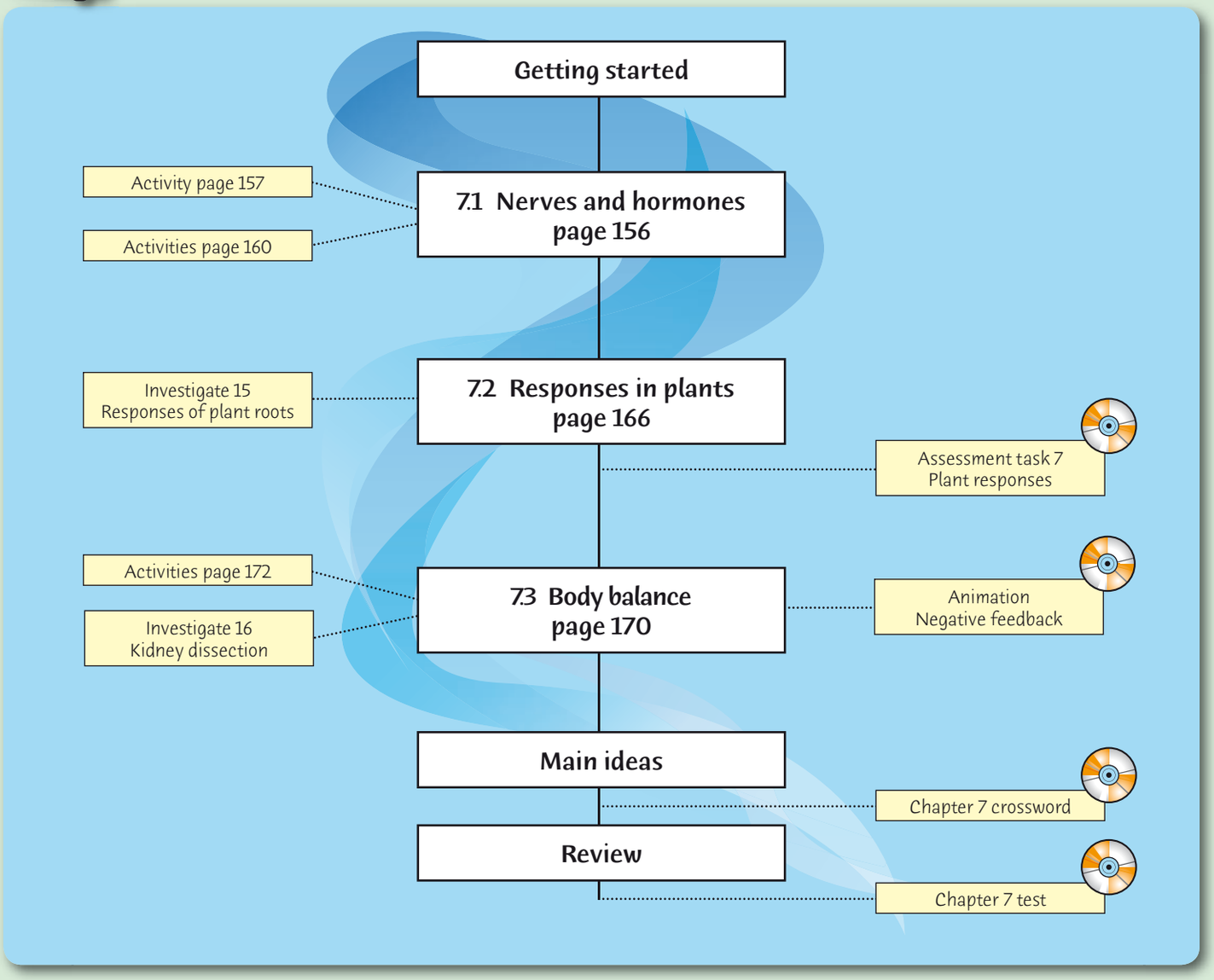
7 Responding

Planning page



Essential Learnings for Chapter 7

Essential Learnings	References		
	Student book (page number)	Workbook (page number)	Teacher Edition CD (Assessment task)
Knowledge and understanding *Life and living* Complex organisms depend on interacting body systems to meet their needs internally and with respect to their environment	pp. 156–176		Assessment task 7 Plant responses
Ways of working Draw conclusions that summarise and explain patterns, and that are consistent with the data and respond to the question	Investigate 15 p. 167 Activities p. 172	pp. 52–53 p. 58	Assessment task 7 Plant responses
Research and analyse data, information and evidence		pp. 49–50 pp. 55–57	
Communicate scientific ideas, explanations, conclusions, decisions and data, using scientific argument and terminology, in appropriate formats		pp. 54–57	Assessment task 7 Plant responses
Plan investigations guided by scientific concepts and design and carry out fair tests			Assessment task 7 Plant responses

QSA Science Essential Learnings by the end of Year 9

Vocabulary

adrenalin
auxin
cerebellum
cerebrum
diabetes
dissection
endocrine system
feedback
hormones
impulses
insulin
involuntary
motor neuron disease
multiple sclerosis
neuron
neurotransmitter
pituitary gland
receptors
reflex
sensory
stimulus/stimuli
thyroid gland
urine

Focus for learning

Analyse human response in stopping at a traffic light, and plants bending towards the light (page 155).

Equipment and chemicals (per group)

Activity page 157 sheep's brain, scalpel, dissecting board, disposable gloves and lab coat, newspaper, videoflex microscope camera (optional)

Activities page 160 **Part B:** sheet of clear plastic.

Investigate 15 page 167 8 small bean seeds (eg mung beans), glass jar, petri dish (11 cm diameter), filling (eg rubber carpet underlay, cotton wool, newspaper or cardboard), 2 filter papers (to fit petri dish), Blu-Tack, adhesive tape

Activities page 172 methylated spirits

Investigate 16 page 173 sheep's kidney, scalpel, scissors, tweezers (forceps), dissecting board, disposable gloves and lab coat, newspaper, microscope and slides, disinfectant and towel

7 Responding

Getting Started

Work in small groups and discuss the following.

- Lucy is driving her car towards an intersection. The traffic lights turn amber and Lucy immediately takes her foot off the accelerator and applies the brakes. The car stops.
  - Which parts of Lucy's body are involved in this series of events?
  - On a piece of paper, draw a flow diagram showing the events, starting from the receptor that detects the amber light to the car stopping.
- Ruby's aunt gave her a pot plant for her room. She placed it near a window. After two weeks the stem had bent towards the window. Ruby rotated the plant 180°. After a week the plant had straightened up, and after another week it was again bending towards the window.
  - What stimulus made the plant bend?
  - Design an experiment to test your idea.
  - Given that plants have neither bones or muscles, suggest how they bend towards the light.

Starting point

1 Have students make a concept map using words and terms from this chapter. The words in the vocabulary list on the previous page (of the *Teacher Edition*) could be used. Consider devising a giant class concept map. Randomly select students to suggest linking sentences and construct the class map this way. Encourage multiple connecting sentences. An interactive whiteboard can be useful here as it allows you to save documents and modify them at a later date. Allow students to work on the map progressively through this chapter.

The final concept map could be printed out and used as a student revision tool. A good idea is blanking out the key words so that students have to finish the map by correctly filling in the missing words. Alternatively, you could use the map as a pre-test to help identify the facts students already know, or any misconceptions they may hold. Make sure to give positive feedback about their work so that they have the opportunity to show improvement when they do the post-test.

2 Students could draw illustrations/cartoons depicting an everyday situation involving the process of responding, like the one on this page. They should provide labels or captions for their illustrations. Alternatively, students could take a series of digital photos. They may like to compile a multimedia presentation of their artwork.

3 Get the students to set specific goals for this chapter. Have them write a goal for improving their practical work, listening and thinking, theory work, homework, research and so on. Encourage them to be specific rather than general. At the end of the chapter ask students to review their goals and complete a self-evaluation. Were their goals achievable? Do they need further improvement in a particular area? What do they think they did well?

4 When students are designing their own experiment to test their ideas about the responses of Ruby's plant to light, it might be an idea to refer them to page 168. Ensure they make systematic observations and interpret data according to the aim of their experiment. Suggest students write a prediction or hypothesis before starting. The usual scientific report format should be used. If you are going to assess their work, consider student design, control of variables, interpretation of results, and the formatting and language of their report. Tomato, basil and marigold seedlings work well for this experiment.

Hints and tips

- There are many commercial DVDs on the nervous and endocrine systems that can be shown during the chapter. Make sure to preview any before you show them to determine how appropriate they are, and prepare worksheets for the students to fill in.
- The central nervous system (CNS) consists of the brain and spinal cord. The peripheral nervous system (PNS) consists of the sensory receptors and nerves which connect the central nervous system to all parts of the body.

7.1 Nerves and hormones

You are walking along a path with a friend, eating an apple. Have you ever wondered how you can move, digest food, breathe, think, talk and keep your blood flowing all at the same time without even having to think about it?

All the systems in your body are controlled and coordinated by two other systems—the **nervous system** and the **endocrine system**. The **brain** is the main organ of the nervous system and controls the actions of the nerves and the endocrine system.

The nervous system consists of the brain, the spinal cord and nerves which run to all parts of your body. Messages called nerve impulses travel very quickly along nerves.

The endocrine system consists of a number of endocrine glands throughout your body, which produce chemical messages called **hormones**. These are sent out by the blood, so they take longer to act than nerves, but their effects generally last longer.

the body. At any one time, a huge number of signals are travelling to and from the 10 000 million nerve cells that make up your brain.

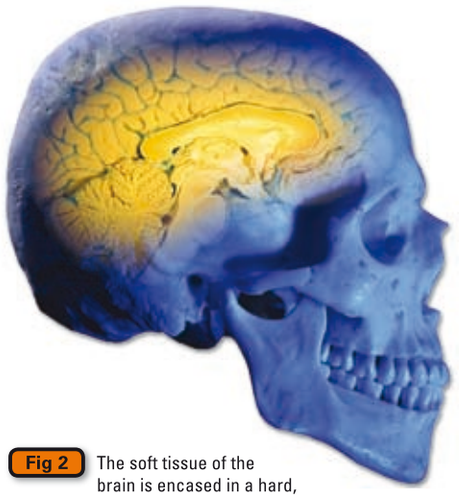
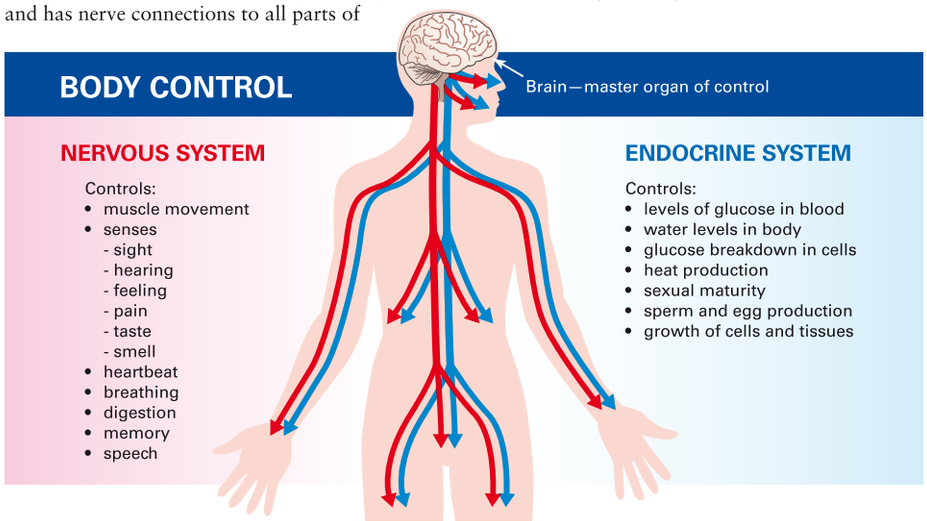


Fig 2 The soft tissue of the brain is encased in a hard, bony skull for protection.

The nervous system

The brain is the control centre of your body, and has nerve connections to all parts of

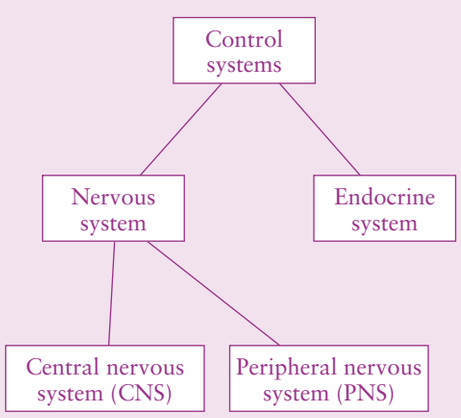


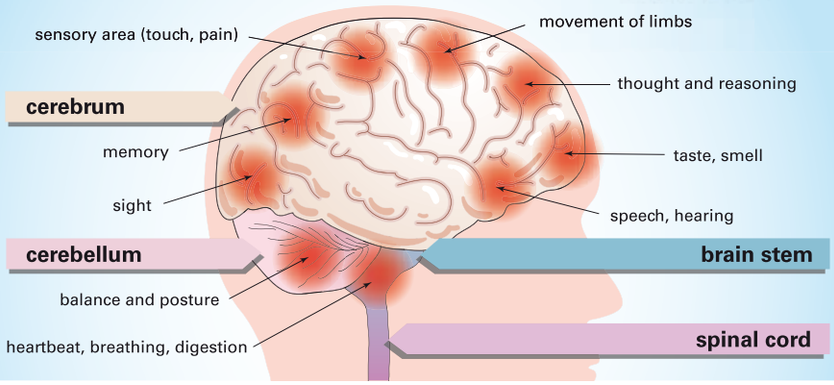
Learning experience

Get the students to write a series of key sentences about each section as they progress through the chapter. Towards the end of the chapter they could use their sentences to form a revision crossword or a multiple-choice quiz.

Learning experience

Get students to construct a flow chart of the human body's control systems. Most students are fascinated by how the brain works, so allow them time to explore this further. Suggest they do further research on the central nervous system. Words, dot points or diagrams could be put into the boxes of the flow chart. Remind students that the simpler their sentences are, the more likely they are to remember the information. The diagram on the right might be a starting point.





There are three main parts to the brain.

Cerebrum

The **cerebrum** (ser-EE-brum) is the largest part and controls memory, speech and conscious thought. It receives information from sense receptors to give you the sensations of taste, sight, touch, hearing and smell. The cerebrum also controls actions such as walking, running and jumping. All of these actions are called *voluntary actions* because you control them by thinking about them.

Cerebellum

The small part of the brain behind the cerebrum is the **cerebellum** (ser-a-BELL-um). This coordinates muscular activity without you having to think about it (*involuntary actions*). It helps you balance when you ride your bike, surfboard or rollerblades, and it coordinates all your muscles when you walk, run and jump so that you do not fall over.

Brain stem

The **brain stem** at the base of the brain is responsible for other *involuntary actions* such as heartbeat, pulse, digestion and breathing.

Activity

Dissection of a sheep's brain

You will need a sheep's brain, scalpel, cutting board, disposable gloves and newspaper.

Your teacher may show you the features of a brain by using a videoflex microscope camera before you start.

1. Identify the cerebrum, cerebellum and brain stem. Describe their colour and appearance.
2. Notice that the cerebrum consists of two parts called hemispheres. Use the scalpel to separate the two hemispheres, then cut one of the hemispheres in half lengthways to see a cross-section of the cerebrum.

Draw a cross-section of the brain and label the parts.

Hints and tips

- There are online brain dissection simulations which allow students to learn and test their knowledge interactively. These simulations can be engaging and can enhance learning, but it is best to avoid them as a substitute for the 'real thing'.
- If you have access to a model of the human brain, bring it into class and get some students to 'dissect' it. It is a very good tool to show the location and divisions of parts of the brain. When one group has finished 'dissecting' it, organise another group to reassemble it. This can be done throughout the lesson in conjunction with board work or completion of exercises.

Activity notes

Dissections can be a bit messy but are worth the trouble because they provide students with hands-on sensory learning about organs which are very similar to those in their own bodies. The following advice will make it a bit easier.

- If possible, buy the organs from your local butcher shop as they are likely to be more intact.
- Explain to students that you are going to do the activity and insist on a note signed by a parent prior to the lesson if they do not wish to participate. If there are any non-participating students, consider giving them a research task about the subject and perhaps send them to the library.
- A partially frozen brain can be easier to dissect because it is less slippery.
- Make sure the bench is covered in newspaper.
- Students should use plastic disposable gloves. Remind them about hygiene.
- Insist on acceptable behaviour while performing the dissection:
  - no screaming
  - proper use of dissection boards and cutting tools
  - no mutilation of material
  - all equipment and hands to be washed with hot water, soap and disinfectant at the end of the lesson
  - all material to be disposed of correctly.

Learning experience

A great activity is to get students to make a balloon model of the brain. Each student is given a balloon to blow up to the estimated size of a human brain. Using felt markers, they then divide the brain into the appropriately proportioned brain parts. Students could have a numbering system and key to accompany the balloon model. It might be more interesting to give students an alternatively labelled diagram, including the lobes of the brain (frontal, occipital, parietal and temporal lobes of the cerebrum), for this activity. A useful website can be found in the *ScienceWorld 3* Webwatch for Chapter 7. Follow the links to 'Brain anatomy'.

Research

Consider discussing the cerebrum in more detail. Get students to explore different types of memory and memory-enhancing techniques, such as the Method of Loci or the use of mnemonics. Give the class some time to practise some of the techniques discovered. Gifted and talented students could research the differences between the left and right sides of the cerebrum. Which side is responsible for artistic and musical ability, intuition and perception, language, and mathematical and logical thinking? Can students identify which side of their brain seems to be more dominant?

Types of nerves

The basic unit in the nervous system is a nerve cell or **neuron** (NEW-ron). Neuron is sometimes spelled *neurone*. This is a specialised cell and it is different from other body cells in two ways. Firstly, it is the longest cell in the body, with a long branch or fibre. Secondly, electrical impulses travel along the nerve fibre. These impulses travel in one direction only.

The main nerves in the body contain many individual nerve fibres wrapped together in a sheath.

There are two types of neurons—*sensory neurons* and *motor neurons*. Sensory neurons send nerve impulses to the brain from the body's receptors. These receptors are attached to one end of the neuron, and detect external stimuli such as light and sound, or internal stimuli such as the level of carbon dioxide in the blood or the fullness of your bladder.

The impulses from the sensory neurons are received by the brain or spinal cord. Other impulses are sent out along the motor neurons to muscles or glands.

The table below lists the sensory receptors in the human body and the stimuli they detect.

Receptor	Stimuli detected
rods and cones in eye	light
cells in cochlear (inner ear)	sounds
skin (many receptors)	touch, tissue damage (pain), vibration, pressure, hot and cold
around hairs in skin	touching the hair
taste buds in tongue	chemicals in food
olfactory cells in nose	chemicals in air

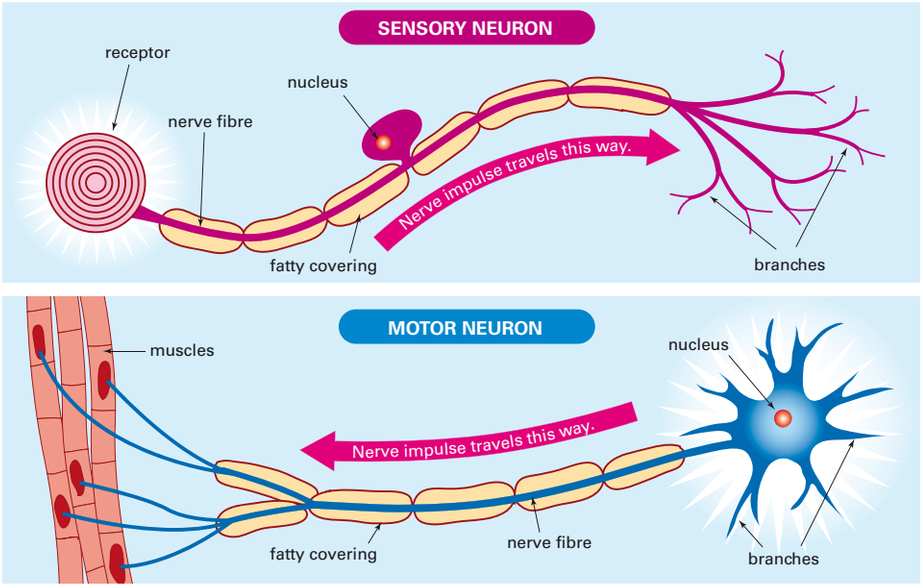


Fig 6 Sensory nerve cells send impulses from receptors to the brain, and motor nerve cells send impulses from the brain to muscles or glands.

Learning experience

In groups of about four, ask the students to make a brain game. Each group draws a simplified diagram of the brain on a sheet of coloured poster paper. They also develop packs of question cards with answers relating to three main areas of the brain (cerebrum, cerebellum and brain stem). Each student then takes it in turn to spin a three-coloured or numbered spinner and answer a question corresponding to the spinner's result. The student with the most correct cards is the winner. Have each group play another group's game instead of their own. This way there is no unfair bias with the questions and answers.

Hints and tips

All living things respond to stimuli—information received from their surroundings. A stimulus is anything that triggers a response or change in the activity of an organism. The stimuli humans respond to are changes in temperature, light, sound, touch, taste and smell.

Homework

Give students a list of words and ask them to find their meanings, then write sentences using each word in its correct context. The following list could be used: *neuron*, *axon*, *dendrite*, *myelin*, *synapse*, *interneuron*, *neurotransmitter*, *meninges*, *cerebrospinal fluid*.

Learning experience

Have the students carefully copy the diagrams of the two types of neurons into their notebooks and label them. Get them to colour-code their diagrams and show the direction of the nerve impulses. Ask students to write a series of steps for each neuron that explain what happens to a nerve impulse travelling along it. Students could examine what the function of each part of the neuron is. For example, the fatty covering called myelin protects (insulates) the nerve fibre. Alternatively, students could make an interactive PowerPoint presentation displaying their researched information, or a colourful playdough model.

science bits

Diseases of the nervous system

There are three major diseases of the nervous system—polio, multiple sclerosis and motor neuron disease.

Polio

Polio, or more correctly poliomyelitis, is a viral disease. The polio virus can be found in faeces and enters the body when a person ingests contaminated food or drink. The virus spreads to the gut and infects the motor neurons in the spinal cord, which control the movement of the trunk, limbs and rib muscles.

When a person is exposed to the disease, it can take from 3 to 35 days for them to first show symptoms. Thus the disease can spread quickly before the person realises they have it. The first symptoms are fatigue, fever, vomiting and pain, but about 90% of the people infected with the polio virus fully recover after the first symptoms.

In severe cases, muscle paralysis occurs in the legs and the ribs, making breathing difficult. People suffering from paralytic polio have to use a ventilator or an 'iron lung' to help them breathe.

Multiple sclerosis (MS)

MS is a disease that attacks the neurons in the brain and spinal cord. It is an unpredictable disease because the symptoms can occur at any time and be mild or severe. MS symptoms range from blurred vision to complete blindness, and from tingling and numbness to paralysis.

MS affects more women than men, and occurs more commonly in people with northern European ancestry. In 2002 there were 2.5 million people worldwide affected with MS, and 15 000 of those were in Australia.

MS is not contagious or directly inherited and the actual cause is at present not known. The disease occurs when the body's own immune system attacks the fatty substance (called myelin) around the neurons, causing a disruption to nerve transmission.

Motor neuron disease (MND)

MND is a group of diseases that affect the motor neurons which control the muscles that enable you to use your arms and legs, breathe, talk and swallow. It does not affect your intellect or your memory.

The cause of MND is not known. In almost all MND sufferers there is no family history of the disease. The disease is often fatal within 2 to 5 years after diagnosis. One well-known exception is Stephen Hawking, the Cambridge University physicist and cosmologist (see photo), who has had MND for over 40 years.

Symptoms of MND usually occur in people aged 50 to 70. They start with muscle weakness in the arms and legs, which gets progressively worse. Muscles tend to wither and speech becomes slurred.

At present there is no cure for MND.

WEBwatch

Use the internet to find out more about the three diseases on this page.

Questions and research

1. Draw up a table listing the causes, symptoms and treatment of the three diseases.
2. Use the table to write a 'compare and contrast' paragraph about MS and MND.
3. Use the table in Question 1 to write a short feature article for a science magazine on one or all of the diseases. Include a fictitous interview in your article.
4. Between 1946 and 1955 there were 10 000 cases of polio and 1013 deaths. In 2006 there were 309 cases worldwide and none in Australia. Use information from the web to write an inference explaining this.

Hints and tips

Consider getting students to read aloud the information on this page. It will help auditory learners and ESL students as they will be able to hear the correct pronunciation of words. A technique that can be used to keep the class focused is to choose readers who appear inattentive. Students soon realise that if they do not want to read aloud they need to make sure they are attentive. However, be mindful of those students with language disorders.

Research

Ask students to research a disease or disorder of the nervous system and present the information as a pamphlet similar to those available in chemists. Their pamphlet needs to include the disease's symptoms, its causes, how the disease affects the nervous system, how it is treated (if it can be treated) and the likely prognosis. Alternatively, students could write and/or perform a play, using the scenario of a doctor trying to diagnose an illness related to a patient's nervous system. The illness could be motor neuron disease, poliomyelitis, Parkinson's disease, Alzheimer's disease, epilepsy, meningitis, stroke or concussion.

Learning experience

For students who enjoy reading, you might like to suggest they read the classic Australian book *I Can Jump Puddles*, written by Alan Marshall, if they have not already done so. It is about a young Australian boy growing up in the early 1900s who contracted poliomyelitis, and details his struggles and courage in overcoming his physical disability. Students who don't like reading could watch the DVD.

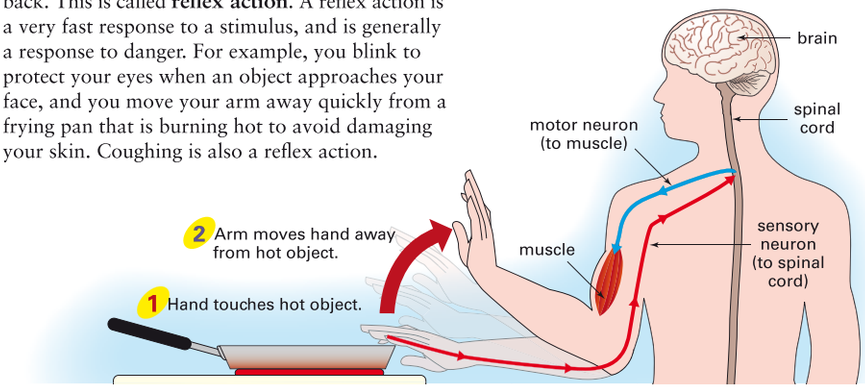
Learning experience

Do the Webwatch if you have access to computers in class, or give it as a homework exercise.

Reflex action

Not all the information from the receptors is coordinated by the brain. Sometimes a nerve impulse takes a short cut to the spinal cord and back. This is called **reflex action**. A reflex action is a very fast response to a stimulus, and is generally a response to danger. For example, you blink to protect your eyes when an object approaches your face, and you move your arm away quickly from a frying pan that is burning hot to avoid damaging your skin. Coughing is also a reflex action.

In a reflex action the nerve impulse travels from a receptor along a sensory neuron to the spinal cord and then back along a motor neuron to a muscle. The whole action takes place very quickly because the brain does not coordinate the action.



Reflex action flow diagram

Receptors in the skin detect heat or cell damage. → Nerve impulse sent along sensory neuron to the spinal cord. → Nerve impulse from spinal cord sent along motor neuron. → Impulse from motor neuron acts on muscle in arm. → Arm moves away from heat.

Activities

Reflex actions

There are a number of reflex actions that you can observe in humans.

A Have your partner sit on a chair with one leg crossed over the other. With the side of your hand, gently tap their knee just below the knee cap.

- Describe this reflex action. What type of receptor detects the stimulus?
- Draw a flow diagram like the one above to show the reflex action.

B Stand behind a window or a glass door or hold a piece of clear plastic in front of your face. Have your partner throw a crumpled-up piece of paper at the glass.

- Why do you blink every time the paper ball is thrown, even though you are protected by the glass?
- Which receptor is used in this reflex action?
- Draw a flow diagram to show the reflex action.

C Cover one eye with your hand for at least 30 seconds. After this time have your partner look at your eye when you take your hand away.

- What happens to the size of the pupil?
- What was the stimulus that caused this response?
- Draw a flow diagram to show the reflex action.

Hints and tips

Reflex actions use a pathway called a reflex arc. It does not involve the brain directly, and actions are automatic and very fast, involving only a few neurons. It is important for students to recognise that a reflex action takes place when sensory neurons, not motor neurons, are stimulated. A message may be sent to the brain but only to keep it informed. So, in the example shown on this page, the brain might trigger a cry of pain and will probably store information that will help you avoid burning your fingers again.

Activity notes

Students could come up with their own safe activity to observe a reflex reaction. Ask them to devise an activity and then test it on their partner. How did they know that their partner's response was the result of a reflex action? To which part of the spinal cord do they think the signal from the sensory neuron travelled?

Issues

Pose the following scenario to the students. A person close to them has received a permanent brain injury, leaving them in an ongoing comatose state. It has been advised by medical professionals that the life support system be turned off. Why do the medical staff believe there is no possibility of recovery? What would you do? How would you feel?

This a very challenging issue to discuss and a high level of sensitivity is needed. Before discussing such an issue, check student records to see if there is any student who might struggle with this activity.

Learning experience

Each year many Australians are seriously injured in road or diving accidents. Many sustain brain or spinal injuries and often don't make a full recovery. Get students to compile a list of statistics relating to these types of injuries in Australia. In pairs, ask them to design an awareness campaign to explain:

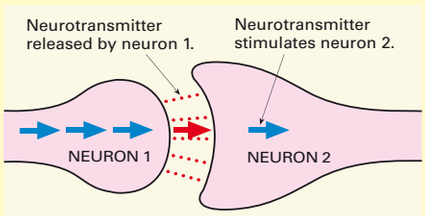
- possible dangers
- how to minimise the risk of injury
- what injuries could be sustained (from the least serious to the most serious)
- what sort of medical care is required
- what kind of recovery is likely
- how the person's life might be changed.

Student campaigns could include poster displays, multimedia or audio presentations, pages posted on the school intranet or internet, and so on.

Science in action

Nerves, poisons and drugs

The neurons in your nervous system do not touch each other—there is a tiny gap between them. When a nerve impulse reaches the end of one neuron, it cannot jump to the next neuron. Instead, the impulse releases a chemical called a *neurotransmitter* which travels over the tiny gap and stimulates the other neuron to send a nerve impulse.



When the neurotransmitter has stimulated the other neuron, it is quickly broken down so the neuron can be stimulated again by more neurotransmitter.

Scientists have found more than 50 types of neurotransmitters in the human body.

Poisons

There are a number of poisons which react with neurotransmitters causing paralysis and even death. For example, curare (coo-RAR-ray) is a poison extracted from plants in South American forests. Animals that are hunted and hit by arrows dipped in curare become paralysed. The poisons given off by bacteria that cause food poisoning and those that cause tetanus also stop neurotransmitters working.

Insecticides

When the neurotransmitter is released and stimulates the other neuron, an enzyme destroys it so that it cannot keep acting and stimulating the other neuron. This process also occurs in insect nerves. The active ingredient in some insecticides reacts with the enzyme and destroys it. This means that nerve impulses fire continuously, causing the insect's muscles to move rapidly and uncontrollably, resulting in death.

Drugs

Nicotine, found in tobacco, is a stimulant because it acts like a neurotransmitter in the brain, giving a pleasurable effect (making the body more active or alert). However, it is addictive and very toxic in large amounts.

Amphetamines ('speed') and cocaine are also stimulants because they increase the release of neurotransmitters. This results in heightened emotions and an increased feeling of alertness and confidence. But later this can lead to anxiety, panic, depression and hostility.

Some other drugs such as alcohol and heroin decrease the release of neurotransmitters, making the person inactive or drowsy. These drugs belong to a group called depressants (the opposite effect of stimulants).

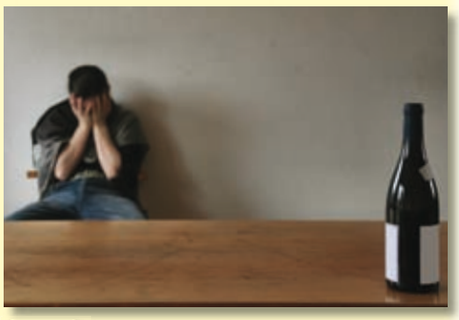


Fig 10 Long term use of depressants such as alcohol leads to liver and heart damage as well as memory loss and brain damage.

Questions and research

1 Compare the action of drugs (stimulants and depressants) on nerve transmission with the action of poisons such as curare.
2 Suppose you want to use the internet to find out more about what is on this page. What search words would you use? How could you guarantee that the information was genuine and accurate?
3 Invite a drug and alcohol consultant to discuss with the class the use and misuse of stimulants and depressants. Prepare some questions to present to the consultant well before the discussion.

Hints and tips

- The tiny gaps between neurons are called synapses. Ask the students to suggest why it is important to have this gap so that the neurons do not touch each other.
- Local community health centres might have a drug and alcohol consultant who is willing to discuss with the students the use and misuse of stimulants and depressants.

Issues

Teenagers sometimes say, 'Just using the drug once won't hurt me'. Why is this a naïve and a dangerous misconception in relation to illicit drugs? In groups, have students discuss the issues surrounding this statement. Their work could be presented in the form of a report for a newspaper or medical journal.

Homework

Children who are diagnosed with ADD (attention deficit disorder) or ADHD (attention deficit hyperactivity disorder) are often prescribed stimulants. Set students the task of doing some research and writing an evaluation of whether they would recommend stimulants to be used to treat the disorder, clearly explaining their reasons. It might be helpful to construct a table showing the advantages and disadvantages of using stimulants. Make sure students include a bibliography.

Learning experience

Gifted and talented students could investigate how acupuncture appears to work. Acupuncture is often used to treat pain and is thought to stimulate the production of the body's natural pain-deadening neurotransmitters, called encephalins. Get students to prepare a fact sheet on acupuncture in the context of this chapter.

Learning experience

Students could draw three charts, one each for poisons, insecticides and drugs. Each could have four columns, displaying the following information: the name of the poison, insecticide or drug; if it is a stimulant or depressant; its short-term effect on the body; and its long-term effect on the body.

Hints and tips

Take a few minutes to revise and reinforce past work in this chapter before moving on to the next section. The students could write down a paragraph or jot down a series of dot points about what they have learned so far, then share it with the person next to them. You could also ask them to write down an area they found challenging, if they would like it reviewed, and what they feel they have grasped or understood. Collect their responses and evaluate what they have written.

Research

Ask students to research a disease or disorder of the endocrine system and present their information as a pamphlet similar to those available in chemists. The pamphlet needs to include the disease's symptoms, its causes, how it affects the endocrine system, how it is treated (if it can be treated) and the likely prognosis. Alternatively, students could write and/or perform a play, using the scenario of a doctor trying to diagnose an illness related to a patient's endocrine system. If students chose the similar activity suggested on page 159, encourage them to do the alternative activity this time (pamphlet or play). Other alternative activities are to draw a cartoon strip, construct a poster for a doctor's surgery, or prepare a set of questions and answers.

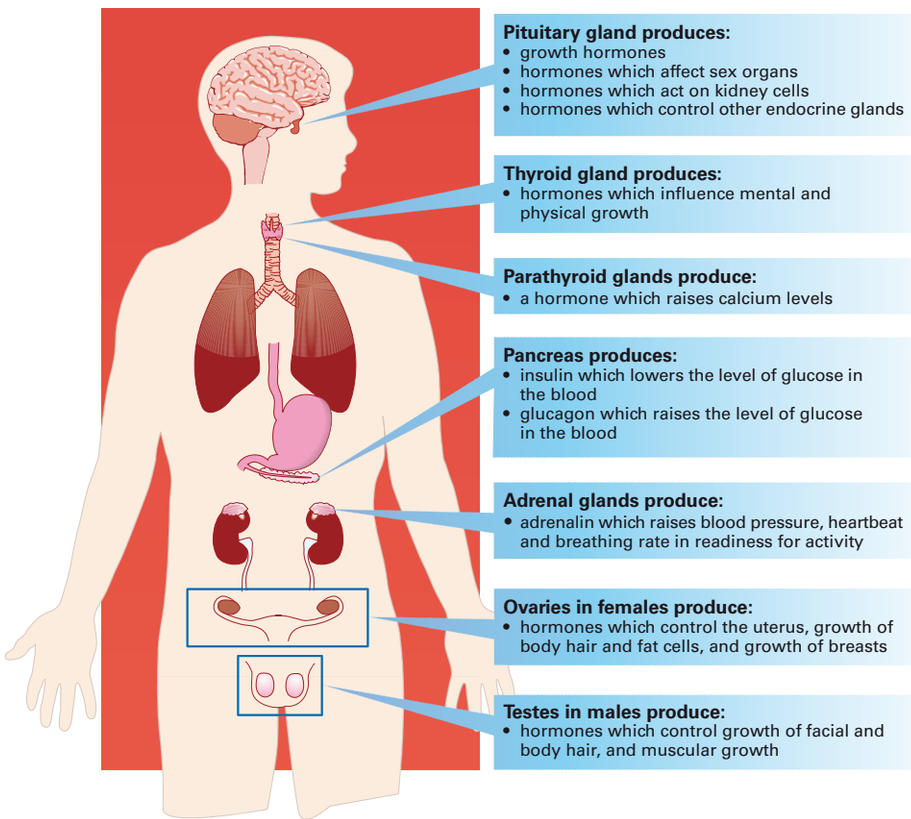
Hormones—chemical controllers

Hormones are produced in **endocrine glands**. The difference between these glands and others in your body, such as sweat glands and glands in the stomach lining, is that the hormones made by endocrine glands pass directly into the blood.

There are many different hormones and each one acts on specific target cells. For example, a hormone released by certain cells in the lining of the first part of the small intestine acts only on cells in the pancreas that make digestive juices. On the other hand, insulin, which is produced in specialised cells in the pancreas, has a broader action. It makes the liver cells store glucose and helps muscle cells throughout the body absorb more glucose from the blood.

Hormones are different from nerves in that they can act on the whole body, on body systems or on individual organs. Nerves act only on muscles and glands.

The diagram below shows some of the major endocrine glands and the effects the hormones produced have on the body.



Learning experience

Have students make colourful posters of the endocrine system, showing the major endocrine glands. They could have flip-up tabs with the name of the gland on the front of the tab and a description of its function on the back.

Learning experience

Get students to write a poem or song about the endocrine system. For example, they could compose their song to the tune of 'Dem Bones' but title it 'Dem Glands'. You might like to start them off with something like:

Dem glands, dem glands, dem endocrine glands

Dem glands, dem glands, dem endocrine glands

Dem glands, dem glands, dem endocrine glands

Dem glands are gonna rise!

The pituitary gland's located next to the hypothalamus …

or

The pituitary gland releases growth hormones …

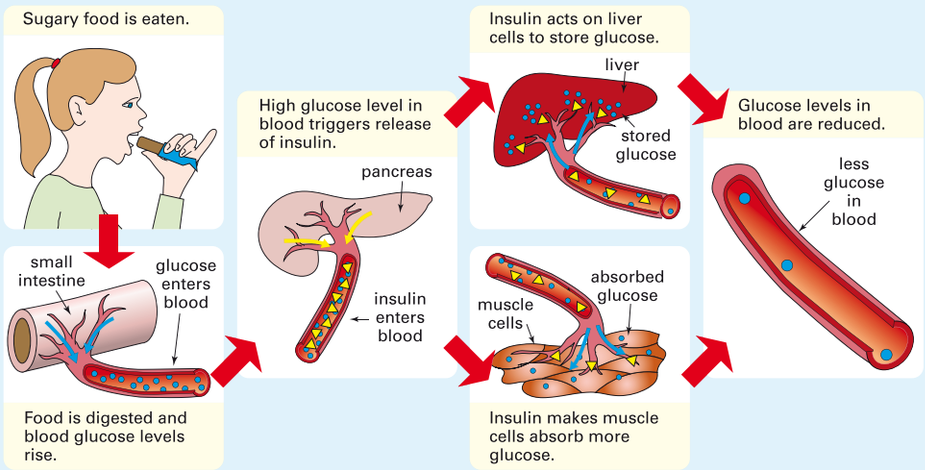
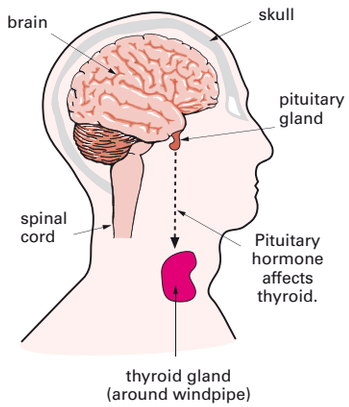


Fig 12 How insulin reduces blood glucose levels

The pituitary—the master gland

The **pituitary** (pit-YOU-it-tree) **gland**, located on the underside of the brain, is the master gland that controls other endocrine glands. For example, the release of the hormone from the thyroid gland in your neck is controlled by a thyroid-stimulating hormone from the pituitary.



Growth and development in humans

The pituitary gland also releases hormones which affect the reproductive organs. Before puberty the main physical growth of a person is under the control of the pituitary, which releases growth hormones.

Between 10 to 15 years after birth, the pituitary begins to release hormones which affect the reproductive organs. This causes major changes to the body and is the beginning of puberty.

In males, one pituitary hormone acts on the cells in the testes, which make sperm. Another acts on the testes to make the hormone testosterone. Testosterone stimulates the growth of facial and body hair and is also responsible for rapid muscular growth.

In females, one pituitary hormone leads to egg production in the ovaries and also to the manufacture of the hormone estrogen. Estrogen causes an increase in body hair growth, the growth of fat cells under the skin and the development of breasts. Another pituitary hormone acts on the ovaries and is responsible for the start of the menstrual cycle.

Hints and tips

Emphasise the importance of the pituitary gland. This gland, which is about the size of a pea, receives signals directly from the hypothalamus in the brain. The hypothalamus provides an important link between the nervous and endocrine systems.

Homework

Ask students to find out what dwarfism and gigantism are, their cause and treatment (if any), and what HGH is the abbreviation for.

Learning experience

Get students to draw a summary table listing the major endocrine glands, the name(s) of the hormones produced and the functions of these hormones.

Learning experience

Why can blood tests be used to check hormone levels in the body? Why is it important for the body to have the right hormonal balance? With the class, develop a set of 'why' questions for them to investigate. The questions could be answered using a spider map. The central idea (spider's body) could be *regulating hormones*, with each leg having a different question on it to explore.

Science in action

Diabetes

Diabetes is a fairly common disorder. Its main symptoms are glucose in the urine, extreme thirst, hunger and loss of weight. Before the 1930s fewer than 20% of people lived more than 10 years after developing diabetes.

Diabetes is caused by the body not producing any or enough of the hormone insulin. After a meal is digested a large amount of glucose is absorbed by the blood and the level of blood glucose rises. Insulin makes liver cells store glucose, and makes muscle cells absorb more glucose from the blood. The net effect is to reduce the amount of glucose in the blood. In people with diabetes, the pancreas does not produce enough insulin, or in other cases none at all, hence the high levels of glucose in their blood.

Types of diabetes

There are two main types of diabetes.

- **Type 1 diabetes** occurs when the body stops making insulin. This type is found in only 10 to 15% of all diabetes sufferers, and it occurs mainly in younger people. It cannot be prevented and is treated by daily insulin injections.
- **Type 2 diabetes** is the most common type and it occurs mainly in people over 40 who are overweight and inactive, have high blood pressure or heart disease, or in women who develop diabetes in pregnancy.

Diabetes is a serious illness for which there is no cure at present. *You cannot cure diabetes but you can control it.*

Parts of the body affected by diabetes

The high levels of glucose in the blood cause serious problems in the body. The blood vessels and nerves are the most affected. The walls of the small blood vessels thicken and block the blood supply. This causes problems in your eyes, kidneys, legs and heart.

Working with diabetes

Susan Mylne is a podiatrist (a person who examines feet) who works in Community Health and is very interested in diabetes.

Why is Susan interested in diabetes? Type 2 diabetes sufferers often have nerve damage in their feet. This causes 'pins and needles', a burning sensation and numbness. These people also suffer blood vessel damage which leads to poor blood circulation, and causes cramps, ulcers and pains in the legs.

Many of Susan's patients who have these symptoms often do not know they have diabetes. She can test for the complications of diabetes in their feet, help them in their treatment, and help educate them about their illness.

Questions and research

For this section you may use the websites on the left or surf the web for further information.

1 What is the importance of insulin in the body?
2 What is the difference between Type 1 and Type 2 diabetes? Which type would you class as a 'lifestyle illness'? Why?
3 There has been a rapid increase in the number of people contracting Type 2 diabetes in the last 5 years. Suggest reasons for this.
4 Suppose you are in charge of preparing a diabetes brochure. What information will you include to inform people about the affects of diabetes and its prevention? Prepare a draft design for the brochure.

WEBwatch

Go to www.scienceworld.net.au and follow the links to the websites below.

Diabetes Australia

International Diabetes Home Page

Hints and tips

The difference between a disease and a disorder is that diseases are caused by an external pathogen that has come from outside of the body. A disorder is a medical condition that is not caused by a pathogen. Genetic disorders cannot be caught—you are born with them.

Homework

Ask students to investigate what it means if a diabetic person has a 'hypo' (becomes hypoglycaemic). What symptoms does the person have, and what action is required to bring the person's blood sugar levels back to normal?

Learning experience

Consider getting a presenter from Diabetes Australia to give a presentation to the class on diabetes. If there is anyone in the class who is diabetic they might like to share what it is like having the disorder. Which type of diabetes do they have—Type 1 or Type 2?

Learning experience

Do the Webwatch if you have access to computers in class, or give it as a homework exercise.

Learning experience

Have students examine the issue of Type 2 diabetes. It once was more likely to affect older, overweight people but these days younger people, including teenagers, are being diagnosed with it. Why? Do students think the increase in sufferers can be halted? How? What health issues are associated with diabetes? How do Type 1 and Type 2 diabetes differ? How are they similar? What advice would students give to the community about diabetes? How would they educate the community to help them reduce their risk of getting diabetes? If it was their job to educate the community, what form of presentation would they use (eg media campaigns; advertising on TV, online or radio; organising parent information evenings)?

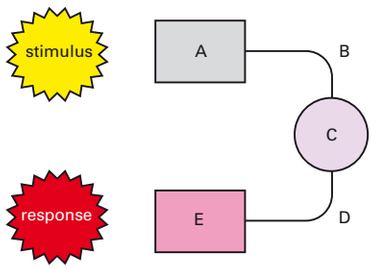
Check!

1 Some of the following statements are false. Find the false ones and rewrite them to make them correct.
   - **a** The endocrine system controls muscle movement, speech and the senses.
   - **b** The cerebrum controls involuntary actions like heartbeat and breathing.
   - **c** The spinal cord is protected from injury by the skull.
   - **d** Motor nerves carry impulses from receptors to the brain.
   - **e** Hormones are released directly into the bloodstream.

2 Suggest why reflex actions might be useful for an organism's survival.

3 What are the differences between a sensory nerve and a motor nerve?

4 The knee jerk reflex that occurs when the knee is tapped is an example of a simple reflex action. Copy the drawing top right and replace the letters with a description of what occurs at each stage.



5 Describe how hormones control the growth and development of the human body.

6 How are the actions of nerves different from those of hormones? Give examples.

7 What is the role of the pituitary gland in the functioning of your body?

8 Suppose you hear a sudden, extremely loud noise. What type of responses might occur to this stimulus? Would these responses be caused by nerves or by hormones? Explain.

challenge

1 A way to test a person's reaction to a stimulus is to drop a ruler between their thumb and fingers. The reaction distance is how far the ruler falls before they catch it.
   - **a** Ruby tested Ben's reaction by dropping a ruler seven times. The table shows his results. Suggest an inference to explain the results.

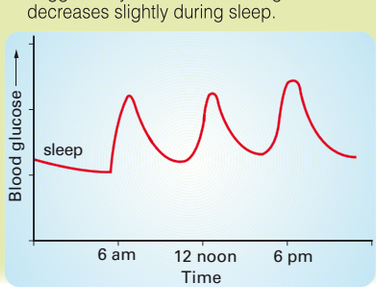
Trial	1	2	3	4	5	6	7
Reaction distance (cm)	28	21	17	13	11	10	9

   - **b** Ruby then tested Mia's reactions. The ruler fell an average of 16 cm before she caught it with her right hand, and 18 cm with her left hand. Suggest a reason for the different results.
   - **c** Use the formula below to find Mia's reaction time.

$$\text{reaction time (s)} = \sqrt{\frac{\text{reaction distance (cm)}}{500}}$$

2 A person who suffers a fractured neck is often paralysed below the fracture. Why is this?

3 The graph below shows the amount of glucose in someone's blood over a 24-hour period.
   - **a** Explain the reason for the peaks in the graph.
   - **b** At what times during the 24 hours did the amount of insulin being released from the pancreas increase? Suggest what caused this increase. What was the effect of the increase in insulin in the blood?
   - **c** Suggest why the level of blood glucose decreases slightly during sleep.



Challenge solutions

1 **a** The most likely inference is that Ben learned a technique which enabled him to catch the ruler more quickly. In other words, he improved with practice.

b The most likely reason is that Mia is right handed and uses her right hand more often than her left to respond to stimuli.

c Using the formula given, the reaction time can be calculated as follows:

$$\text{r.h.} = \sqrt{\frac{16\text{ cm}}{500}} = \sqrt{0.032} = 0.18\text{ seconds}$$

$$\text{l.h.} = \sqrt{\frac{18\text{ cm}}{500}} = \sqrt{0.036} = 0.19\text{ seconds}$$

2 If a person's neck is fractured it is likely that the sharp parts of the broken bones will damage or even cut the spinal cord. If this happens, messages will not be able to get from the receptors to the brain, or from the brain to the muscles or glands. This may cause partial or total paralysis. In the case of total paralysis, it is called quadriplegia.

3 Referring to the graph:

a The peaks show an increase in blood glucose and correspond to a short time after meals (ie 7 am, 1 pm and 6.30 pm).

Continued on next page

Check! solutions

1 **a** False. The nervous system controls muscle movement, speech and the senses.

b False. The cerebrum controls voluntary actions like speech and walking.

c False. The spinal cord is protected from injury by the spinal column or backbone.

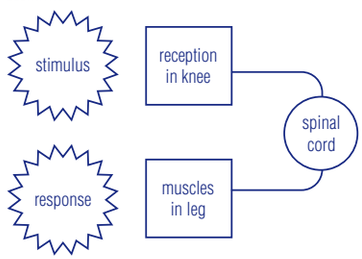
d False. Sensory nerves carry impulses from the receptors to the brain.

e True.

2 Reflexes are important because sometimes there is not enough time for the organism to think and respond consciously in a dangerous situation.

3 The main difference is that a sensory nerve brings information from the environment into the central nervous system, whereas a motor nerve takes it from the CNS to the glands and muscles.

4



5 Several growth hormones are produced by the pituitary gland in the brain and circulate in the blood. These hormones stimulate many cells throughout the body to divide and grow, which causes the human body to grow.

6 Nerves are different from hormones because they act on muscles and glands, whereas hormones can act on the whole body, body systems or special target cells in body organs. A simple example of nerve action is blinking your eyelid; an example of hormone action is insulin slowly removing glucose from the blood after a meal.

7 The pituitary gland is called the 'master' gland because it releases hormones that act on other glands in the body, causing them to release other hormones.

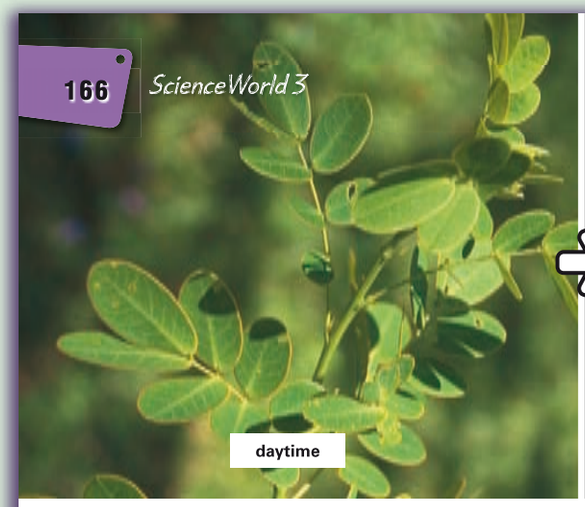
8 It is likely that different people may respond in different ways but generally there will be a quick reflex response, like moving your hand to protect your head, covering your ears or ducking down. These responses are caused by nerves. There may also be responses like running away or yelling out a warning to others. These responses are caused by hormones, especially adrenalin from the adrenal gland.

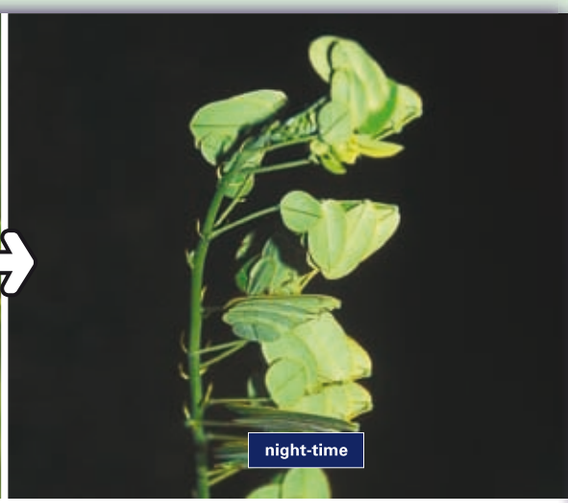
b The amount of insulin released from the pancreas increased at about 7 am, 1 pm and 6.30 pm. The increase was due to an increase in the amount of blood glucose after the meals were digested. The insulin decreased the level of glucose in the blood.

c During sleep, some of the glucose in the blood is used up slowly by cells.

Hints and tips

Tropism is the response where a plant grows towards or away from a stimulus. Stimuli include gravity, light, temperature and moisture.





7.2 Responses in plants

Why do some plants, like the one in the photos above, close the their leaves at night?

The plant closes its leaves in response to light and darkness. In the morning, the sunlight acts as a stimulus for the leaves to open. Plants also respond to other external stimuli such as gravity, temperature, moisture and, in some plants, touch.

Plants have no nervous system, muscles or specialised glands, so how do they detect stimuli and how do they react to these stimuli?

Plant hormones

The internal control of activities in a plant are due to hormones. These chemical compounds are made by certain cells and are distributed throughout the plant from cell to cell or by the microscopic tubes that run through the plant. Plant hormones are quite different chemically from those in animals. But, like in animals, very small amounts of the hormones have a large effect on the target cells and the plant as a whole.

Plants have far fewer hormones than animals, and, unlike animals, have no specialised glands such as those in the endocrine system.

Plant hormones are responsible for controlling the growth of stems and roots, the ripening of fruit and the loss of leaves during autumn. Hormones also determine when a plant will flower and when seeds will germinate.

When a seed germinates, the young root of the plant grows downwards. If the seedling is turned upside down, the root will bend and continue to grow downwards. This response to gravity is caused by a number of hormones which are produced in the root cells. You can investigate the response to gravity on the next page.

Fig 19 Deciduous plants lose their leaves in autumn. As the weather becomes warmer in spring, hormones are produced which stimulate the growth of new leaves.

Learning experience

Develop a series of 'fill-in-the-gaps' worksheets about responses in plants. Students enjoy activities that appear to be different from the traditional methods of note taking and copying information from the board. Make sure to include spaces in the worksheets for students to draw their own diagrams to illustrate points.

Learning experience

If it is at all possible, set up a video camera on time lapse to video the growth of a plant. Choose fast-growing plants such as vegetable seedlings—zucchini are ideal. You will need to set the camera up to record over a number of days. Enthusiastic students might like to attempt to do this themselves. Alternatively, students could take daily digital photos for a week and compile a photo chart of the plant's growth.

Learning experience

Students could take digital photos of plants showing evidence of the plant's responses to a stimulus. The photos could be displayed in a class book as a photo library. Each photo needs to have information about the stimulus to which the plant is responding, and who took the photo. Put the book on show for other classes to view. Any eye-catching photos could be enlarged and displayed around the science complex. Alternatively, students could choose to have an online photo exhibition.

Investigate
15 RESPONSES OF PLANT ROOTS

Aim

To investigate the responses of roots to gravity.

Materials

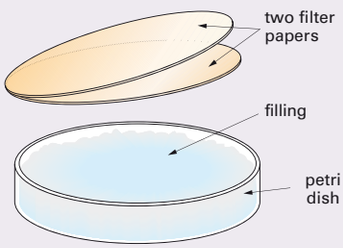
- 8 small bean seeds, eg mung beans (see Planning and Safety Check below)
- glass jar
- petri dish (11 cm diameter)
- filling, eg rubber carpet underlay, cotton wool, newspaper or cardboard
- 2 filter papers (to fit petri dish)
- Blu-Tack
- adhesive tape

Planning and Safety Check

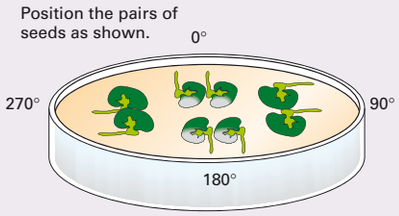
Prepare the bean seeds in advance. Soak them in a jar of water until they start to germinate. Tip out the water and leave the jar in a cupboard until the roots grow to about 1 cm long. Rinse the sprouts with fresh water each day.

Method

1 Place some filling (cotton wool, rubber underlay, cardboard) in the bottom of the petri dish. Then place two filter papers on top of the filling.

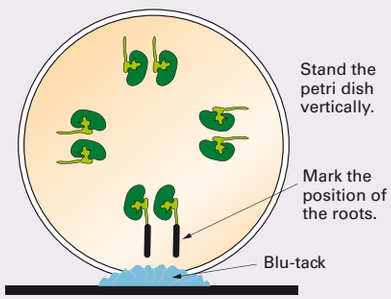


2 Place two bean sprouts on the filter paper with their roots pointing outwards, as shown in the diagram at the top of the next column. Place another two sprouts at the 90°, 180° and 270° positions.



3 Moisten the filter paper with some water. Put the lid on, and tape it securely. Make sure the seeds are jammed in by the thickness of the filling and filter papers. If the seeds move, add more layers of filter paper.

4 Place the petri dish on a piece of Blu-Tack in a vertical position, as shown. Use a marking pen to mark the position of the roots.



5 Leave the petri dish in this position for a day. Then rotate the dish 90°.

Record what happens to the direction of growth of the roots.

6 Repeat for another position and again record your observations.

Discussion

1 Write a report of your findings.

2 Suggest what might happen to the roots if the petri dish was taken into space.

Lab notes

- Quick-growing seeds, such as mung beans or pea seeds, are ideal.
- Some commercial seeds are dusted with a fungicide so it is important for students to wash their hands after handling.
- Paper towelling can be used instead of filter paper.
- It is a good idea to wash the roots with distilled water each day to reduce fungal growth (or spray with a fungicide).
- Students can take digital photos and use them to create a PowerPoint presentation of their report.

Growth hormones

A group of hormones called **auxins** (ORK-sins) are responsible for controlling the growth of stems and roots. They also make plants bend towards the light.

Response to light

One type of auxin is made in the cells in the growing tips of plants. This hormone moves through the cells away from the light.

The hormone passes downwards until it reaches the cells in the growth region just below the tip. It acts on these cells and makes them divide and grow in length. Hence the plant grows taller. The cells in the growing region of the plant are the target cells for auxin. Cells outside this region do not respond to the hormone. (See Fig 24.)

When light comes from one side, more auxin is found on the side away from the light. This causes the growth of cells on the darker side, which bends the plant towards the light. (See Fig 25.)

Fig 23 This tomato plant was placed on its side two days before the photo was taken.

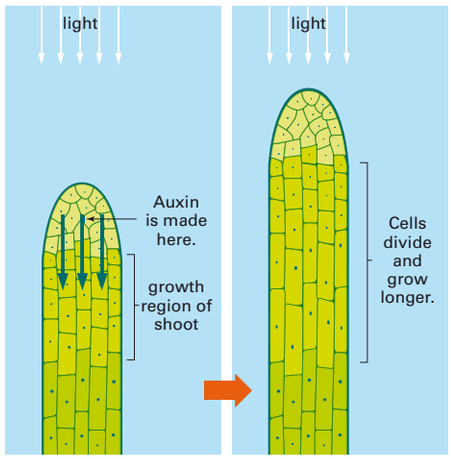


Fig 24 Auxin moves to the cells in the growth region where it makes them divide and grow longer.

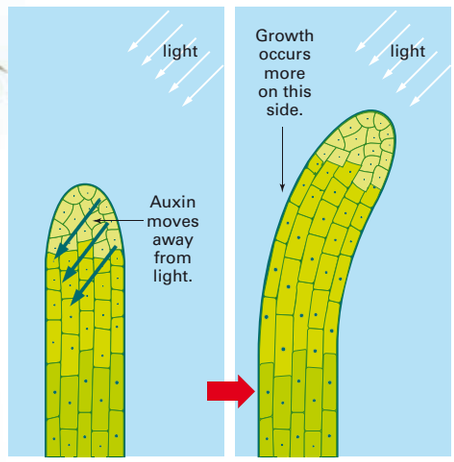


Fig 25 When light comes from one side, cells on the darker side divide and grow more than the ones on the other side.

Weedkiller

The weedkiller *glyphosate* is a compound with a similar structure to the auxin produced in a plant's growing tip. (*Roundup* is a brand name of the weedkiller which contains this compound.) When glyphosate is applied in very dilute solutions it will promote plant growth. However, in stronger solutions, plants grow uncontrollably and eventually die.

Hints and tips

- Phototropism is when plants grow towards light.
- Now would be a good time to do the experiment suggested in Getting Started on page 155, if students have not already done so.

Homework

Plant rooting powder, often used to propagate plant cuttings, is a plant hormone. Ask students to find out what the hormone is, and the likely effect of using it.

Learning experience

Have students investigate the commercial use of plant hormones or stimulant control to help plant growth, and to promote earlier or out-of-season flowering, quicker ripening of fruit, or larger fruit and vegetables. Students could present their work as *A grower's guide to using plant hormones or stimulant control*. They need to outline clearly the difference between using plant hormones and stimulant control:

- How does each method alter the growth of the plant?
- What are the benefits/drawbacks of each method?
- Are there any risks associated with either growing method—to the plant, the grower or the consumer?

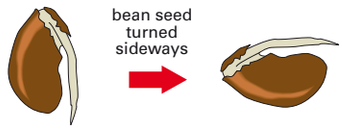
Check!

1 Describe the changes in plants that hormones are responsible for.

2 Most animals, particularly mammals, show rapid responses to certain stimuli such as hot objects, loud noises and bright light. Plants, however, respond very slowly to stimuli. Suggest reasons for this difference.

3 A pot plant has been growing near a window for a number of weeks and all the leaves face the window.
The plant is turned around 180°. After a few weeks the leaves of the plant have moved around to face the window again.
a What external stimulus is the plant responding to?
b What is the advantage of such a response to the survival of the plant?

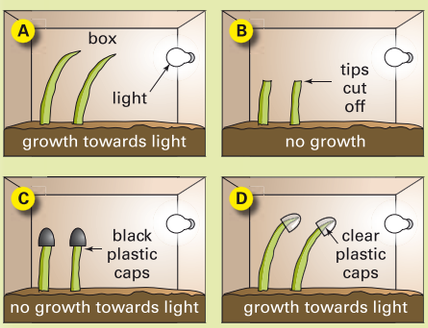
4 A bean seed was germinated and left to grow for a number of days. It was then turned sideways as shown.
a Draw what you would expect to happen to the seedling.
b What stimulus is the seedling responding to?



challenge

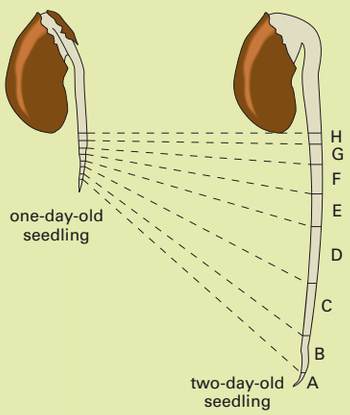
1 Biologists believe that another hormone besides auxin is produced in root tips. They think that this hormone stops the action of auxin. Suggest how the two hormones might be responsible for the growth of the bean shoot in Check 4 above.

2 The diagrams below show the results of four tests in an experiment using oat seedlings. Use the diagrams to answer the following questions.
a Suggest a title for the experiment.
b Look at the results of C and D. Write an inference to explain the differences.
c Which were the control seedlings? Explain.



3 Plant fertilisers promote the growth of plants. In which ways are fertilisers different from plant hormones?

4 The root of a one-day-old bean seedling was marked with equally spaced lines. The root was observed on the second day.



a Which sections showed most growth?
b Suggest what would have happened if the lower four sections had been cut off after day one.

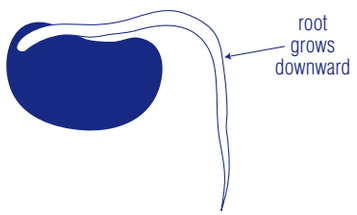
Check! solutions

1 Plant hormones are responsible for controlling the growth of stems and roots, the ripening of fruit and the loss of leaves. They also control the direction of growth of the roots.

2 The main reason for the slower response of plants is that they have no nervous system or muscles and must rely on the production and action of plant hormones.

3 **a** The plant is responding to the external stimulus of light.
b The advantage of this response is that the leaves of the plant will get more light, which will help with photosynthesis and growth.

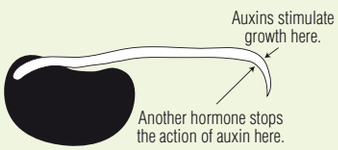
4 **a**



b The seedling is responding to the stimulus of gravity.

Challenge solutions

1 Auxins are plant hormones which stimulate cells to divide and grow larger. This would happen on the top right part of the root shown above in Check! 4. Another hormone might act on the opposite side of the root causing the effects of auxin to be slowed down or stopped. The combined effect would be as shown, with the root curving downwards (see diagram below).



2 **a** A suitable title for this experiment is 'The effect of light on the direction of growth of oat seedlings'.
b An inference to explain the differences between C and D is that light is responsible for the change in direction, because black plastic caps will not allow light through but clear plastic will.
c The control seedlings are in A. Generally you can say that nothing is done to the control in an experiment so that you can use it for comparison with other parts of the experiment.

3 Plant fertilisers are dissolved in water and absorbed by the roots of plants. They stimulate growth because they are used by the plant to make new cells or materials in cells. Hormones, on the other hand, are produced by the plant and speed up the reactions in the cells that use the chemicals in the fertilisers, and other substances like CO_2 and H_2O.

4 **a** The sections that showed the most growth were C and D.
b If the lower sections were cut off after day one, you would expect that no growth would occur. The reason is that the cells actually divide in Section A and then grow longer in Sections B, C and D.

Hints and tips

Spend a few minutes revising the chapter so far. You could conduct a quick quiz, making sure to include a few open-ended thinking questions. Go through the answers immediately after the quiz so that the students have instant feedback. Alternatively, you could give them a 'Match the word and meaning' worksheet to place into their notebooks.

7.3 Body balance

In Section 1 you learnt how the glucose level in the blood is controlled by the hormone insulin. Now let's look at the control of heat and water in the body.

Heat balance

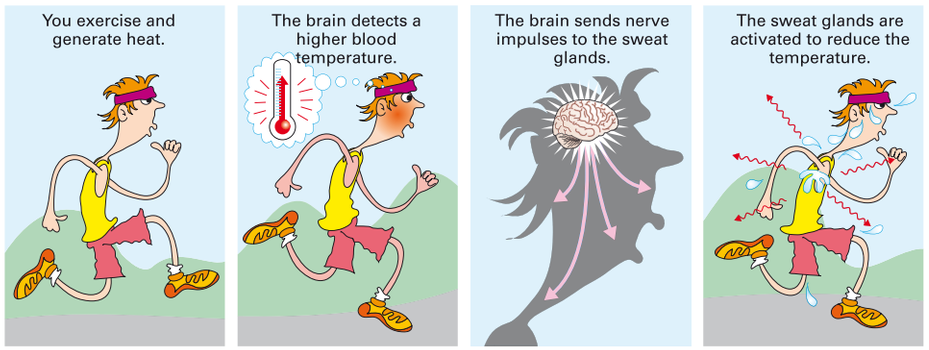
Your body temperature stays at about 37°C. This is the set-point temperature for humans. The chemical reactions in the cells of your body work best at this temperature. All mammals and birds have a constant body temperature, although the set-point temperature varies between groups of these animals. For example, the set-point temperature for a magpie is about 39°C, while for echidnas it is about 31°C.

Most of the heat needed to maintain the set-point temperature is generated during the respiration of glucose in your body cells, particularly in the liver, kidney and brain. On the other hand, most of your body's heat loss is by radiation from your skin surface and by evaporation of sweat from your skin. The table at the bottom of the page summarises the ways in which heat is gained and lost by your body.

Control of heat balance

During exercise, your muscles generate heat, which increases the temperature of the blood. A receptor in the brain just above the pituitary gland is sensitive to changes in the temperature of the blood and sends out nerve impulses to the skin and sweat glands.

Fig 29 The heat receptors in your brain are sensitive to changes in blood temperature and send impulses to the skin.



How heat is gained	How heat is lost
• heat released from respiration in all cells in the body • heat released from respiration in muscle cells during exercise • absorption of heat from the Sun and atmosphere	• radiation of heat from blood flowing beneath the skin (The heat loss increases as the outside temperature decreases.) • evaporation of sweat from the skin • heat lost when breathing out • heat lost in urine and faeces

Learning experience

Students could do two PMI charts—one for mammals with a set-point temperature, and the other for reptiles that don't have a set-point temperature. Students can then use the charts to write a paragraph comparing and contrasting mammals and reptiles.

Learning experience

Get students to find out what homeostasis is and to explain its meaning in the context of this chapter. *Homeostasis* is a good word to add to the concept map or the list of progressive summary points started earlier.

Learning experience

Students could draw their own pictures (similar to Fig 29) to show what happens to the body in a cold environment. Alternatively, they could draw their own concept cartoon to explain the heat balance of the human body. The pictures could be drawn on A4 paper (landscape orientation) and joined together to make a frieze which can be displayed in the room or hallway.

By sweating and radiating heat, your body temperature falls. But when the temperature falls below the set-point temperature, the heat receptors in the brain detect a lower blood temperature and send nerve impulses to the skin and sweat glands to reduce heat loss, and the body temperature gradually rises. All of these actions cause the body temperature to fluctuate between 36°C and 38°C.

This system of control is called a **negative feedback system** because the response acts as a stimulus to oppose (negative action) the change caused by the original stimulus.

In the example, the original stimulus is the higher body temperature. The body's response is to activate the skin and sweat glands to lower the body temperature. Following this, the lower body temperature acts as a stimulus for the brain to oppose the original action caused by the high body temperature.

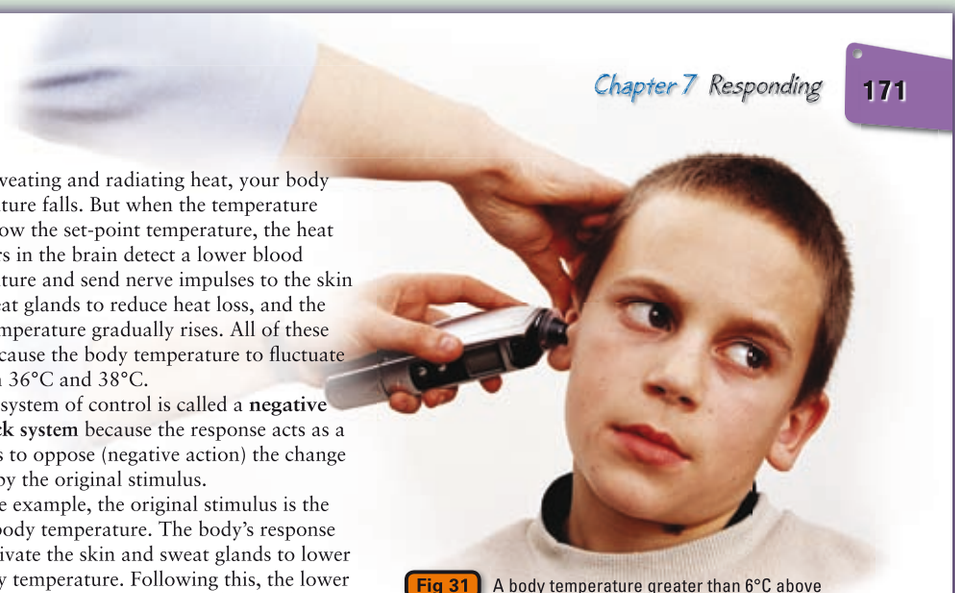


Fig 31 A body temperature greater than 6°C above set point can lead to death. This is why the temperature of patients suffering from fever is closely monitored.

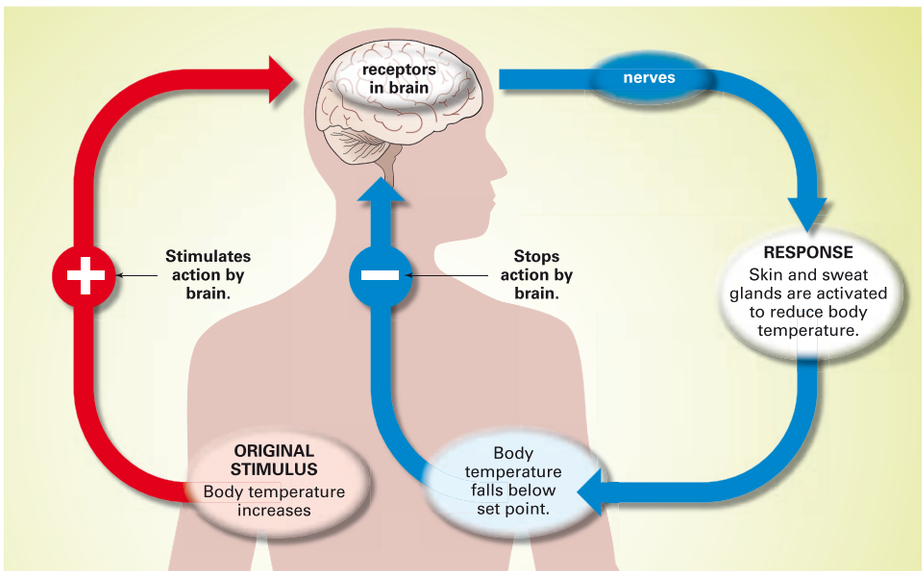


Fig 30 The negative feedback system involved in the control of body temperature

To see how the body controls temperature, open the **Negative feedback animation** on the CD. Working with technology

Hints and tips

Have a box with assorted science activities/puzzles for students who complete their class work early. Rate each activity according to the difficulty of the task/problem. Set the challenge for each student in the class to complete a certain number of activities each semester. They should have a record sheet which you can sign after they complete each task, and you can award them marks according to the level of difficulty. At the end of the semester you may like to issue certificates to 'Super Science Achiever' students. Such an activity can help cater for gifted and talented students.

Learning experience

Have students investigate hyperthermia and hypothermia. They could present their work as an article for a sports magazine in the form of an interview with someone who has suffered the condition, or as a survivor's guide to hyperthermia and hypothermia for outdoor/extreme weather sports. The following questions are a suggested starting point:

- How are the conditions different from each other?
- What are some causes, and factors that could increase the risk of getting the condition?
- What are the symptoms?
- What are the short-term and long-term effects on the body?
- What medical treatment should be given?

Learning experience

If a person's body temperature is greater than 6°C above set-point it can result in death. Have students investigate why this is so and find out more about fevers. A good way for students to approach this task is for them to do it as a Round Table activity. However, before working in a group, ask students to write a list of questions they think would be important to investigate, and then discuss them as a group. Allow groups to choose how to present their findings.

Activities

Evaporation and cooling

When your body gets hot, you sweat to reduce your temperature. How does sweating affect body temperature?

1 Place a small drop of water on your arm. Blow on it to evaporate the drop.
   - What do you feel? Blow on your other (dry) arm to compare the sensation.

2 Repeat Step 1 using a drop of methylated spirits.
   - Suggest a reason for the different sensation with the methylated spirits.
   - Your arm feels cooler when the liquids evaporate. Why? Use the particle model and your knowledge of change of state to help you answer this.
   - Write an inference to explain why sweating lowers your body temperature.
   - Design an experiment to measure the cooling effect of evaporation. (You can use a thermometer or a datalogger with a temperature sensor for this.)

Air conditioners

Like your body's control of temperature, air conditioners also use negative feedback to control temperature.

Use the points below to design a negative feedback flow diagram for an air conditioner, like the flow diagram on the previous page.

- You set the temperature on the control panel to, say, 23°C. This is the set-point temperature.
- There is a temperature sensor in the air conditioner unit.
   - Draw the flow diagram showing how the air conditioner works.
   - A sensitive thermometer will show that the temperature in the room fluctuates around 23°C. Why is this? Sketch a graph that shows the temperature in the room over a few hours. Mark on it when you think the air conditioner switches on, and when it switches off.

Water balance

Water is a very important substance in the body since just over 70% of your body mass is water.

You constantly lose water by evaporation from your skin (sweat), in your breath and in liquid and solid wastes. However, water is replaced by drinking liquids and by eating foods. Many cell reactions also produce water.

The kidneys are responsible for water balance in your body. These two bean-shaped organs lie close to your backbone behind the small intestine. They have a rich blood supply from a branch of the large artery that runs from the heart to the lower part of your body.

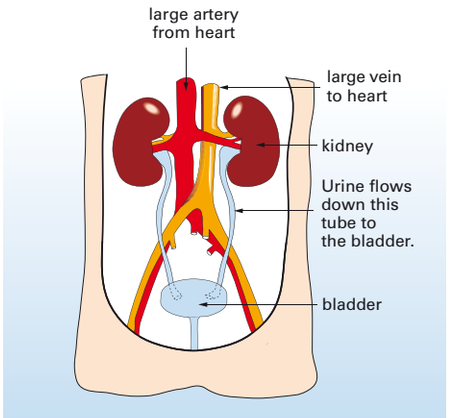


Fig 32 The wastes in the blood are filtered by the kidneys and are then eliminated by the body as urine.

The kidneys filter wastes from your blood. Your body contains about 5 litres of blood, and about one litre of this passes through the kidneys every minute. So in five minutes all the blood in your body is filtered. The filtering process occurs as the blood flows through capillaries in the kidney. Water and dissolved wastes pass out of the blood into tiny collecting tubes. A lot of the water is reabsorbed, and a concentrated solution called urine flows into the bladder for storage until it is eliminated.

Hints and tips

Get the students to revise the goals they set at the beginning of the chapter. How many have they achieved? Were their goals realistic? Do they need further improvement in a particular area? What do they think they did well? Ask students to write a self-evaluation.

Activity notes

- Make sure students do not get methylated spirits in their eyes when blowing on their arm. They should blow gently.
- The usual scientific report format should be used when students design and carry out their experiment on the cooling effect of evaporation. Remind students to consider the variables tested, what they want to measure, how to display and interpret their results, and so on.

Research

Have students research what dialysis is. How does it work? What types of dialysis are there? What sort of life can people on dialysis live? What percentage of Australians under the age of 18 have the treatment? Write your findings as an interview with someone who undergoes dialysis.

Issues

- What do students think about organ donation, particularly donation of kidneys? How would they feel about receiving an organ donation if it was their only chance of prolonging their life? Ask them to explain.
- If they decided to have the transplant, would they want to meet the donor's family? Why or why not?
- What ongoing treatment is required for transplant recipients? Have students write a one-page set of lecture notes for a medical professional outlining issues relating to organ transplants.

Learning experience

Find out some interesting facts about kidneys. Did you know it is possible to live a normal life with only one kidney? In fact, you can live a relatively normal life with less than one kidney functioning properly. Generate a 'Did you know' list of facts about kidneys. This exercise could be further extended to include facts about all aspects of this chapter.

Investigate

16 KIDNEY DISSECTION

Aim

To examine a sheep's kidney.

Materials

- sheep's kidney
- scalpel, scissors and tweezers (forceps)
- dissecting board
- disposable gloves and lab coat
- newspaper
- microscope and slides
- disinfectant and towel

Wear safety glasses.

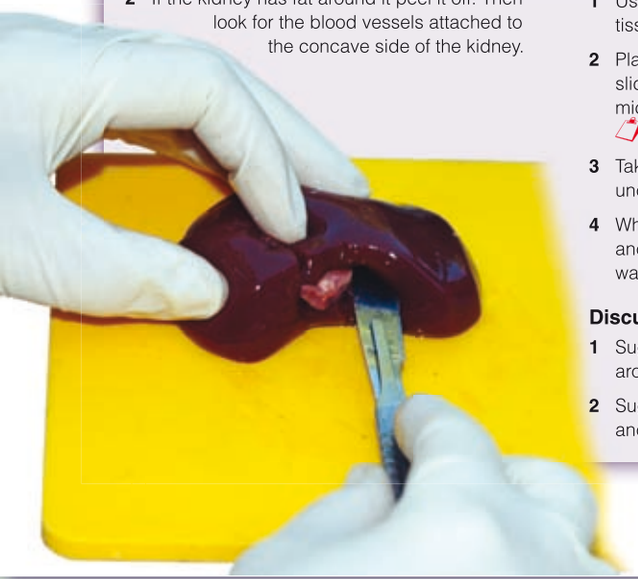
Planning and Safety Check

- Read through the investigation so that you know exactly what to do.
- What safety precautions will you take when handling the kidney? How will you dispose of the kidney when you have finished with it?

PART A

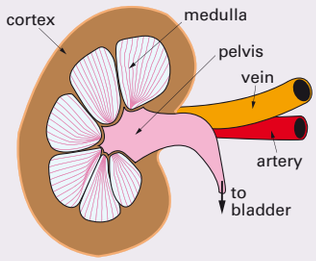
1 Lay a few pages of a newspaper on the bench and put the dissecting board on them.

2 If the kidney has fat around it peel it off. Then look for the blood vessels attached to the concave side of the kidney.



3 Use the scalpel to cut the kidney in half. Then use the diagram to identify the various parts.

Warning: Take care when using a scalpel.



The cortex is where the wastes are filtered out of the blood into tiny collecting tubes. The dark red colour of the cortex is due to blood capillaries. The medulla contains the collecting tubes. There are about a million of these tubes in a kidney. Urine trickles down the collecting tubes into the pelvis and then into the bladder.

PART B

1 Use a scalpel to cut a very thin piece of kidney tissue from the cortex region.

2 Place the thin section on a microscope slide and look at it under low power on a microscope.
Record what you see.

3 Take a thin section of the medulla and look at it under a microscope.

4 When you have finished, dispose of the kidney and scraps, disinfect the dissecting board and wash your hands thoroughly.

Discussion

1 Suggest why there is usually a thick layer of fat around the kidneys.

2 Suggest the advantages in having two kidneys and not just one.

Lab notes

- If possible, buy the organs from your local butcher shop as they are more likely to be intact. Try to get the kidneys with fat (and ureter) still attached.
- Explain to students, in advance, that you are going to do the activity, and insist on a note signed by a parent prior to the lesson if they do not wish to participate.
- Make sure the bench is covered in newspaper.
- Remind students to be very careful when they are using a scalpel.
- Students should use plastic disposable gloves. Remind them of hygiene issues.
- Insist on acceptable behaviour while performing the dissection. See the notes for the Activity on page 157.

Part B

This part can be difficult and is probably better done as a teacher demonstration using a Video Flex or similar device.

The table below shows the water inputs and outputs that might occur in a person on a mild day. The outputs and inputs are generally balanced.

Water outputs (mL)		Water inputs (mL)	
urine	1500	drinking	1500
sweat	600	food	800
breath	400	from cell reactions	300
faeces	100		
total	**2600**	**total**	**2600**

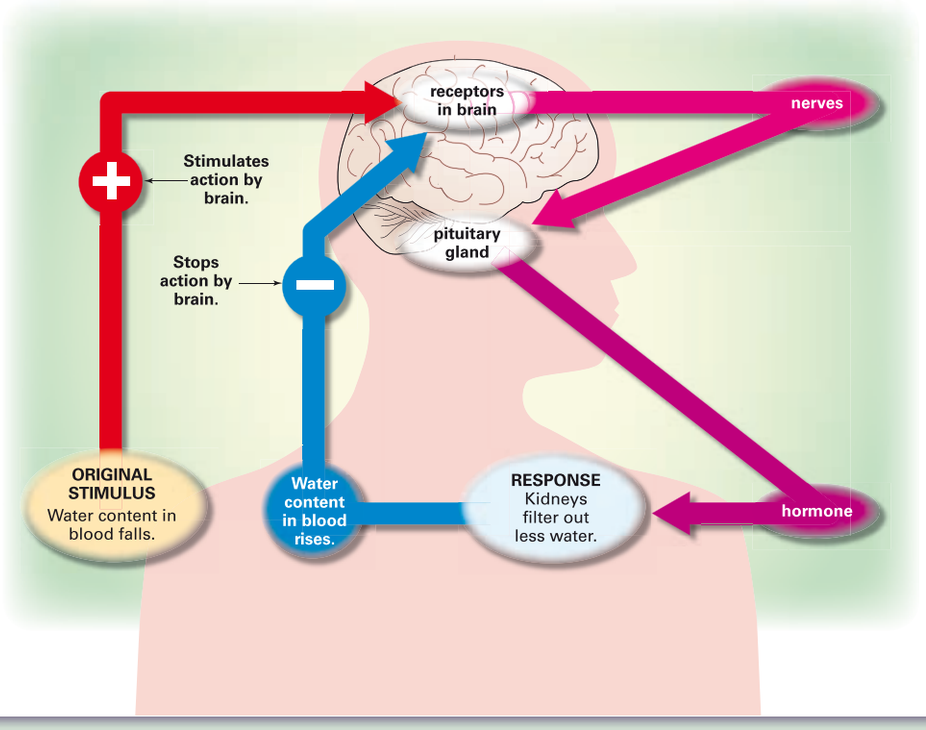
The amount of water that is filtered out of the blood changes with the heat and humidity of the day, the amount of sweat you produce and the amount of water you drink.

How much water is lost from the kidneys is controlled by nerves and hormones. Receptors in the brain are sensitive to changes in the amount of water in the blood. For example, on a hot day a lot of water is lost in sweat. This means that the water content of body fluids, including blood, drops. The brain detects a lower water content in the blood and sends a nerve impulse to the pituitary gland. A hormone called ADH is released which acts on the tiny tubes in the kidney. These tiny tubes filter out less water and the volume of water lost decreases.

Water balance and negative feedback

Water balance in the body operates by a negative feedback system (see diagram below). When the kidneys reduce the amount of water in the urine (because of the water lost by sweating), the water content of the blood gradually increases. This increase is detected by the receptors in the brain which in turn stimulate the pituitary gland to release less hormone, and so the reverse of the original action occurs.

Fig 35 The amount of water lost by the body through the kidneys operates by negative feedback.



Hints and tips

Revise section 7.3 by asking the students to write a paragraph about what they have learned so far and share it with the person next to them. Then choose a few students to read aloud their paragraphs to share with the class.

Homework

Can drinking too much water be just as harmful as not drinking enough? Ask students to explain this. Fluid retention can cause major health problems. What are some causes of fluid retention and what are some ways of treating it?

Learning experience

Students could make a crossword or a multiple-choice quiz using the key sentences they have written for each section of the chapter. If the students do this, collect their questions and use them to compile a revision quiz or topic test for the class.

Learning experience

Poor kidney function can lead to high blood pressure. Why? Turn this into a Think/Pair/Share activity. Can students come up with their own Think/Pair/Share question?

Check!

1 How is heat lost from the human body? In which ways can this loss be reduced?

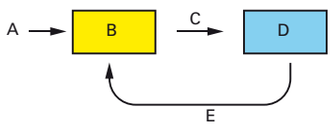
2 **a** What is a set-point temperature?
b Which groups of organisms have a constant body temperature?
c What is the advantage to organisms that have a constant body temperature?

3 Some of the sentences below are false. Select the false ones and rewrite them to make them correct.
a Most water is lost from the body as sweat.
b Body heat is lost only by evaporation of water from the skin.
c Heat energy is released during cell respiration.
d Urine is made in the bladder and stored in the kidneys.
e The pituitary gland detects changes in body temperature and sends hormones to the skin and sweat glands.

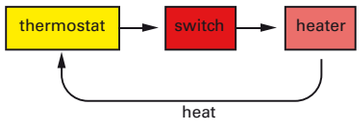
4 How is water lost by your body? How is it replaced?

5 Use the table of water inputs and outputs on page 174 to infer the changes that would occur if:
a the measurements had been taken on a very cold day.
b the measurements had been taken over a period which included exercise.

6 The boxes and arrows below represent the negative feedback system involved in the control of body temperature in Fig 30 on page 171.
Use the labels on the diagram in Fig 30 to replace the letters in the diagram below.

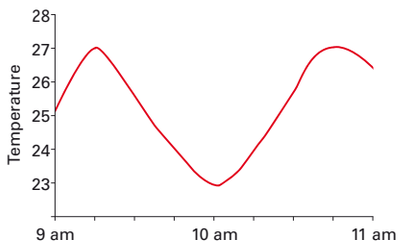


7 The diagram shows the parts of a heating unit that controls the temperature in a house.



a What is the function of the thermostat?
b What is the function of the switch?
c Why is this an example of a negative feedback system?

8 The graph below refers to the information in Question 7. It shows the temperature inside the house over a 2-hour period.
a What is the set-point temperature?
b At what time did the heater turn on? When did it turn off?
c By how many degrees did the house temperature vary?
d Why do you get small rises and falls of temperature in systems that operate by negative feedback?



9 Your body contains about 5 L of blood.
a If the kidneys filter one litre of blood per minute, how much blood is filtered in one day?
b How many times is the total volume of blood filtered in a day?
c Suppose your body produced 1500 mL of urine in a day. Express this volume of urine as a percentage of the total volume of blood filtered in a day.

Check! solutions

1 Heat is lost from the human body by radiation through the skin and to a lesser extent by conduction. This loss can be reduced by providing a cover of clothing or a shiny reflective blanket.

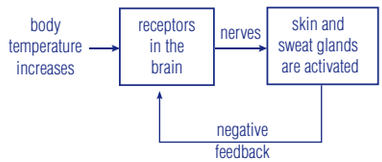
2 **a** A set-point temperature is the temperature at which the cells in an organism work best. If this temperature changes up or down there are systems that will return it to this set-point temperature.
b Birds and mammals are the groups of animals which have this set-point temperature.
c The advantage of this set-point temperature is that the animals are usually able to remain active irrespective of the outside temperature. This means that they can hunt for food and reproduce throughout the year.

3 **a** False. Most water is lost from the body as urine.
b False. Body heat is lost not only by evaporation of water from the skin, it is also lost in your breath, faeces and urine, and by radiation from the skin.
c True.
d False. Urine is made in the kidney and stored in the bladder.
e False. Receptors in the brain just above the pituitary gland detect changes in body temperature and send out nerve impulses to the skin and sweat glands.

4 Water is lost from your body as urine, breath, sweat and in faeces. It is replaced by drinking, eating food and from cell reactions.

5 Referring to the table on page 174:
a If the measurement had been done on a very cold day there would be less water lost by sweat and more by urine, and probably less input by drinking.
b If the measurements had been taken over a period including exercise there would be greater inputs from cell reactions and drinking, and greater outputs in the breath and sweat.

6



7 **a** The function of the thermostat is to measure the temperature in the house.
b The function of the switch is to turn the heater on and off.
c This is an example of a negative feedback system because if the heater is on and the temperature gets too high the thermostat will switch the heater off and the temperature will fall again.

8 Referring to the graph:
a The set-point temperature is about 25°C. The set-point temperature is the average temperature of the house. In a negative feedback system the house temperature would rise slightly above the set-point and then fall slightly below it.
b The heater turned on at 10 am. It turned off at about 9.15 am and 10.45 am.
c The house temperature varied by about 4°C.
d For a negative feedback system to work, the house temperature must rise slightly above the set-point temperature for the heater to switch off. It must fall slightly below the set-point for the heater to switch on.

9 **a** You can calculate this by multiplying :
1 L × 60 mins × 24 hours = 1440 litres
b The total volume of blood filtered per day should be divided by the volume of blood in the body:
1440/5 = 288 times each day
c 1.5 L/1440 L × 100 = 0.1%

challenge

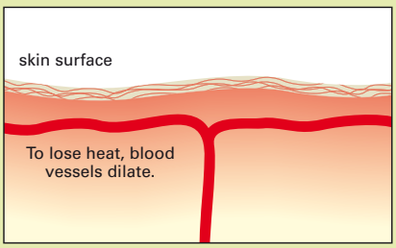
1 Sweat contains about 99% water and 1% salt, mainly sodium chloride. It is made in the sweat glands in the dermis of the skin and is released over the surface of the skin through the sweat pores. There are about 2 million sweat glands in the human skin.

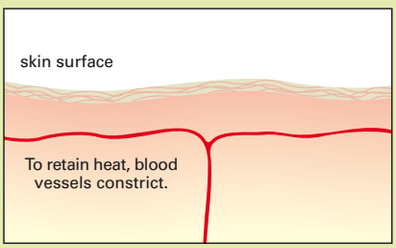
a Use your knowledge of change of state of matter to explain in terms of the particle model how sweat reduces the temperature of the skin.

b Some other mammals such as dogs have very few sweat glands. During exercise or hot weather dogs pant. Suggest how they might lose heat by this action.

c Why do you think that athletes, after a very vigorous workout, drink liquids containing salts and minerals?

2 To lose heat, the capillaries in your skin dilate (become much larger in diameter) and carry more blood. To retain heat, the capillaries constrict (become smaller in diameter).





a Suggest how the actions of the blood capillaries can increase and decrease heat loss from the body.

b Why does your skin look much redder during or just after exercise?

c Suggest how a wet suit helps divers reduce heat loss when they are under water.

3 A car is being driven at 60 km/h, the speed limit around town. The car goes up a hill and starts to slow down. The driver presses harder on the accelerator pedal. As the car goes over the top of the hill, it speeds up.

Draw a flow diagram to explain how keeping a car at 60 km/h in this story is controlled by negative feedback.

4 Your breathing rate at rest is about 18 breaths per minute, but when you breathe into and out of a paper bag, your breathing rate increases.

To find out whether it is the lack of oxygen or the rise in carbon dioxide that acts as the stimulus to increase breathing rate, an experiment was carried out. The tables below show the results.

% of O_2 in air breathed in	10	15	20	25	30
breathing rate (breaths/min)	18	19	18	18	19

% of CO_2 in air breathed in	1	3	6	9	12
breathing rate (breaths/min)	18	19	25	35	50

a Which gas seems to affect the rate of breathing?

b A receptor at the base of the brain is sensitive to levels of CO_2 in the blood. Suggest how negative feedback might control your breathing rate. Draw a flow diagram to help your explanation.

Challenge solutions

1 **a** Sweat is a liquid and consists of particles which are continually moving around. If they begin to move faster and change into a gas they are said to evaporate. To do this, they take some heat energy from the skin and the skin feels cooler.

b When the body temperature of a dog rises it begins to pant. During panting, the dog's breath passes in and out rapidly and some of the saliva on the tongue evaporates. This action takes heat from the tongue and this causes a cooling effect for the whole animal.

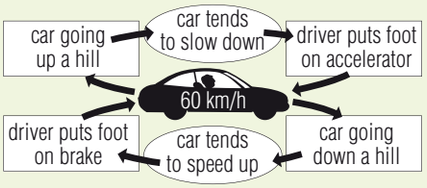
c During vigorous exercise the temperature of an athlete's body rises and as a response there is an increase in the amount of sweat. This is why it is important to drink liquids that contain water and salts to replace those lost in the sweat.

2 **a** The blood capillaries carry large amounts of blood near the surface of the body. Some of this heat is radiated into the air and lost from the body. If the blood vessels are dilated then more blood will be carried and more heat will be lost.

b Your skin will look redder after exercise because there is more blood flowing closer to the surface of the skin to remove heat from the body.

c A wet suit traps a layer of water near the skin when a diver is submerged in water. This water is warmed up by the diver's body and then acts as an insulating layer to reduce heat loss when the diver is in the water.

3

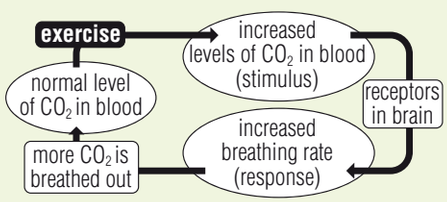


Negative feedback occurs whenever the response reduces the stimulus. This occurs both when the car speeds up and when it slows down, as shown in the flow diagram above.

4 Using the information given:

a The gas that controls the rate of breathing is carbon dioxide (CO_2) because an increase in its concentration causes an increase in the breathing rate. An increase in the oxygen concentration has no effect on the breathing rate.

b During exercise, the level of carbon dioxide dissolved in the blood increases. This change is detected by receptors in the brain and the response is an increase in the breathing rate, which causes a decrease in the amount of carbon dioxide in the blood. This is an example of negative feedback and is shown in the diagram below.



MAIN IDEAS

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

1 All of the body's functions are controlled and coordinated by the _____ system and _____ system.

2 The _____ is the main organ of the nervous system and consists of three main parts; the _____ controls voluntary actions, while the cerebellum and brain stem control _____ actions.

3 Sensory neurons relay _____ from _____ to the brain, while _____ neurons relay impulses from the brain to muscles or glands.

4 A _____ is an automatic response which occurs when an impulse travels to the spinal cord then straight back to a muscle.

5 Hormones are _____ which are made in endocrine glands and are released directly into the blood.

6 _____ are responsible for controlling growth, ripening of fruit and the timing of flowering.

7 Many of the body's processes such as water and _____ balance are controlled by _____.

brain
cerebrum
chemical controllers
endocrine
heat
impulses
involuntary
motor
negative feedback
nervous
plant hormones
receptors
reflex action

Try doing the Chapter 7 crossword on the CD. Working with technology

REVIEW

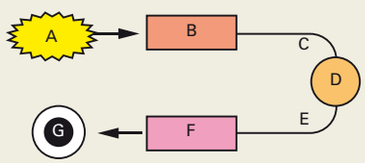
1 In a darkened room, Joel felt a sticky cobweb suddenly cover his face, and he immediately pulled away.
Which type of receptor was used for this action?
A vision
B taste
C touch
D sound

2 The action of Joel pulling away from the cobweb was probably:
A caused by muscles activated by hormones
B a reflex action
C the stimulus to the response
D caused by a negative feedback system

3 Parts of the body are under voluntary control and others are under involuntary control.
a Which body actions are involuntary?
b Which parts of the nervous system coordinate involuntary actions?

4 The flow diagram below shows a typical reflex action after a bright light has been shone in your eye. Match the letters in the diagram with the words in the following list.

receptors in eye
flash of light
spinal cord
sensory neuron
pupil
motor neuron
pupil decreases



Main ideas solutions

1 nervous, endocrine
2 brain, cerebrum, involuntary
3 impulses, receptors, motor
4 reflex action
5 chemical controllers
6 plant hormones
7 heat, negative feedback

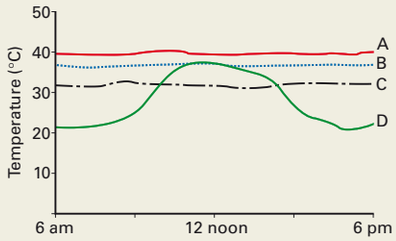
Review solutions

1 **C**
2 **B**
3 **a** Involuntary actions include heartbeat, breathing, digestion and balance (see page 157).
b The cerebellum and the brain stem coordinate involuntary actions.
4 **A** flash of light **E** motor neuron
B receptors in eye **F** pupil
C sensory neuron **G** pupil decreases
D spinal cord

REVIEW

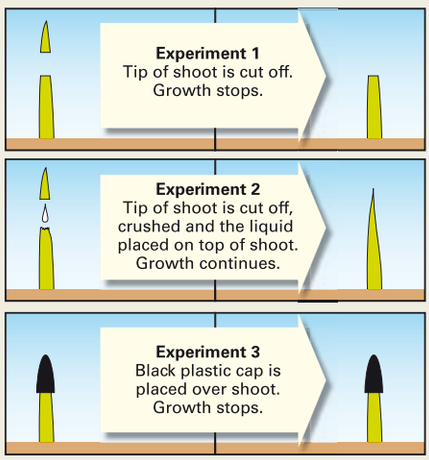
5 Nerves and hormones are both used by the body to relay messages from one point to another. How does the action of nerves differ from that of hormones?

6 The body temperatures of four animals were recorded over a 12-hour period. The results are shown in the graph below.



- **a** Which of the animals are likely to be mammals or birds. Explain.
- **b** What is the set-point temperature for animal A?
- **c** Which animal is probably a human?
- **d** Suggest an inference to explain the shape of the graph for animal D.

7 The following three experiments on plant hormones were done with oat seedlings.



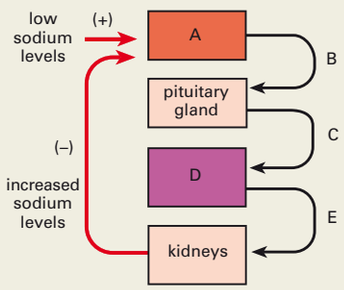
- **a** Write an inference to explain the results of each of the three experiments.
- **b** Design an experiment to show that the plant hormone will act only on cells just below the tip of the seedling and not on cells further down.

8 Read the following about a hormone which controls the sodium levels in your body.

The adrenal glands are situated on top of each kidney and produce a hormone (we will call this hormone X) which regulates the amount of sodium in the blood. It does this by acting on the kidney to reduce the amount of sodium that is filtered out into the urine.

The adrenal glands are under the control of the brain and the pituitary gland. Receptors in the brain detect a low blood sodium level. Nerve impulses from the brain are sent to the pituitary gland which releases a hormone (called hormone Y) which stimulates the adrenal glands to release hormone X.

- **a** What happens to the blood when hormone X is released from the adrenal glands?
- **b** Which part of your body is sensitive to levels of sodium in the blood?
- **c** Negative feedback is used to control the amount of sodium in the blood. Use the information above to replace each of the letters in the flow diagram below.



Check your answers on page 335.

5 Hormones can act on the whole body, on body systems or on individual organs. On the other hand, nerves act only on muscles and glands.

6 **a** Animals A, B and C are mammals or birds because they have a constant body temperature.

b 40°C

c Animal B is probably a human because the set-point temperature is about 37°C.

d The body temperature of animal D increases during the morning as the outside temperature increases. Its body temperature decreases when the outside temperature decreases in the afternoon.

7 **a** **Experiment 1:** The cells that produced the growth hormone were removed, so the growth of the shoot stopped.

Experiment 2: The growth hormone in the extract acted on the cells below the cut and growth continued.

Experiment 3: The aluminium cap stopped the light getting to the cells in the tip, which in turn stopped the production of growth hormone, and growth stopped.

b There are several possible designs. Here is one way:

- Cut the tip off one plant, crush it and place the extract on the cut shoot (as in Experiment 2).
- Cut the tip off a second plant and crush it. Then cut off another piece of the shoot to expose the cells further down. Place the extract on this shoot.
- The first plant should grow while the second one will not.

8 **a** Hormone X stimulates the kidney to reduce the amount of sodium being filtered out of the blood and therefore increases the amount of sodium in the blood.

b the receptors in the brain

c