Each unit in this chapter opens with an engaging image, supported by text and questions. These can stimulate discussion, helping teachers to determine what students know and to give them an idea of the chapter theme. This encourages a self-directed inquiry approach to learning.

Curriculum guidance

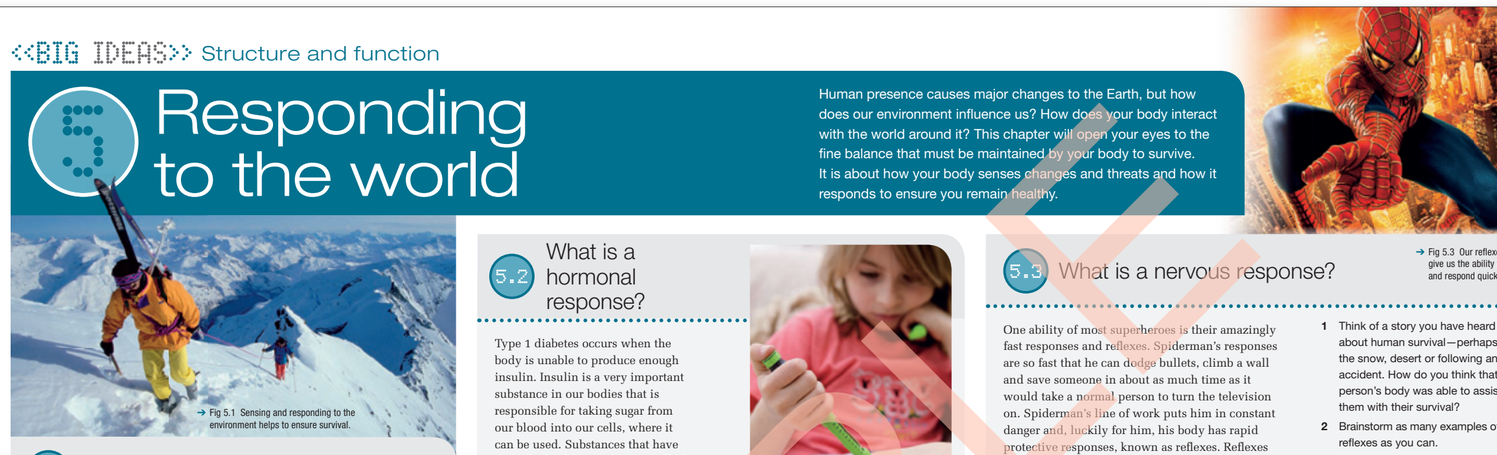
Big idea	Previous curriculum content	Year 9 curriculum content
Structure and function: the form and features of living things are related to the functions that their body systems perform	Multi-cellular organisms contain systems of organs that carry out specialised functions that enable them to survive and reproduce (Year 8)	Multi-cellular organisms rely on coordinated and independent internal systems to respond to changes to their environment

Big ideas

The 'big ideas' questions, used as a class discussion, will help to determine prior knowledge and to identify any misconceptions.

Common misconceptions include:

- The brain is separate from the nervous system.
- The brain is a uniform mass of tissue.
- The brain is stable and does not change.
- The brain is not responsible for hormones.
- We sense our world in only one way at a time.
- Hormones are produced by the target organs.
- Hormones act quickly.
- Hormones 'just travel around the body' (students don't necessarily understand that they travel via the bloodstream/blood).
- Organs such as the heart and lungs are part of the nervous system.
- Humans only use their brains, nervous system, endocrine system etc. when they are *doing* something, such as thinking or performing a physical action.
- The electrical impulses of the nervous system aren't actually electricity.
- All actions, including breathing, heart rate and reflexes, are voluntary actions.
- Only one strain of pathogens exists (for example, the 'flu is the same each year).
- Antibiotics can be used to treat any disease.
- The immune system is a simple system.



<<BIG IDEAS>> Structure and function

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?

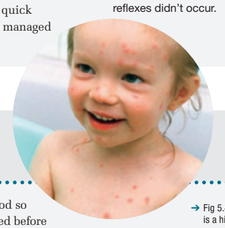
→ Fig 5.3 Our reflexes give us the ability to act and respond quickly.

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?

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.



→ Fig 5.4 Chickenpox is a highly contagious infection caused by the varicella-zoster 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?

Answers

5.1 How do we sense our world?

1 The body senses changes in its external environment via sight, sound, taste, smell and touch.
2 The body can sense and respond to many things including hormone levels, balance, pain, hunger, body temperature, stress, fatigue and illness.
3 The body regulates many things such as temperature, heartbeat, breathing rate, blood pressure, haemoglobin levels, blood pH, metabolism and iron levels.

5.2 What is a hormonal response?

1 Type 1 diabetes occurs when the body is unable to produce enough insulin, whereas type 2 diabetes occurs when the body doesn't respond to the insulin being produced.
2 Insulin is a hormone that is responsible for taking sugar from the blood into the cells, where it can be used.
3 It's important to get sugar into the cells so the body can use it as energy.
4 If you consume too much sugar, you are likely to feel sick as your blood sugar levels increase rapidly. This increases insulin levels to remove the sugar from your blood. High levels of sugar in the blood can be dangerous because this can induce fatigue and lead to diseases such as liver disease, kidney disease and type 2 diabetes.

5.3 What is a nervous response?

1 Student responses will vary; however, the human body's reflexes and responses would have helped them survive, regardless of the situation.
2 Student responses will vary. Examples of reflexes include kicking out when a doctor taps your knee with a small hammer, pulling your hand away when you touch a hot kettle, and blinking when something suddenly comes very close to your face.
3 If reflexes didn't occur, the body may be injured or face some other type of danger.

5.4 How do we respond to threats?

1 Student responses will vary. Any reasonable answers should be accepted.
2 Influenza changes or mutates each year, so the body's antibodies are not active against the new strain. Therefore, people can get the 'flu more than once.
3 Student responses will vary; however, the most likely answers are hepatitis B, diphtheria, tetanus and whooping cough, measles, mumps and rubella, meningococcal C, hepatitis A, human papillomavirus (HPV) and influenza.

Activity

Making a glossary

Ask the students to keep a glossary of key words as they work through the chapter. It is a great literacy strategy to help students through the topic.

SAMPLE

How do we sense our world?

The body responds to the external and internal environment to maintain homeostasis. For example, if the body is hot it will sweat to cool itself down.

Students should have a basic understanding of how we sense the world; however, in most instances, they haven't actually considered how/why this happens and how the body responds. This should be the focus for this chapter. A good way to start could be to brainstorm to elicit current understanding, and continue to get students to think about ways in which the body responds. This would be a good place to start introducing new words such as 'stimulus', 'receptors' and 'homeostasis'.

Activity

Think, pair, share: Ask students to write down 3–4 stimuli and the ways in which the body responds to these changes in the environment (internal/external), pair up and add to their list, then share with the class. By the end of this activity, students should have a good list of different ways in which we respond to our environment. This activity can be extended to discuss why the body acts/responds in the ways it does—to maintain homeostasis and ensure survival.

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.

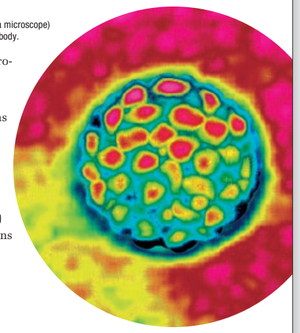
A stimulus is any information that your body receives that might cause it to respond. The easiest stimuli to identify are those that we respond to physically:

- 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.



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

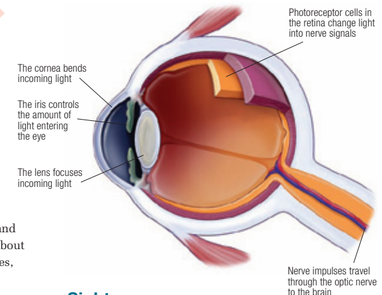
Your body is an amazing combination of cells, tissues, organs and systems, all working together to maintain **homeostasis**. These parts have a variety of ways of communicating, a whole range of systems and structures for receiving stimuli (called **receptors**) and an equally wide range of options to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

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.

Sight

Sight organs vary dramatically across the animal kingdom, depending on the need of the animal. There are ten different types of eyes currently known. Some are better for dark-dwelling creatures, whilst others can achieve greater sensitivity. Further, the position of the eyes can determine how an animal views the world. For example, rabbits and horses have monocular vision—each eye is used separately to enhance the field of view and enable the animal to see two objects at once, sometimes on either side of their body. In this instance, depth perception is limited. Animals with binocular vision, such as humans and wolves, use both eyes together. These animals have good depth perception, but a more limited field of view.

Answers

What do you know about identifying stimuli?

1. 'Stimulus' refers to any information that the body receives that might cause it to respond.
2. Examples of stimuli (answers will vary):
   - internal: hunger, thirst, fatigue
   - external: temperature, light, sound.
3. Homeostasis is the body's ability to regulate and maintain a stable internal condition, regardless of changes to the external environment.
4. If the body didn't maintain homeostasis, it wouldn't have the ability to sense and respond to changes. An unstable internal environment increases the risk of illness, increases the ageing process and leads to death.

obook

ID05.01 Weblink: A homeostasis online multimedia resource that contains examples, explanations and definitions
ID05.02 Weblink: Interactive senses task
Allows students to put their senses to the challenge
ID05.03 Weblink: Information, an animation and an interactive game on sight can be found at the BBC science website

SAMPLE

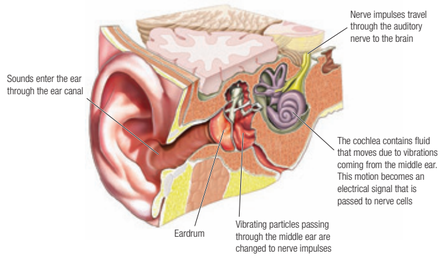
Hearing, taste, smell and touch

To extend students, ask them to compare their senses to that of other animals and suggest similarities and differences. For some students, suggest they choose animals that aren't necessarily mammals, or have different structures for the senses for example dolphin, lizard, worm, beetle.

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.

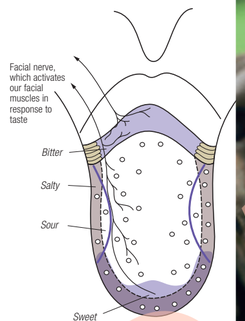
→ Fig 5.9 The human ear transfers vibrations to the middle ear. These become nerve impulses.



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.



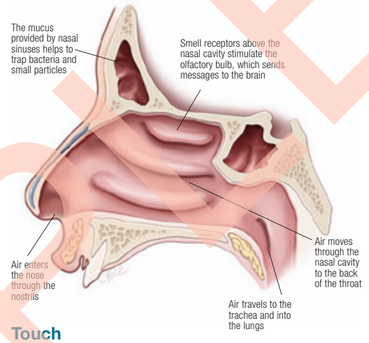
→ Fig 5.10 The large ears of some bats help them use sound waves to locate their prey.

→ 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.

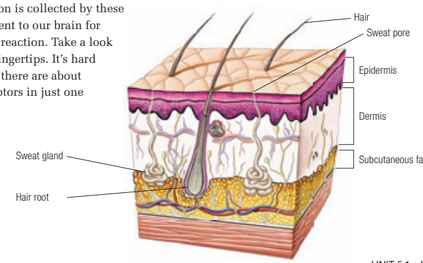
→ Fig 5.13 Smell receptors in human nostrils detect chemicals and send messages to the brain.

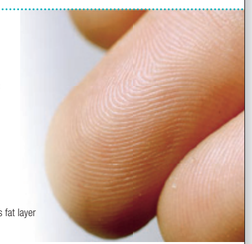


Touch

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

→ 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?

PRACTIVITY 5.1

Navigating without vision

At the beginning of this activity, the path on which students walk their partner should be fairly easy and straightforward. As they get used to having no vision, a basic obstacle course could be set up, where students need to identify an object/scent at various points. Additionally, instead of leading their partner, students could verbally direct their partner around the course/path.

Some students may become frustrated with this activity if they are blindfolded for an extended period of time as they are used to having sight as their primary sense. Other students may panic or refuse to take part in this activity. These students could be responsible for leading other students, or helping the teacher set up, and ensuring no one is in danger when blindfolded.

As an extension, students could investigate how animals, such as bats, use echolocation to determine and respond to their surroundings.

- The sense of touch will be used to determine whether there are objects in the way and to determine location within the classroom.
- Hearing is used to follow directions, avoid other people and determine location within the classroom.
- Smell isn't necessarily used; however, it may be used to identify objects.
- Answers will vary; however, touch and sound are usually the two best senses to navigate an area.

As an extension, students may like to investigate how people with vision impairment navigate a world that is predominantly based on visual cues. This may include inviting a relevant speaker to the classroom or conducting research.

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ID05.04 Video link: Science of fussy eaters
ID05.05 Weblink: Information, an animation and an interactive game on hearing can be found at the BBC science website
ID05.06 Weblink: Information, an animation and an interactive game on taste can be found at the BBC science website
ID05.07 Weblink: Information, an animation and an interactive game on smell can be found at the BBC science website
ID05.08 Weblink: Information, an animation and an interactive game on touch can be found at the BBC science website
ID05.09 Weblink: A senses challenge can be found at the BBC science website

SAMPLE

DESIGN YOUR OWN …

The senses

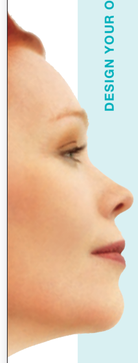
Discuss the process of designing an experiment, including creating, testing and modifying. Students should be given a significant amount of time to complete this task; however, it can be broken up so students know what's expected in a certain period of time. For example, one class could be designated to questioning and predicting and the next to planning and conducting. To ensure students are on task, they could be required to get permission from the teacher to continue to the next stage. Their results could be presented in a number of ways including a traditional prac write-up, a presentation to the class or a movie showing the entire process. This could be used as an assessment item.

Answers

What do you know about the sense organs?

1 The five sense organs are the tongue, skin, eyes, ears and nose.
2 Answers will vary; however, suggestions include:
- tongue: eating or drinking, including different types of tastes
- skin: heat, cold, pressure, pain
- eyes: changes in light intensity, determining/identifying objects or situations
- ears: identifying noises, determining location
- nose: identifying a smell, eating (smell is closely linked to taste).

3 It is possible to live without one or more of the sense organs because the other senses are magnified to compensate for the loss.



DESIGN YOUR OWN …

The senses

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.

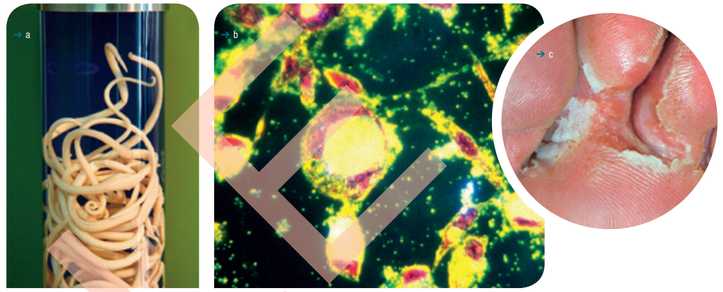
Pathogens

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.

Activities

- Students could investigate the Fukushima Nuclear Power Plant disaster, as well as other nuclear disasters that have occurred around the world. (Three Mile Island and Chernobyl, for example.)
- Australia has been considering using nuclear power. Based on information students have gathered, they could debate whether nuclear power is a viable option for Australia.

Answers

What do you know about what causes disease?

1 A disease is an unhealthy impairment of the body that stops it from functioning as it should.
2 Infectious diseases are caused by pathogens that can be easily passed from one person to another.
3 Virus: not a cell, contains genetic information surrounded by a protein coat; not considered living. Bacterium: unicellular organism; cell wall but no nucleus; usually considered to be living.
4 A pathologist studies diseases and diagnosis of diseases.

Radiation and disease

Radiation can be used to diagnose/treat certain medical conditions. It is extremely helpful in determining what course of treatment needs to follow an injury or illness. Radiation can, however, cause radiation sickness, cancer and burns.

A disease is any change that impairs the function of an individual in some way, including causing harm.

One way of engaging students in this topic is to discuss the Fukushima Nuclear Power Plant disaster in 2011 after an earthquake and tsunami in Japan. The tsunami broke the reactor's connection to the power grid, causing the reactors to begin to overheat, whilst the earthquake and flooding damaged the external structures. As a result of these events, several hydrogen explosions occurred and the accident was eventually listed as a level 7 event, which is the highest level. It is estimated that radioactive material was found as far as 50 km from the power plant.

obook

ID05.10 Video link: Pathogens
Video looking at the pathogen that causes hantavirus, how it is spread and how it affects humans

SAMPLE

Radiation and disease

Students may like to share their experiences with X-rays or CT scans, including showing X-rays.

PRACTIVITY 5.2

Background radiation

The *Safety Guide for Use of Radiation in Schools* (ionising radiation) can be found at http://www.arpansa.gov.au/publications/codes/rps18.cfm

Answers will vary; however, the most likely place to have the highest radiation in a secondary school is the science prep room where chemicals are kept.

Answers

What do you know about radiation and disease?

1 Types of radiation include X-rays, radioisotopes, microwaves, infrared radiation, visible light and radio waves.
2 Some types of radiation are more likely to cause harm to living things because they travel at the speed of light and can cause charged particles to move really fast. The higher the energy, the more damage that type of radiation can cause.
3 Radiation is used in medicine for X-rays, CT scans, radiotherapy, etc.
4 Answers will vary. Information about mobile phones and radiation can be found at the ARPANSA (Australian Radiation Protection and Nuclear Safety Agency) website.
This could be discussed as a class to cover issues such as ethics of mobile phone companies in producing harmful products, whether a governing body is needed, what an acceptable level of radiation may be, what level of responsibility is there and who should take it if mobile phones are found to cause cancers.

BIG IDEAS

5.1 How do we sense our world?

Remember and understand

1 a stimulus: any information that the body receives that might cause it to respond
b homeostasis: the body's ability to regulate and maintain a stable internal condition, regardless of changes to the external environment
c pathogen: an organism capable of causing disease or sickness

→ 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?

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?

SAMPLE

2 The human body can receive a stimulus from the environment via taste, touch, smell, sight and sound.
3 a run, put shoes on
b hands up to block/protect head, close eyes, blink
c get taste out of mouth, dispose of cereal in bowl
d drink water, sleep, take medication

Apply

4 Reponses to an extreme change in temperature:
- sweating to cool down the body and shivering to warm up the body
- changing clothes worn
- moving to a cooler/warmer place
- convulsions, nausea, vomiting if the core temperature exceeds normal.

Responses to a subtle change in temperature:
- body hairs stand up to form a heat-trapping layer, or lay flat to allow excess heat to 'escape'
- vasodilation: blood vessels get larger, allowing more blood to be close to the skin. The closer blood is to the outside, the more heat can escape; this may make people look pink
- sweating/shivering to maintain core temperature.

Analyse and evaluate

5 Eyes and ears are in pairs to increase the sensory information being received. Humans rely on these two sets of sensory organs the most, and therefore need to be able to take in lots of information from them. They give humans the ability to gain a better understanding of the environment, assess the situation and decide whether or not the fight or flight option is needed.
- Two eyes gives a wide field of view over 200 degrees, they give a binocular image by which to compare and to detect faint objects and give a stereo parallax with two eyes in a slightly different position and angle on the head to simulate depth perception.
- Having two ears enables humans to tell where a sound is coming from in a three-dimensional space, and to perceive the distance from which the sound is coming.

6 Holding your nose can help you swallow something that tastes awful because taste is closely linked to being able to smell.
7 Predators generally have their eyes at the front of their head, which gives them stereo vision and allows them to better gauge the distance from their prey. Prey animals usually have their eyes on the sides of their head because they are more interested in spotting an animal creeping up on them and therefore need a wider angle in which they can see.

Ethical behaviour

8 A doctor may advise resting an injured joint for a couple of days before an X-ray to allow any initial swelling to go down and assess whether exposure to radiation is necessary. For example, some joint injuries may be as a result of ligament damage, which doesn't show up on X-rays.

Critical and creative thinking

9 Student responses will vary.
10 To assist the body in controlling pathogens, you should eat a healthy diet and maintain a healthy lifestyle. A doctor can prescribe medication to assist the body in fighting off some pathogens, or by providing a vaccination.

<<CONNECTING IDEAS>>

11 The sense organs are located mainly on the human head. The skin, as an organ for touch, is located all over the body. The location of sensory organs is important to ensure the body receives as much information about the external environment as possible. The size and structure of each sensory organ is relative to the role it plays and the amount of information or type of information it needs to receive and send to the brain. The location of the organs suits their function. Eyes, for example, are needed to guide an organism, and therefore need to be at the head, or front, of the animal, and ears are helpful when on the side of the head to determine where a sound is coming from.

obook
ID05.11 Weblink: Safety guide to radiation

<<DISCOVERING IDEAS>>

Responding

Students should be able to list and explain the digestive, circulatory, respiratory, excretory and reproductive systems.

Students' mind maps will vary, and many answers are possible. Any feasible answers should be accepted. Students should aim for between three and five links per requirement for life (oxygen, nutrients, water and removal of wastes).

- The circulatory system and the respiratory system work closely together to ensure that organ tissues receive enough oxygen. They supply the body with oxygen and remove metabolic waste products. The oxygen obtained through respiration is transported around the body by the circulatory system to provide the rest of the body with oxygen and nutrients. It also carries deoxygenated blood back to the lungs and heart to be 'refreshed'.
- If the systems didn't work together, the body wouldn't be able to function normally and would be starved of oxygen.
- Student responses will vary; however, some clues that these systems work together are that oxygen is found in different parts of the body, oxygenated blood leaves the lungs and deoxygenated blood returns to the lungs, heart pumps the blood around the body and a functioning animal must have oxygen supplied to the brain.

Function	Body systems working together
Oxygen transported in the blood	Circulatory, respiratory
Nutrients from food absorbed and transferred into the bloodstream	Circulatory, respiratory, digestive
Unwanted nutrients transported out of the body	Circulatory, respiratory, digestive, excretory

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.

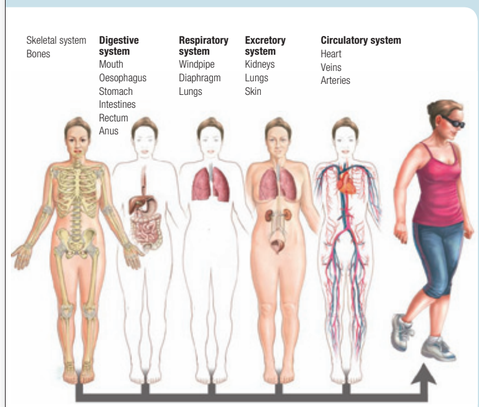
<<DISCOVERING IDEAS>>

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?

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!



→ Fig 5.22 Our body systems work together.

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)	

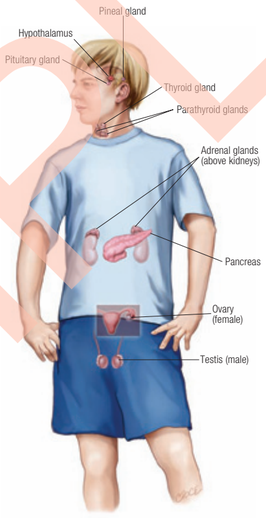
The endocrine system

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

The endocrine system

Internal changes are detected by sensory neurons in blood vessels, muscles and internal organs and trigger the endocrine system to become active. Endocrine glands are usually ductless, so the hormone is secreted directly into the bloodstream. Some organs have other functions as well as an endocrine function. The pancreas, for example, produces digestive enzymes that are secreted via a duct into the small intestine, and contains cells that produce insulin.

Students should understand the main differences between the endocrine and nervous systems by the end of the topic.

Characteristic	Nervous	Endocrine
Method of transmission	Electrical/ chemical through neurons	Chemicals through the bloodstream
Speed of travel	Fast	Slow
Speed of response	Immediate	Usually slow
Duration of response	Short	Long lasting
Area of response	Direct to one place	Usually indirect and widespread

obook

ID05.12 Interactive activity: Endocrine system

ID05.13 Weblink: An outline of the endocrine system, including hormones and how they work, with diagrams, can be found at the BBC science website

ID05.14 Weblink: A hormone activity with animations can be found on the BBC science website. This activity also looks at menstruation and the hormones involved in this process

ID05.15 Video link: The endocrine system – pituitary gland

Video looking at problems with the pituitary gland which causes too much growth hormone to be released by the body which leads to gigantism

SAMPLE

ZOOMING IN

Fight or flight?

To extend students, a discussion about the bystander effect could be undertaken. The case of Kitty Genovese and the investigation of this murder prompted the research into what is now known as the bystander effect. This is the phenomenon where the more people are present in a situation, the less likely they are to help a person in distress. Conversely, observers are more likely to take action if there are few or no other witnesses.

Kitty Genovese was a New York woman who was stabbed to death near her home in 1964. It is reported that a number of people (12 estimated) either saw or heard the attack, but didn't respond. A few of the interviewed witnesses thought it was a lovers' quarrel and didn't want to intervene. One witness phoned the police minutes after the final attack. It is thought that if any of the witnesses had called police at the first sign of trouble, the victim would have survived. This lack of response/reaction by observers prompted research into what is now known as the 'bystander effect'.

The bystander effect suggests that as the number of bystanders increases, the chance of any one witness or bystander helping another decreases proportionately, and more time will pass before anyone seeks outside help for a person in distress. Furthermore, people often have a desire not to get involved, and so if others are around, they feel less inclined to have to act. Psychologists have suggested that bystanders monitor the reactions of others in a situation to see if they think it's necessary to intervene. Since everyone is doing the same (nothing), they conclude from the inaction of others that help is not needed. The bystander effect is coupled with the 'diffusion of responsibility', which occurs when onlookers assume that someone else will intervene and so each individual feels less responsible to do something.

PRACTIVITY 5.3

Glands and organs of the endocrine system

Students should use Table 5.2 on page 145 of the textbook to help them complete this task.

They will need to conduct further research to complete the last dot point. This could be presented in a number of different ways, such as a presentation, poster or pamphlet.

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

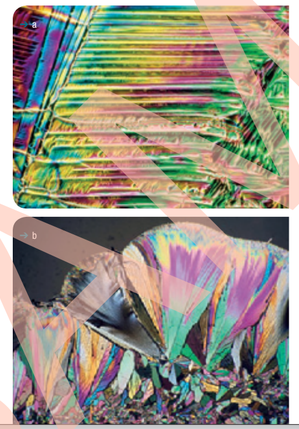
1. Working in pairs, draw an outline of your partner's body onto the paper.
2. With your partner, draw in the different glands and organs of the endocrine system. Using the information in Table 5.2, annotate each gland with a brief description, in your own words, of what it is responsible for.
3. Use 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?

Hormones at work

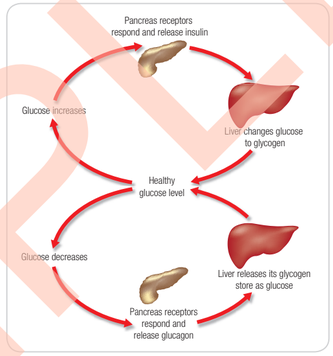
Hormonal effects are often controlled by **feedback mechanisms**. This means that when a hormone—a messenger—is sent out into the body, information is received back about what is going on. This then affects other responses by the body. The rate of hormone production and secretion is often regulated by 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.



→ 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.

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?

Answers

What do you know about the endocrine system?

1. endocrine system
2. 'Fight or flight' refers to the biological response of animals to stressful situations. Adrenaline is released to strengthen heartbeat, raise blood pressure and speed up the conversion of glycogen into glucose to provide extra energy to defend (fight) or run away (flight).
3. Peptide hormones are made from proteins and produced by the anterior pituitary, parathyroid gland, placenta, thyroid gland and pancreas. They travel through the bloodstream to their target cells. Steroid hormones are secreted by the adrenal glands and ovaries or testes, and produced from cholesterol.
4. The endocrine system is referred to as a communications system because it is involved in sensing and responding to the environment. It uses hormones to maintain homeostasis and regulate growth. The hormones travel through the bloodstream and arrive at a target cell, where they perform their task.
5. A hormonal response is much slower but the effects last a much longer time.

Hormones at work

Hormones are produced by endocrine glands and work by regulating cell activities, including increasing or decreasing the activity of the target organ. Hormones find their target organ through a 'lock and key' mechanism, which is also known as an 'induced fit' model. This model explains how each hormone only reacts with or binds to a specific substrate due to their complementary shapes.

Answers

What do you know about hormones at work?

1. A feedback mechanism is a process or signal that is looped back to control a system within itself. For example, when a hormone is released, information is received back about what is happening in the body. This then affects other responses in the body.
2. A positive feedback system would increase the effect of a hormone.
3. low blood sugar levels

A negative feedback mechanism is a control system in which change in a variable is detected and action occurs to produce a change in the opposite direction. It helps maintain stability in spite of external changes. One example would be touching a hot object and moving your hand away to remove the stimulus.

obook

ID05.16 Video link: Fight or flight response
Video briefly describing the role of hormones in the fight/flight response
ID05.17 Weblink: Diabetes interactive tutorial
Describes the hormonal imbalance that causes diabetes
ID05.18 Website: Diabetes Australia
ID05.19 Website: Thyroid Australia

SAMPLE

BIG IDEAS

5.2 What is a hormonal response?

Remember and understand

1 A stimulus is an external factor that influences an activity, or a detectable change in the internal or external environment that influences a response.
2 Glands that produce hormones in humans include the pituitary gland, ovary, testes, thyroid gland, pineal gland, hypothalamus, parathyroid gland, adrenal gland and pancreas.
3 Diseases caused by hormonal problems include diabetes, goitre and obesity.
4 The nervous and endocrine systems are considered to be communication systems because they are involved in sensing and responding to the environment via messages that are sent around the body to coordinate a response.
5 Hormones are secreted by a gland and transported via the bloodstream around the body to a target organ.

Apply

7 A person with diabetes has a problem with the hormone *insulin*, which is secreted by the *pancreas*.
8 A feedback mechanism is process or signal that is looped back to control a system within itself. For example, when a hormone is released, information is received back about what is happening in the body. This then affects other responses in the body. The rate of hormone production and secretion is usually regulated by a negative feedback system, meaning if the stimulus indicates there is too much insulin then the response would be to produce less to reduce the effects.

Analyse and evaluate

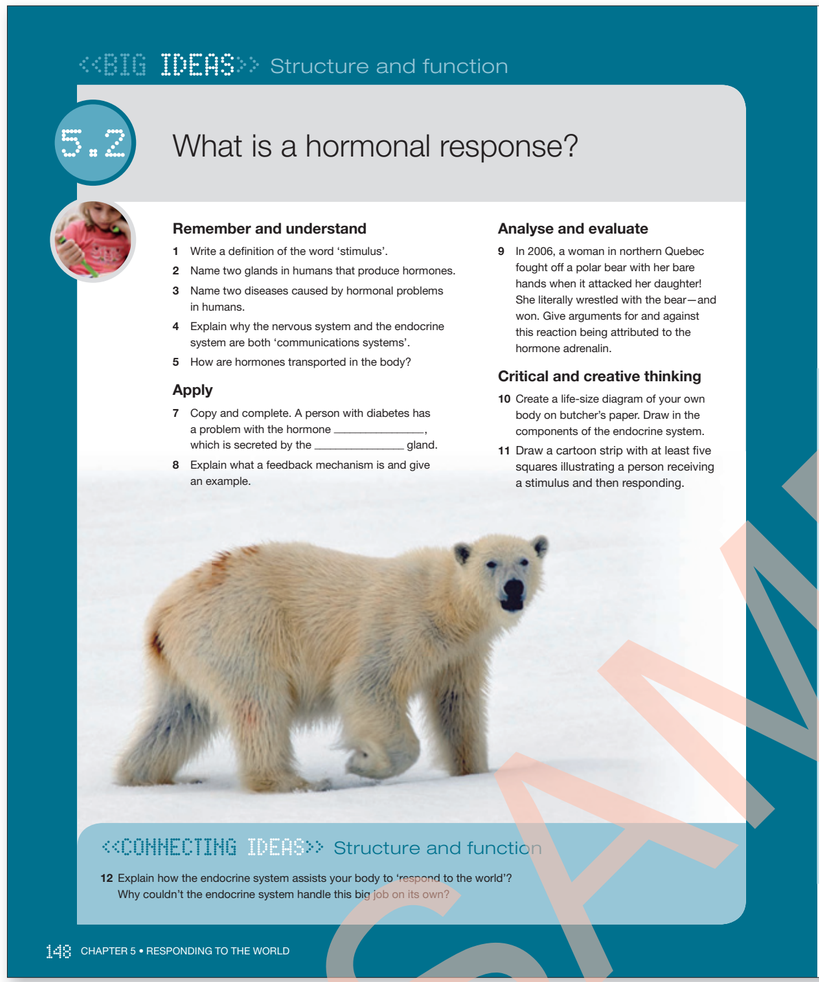
9 The woman was able to fight off the polar bear due to the release of the hormone adrenaline. When adrenaline is released, the heartbeat strengthens, blood pressure rises and the conversion of glycogen into glucose speeds up to provide extra energy to defend (fight) or run away (flight). The woman's reaction may also be attributed to a maternal instinct to protect her daughter.

Creative and critical thinking

10 Student responses will vary. Students should include the pituitary gland, ovary, testes, thyroid gland, pineal gland, hypothalamus, parathyroid gland, adrenal gland and pancreas.
11 Student answers will vary.

<<CONNECTING IDEAS>>

12 The endocrine system is involved in sensing and responding to the environment by using hormones to maintain homeostasis and regulate growth. The hormones travel through the bloodstream and arrive at a target cell where they perform their task. The endocrine system couldn't handle this job on its own because the response time is quite slow, unlike the nervous system, which responds extremely quickly.



DISCOVERING IDEAS

How fast is the nervous system?

- The fastest results will be when the students are not blindfolded. This is because they are able to use multiple senses to determine when to catch the ruler.
- To ensure the results are as accurate as possible, the ruler should be dropped from the same height, by the same person, in the same conditions and the same number of times for each person.
- This is a fair test because the students repeat the process multiple times and only change one variable at a time.

SAMPLE

Nerves and the nervous system

As students read through this information, they could be encouraged to add the bolded words to a glossary, and to use Figure 5.31 to help understand the structure and function of a nerve cell.

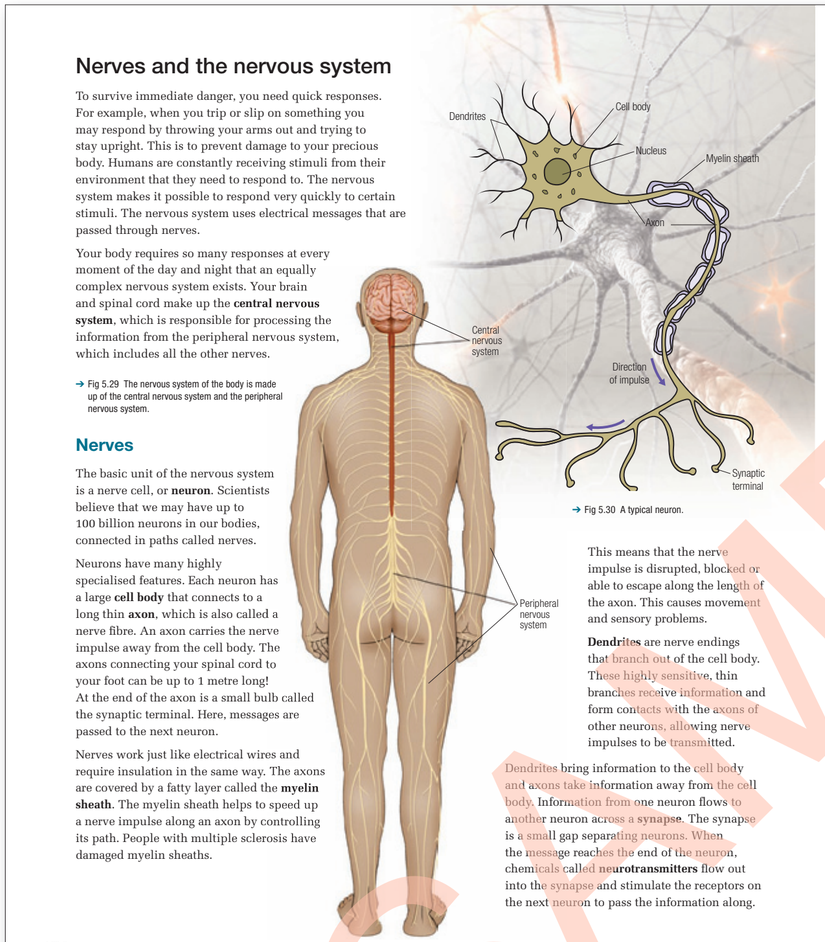
The nervous system can be a difficult concept for students to understand, as it's quite abstract. The nervous system can be split into two components—the central nervous system (CNS), which consists of the spinal cord and the brain, and the peripheral nervous system (PNS), which consists of all other nerves that lie outside the central nervous system (sensory nervous system and motor nervous system). The sensory nervous system has somatic and visceral neurons that bring information from the CNS to the sensory receptors. The motor nervous system contains motor neurons that convey signals from the CNS to effector cells, and can be further separated into autonomic and somatic systems.

A nerve that is not responding to stimuli is considered to be at 'rest', whilst nerves that are activated are said to be 'excited'. A nerve impulse travels from dendrites on the pre-synaptic nerve (first nerve) through the cell body, down the axon and out through the synaptic terminal to the post-synaptic neuron (next nerve). Nerve impulses involve changes in the electrical charge (positive/negative) across the axon membranes. The speed of a nerve impulse along a myelin-covered axon is about 200 metres per second, compared with a speed of about 0.5 metres per second along an axon without myelin.

Students don't necessarily need to know this level of detail; however, they should be aware that it is a complex system that performs very complex functions.

Activity

Construct a labelled diagram to assist students in understanding the pathway of a nerve impulse.



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.

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.

→ Fig 5.30 A typical neuron.

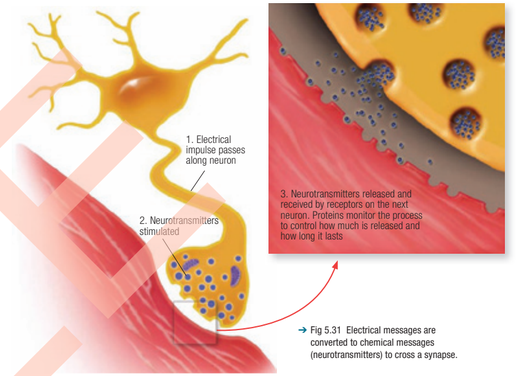
This means that the nerve impulse is disrupted, blocked or able to escape along the length of the axon. This causes movement and sensory problems.

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 neu**rotransmitters** 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.
- **Inter**neurons 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.

PRACTIVITY 5.4

Pipecleaner neurons

To extend students, ask them to find out about the three different types of neuron (sensory, motor and interneuron) and create an example of each. They could then discuss the similarities and differences between the three types.

Answers

What do you know about nerves and the nervous system?

1. Student ideas will vary. The main differences are in the information they receive and distribute, and how they connect.
2. The features of a neuron that enable it to carry messages include:
   - cell body: connects to the axon
   - axon: nerve fibre that carries nerve impulses away from the cell body
   - myelin sheath: covers the axon to help speed up a nerve impulse by controlling its path
   - synaptic terminal: end of an axon where the messages are passed to the next neuron
   - dendrites: nerve endings that branch out of the cell body to receive information and form contacts with the axons of other neurons, allowing impulses to be transmitted
   - synapse: small gap that separates neurons
   - neurotransmitters: chemicals that flow out into the synapse and stimulate the receptors on the next neuron to pass the information on.
3. smells: nose; tastes: tongue; sounds: ears; touch: skin; sights: eyes
4. The myelin sheath covers the axon to help speed up a nerve impulse by controlling its path.
5. Diagrams will vary. If damage to the myelin sheath occurs, the nerve impulse is disrupted, blocked or able to escape along the length of the axon. This causes movement and sensory problems.
6. Student responses will vary. Students should be able to correctly describe how a message is transferred through the body and also through a neuron.

obook

ID05.20 Interactive activity: The neuron.
ID05.21 Weblink: An interactive nervous system diagram can be found at the BBC science website

SAMPLE

The central nervous system

Students should understand that reflexes exist to help protect the body from potentially dangerous situations, and they occur without us even knowing about them until after they have happened.

PRACTIVITY 5.5

Testing reflexes

Pupils allow light to enter the retina and appear black because other tissues in the eye absorb most of the light entering the pupil. The iris regulates the amount of light by controlling the size of the pupil.

When bright light is shone on the eye, light-sensitive cells in the retina send messages to the parasympathetic division of the eye and the muscles contract, causing the pupils to contract. Conversely, when there is less light, messages are sent to the sympathetic division of the eye and the muscles relax, causing the pupils to dilate. Pupils will also dilate if a person sees an object of interest.

- The pupil will get wider in the dark to allow more light to enter the retina.
- When the lights are turned back on in the classroom, the pupils will constrict to control the amount of light entering the retina, ensuring damage doesn't occur to the eye.
- Other reflexes that could be tested include skin sensitivity, knee jerk reaction, blinking when an object comes close to the face and sneezing.

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

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.

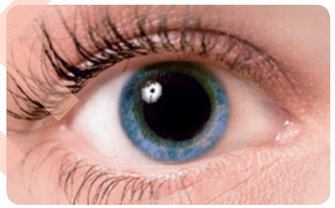
When the spine is damaged, messages from below the level of injury to the brain or above the level of injury from the brain are blocked. How much of the body is able to move after a spinal injury depends on where the injury is in the spine. If it is high up, most of the body is 'cut off' from the brain; 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.

ZOOMING IN

→ 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.

ZOOMING IN

Spinal damage

Students should understand that these types of injury are permanent and irreversible.

Answers

What do you know about the central nervous system?

1. The two parts that make up the central nervous system are the brain and spinal cord.
2. The skull protects the brain, whilst the spine protects the spinal cord.
3. The individual bones that make up the spine are called vertebrae.
4. Quadriplegia occurs when the upper part of the spinal cord is damaged, and people with this damage cannot use their arms or legs. Paraplegia occurs when there is damage to the lower spinal cord. These people are able to use their arms, but not their legs.
5. The parts of the central nervous system involved in a reflex reaction are the spinal cord, sensory neurons, motor neurons and eventually the brain. 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 to the brain.

obook

ID05.22 Weblink: The nervous system interactive task
Looks at the nervous systems including their components and functions
ID05.23 Weblink: An online activity on reflexes can be found at the BBC science website
ID05.24 Weblink: Further information about spinal cord damage is available from the Spinal Injuries Association

SAMPLE

DESIGN YOUR OWN …

Skin sensitivity

Discuss the process of designing an experiment including creating, testing and modifying. Students should be given a significant amount of time to complete this task; however, it can be broken up so students know what's expected in a certain period of time. For example, one class could be designated to questioning and predicting and the next to planning and conducting. To ensure students are on task, they could be required to get permission from the teacher to continue to the next stage. Their results could be presented in a number of ways, including a traditional prac write-up, a presentation to the class or a movie showing the entire process.

This could be used as an assessment item.

1 Some areas of the body are more sensitive than others because they have more nerve endings to protect against different dangers.
2 Students' own responses.
3 Students' own responses.
4 Students' own responses.
5 Students' own responses.
6 Students could test whether heavy input into another sense interferes with the sense of touch by using the other sense whilst performing the same skin sensitivity tests as they have during their experiment.
7 The experiment would have different outcomes if done with a group of people who were blind as their other senses are magnified to compensate for the loss of their sight.

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

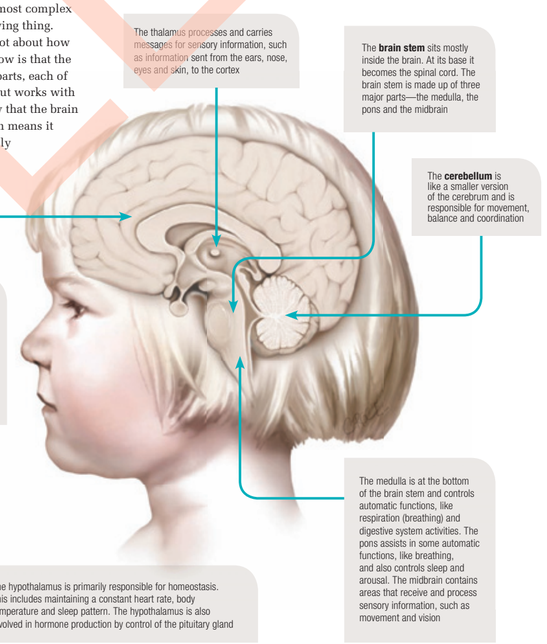
Present your findings in a formal experimental report.

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.

Answers

What do you know about the peripheral nervous system?

1 The peripheral nervous system consists of the somatic nervous system and the autonomic nervous system. The autonomic nervous system is divided into two parts: the sympathetic division and the parasympathetic division.
2 The peripheral nervous system carries information to and from the central nervous system to the rest of the body. Examples will vary. Any suitable example should be accepted.
3 The somatic nervous system is responsible for voluntary movements, whereas the autonomic nervous system is responsible for involuntary movements/actions.
4 The autonomic nervous system is responsible for maintaining homeostasis, and is important for the body to function properly.

A closer look at the brain

The brain dictates the behaviours that allow us to survive. It makes up only 2 % of our body weight, but it consumes 20 % of the oxygen we breathe and 20 % of the energy we consume. The variation within the brain is what allows it to function as 'command central' of the human body.

obook

ID05.25 Weblink: An online activity on the peripheral nervous system can be found at the BBC science website
ID05.26 Weblink: Brain interactive task
Allows students to identify parts of the brain responsible for certain functions
ID05.27 Weblink: A human brain map can be found at the BBC science website

SAMPLE

Lobes of the brain

To help students remember and understand the location of the lobes, ask them to colour in a picture of the brain and label the lobes. As part of labelling, they could write a description of what each lobe is responsible for.

EXPERIMENT 5.1

Sheep brain dissection

Safety

Wear gloves, lab coats and safety goggles. There may be a risk of fluid splashing in the eyes.

Practical hints

- Brains can be bought from the local butcher or directly from abattoirs. Fresh is always best; however, frozen also work well. Partially thawed brains are easier to work with because they hold their shapes better. Totally thawed brains can be soft, mushy, messy and difficult to dissect.
- It will be very difficult to get a thin enough slice of brain from a preserved brain to look at under a microscope. A slightly frozen fresh brain is easier.

Lab tech notes

- A short soaking of utensils is enough and then blades can be removed and cleaned. It is advisable to keep soaking short and dry all the utensils thoroughly, to avoid rusting. Coating in a protective grease barrier is an option but is not necessary if the utensils are washed and dried promptly.
- Blades can be removed with a commercial scalpel blade remover; however, a pair of pliers works just as well. Scalpel blades need to be put in a sharps container.

Clean-up

- Scalpels should be collected and placed, without washing, into a tub containing disinfectant or detergent. Other utensils need to be separated from the scalpels to eliminate the risk of cuts.
- Gloves and dissection wastes can be wrapped in newspaper, placed in a sealed rubbish bag and discarded to rubbish.
- Dissecting trays or boards can be washed in hot soapy water and a little disinfectant, then dried.

Discussion

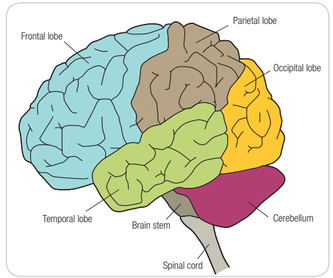
1 The structure of a sheep brain is extremely similar to that of a human brain because both organs are those of mammals, and therefore require similar processes.
2 Answers will vary; however, the brain is usually quite a soft mass, and unless relatively frozen, is quite hard to dissect.

Lobes of the brain

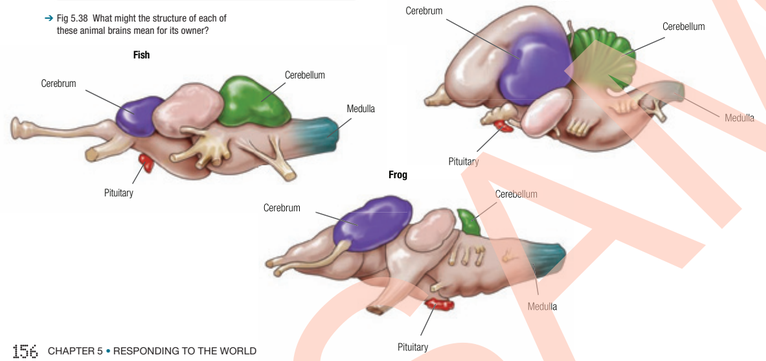
The cerebrum is divided into four lobes or sections. These lobes have specific functions:

- 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.

Answers

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

1 a frontal lobe: emotions, reasoning, movement, problem-solving
parietal lobe: perception of senses including taste, pain, pressure, temperature and touch
temporal lobe: recognition of sounds and smells
occipital lobe: various aspects of vision
b Students' own responses.
2 The brain stem consists of the medulla, the pons and the midbrain.
3 Maintaining homeostasis in the body is important because it keeps the internal environment stable so the body can function properly. Homeostasis involves regulation and maintenance of a stable internal condition, regardless of any changes to the external environment. Examples are maintaining an optimum temperature, blood glucose level, carbon dioxide concentration and pH level.
4 The cerebrum is the largest part of the brain and is divided into two hemispheres. The cerebrum controls all conscious activities. The cerebellum is responsible for movement, balance and coordination.
5 If you slipped and hit the back of your head, everything may go black because the brain has been injured. The occipital lobe, responsible for vision, is at the back of the brain, and would most likely bear the brunt of the impact.
6 Trauma to the frontal lobe can have an overarching effect on a person's ability to think, communicate and connect with the world. The person may experience impairment to movement, reasoning, emotional well-being/understanding and problem-solving. This may be exhibited in many ways such as loss of motor skills and behavioural instability. Impairment of frontal lobe functioning is also found in a range of psychiatric conditions including schizophrenia.
7 Individual answers will vary; however, students should understand that all vertebrate brains share a common underlying form. The brain consists of six main regions: the cerebral hemispheres (telencephalon), thalamus and hypothalamus (diencephalon), midbrain (mesencephalon), cerebellum, pons and medulla oblongata. Each of these areas has a complex internal structure, responsible for different functions. Size of the brain regions is directly proportional to the degree to which the animal uses each region. Humans have the largest cerebral hemispheres to control specific and complex movement, language, reasoning and senses, not necessarily needed in the same capacity as the other animals. Fish have the largest optic lobe because sight is their main sense and way of detecting the external environment, including the presence of predators. Humans have the smallest olfactory bulb because smell is not a critical sense, and frogs have the smallest cerebellum because only a small amount of movement needs to be coordinated.

obook

ID05.28 Weblink: An online dissection is available for students who may not wish to participate in the class dissection
ID05.29 Weblink: Explore the brains of different animals and find information about each brain type

SAMPLE

BIG IDEAS

5.3 What is a nervous response?

Remember and understand

1 The nervous system consists of the central nervous system (brain and spinal cord) and peripheral nervous system (nerves outside the central nervous system).

2 a autonomic nervous system: part of the peripheral nervous system, it controls involuntary actions
b reflex action: an involuntary and nearly instantaneous movement in response to a stimulus
c peripheral nervous system: all the nerves outside the central nervous system that carry information to and from the central nervous system to the rest of the body
d myelin sheath: a fatty layer covering axons to help speed up a nerve impulse along an axon by controlling its path

3 Students should use Figure 5.30 on page 150 of the textbook to help them complete this question.

4 Dendrites bring the information to the cell body and the nerve impulse is carried away from the cell body by an axon. At the end of the axon, synaptic terminals pass the message to the next neuron. When the message reaches the end of the neuron, neurotransmitters flow out of the synapse and stimulate the receptors on the next neuron to accept the message and pass it along.

5 Potential effects of spinal damage include paraplegia and quadriplegia, meaning the person will have no movement of limbs, or only movement of upper limbs, respectively.

Apply

6 The somatic nervous system is responsible for voluntary movements, whereas the autonomic nervous system is responsible for involuntary movements/actions.

7

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

8 Concept maps will vary; however, students should understand that the autonomic nervous system has two divisions—sympathetic and parasympathetic—that work together to maintain a balance in the body. The two divisions have opposite effects; for example, the sympathetic division could speed up the heart rate, while the parasympathetic division could slow it down. The parasympathetic system is responsible for stimulation of 'rest and digest' activities that occur when the body is at rest. These include salivation, tears, urination, digestion and excretion. The sympathetic nervous system is responsible for stimulating activities associated with the fight-or-flight response.

9
- dendrites: information wouldn't be received or taken to the cell body
- cell body: information couldn't be passed along and neuron couldn't do its job
- nucleus: the neuron couldn't function
- axon: information couldn't travel from one neuron to another
- myelin sheath: the nerve impulse may be slow and the path of the impulse wouldn't be controlled
- synaptic terminal: information wouldn't be passed onto the next neuron

Analyse and evaluate

10 If a person is experiencing loss of control of their legs and lack of feeling in their hands, it's likely that some nerve damage has occurred. The nerve impulses aren't travelling through the body as they should be.

11 Answers will vary; however, an example may be that the text is the nerve impulse and it travels from one phone (cell body) via the telecommunications network (axon and synapse) to the second phone (next neuron).

12 Student responses will vary.

Ethical behaviour

13 Answers will vary. Students could use the TAC (Transport Accident Commission) website for ideas for their commercials.

Critical and creative thinking

14 Student responses will vary; however, students should understand that structure is linked to function. The function of a typical neuron is to transmit information, and therefore its structure enables this with impulses only travelling in a single direction, sped up by the myelin sheath and having different structures for uptake and release of information.

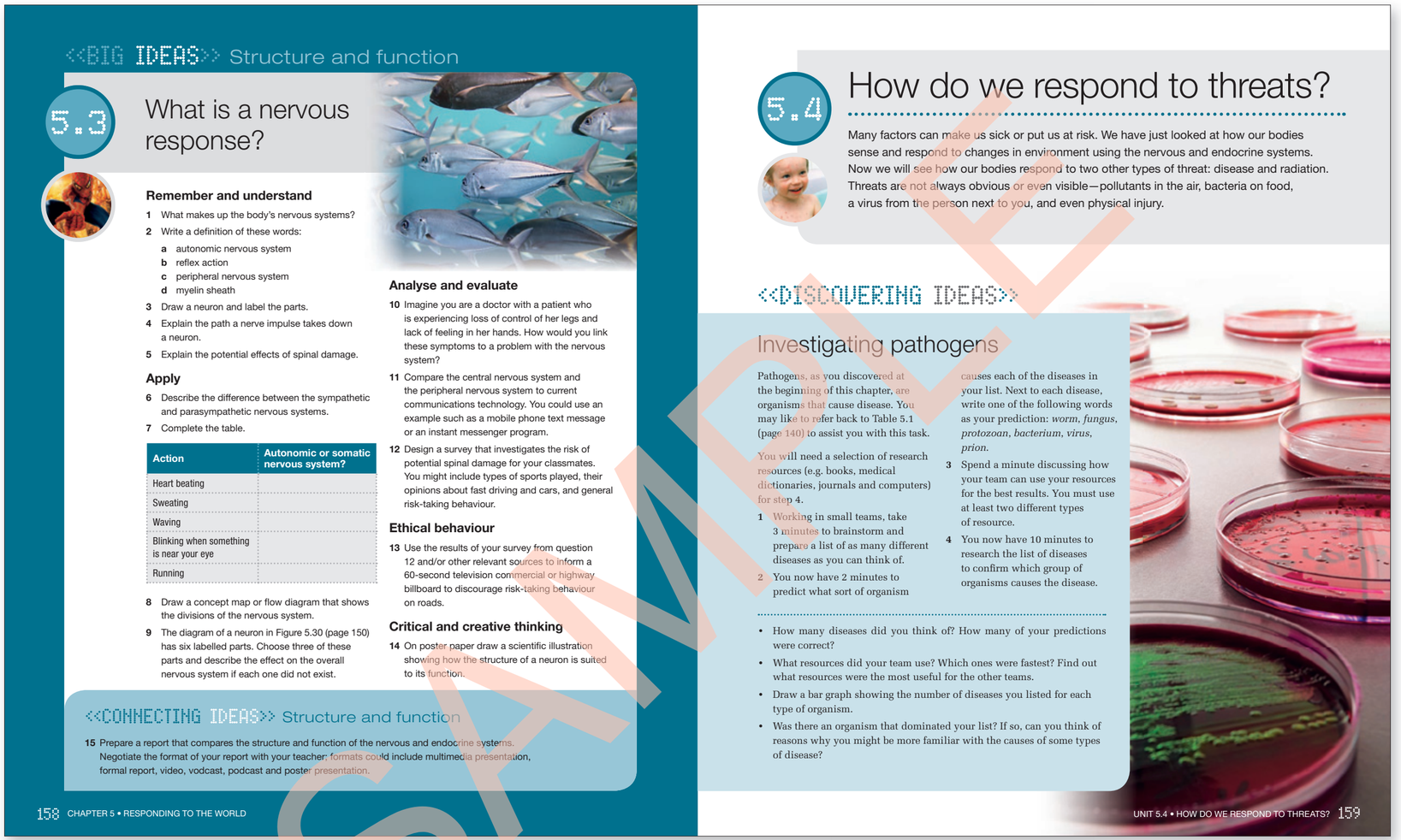
<<CONNECTING IDEAS>>

15 Answers will vary. The endocrine and nervous systems work together to coordinate the body's activities and functions. The human nervous system is composed of two parts: the central nervous system, which includes the brain and spinal cord; and the peripheral nervous system, which is composed of nerves and nerve networks throughout the body. This system produces a quick response. The endocrine system is also essential to communication; however, this system utilises glands located throughout the body, which secrete hormones that regulate a variety of things such as metabolism, digestion, blood pressure and growth. The response from this system is quite slow.

<<DISCOVERING IDEAS>>

Investigating pathogens

Students may be aware of diseases, but not the pathogens that cause them. This could be a source of discussion and then researched as stipulated by the activity.



<<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.

158 CHAPTER 5 • RESPONDING TO THE WORLD

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?

UNIT 5.4 • HOW DO WE RESPOND TO THREATS? 159

SAMPLE

The immune system

Discuss what the immune system is, and its role. Ask students why there are multiple lines of defence, what would happen if the immune system was compromised and how could it be compromised. To extend students, a research project on how the immune system is compromised could be undertaken. Students could look at how antibiotics may compromise our immune systems.

The immune system can determine if foreign material is present and becomes activated, attempting to remove the material before it becomes harmful to the body. There are two types of responses: non-specific immunity and specific immunity. Non-specific immunity is the first line of defence and involves physical and chemical barriers. Specific immunity involves the production of specialised cells and chemical substances (antibodies) to act against a particular infection. Specific immunity has a 'memory', so if the body is infected by the same organism again, an increased response occurs. This is sometimes considered to be the third line of defence. Lymphocytes (white blood cells) are the cells that recognise the invading particles/cells and react to the invasion. This 'memory' explains the immunity to childhood diseases once an infection or immunisation has taken place.

Active immunity occurs through immunisation and involves the production of antibodies within a person in response to exposure to a particular antigen. Vaccines that contain dead or treated living microorganisms are used to activate the immune system to produce antibodies against specific disease-causing organisms without actually causing the disease. *Passive immunity* occurs when antibodies are produced in one person and introduced into another so they can react with antigens to provide immunity in the second person. This occurs when a woman is pregnant and passes on her immunity to her unborn child, or during breastfeeding after birth.

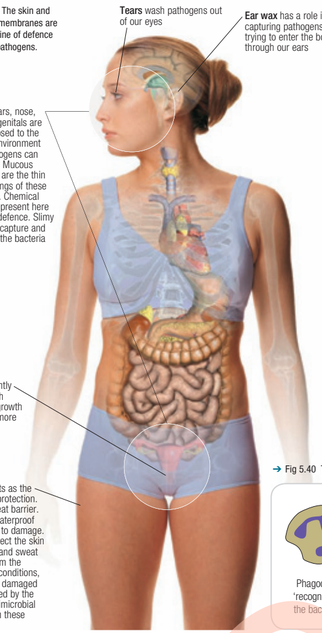
The immune system

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.

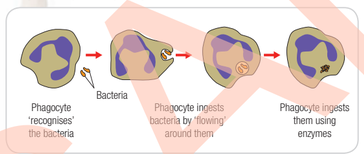
The key parts of the non-specific immune response are:

- 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.

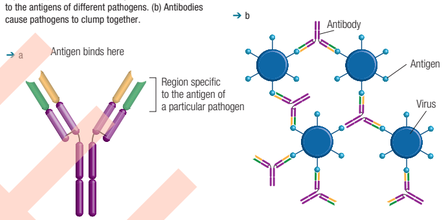
The specific immune response creates antibodies. **Antibodies** are protein molecules that bind specifically to a target called an **antigen**. Antigens may be the pathogen itself or even marker molecules on the surface of a pathogen.

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 antibodies. This is called **vaccination**, or inoculation. Vaccination is an example of acquired passive immunity.

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



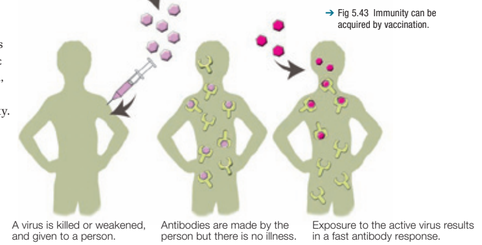
→ Fig 5.42 Natural passive immunity is obtained by a baby from its mother. The mother's antibodies are passed onto the child through the placenta and are in the mother's breast milk.

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.



Activity

Students could investigate immune diseases/disorders. Some suggestions are rhesus incompatibility, systemic lupus erythematosus (SLE), Grave's disease, pernicious anaemia, insulin dependent diabetes, rheumatoid arthritis, multiple sclerosis and AIDS.

obook

ID05.30 Video link: Antibodies
Describes how antibodies destroy viruses
ID05.31 Weblink: Pathogens and vaccines interactive task
Allows students to make virtual vaccines for selected pathogens
ID05.32 Video link: HIV vaccine
Video that describes how an AIDS vaccine may work. Includes computer generated graphics of cells
ID05.33 Weblink: Immune system game

SAMPLE

OVERARCHING IDEAS

Antibiotics

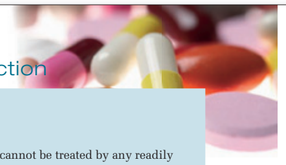
Antibiotics are among the most frequently prescribed medications in modern medicine. Although antibiotics are useful in a wide variety of infections, it is important to realise that antibiotics only treat bacterial infections. Antibiotics are useless against viral infections and fungal infections. If an antibiotic is stopped in mid-course, the bacteria may be partially treated and not completely killed, causing the bacteria to be resistant to the antibiotic. This can cause a serious problem if those now-resistant bacteria grow enough to cause a re-infection. Additionally, they may compromise the immune system if prescribed or taken when not needed.

As an extension, students could investigate how antibiotics work and how they may compromise the immune system.

Answers

What do you know about the immune system?

1 The body's first major line of defence is the skin.
2 Mucus, tears, earwax and chemical barriers can also prevent pathogens from entering the body.
3 The non-specific immune response works by seeking and destroying the pathogens in a number of different ways including blood clotting, inflammation, fever and production of leucocytes (white blood cells).
4 The different types of immunity are natural active immunity, natural passive immunity and acquired Passive immunity.
5 A vaccine is the preparation given in the vaccination. A vaccination is the ingestion or injection of specific antibodies to produce immunity to disease.
6 A vaccine might contain a dead pathogen, an alive but weakened form of the pathogen or antigens of the pathogen that have been separated from it.



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.

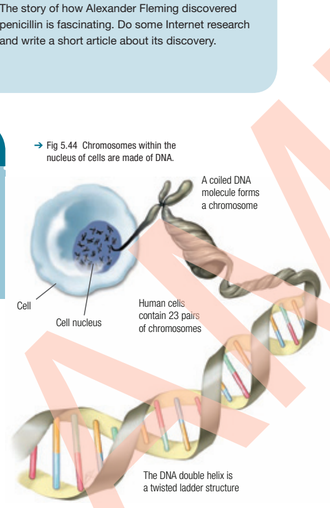
What do you know about the immune system?

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.



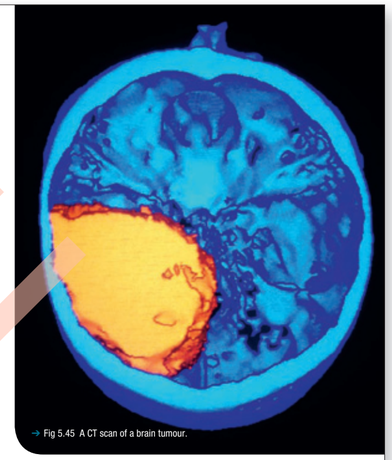
→ Fig 5.44 Chromosomes within the nucleus of cells are made of DNA.

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?

SAMPLE

PRACTIVITY 5.6

Interpreting scans

Images of X-rays can be found by performing an Internet image search.

Videos explaining how X-rays, CT scans or MRIs work can be found on YouTube.

- MRIs are used to view soft tissues of the body, making them especially useful in imaging the brain, muscles, the heart and cancers.
- CT scans enable radiologists to more easily diagnose problems such as cancers, cardiovascular disease, infectious disease, appendicitis, trauma and musculoskeletal disorders. They produce multiple, cross-sectional images or pictures of the inside of the body.
- X-rays are useful in the detection of pathology of the skeletal system as well as some disease processes in soft tissue.

Answers

What do you know about responding to radiation?

1 Radiation affects body cells by interfering with the structure, composition or functioning of molecules in the cells by breaking important chemical bonds.
2 The nucleus of a cell is the most vulnerable to radiation exposure because it contains the instructions for the cell (DNA). The major effect of radiation in the nucleus is the inhibition of DNA replication. This means the cell is unable to prepare for division.
3 Our bodies need to reproduce cells in order to reproduce old cells and enable healing to occur.
4 Tumours are faulty cells that continue to multiply, replicating the fault with each cell division.
5 Radiation can control tumours by damaging the DNA of the cancerous cells.

obook

ID05.34 Video link: Antibiotics
Video demonstrating the effect of viruses on the body and how antibiotics are used. Useful for immune system/antibodies content

BIG IDEAS

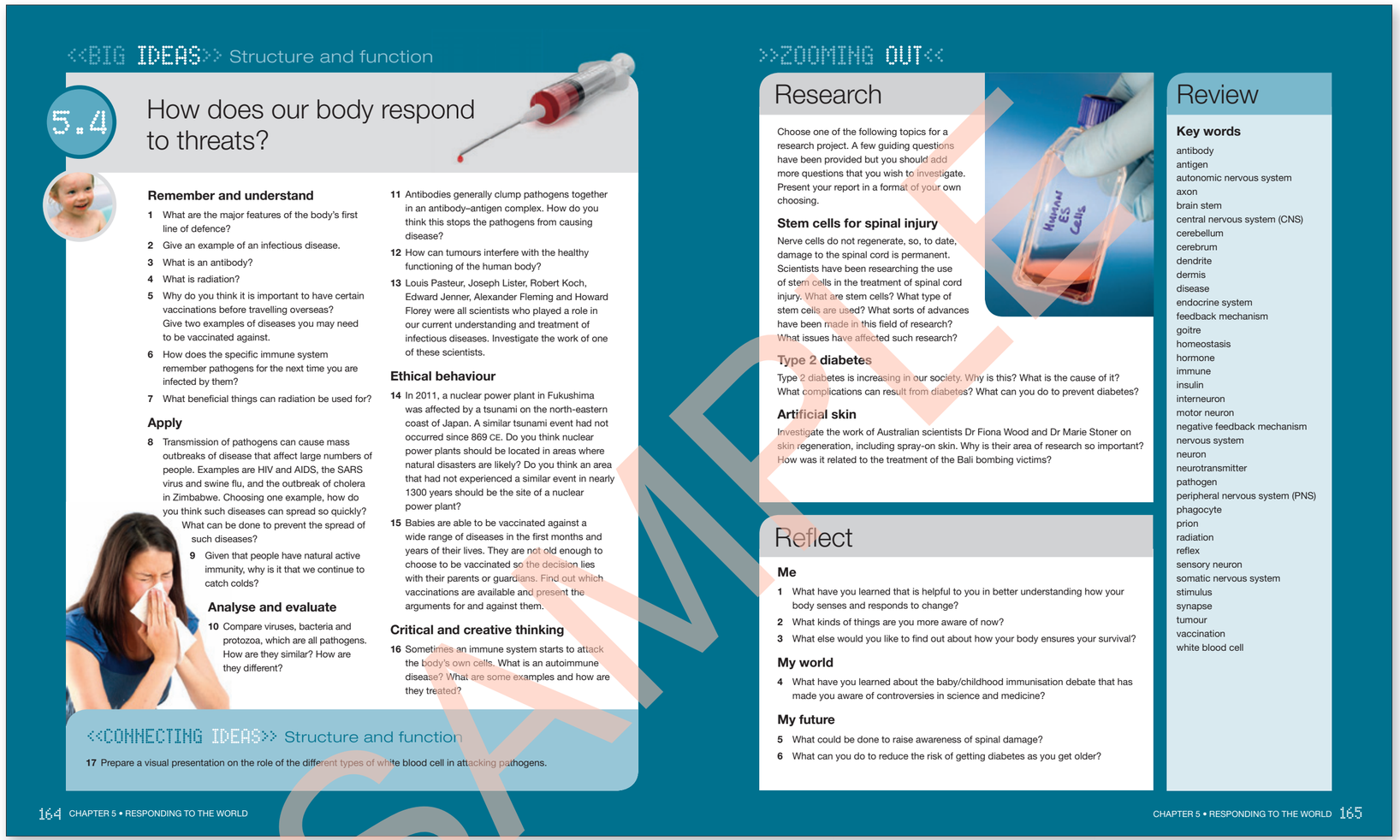
5.4 How does our body respond to threats?

Remember and understand

1 The major features of the body's first line of defence are the skin, mucus, tears, earwax and chemical barriers.
2 Infectious diseases are caused by pathogenic microorganisms, such as bacteria, viruses, parasites or fungi; the diseases can be spread, directly or indirectly, from one person to another. Examples include malaria, HIV/AIDS, the common cold and hepatitis.
3 Antibodies are created by an immune system response. An antibody is a protein molecule that binds specifically to a target, called an antigen.
4 Radiation is energy that can be used to make or break chemical bonds, so it can interfere with molecules in the body's cells.
5 It's important to have vaccinations before travelling overseas to help the body acquire immunity to diseases that may not be a problem in Australia. Some examples include malaria, rabies, yellow fever and typhoid.
6 The specific immune system 'remembers' pathogens if a person is re-infected by a disease as antibodies are produced in response to infection the first time, and they react if a person is re-infected.
7 Radiation can be used for X-rays, CT scans, MRIs and attacking cancerous cells.

Apply

8 Answers will vary. Diseases can spread quickly for a number of reasons including travel, animal contact (including with insects), poor hygiene, poor food preparation, water contamination, living in close quarters and transmission between a mother and an unborn child. Preventing such diseases from spreading needs to be addressed. This is usually case-specific.
9 People continue to catch colds, despite natural active immunity, because the virus mutates every year, meaning the immune system doesn't have antibodies to combat that particular strain of disease.



Analyse and evaluate

10 Viruses, bacteria and protozoa are similar because they can all cause harm to the body/create disease. They differ in the following ways:
- viruses: not cells; contain genetic information surrounded by a protein coat; not considered living
- bacteria: unicellular organisms; have a cell wall but no nucleus; usually considered to be living
- protozoa: single-celled organisms that commonly show characteristics usually associated with animals, most notably mobility and heterotrophy (cannot make their own food).

11 Antibodies can stop pathogens causing disease by clumping them together in an antibody–antigen complex. By doing this, they can cause pathogens to stick together and become harmless. After antibodies become attached to antigens on the surfaces of invading cells, they activate special proteins in the blood. These special proteins then break down the invading cells so that they cannot do any harm.
12 Tumours can interfere with the healthy functioning of the human body by causing physical blockages in the body or interfering with certain chemical processes.
13 Student responses will vary.

Ethical behaviour

14 Student responses will vary. Both sides can be argued successfully. On one hand, nuclear power plants should not be located in areas where natural disasters may cause emergency situations, with significant and long-term effects. On the other hand, natural disasters may not occur in that area for long periods of time or the magnitude of a natural disaster may not be as bad as predicted. The absence of nuclear power may have an impact on the availability of utilities, such as energy, in the area.
15 Vaccinations available for children include:
- hepatitis B (hepB)
- diphtheria, tetanus and acellular pertussis (DTPa)
- *Haemophilus influenzae*
- inactivated poliomyelitis (IPV)
- pneumococcal conjugate (7vPCV)
- rotavirus
- measles, mumps and rubella (MMR)
- meningococcal C (MenCCV)
- varicella (VZV)
- human papillomavirus (HPV)

Create

16 An autoimmune disease is a condition in which the immune system mistakenly attacks and destroys healthy body tissue. There are more than 80 different types of autoimmune disorders. Some examples include allergies, Addison's disease, multiple sclerosis, rheumatoid arthritis and type 1 diabetes.

<<CONNECTING IDEAS>>

17 Answers will vary. Options include eosinophil, basophil, lymphocyte, neutrophil, monocyte, macrophage and fixed leucocyte.

ZOOMING OUT

Research

Research tasks are an effective way of assessing learning and other capabilities and can be used effectively as an assessment task in lieu of or alongside other methods of assessment. The topics presented give students a choice based on their interests, and some control over their learning.

Reflect

Reflection activities are useful for students to gain insight into their own learning. They may be a useful tool in assessing students' personal learning journey. This may be in the form of a discussion with the student, or as a reflective journal that each student keeps throughout the year.

obook
ID05.35 Weblink: Howard Florey Institute
Research projects can be found by clicking on the 'Research' link

SAMPLE

CONNECTING IDEAS

A life with no pain

Congenital analgesia is a very rare condition (probably fewer than 30 individuals in the world) characterised by inability to perceive pain despite being normal in all other respects. It is caused by a gene mutation with no detectable physical abnormalities. Symptoms include no response to painful stimuli, frequent physical injuries, absent or reduced sense of smell, frequent mouth injuries, with other sensations such as pressure and touch intact.

The body is a complex system and our understanding of its intricacies is still not complete. Variations possible within the human genome extend to 10^{600}, so it is entirely possible that many genetic diseases are not yet known or understood. Other diseases are so rare that studies and treatments are difficult to undertake.

It may be beneficial to approach this topic with sensitivity and care, as some students may know people with undiagnosed conditions, or conditions that they will only find out about through this discussion. Sensitive information may be available about your students, and this may be worth checking prior, especially if genetic diseases are being discussed. An alternative would be to look at medical cases, which can be found online, and discussing these particular cases only.

Activity/Assessment task

Students could research other unusual and rare medical conditions such as:

- Porphyria—A rare blood disease where an enzyme deficiency occurs and affects the nervous system
- Fatal familial insomnia—A disease where the sufferer can't sleep
- Alice in wonderland syndrome—A radical shift in perceptions of the world caused by a disturbance in the brain's electrical charge
- Body integrity identity disorder (apotemnophilia)—Compels a person to cut off perfectly fine limbs or body parts
- Lipodystrophy—A condition where the body rapidly burns fat, and the sufferer can't gain weight
- Chiari malformation—Structural defects in the cerebellum, and the brain can be squeezed into the spinal column
- Aquagenic urticaria—A rare skin disorder where the sufferer is allergic to water
- Cataplexy—A condition where the sufferer can suddenly collapse on the spot
- Capgras—A person has a delusional belief that someone close to them is an imposter
- Narcolepsy—A condition that makes a person drop off to sleep without warning.

This activity could be used as an assessment task. Students could research what the disorder is, causes, signs and symptoms, treatments and prognosis/outcomes. It could be submitted in a number of different ways such as a vodcast, podcast, poster, oral presentation or interview with a medical professional.

obook
ID05.36 Flashcard glossary
ID05.37 Student self-test

SAMPLE