5 Responding to the world

Human presence causes major changes to the Earth, but how does our environment influence us? How does your body interact with the world around it? This chapter will open your eyes to the fine balance that must be maintained by your body to survive. It is about how your body senses changes and threats and how it responds to ensure you remain healthy.

Fig 5.1 Sensing and responding to the environment helps to ensure survival.

5.1 How do we sense our world?

So far scientists have been unable to discover another planet that humans could inhabit. Why is that? Humans are pretty tough, right? We survive car accidents, wars and even school camps! The reality is that humans can only survive in very specific environments. Our bodies are quite fussy and need to have access to the right amount of food and water, oxygen and carbon dioxide. If you're lost in a desert or in freezing temperatures your body will try to maintain a temperature of about 37°C at all times to keep cells working efficiently. This 'business as usual' that is maintained by your body is called homeostasis. Homeostasis is your body's ability to regulate and maintain a stable condition inside your body, regardless of changes to the external environment. To maintain homeostasis your body uses two very important body systems to sense and respond to change: the nervous and endocrine systems. They have a big job due to the huge number of changes and threats your body encounters.

1 With a partner, brainstorm the different ways your body might sense changes in its external environment, including threats.
2 What things do you think your body can sense and respond to that occur within your body, not from the external environment?
3 Homeostasis is the maintenance of a stable environment in your body. What are some of the important conditions that your body would keep the same (regulate)?

5.2 What is a hormonal response?

Type 1 diabetes occurs when the body is unable to produce enough insulin. Insulin is a very important substance in our bodies that is responsible for taking sugar from our blood into our cells, where it can be used. Substances that have special jobs, like insulin, are called hormones and are produced by the endocrine system.

People with type 1 diabetes usually know they have it from a very early age because they are not getting enough energy. Once diagnosed, they can inject themselves with insulin every day to make sure all their cells get the energy they require. In type 2 diabetes the body produces enough insulin but doesn't recognise or respond to its actions. Lifestyle factors such as obesity put people at greater risk of type 2 diabetes.

1 What is the difference between type 1 and type 2 diabetes?
2 What is the role of insulin in the body?
3 Why is it so important to get sugars into our cells?
4 Have you ever eaten too much sugar? How did it make you feel? Why could high levels of sugar in your blood be dangerous?

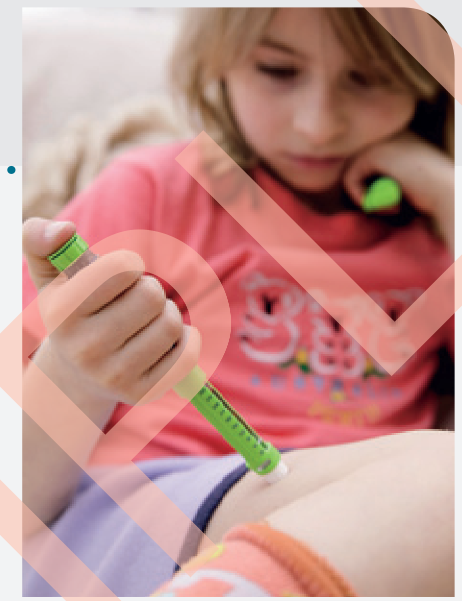


Fig 5.2 People with type 1 diabetes must inject themselves with insulin because their bodies don't produce enough.

5.3 What is a nervous response?

Fig 5.3 Our reflexes give us the ability to act and respond quickly.

One ability of most superheroes is their amazingly fast responses and reflexes. Spiderman's responses are so fast that he can dodge bullets, climb a wall and save someone in about as much time as it would take a normal person to turn the television on. Spiderman's line of work puts him in constant danger and, luckily for him, his body has rapid protective responses, known as reflexes. Reflexes occur without you even having to think about them. We may not be superheroes, but our responses and reflexes can be quick and useful too. The quick messages and responses in your body are managed by the nervous system.

1 Think of a story you have heard about human survival—perhaps in the snow, desert or following an accident. How do you think that person's body was able to assist them with their survival?
2 Brainstorm as many examples of reflexes as you can.
3 With a partner, describe what would happen if one of these reflexes didn't occur.

5.4 How do we respond to threats?

Fig 5.4 Chickenpox is a highly contagious infection caused by the varicella-zoster virus.

Chickenpox is highly contagious. This means that it is very easy to pick up from people who already have it. Chickenpox is caused by the varicella-zoster virus. Most people only get sick from chickenpox once. The first time you get chickenpox, or are vaccinated against it, your immune system responds to the virus and produces special cells, called antibodies, which destroy the virus. Next time the chickenpox virus infects you, your immune system 'remembers' how to respond and quickly produces more of these antibodies in your blood so the virus is quickly controlled before it can make you sick again. In the case of chickenpox, however, the virus may not be killed completely and can hide within the body and remain dormant. Later in life, the virus may become active again and cause shingles. Some other viruses, like influenza (the 'flu), may mutate, or change, so that the antibodies in your body are no longer effective. Next time you are infected by the virus your body has to make new antibodies to the mutated virus.

1 What contagious diseases have you had?
2 Why can you catch the 'flu many times in a lifetime?
3 Vaccines help your body build antibodies against a virus to protect you when you get infected with that virus. What vaccines have you had? What diseases are they designed to protect you from?

5.1 How do we sense our world?

When your body receives information, this is called a **stimulus**. Have you ever accidentally touched something really hot and instantly moved your hand away? Your fingertips registered the heat stimulus and the response was your hand quickly withdrawing from the heat source. Your five main senses, including touch, receive information from your environment. However, not all stimuli are received from outside your body. Your body can recognise stimuli from inside your body, for example when you feel hungry, sick or tired.

<<DISCOVERING IDEAS>>

Responding to change

As a class, brainstorm as many environmental changes as you can think of that would require you to respond in some way. They could be as significant as a bushfire or as simple as realising your toothbrush is old.

Once every member of the class has contributed at least one example, try to identify the possible responses for each stimulus. Is there only one way to respond to each? If not, how would you decide how to respond?

Identifying stimuli

Before considering how our body responds to changes and threats, we need to identify what these changes and threats might be.

A stimulus is any information that your body receives that might cause it to respond. The easiest stimuli to identify are those that we respond to physically:

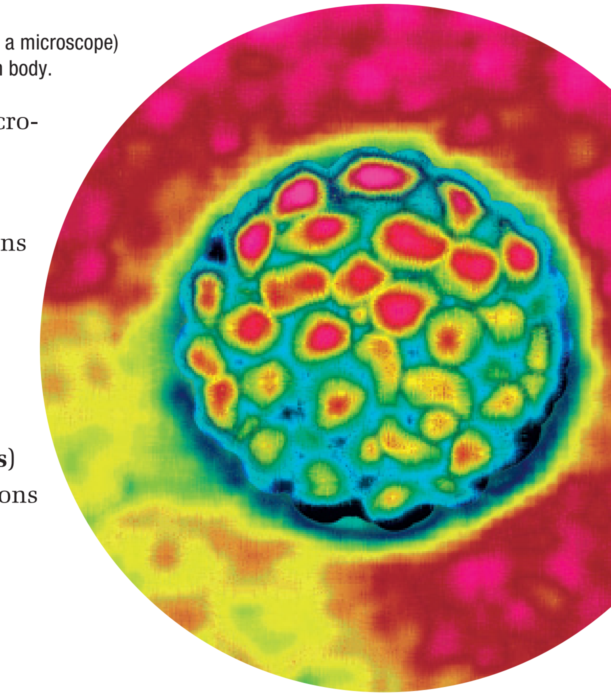
- Temperature changes cause us to shiver, put on or remove clothing, sweat, or feel pain (if the changes are extreme or for long periods).
- Pressure on a part of our body might be light and ticklish, strong and painful, it might reduce blood circulation or simply make us look at what is causing it.
- Light might make us squint, close our eyes or look towards its source.
- Sound might makes us look towards its source, follow an instruction or cover our ears.

→ Fig 5.5 We often respond to hot weather by drinking more.

Within our bodies, we are regularly responding to changes without consciously acknowledging a stimulus and response. What makes you know that you're hungry or thirsty? Something in your body is communicating with your brain to tell you to find food or water. A similar process occurs when you feel tired or have a headache—what would the source of these stimuli be?

Other examples of stimuli are less obvious. We are surrounded by bacteria, viruses and fungi, many of them too small to see, yet our bodies are constantly monitoring their numbers and fighting off micro-organisms that are harmful.

Your body is an amazing combination of cells, tissues, organs and systems, all working together to maintain **homeostasis**. These parts have a variety of ways of communicating, a whole range of systems and structures for receiving stimuli (called **receptors**) and an equally wide range of options to ensure appropriate responses.



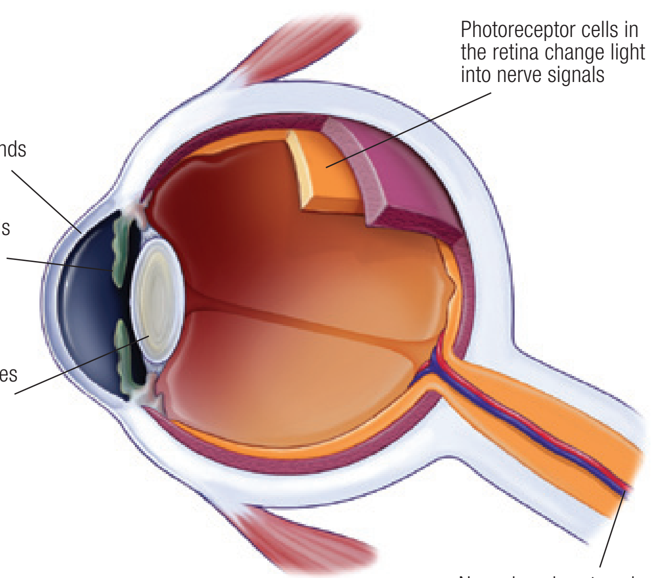
→ Fig 5.6 The papilloma virus (seen here under a microscope) stimulates an immune response in the human body.

What do you know about identifying stimuli?

1 Define the term 'stimulus'.
2 Stimuli can be changes in our immediate environment or changes within our bodies. Give two examples of each.
3 What is homeostasis?
4 What might happen if our bodies did not maintain homeostasis?

The sense organs

We have five main **senses**: sight, hearing, taste, smell and touch. These are external senses because they tell us about the world outside our body. The **sense organs**—the eyes, ears, tongue, nose and skin—are highly specialised to receive stimuli from the environment.



→ Fig 5.7 Photoreceptors in the human eye transform light into nerve signals.

Sight

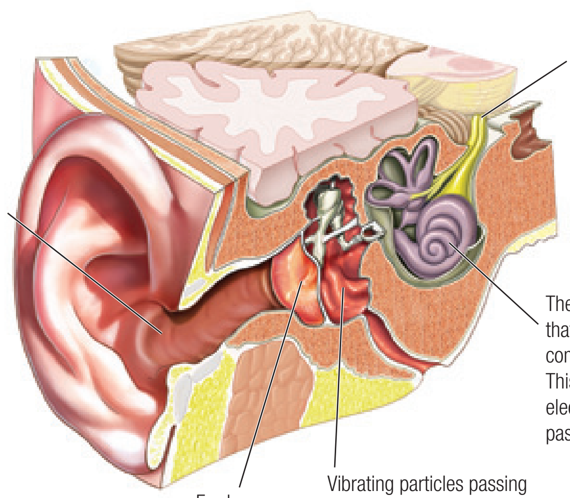
Sight tells us more about the world than any other sense. The pupils change size to control how much light enters the eye. Light entering the eye forms an upside-down image on the back of the eye. The photoreceptor cells here transform the light into nerve signals for the brain. Think about this—it's not your eyes that allow you to see, but your brain! The information from your eyes is transferred to your brain, which then tells you what you are seeing.

→ Fig 5.8 A crocodile's eye has an elliptical (oval-shaped) pupil, which helps to protect its sensitive retina from the bright light of day. At night the pupil is fully open and rounded, maximising the amount of light entering.

Hearing

Imagine the strumming of a guitar. This action sets up a range of vibrating particles in the air. These particles enter your ear as waves and cause the eardrum to vibrate. The vibrations are transferred along the bones of the middle ear—the smallest bones in your body—and converted into nerve impulses. The brain then interprets the information, telling you what you are hearing.

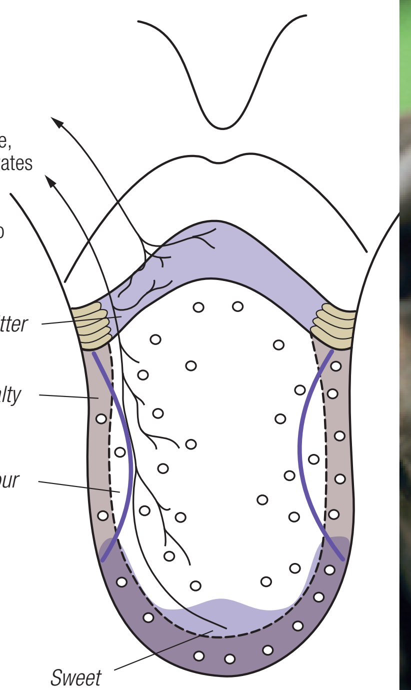
→ Fig 5.9 The human ear transfers vibrations to the middle ear. These become nerve impulses.



Taste

If you look at your tongue in a mirror you will be able to see thousands of tiny taste buds. Taste buds contain special receptor cells that react to chemicals in foods. Taste buds can recognise basic kinds of taste: sweet, salty, sour and bitter. The areas for these four kinds of taste are located in different parts of the tongue. Recently, a fifth taste, umami, was added to the group. This taste is otherwise known as 'savoury' or 'meaty' and seems to coat the entire tongue. The taste buds themselves are receptors that each have nerves of their own. When eating or drinking, the information from the taste receptor cells is sent to the brain, which tells you what flavours you are tasting.

→ Fig 5.11 The human tongue has separate areas that recognise four kinds of tastes. A fifth taste, umami, is recognised all over the tongue.



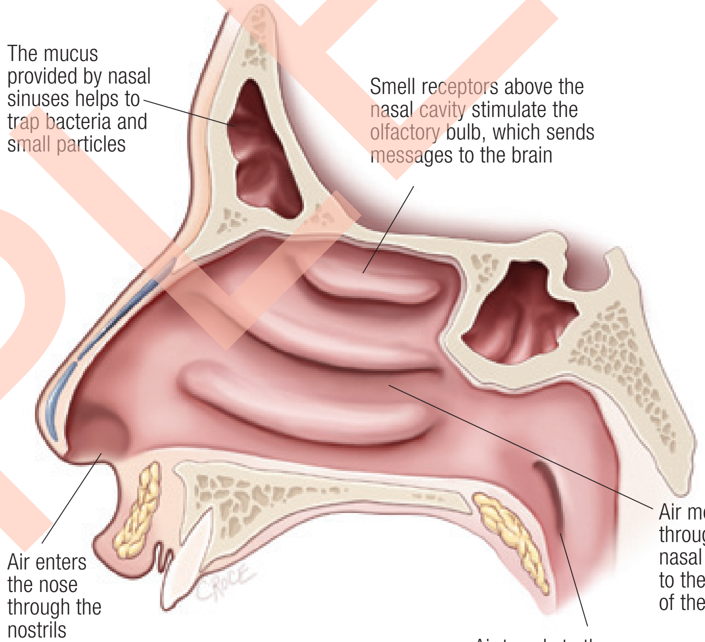
→ Fig 5.10 The large ears of some bats help them use sound waves to locate their prey.

→ Fig 5.12 A dog uses its tongue for many things, including taste and temperature control. Panting moves cool air over the tongue and lungs, allowing heat loss.

Smell

Our perception of smell depends on chemical receptors that are found in each of our nostrils. These receptors detect airborne chemicals and then send messages to the brain, which interprets the message and tells us what we are smelling. Smell is closely linked to taste. If this seems strange, think about the last time you had a bad cold and a blocked nose. Did it affect your ability to taste? A lot of what people think is taste is actually smell.

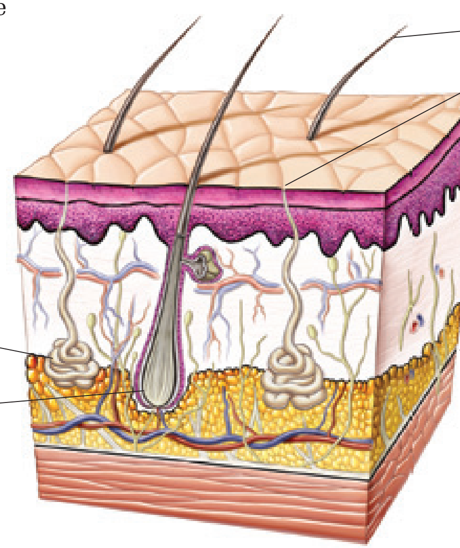
→ Fig 5.13 Smell receptors in human nostrils detect chemicals and send messages to the brain.



Touch

While the other four senses are located in specific locations, touch is felt all over the body through the skin. The bottom layer of skin, called the **dermis**, contains many nerve endings that can detect heat, cold, pressure and pain. Information is collected by these receptors and sent to our brain for processing and reaction. Take a look at one of your fingertips. It's hard to imagine that there are about 100 touch receptors in just one fingertip!

→ Fig 5.15 A cross-section of human skin.



→ Fig 5.14 Elephants use their trunks for a wide range of smelling tasks, such as sensing danger.

PRACTIVITY 5.1

Navigating without vision

What you need: blindfold

With a partner, explore how the senses of touch, hearing and smell can be used to navigate around a room without the use of sight.

1 Ensure all small or potentially hazardous obstacles are removed from around the room. Decide with your partner the path that the blindfolded student is required to take around the room.
2 Take turns being blindfolded and navigating the room, with your partner walking with you to ensure your safe navigation and providing assistance if needed.

- How was the sense of touch used in navigation?
- How was the sense of hearing used to find your way around?
- How was the sense of smell used?
- Was one sense better than another to help you navigate around the room?

→ Fig 5.16 The skin of a human's fingertip has not only touch receptors but also a unique pattern.

The senses

DESIGN YOUR OWN …

Challenge

Select one sense organ and design an experiment that allows you to test its function.

Questioning and predicting

- What is the main job of this organ?
- What type of stimulus does it receive?

Planning and conducting

- How will you ensure that it is a 'fair test' and that is as accurate as possible?
- What stimuli can you use that would be safe?

Processing, analysing and evaluating

1. What did you decide indicates a response?
2. Was the response identical each time?
3. How would the number of repetitions affect your results?
4. Suggest an alternative experiment that could have been designed to be unethical. Discuss what would have made it unethical.

Communicating

Consider a sense organ (e.g. the tongue for taste) and discuss how its form (its structure) links to its function (use).

What do you know about the sense organs?

1. What are the five sense organs?
2. Describe five situations in which each sense organ would need to respond.
3. Is it possible to survive without one or more of your sense organs? Explain.

What causes disease?

A **disease** is an unhealthy impairment of the body that stops it from functioning as it should. We have all had some sort of disease, such as the common cold, chickenpox or measles. These types of sickness are called infectious diseases because they are caused by pathogens that can be easily passed from one person to another. A pathogen is an organism that is capable of causing disease or sickness. Other diseases, such as heart disease or diabetes, are called non-infectious diseases because they may be inherited, caused by lifestyle choices or non-living factors in the environment, such as air pollution.

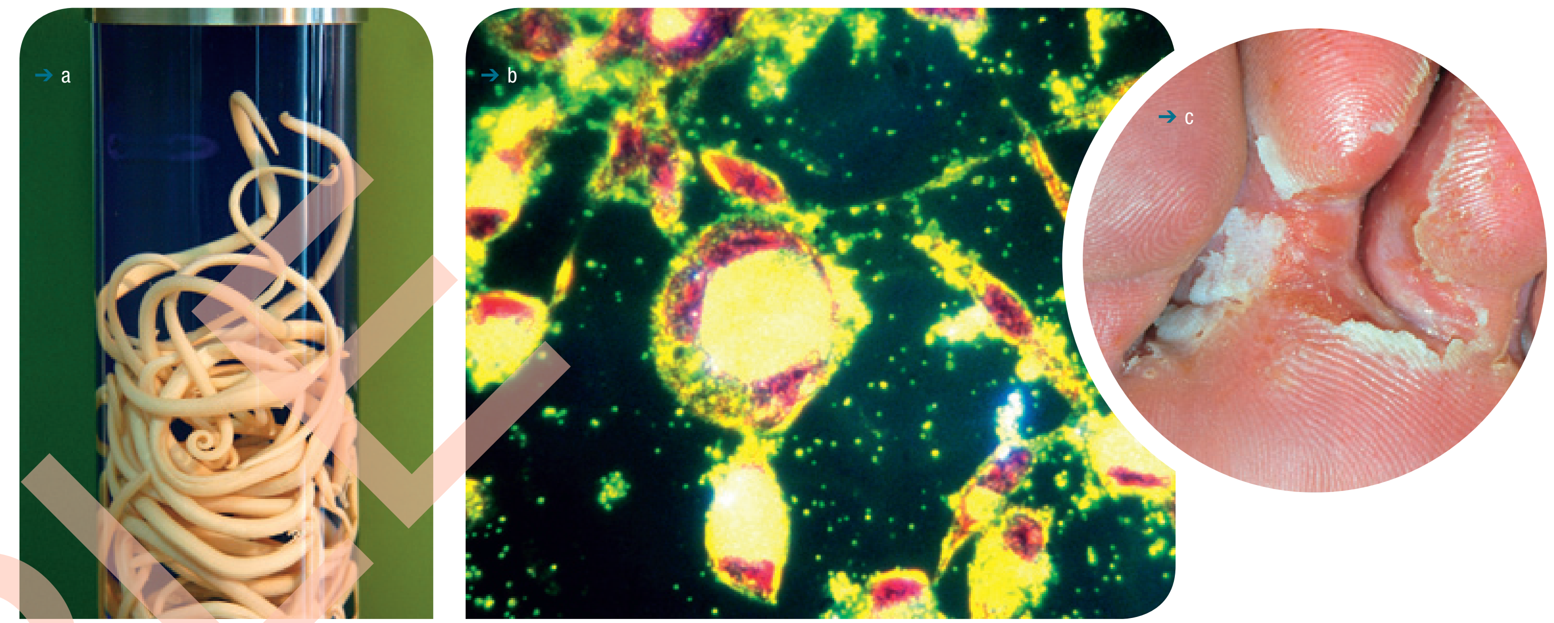
Pathogens

Pathogens can vary in type and size, from unicellular micro-organisms to multicellular worms and fungi. **Prions** are a group that has only recently been added to the list of pathogens. They are responsible for diseases such as 'mad cow' (Creutzfeldt–Jakob) disease. Prions are not organisms, they are proteins. Until scientists learn more about them, they are considered alongside the other pathogens because of the way they behave. Table 5.1 shows the different types of pathogen and the types of disease they cause.

Table 5.1 Types of disease-causing pathogen

Pathogen	Features	Example of disease
Flatworm and roundworm	Multicellular organism, usually parasitic; no digestive system	Schistosomiasis (an infection from contaminated water)
Fungus	Unicellular or multicellular organism; cell wall and nucleus; no chlorophyll	Tinea (a fungal infection, often between the toes)
Protozoan	Unicellular organism; cell wall; nucleus	Malaria (transmitted by mosquitoes and causes high fever and 'flu-like symptoms)
Bacterium	Unicellular organism; cell wall but no nucleus	Chlamydia (a sexually transmitted infection)
Virus	Not a cell: contains genetic material surrounded by a protein coat; not considered living	Hepatitis (inflammation of the liver)
Prion	Not an organism: protein that is 'bad' and makes other proteins 'bad' through direct contact	'Mad cow' (Creutzfeldt–Jakob) disease (affecting the brain and caused by eating infected beef)

Fig 5.17 Different types of pathogens. (a) Tapeworms can grow to several metres in length. (b) Chlamydia (seen here under a microscope) is a disease caused by the *Chlamydia* genus of bacteria. (c) Athlete's foot (tinea pedis) is caused by the ringworm fungus.



What do you know about what causes disease?

1. What is a disease?
2. What causes an infectious disease?
3. How is a virus different from a bacterium?
4. What do you think a pathologist studies? Explain.

Radiation and disease

Mobile phones, microwaves and X-rays all work because of electromagnetic radiation. Electromagnetic radiation is any type of energy transmitted by electric and magnetic field waves. It travels at the speed of light and can cause charged particles to move about really fast. It is this fast movement of particles that causes your food to heat up in the microwave.

Radiation is regularly used to see inside the body. It may be used to make an image (X-rays and computed tomography (CT) scans) or be swallowed or injected as radioisotopes to enhance the view of certain parts inside the body for imaging. Radioisotopes are radioactive forms of substances such as iodine and bromine.

Radiotherapy (radiation treatment) is used to treat many cancers. X-rays, gamma rays and beta particles are delivered by specialised machines or as radioisotopes to target affected cells. Here, specific damage is the desired effect.

Fig 5.18 X-rays allow medical professionals to detect some problems inside the body, such as broken bones.

→ Fig 5.19 Radiotherapy delivers radiation to cancerous cells.

Exposure to higher energy types of radiation can result in damage to the human body. An example of this is sunburn caused by ultraviolet light from the Sun. Exposure to high levels of gamma radiation can result in damage to the human body including burns, cancers and death.

Radiation presents a dilemma in medicine because it can be harmful. However, in controlled doses, and when targeting a specific part of the body, radiation can safely be used to treat certain diseases. Most people don't need these tests and treatments often, and so their exposure is low. If a person needs frequent exposure, doctors will compare the risks of exposure with the risks of not having treatment.

People who work with radiation for medical purposes take significant precautions in their job. They wear protective clothing, such as aprons reinforced with lead, to block radiation. Whenever possible they will leave the room while a person is being treated by exposure to radiation. The radiation equipment operates in special reinforced rooms with a viewing window so that people can safely observe from the outside. People working with radiation wear a special badge that monitors their exposure.

→ Fig 5.20 People working with radiation need to limit their exposure.

PRACTIVITY 5.2

Background radiation

What you need: Geiger counter, stopwatch

1 Set up the Geiger counter in the science laboratory and measure the background radiation count each minute for 5 minutes.
2 Calculate the average background radiation count.
3 Go to different locations in the school and repeat steps 1 and 2.

→ Fig 5.21 A Geiger counter.

- Was there much variation in your initial results for the science laboratory?
- How could you explain variations?
- Where in the school was the background radiation count the highest? How could you explain this result?

What do you know about radiation and disease?

1 What are three types of radiation and what are their sources?
2 What characteristic of radiation makes certain types more likely to cause harm to living things?
3 Describe two ways in which radiation is used in medicine.
4 Some recent studies suggest links between using mobile phones and brain tumours. Would this stop you using your mobile phone? What evidence would you need to change your habits?

5.1 How do we sense our world?

Remember and understand

1 Write a definition of these words:
  a stimulus
  b homeostasis
  c pathogen
2 Describe three different ways the human body can receive a stimulus from the environment.
3 What would be the most likely response to the following stimuli?
  a walking on hot sand
  b seeing something flying towards you
  c realising you've put salt on your cereal instead of sugar
  d throbbing in your head

Apply

4 Outline six different responses to a change in temperature—three for an extreme change and three for a subtle change.

Analyse and evaluate

5 Why do you think eyes and ears come in pairs, while the other sense organs are solitary?
6 Why might holding your nose help you to swallow something that tastes awful?
7 Predatory animals have their eyes on the front of their face, while their prey generally have eyes on the sides of their heads. Why might this be the case?

Ethical behaviour

8 Why might a doctor advise resting an injured joint for a couple of days before suggesting further tests?

Critical and creative thinking

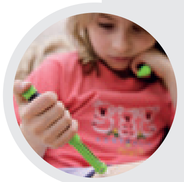
9 Imagine that you wake up one day and one of your sense organs has stopped working. Write a creative story outlining this day in your life.
10 Your body is constantly monitoring and controlling the numbers of pathogens in and on your body. What can you do to assist your body in controlling pathogens? What can a doctor help you with?

<<CONNECTING IDEAS>> Structure and function

11 Where are your sense organs located? Why is their location important? How does their size and structure suit their function? How does their location suit their function?

5.2

What is a hormonal response?



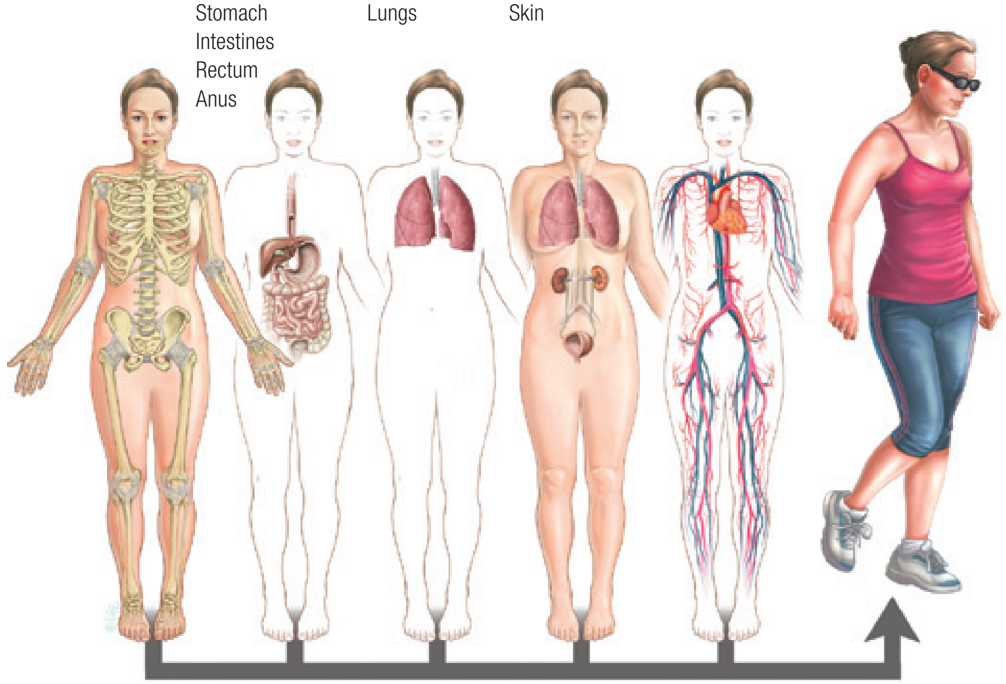
When something changes in the external or internal environment and a stimulus is received, what happens next? Body systems, although separate, have to work together to receive and process this information, then respond appropriately. Think of it like an orchestra: a complex meeting of different parts with different purposes to create a wonderful symphony.

<<DISCOVERING IDEAS>>

Responding

What you need: A3 sheet of paper

You've most likely heard of a variety of different body systems and probably learned about them in year 8. Do you remember all the different body systems?



→ Fig 5.22 Our body systems work together.

On an A3 sheet of paper draw a mind map showing the links between the requirements for life (oxygen, nutrients, water and removal of waste) and the different body systems. You will get a point for each link that you make—there are lots of connections to be made!

Team up with a partner. Imagine you are both famous scientists who have been asked to speak to a year 9 class at a local high school about body systems and how they work together. Prepare two separate file notes of at least half a page each, including a diagram, on the respiratory and circulatory systems.

- What interaction do these two systems have?
- What would happen if the two systems didn't work together?
- Looking at the forms of the systems, what clues can you find that show they work together?

Complete the following table:

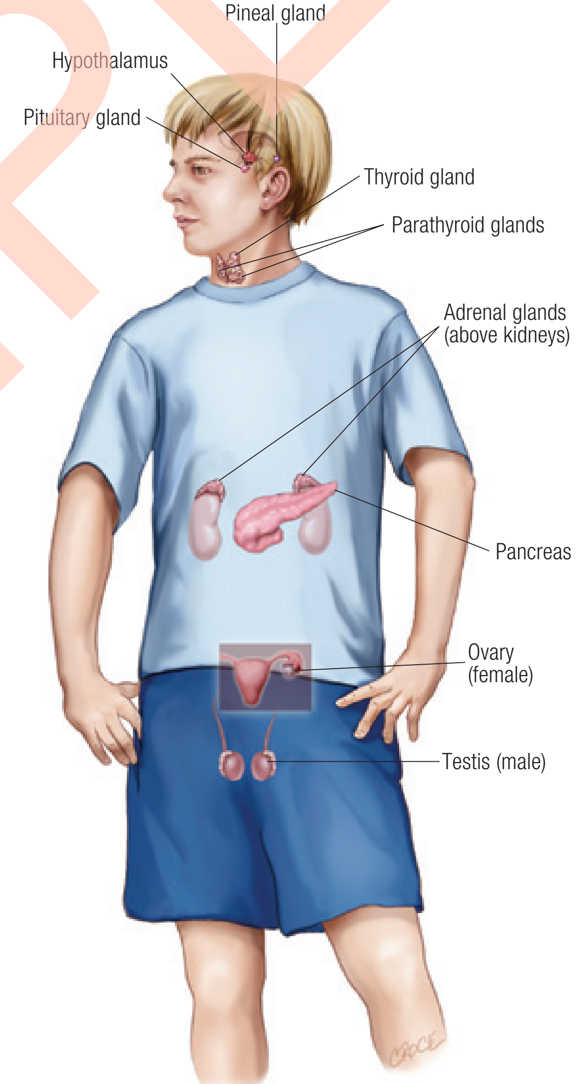
Function	Body systems working together
Oxygen transported in the blood	
Nutrients from food absorbed and transferred into the bloodstream	
Unwanted nutrients transported out of the body	
(Think of your own)	
(Borrow one from a friend)	

The endocrine system

The endocrine and nervous systems are the systems largely responsible for sensing and responding to the environment. Part of this important job is communication: once a change or threat has been received, messages must be sent around the body to coordinate a response. The nervous system sends very fast electrical messages, and the **endocrine system** is a much slower system that uses chemical messengers called **hormones** to maintain homeostasis and to regulate growth. These chemical messengers act more slowly than the nerve impulses sent around by the nervous system, but their effects often last for a lot longer.

The endocrine system is a collection of glands that secrete (release) hormones. These hormones are secreted directly into the bloodstream and then travel through the blood to arrive at a target organ. How does the hormone know where to go? Hormones bind to a matching receptor, working like a lock and key mechanism.

The glands and organs of the endocrine system are spread throughout the body (Table 5.2).



→ Fig 5.23 The human endocrine system.

→ Table 5.2 Some organs and hormones of the endocrine system

Organ	Hormone	Target tissue	Main effects
Hypothalamus	Wide range of neurohormones	Pituitary gland	Links nervous system to endocrine system via pituitary gland to control many homeostatic functions such as body temperature, hunger, thirst and sleep patterns
Ovaries	Progesterone	Uterus	Thickens wall of uterus
	Oestrogens	Body cells	Development of female sexual characteristics; aspects of pregnancy and foetal development
Testes	Testosterone, progesterone and oestrogen	Male reproductive system, body cells	Development and control of male sexual characteristics; production of sperm
Pancreas	Insulin	Liver, most cells	Lowers blood glucose level
	Glucagon	Liver	Raises blood glucose level
Pituitary gland	Thyroid-stimulating hormone	Thyroid	Changes the rate of thyroxine release from the thyroid
	Anti-diuretic hormone	Kidneys	Reduces the amount of water reabsorbed from the kidneys
	Pituitary growth hormone	Bones, muscles	Stimulates muscle growth; controls the size of bones
Thyroid gland	Thyroxine	Body cells	Affects rate of metabolism, and physical and mental development
	Calcitonin	Blood	Decreases the amount of calcium in the blood
Parathyroid glands	Parathyroid hormone	Blood	Regulates the amount of calcium in the blood
Adrenal glands	Adrenalin, progesterone and oestrogen	Body cells	Adrenalin increases body metabolism in 'fight or flight' response Progesterone is important for calcium in bones Oestrogen develops certain sexual characteristics
Pineal gland	Melatonin	Skin cells	Whitening of skin; involved in daily biological rhythms

ZOOMING IN

Fight or flight?

Have you ever been in a dangerous or frightening situation? If you have, you may understand very well what the 'fight or flight' response is all about—you break out in a cold sweat, your heart is beating wildly, everything around you seems to slow down and your senses are bombarding you with information.

Most of the symptoms are triggered by the release of the hormone adrenalin. Adrenalin is being constantly produced by the adrenal glands in small doses. The adrenal glands are located above the kidneys. Usually, this hormone is used for everyday things like stimulating your heart rate and enlarging blood vessels. However, when you are in danger, adrenalin takes on a whole new role. At times like these it floods into your system, causing an increase in the strength and rate of the heart beat, raising your blood pressure and speeding up the conversion of glycogen into glucose, which provides energy to the muscles. In this way, adrenalin prepares your body for the extra effort required if you need to defend yourself (fight) or run away (flight).

➔ Fig 5.24 Adrenalin is responsible for the 'fight or flight' response in mammals.

PRACTIVITY 5.3

Glands and organs of the endocrine system

What you need: large sheet of butcher's paper, marker pen, sticky tape

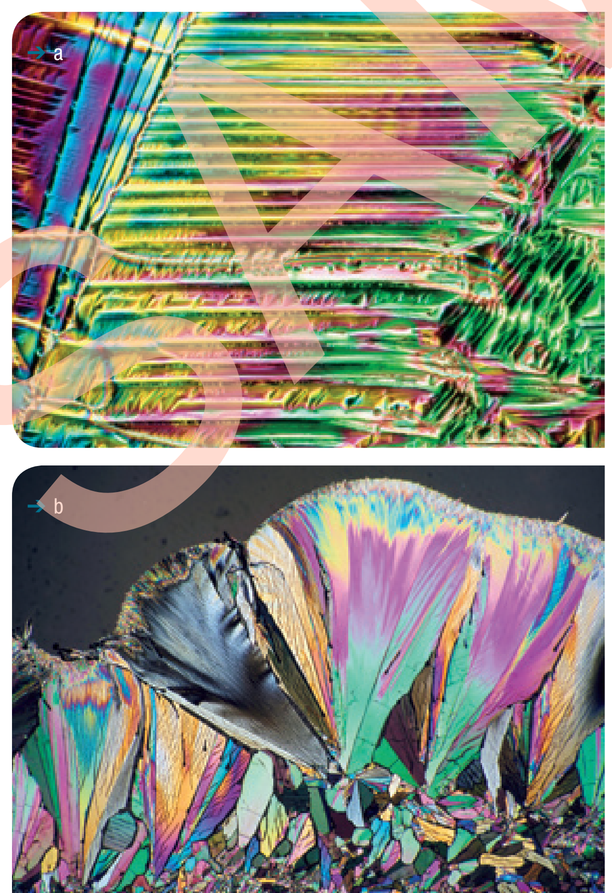
1. Working in pairs, draw an outline of your partner's body onto the paper.
2. With your partner, draw in the different glands and organs of the endocrine system. Using the information in Table 5.2, annotate each gland with a brief description, in your own words, of what it is responsible for.
3. Use colour-coding and arrows to show the path of the hormone(s) produced by each gland to its target organ.
4. Choose one gland or organ to research. Include:
   - the hormone it secretes
   - what the hormone does
   - disorders related to this organ or gland.

Types of hormone

Hormones are classified into two types based on their chemical structure: peptide hormones and steroid hormones. Peptide hormones are made from proteins and produced by the anterior pituitary, parathyroid gland, placenta, thyroid gland and pancreas. Most hormones are peptides. Peptides travel through the bloodstream until they find and interact with specific receptors on the surface of their target cells.

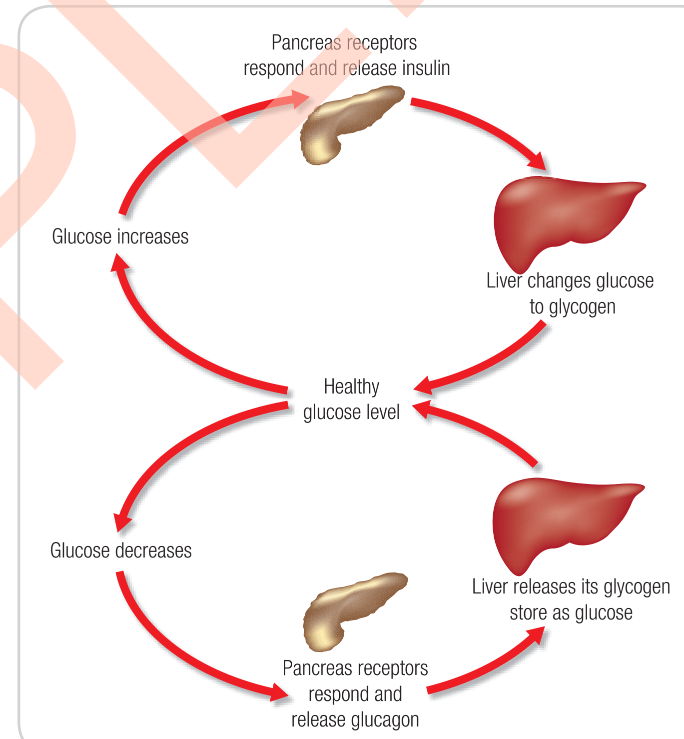
Steroid hormones include those hormones secreted by the adrenal glands and the ovaries (women) or testes (men). Steroid hormones are produced from cholesterol.

➔ Fig 5.25 Crystal structures (as seen under a microscope) of (a) the peptide hormone calcitonin and (b) the steroid hormone testosterone.



What do you know about the endocrine system?

1. What is the name of the system in your body responsible for hormones?
2. What is meant by the phrase 'fight or flight' and how does it relate to hormones?
3. Describe the two different types of hormone.
4. Why is the endocrine system referred to as a communications system?
5. How is a hormonal response different to a nervous response?



➔ Fig 5.26 The pancreas and the liver work together to maintain healthy glucose levels in the body.

➔ Fig 5.27 A goitre is a swelling of the thyroid gland.

Hormones at work

Hormonal effects are often controlled by **feedback mechanisms**. This means that when a hormone—a messenger—is sent out into the body, information is received back about what is going on. This then affects other responses by the body. The rate of hormone production and secretion is often regulated by a **negative feedback mechanism**. This means that if a stimulus is received indicating that something in the body is happening 'too much', the response would be to produce less of that hormone to reduce the effects.

When things go wrong in the endocrine system

Disorders and diseases of the endocrine system are fairly common and are often due to imbalances in feedback mechanisms within hormonal systems. Diabetes, thyroid goitre and obesity are all caused by imbalances in the endocrine system.

Diabetes is one of the more serious and common results of hormone imbalance. Left untreated it can result in blindness, kidney failure, heart disease or death. Diabetes occurs when the pancreas either produces too little insulin or doesn't properly use the insulin it does produce. **Insulin** is the hormone that assists the body to process sugar in the bloodstream. A message that blood sugar is low results in less insulin being produced. The opposite happens when blood sugar is high.

A **goitre** occurs when the thyroid gland, which is located in the neck, becomes enlarged. The thyroid gland needs iodine to produce thyroid hormones. If a person's diet is low in iodine, the thyroid gland is not able to produce the hormones. The gland enlarges as it tries to make more thyroid hormones. An underactive thyroid gland can also produce a goitre.

What do you know about hormones at work?

1. What is a feedback mechanism?
2. If a negative feedback loop reduces the effect of a hormone, what do you think a positive feedback loop does?
3. What is the stimulus that triggers insulin production?

5.2 What is a hormonal response?

Remember and understand

1 Write a definition of the word ‘stimulus’.

2 Name two glands in humans that produce hormones.

3 Name two diseases caused by hormonal problems in humans.

4 Explain why the nervous system and the endocrine system are both ‘communications systems’.

5 How are hormones transported in the body?

Apply

7 Copy and complete. A person with diabetes has a problem with the hormone ______________, which is secreted by the ______________ gland.

8 Explain what a feedback mechanism is and give an example.

Analyse and evaluate

9 In 2006, a woman in northern Quebec fought off a polar bear with her bare hands when it attacked her daughter! She literally wrestled with the bear—and won. Give arguments for and against this reaction being attributed to the hormone adrenalin.

Critical and creative thinking

10 Create a life-size diagram of your own body on butcher’s paper. Draw in the components of the endocrine system.

11 Draw a cartoon strip with at least five squares illustrating a person receiving a stimulus and then responding.

<<CONNECTING IDEAS>> Structure and function

12 Explain how the endocrine system assists your body to ‘respond to the world’? Why couldn’t the endocrine system handle this big job on its own?

5.3 What is a nervous response?

To survive immediate danger, you need quick responses. For example, when you trip or slip on something you may respond by throwing your arms out and trying to stay upright. This is to prevent damage to your precious body. Humans are constantly receiving stimuli from their environment that they need to respond to. The nervous system makes it possible to respond very quickly to certain stimuli. The nervous system uses electrical messages that are passed through nerves.

<<DISCOVERING IDEAS>>

How fast is the nervous system?

What you need: metre ruler

1 Working in pairs, one student holds a metre ruler between their thumb and forefinger so that the ruler hangs with the zero mark at the bottom. The other student needs to wait with their thumb and forefinger at the bottom of the ruler, level with the zero mark.

2 The first student drops the ruler without warning, while the other student catches the ruler as fast as they can between their thumb and forefinger.

3 Record the number of centimetres the ruler has dropped by looking at the location of the second student’s thumb and forefinger on the ruler (Fig. 5.28).

4 Repeat until you have ten results for each student.

5 Work out the average reaction distance for each student.

6 Measure the approximate distance the messages must have travelled if they travelled from your ear to your brain to your fingers.

7 Blindfold one student to try the experiment using touch. Tap the person on the head when you drop the ruler. Does this make a difference to the reaction distance?

8 Blindfold one student to try the experiment using hearing. Say ‘now’ when you drop the ruler. Does this make a difference to the reaction distance?

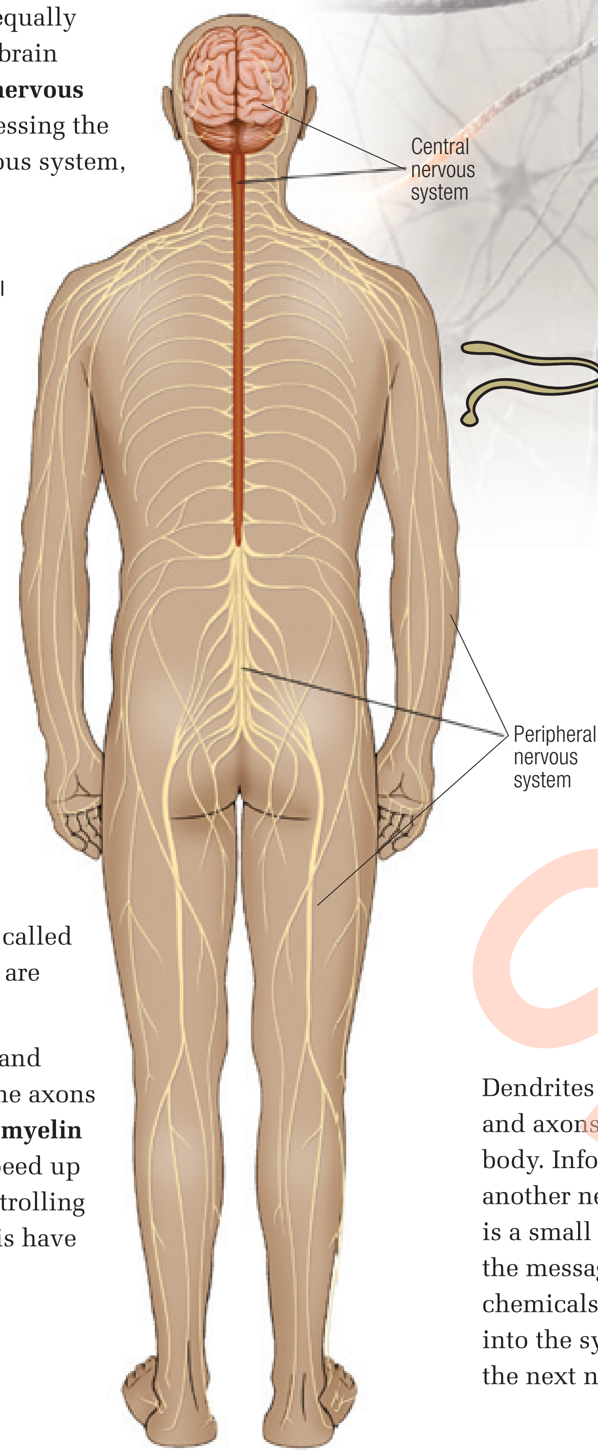
- Which experiment had the fastest results? Why might this be?
- How could you make sure the results are as accurate as possible?
- Do you think this is a ‘fair test’? Why or why not?

→ Fig 5.28 Testing responses.

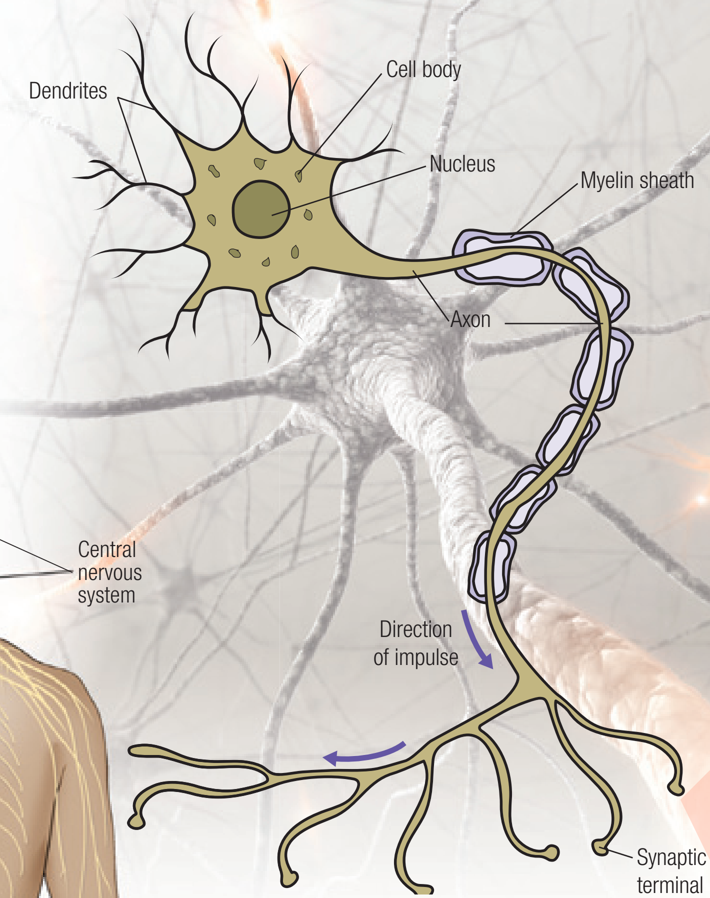
Nerves and the nervous system

To survive immediate danger, you need quick responses. For example, when you trip or slip on something you may respond by throwing your arms out and trying to stay upright. This is to prevent damage to your precious body. Humans are constantly receiving stimuli from their environment that they need to respond to. The nervous system makes it possible to respond very quickly to certain stimuli. The nervous system uses electrical messages that are passed through nerves.

Your body requires so many responses at every moment of the day and night that an equally complex nervous system exists. Your brain and spinal cord make up the **central nervous system**, which is responsible for processing the information from the peripheral nervous system, which includes all the other nerves.



→ Fig 5.29 The nervous system of the body is made up of the central nervous system and the peripheral nervous system.



→ Fig 5.30 A typical neuron.

Nerves

The basic unit of the nervous system is a nerve cell, or **neuron**. Scientists believe that we may have up to 100 billion neurons in our bodies, connected in paths called nerves.

Neurons have many highly specialised features. Each neuron has a large **cell body** that connects to a long thin **axon**, which is also called a nerve fibre. An axon carries the nerve impulse away from the cell body. The axons connecting your spinal cord to your foot can be up to 1 metre long! At the end of the axon is a small bulb called the synaptic terminal. Here, messages are passed to the next neuron.

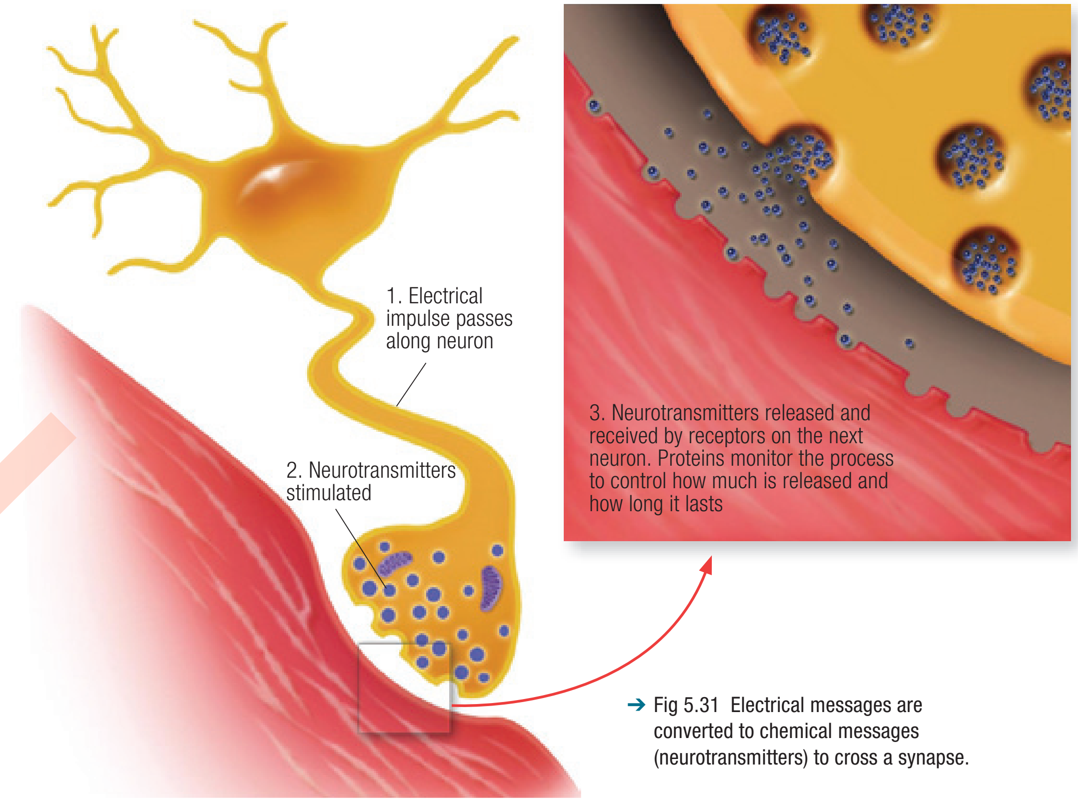
Nerves work just like electrical wires and require insulation in the same way. The axons are covered by a fatty layer called the **myelin sheath**. The myelin sheath helps to speed up a nerve impulse along an axon by controlling its path. People with multiple sclerosis have damaged myelin sheaths. This means that the nerve impulse is disrupted, blocked or able to escape along the length of the axon. This causes movement and sensory problems.

Dendrites are nerve endings that branch out of the cell body. These highly sensitive, thin branches receive information and form contacts with the axons of other neurons, allowing nerve impulses to be transmitted.

Dendrites bring information to the cell body and axons take information away from the cell body. Information from one neuron flows to another neuron across a **synapse**. The synapse is a small gap separating neurons. When the message reaches the end of the neuron, chemicals called **neurotransmitters** flow out into the synapse and stimulate the receptors on the next neuron to pass the information along.

There are three specialised types of neuron, all with different jobs.

- **Sensory neurons** are sensitive to various stimuli, collecting information either from the body's internal environment or the outside world. Sensory neurons send the information they have collected to the central nervous system for processing.
- **Motor neurons** carry messages from the central nervous system to muscle cells throughout the body, which then carry out the response. Motor neurons are also known as effector cells.
- **Interneurons** link sensory and motor neurons, as well as other interneurons. Interneurons only make connections with other neurons. They are also known as connector neurons.



→ Fig 5.31 Electrical messages are converted to chemical messages (neurotransmitters) to cross a synapse.

PRACTIVITY 5.4

Pipecleaner neurons

What you need: 5 different coloured pipecleaners representing different parts of the neuron (cell body, axon, dendrites, myelin sheath and synaptic terminal), A3 or A4 paper, sticky tape, red felt marker

1. Take one pipecleaner and roll it into a ball to make the cell body.
2. Take another pipecleaner and attach it to the cell body by pushing it through the ball so that there are two halves sticking out. Take the two halves and twist them together into a single long axon.
3. Take another pipecleaner and push it through the cell body on the side opposite the axon. This can be shorter than the axon and you can twist more pipecleaners to make more dendrites.
4. Wrap a pipecleaner along the length of the axon to form the myelin sheath.
5. Wrap another pipecleaner on the end of the axon to make the synaptic terminal.
6. Tape your finished pipecleaner neuron onto a piece of A3 or A4 paper and label the parts.
7. Mark the path of the nerve impulse, from start to finish, along the neuron.

What do you know about nerves and the nervous system?

1. With a partner, come up with a way to remember the difference between sensory neurons, motor neurons and interneurons. Be creative! Share your memory trick with the class.
2. Name and describe the features of a neuron that enable it to carry messages.
3. Where are sensory neurons that detect:
   a. smells?
   b. tastes?
   c. sounds?
   d. touch?
   e. sights?
4. What is the role of the myelin sheath?
5. Using a diagram, explain what problems may result from damage to the myelin sheath.
6. Write a story or draw a cartoon about the travels of a message that is communicated from a sensory neuron in your eye to your central nervous system. 'Zoom in' to talk about how it travels through one neuron to reach another.

The central nervous system

The central nervous system is the control centre of the body. All incoming messages from your environment and your responses to them are processed through the central nervous system. The two main features of the central nervous system are the brain and the spinal cord.

The brain

The brain is the processing centre of the body and is mainly concerned with our survival. The brain is a soft, heavy organ that is surrounded by a tough skull. The brain gathers information about what is going on inside and outside the body. It then makes decisions about things like internal changes and movements. It is also home to your memories, personality and thought processes.

The spinal cord

Have you ever accidentally touched something very hot? If you have, you will remember how quickly you snatched your hand away. In fact, it was so quick that you know you didn't even have time to think about it—it was automatic. A **reflex**, or reflex action, is an involuntary and nearly instantaneous movement in response to a stimulus.

During a reflex action, an impulse is passed along a sensory neuron to the spinal cord, where it crosses a synapse to a motor neuron. This allows reflex actions to occur quickly by activating motor neurons without having to wait for signals to pass through the brain. Of course, the message is eventually sent on to the brain so the brain can record what has happened. So a fraction of a second after you pull your hand away from a hot stove, you feel the pain in your hand.

PRACTIVITY 5.5

Testing reflexes

1. Look at the pupils (the black spots in the middle of the eyes) in the eyes of a classmate. Note the size of the pupils.
2. As a class, dim the lights in the room. After a few minutes, look at your classmate's eyes and note the size of the pupil.
   - How big are the pupils? Has their size changed?
   - Why do you think this happened?
3. Turn the room lights back on. Check the size of your classmate's pupils again.
   - How big are the pupils this time?
   - Why do you think this happened?

- What other reflexes do you think you could safely test? With a partner, design an experiment of your own. Make sure you write out a full report, including your aim, equipment, method and discussion.

→ Fig 5.32 Our reflexes protect us from dangerous situations.

Spinal damage

ZOOMING IN

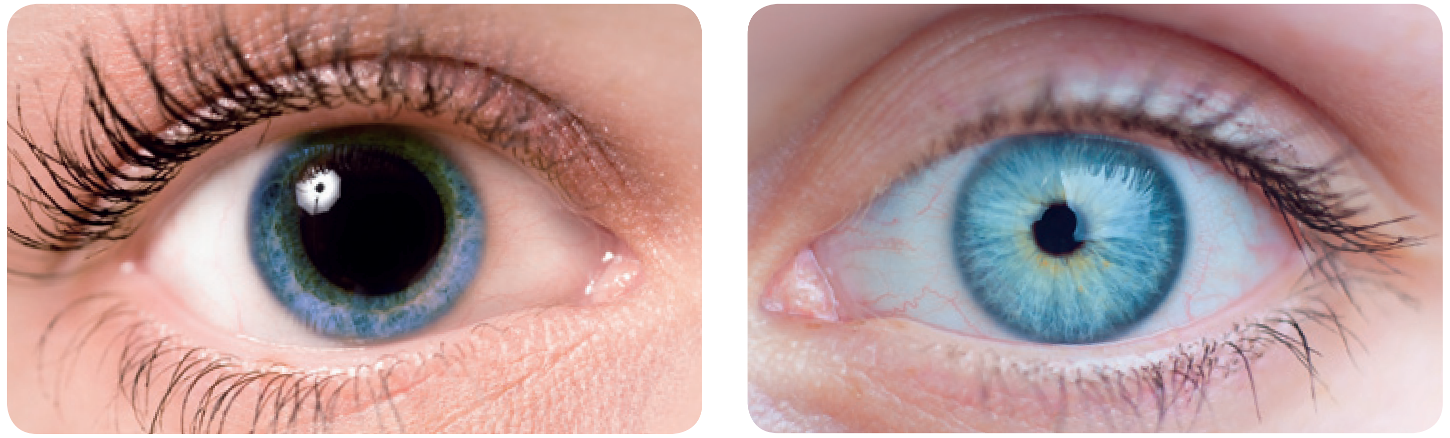
Spinal injury is a major cause of injury in Australia, especially to young men. These injuries commonly result from motor vehicle accidents, everyday falls and sports.

When the spine is damaged, messages from below the level of injury to the brain or above the level of injury from the brain are blocked. How much of the body is able to move after a spinal injury depends on where the injury is in the spine. If it is high up, most of the body is 'cut off' from the brain; if it is lower down, then the upper body and arms will be able to work as they normally would.

People with damage to the upper part of the spinal cord have quadriplegia—they are unable to use their arms or their legs. If the injury is very high, they may even have trouble breathing on their own. People with damage below this level have paraplegia—they are still able to use their arms but not their legs.

→ Fig 5.33 Paraplegia is spinal damage that affects the lower part of the body.

→ Fig 5.34 Which pupil is in low light and which is in bright light?



What do you know about the central nervous system?

1. Which two parts make up the central nervous system?
2. What protects your:
   a. brain?
   b. spinal cord?
3. What is the name of the individual bones that make up the spine?
4. Explain the difference between quadriplegia and paraplegia.
5. Which part(s) of the central nervous system are involved in a reflex reaction? Explain.

The peripheral nervous system

The peripheral nervous system is a large system made up of all the nerves outside the central nervous system. The peripheral nervous system carries information to and from the central nervous system to the rest of the body, such as the limbs and organs.

The peripheral nervous system is divided into two parts:

- The **somatic nervous system** controls voluntary skeletal muscle movements, such as waving or reaching out to take something.
- The **autonomic nervous system** controls involuntary actions, which happen without our conscious control. This includes heartbeat, digestion, respiration, salivation and perspiration. It is the autonomic nervous system that maintains your body's internal environment (homeostasis).

The autonomic nervous system also has two parts: the sympathetic division and the parasympathetic division. These two divisions often have opposite effects. For example, the parasympathetic division slows down the heart rate, whereas the sympathetic division speeds up the heart rate. The systems work together to maintain a balance in the body.

DESIGN YOUR OWN ...

Skin sensitivity

Challenge

Design and conduct an experiment to test skin sensitivity. Do not conduct a test that might hurt the person you are testing.

Questioning and predicting

Create your own hypothesis about the relationship between the amount of touch you can sense and the different parts of the body that you test.

Planning and conducting

- What will you do to test your hypothesis? Are there any areas of the body that you think would be more sensitive than others? Why would it be more important to have more sensitivity in some areas than others? How would increased (or decreased) sensitivity be beneficial to your body in sensing and responding to changes and threats?
- Conduct your experiment and record your results in an experimental report so that someone else could perform the same experiment.

Processing, analysing and evaluating

1 How can you explain your results?
2 Are there any variables you were unable to control?
3 What do you know about the connection between the sense of touch and different areas of the body?

→ Fig 5.35

4 Why do you think some areas of your body are more sensitive than others?
5 How do your results compare with those of other groups?
6 How could you test whether heavy input into another sense (hearing, sight, smell, taste) interferes with the sense of touch?
7 Do you think that the experiment would have different outcomes if done with a group of people who were blind? Why or why not?

Communicating

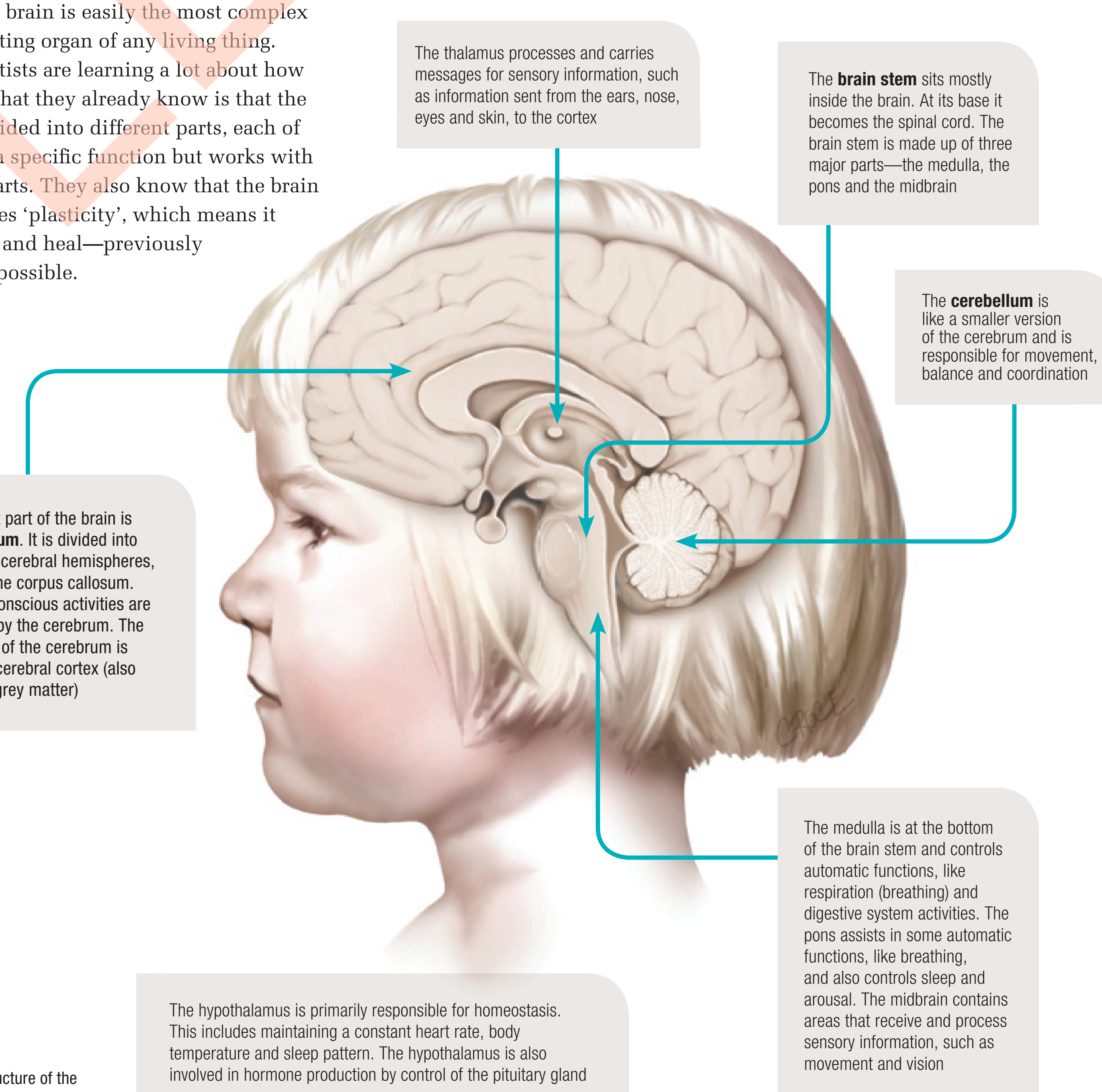
Present your findings in a formal experimental report.

What do you know about the peripheral nervous system?

1 What is the peripheral nervous system made up of?
2 How do the peripheral nervous system and central nervous system work together? Use an example to illustrate your answer.
3 What is the difference between the somatic nervous system and the autonomic nervous system?
4 Which part of the nervous system is responsible for maintaining homeostasis? Why is this such an important job?

A closer look at the brain

The human brain is easily the most complex and fascinating organ of any living thing. Neuroscientists are learning a lot about how it works. What they already know is that the brain is divided into different parts, each of which has a specific function but works with the other parts. They also know that the brain demonstrates 'plasticity', which means it can change and heal—previously thought impossible.



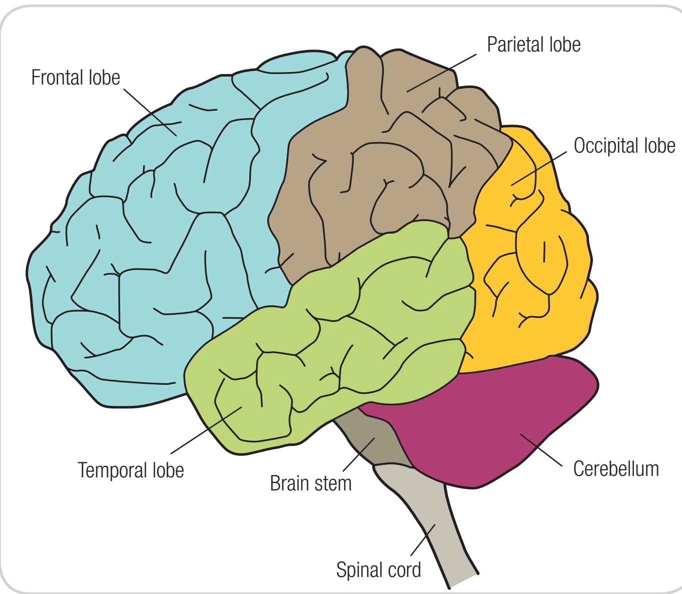
→ Fig 5.36 Structure of the human brain.

Lobes of the brain

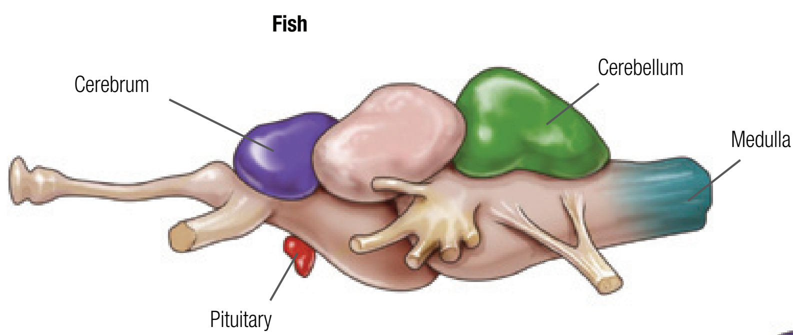
The cerebrum is divided into four lobes or sections. These lobes have specific functions:

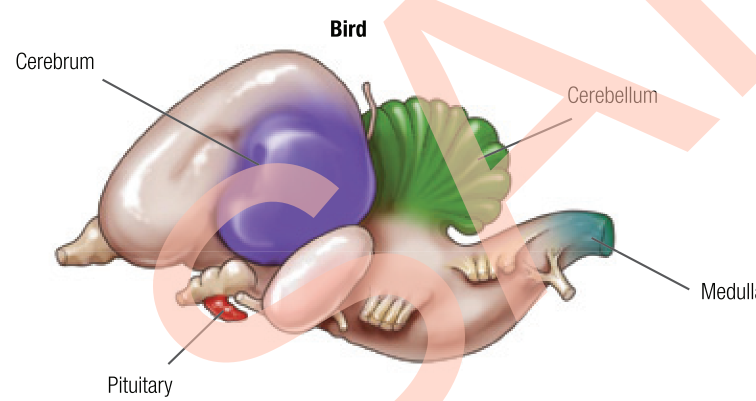
- The frontal lobe is located at the front of the brain. Its functions include emotions, reasoning, movement and problem solving.
- The parietal lobe manages the perception of senses, including taste, pain, pressure, temperature and touch.
- The temporal lobe is located in the region near your ears. It deals with the recognition of sounds and smells.
- The occipital lobe is at the very back of the brain. It is responsible for various aspects of vision.

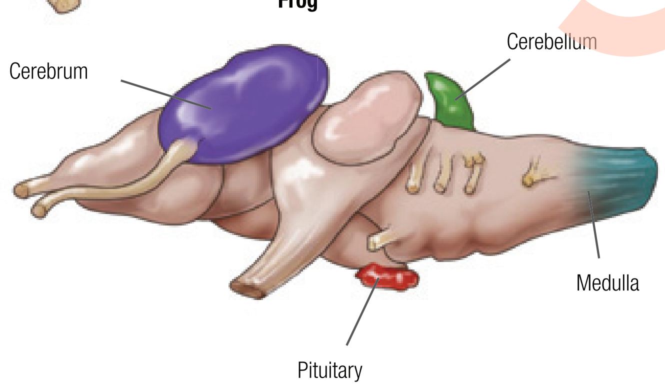
→ Fig 5.37 The lobes of the brain.



→ Fig 5.38 What might the structure of each of these animal brains mean for its owner?







EXPERIMENT 5.1

Sheep brain dissection

Aim

To explore the structure of a sheep's brain.

Materials

Lab coat, safety goggles and vinyl gloves

Sheep's brain	Dissecting board
Scalpel	Dissecting scissors
Coloured pins	Microscope, slide and cover slip (optional)

You will need to wear your lab coat, safety goggles and gloves. Be careful with the scalpel because it is likely to be very sharp.

Method

1. Examine the outside of the brain. Set the brain down so that the flatter side, with the white spinal cord at one end, rests on the board. Using the different coloured pins, identify the two hemispheres, the four lobes of the brain, the spinal cord, the cerebellum and the cerebrum. Check this with your teacher before continuing.
2. Turn the brain over. Identify the medulla and pons.

3. Place the brain with the curved top side of the cerebrum facing up. Use a scalpel to slice through the brain along the centre line, starting at the cerebrum and going down through the cerebellum, spinal cord, medulla and pons. Separate the two hemispheres of the brain. Record what you see.
4. Cut one of the hemispheres in half lengthwise. Record what you see.
5. If a microscope is available, slice a very thin section of the cerebrum and put it on a slide, covering it with a drop of water and a cover slip. Draw what you see at two magnifications. Follow the same procedure with a section of the cerebellum, and then compare and contrast the two.

Discussion

1. Was the sheep's brain similar to a human brain in structure? Why do you think this is so?
2. What does the brain feel like? Was it easy to dissect?

What do you know about a closer look at the brain?

1. Draw a scientific diagram of the brain that shows the four lobes. In each of the lobes:
   a. write what functions are carried out in that lobe
   b. draw something to remind you of the functions carried out in that lobe
2. Which parts of the brain make up the brain stem?
3. The hypothalamus maintains homeostasis in your body. Why is this job so important? What does it involve?
4. Highlight the differences between the cerebrum and the cerebellum.
5. Explain why, if you slipped and hit the back of your head, everything might go black.
6. Explain some of the potential effects of trauma to the frontal lobe.
7. Compare the structure of the human brain to that of fish, birds and frogs (Fig. 5.38). Identify the animal with the largest and smallest of each part and suggest an explanation for the size.

<<BIG IDEAS>> Structure and function

5.3 What is a nervous response?

Remember and understand

1 What makes up the body's nervous systems?
2 Write a definition of these words:
  a autonomic nervous system
  b reflex action
  c peripheral nervous system
  d myelin sheath
3 Draw a neuron and label the parts.
4 Explain the path a nerve impulse takes down a neuron.
5 Explain the potential effects of spinal damage.

Apply

6 Describe the difference between the sympathetic and parasympathetic nervous systems.
7 Complete the table.

Action	Autonomic or somatic nervous system?
Heart beating	
Sweating	
Waving	
Blinking when something is near your eye	
Running	

8 Draw a concept map or flow diagram that shows the divisions of the nervous system.
9 The diagram of a neuron in Figure 5.30 (page 150) has six labelled parts. Choose three of these parts and describe the effect on the overall nervous system if each one did not exist.

Analyse and evaluate

10 Imagine you are a doctor with a patient who is experiencing loss of control of her legs and lack of feeling in her hands. How would you link these symptoms to a problem with the nervous system?
11 Compare the central nervous system and the peripheral nervous system to current communications technology. You could use an example such as a mobile phone text message or an instant messenger program.
12 Design a survey that investigates the risk of potential spinal damage for your classmates. You might include types of sports played, their opinions about fast driving and cars, and general risk-taking behaviour.

Ethical behaviour

13 Use the results of your survey from question 12 and/or other relevant sources to inform a 60-second television commercial or highway billboard to discourage risk-taking behaviour on roads.

Critical and creative thinking

14 On poster paper draw a scientific illustration showing how the structure of a neuron is suited to its function.

<<CONNECTING IDEAS>> Structure and function

15 Prepare a report that compares the structure and function of the nervous and endocrine systems. Negotiate the format of your report with your teacher; formats could include multimedia presentation, formal report, video, vodcast, podcast and poster presentation.

5.4 How do we respond to threats?

Many factors can make us sick or put us at risk. We have just looked at how our bodies sense and respond to changes in environment using the nervous and endocrine systems. Now we will see how our bodies respond to two other types of threat: disease and radiation. Threats are not always obvious or even visible—pollutants in the air, bacteria on food, a virus from the person next to you, and even physical injury.

<<DISCOVERING IDEAS>>

Investigating pathogens

Pathogens, as you discovered at the beginning of this chapter, are organisms that cause disease. You may like to refer back to Table 5.1 (page 140) to assist you with this task.

You will need a selection of research resources (e.g. books, medical dictionaries, journals and computers) for step 4.

1 Working in small teams, take 3 minutes to brainstorm and prepare a list of as many different diseases as you can think of.
2 You now have 2 minutes to predict what sort of organism causes each of the diseases in your list. Next to each disease, write one of the following words as your prediction: *worm*, *fungus*, *protozoan*, *bacterium*, *virus*, *prion*.
3 Spend a minute discussing how your team can use your resources for the best results. You must use at least two different types of resource.
4 You now have 10 minutes to research the list of diseases to confirm which group of organisms causes the disease.

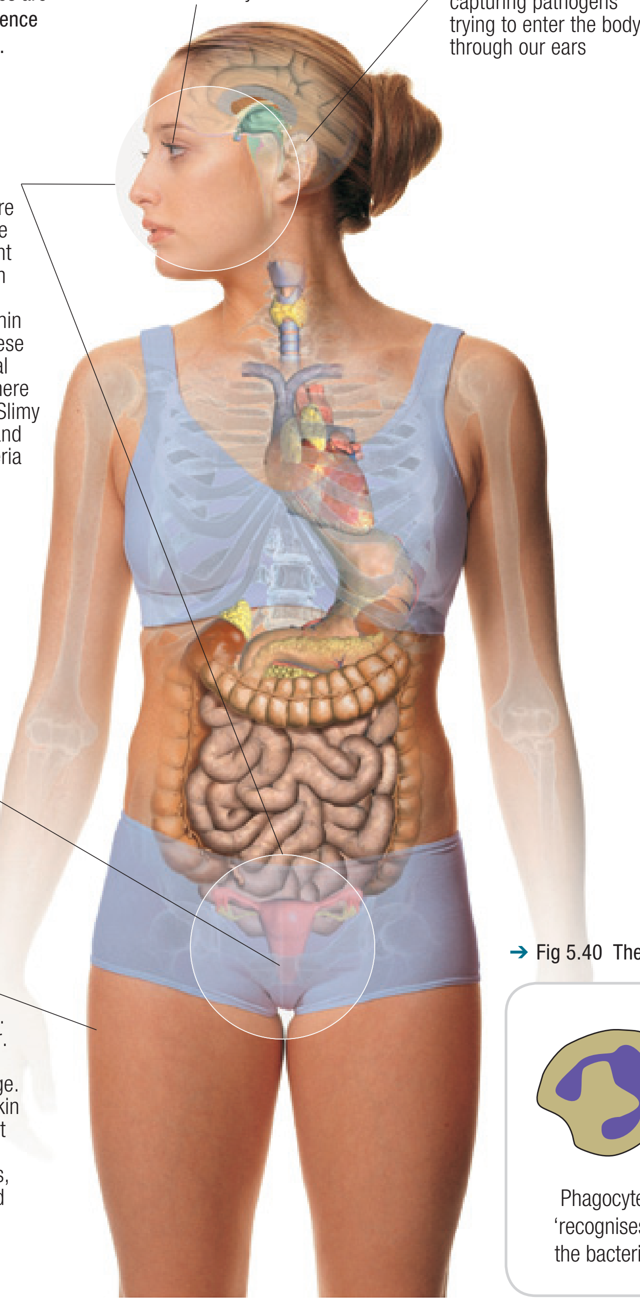
- How many diseases did you think of? How many of your predictions were correct?
- What resources did your team use? Which ones were fastest? Find out what resources were the most useful for the other teams.
- Draw a bar graph showing the number of diseases you listed for each type of organism.
- Was there an organism that dominated your list? If so, can you think of reasons why you might be more familiar with the causes of some types of disease?

The immune system

The role of your **immune system** is to protect you against foreign invaders by physically stopping them from entering your body, and identifying and attacking them if they manage to enter. Your immune system has three lines of defence against disease, each with a different role.

First line of defence

The first line of defence against pathogens is to stop the pathogens from getting inside our bodies (Fig. 5.39).



→ Fig 5.39 The skin and mucous membranes are the first line of defence against pathogens.

Second line of defence

Viruses, unlike bacteria, contain a protective coating that allows them to more easily slip through the first line of defence. If a pathogen gets inside the body, the body tries to remove it in one of two ways.

First, a general 'seek and destroy' approach is taken. This occurs regardless of the type or structure of the pathogen. This is called a general or non-specific immune response.

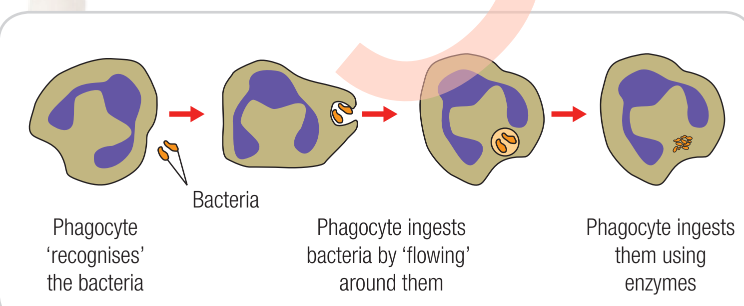
The key parts of the non-specific immune response are:

- blood clotting, to stop additional infection through skin damage
- inflammation, to increase the amount of blood reaching an infected area
- fever—some pathogens cannot survive in extreme heat conditions, so heating up the body is one way to destroy them.

Second, **white blood cells** are produced by the body to destroy pathogens. An increase in the amount of blood reaching an infected area of the body as a result of inflammation means that more white blood cells are available to attack the pathogen. The white blood cells may also release substances that increase the amount of fluid in the infected area, causing swelling.

There are a few different types of white blood cell. Each type does its own job but they all work together. Only some white blood cell types deal with the non-specific immune response. These are called **phagocytes**, and the word comes from Greek words meaning 'cells that eat'. A pathogen can be enveloped by a phagocyte, and when inside the phagocyte it is destroyed. This process is called phagocytosis.

→ Fig 5.40 The process of phagocytosis.



Third line of defence

Any pathogens that remain after a non-specific response are targeted according to their type. This is called a specific immune response.

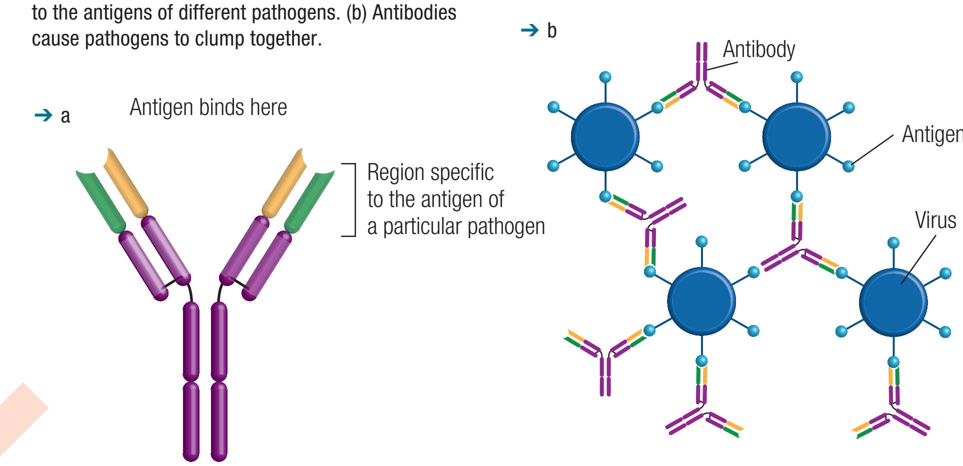
The specific immune response creates antibodies. **Antibodies** are protein molecules that bind specifically to a target called an **antigen**. Antigens may be the pathogen itself or even marker molecules on the surface of a pathogen.

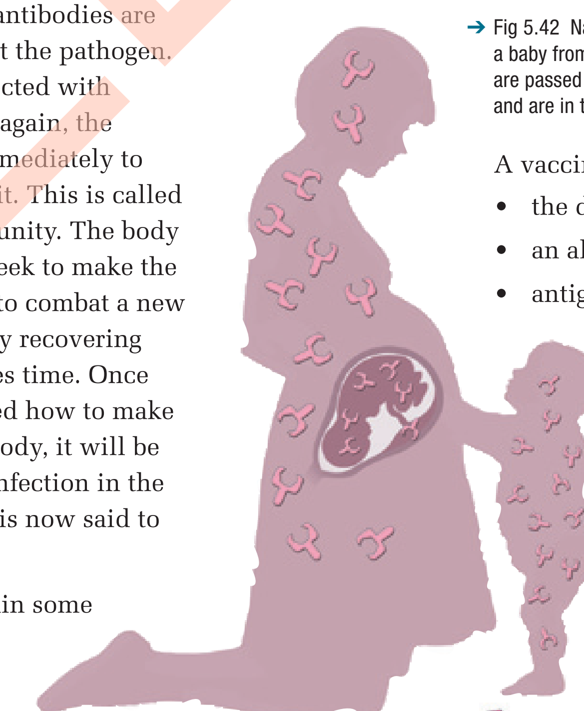
When a person is infected with a pathogen, specific antibodies are produced to combat the pathogen. If the person is infected with the same pathogen again, the antibodies react immediately to attack and destroy it. This is called natural active immunity. The body may take up to a week to make the antibodies needed to combat a new antigen. This is why recovering from an illness takes time. Once the body has learned how to make the particular antibody, it will be protected from re-infection in the future. The person is now said to be **immune**.

Unborn babies obtain some natural immunity by receiving antibodies across the placenta. Antibodies are also passed to babies who drink breast milk. This is called natural passive immunity.

One other way to acquire immunity is by ingestion or injection with specific antigens. This is called **vaccination**, or inoculation. Vaccination is an example of acquired active immunity.

→ Fig 5.41 (a) Antibodies have regions that are specific to the antigens of different pathogens. (b) Antibodies cause pathogens to clump together.



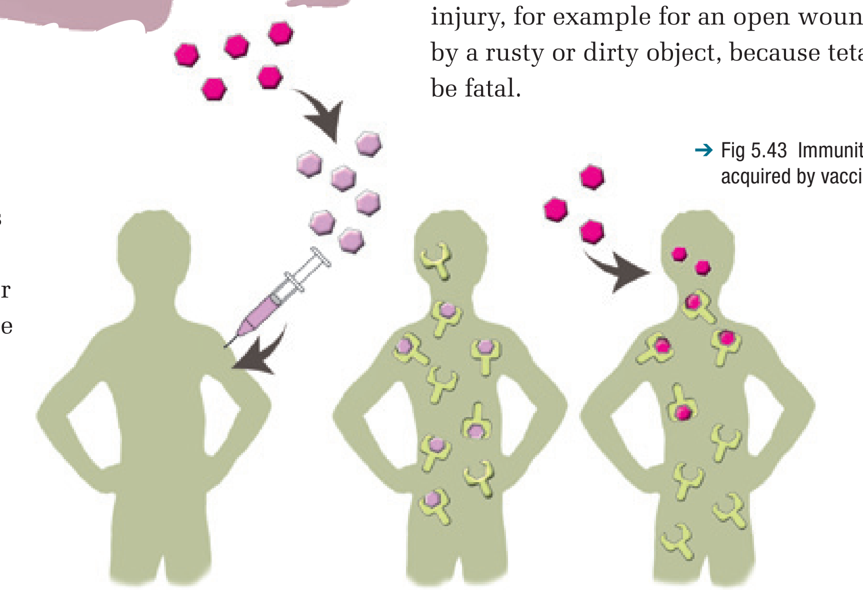


→ Fig 5.42 Natural passive immunity is obtained by a baby from its mother. The mother's antibodies are passed onto the child through the placenta and are in the mother's breast milk.

A vaccine can be given that is:

- the dead pathogen
- an alive but non-virulent (weakened) form of the pathogen
- antigens of the pathogen that have been separated from it.

Through vaccination, a person receives antibodies, which usually leads to immunity. Vaccinations are often given as a preventive measure. For instance, the influenza vaccine is recommended for people over 65 years of age because complications from influenza can be life-threatening in older people. Vaccination can also be given when there is an urgent need to provide immunity. Tetanus vaccine is often given for this reason after a tetanus-prone injury, for example for an open wound caused by a rusty or dirty object, because tetanus can be fatal.



→ Fig 5.43 Immunity can be acquired by vaccination.

<<OVERARCHING IDEAS>> Form and function

Antibiotics

Today, antibiotics are an ordinary solution to kill the bacteria that infect us. However, it was only about the time of the Second World War that the first antibiotic, penicillin, started being used by doctors to treat bacterial infections. Before then, treating infections, such as infected wounds, was difficult. Amputation was one way to deal with serious infections.

In 1928, Alexander Fleming discovered penicillin from a mould. The Australian scientist Howard Florey was then instrumental in developing penicillin into a form that could be mass produced. Both men were awarded the Nobel Prize in Physiology or Medicine for their work. By 1945, penicillin was being produced on an industrial scale and was used by the Allies to treat wounded soldiers in the Second World War. Eventually, penicillin became available to people outside the military.

Penicillin works by breaking down the cell walls of bacteria, but not human cell walls. This means that it will kill the bacteria in your body but not your own body cells. Antibiotics are medicines that are specific for treating bacteria. Other pathogens that infect people require different types of medicine.

Most viruses cannot be treated by any readily available medicines.

Medicines usually work in one of several ways:

- changing how cells work
- replacing substances that are missing from your body
- destroying micro-organisms and abnormal cells
- reducing the symptoms of illness.

Before a medicine can be sold in Australia, it needs to be approved for use by the Therapeutic Goods Administration. This agency decides which medicines are available to you and whether the medicines can be sold without prescription.

1 The story of how Alexander Fleming discovered penicillin is fascinating. Do some Internet research and write a short article about its discovery.

What do you know about the immune system?

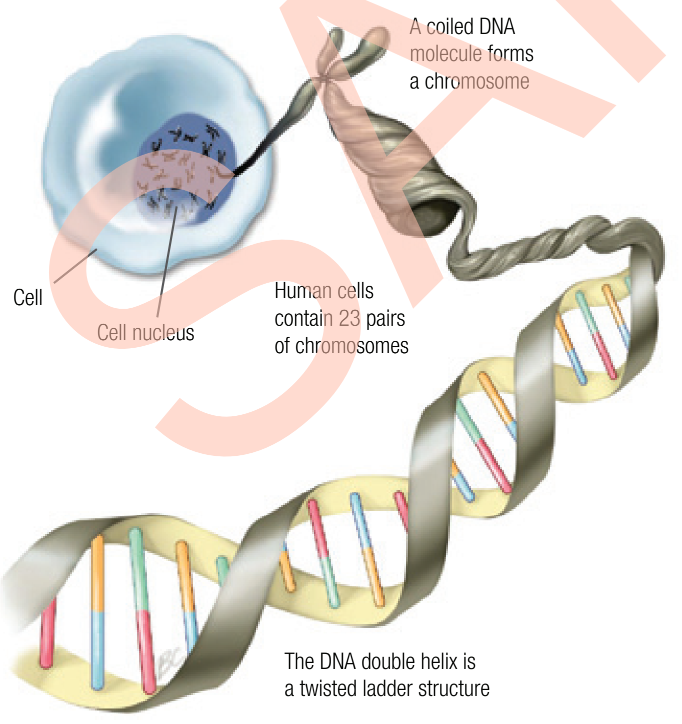
1 What is the body's major first line of defence?
2 In what other ways can the body prevent pathogens from entering?
3 Describe in your own words how the non-specific immune response works.
4 What are the different types of immunity?
5 What is the difference between a vaccination and a vaccine?
6 What might a vaccine contain?

Responding to radiation

Exposure to radiation can fall into one of two categories; it can either be intentional, such as medical treatment, or unintentional, such as everyday exposure or accidents. But what does it actually do to us?

Radiation is energy. Energy is required to make and break chemical bonds, which means radiation can interfere with the molecules in your body's cells.

➔ Fig 5.44 Chromosomes within the nucleus of cells are made of DNA.

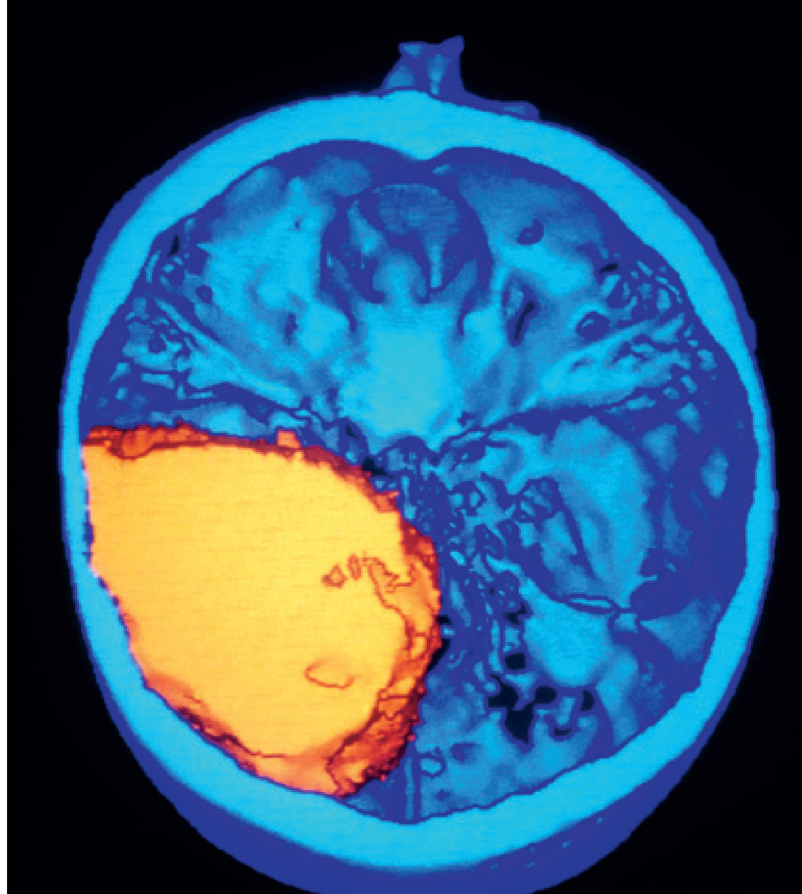


The nucleus of each of your cells contains the instructions for every task and substance required for healthy functioning. The instructions take the form of the molecule DNA. Any change to these instructions can result in damage, which may be major or minor depending on where the change occurs.

We often think of DNA as most important for reproduction. However, DNA is vital for the reproduction of all cells, not just the ones that make new organisms. Many of your other cells need to be regularly replaced and cells need to be reproduced for healing to occur.

Your body is quite incredible in its ability to protect itself from harm and repair or destroy faulty cells. However, sometimes parts of the body's cellular systems don't work as they should. **Tumours** are faulty cells that continue to multiply, replicating the fault with each cell division. These tumours can cause physical blockages in the body or interfere with certain chemical processes. Location, size and type determines whether a particular tumour is considered **malignant** (cancerous) or **benign** (not cancerous). Tumours that continue to grow and spread, forming new tumours, are considered to be cancers.

When radiation is used to treat tumours, high doses of radiation are focused solely on the cells making up the tumour. Not all tumours are caused by radiation; some may be caused by chemicals or genetic factors.



➔ Fig 5.45 A CT scan of a brain tumour.

PRACTIVITY 5.6

Interpreting scans

What you need: selection of X-ray, CT or MRI images, overhead projector or light box

1 Bring to class any X-ray, CT or MRI images you or your family might have (ask their permission first) showing a broken bone, or download some images from the Internet.
2 Show the images to the class and ask whether anyone can suggest what the problem was.
3 Explain what happened to warrant a scan.

- What body parts can be seen clearly in each image?
- What body parts are difficult or impossible to see?
- When might a CT or MRI scan be used instead of an X-ray?
- When might an MRI scan be used instead of a CT scan?

What do you know about responding to radiation?

1 How does radiation affect body cells?
2 Which part of a cell is most vulnerable to radiation exposure? Why?
3 Why does our body need to reproduce cells?
4 What is a tumour?
5 How can radiation be used to control tumours?

5.4 How does our body respond to threats?

Remember and understand

1 What are the major features of the body's first line of defence?

2 Give an example of an infectious disease.

3 What is an antibody?

4 What is radiation?

5 Why do you think it is important to have certain vaccinations before travelling overseas? Give two examples of diseases you may need to be vaccinated against.

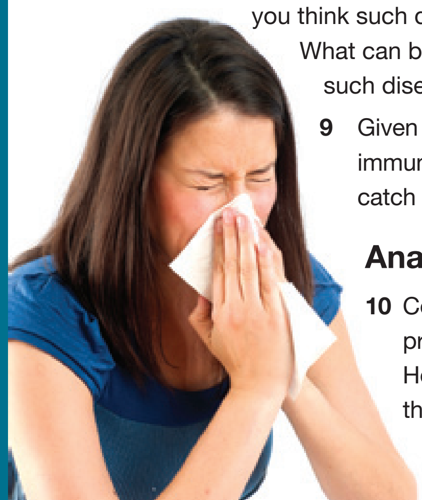
6 How does the specific immune system remember pathogens for the next time you are infected by them?

7 What beneficial things can radiation be used for?

Apply

8 Transmission of pathogens can cause mass outbreaks of disease that affect large numbers of people. Examples are HIV and AIDS, the SARS virus and swine flu, and the outbreak of cholera in Zimbabwe. Choosing one example, how do you think such diseases can spread so quickly? What can be done to prevent the spread of such diseases?

9 Given that people have natural active immunity, why is it that we continue to catch colds?



Analyse and evaluate

10 Compare viruses, bacteria and protozoa, which are all pathogens. How are they similar? How are they different?

11 Antibodies generally clump pathogens together in an antibody–antigen complex. How do you think this stops the pathogens from causing disease?

12 How can tumours interfere with the healthy functioning of the human body?

13 Louis Pasteur, Joseph Lister, Robert Koch, Edward Jenner, Alexander Fleming and Howard Florey were all scientists who played a role in our current understanding and treatment of infectious diseases. Investigate the work of one of these scientists.

Ethical behaviour

14 In 2011, a nuclear power plant in Fukushima was affected by a tsunami on the north-eastern coast of Japan. A similar tsunami event had not occurred since 869 CE. Do you think nuclear power plants should be located in areas where natural disasters are likely? Do you think an area that had not experienced a similar event in nearly 1300 years should be the site of a nuclear power plant?

15 Babies are able to be vaccinated against a wide range of diseases in the first months and years of their lives. They are not old enough to choose to be vaccinated so the decision lies with their parents or guardians. Find out which vaccinations are available and present the arguments for and against them.

Critical and creative thinking

16 Sometimes an immune system starts to attack the body's own cells. What is an autoimmune disease? What are some examples and how are they treated?

<<CONNECTING IDEAS>> Structure and function

17 Prepare a visual presentation on the role of the different types of white blood cell in attacking pathogens.

Research

Choose one of the following topics for a research project. A few guiding questions have been provided but you should add more questions that you wish to investigate. Present your report in a format of your own choosing.

Stem cells for spinal injury

Nerve cells do not regenerate, so, to date, damage to the spinal cord is permanent. Scientists have been researching the use of stem cells in the treatment of spinal cord injury. What are stem cells? What type of stem cells are used? What sorts of advances have been made in this field of research? What issues have affected such research?

Type 2 diabetes

Type 2 diabetes is increasing in our society. Why is this? What is the cause of it? What complications can result from diabetes? What can you do to prevent diabetes?

Artificial skin

Investigate the work of Australian scientists Dr Fiona Wood and Dr Marie Stoner on skin regeneration, including spray-on skin. Why is their area of research so important? How was it related to the treatment of the Bali bombing victims?

Reflect

Me

1 What have you learned that is helpful to you in better understanding how your body senses and responds to change?

2 What kinds of things are you more aware of now?

3 What else would you like to find out about how your body ensures your survival?

My world

4 What have you learned about the baby/childhood immunisation debate that has made you aware of controversies in science and medicine?

My future

5 What could be done to raise awareness of spinal damage?

6 What can you do to reduce the risk of getting diabetes as you get older?

Review

Key words

antibody
antigen
autonomic nervous system
axon
brain stem
central nervous system (CNS)
cerebellum
cerebrum
dendrite
dermis
disease
endocrine system
feedback mechanism
goitre
homeostasis
hormone
immune
insulin
interneuron
motor neuron
negative feedback mechanism
nervous system
neuron
neurotransmitter
pathogen
peripheral nervous system (PNS)
phagocyte
prion
radiation
reflex
sensory neuron
somatic nervous system
stimulus
synapse
tumour
vaccination
white blood cell

5

A life with no pain

We rely very heavily on our ability to sense our world. Taste and smell enhance our enjoyment of life. Loss of either sight or hearing has many implications for the life of the person affected. Sounds, flashing lights and textured sections on the footpath are some examples of ways to assist people with sight or hearing impairment. But what if you lost your sense of touch?

Congenital analgesia is a disorder in which sufferers are unable to feel pain. This might sound like a lovely way to live—you could take a few more risks, knowing that a little burn or grazed knee would not hurt, and immunisations would be a breeze! Women would experience no pain during childbirth and you could possibly stay awake during operations and see your own insides! But how would you know if you were sick or injured? How would the absence of any touch sensation affect your life?

1 Research congenital analgesia (sometimes known as congenital insensitivity to pain) to find out more. What causes it? What are the major symptoms? What are the minor symptoms? How common is it?

2 From your research, prepare a detailed creative writing piece that outlines a typical day for a person with congenital analgesia. You might choose to present your task as a video.