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FOR NSW STAGE 5

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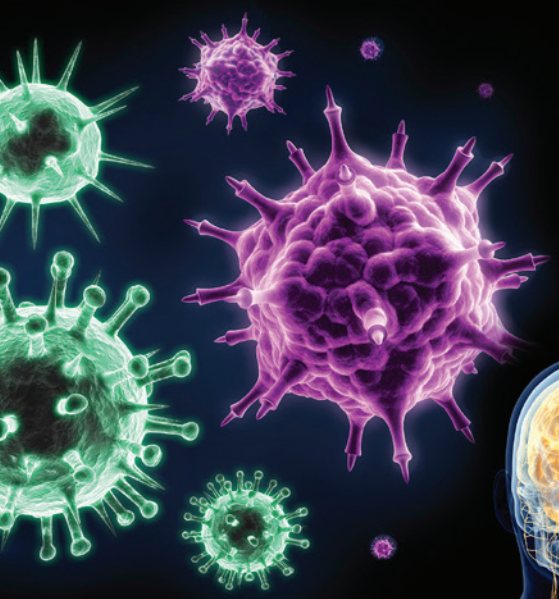
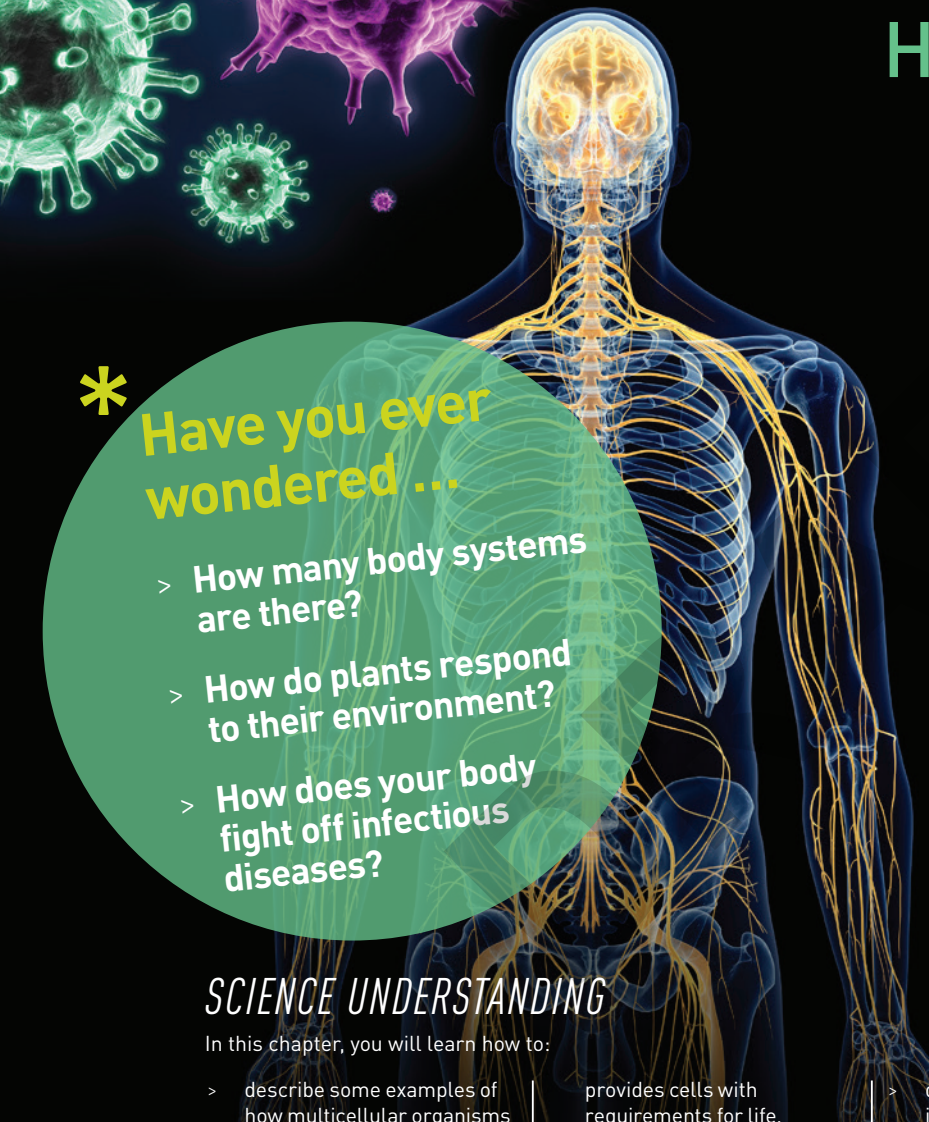
CONTENTS

BODY SYSTEMS AND RESPONSES

How does our body respond to the world we live in?

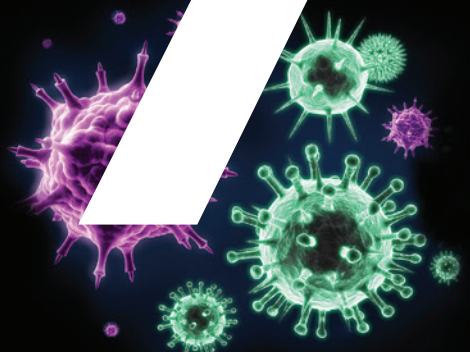




Have you ever wondered ...

- How many body systems are there?
- How do plants respond to their environment?
- How does your body fight off infectious diseases?

9



SCIENCE UNDERSTANDING

In this chapter, you will learn how to:

- describe some examples of how multicellular organisms respond to changes in their environment
- describe how the coordinated function of internal systems in multicellular organisms
- provides cells with requirements for life, including gases, nutrients and water, and removes cell wastes
- outline some responses of the human body to infectious and non-infectious diseases
- describe the role of, and interaction between, the coordination systems in maintaining humans as functioning organisms
- discuss, using examples, how the values and needs of contemporary society can influence the focus on scientific research, eg the occurrence of diseases affecting animals and plants, an epidemic or pandemic disease in humans or lifestyle related non-infectious diseases in humans

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9.1 Plants have hormones that detect changes in the environment to survive

Figure 1 The leaves on a deciduous plant change colour and fall off during autumn.

Key ideas

In this topic, you will learn that:

- plants respond to changes in the environment using hormones and receptors
- different types of plants produce different responses.

All organisms have the ability to respond to changes in the environment. If they don't respond, they are at risk of dying. Multicellular organisms have both internal and external receptors, which are able to detect changes in the environment (i.e. stimulus). This information is then passed on to other parts of the organism, which causes a response to occur.

Plants respond to changes in the environment

Plants need light for photosynthesis. As Earth rotates past the Sun throughout the day, plants respond to the changing light conditions in order to maximise photosynthesis. Plants do this by **phototropism**, in which cells of a plant that are in the dark (e.g. a shadow) expand. This expansion causes the plant to bend towards the light.

Plants also need water to survive. **Hydrotropism** directs a plant's roots to grow towards water. The roots have specialised receptors that cause the roots to grow downwards. These receptors also detect changes in pressure in the soil. More pressure means more water, and so the roots of the plants grow towards these areas of increased pressure.

Deciduous plants lose their leaves

Plants that lose their leaves during the changing seasons are called **deciduous**. These plants typically lose their leaves in autumn, before the coldest months of winter.

hydrotropism
the tendency for plant roots to grow towards or away from moisture in the soil

phototropism
the process where a plants cells in the dark expand to bend the plant towards a light source

deciduous
a type of plant that loses its leaves during the cooler months, to conserve energy when there is less sunlight

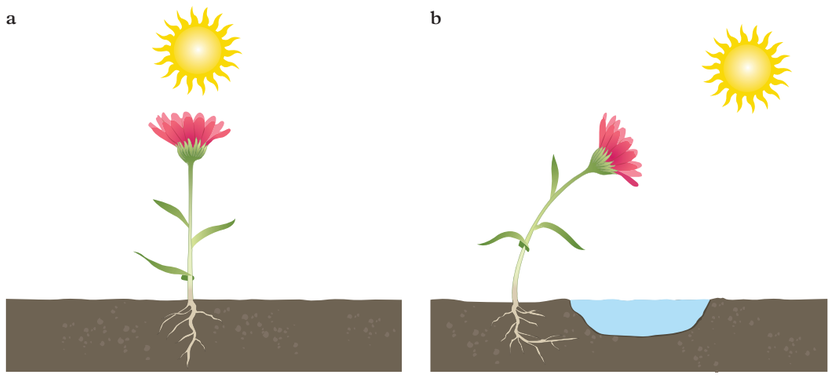

Figure 2 Phototropism is the movement of plants towards a light source, caused by cells in the dark expanding. Hydrotropism is why a plant's roots grow towards water.

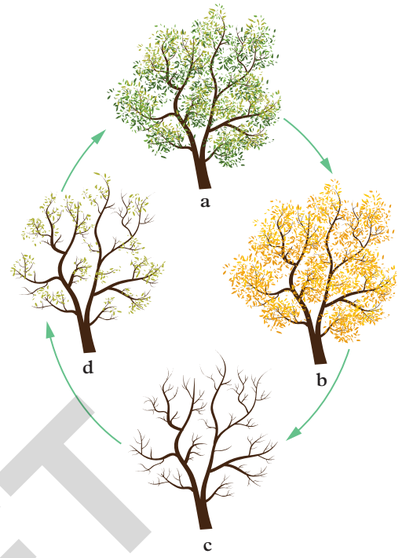

Figure 3 The life cycle of a deciduous tree: **a** summer, when the tree is full of leaves, **b** autumn, when a trees leaves stop growing and begin to fall off, **c** winter, when a tree has no leaves left and **d** spring, where new leaves grow.

The shorter days during winter have less daylight hours, which means less light for photosynthesis. Plants detect the change in temperature and the reduced daylight length. This triggers a reduction in the amount of growth hormone being sent to the leaves.

Epicormic buds: A response to fire

Epicormic buds are growth points that lay dormant under the trunk of a tree until they are stimulated. Many Australian plants, including eucalypts, have epicormic buds. These epicormic buds are kept dormant by higher plant shoots that inhibit the release of growth hormones to the lower buds. When a bushfire burns the higher plant shoots, the inhibition of the growth hormones ceases, which stimulates rapid growth from the epicormic buds. The new leaves that come from the epicormic buds allow the tree to photosynthesise, which keeps the plants alive after a bushfire.

Figure 4 The new growth on this tree exists because of epicormic buds. These buds can grow after a bushfire.

Figure 5 Plants have inbuilt systems to increase their responses to the environment around them.

Check your learning 9.1

Recall and explain

1. **Describe** the process that causes plants to grow towards light.
2. **Identify** two things plants need to survive.
3. **Explain** how plants use epicormic buds to respond to bushfire.

Apply and analyse

4. Plant roots have been said to 'hear' running water and grow towards them. **Construct** an experiment to determine if this is possible. In your answer, **identify** the following:
   - a independent variable
   - b dependent variable
   - c hypothesis
   - d method, including all materials required.

Evaluate and create

5. **Investigate** what plants are deciduous in Australia, and then **assess** whether deciduous plants can recover from a bushfire.

Skill builder: Making predictions

6. Imagine you are a scientist investigating the different types of plants that grow around Australia. You have come up with the following prediction: If palm trees from Queensland are moved to Tasmania, they will see less annual growth than those that stay in Queensland.
   - a **Identify** the controlled and measured variables. (THINK: What is being manipulated?)
   - b **Predict** what will happen to the trees as they grow in Tasmania. (THINK: What would colder weather do to the trees?)

9.2 Animals respond to changes in the environment

Key ideas

In this topic, you will learn that:

- animals use their senses (sight, hearing, smell, touch and taste) to respond to the environment
- animals receive information from the environment via receptors.

endotherm
an animal that controls its own body temperature

Most animals use one of five senses to detect changes in their environment; these senses are sight, hearing, smell, touch and taste. The degree to which they use each of the senses depends on the environment in which they live and the adaptations they possess to survive those conditions. Each sense is associated with specialised receptors that will detect changes and bring about a response. Changes in the environment including temperature and the seasons also trigger responses in animals.

Animals respond to temperature differently

ectotherm
animals who do not regulate their own body temperature

migrate
when an animal moves location due to changes in the environment

hibernation
a period of inactivity due to changes in the environment, often to survive winter

Ectotherms are animals that are unable to regulate their own body temperature; examples of ectotherms are amphibians, reptiles and invertebrates. If the external temperature increases, then their internal temperature increases, and if the external temperature decreases, then their internal temperature decreases.

For example, when a lizard's thermoreceptors detect a decrease in body temperature, they will seek out a warm rock to lie on. This will bring its body temperature back up. The lizard needs to leave the rock eventually so that it doesn't overheat.

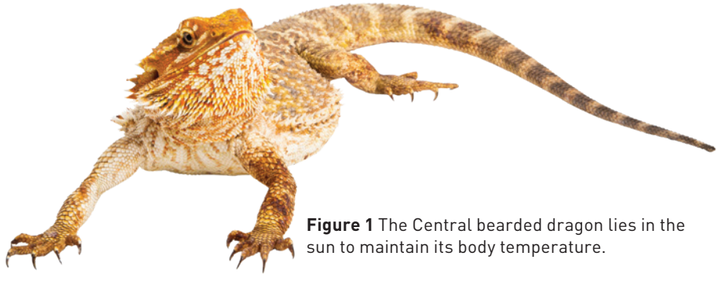

Figure 1 The Central bearded dragon lies in the sun to maintain its body temperature.

Endotherms are animals that regulate their own body temperature; examples of endotherms are mammals and birds. An endotherm's internal body temperature remains constant throughout their life, regardless of the external temperature. For example, humans maintain a body temperature of approximately 37°C. When your body temperature starts to rise, your body produces sweat to release heat from your body. When your body temperature starts to drop, you may start shivering to generate heat.

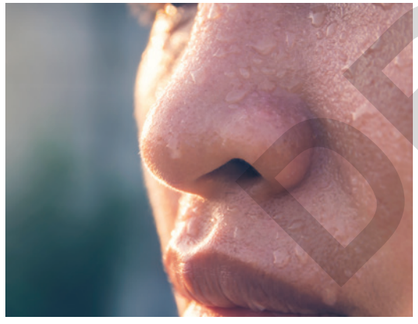

Figure 2 People sweat to cool themselves down when their internal body temperature starts to increase.

Animals move locations in response to their environment

Many animals **migrate** in response to changes in their environment. For example, birds often fly south during North America's winter. Notably, the great wildebeest migration occurs each year, in which the animals travel over 3000 km. In doing so, they find more readily available water and food.

Migration is only one solution to the changing seasons. **Hibernation** is an alternate solution, in which some animals will enter an extended period of inactivity for the winter. During hibernation, animals will have a slower heart rate, slower breathing and slower metabolic rate. These responses make the animal better equipped to survive winter, where food sources may be low.

CHALLENGE
9.2: Testing your senses
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Figure 3 The great wildebeest migration occurs every year as thousands of wildebeest move to find more food and water.

Humans respond to changes in stimulus

Our bodies are constantly responding to internal and external changes. A **stimulus** is any information an organism receives that might cause it to respond. Responding to a stimulus can prevent major changes to the internal environment that could cause the organism to become ill or possibly die. The easiest stimuli to identify are those we detect with the major sense organs (the eyes, ears, tongue, nose and skin).

Responding to external change

Within our bodies, we regularly respond to changes without consciously acknowledging a stimulus and response. What tells you that you are thirsty or hungry? Your body is communicating with your brain to tell you to find water or food. A similar process occurs when you feel tired or have a headache. But what is the source of these stimuli?

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

Your body is an amazing combination of cells, tissues, organs and systems, all working together. Each plays a part in detecting stimuli and passing on the information to other parts of the body. The structures that receive stimuli are called **receptors**. There are different receptors for different purposes; for example, cells that detect light are called photoreceptors.

receptor
a structure that detects a stimulus or change in the normal functioning of the body

Sight

Sight tells us more about the world than any other sense. When light enters the eye, the photoreceptors convert the light into nerve signals. Two messages are sent: one message is to the iris (the coloured part of your eye) telling it to constrict and close the pupil, and the second message is to the brain via the optic nerve. The message sent along the optic nerve is interpreted by the brain, which then tells you what you are looking at.

stimulus
any information that the body receives that causes the body to respond

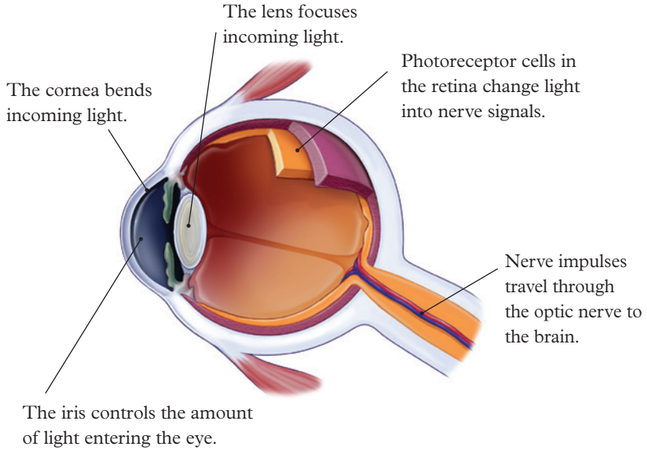

Figure 4 The human eye

Hearing

Strumming a guitar sets off a wave of vibrating particles in the air. These vibrations enter your ear and cause the eardrum to vibrate. These vibrations are transferred along the tiny bones of the middle ear and converted into nerve impulses. Your brain can then interpret these impulses, telling you what you are hearing.

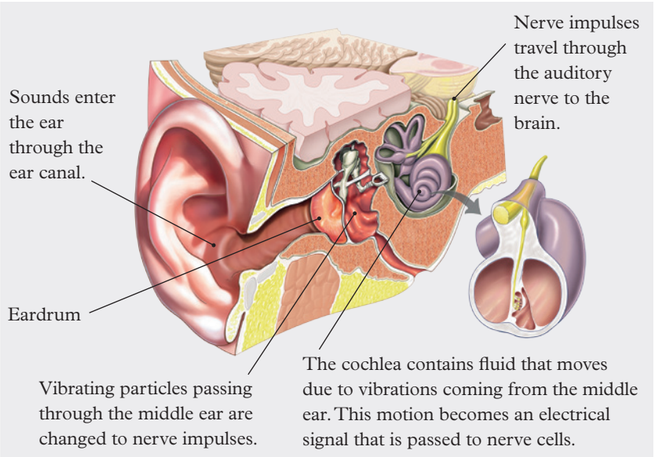

Figure 5 The human ear transfers vibrations to the middle ear. These then become nerve impulses.

Taste

Your tongue is covered in thousands of tiny tastebuds (Figure 6). You can see these in a mirror. Taste buds contain special receptor cells that react to chemicals in foods. Taste buds can recognise basic kinds of taste such as sweet, salty, sour, bitter and a savoury taste called umami. When you eat or drink the information from the taste receptor cells is sent to the brain through nerves. This tells you what flavours you are tasting.

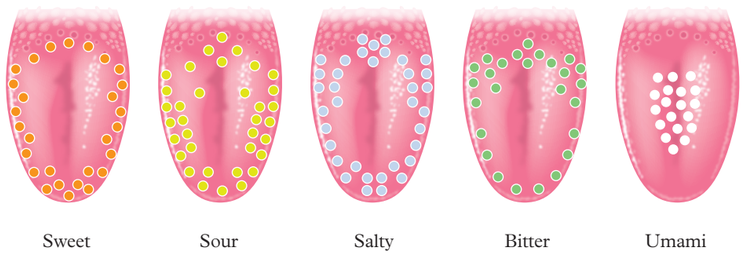

Figure 6 The human tongue can perceive all tastes equally well everywhere on the tongue.

Smell

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

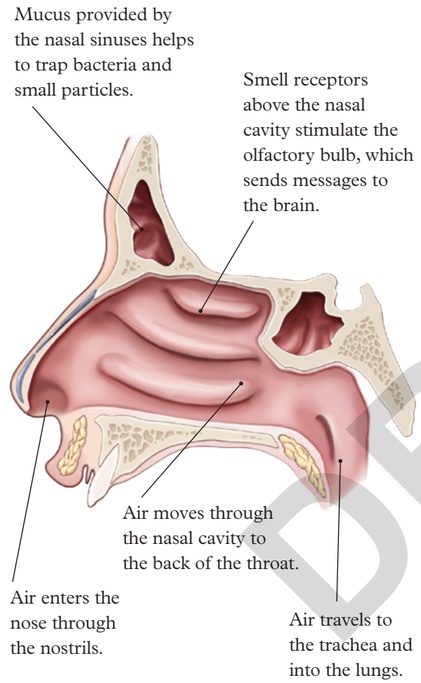

Figure 7 Chemoreceptors in human nostrils detect chemicals and send messages to the brain.

Touch

While the other four senses are located in specific locations, touch is felt all over the body through the skin. The bottom layer of skin, called the dermis, contains many nerve endings that can detect temperature (thermoreceptors), pressure (mechanoreceptors) and pain (pain receptors). Information is collected by these receptors and sent to the brain for processing and reaction.

Some examples of how the skin responds to stimuli include:

- temperature changes, resulting in humans sweating to cool down or shivering to warm up
- changes in pressure, resulting in tickling sensations or pain.

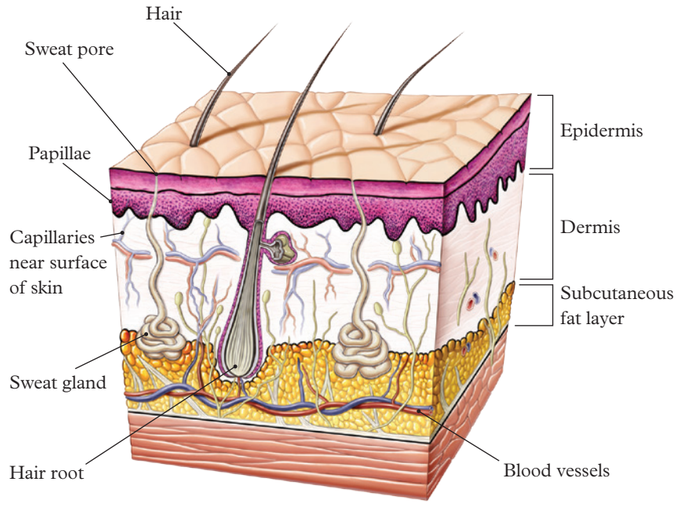

Figure 8 A cross-section of human skin

Check your learning 9.2

Recall and explain

1 **Define** the following terms.
   - a Stimulus
   - b Response
   - c Ectotherm
   - d Endotherm

2 **Explain** how an ectotherm regulates its body temperature.

3 **Identify** the five sense organs and **explain** their function.

Apply and analyse

4 **Compare** ectotherms and endotherms.

5 **Explain** why there no reptiles found in Antarctica.

6 **Identify** a likely response to:
   - a walking on hot sand
   - b seeing something running straight towards you
   - c realising you've put salt on your cereal instead of sugar
   - d hearing a loud bang.

7 Imagine a situation where you are faced with a shortage of water. **Construct** a flow chart that outlines some of the possible responses within your body or in your behaviour.

Evaluate and create

8 **Discuss** how survival is possible without one or more of your sense organs.

Skill builder: Assessing risk

9 Jacob wants to know if umami is really all over the tongue or if it is only at the front. He wants to give people the following to test his theory: sour hard sweets, gummy bears, sea salt crisps, grapefruit and mi goreng.
   - a **Identify** what experimental method Jacob could use to test his theory. (THINK: What is Jacob trying to test? How many repeats would he need to measure?)
   - b List any additional materials Jacob might need. (THINK: How could he make this experiment safe? How would the flavours be tasted?)
   - c Select two risks associated with Jacob's test (THINK: Does Jacob need to use people in his experiment? Are there allergies?)
   - d **Explain** how the risks you identified in Part c could be managed. (THINK: What would Jacob need to know about the participants? How could he avoid making people sick?)

Figure 9 Our tongue's receptors detect that a lemon is sour.

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9.3 The central nervous system receives information from the peripheral nervous system

Key ideas

In this topic, you will learn that:

- the central nervous system includes the brain and the spinal cord
- the central nervous system is the control centre of the human body
- the peripheral nervous system is made up of nerves outside the central nervous system
- the peripheral nervous system carries information to and from the central nervous system to the rest of the body.

Humans are constantly receiving stimuli from their environment through the peripheral nervous system. The neurons use electrical messages that are passed along to neurons in the brain and spinal cord that make up your central nervous system.

central nervous system
the brain and spinal cord

spinal cord
responsible for sending messages from the brain to the body and reflex actions

brain
an organ responsible for emotions, thoughts, and behaviour

peripheral nervous system
all the neurons (nerve cells) that function outside the brain and spinal cord

somatic nervous system
the part of the nervous system that controls the muscles that are attached to the skeletal system

autonomic nervous system
the part of the nervous system that controls involuntary actions such as heartbeat, breathing and digestion

Central nervous system

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

The brain

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

Lobes of the brain

The cerebrum or outer section of your brain is divided into four lobes or sections. These lobes have specific functions.

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

The spinal cord

The **spinal cord** has three major roles. It sends messages from the brain to different parts of the body causing them to respond. It sends messages from sensory neurons to the brain, and it is also responsible for reflex actions.

Peripheral nervous system

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

The peripheral nervous system is divided into two parts.

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

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

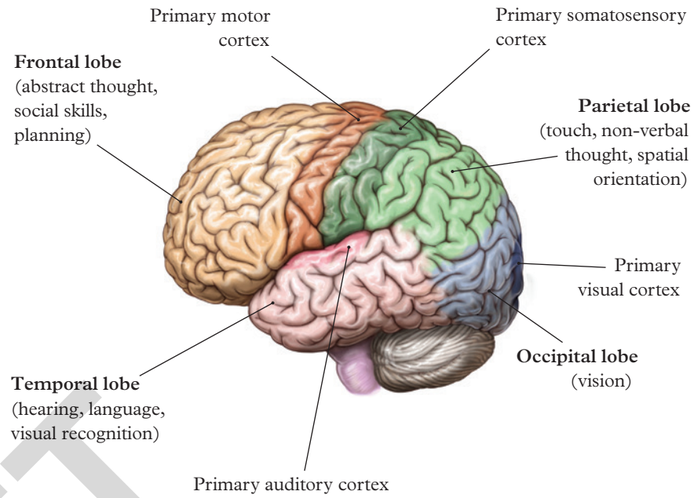

Figure 1 The lobes of the brain

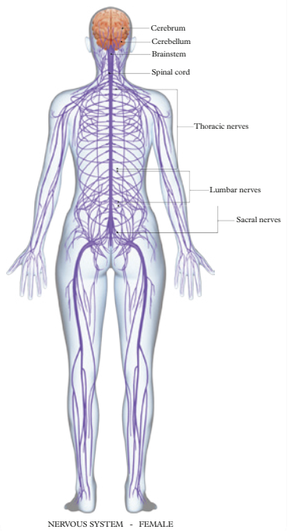

Figure 2 The nervous system is made up of the central nervous system and the peripheral nervous system.

Check your learning 9.3

Recall and explain

1. **Identify** the two key components of the central nervous system.
2. **Explain** the role of the peripheral nervous system.

Apply and analyse

3. **Compare** the occipital lobe with the frontal lobe.
4. **Distinguish** between the role of the somatic nervous system and the autonomic nervous system.
5. **Describe** the role of the cerebellum.
6. Draw a scientific diagram of the brain that shows the four lobes. For each of the lobes:
   a. **summarise** the functions carried out
   b. draw something to remind you of the functions carried out in that lobe.

Evaluate and create

7. **Propose** what someone with damage to their frontal lobe might have difficulty with.

Skill builder: Communicating

8. Create an information booklet explaining the difference between the central nervous system and the peripheral nervous system. This booklet should help students in your year level understand the differences between and the responsibilities of each system.
   a. **Identify** the key information. (THINK: Can you explain the components of each system simply? Why is this important?)
   b. **Synthesise** the information you found in part a and present this information for your target audience. (THINK: Who is your audience? Is it age appropriate?)
   c. **Construct** the information booklet. (THINK: What is the best way to explain this information? Is the language I am using scientific (i.e. clear and concise)? Would including diagrams help?

9.4 Nerve cells are called neurons

Key ideas

In this topic, you will learn that:

- neurons are nerve cells that relay information throughout the body
- motor neurons take information to the body from the brain
- sensory neurons take information from the body to the brain
- interneurons relay information along the spinal cord.

neuron
nerve cells that are responsible for sending and receiving messages in the human body

cell body (soma)
the main part of a cell that contains the nucleus/genetic material

axon
the part of a neuron (nerve cell) that carries the electrical message away from the cell body to the synapse

synaptic terminal
found at the end of the axon, it released neurotransmitters into the synapse

myelin sheath
a fatty layer that covers the axon of a nerve cell

dendrite
the part of a neuron (nerve cell) that receives the message and sends it to the cell body

sensory neuron
a nerve cell that carries a message from a receptor to the central nervous system

motor neuron
a nerve cell that carries a message from the central nervous system to a muscle cell

interneuron
a nerve cell that links sensory and motor neurons; also known as a connector neuron

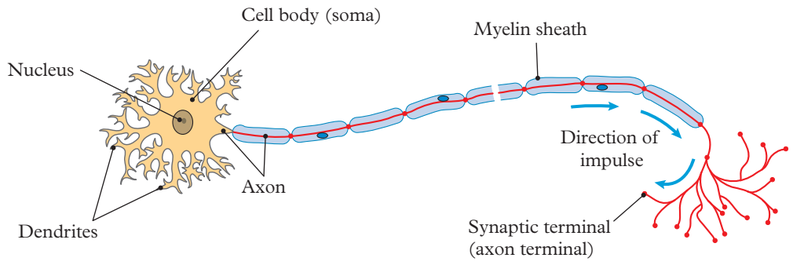

Figure 2 The basic structure of a neuron

Humans are constantly receiving stimuli from their environment through the peripheral nervous system. They relay this information via neurons that send electrochemical messages to neurons in the brain and spinal cord, which make up the central nervous system.

Nerves

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

Neurons have many highly specialised features. Each neuron has a large **cell body (soma)** that connects to a long thin **axon**, which is also called a nerve fibre. The axon carries nerve impulses away from the cell body. The axons connecting your spinal cord to your foot can be 1 metre long. At the end of the axon is a small bulb called the **synaptic terminal**, also known as the axon terminal. Here, messages are passed to the next neuron. The axon is covered by a fatty layer called the **myelin sheath**, which helps to speed up a nerve impulse along an axon by controlling its path.

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

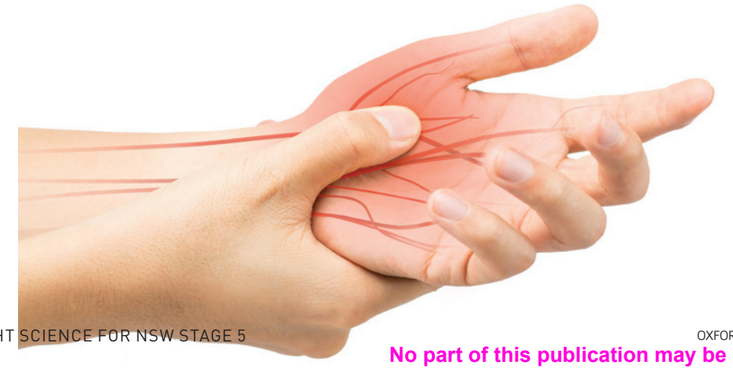

Figure 1 Neurons carry messages from your hands to the central nervous system.

CHALLENGE
9.4: Pipe cleaner neurons
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Dendrites bring information to the cell, and axons take information away from the cell body. Information from one neuron flows to another neuron across a **synapse**. The synapse is a small gap separating neurons. When the message reaches the end of the neuron, chemicals called **neurotransmitters** are released from the synaptic terminal of an axon and travel across the gap to the dendrite of the next neuron. In this way, electrical messages are passed around the body.

Types of neuron

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

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

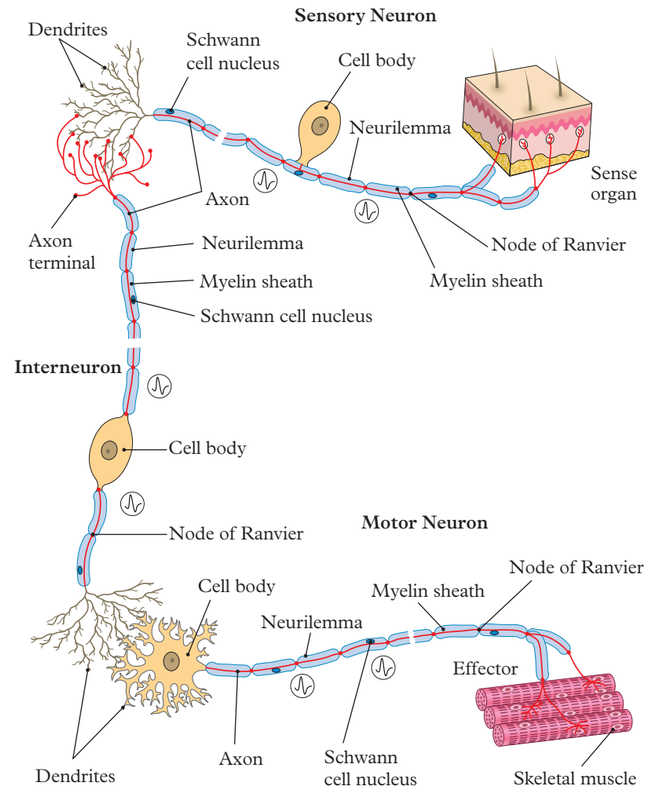

Figure 3 Sensory neurons receive information from sense organs (e.g. the eye); motor neurons take messages from the nervous system to the body (e.g. to your fingers to tell them to write); and interneurons link sensory neurons, motor neurons and other interneurons.

Check your learning 9.4

Recall and explain

1 **Define** the term 'neuron'.
2 **Explain** the role of the myelin sheath.
3 **Recall** what happens in the synapse.

Apply and analyse

4 **Compare** the roles of motor neurons, sensory neurons and interneurons.
5 **Propose** what may happen to someone if their interneurons weren't working.
6 Draw a diagram of a sensory neuron. Include the following in your diagram and **explain** each of their roles.
   a Axon
   b Cell body
   c Dendrites
   d Myelin sheath
   e Synapse

Evaluate and create

7 **Investigate** motor neuron disease using the internet. Find out about the following:
   a symptoms
   b cause
   c treatment.

Skill builder: Identifying problems

8 Isadora's myelin sheath is deteriorating. **Identify** two problems associated with this. (THINK: What does myelin sheath do? How will this impact Isadora's life?)

9.5 The nervous system provides fast control of the body

Key ideas

In this topic, you will learn that:

> reflexes are involuntary actions that your body makes in response to particular stimulus.

To survive immediate danger, you need quick responses to stimuli. Receptors in the nervous system detect the stimuli and pass it on to control centres. The control centres initiate a message to the effectors, which cause a response. Reflexes are special pathways that allow a response to occur before the brain has time to think.

reflex
an involuntary movement in response to a stimulus

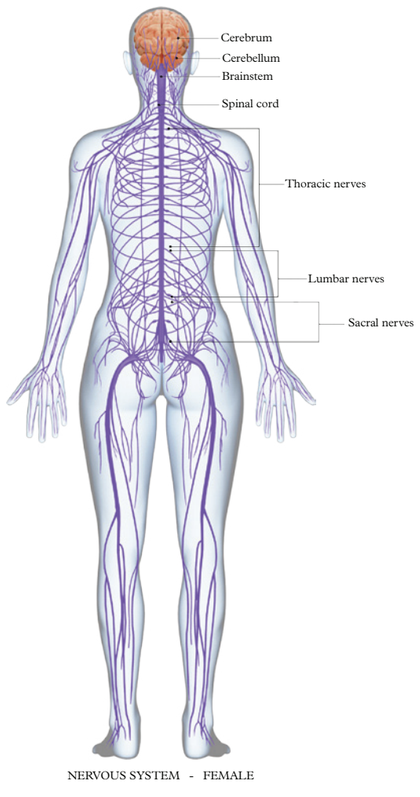

Figure 1 The nervous system is made up of the central nervous system and the peripheral nervou system.

Stimulus response model

Stimuli can come in many different forms. It may be pressure or heat on the skin, a puff of air or strong light in your eye. These stimuli are detected by the receptors, and the message gets sent to the spinal cord and the brain via the sensory neurons. The spinal cord and brain form the control centre of the nervous system. The interneurons in this control centre pass the message on to other interneurons as your brain thinks about how you should respond to the stimuli. Eventually you make a decision, and the motor neurons pass the message on to the muscles. In this case, the muscles are called the effectors because they are the cells that cause the body to respond. This simple pathway is called the stimulus response model.

Reflexes

If you ever accidentally touched something very hot, you will remember how quickly you snatched your hand away. In fact, it was so quick that you know you didn't even have time to think about it: it was automatic.

A **reflex**, or reflex action, is an involuntary and nearly instantaneous movement in response to a stimulus.

During a reflex action, the sensory neuron carries the message from the receptor to the spinal cord. The interneuron then sends two messages at the same time: one to the brain and the other to the muscles via the motor neuron. This means the muscle is moving at the same time as the brain gets the message that the object was hot. This make reflexes even faster than usual responses.

Most reflexes help us in survival situations. Can you think of the advantages to these reflexes?

CHALLENGE **9.5a:** How fast is the nervous system? Go to page XXX

CHALLENGE **9.5b:** Testing reflexes Go to page XXX

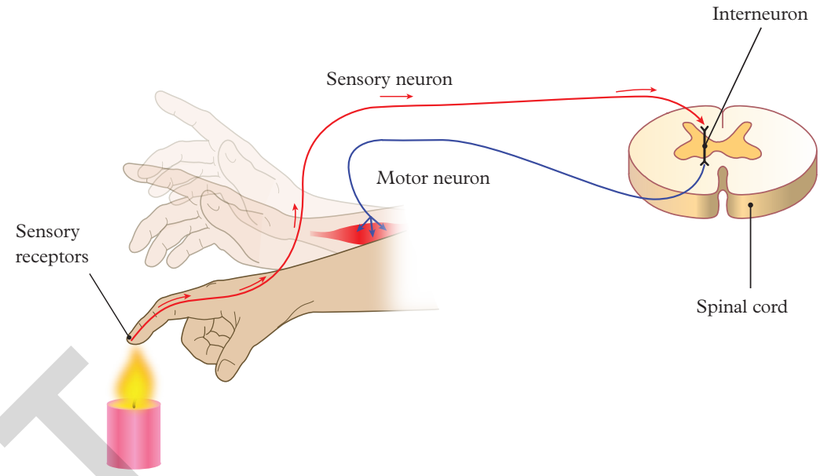

Figure 2 A reflex action ensures that a fraction of a second after you pull your hand away from a flame, you feel the pain in your hand.

Check your learning 9.5

Recall and explain

1 **Explain** what a reflex is.
2 **Describe** how a reflex works.

Apply and analyse

3 **Discuss** how reflexes help us survive.
4 **Construct** an experiment that measures the reaction time of your classmates. Make sure to include the:
   a aim
   b hypothesis
   c materials you would need
   d method you would use.

Evaluate and create

5 Imagine you are baking at home, and you reach to grab the tray from the oven without an oven mitt. **Assess** how a reflex stops you from burning your hand.
6 **Evaluate** this statement: 'People would get injured more frequently if their reflexes weren't working.' You will need to conduct some extra research before you can answer this question.

Skill builder: Processing and analysing data and information

7 Seth conducted a reflex test to measure the average time it takes someone to respond to catching a ball. He found that it took people the following amount of time (in seconds) to react: 0.04, 3, 2, 1, 0.9, 2, 4, 3, 2 and 1.
   a **Identify** any outliers in the data. (THINK: Is something unusual? Is there a result that seems different to the others?)
   b **Identify** the median and mode. (THINK: What is the most common number? What is the middle number?)
   c **Calculate** the mean. (THINK: What is the average reaction time?)

Figure 3 When you touch something sharp, like a cactus, a reflex response causes you to pull your hand away.

9.6 The endocrine system causes long-lasting effects

Key ideas

In this topic, you will learn that:

- the endocrine system is slower than the nervous system
- the endocrine system uses hormones to maintain control and regulate growth
- the chemical messengers act slower than nerve impulses sent by the nervous system, but their effects are longer lasting.

endocrine system
a collection of glands that make and release hormones

hormone
a chemical messenger that travels through blood vessels to target cells

target cell
a cell that has a receptor that matches a specific hormone

peptide hormone
a hormone made from proteins

steroid hormone
a hormone secreted by the adrenal glands and ovaries (females) and testes (males). They are produced from cholesterol

feedback mechanism
a system that helps to control the effects of hormones on the body

negative feedback mechanism
regulates the rate of hormone produced and released into the body

The **endocrine system** is a collection of glands that secrete (release) **hormones**. The hormones are secreted directly into the bloodstream and then travel around the body through the blood. Some cells in the body have receptors that match the hormone like a lock to a key. These cells are called **target cells**. It only takes one hormone to cause a change in the target cell.

The glands and organs of the endocrine system are spread throughout the body; this is shown in Table 1. Note that the endocrine system shares the hypothalamus with the nervous system.

Types of hormone

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

Steroid hormones include those hormones secreted by the adrenal glands and the ovaries (female) and testes (male). Steroid hormones are produced from cholesterol. Most steroid hormones are **lipid-derived hormones**. Lipid-derived hormones are produced from cholesterol and can pass through the cell membrane and move directly into the target cells.

Amino acid-derived hormones travel through the bloodstream. Examples of these are growth hormone and antidiuretic hormone.

Hormones at work

Feedback mechanisms often control the effects of hormones on the body. Releasing a hormone into the body triggers a series of responses. A **negative feedback mechanism** regulates the rate of hormone production and secretion. When a stimulus is received that indicates there is too much of a hormone, this mechanism will produce less of the hormone.

Table 1 Some structures and hormones of the endocrine system

Structure	Hormone	Target tissue	Main effects
Hypothalamus	Wide range of neurotransmitters	Pituitary gland	Links nervous system to endocrine system via pituitary gland to control many homeostatic functions such as body temperature, hunger, thirst and sleep patterns
Ovaries	Progesterone Oestrogen	Uterus Body cells	Thickens wall of uterus Development of female sexual characteristics; aspects of pregnancy and foetal development
Testes	Testosterone, progesterone and oestrogen	Male reproductive system, body cells	Development and control of male sexual characteristics; production of sperm
Pancreas	Insulin Glucagon	Liver, most cells Liver	Lowers blood glucose level Raises blood glucose level

CHALLENGE
9.6: Glands and organs of the endocrine system
Go to page **XXX**

This also occurs in reverse: if there is not enough of a hormone being produced and secreted, the negative feedback mechanism will increase the amount.

Fight or flight?

Fight or flight (recently renamed as fight, flight or freeze) is a hormone and nervous-system response to dangerous, stressful or frightening situations. If you have experienced a scary situation, you may have noticed that your heart begins to race, you break out in a cold sweat, and everything around you slows down as your senses are bombarded with information. Most of the symptoms are triggered by the hormone adrenalin (also called epinephrine).

Adrenalin is constantly produced by the adrenal glands in small doses, and its usual function is to stimulate heart rate and enlarge blood vessels. When you are in danger, it takes on another role. It floods your system to cause an increase in strength and the rate of your heartbeat, raising your blood pressure and speeding up the conversion of glycogen into glucose, which provides energy to the muscles. Adrenalin provides your body with extra energy required if you need to fight or run away from a situation.

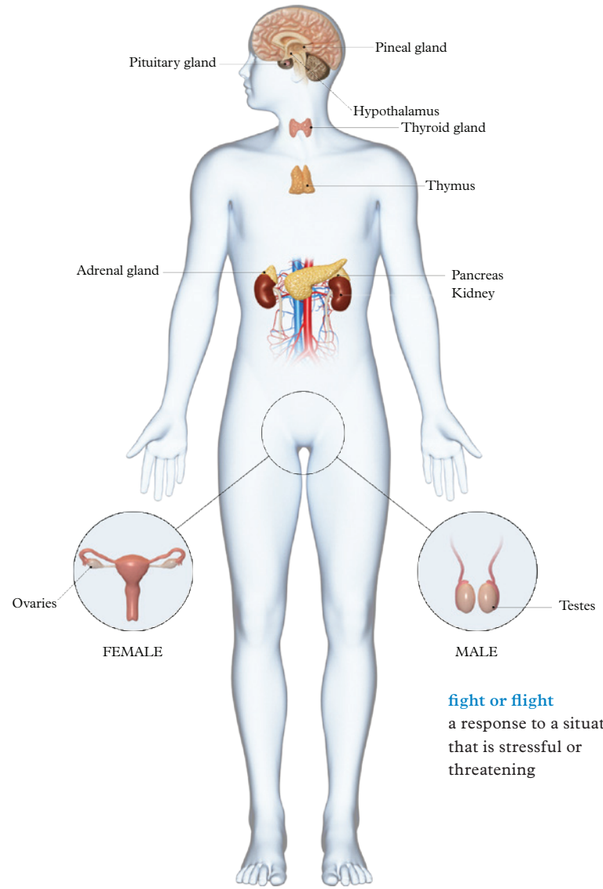

Figure 1 The human endocrine system

fight or flight
a response to a situation that is stressful or threatening

Check your learning 9.6

Recall and explain

1 **Identify** the name of the system in your body responsible for producing hormones.
2 **Describe** the two different types of hormone.

Apply and analyse

3 **Compare** the roles of the thyroid glands and the pancreas in the endocrine system.
4 **Propose** why the endocrine system tends to be slower than the nervous system.

Evaluate and create

5 **Investigate** a disease associated with a hormone. Write a brief essay that introduces the disease, explains its cause and symptoms, and summarises research into the disease.

Skill builder: Questioning and predicting

6 A scientist claimed that because people have evolved, we no longer use the fight or flight response as we don't experience stress to our survival.
a **Identify** the 'if' in this claim. (THINK: What would happen if we had evolved to no longer require this response?)
b **Identify** the 'when' in this situation?
c **Construct** a scientific question that you can test for this claim. (THINK: Is this question testable?)

INVESTIGATION
9.7: Experiencing homeostasis
Go to page 33

9.7 Homeostasis is the interaction of internal body systems

Key ideas

In this topic, you will learn that:

- internal body systems interact to maintain homeostasis
- the endocrine and nervous systems interact to maintain this balance by increasing or decreasing hormones throughout your body.

Figure 1 Your body must remain at 37°C. To achieve homeostasis your body might shiver if you are cold to try and warm itself back up again.

homeostasis
the process your body goes through to regulate internal conditions such as temperature

Your body works to maintain constant levels of important nutrients, water and temperature in order to stay healthy. The process of regulating the internal conditions of the body is called homeostasis. Negative feedback occurs when the body responds in a way that removes the initial stimulus.

So far, scientists have been unable to discover another planet that humans could inhabit. The reality is that humans can only survive in very specific environments. Our bodies are quite fussy and need to have access to the right amount of food and water, oxygen, and carbon dioxide. If you're lost in a desert or in freezing temperatures, your body will try to maintain a temperature of about 37°C at all times to keep cells working efficiently. This 'business as usual' that is maintained by your body is called homeostasis.

The nervous and endocrine systems work together to control different parts of the body. They work in different ways and at different rates to detect change and produce immediate responses or slower changes.

Homeostasis

To maintain **homeostasis**, your body uses a mechanism a bit like a thermostat on a heater. When temperature receptors on your skin and in the hypothalamus of your brain detect cooling down (stimulus), then a message gets sent to a variety of effectors around your body. This may include muscles to make you shiver (to warm up) or blood vessels to redirect the warm blood flow to the important organs in your body (your heart liver and brain).

If the temperature receptors detect that you are too hot (stimulus), then the effectors include your sweat glands and blood vessels. This causes your body to respond by the blood carrying heat to your skin so that sweat evaporates and cools you. This is a negative feedback mechanism system: the effectors respond by removing the stimulus. If you are too hot, then your body tries to cool you down. If you are too cold, then your body works to warm you up.

Hormones at work

The rate of hormone production and secretion is often regulated by the negative feedback mechanism. This means that if a stimulus is received that indicates something in the body is happening 'too much', the response would be to produce a hormone to remove it.

Blood glucose

As you eat, food gets broken down into smaller nutrients. All carbohydrates get broken down into simple sugars, including glucose. These glucose molecules travel through your blood and provide the energy for cellular respiration (i.e. the reaction of glucose with oxygen to produce carbon dioxide, water and ATP [adenosine triphosphate]). Too much glucose in the blood is not healthy because it causes water to be lost from cells through osmosis. Your body tries to control the amount of glucose in your blood. If the concentration of glucose in your blood is too high (stimulus), then receptors in the pancreas will detect it. They will then release the hormone insulin into the blood. Insulin will travel throughout the body to the insulin receptors on muscle and liver cells. These cells will then act as effectors and remove the glucose from the blood. This causes the blood glucose to decrease, removing the original stimulus. This is an example of negative feedback.

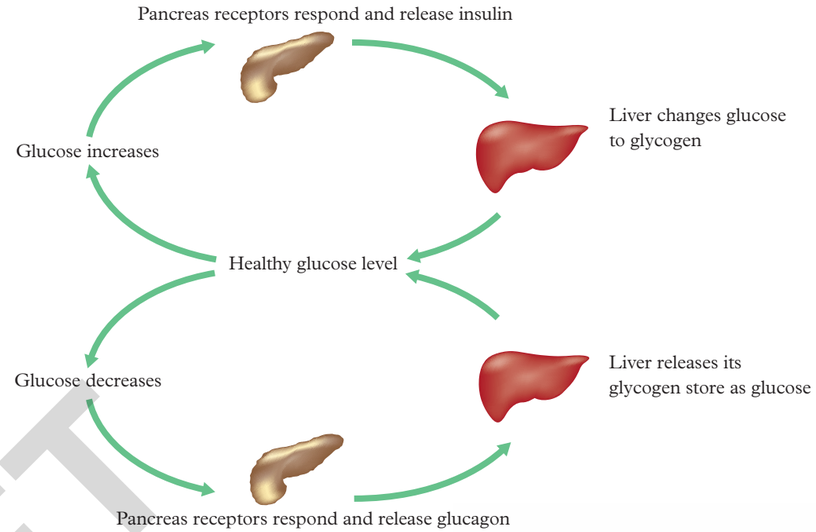

Figure 2 The pancreas and the liver work together to maintain healthy glucose levels.

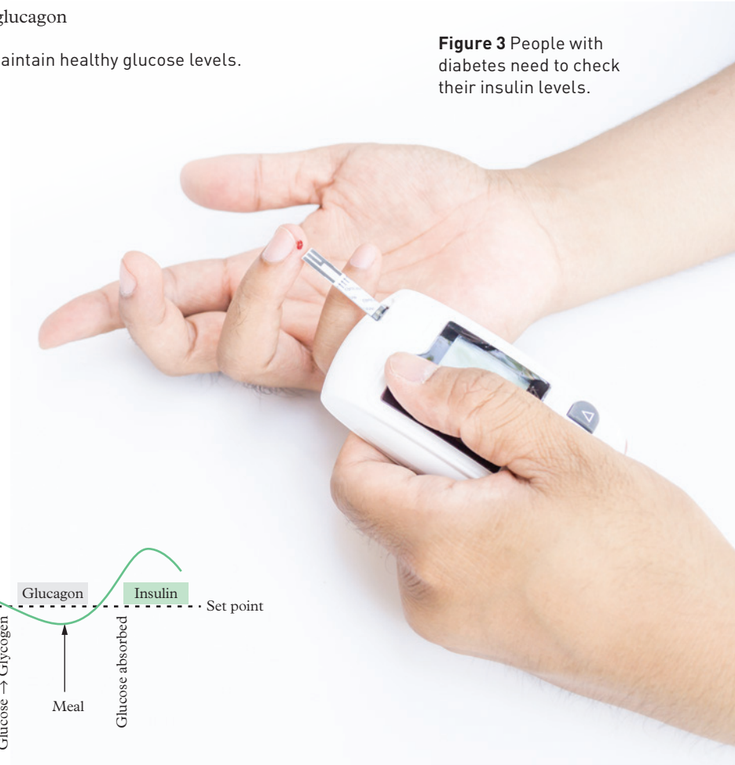

Figure 3 People with diabetes need to check their insulin levels.

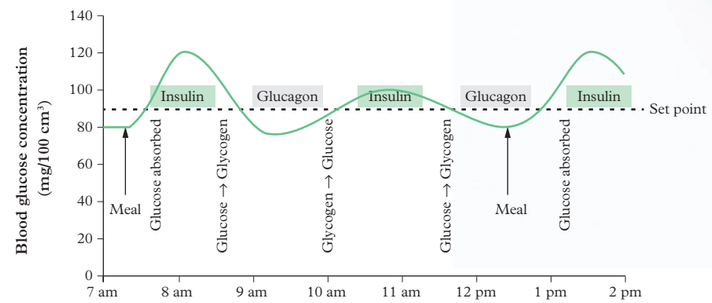

Figure 4 After eating, blood glucose levels increase. The body's response is to release insulin, which causes the muscle and liver effectors to remove the glucose and restore homeostasis.

If blood glucose levels are too low, then your body will use negative feedback to restore the levels to a homeostatic state. The low glucose levels are detected by receptors in the pancreas (stimulus). This time, the hormone glucagon is released into the blood. Receptors for glucagon are also found on the effector cells in the liver and muscle. Glucagon binding to the receptors causes the muscle and liver cells to release the stored glucose into the blood (response), increasing the amount of blood glucose once again.

Water regulation

Water is vital for human survival, but you may have noticed that when you drink a whole bottle of water, you might need to visit the bathroom within the next hour. Your body uses homeostasis to control the balance of water in your body. Water is needed to control all the chemical reactions, and if there is too much or too little water in your body, these chemical reactions are affected and the cells can be damaged.

The hypothalamus regulates water levels in your brain. If you have been sweating on a hot day, your body is likely to have lost a lot of water. Receptors from the hypothalamus will notice changes in your levels of water and alert the pituitary gland. This will then release antidiuretic hormone (ADH) into your body, which reaches your kidney to tell it to reabsorb water from your urine. This is why your urine becomes darker if you are dehydrated. This is a negative feedback response. When you drink a lot of water, your pituitary gland receives a message to stop producing ADH.

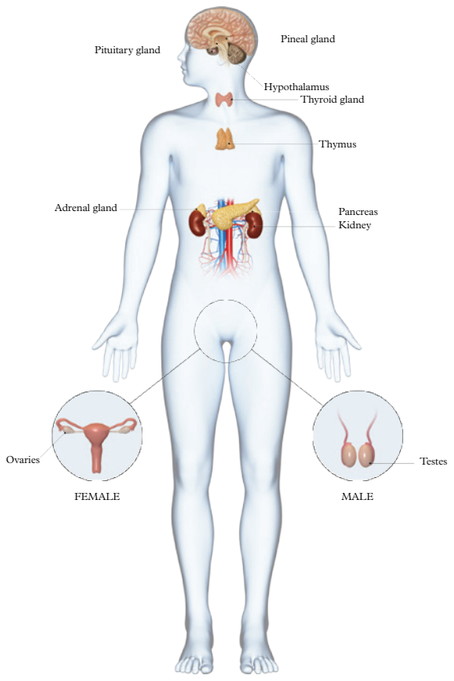

Figure 5 The pancreas is the endocrine organ responsible for the regulation of blood glucose levels.

Figure 6
Your hypothalamus regulates how much water you have in your body and causes reactions when you have too much or too little; this is what prompts you to drink water.

Oxygen and homeostasis

Have you ever wondered why you became puffed when running a race? Oxygen and carbon dioxide in the blood are under strict homeostatic control. You need the oxygen for cellular respiration (i.e. the reaction between glucose and oxygen to produce water, carbon dioxide and energy) in a cell. Carbon dioxide is the waste product of this reaction.

When you sprint during a race, the muscles in your legs use a lot of glucose and oxygen, which produces a lot of carbon dioxide. This is released into the blood and is bad for the body. If you have too much carbon dioxide, a message is sent to make your heart beat faster and make your diaphragm move faster, which is why you might feel puffed after a race. These responses remove the carbon dioxide from your body.

Waste removal

The waste products of cells are removed by the respiratory system. The respiratory system and the circulatory system work together to ensure that carbon dioxide is removed from the lungs as we exhale. The kidneys, which are part of the excretory system, are responsible for removing wastes from the blood. The kidneys then ensure that this waste is removed from the body via urine.

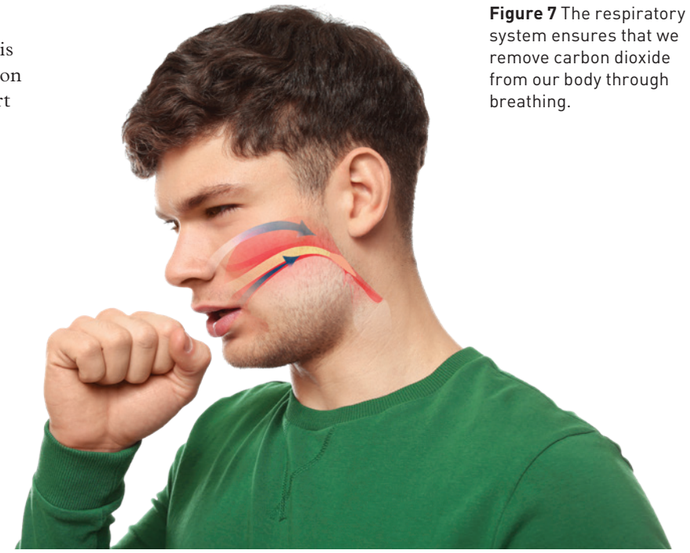

Figure 7 The respiratory system ensures that we remove carbon dioxide from our body through breathing.

Check your learning 9.7

Recall and explain

1 Using your own words, **define** homeostasis.
2 **Describe** how your body responds to excess carbon dioxide.
3 **Explain** what happens to your blood sugar levels when you eat.
4 **Recall** how your body responds to low blood sugar levels.

Apply and analyse

5 **Compare** the removal of waste from cells with the removal of waste from the kidneys.
6 If a negative feedback mechanism reduces the effect of a hormone, **assess** what a positive feedback mechanism might do.

Evaluate and create

7 In type I diabetes, cells in the pancreas are unable to produce insulin. **Propose** what effect this would have on blood glucose levels. **Investigate** how people with type I diabetes ensure that their blood glucose levels remain at the homeostatic level.

Skill builder: Planning investigations

8 To investigate homeostasis in humans, scientists may need to test body responses including temperature and heart rate.
   a **Identify** what equipment you would need to measure temperature in humans. (THINK: What is the best device to use?)
   b **Explain** whether taking someone's pulse with your fingers would be as successful as using a device, such as a smart watch. (THINK: What could go wrong measuring a pulse with fingers? Are the results from a device more accurate?)
   c **Recall** why it is important to use the appropriate device to measure a body response. (THINK: How might the wrong device impact your results?)

Figure 8 What is the best device to use to measure a body response?

9.8 Pathogens cause disease

Key ideas

In this topic, you will learn that:

- infectious diseases are caused by pathogens
- pathogens include bacteria, fungi, protozoans, prions and non-living viruses.

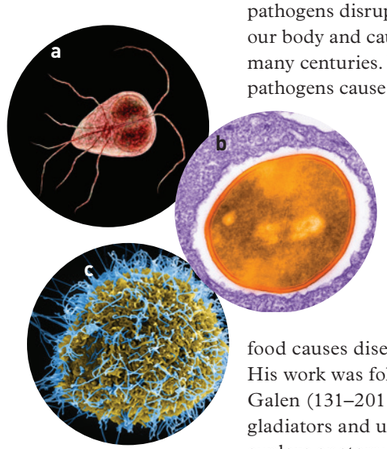

Figure 1 Most infections are caused by microscopic pathogens such as bacteria or viruses. **a** Bacteria are very small cells that are able to reproduce by themselves. They can release toxins that affect the normal functioning of our body. **b** Viruses are unable to reproduce by themselves. Instead, they invade our cells and use the organelles to make new copies of themselves. This stops our cells from functioning properly.

Our understanding of how infectious pathogens disrupt the normal functioning of our body and cause disease has developed over many centuries. It is now broadly accepted that pathogens cause disease, Table 1 shows the different types of pathogen.

One of the first people in Western medicine to question the accepted idea of supernatural causes of diseases was Hippocrates (460–377 bce). He concluded that something in the air, soil, water and food causes diseases in humans and animals. His work was followed up by Claudius Galen (131–201 ce), who was a doctor to the gladiators and used animal dissections to explore anatomy.

Girolamo Francastor (1478–1553) was an Italian astronomer and doctor who was one of the first to suggest that disease could be transmitted from person to person via small invisible particles. He theorised that these particles could travel through the air, via contaminated clothing or by direct contact with the sick person. It took 200 years and the discovery of the microscope to confirm his theories and to develop the 'germ theory' used today.

Germ theory

Germ theory states that many diseases are caused by the presence and actions of specific microorganisms. These microorganisms are called **pathogens**. Germ theory was confirmed by Louis Pasteur and Robert Koch. Robert Koch went on to develop Koch's postulates.

1. The microorganism or other pathogen must be present in all cases of the disease.
2. The pathogen can be isolated from the diseased host and grown in the laboratory.
3. The pathogen from a pure culture must cause the disease when inoculated into a healthy susceptible laboratory animal.
4. The pathogen must be re-isolated from the new host and shown to be the same as the originally inoculated pathogen.

Australian scientists Barry Marshall and Robin Warren followed these postulates when they researched stomach ulcers in 1984. Together they discovered that a bacterium (*Helicobacter pylori*) was found in all patients with stomach ulcers. Most doctors at the time thought that no bacteria could survive in the acidic environment of the stomach. Marshall and Warren isolated the bacteria and injected it to cause the disease in mice. Unfortunately, many doctors still did not believe the research, so Barry Marshall swallowed a culture of the bacteria to cause the disease in himself. Treatment with **antibiotics** killed the bacteria and cured his stomach ulcer. Barry Marshall and Robin Warren were awarded the Nobel Prize in Physiology or Medicine in 2005.

Antibiotics

Before antibiotics were discovered, a single scratch from the thorn on a rose bush could become infected and kill you. In 1928, Alexander Fleming was trying to grow bacteria in his laboratory. When he returned from holidays, he discovered some Petri dishes he had left open on the bench were growing a mould similar to that found growing on bread. There were no bacteria growing near the mould. Fleming recognised that further investigation was necessary. He performed some experiments and discovered that the *Penicillium* mould was releasing a chemical that killed bacteria. Australian scientist Howard Florey was then instrumental in developing penicillin into a form that could be mass-produced. Both men were awarded the Nobel Prize in Physiology or Medicine for their work.

CHALLENGE
9.8a: Investigating pathogens
Go to page XXX

INVESTIGATION
9.8a: Investigating germ theory
Go to page XXX

Table 1 Different types of pathogens

Pathogen	Features	Example of disease
Bacterium	Unicellular organism Cell wall without nucleus or membrane bound organelles	Staphylococcus aureus
Fungus	Unicellular or multicellular organism Cell wall with nucleus No chloroplasts or chlorophyll	Tinea (a fungal infection that occurs between the toes)
Macroparasite	Multicellular organism Usually parasitic Absorbs nutrients across the cell membrane	Cysticercosis (an infection from eating contaminated uncooked meat, caused by tapeworm)
Prion	Not an organism Faulty protein molecule, which makes other proteins faulty through contact	Mad cow disease or Creutzfeldt-Jakob disease in humans
Protozoan	Unicellular or multicellular Cell wall with nucleus	Malaria
Virus	Contains genetic material surrounded by a protein	Hepatitis

germ theory
a theory that germs are caused by pathogens

antibiotics
medicine that is prescribed to stop the growth of bacteria

pathogen
anything that causes disease

Penicillin works by breaking down the cell walls of bacteria. Because human cells do not have a cell wall, they are unaffected. This means that penicillin will kill the bacteria in your body but not kill your own body cells. Viruses do not have cell walls. Instead, they have a protein coat that sur-rounds and protects them. This means penicillin does not affect viruses such as influenza or the common cold. Most viruses cannot be treated by any readily available medicines.

Check your learning 9.8

Recall and explain

1. **Identify** three living groups of pathogens.
2. **Explain** the difference between a virus and a bacterium.
3. **Summarise** germ theory.
4. **Identify** how Warren and Marshall used each of Koch's postulates to find the cause of stomach ulcers.
5. **Identify** an infection that you or someone you know had, that required antibiotics to be cured.
6. **Explain** how Louis Pasteur's discovery is still in use today.

Apply and analyse

7. A scientist believes a particular protozoan in Sydney water is responsible for an outbreak of a disease that causes an upset stomach and diarrhoea. **Outline** an experiment that could be performed to determine if the protozoan was in fact responsible for the disease.
8. A friend has been diagnosed with having a cold. His parents ask the doctor for some antibiotics to treat the infection. Determine what advice you think should be given and **justify** why.

Evaluate and create

9. **Investigate** a disease caused by a virus, bacteria, fungi and protozoan. Provide details of the pathogen's discovery, and the symptoms, treatment and prevention of the disease.

Skill builder: Conducting investigations

10. Scientists that work with pathogens in the laboratory are at risk of being exposed to extremely dangerous illnesses. You may have seen people in a laboratory wearing full personal protective equipment (PPE). Those that work with pathogens typically have all their skin covered and sealed. This is one of the ways scientists manage risk.
    a. **Explain** why wearing PPE in the laboratory is important when working with pathogens. (THINK: What are the risks of contracting a virus? What could happen if results were contaminated?)
    b. **Identify** one other measure that can help keep scientists safe in the laboratory. (THINK: Should scientists work alone? What can go wrong if you are alone in the lab?)

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9.9 The immune system protects our body

immune system
a system of organs and structures that protect an organism against disease

Key ideas

In this topic, you will learn that:

- the immune system has three lines of defence to stop invaders entering your body
- the immune system attacks any invaders if they do enter your body, to fight disease and keep you healthy.

white blood cell
an immune system cell that destroys pathogens

phagocyte
an immune system cell that surrounds, absorbs and destroys pathogens

Our bodies have several ways of preventing us from catching diseases, as well as a series of responses in case we do become unwell. These responses are all part of the **immune system**. There are three lines of defence, and each line has a different mechanism for protecting and combating illness.

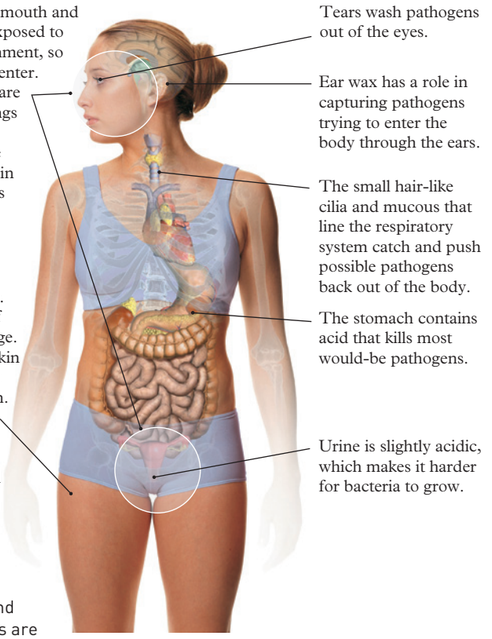


Figure 1 The skin and mucous membranes are the first line of defence against pathogens.

B cell
an immune system cell that produces antibodies in response to pathogens

First line of defence

The first line of defence is to stop the pathogens from getting inside your body (Figure 1). It consists of the skin and mucous membranes.

Second line of defence

Viruses, unlike bacteria, contain a protective coating that allows them to more easily slip through the first line of defence. If a pathogen gets inside your body, the body tries to remove it in one of two ways. First, a general 'seek and destroy' approach occurs regardless of the type of the pathogen. This is called a general or **non-specific immune response**. The key parts of the non-specific immune response are:

- blood clotting, to stop additional infection through skin damage
- inflammation, to increase the amount of **white blood cells** reaching an infected area
- fever (some pathogens cannot survive at high temperatures, so heating up the body is one way to destroy them).

Second, white blood cells are produced by the body to destroy pathogens. Inflammation increases the amount of blood reaching an infected area so more white blood cells are able to attack the pathogen. The white blood cells may also release chemical messengers that increase the amount of fluid in the infected area, causing swelling. There are a few different types of white blood cells. Each type has its own role but they all work together. **Phagocytes** (Greek for 'cells that eat') deal with the non-specific immune response. They surround and absorb pathogens, destroying them in a process called phagocytosis.

Third line of defence

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

CHALLENGE
9.9: Modelling infection and vaccination
Go to page **XXX**

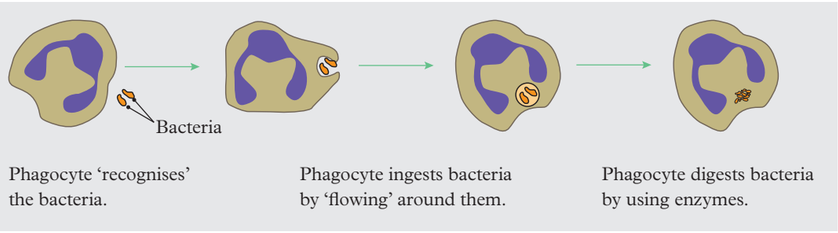


Figure 2 The process of phagocytosis

The specific immune response has two forms of attack. **B cells** (a type of white blood cell) produce special molecules called **antibodies**. These antibodies fit exactly onto a specific part of the pathogen. Each antibody will fit only one section of the pathogen. This will cause the pathogens to become locked together and stop them invading.

T cells (another type of white blood cell) then recognise the same specific pathogen and attack and kill it. B and T cells may take up to a week to recognise and destroy a pathogen. This is why recovering from an illness takes time.

Both the B and T cells will keep some memory cells alive, just in case the pathogen tries to invade again. This means the pathogen will be attacked and killed before it does damage a second time. Your body will be protected from re-infection in the future. You are now **immune**. This is called **natural active immunity**.

Unborn babies obtain some natural immunity by receiving antibodies across the placenta from the mother. Antibodies are also passed to babies through breast milk.

Another way to acquire immunity is through **vaccination** (or inoculation).

A vaccine can be:

- the dead pathogen
- a living but non-virulent (weakened) form of the pathogen
- parts of the broken-up pathogen.

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

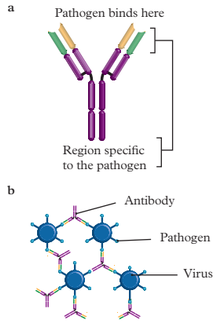


Figure 3 a Antibodies have regions that are specific to pathogens. **b** Antibodies cause pathogens to clump together.

antibody
a specific molecule produced by B cells that binds to a pathogen

T cell
an immune system cell that recognises and kills pathogens

immune
able to fight an infection as a result of prior exposure

vaccination
an injection of an inactive or artificial pathogen that results in the individual becoming immune to the disease

Check your learning 9.9

Recall and explain

1 **Identify** the parts of the body that make up the first line of defence.
2 **Describe** how the body responds if a pathogen gets past the first line of defence.

Apply and analyse

3 **Explain** the difference between a vaccination and a vaccine.

Evaluate and create

4 **Assess** which line of defence, if any, is most important. **Justify** your answer.
5 **Investigate** a disease that people are commonly vaccinated against. Write a list of details of what is in the vaccine and how effective it has been.

Skill builder: Scientific diagrams

6 You have been asked by a teacher at your school to explain the differences between the three lines of defence to year 7 science students. The teacher has encouraged you to use a diagram to explain this to the students, as they think the class will respond better to this.
   a **Identify** what you need to include in a diagram for the three lines of defence. (THINK: What is the most important information?)
   b **Construct** a scientific diagram/s to explain the three lines of defence to year 7 students. (THINK: What do scientific diagrams include? Where should you place labels?)

9.10 Humans respond to non-infectious diseases

Key ideas

In this topic, you will learn that:

- non-infectious diseases are not caused by pathogens
- non-infectious diseases are the result of environmental, genetic and nutritional factors.

Figure 1 A child with Kwashiorkor disease, caused by a diet low in protein.

Unlike infectious diseases, non-infectious diseases are not caused by a pathogen. Instead, they are the result of genetic, environmental or nutritional factors. They can also be caused by a combination of these factors. They are not contagious: you cannot 'catch' a non-infectious disease from someone. However, some may be passed down from parent to child in the case of genetic disorders like Huntington's disease or cystic fibrosis.

Nutritional deficiency can cause disease

The nutrients you supply to your body can affect how well your individual cells do their job. The right balance of nutrients is very important. Too much or not enough of some nutrients can cause diseases like rickets, scurvy and kwashiorkor.

Although other conditions such as type II diabetes, heart disease and obesity have nutritional links, patients can also have an underlying genetic predisposition to the disease. To further complicate the situation, the environment in which someone finds themselves can influence the development of nutritional diseases. For example, the home is part of your environment. If there is little fresh fruit and vegetables available, you are more likely to develop some of these diseases.

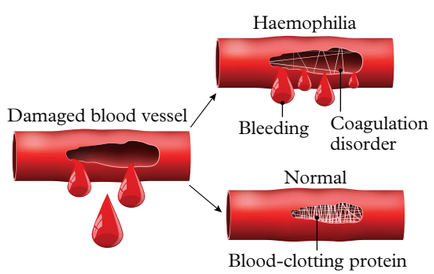


Figure 2 Haemophilia causes issues in blood clotting.

Kwashiorkor

Protein is an important component of any diet because it is essential for cell growth and repair. If enough protein is not consumed, the body responds by slowing cell growth and repair. Kwashiorkor can develop, which leads to stunted growth, loss of muscle mass and fluid retention. If not treated, it is life-threatening.

Scurvy

Vitamin C plays an important role in the growth and repair of all body tissues. When people do not consume enough Vitamin C, for example by eating citrus fruits like oranges, the body's ability to repair damaged tissue is inhibited. This can lead to scurvy, with symptoms such as weakness, spontaneous bleeding, ulceration of the gums and loss of teeth.

Genetic diseases and disorders

All genetic disorders are a result of a mutation in the DNA or chromosomes at some stage. If these mutations occur in the DNA of sperm and eggs, they can be passed on to future children. Examples of genetic diseases and disorders include haemophilia, cystic fibrosis, sickle-cell anaemia, muscular dystrophy, Down syndrome and fragile X syndrome.

Haemophilia

Haemophilia is an inherited disorder that prevents the affected person's blood from clotting. Typically, when we injure ourselves, our blood has a protein that assists in plugging the gap to stop the bleeding. If these proteins are not present, the body responds with continued bleeding. If someone with haemophilia injures themselves, they are at serious risk. Modern science has isolated these proteins in blood cells and provides them to patients with haemophilia when needed.

Cystic fibrosis

Cystic fibrosis is a genetic disease that is inherited from the parents. Although both parents themselves can be healthy, they can each carry a copy of the gene that carries cystic fibrosis. If both the egg and sperm carry this gene, the child receives two copies and will develop to have cystic fibrosis. Cystic fibrosis stops the body from producing an important protein responsible for clearing mucous from the respiratory and digestive systems. The body responds by producing an excessive build-up of mucous, which can impair breathing and digestion. Microbes can also take advantage of these conditions, which may place the child at a great risk of infection.

Environmental and lifestyle diseases

As humans we are exposed to toxins, carcinogens and radiation on a daily basis. Some of these are harmless in small amounts, but with prolonged or extreme exposure, they can cause a non-infectious disease.

For example, excessive exposure to UV radiation can break chemical bonds within the DNA of your cells. DNA contains the instructions for every task and substance required for healthy functioning. Any change to these instructions can result in damage, which may be minor or major depending on where in the body the change occurs.

Asbestosis

Asbestosis is a lung disease caused by the inhalation of asbestos fibres. The fibres lodge in the lung tissue, and the body responds with inflammation and the creation of scar tissue to enclose the fibres. In the long term, this response can cause genetic change in the cells and result in lung cancer and mesothelioma (a cancer that forms in the thin layer lining the abdomen and organs such as the lungs and heart).

Emphysema

Emphysema is a progressive disease of the lungs. It causes shortness of breath due to inflation of the air sacs, which have been lined with tar from cigarette smoke. Smoking cigarettes can increase the likelihood of developing this disease. Cigarette smoke contains over 70 known carcinogens, which are capable of causing emphysema, lung cancer and other health issues in the body.

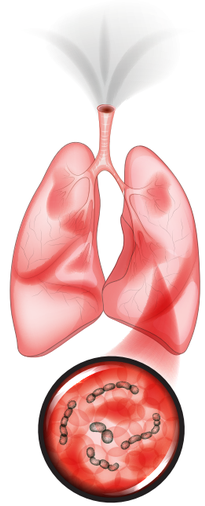


Figure 4 Asbestosis affects the lungs.

Check your learning 9.10

Recall and explain

1. **Define** infectious disease, and provide an example.
2. **Identify** the three types of non-infectious disease,
3. **Propose** why our body needs a healthy diet.

Apply and analyse

4. **Compare** infectious diseases with non-infectious diseases.

Evaluate and create

5. Techniques for detecting genetic disorders are becoming more accurate and accessible. Write a brief essay to **discuss** the benefits and disadvantages of screening parents for common genetic disorders before having children.
6. **Investigate** a nutritional, genetic and environmental disease or disorder not covered in this section. **Construct** a presentation that provides details about the cause, symptoms and treatment of each. Your presentation should be no longer than 2 minutes and can involve a digital presentation, poster or any other elements you may need.

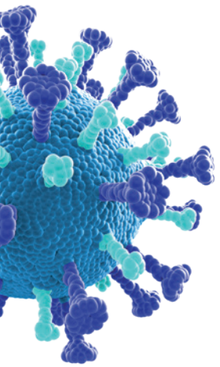
Skill builder: Communicating

7. A group of people were found to have the following measurements in Table 1.
   a. Calculate the mean height and weight for this group. (THINK: what is the average?)
   b. Sketch the mean for each group on a graph. (THINK: What goes on the x-axis? What goes on the y-axis? What type of data is this?)

Table 1 Height and weight measurements for a group of people

Participant	Height (cm)	Weight (kg)
1	203	80
2	165	58
3	176	67

9.11 Societies influence scientific research



Key ideas

In this topic, you will learn that:

- the needs and demands of society influence scientific research
- Australia invests research on a global level and also on a country level.

History has shown that as scientific knowledge improves, better health and increased life expectancy follows. In developing countries, the majority of the top ten causes of death are the result of infectious disease. In contrast, for developed countries (including Australia) none of the top ten causes of death are due to infectious disease. Because of this, Australian society places more emphasis on supporting scientific research into non-infectious diseases such as obesity, heart disease and cancer.

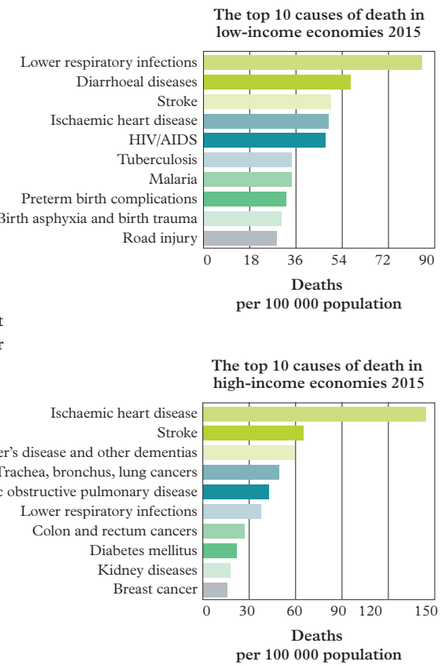


Figure 1 The top ten causes of death in low- and high-income economies in 2015

epidemic
an outbreak of disease that is spreading in a particular area and infecting more people than would be normally expected

pandemic
global spread of a new disease

Obesity

Obesity tends to result from the interplay between an individual's genetics, nutrition and environment. The World Health Organization (WHO) defines obesity as 'an excessive fat accumulation that presents a risk to health'.

Obesity requires a nutritional intake of calories greater than the amount being burnt off through your metabolism. Individuals can have a genetic predisposition to the disease, and home and work environments also influence dietary habits. The body's response to excess nutrients is to store these as fat.

Approximately 65% of adults and nearly 40% of all children in Australia are overweight or obese. These individuals have a greater risk of musculoskeletal disorders and a range of other diseases, including heart disease, type II diabetes and cancer. This places pressure on Australia's economy and health systems. The increased pressure causes Australian society to value research into obesity and ways to combat this disease.

Epidemics and pandemics

An **epidemic** refers to a disease outbreak that is actively spreading and affects a greater number of people in an area than would normally be expected. A **pandemic** relates to worldwide spread of a disease.

Epidemics and pandemics have popped up at various times throughout history. The Black Death (the Great Plague) in the 1300s killed as many as 200 million people. In 1918, the Spanish flu infected approximately 500 million people worldwide, and approximately 50 million people died. Different versions of influenza continue to cause health authorities concern every year. Since 2009, swine flu has caused up to 500 000 deaths around the world. This disease was transmitted between pigs and then from a pig to humans.

The rise of globalisation and ease of world travel dictates that contemporary society must be vigilant about outbreaks of dangerous strands of influenza.

Figure 2 Epidemics are an increased number of people with a disease in an area, whereas pandemics are the worldwide spread of the disease.

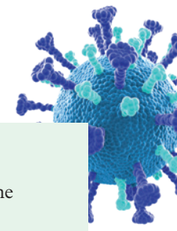
In late 2019, the disease COVID-19 emerged in China. This disease is caused by a new coronavirus similar to the SARS virus in 2003. In March 2020, this virus was declared a pandemic by the World Health Organization.

HIV/AIDS

In the 1980s, the HIV/AIDS pandemic began. Without treatment, the human immunodeficiency virus (HIV) infection progressed to AIDS within five years, eventually resulting in deaths. The current worldwide death toll stands at approximately 40 million people.

Around the world, there are many health campaigns to prevent the spread of the disease. Despite a relatively low infection rate in Australia, research was conducted to develop anti-viral drugs, which has resulted in very low HIV-to-AIDS progression rates in Australia.

Figure 3 Societies must be vigilant about outbreaks of dangerous viruses.



Check your learning 9.11

Recall and explain

1. **Explain** the difference between a pandemic and an epidemic.
2. In your own words, **define** obesity.

Apply and analyse

3. **Examine** the graphs in Figure 1.
   - a. **Identify** the top cause of death in both developing and developed countries.
   - b. **Identify** the death rate of the top cause of death in both developing and developed countries.
   - c. **Interpret** if there is any overlap between the economies.

Evaluate and create

4. **Investigate** an example of how the values and needs of contemporary society have influenced the focus on scientific research in relation to the occurrence of diseases affecting animals and plants.
5. **Investigate** the global effort to produce a vaccine for COVID-19. **Discuss** why it is important for the world to act together to combat global diseases.

Skill builder: Processing and analysing data

6. Figure 3 shows the number of annual deaths from HIV/AIDS from 1982 to 2011.
   - a. **Identify** what the *y*-axis and *x*-axis have information about.
     (THINK: What are the labels? What is happening in the graph?)
   - b. **Identify** what year had the most deaths.
     (THINK: What is the highest point on the graph?)
   - c. **Identify** how many deaths were in the year for part a.
     (THINK: What is the corresponding point on the graph?)
   - d. **Identify** the death rate in 2001.

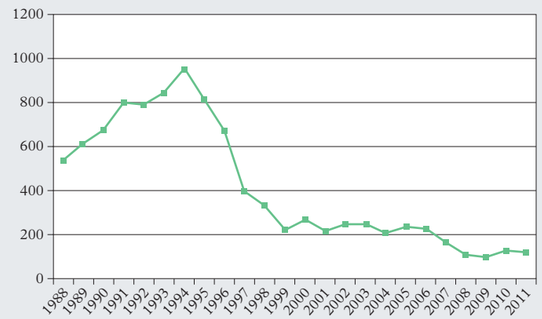


Figure 3 Annual deaths from HIV/AIDS from 1982 to 2011

*REVIEW

Multiple choice

1 Which of the following explains what a neuron is?
- **A** A chemical released by organs of the body to create slow change
- **B** An electrical message released from the nervous system to create fast change
- **C** A cell that helps plants respond to sunlight
- **D** Part of the brain

2 Photoreceptors belong to sight, the way that chemoreceptors belong to _____
- **A** taste
- **B** touch
- **C** smell
- **D** hearing.

3 Select which of the following is not a pathogen.
- **A** Fungi
- **B** Bacteria
- **C** Adrenalin
- **D** Prion

Recall and explain

4 In your own words, **define** the following.
- **a** Stimulus
- **b** Homeostasis
- **c** Pathogen

5 **Describe** three ways the human body can receive a stimulus from the environment.

6 **Identify** two structures in humans that produce hormones, and **describe** their roles.

7 **Explain** why the nervous system and the endocrine system are both communication systems.

8 **Recall** how hormones are transported around the body.

9 **Describe** the features of the body's first line of defence.

10 Provide an example of an infectious disease.

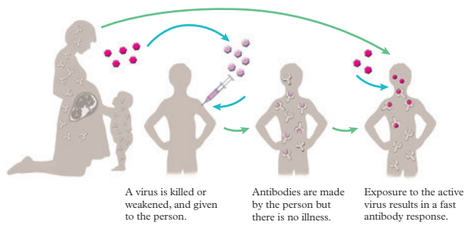


Figure 1 A person can become protected or immune through active vaccination or antibodies passively being passed on from their mother.

11 **Explain** what an antibody is.

12 **Explain** how the specific immune system remembers pathogens for the next time you are infected by them.

13 **Recall** how epicormic buds allow survival of a plant after a bushfire.

14 **Describe** reasons why it might be important to have certain vaccinations before travelling overseas. Find two diseases you may need to be vaccinated against.

15 **Explain** what is meant by the phrase 'fight or flight' and how it relates to hormones.

16 The hypothalamus is an important structure within the brain that secretes hormones. It is responsible for maintaining a stable environment in your body.**Explain** how the hypothalamus is an example of the nervous and endocrine systems working together.

Apply and analyse

17 **Explain** what a feedback mechanism is and give an example.

18 Complete the following sentence by inserting the missing words. A person with diabetes has a problem with the hormone _____, which is secreted by the _____ gland.

19 Transmission of pathogens can cause mass outbreaks of disease that affect large numbers of people. Examples are HIV/AIDS, the SARS virus, the swine flu and the outbreak of cholera in Zimbabwe. **Assess** the role of international travel in the spread of disease.

20 Given that people have usually had a cold before, **propose** why people continue to catch colds.

21 **Examine** Table 1, which shows the leading cause of death in different age groups of Australians.
- **a** What is the second leading cause of death in people aged 15–24?
- **b** **Construct** a hypothesis about why lung cancer is the leading cause of death in people aged 65–74, whereas the age brackets on either side have the leading cause of deaths by coronary heart disease.

22 **Propose** a reason why recent pandemics typically don't kill as many people as the Black Death and the Spanish flu.

Evaluate and create

23 **Assess** why holding your nose might help you to swallow something that tastes awful.

24 In 2006, a woman in Canada fought off a polar bear with her bare hands when it attacked her son. **Propose** reasons for and against this reaction being attributed to the hormone adrenalin.

Table 1 Leading cause of death in different age groups, by age group, 2015-2017

Age group (years)	1st	2nd	3rd	4th	5th
Under 1	Perinatal and congenital conditions	Other ill-defined causes	SIDS (Sudden Infant Death Syndrome)	Accidental threats to breathing	Influenza and pneumonia
1-14	Land transport accidents	Perinatal and congenital conditions	Brain cancer	Accidental drowning and submersion	Leukaemia
15-24	Suicide	Land transport accidents	Accidental poisoning	Assault	Other ill-defined causes
25-44	Suicide	Accidental poisoning	Land transport accidents	Coronary heart disease	Breast cancer
45-54	Coronary heart disease	Lung cacner	Colorectal cancer	Suicide	Breast cancer
65-74	Lung cancer	Coronary heart disease	COPD	Colorectal cancer	Cerebrovascular disease
75-84	Coronary heart disease	Dementia and Alzheimer's disease	Cerebrovascular disease	Lung cancer	COPD
85 and over	Coronary heart disease	Dementia and Alzheimer's disease	Cerebrovascular disease	COPD	Heart failure

25 **Compare** viruses, bacteria and protozoa. **Explain** how they are similar and how they are different.

26 Imagine that you wake up one day and one of your sense organs has stopped working. Write a creative story outlining this day in your life.

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

28 **Explain** how the endocrine system assists your body to 'respond to the world'. **Discuss** why the endocrine system can't handle this big job on its own.

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

30 The hygiene hypothesis suggests that childhood exposure to microbes and certain infections helps the immune system develop. As a result of potentially being too hygienic, developed countries continue to see a rise in autoimmune conditions such as asthma and anaphylaxis. **Investigate** these conditions, and **outline** the role of the body's own immune response in causing the symptoms.

31 **Describe** in your own words how the non-specifi c immune response works.

32 **Construct** a table that distinguishes between the different lines of defence.

33 **Outline** what a vaccine may contain.

34 Most scientists and doctors believe that vaccinations for certain diseases should be compulsory, whereas small numbers of people believe it should be personal choice. In small groups, **discuss** different points of view and the consequences of these points of view.

Critical thinking

35 Haemophilia is carried on the X chromosome and is more likely to affect males. It is a genetic disorder.
- **a** Research the following claim: People with haemophilia will have more complications from injuries than those who do not have haemophilia.
- **b** Find two sources to support your answer.

36 Animals enter hibernation to better survive changes in their external environment such as winter.
- **a** **Investigate** how this helps the Eastern Pygmy possum.
- **b** **Propose** what might happen if the possum did not enter hibernation.

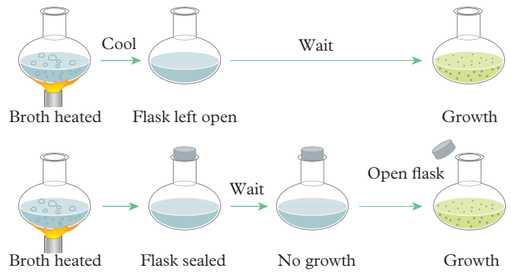


Figure 2 Louis Pasteur's experiments found that microorganisms in milk were killed by heat. This process is called pasteurisation and is still in use today.

37 Louis Pasteur found that heat could kill microorganisms in milk. This discovery is still in use today. Investigate the use of heat in killing pathogens.
- **a** Identify two reliable sources.
- **b** Summarise one use of heat.

Go further

38 Human body cells are extremely sensitive to change, which is why our systems work very hard to maintain a relatively stable internal environment and why we move out of environments that are too hot or too cold. Plants are unable to get up and move to a new external environment. **Evaluate** whether plants would be more sensitive, be less sensitive or have the same sensitivity to their internal environment than more mobile organisms. **Justify** your decision.

39 **Propose** what the structure of each of the following brains in Figure 3 might mean for its owner.

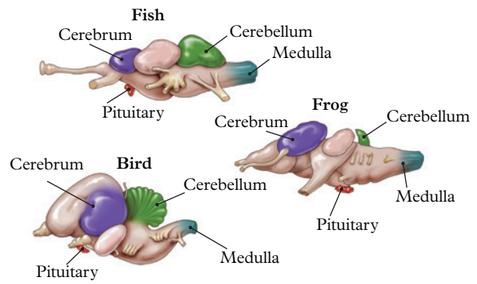


Figure 3 Three different brains

40 Choose one of the following topics for a research project. A few guiding questions have been provided for you, but you could add more questions that you want to investigate. Present your research in a format of your own choosing, giving careful consideration to the information you are presenting.

41 View the image of the brain in Figure 4.
- **a** Research what happens if someone damages their left occipital lobe.
- **b** Create a poster that explains the role of this in the nervous system.

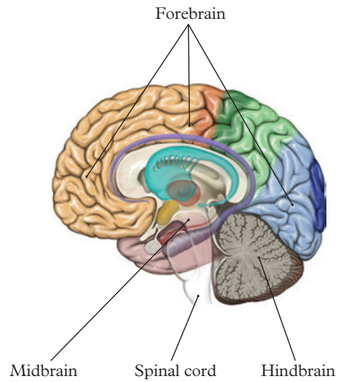


Figure 4 The internal structure of the brain

Research

»Stem cells for spinal injury

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

»Type 2 diabetes

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

»Artificial skin

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

Reflect

Now that you've completed this chapter, reflect on your ability to do the following:

	I can do this.	I cannot do this yet.
Describe some examples of how multicellular organisms respond to changes in their environment.	☐	☐ Go to pages xxx - xxx
Describe how the coordinated function of internal systems in multicellular organisms provides cells with requirements for life, including gases, nutrients and water, and removes cell wastes.	☐	☐ Go to pages xxx - xxx
Outline some responses of the human body to infectious and noninfectious diseases.	☐	☐ Go to pages xxx - xxx
Describe the role of, and interaction between, the coordination systems in maintaining humans as functioning organisms.	☐	☐ Go to pages xxx - xxx
Discuss, using examples, how the values and needs of contemporary society can influence the focus of scientific research, eg the occurrence of diseases affecting animals and plants, an epidemic or pandemic disease in humans or lifestyle related non-infectious diseases in humans.	☐	☐ Go to pages xxx - xxx

9.2 Testing your senses

CHALLENGE

Design brief

Design equipment that uses a block of wood to hit a tennis ball. A block of wood from home or woodwork room is ideal.

Experiment video
7.4 Experiment

Risk assessment
7.4 Experiment

Lab tech notes
7.4A What if a balloon were electrostatically charged?

PART A: TEMPERATURE RECEPTORS

What you need

- Very warm water
- Room-temperature water
- Ice cubes
- 3 ice-cream containers
- Thermometer

What to do

1. Half-fill one container with cold water and add the ice cubes.
2. Half-fill the second container with room-temperature water.
3. Half-fill the last container with very warm water.
4. Place one hand in the ice water and the other in the very warm water for 2 minutes.
5. Remove both hands from the water and place them in the room-temperature water.

Discussion

1. What was the stimulus for the hand in very warm water?
2. What change did the hand detect when it moved from the ice water to the room-temperature water?
3. Is there a set temperature that acts as a stimulus for your hand?
4. Why do scientists use a thermometer rather than their hands to test the temperature of solutions?

PART B: TOUCH RECEPTORS

What you need

- 2 toothpicks
- Ruler
- Cork
- Blindfold

What to do

1. Work in pairs. One person puts on the blindfold.
2. Place the toothpicks 50 mm apart in the cork.
3. Carefully use the cork to place the pointed ends of the toothpicks on the blindfolded person's finger. They should indicate whether they feel 'one point' or 'two points'.
4. If two points are felt, move the toothpicks closer together and repeat step 3.
5. Repeat steps 3 and 4 until the blindfolded person reports 'one point' for the first time.
6. Record your results in a table.
7. Repeat this procedure for the palm of the hand, back of the hand and forearm.

Discussion

1. Are the 'two point' distances the same on different areas of the skin?
2. Which part of the body was best at detecting when two close points are touching it?
3. Which skin areas do you think have more touch receptors? Use your results to support your answer.

9.7 Experiencing homeostasis

INVESTIGATION

Aim

To demonstrate how homeostasis maintains control of the heart rate during and after exercise

Experiment video
7.4 Experiment

Risk assessment
7.4 Experiment

Lab tech notes
7.4A What if a balloon were electrostatically charged?

Materials

- Stopwatch
- Heart rate monitors (optional)

Method

1. While sitting down, find your pulse and count the number of times your heart beats in 15 seconds.
2. Multiply this number by 4 to determine the number of beats every minute.
3. Measure your respiration rate by counting the number of breaths you take in 1 minute.
4. Do step-ups or star jumps for 2 minutes.
5. Measure your heart rate and respiration rate immediately after stopping exercise.
6. Measure your heart rate and respiration rate every 2 minutes for 10 minutes. Record your results each time.

Results

1. Present the data in a table.
2. Draw a line graph showing how your heart rate varied after exercise.
3. Draw a line graph showing how your respiration rate varied after exercise.

Discussion

1. Explain what happened to your breathing rate during exercise.
2. Explain why your heart rate increased during exercise.
3. Describe what happened to your heart rate during the 10 minutes after exercise.
4. Use homeostasis to explain why your heart rate was different before, during and after exercise.

Conclusion

How does homeostasis ensure your muscles get enough nutrients and remove wastes during exercise?

A volcanologist wearing a heat suit watching an eruption of ash, vapours and glowing lava (i.e. molten rock) from Mount Etna.

Lava can range in temperature from 475°C to 1150°C and changes colour from glowing red to white as it becomes hotter. The suit is designed to protect the scientist from this heat. Other dangers on the slopes of a volcano include poisonous gases, like hydrogen sulphide, and lava bombs (i.e. chunks of molten rock ejected by the volcano).

Mount Etna stands 3323 metres tall on the Italian island of Sicily. It is the largest active volcano in Europe.

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