter how clever you are or how much you can remember or understand, it is important to be able to communicate your ideas to others effectively. There are many different ways that you can communicate and share your understanding. One way of organising your thinking and coordinating your approach to a task is by using visual thinking tools such as those shown on the following page. These can help you to control and coordinate your thinking so that you can effectively communicate your understanding of scientific ideas.

HOW ABOUT THAT!

Bruno Annetta is a film-maker, graphic designer, actor and science teacher. Through his animated cartoons, Bruno communicates scientific ideas and shares his excitement about the wonders of science.

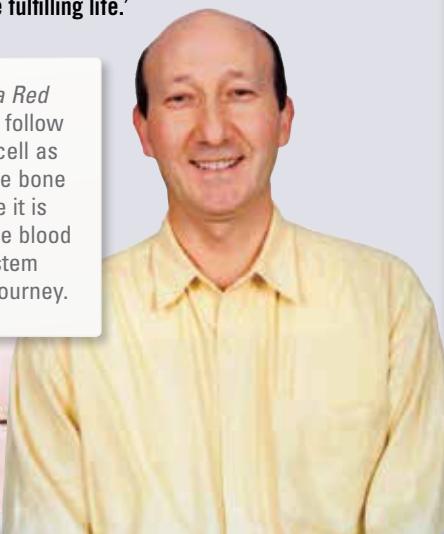
'I've always found it easier to remember information by doing something with it that was personal to me. The basic idea for the film *The Life of a Red Blood Cell* came out of me trying to remember the circulatory system when I first encountered it in

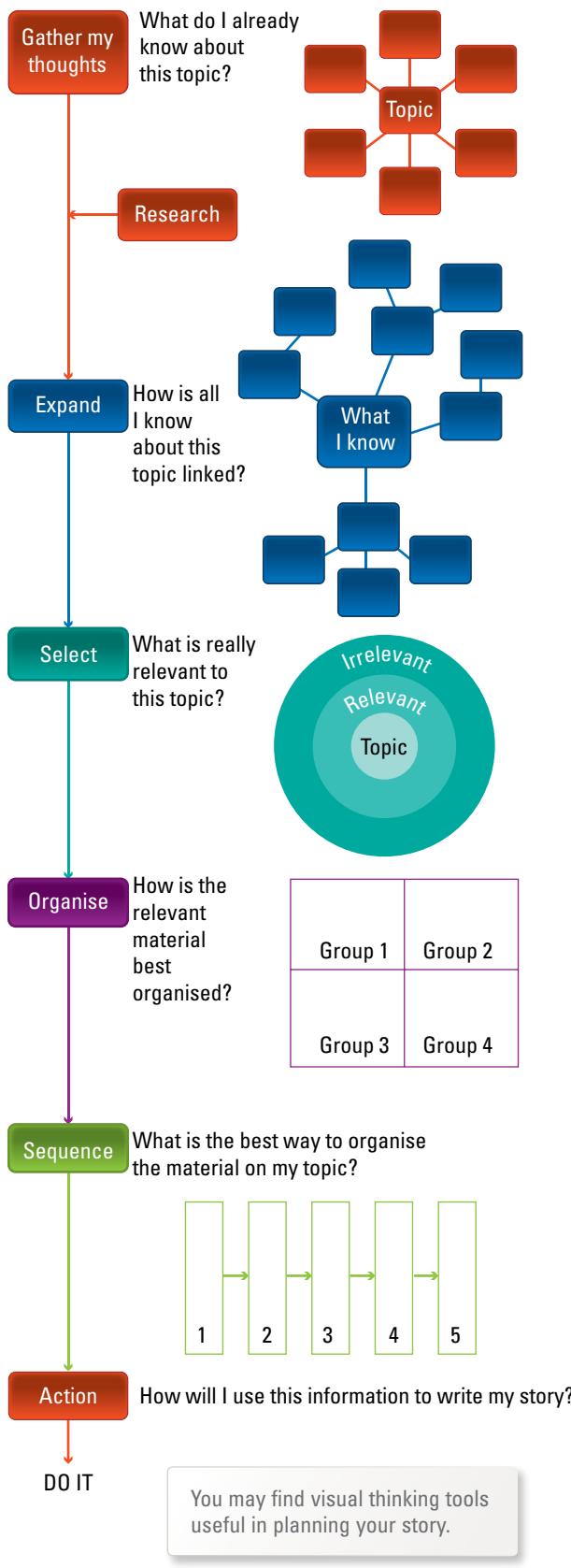


Year 9 (Form 3). I created the animation in my head and later turned that idea into a film.'

'I believe that, through the use of animation, humour, music and storytelling, learning can be fun and easy. I have used science in the making of animated films. An understanding of light, lenses and different coloured filters is crucial in exposing film correctly. I believe that through combining the sciences with the arts, one has a richer and more fulfilling life.'

In *The Life of a Red Blood Cell*, we follow the red blood cell as it goes from the bone marrow, where it is formed, into the blood circulatory system and starts its journey.





UNDERSTANDING AND INQUIRING

REMEMBER

- 1 Draw and label diagrams of the respiratory, circulatory, digestive and urinary (excretory) systems.
- 2 Compare and contrast the endocrine system and the nervous system.
- 3 Explain why your brain needs oxygen and glucose.
- 4 Describe how your brain cells obtain oxygen and glucose.
- 5 Describe how waste products are removed from cells such as those in the brain.
- 6 Explain why it is important for systems to work together.
- 7 Outline the relationship between proteins in food and neurotransmitters in the brain.
- 8 Describe some of the effects of norepinephrine.
- 9 Explain why it is important to drink water.

THINK AND DISCUSS

- 10 Who am I? Identify the body part or organ that matches the function statement.
- (a) I am an organ that pumps blood around the body.
 - (b) We are the top two chambers of the heart.
 - (c) I am a blood vessel that takes blood to the heart.
 - (d) I am an organ from which nutrients move from the digestive system into the circulatory system.
 - (e) I am an organ from which oxygen diffuses into the bloodstream and from which carbon dioxide is removed.

INVESTIGATE, THINK, CREATE AND PRESENT

- 11 Select one of the research questions related to two different body systems below to investigate or identify your own. Use the coordinated thinking and planning figure opposite to investigate this question and produce a summary of your findings that can be shared with others.
- What evidence supports the link between obesity and diabetes?
 - My dad has diabetes; does that mean that I have an increased chance of getting it too?
 - What is the link between folate deficiency and neural tube defects?
 - What evidence supports the link between depression (Seasonal Affective Disorder) and vitamin D deficiency?
 - Can omega-3 fatty acids really affect behaviour and mood?
 - Why is a person who has coeliac disease more likely to be anaemic?
 - Why do heavy drinkers of alcohol have a greater risk of developing cirrhosis of the liver?

STUDY CHECKLIST

MULTICELLULAR ORGANISMS

- explain why multicellular organisms need specialised organs and systems
- outline the relationship between cells, tissues, organs and systems

DIGESTIVE SYSTEM

- identify nutrients that are essential for a healthy body
- describe the roles of carbohydrates, proteins, lipids, vitamins and minerals in the diet
- provide examples of two vitamins and two minerals that are essential for your health, and possible consequences of deficiencies
- explain why animals need to eat food
- label a diagram of the digestive system
- describe the role of enzymes in digestion
- outline the overall function and key components of the digestive system and circulatory system
- use flowcharts to describe how structures within the digestive system and circulatory system work together

CIRCULATORY SYSTEM

- outline the overall function and key components of the circulatory system
- describe how blood circulates around the body

- use flow charts to describe how structures within the digestive system work together
- describe how and why the circulatory system and digestive system work together

RESPIRATORY SYSTEM

- outline the overall function and key components of the respiratory system
- describe what happens at an alveolus
- use flowcharts to describe how structures within the respiratory system work together
- describe how and why the respiratory system and circulatory system work together

EXCRETORY SYSTEM

- outline the overall function and key components of the excretory system
- label a diagram of the urinary system
- describe the roles of the main organs of the excretory system
- describe how the excretory system and respiratory system work together

NERVOUS AND ENDOCRINE SYSTEMS

- outline the overall function and key components of the endocrine and nervous systems

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DIGITAL RESOURCES



ANSWERS for this chapter can be found online in your eBookPLUS.

Individual pathways

Activity 3.1
Revising systems
doc-14552

Activity 3.2
Investigating systems
doc-14553

Activity 3.3
Investigating systems furthes
doc-14554

eLessons

Robotic heart surgery

Watch an ABC Catalyst report to find out how the treatment of the heart condition atrial fibrillation is being revolutionised by the use of robotic systems.

Searchlight ID: eles-1081

The nervous system and neurons

Watch a video from *The story of science* about early research about the brain.

Searchlight ID: eles-1770

FOCUS activity

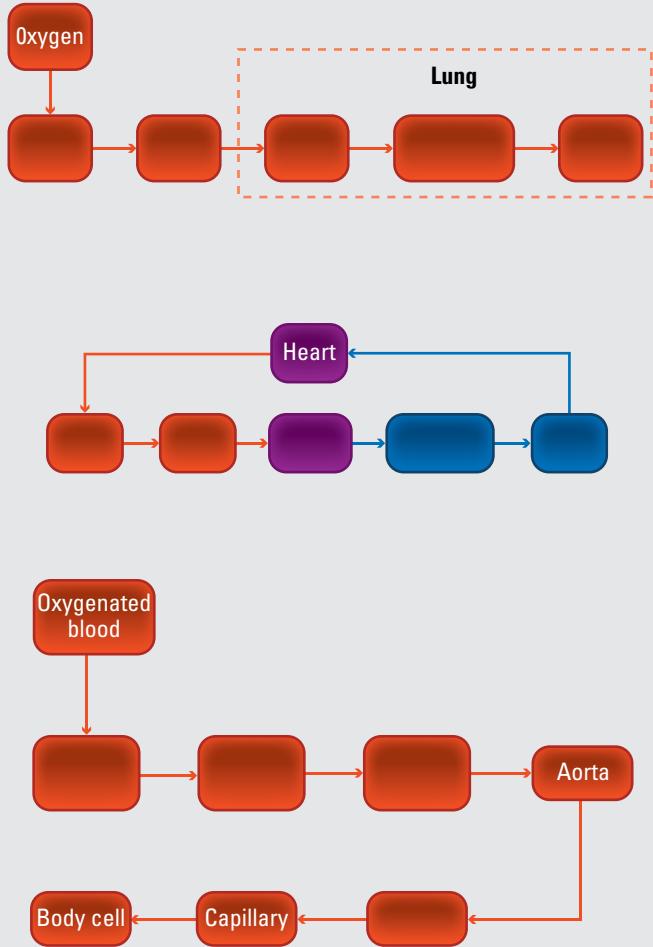
Access more details about focus activities for this chapter in your eBookPLUS.

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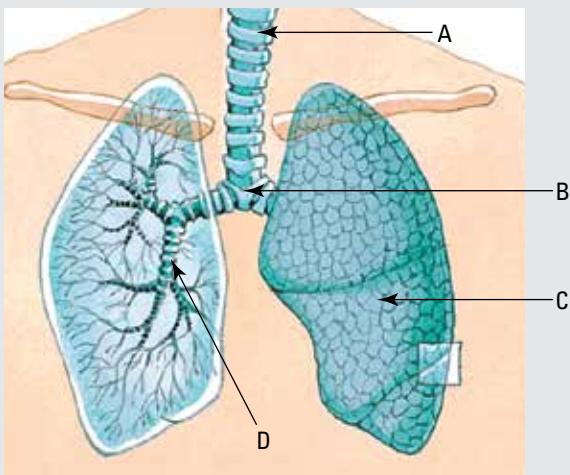
LOOKING BACK

- 1 Select the appropriate terms to complete the flow charts shown below:

trachea, bronchi, arterioles, pulmonary vein, artery, left atrium, capillary, alveoli, body cells, left ventricle, capillary, vein, nose, bronchioles

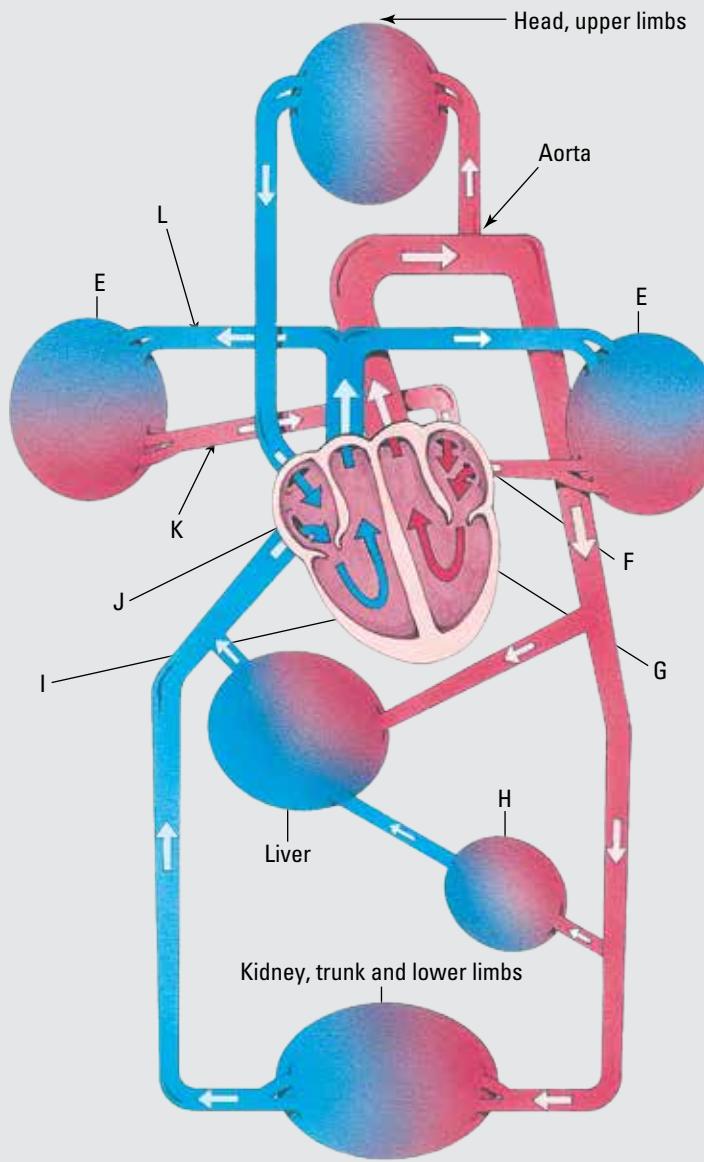


- 2 Label the diagrams of the respiratory system and the circulatory system.



Link to assessON for questions to test your readiness **FOR** learning, your progress **AS** you learn and your levels **OF** achievement. www.assesson.com.au

assesson



- 3 Identify whether the following statements are true or false. Justify your response.

- Your circulatory and respiratory systems work together to provide your cells with carbon dioxide for cellular respiration.
- Arteries transport blood to the heart whereas veins transport blood away from it.
- Oxygen moves from the alveoli of your respiratory system into the red blood cells in the surrounding capillaries of your circulatory system.
- The left atrium of the heart contains oxygenated blood.
- Oxygenated blood travels from your lungs via the pulmonary vein to the right atrium of your heart.

4 Copy and complete the following table.

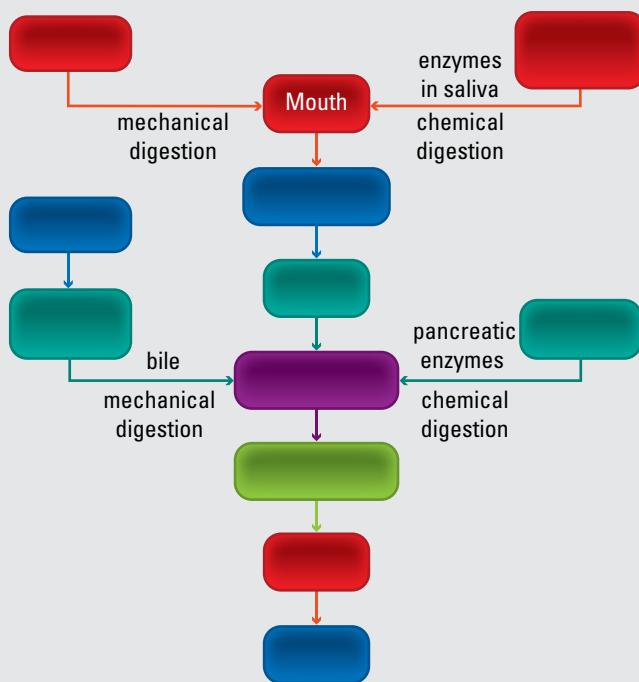
| Nutrient | Why it is needed? | Examples of sources |
|--------------|-------------------|---------------------|
| Carbohydrate | | |
| Protein | | |
| Lipid | | |
| Vitamin | | |
| Mineral | | |

5 Which am I? Match the chemical in the list below to the most appropriate description.

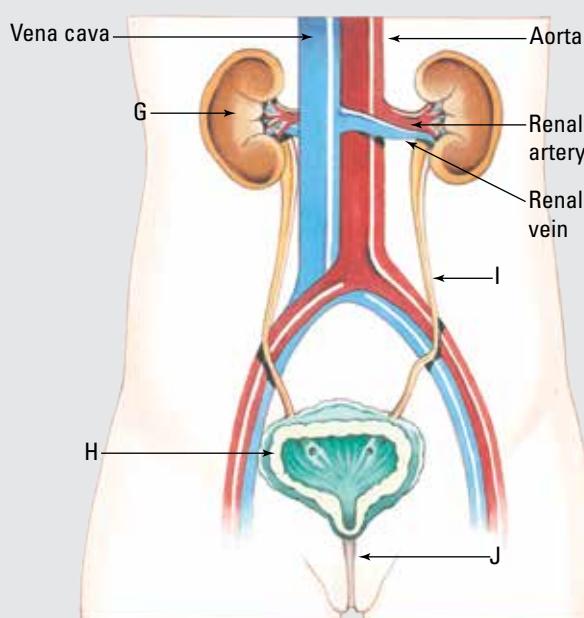
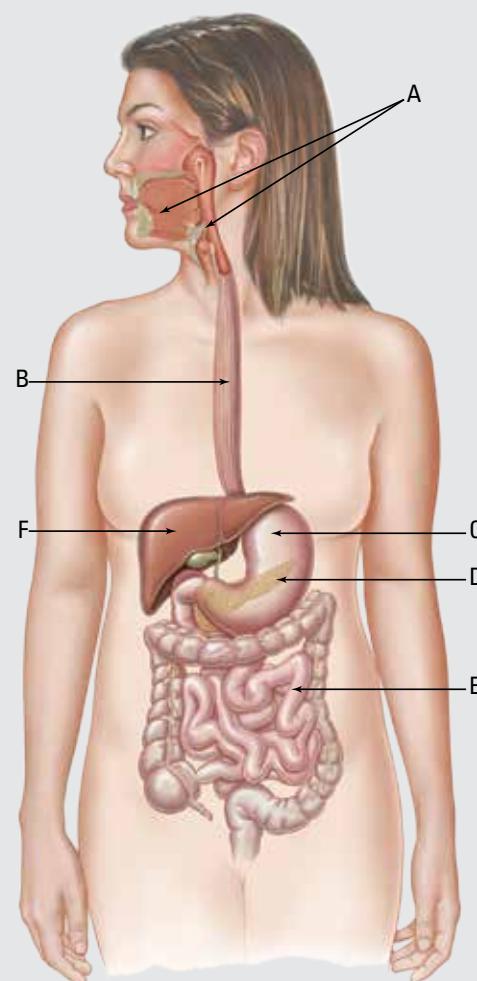
- potassium, vitamin A, fat, iron, protein, cellulose, starch
- (a) I am needed by red blood cells to carry oxygen to tissues.
 - (b) I assist nerves in functioning and a deficiency may cause fatigue and slow reflexes.
 - (c) I am made up of amino acids and can make up hormones and enzymes.
 - (d) I can be stored under the skin and am solid at room temperature.
 - (e) I am a polysaccharide that is not digested but can increase the fibre in your diet.
 - (f) I am a fat-soluble vitamin that is needed for healthy lining of your digestive and respiratory systems.
 - (g) I am a polysaccharide that can be digested and broken down into glucose.

6 Select the appropriate terms to complete the flowchart below:

oesophagus, teeth, salivary glands, stomach, large intestine, mouth, anus, small intestine, rectum, liver, gall bladder



7 Label the diagrams of the digestive and excretory systems below.



- 8 Match the organ up with the unwanted product or waste that it excretes.

| Organ | Unwanted product or waste to be excreted |
|---------------------------|--|
| Kidney | Bile pigments from old red blood cells |
| Liver and large intestine | Carbon dioxide |
| Lungs | Urea |

- 9 Explain how the shapes of the following structures well suit them to their function.

- (a) trachea
- (b) oesophagus
- (c) nephrons
- (d) villi
- (e) alveoli

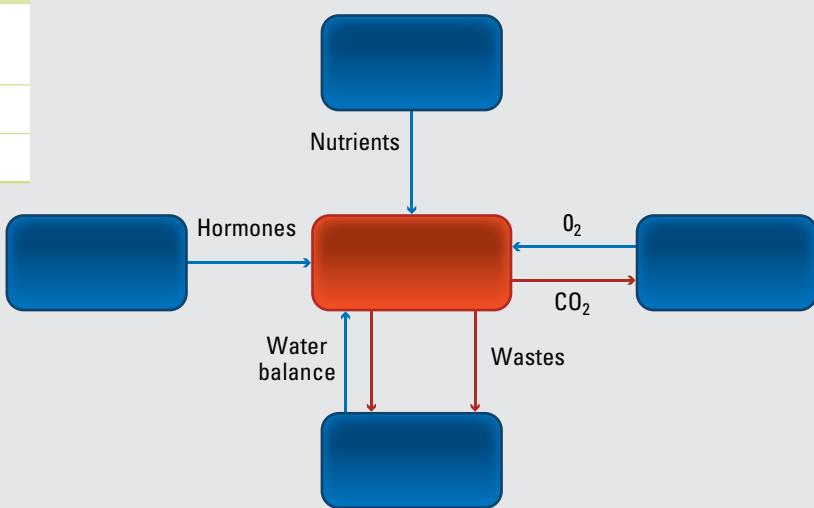
- 10 Is it the level of oxygen or carbon dioxide in your blood that has the major influence on breathing rate? How are variations in blood concentrations detected?

- 11 Describe the relationship between the respiratory, circulatory, excretory and digestive systems and cellular respiration.

- 12 Copy and complete the table below.

| Term | Function |
|--------------------|---|
| Respiratory system | To get into your body and out |
| Circulatory system | To transport and to your body cells, and wastes such as away from them |
| Digestive system | To supply your body with such as so that it functions effectively |
| Excretory system | To remove products of a variety of necessary chemical reactions |
| Endocrine system | Uses chemical messengers called secreted from special glands called throughout the body to control and coordinate at both cellular and system level |
| Nervous system | Uses and chemical messengers called to control and coordinate at both cellular and system level |

- 13 Suggest which body systems belong in each of the blank boxes in the figure below.



- 14 (a) In a team of four, brainstorm:

- (i) examples of situations and tactics that might be used to encourage or pressure young people to take drugs
- (ii) possible consequences of taking the drugs offered
- (iii) strategies (both verbal and non-verbal) that could be used to say 'No thanks!' or remove the pressured person from the situation.

- (b) Write a story or play that would help to provide young people with ideas on how to say 'no' or get out of difficult drug situations.
(c) Present your play to the class.

- 15 List the following in order from highest to lowest alcohol content (for a volume of 180 mL): whisky, full-strength beer, white wine, port.

- 16 Classify the following as being (a) excitatory or (b) inhibitory psychoactive drugs.

- Barbiturates
- Nicotine
- Heroin
- Caffeine
- Amphetamines
- Benzodiazepines
- Cocaine