5 RESPONDING TO THE WORLD

Big ideas

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

COMMUNICATING

Communication is a process involving:
- The brain is separate from the nervous system.
- The brain is a uniform mass of tissue.
- The brain is not responsible for hormones.
- We sense our world in only one way at a time.
- Hormones are produced by the target organs.
- Hormones act quickly.
- Hormones ‘just travel around the body’ (students don’t necessarily understand that they travel via the bloodstream/bloodstream).
- Organs such as the heart and lungs are part of the nervous system.
- Humans only use their brains, nervous system, endocrine system etc. when they are doing something, such as thinking or performing a physical action.
- The electrical impulses of the nervous system aren't actually electricity.
- All actions, including breathing, heart rate and reflexes, are voluntary actions.

Answers

5.1 How do we sense our world?

1. The body senses changes in its external environment via sight, sound, taste, smell and touch.
2. The body can sense and respond to many things including hormone levels, balance, pain, hunger.
3. The immune system is a simple system.
4. Organs such as the heart and lungs are part of the nervous system.
5. Humans only use their brains, nervous system, endocrine system etc. when they are doing something, such as thinking or performing a physical action.
6. The electrical impulses of the nervous system aren’t actually electricity.
7. All actions, including breathing, heart rate and reflexes, are voluntary actions.

5.2 What is a hormonal response?

1. A hormonal response is something that the body is unable to produce enough hormones to complete a very important substance in the body. When the body has an imbalance of hormones, it can cause problems such as heavy periods or hair loss.
2. Hormones are responsible for the growth and development of critical organs, such as the heart and lungs. People who take drugs to get high may cause these hormones to not work properly.
3. Some hormones are produced by the pituitary gland, which can produce hormones such as insulin and adrenaline.
4. People with type 1 diabetes usually know they have it from a very young age because they are not getting enough energy. People who take drugs to get high may cause these hormones to not work properly.
5. People who take drugs to get high may cause these hormones to not work properly.

5.3 What is a nervous response?

1. A nervous response is something that the body is unable to produce enough nerves to complete a very important substance in the body. When the body has an imbalance of nerves, it can cause problems such as heavy periods or hair loss.
2. Hormones are responsible for the growth and development of critical organs, such as the heart and lungs. People who take drugs to get high may cause these hormones to not work properly.
3. Some hormones are produced by the pituitary gland, which can produce hormones such as insulin and adrenaline.
4. People who take drugs to get high may cause these hormones to not work properly.
5. People who take drugs to get high may cause these hormones to not work properly.

5.4 How do we respond to threats?

1. A nervous response is something that the body is unable to produce enough nerves to complete a very important substance in the body. When the body has an imbalance of nerves, it can cause problems such as heavy periods or hair loss.
2. Hormones are responsible for the growth and development of critical organs, such as the heart and lungs. People who take drugs to get high may cause these hormones to not work properly.
3. Some hormones are produced by the pituitary gland, which can produce hormones such as insulin and adrenaline.
4. People who take drugs to get high may cause these hormones to not work properly.
5. People who take drugs to get high may cause these hormones to not work properly.

5.5 What is a psychological response?

1. A psychological response is something that the body is unable to produce enough nerves to complete a very important substance in the body. When the body has an imbalance of nerves, it can cause problems such as heavy periods or hair loss.
2. Hormones are responsible for the growth and development of critical organs, such as the heart and lungs. People who take drugs to get high may cause these hormones to not work properly.
3. Some hormones are produced by the pituitary gland, which can produce hormones such as insulin and adrenaline.
4. People who take drugs to get high may cause these hormones to not work properly.
5. People who take drugs to get high may cause these hormones to not work properly.

5.6 How do we react to threats?

1. A nervous response is something that the body is unable to produce enough nerves to complete a very important substance in the body. When the body has an imbalance of nerves, it can cause problems such as heavy periods or hair loss.
2. Hormones are responsible for the growth and development of critical organs, such as the heart and lungs. People who take drugs to get high may cause these hormones to not work properly.
3. Some hormones are produced by the pituitary gland, which can produce hormones such as insulin and adrenaline.
4. People who take drugs to get high may cause these hormones to not work properly.
5. People who take drugs to get high may cause these hormones to not work properly.

5.7 What is a reflex?

1. A reflex is something that the body is unable to produce enough nerves to complete a very important substance in the body. When the body has an imbalance of nerves, it can cause problems such as heavy periods or hair loss.
2. Hormones are responsible for the growth and development of critical organs, such as the heart and lungs. People who take drugs to get high may cause these hormones to not work properly.
3. Some hormones are produced by the pituitary gland, which can produce hormones such as insulin and adrenaline.
4. People who take drugs to get high may cause these hormones to not work properly.
5. People who take drugs to get high may cause these hormones to not work properly.

5.8 How do we adapt to threats?

1. A nervous response is something that the body is unable to produce enough nerves to complete a very important substance in the body. When the body has an imbalance of nerves, it can cause problems such as heavy periods or hair loss.
2. Hormones are responsible for the growth and development of critical organs, such as the heart and lungs. People who take drugs to get high may cause these hormones to not work properly.
3. Some hormones are produced by the pituitary gland, which can produce hormones such as insulin and adrenaline.
4. People who take drugs to get high may cause these hormones to not work properly.
5. People who take drugs to get high may cause these hormones to not work properly.

5.9 What is the immune system?

1. A nervous response is something that the body is unable to produce enough nerves to complete a very important substance in the body. When the body has an imbalance of nerves, it can cause problems such as heavy periods or hair loss.
2. Hormones are responsible for the growth and development of critical organs, such as the heart and lungs. People who take drugs to get high may cause these hormones to not work properly.
3. Some hormones are produced by the pituitary gland, which can produce hormones such as insulin and adrenaline.
4. People who take drugs to get high may cause these hormones to not work properly.
5. People who take drugs to get high may cause these hormones to not work properly.

5.10 How do we control threats?

1. A nervous response is something that the body is unable to produce enough nerves to complete a very important substance in the body. When the body has an imbalance of nerves, it can cause problems such as heavy periods or hair loss.
2. Hormones are responsible for the growth and development of critical organs, such as the heart and lungs. People who take drugs to get high may cause these hormones to not work properly.
3. Some hormones are produced by the pituitary gland, which can produce hormones such as insulin and adrenaline.
4. People who take drugs to get high may cause these hormones to not work properly.
5. People who take drugs to get high may cause these hormones to not work properly.

5.11 What causes a nervous response?

1. A nervous response is something that the body is unable to produce enough nerves to complete a very important substance in the body. When the body has an imbalance of nerves, it can cause problems such as heavy periods or hair loss.
2. Hormones are responsible for the growth and development of critical organs, such as the heart and lungs. People who take drugs to get high may cause these hormones to not work properly.
3. Some hormones are produced by the pituitary gland, which can produce hormones such as insulin and adrenaline.
4. People who take drugs to get high may cause these hormones to not work properly.
5. People who take drugs to get high may cause these hormones to not work properly.
**5.1 HOW DO WE SENSE OUR WORLD?**

**How do we sense our world?**

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

Students should have a basic understanding of how the senses work; however, in most instances, they haven’t actually considered why this happens and how the body responds. This should be the focus for this chapter. A good way to start could be brainstorming and discussing the ways in which the body responds. This would be a good place to start introducing new words such as ‘stimuli’, ‘receptors’ and ‘homeostasis’.

**Activity**

Think, pair, share: Ask students to write down 1–4 stimuli and the ways in which the body responds to these changes in the environment (internal/external). Pair up and add to their list, then share with the class. By the end of this activity, students should have a good list of different ways in which the body responds to stimuli and the ways in which it does—to maintain homeostasis and ensure survival.

#### Identifying stimuli

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

**A stimulus** is any information that your body receives that might cause it to respond. The simplest stimuli are those that are received by directly:

- Temperature changes- for example, you know that you’ve caught a cold when your temperature goes up.
- Pain: the reason you stop walking and cry out is that your toe has been stepped on.
- Odor: your nose is sensitive to the smell of a delicious meal that’s being cooked.
- Sound: loud music makes us jump—your ears react to it.
- Touch: your hand feels the heat stimulus and the response was your hand quickly withdrawing from the heat source.

How many stimuli can you think of that would require you to respond in some way? There could be as insignificant a change as a breeze or as simple as realising your toothbrush is old.

**What do you know about identifying stimuli?**

1. **What is a stimulus?**
   - A stimulus is any information that your body receives that might cause it to respond.
2. **When would you respond to a stimulus?**
   - When something is happening that might affect you.
3. **How many stimuli can you think of that would require you to respond in some way?**
   - There could be as insignificant a change as a breeze or as simple as realising your toothbrush is old.

#### How do we sense our world?

**5.1 HOW DO WE SENSE OUR WORLD?**

When your body receives information, this is called a stimulus. Have you ever accidentally touched something really hot and instantly jumped your hand away? Your fingertips registered the heat stimulus and the response was your hand quickly withdrawing from the heat source.

Your five main senses, including touch, receive information from your environment. However, not all stimuli are received from outside your body. Your body can recognize stimuli from inside your body, for example when you feel hungry, sick or tired.

**<<DISCOVERING IDEAS>>**

**Responding to change**

Are all stimuli in our environment changes that you can think of that would require you to respond in some way? They could be as insignificant a change as a breeze or as simple as realising your toothbrush is old.

How many stimuli can you think of that would require you to respond in some way? Is there only one way to respond to each? If not, how would you decide how to respond?

**The sense organs**

The sense organs are the main sensory organs. They are sensitive to stimuli because they tell us about the world outside our body.

- **Vision**—eyes
- **Taste**—tongue, palate and teeth
- **Hearing**—ears
- **Touch**—nerves, skin, and hair
- **Smell**—nasal passages
- **Temperature**—skin
- **Chemical**—nose
- **Anxiety**—brain
- **Gustatory**—tongue
- **Rhesus**—placenta
- **Receptor**—nerve ending
- **Sodium**—nose
- **Olfactory**—nose and skin
- **Magnet**—brain

**What is homeostasis?**

**Homeostasis** is the body’s ability to regulate and maintain a stable internal condition, regardless of changes in the external environment.

**Answers**

**What do you know about identifying stimuli?**

1. **‘Stimulus’ refers to any information that the body receives that might cause it to respond.**
2. **Examples of stimuli (answers will vary):**
   - internal: hunger, thirst, fatigue
   - external: temperature, light, sound

**How do we sense our world?**

- **Stimuli** refer to any information that the body receives that may cause it to respond.
- **Homeostasis** is the body’s ability to regulate and maintain a stable internal condition, regardless of changes in the external environment.
- **If the body didn’t maintain homeostasis, it wouldn’t have the ability to sense and respond to changes.** An unstable internal environment increases the risk of illness, increases the aging process and leads to death.

**ebook**

ID03.01 Weblink: A homeostasis online multimedia resource that contains examples, explanations and definitions

ID03.02 Weblink: Interactive senses task

Allows students to put their senses to the challenge

ID03.03 Weblink: Information, an animation and an interactive game on sight can be found at the BBC science website
Hearing, taste, smell and touch

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

Hearing

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

Touch

If you look at your tongue in a mirror you will be able to see thousands of tiny taste buds. Taste buds contains special receptor cells that send to chemicals in foods. Taste buds can recognize basic kinds of taste: sweet, salty, sour and bitter. The sense for these four kinds of taste are located in different parts of the tongue. Recently, a fifth taste, umami, can be recognized by the receptors in the back of the tongue. This taste is different known as ‘savoury’ as ‘salty’ and seems to use the whole tongue. The taste buds themselves are receptors that work by nerves sending messages to the brain. When you are drinking, the information from the taste buds goes straight to the brain, which tells you what flavour you are tasting.

Taste

Our perception of smell depends on chemical receptors that are found in each of our nostrils. These receptors detect airborne chemicals and then send messages to the brain. The brain interprets the message and tells us what we are smelling. Smell is closely linked to taste. If you sense strange things for the first time you had a bad cold and a blocked nose. Do you lose ability to taste a lot of what people think is naturally sweetly or sourly?

Small

This perception of smell depends on chemical receptors that are found in each of our nostrils. These receptors detect airborne chemicals and then send messages to the brain. The brain interprets the message and tells us what we are smelling. Smell is closely linked to taste. If you sense strange things for the first time you had a bad cold and a blocked nose. Do you lose ability to taste a lot of what people think is naturally sweetly or sourly?

Small

Navigating without vision

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

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

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

The sense of touch will be used to determine whether there are objects in the way and to determine location within the classroom.

Hearing is used to follow directions, avoid other people and determine location within the classroom.

Smell isn’t necessarily used; however, it may be used to identify objects.

PRACTIVITY 5.1

Navigating without vision

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

1. Ensure all students or potentially hazardous objects are removed from around the room. Discuss with your partner the path that the blindfolded student is required to take around the room.

2. Once your partner has finished navigating the route, your partner walking with you to ensure your safe navigation and avoiding obstacles.

How was the sense of touch used to navigate?

How was the sense of hearing used to find your way around?

How was the sense of smell used?

What can sense better than another to help you navigate around the area?

PRACTIVITY 5.1

Navigating without vision

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

1. Ensure all students or potentially hazardous objects are removed from around the room. Discuss with your partner the path that the blindfolded student is required to take around the room.

2. Once your partner has finished navigating the route, your partner walking with you to ensure your safe navigation and avoiding obstacles.

How was the sense of touch used to navigate?

How was the sense of hearing used to find your way around?

How was the sense of smell used?

What can sense better than another to help you navigate around the area?

PRACTIVITY 5.1

Navigating without vision

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

1. Ensure all students or potentially hazardous objects are removed from around the room. Discuss with your partner the path that the blindfolded student is required to take around the room.

2. Once your partner has finished navigating the route, your partner walking with you to ensure your safe navigation and avoiding obstacles.

How was the sense of touch used to navigate?

How was the sense of hearing used to find your way around?

How was the sense of smell used?

What can sense better than another to help you navigate around the area?

PRACTIVITY 5.1

Navigating without vision

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

1. Ensure all students or potentially hazardous objects are removed from around the room. Discuss with your partner the path that the blindfolded student is required to take around the room.

2. Once your partner has finished navigating the route, your partner walking with you to ensure your safe navigation and avoiding obstacles.

How was the sense of touch used to navigate?

How was the sense of hearing used to find your way around?

How was the sense of smell used?

What can sense better than another to help you navigate around the area?

PRACTIVITY 5.1

Navigating without vision

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

1. Ensure all students or potentially hazardous objects are removed from around the room. Discuss with your partner the path that the blindfolded student is required to take around the room.

2. Once your partner has finished navigating the route, your partner walking with you to ensure your safe navigation and avoiding obstacles.

How was the sense of touch used to navigate?

How was the sense of hearing used to find your way around?

How was the sense of smell used?

What can sense better than another to help you navigate around the area?

PRACTIVITY 5.1

Navigating without vision

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

1. Ensure all students or potentially hazardous objects are removed from around the room. Discuss with your partner the path that the blindfolded student is required to take around the room.

2. Once your partner has finished navigating the route, your partner walking with you to ensure your safe navigation and avoiding obstacles.

How was the sense of touch used to navigate?

How was the sense of hearing used to find your way around?

How was the sense of smell used?

What can sense better than another to help you navigate around the area?

PRACTIVITY 5.1

Navigating without vision

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

1. Ensure all students or potentially hazardous objects are removed from around the room. Discuss with your partner the path that the blindfolded student is required to take around the room.

2. Once your partner has finished navigating the route, your partner walking with you to ensure your safe navigation and avoiding obstacles.

How was the sense of touch used to navigate?

How was the sense of hearing used to find your way around?

How was the sense of smell used?

What can sense better than another to help you navigate around the area?

PRACTIVITY 5.1

Navigating without vision

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

1. Ensure all students or potentially hazardous objects are removed from around the room. Discuss with your partner the path that the blindfolded student is required to take around the room.

2. Once your partner has finished navigating the route, your partner walking with you to ensure your safe navigation and avoiding obstacles.

How was the sense of touch used to navigate?

How was the sense of hearing used to find your way around?

How was the sense of smell used?

What can sense better than another to help you navigate around the area?

PRACTIVITY 5.1

Navigating without vision

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

1. Ensure all students or potentially hazardous objects are removed from around the room. Discuss with your partner the path that the blindfolded student is required to take around the room.

2. Once your partner has finished navigating the route, your partner walking with you to ensure your safe navigation and avoiding obstacles.

How was the sense of touch used to navigate?

How was the sense of hearing used to find your way around?

How was the sense of smell used?

What can sense better than another to help you navigate around the area?
**5.1 HOW DO WE SENSE OUR WORLD?**

**The senses**

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

**Answers**

**What do you know about the sense organs?**

1. The five sense organs are the tongue, skin, eyes, ears and nose.

2. Answers will vary; however, suggestions include:
   - tongue: eating or drinking, including different types of tastes
   - skin: heat, cold, pressure, pain
   - eyes: changes in light intensity, determining location, identifying objects or situations
   - ears: identifying noises, determining location
   - nose: identifying a smell, eating (smell is connected to taste)

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

---

**What do you know about what causes disease?**

1. A disease is an unhealthy impairment of the body that stops it from functioning as it should.

2. Infectious diseases are caused by pathogens that can be easily passed from one person to another.

3. Virus: not a cell, contains genetic information surrounded by a protein coat; not considered living. Bacteria: unicellular organism; cell wall but no nucleus; usually considered to be living.

4. A pathologist studies diseases and diagnosis of diseases.

**Radiation and disease**

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

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

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

**Activities**

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

**b**

ID 05.10 Video link: Pathogens

**Video**

Looking at the pathogen that causes hantavirus, how it is spread and how it affects humans.
5.1 HOW DO WE SENSE OUR WORLD?

Radiation and disease

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

PRACTIVITY 5.2

Background radiation


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

Answers

What do you know about radiation and disease?

1. Types of radiation include X-rays, radioisotopes, microwaves, infrared radiation, visible light and radio waves.

2. Some types of radiation are more likely to cause harm to living things because they travel at the speed of light and can cause chemical particles to move very fast. The higher the energy, the more damage that type of radiation can cause.

3. Radiation is used in medicine for X-rays, CT scans and radiotherapy.

4. Answers will vary. Information about mobile phones and radiation can be found at the ARANSA (Australian Radiation Protection and Nuclear Safety Agency) website. This could be discussed as a class to cover issues such as ethics of mobile phone companies in producing harmful products, whether a governing body is needed, what an acceptable level of radiation may be, what level of responsibility is there and who should take it if mobile phones are found to cause cancer.

BIG IDEAS

5.1 How do we sense our world?

Remember and understand

1. a. stimulus: any information that the body receives that might cause it to respond

b. homeostasis: the body’s ability to regulate and maintain a stable internal condition, regardless of changes to the external environment

c. pathogen: an organism capable of causing disease or illness

2. a. sweating to cool down the body and shivering to warm up the body

b. changing clothes worn

c. moving to a cooler/warmer place

d. convulsions, nausea, vomiting if the core temperature exceeds normal

Responses to a subtle change in temperature:

- Body hairs stand up to form a heat-trapping layer, or lay flat to allow excess heat to ‘escape’

- Vasodilation: Blood vessels get larger, allowing more blood to be close to the skin.

The closer blood is to the outside, the more heat can escape; this may make people look pink.

sweating/shivering to maintain core temperature

Analyse and evaluate

1. a. Low

b. Low

c. High

2. a. Can be discussed as a class to cover issues such as whether it could be dangerous to leave a device that causes harmful products. Does it make sense to expose yourself to harmful products?

b. Can be discussed as a class to cover issues such as whether it could be dangerous to leave a device that causes harmful products. Does it make sense to expose yourself to harmful products?

Ethical behaviour

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

2. Critical and creative thinking

- Imagine that you wake up in the morning and one of your senses is no longer working. How would you adapt to a creative story setting this day in your life?

- Your body is constantly monitoring and controlling the number of pathogens it can sustain. What can you do to assist your body in controlling pathogens? What sort of help do you need?

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

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

The endocrine system

The endocrine and nervous systems are the systems largely responsible for sensing and responding to the environment. Part of this important job is communication - chemical messages (hormones) have been received, messages must be delivered around the body to coordinate a response. The endocrine system sends fast electrical messages, and the nervous system is a much slower nervous system that uses chemical messengers called hormones to maintain homeostasis and to regulate growth.

Hormones are chemical messengers that carry information in the bloodstream. Hormones are responsible for sensing and responding to the environment. The endocrine system is a collection of glands that receive (sense) information. These hormones are secreted directly into the bloodstream and then travel through the blood to arrive at target organs, and once they leave the bloodstream, the hormone has its effect. The glands and organs of the endocrine system are spread throughout the body (Table 5.2).

The endocrine system involves a series of glands that produce hormones, which are hormones that affect the way the body works. The hormones control a variety of processes, such as growth and development, metabolism, and reproduction. The endocrine system includes glands such as the thyroid gland, which produces hormones that regulate metabolism, growth, and development.

The nervous system

The nervous system receives and processes information from the external and internal environment. It uses electrical impulses to respond quickly to changes, and then it sends information to the brain. The nervous system includes the brain, spinal cord, and peripheral nerves. The brain receives and processes information from the body, and the spinal cord and peripheral nerves transmit information to the brain and the body.

Functions of the nervous system

- Sensation: Information arrives at the brain via sensory receptors, which send impulses to the brain for processing.
- Motor control: The brain sends impulses to muscles to cause movement.
- Autonomic control: The brain controls involuntary functions such as heart rate and breathing.

The endocrine system and the nervous system work closely together to ensure that our body can respond appropriately to changes in the environment.

Table 5.2 Some organs and hormones of the endocrine system

<table>
<thead>
<tr>
<th>Organ</th>
<th>Hormone</th>
<th>Target tissue</th>
<th>Main effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrenal gland</td>
<td>Cortisol, adrenaline</td>
<td>Body systems</td>
<td>Stress response, fight or flight response</td>
</tr>
<tr>
<td>Parathyroid gland</td>
<td>Parathyroid hormone</td>
<td>Bones, muscles</td>
<td>Stimulates muscle growth; increases blood calcium</td>
</tr>
<tr>
<td>Pancreas</td>
<td>Insulin</td>
<td>Liver, muscle</td>
<td>Lowers blood glucose level</td>
</tr>
<tr>
<td>Pituitary gland</td>
<td>luteinizing hormone, growth hormone</td>
<td>Body cells</td>
<td>Controls growth of sex organs; regulates metabolism</td>
</tr>
</tbody>
</table>

The endocrine system and nervous system work together to maintain homeostasis, which is the body's ability to maintain a stable internal environment. The endocrine system produces hormones, which are chemical messengers that travel in the bloodstream to target organs, where they cause specific responses.

Ebook: ID05.12 Interactive activity: Endocrine system
Ebook: ID05.13 Weblink: An outline of the endocrine system, including hormones and how they work, with diagrams, can be found at the BBC science website.
Ebook: ID05.14 Weblink: A hormone activity with animations can be found on the BBC science website.
Ebook: ID05.15 Video link: The endocrine system – pituitary gland

Video looking at problems with the pituitary gland which causes too much growth hormone to be released by the body which leads to gigantism.
**5.2 What is a hormonal response?**

**Glands and organs of the endocrine system**

Students should use Table 5.2 on page 143 of the textbook to help them complete this task.

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

---

**Answers**

**What do you know about hormones at work?**

1. A feedback mechanism is a process or signal that is looped back to control a system within itself. For example, when a hormone is released, information is received back about what is happening in the body. This then affects other responses in the body.

2. A positive feedback system would increase the effect of a hormone.

3. Low blood sugar levels

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

---

**What do you know about the endocrine system?**

1. Endocrine system

2. ‘Fight or flight’ refers to the biological response of animals to stressful situations. Adrenaline is released to strengthen heartbeat, raise blood pressure and spur the conversion of glycogen into glucose to provide extra energy to defend (fight) or run away (flight).

3. Peptide hormones are made from proteins and produced by the anterior pituitary, parathyroid gland, placenta, thyroid gland and pancreas. They travel through the bloodstream to their target cells. Steroid hormones are secreted by the adrenal glands and ovaries or testes, and produced from cholesterol.

4. The endocrine system is referred to as a communications system because it is involved in sensing and responding to the environment. It uses hormones to maintain homeostasis and regulate growth. The hormones travel through the bloodstream and arrive at a target cell, where they perform their task.

5. A hormonal response is much slower but the effects last a much longer time.

---

**Hormones at work**

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

BIG IDEAS

5.2 What is a hormonal response?

Remember and understand

1. A stimulus is an external factor that influences an activity, or a detectable change in the internal or external environment that influences a response.

2. Glands that produce hormones in humans include the pituitary gland, ovary, testes, thyroid gland, pineal gland, parathyroid gland, adrenal gland and pancreas.

3. Diseases caused by hormonal problems include diabetes, goitre and obesity.

4. The nervous and endocrine systems are considered to be communication systems because they are involved in sensing and responding to the environment via messages that are sent around the body to coordinate a response.

5. Hormones are secreted by a gland and transported via the bloodstream to a target organ.

Analyse and evaluate

6. A person with diabetes has a problem with the hormone insulin because they are involved in sensing and communicating internally.

7. The endocrine system is involved in sensing and responding to the environment by using hormones to maintain homeostasis and regulate growth.

Critical and creative thinking

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

Apply

9. A person with diabetes has a problem with the hormone insulin because it is involved in sensing and communicating internally.

10. A person with diabetes has a problem with the hormone insulin because it is involved in sensing and communicating internally.

11. A person with diabetes has a problem with the hormone insulin because it is involved in sensing and communicating internally.

Analyse and evaluate

12. A person with diabetes has a problem with the hormone insulin because it is involved in sensing and communicating internally.

Critical and creative thinking

13. A feedback mechanism is a system that is looped back to control a system within itself. For example, when a hormone is released, information is received back about what is happening in the body. This then affects other responses in the body. The rate of hormone production and secretion is usually regulated by a negative feedback system, meaning if the stimulus indicates there is too much insulin, the response would be to produce less to reduce the effects.

Creative and critical thinking

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

15. Student answers will vary.

What is a nervous response?

BIG IDEAS

5.3 What is a nervous response?

<<DISCOVERING IDEAS>>

How fast is the nervous system?

1. How fast is the nervous system?

2. The fastest results will be when the students are not blindfolded. This is because they are able to use multiple senses to determine when to catch the ruler.

3. To ensure the results are as accurate as possible, the ruler should be dropped from the same height, by the same person, in the same conditions and the same number of times for each person.

4. This is a fair test because the students repeat the process multiple times and only change one variable at a time.

5. The fastest results will be when the students are not blindfolded. This is because they are able to use multiple senses to determine when to catch the ruler.

6. To ensure the results are as accurate as possible, the ruler should be dropped from the same height, by the same person, in the same conditions and the same number of times for each person.

7. This is a fair test because the students repeat the process multiple times and only change one variable at a time.

<<CONNECTING IDEAS>>

Structure and function

8. The endocrine system is involved in sensing and responding to the environment by using hormones to maintain homeostasis and regulate growth. The hormones travel through the bloodstream and arrive at a target cell where they perform their function. The endocrine system is a ‘communications system’.

9. The endocrine system is involved in sensing and responding to the environment by using hormones to maintain homeostasis and regulate growth. The hormones travel through the bloodstream and arrive at a target cell where they perform their function. The endocrine system is a ‘communications system’.

10. The endocrine system is involved in sensing and responding to the environment by using hormones to maintain homeostasis and regulate growth. The hormones travel through the bloodstream and arrive at a target cell where they perform their function. The endocrine system is a ‘communications system’.

<<CONNECTING IDEAS>>

Structure and function

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

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

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

<<CONNECTING IDEAS>>

Structure and function

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

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

<<CONNECTING IDEAS>>

Structure and function

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

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

<<CONNECTING IDEAS>>

Structure and function

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

19. The endocrine system is involved in sensing and responding to the environment by using hormones to maintain homeostasis and regulate growth. The hormones travel through the bloodstream and arrive at a target cell where they perform their task. The endocrine system couldn’t handle this job on its own because the response time is too slow, unlike the nervous system, which responds extremely quickly.
As students read through this information, they could be encouraged to add the bolded words to a handout, and to use Figure 5.3 to help understand the structure and function of a nerve cell.

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

A nerve that is not responding to stimuli is said to be ‘at rest’, whereas nerves that are activated are said to be ‘excited’. A nerve impulse travels along an axon by controlling its path. People with multiple sclerosis have problems with the myelin sheath around the axon. The myelin sheath helps to speed up a nerve impulse by controlling its path. They could then discuss the similarities and differences between the three types.

Answers

1. Student ideas will vary. The main differences are in the information they receive and distribute, and how they connect.

2. The features of a neuron that enable it to carry messages include:
   - cell body: connects to the axon
   - axon: nerve fibres that carries nerve impulses away from the cell body
   - myelin sheath: covers the axon to help speed up a nerve impulse by controlling its path
   - synaptic terminal: end of an axon where the messages are passed to the next neuron
   - dendrites: nerve endings that branch out from the cell body to receive information and form contacts with the axons of other neurons, allowing impulses to be transmitted
   - synapse: small gap that separates neurons
   - neurotransmitters: chemicals that flow out into the synapse and stimulate the receptors on the next neuron to pass the information on

PRACTIVITY 5.4

Pipetted neurons

Materials: 5 different coloured pipe cleaners representing different parts of the neuron (cell body, axon, dendrite, synapse and synaptic terminal). Art A2 paper, white tape, felt marker.

1. Start by cutting out shapes for sensory, motor, and interneurons.
2. Cut the sensory neuron and add a thin ‘nerve’ to it by twisting the pipe cleaner together. This can be exchanged for a sensory neuron. This can be exchanged for a sensory neuron. This can be exchanged for a sensory neuron.
3. Cut another pipe cleaner and overlap through the cell body. The cell body can be made smaller and larger to make a more appropriate cell body. The cell body can be made smaller and larger to make a more appropriate cell body.
4. Wrap another pipe cleaner on the end of the axon to form the synaptic terminal.
5. Take your finished pipetted neuron away from a piece of Art A2 paper and finish the parts.
6. Make your parts of the sensory impulse, start from the feeler, along the axon.

What do you know about nerves and the nervous system?

1. What do you know about nerves?
2. What do you know about the nervous system?
3. Suggest three differences between the three types.

Student responses will vary. Students should be able to correctly describe how a message is transferred through the body and also through a neuron.
The central nervous system

The central nervous system is the control center of the body. It receives 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 center of the body and is mainly concerned with survival. The brain is a soft, heavy organ that is protected by a tough skull. The brain gathers information about what is going on inside and outside the body. It then makes decisions about things like internal change and movements. It is also home to your memories, personality and thought processes.

The spinal cord

Have you ever accidentally touched something very hot? If you have, you’ll remember how quickly (and without your brain’s consent) you pulled your hand away. In fact, you won’t even have time to think about it—it was automatic.

When bright light is shone on the eye, light-sensitive cells in the retina send messages to the parasympathetic division of the eye and the muscles relax, causing the pupils to dilate. Pupils also dilate if a person sees an object of interest. When the lights are turned back on in the classroom, the pupils will constrict to control the amount of light entering the pupil.

The iris regulates the amount of light entering the pupil. It does this by expanding muscles that relax, causing the pupils to dilate. Pupils also dilate if a person sees an object of interest. When the lights are turned back on in the classroom, the pupils will constrict to control the amount of light entering the pupil.

Testing reflexes

Pupils allow light to enter the retina and appear black because other tissues in the eye absorb most of the light entering the pupil. Pupils are sent to the sympathetic division of the eye and the parasympathetic division of the eye and the pupil.

The iris regulates the amount of light by controlling the size of the pupil.

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

• The pupil will get wider in the dark to allow more light to enter the retina.

• When the lights are turned back on in the classroom, the pupils will constrict to control the amount of light entering the retina, ensuring damage doesn’t occur to the eye.

• Other reflexes that could be tested include skin sensitivity, knee joint reaction, blinking when an object comes close to the face and numbing.

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

• The pupil will get wider in the dark to allow more light to enter the retina.

• When the lights are turned back on in the classroom, the pupils will constrict to control the amount of light entering the retina, ensuring damage doesn’t occur to the eye.

• Other reflexes that could be tested include skin sensitivity, knee joint reaction, blinking when an object comes close to the face and numbing.

Spinal damage

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

When the spine is damaged, damage occurs from below the level of injury to the level at which nerve damage occurs. The level of injury to the spine is directly related to the level of injury to the body. If injury occurs to the lower spine, the portion below the injured level is cut off from the brain. The spinal cord is a heavy organ that is surrounded by a tough skull. The brain, on the other hand, is soft and is unable to function without a skull to protect it. Injury to the lower spine is often fatal, but two people could survive with different injuries.

People with damage to the lower part of the body have paraplegia—people who are unable to use their legs. If the injury is very high, the person may even have trouble breathing, swallowing and using their arms. People with damage to the upper part of the body have quadriplegia—they are unable to use their arms or their legs. If the injury is very high, they may even have trouble breathing. How much damage a person has depends on where the injury is in the spine.

Testing reflexes

1. Look at the pupils (the black spots in the middle of the eyes) in the eyes of a classmate. Note the size of the pupils.

2. As a class, dim the lights in the room. After a few minutes, look at your classmates’ eyes and rate the size of the pupils.

3. How are the pupil? Has their size changed?

4. Why do you think this happened?

5. Turn the room lights back on. Check the size of your classmates’ pupils again.

6. How are the pupils now?

7. Why did you think this happened?

8. What other reflex do you think you could safely test?

9. With a partner, design an experiment of your own. Make sure you write it out as a full report, including your aim, equipment, method and discussion.
Skin sensitivity

This includes heart rate, algorithms, respiration, salivation and perspiration. It is the autonomic nervous system that maintains your body's internal environment (homoeostasis).

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.

Skin sensitivity

Design your own experiment to test skin sensitivity. Do not conduct an experiment with the person you are testing.

Planning and conducting

What will you test as your input? How will you measure how sensitive the area of skin is? How could you reduce (or increase) sensitivity to test your results?

What are your variables? What is your independent variable? How can you test for an average result?

Presenting, analysing and evaluating

1. How can you explain your results?
2. How do you compare and contrast your results?
3. What were the other variables you considered?
4. What were the other factors that contributed to the experiment?
5. Can you identify any other factors that may have contributed to the results?

Communicating

Present your findings in a formal experimental report.

Answers

What do you know about the peripheral nervous system?

1. The peripheral nervous system consists of the somatic nervous system and the autonomic nervous system. The autonomic nervous system is divided into two parts: the sympathetic division and the parasympathetic division.

2. The peripheral nervous system carries information to and from the central nervous system to the rest of the body. Examples will vary. Any suitable example should be accepted.

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

4. The autonomic nervous system is responsible for maintaining homeostasis, and is important for the body to function properly.

A closer look at the brain

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

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

EXPERIMENT 5.1

Sheep brain dissection

Safety

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

Practical hints

• Brains can be bought from the local butcher or directly from abattoirs. Fresh is always best; however, frozen also work well. Partially thawed brains are easier to work with because they hold their shapes better. Totally thawed brains can be soft, mushy and difficult to dissect.

Lab tech notes

• A short soaking of utensils is enough and then blades can be removed and cleaned. It is advisable to keep soaking short and dry all the utensils thoroughly to avoid rusting. Coating in a protective grease barrier is an option but is not necessary if the utensils are washed and dried promptly.

• Blades can be removed with a commercial scalpel blade remover; however, a pair of pliers works just as well. Scalpels need to be put in a sharps container.

Clean-up

• Scalpels should be collected and placed, without washing, into a tub containing disinfectant or detergent. Other utensils need to be separated from the scalpels to eliminate the risk of cuts.

• Gloves and dissection wastes can be wrapped in newspaper, placed in a sealed rubbish bag and discarded to rubbish.

• Dicing trays or boards can be washed in hot soapy water and a little disinfectant, then dried.

Discussion

1. The structure of a sheep brain is extremely similar to that of a human brain because both organs are those of mammals, and therefore require similar processes.

2. Answers will vary; however, the brain is usually quite a soft mass, and unless relatively frozen, is quite hard to dissect.

Dissecting trays or boards can be washed in hot soapy water and a little disinfectant, then dried.

1. Dissecting trays or boards can be washed in hot soapy water and a little disinfectant, then dried.

2. The brain stem consists of the medulla, the pons and the midbrain.

3. Maintaining hemostasis in the body is important because it keeps the internal environment stable so the body can function properly. Hemostasis involves regulation and maintenance of a stable internal condition, regardless of any changes to the external environment. Examples are maintaining an optimum temperature, blood glucose level, carbon dioxide concentration and pH level.

4. The cerebellum is the largest part of the brain and is divided into two hemispheres. The cerebellum controls all conscious activities. The cerebellum is responsible for movement, balance and coordination.

5. If you slipped and hit the back of your head, everything may go black because the brain has been injured. The occipital lobe, responsible for vision, is at the back of the brain, and would most likely bear the brunt of the impact.

6. Trauma to the frontal lobes can have an overarching effect on a person’s ability to think, communicate and interact with the world. The person may experience impairment in movement, reasoning, emotional well-being and understanding and problem-solving. This may be exhibited in many ways such as loss of motor skills and behavioral instability. Impairment of frontal lobe functioning is also found in a range of psychiatric conditions including schizophrenia.

Other answers may vary; however, students should understand that all vertebrate brains share a common underlying form. The brain consists of six main regions: the cerebral hemispheres (telencephalon), thalamus and hypothalamus (diencephalon), midbrain (mesencephalon), cerebellum, pons and medulla oblongata. Each of these areas has a complex internal structure, responsible for different functions. Size of the brain regions is directly proportional to the degree to which the animal uses each region. Humans have the largest cerebral hemispheres to control specific and complex movement, language, reasoning and sense, not necessarily needed in the same capacity as the other animals. Fish have the largest optic lobes because sight is their main sense and way of detecting the external environment, including the presence of predators. Humans have the smallest olfactory bulb because smell is not a critical sense, and frogs have the smallest cerebellum because only a small amount of movement needs to be coordinated.

1. Do you know a closer look at the brain?

2. The brain stem consists of the medulla, the pons and the midbrain.

3. Maintaining hemostasis in the body is important because it keeps the internal environment stable so the body can function properly. Hemostasis involves regulation and maintenance of a stable internal condition, regardless of any changes to the external environment. Examples are maintaining an optimum temperature, blood glucose level, carbon dioxide concentration and pH level.

4. The cerebellum is the largest part of the brain and is divided into two hemispheres. The cerebellum controls all conscious activities. The cerebellum is responsible for movement, balance and coordination.

5. If you slipped and hit the back of your head, everything may go black because the brain has been injured. The occipital lobe, responsible for vision, is at the back of the brain, and would most likely bear the brunt of the impact.

6. Trauma to the frontal lobes can have an overarching effect on a person’s ability to think, communicate and interact with the world. The person may experience impairment in movement, reasoning, emotional well-being and understanding and problem-solving. This may be exhibited in many ways such as loss of motor skills and behavioral instability. Impairment of frontal lobe functioning is also found in a range of psychiatric conditions including schizophrenia.

7. Individual answers will vary; however, students should understand that all vertebrate brains share a common underlying form. The brain consists of six main regions: the cerebral hemispheres (telencephalon), thalamus and hypothalamus (diencephalon), midbrain (mesencephalon), cerebellum, pons and medulla oblongata. Each of these areas has a complex internal structure, responsible for different functions. Size of the brain regions is directly proportional to the degree to which the animal uses each region. Humans have the largest cerebral hemispheres to control specific and complex movement, language, reasoning and sense, not necessarily needed in the same capacity as the other animals. Fish have the largest optic lobes because sight is their main sense and way of detecting the external environment, including the presence of predators. Humans have the smallest olfactory bulb because smell is not a critical sense, and frogs have the smallest cerebellum because only a small amount of movement needs to be coordinated.
5.3 WHAT IS A NERVOUS RESPONSE?

BIG IDEAS

5.3 What is a nervous response?

Remember and understand

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

3. Students should use Figure 5.30 on page 150 of the textbook to help them complete this question.
4. Dendrites being the information to the cell body and the nerve impulse is carried away from the cell body by an axon. At the end of the axon, synaptic terminals pass the message to the next neuron. When the message reaches the end of the neuron, neurotransmitters flow out of the synapse and stimulate the receptors on the next neuron to accept the message and pass it along.
5. Potential effects of spinal damage include paraplegia and quadriplegia, meaning the person will have no movement of limbs, or only movement of upper limbs, respectively.

Apply

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

7. Concept maps will vary; however, students should understand that the autonomic nervous system has two divisions—sympathetic and parasympathetic—that work together to maintain a balance in the body. The two divisions have opposite effects; for example, the sympathetic division could speed up the heart rate, while the parasympathetic division could slow it down. The parasympathetic system is responsible for stimulation of ‘rest and digest’ activities that occur when the body is at rest.

These include respiration, tears, urination, digestion and excretion. The sympathetic nervous system is responsible for stimulating activities associated with the ‘fight or flight’ response.

- dendrites: information from sensory organs enters the brain as it travels along the axon.
- myelin sheath: the insulating protein that covers the axons of neurons.
- neuron: the functional unit of the nervous system.

Analyse and evaluate

10. Imagine you are a doctor with a patient who is experiencing loss of control of her legs and lack of feeling in her hands. How would you use these skills to predict what the problem could be?

How do we respond to threats?

Many factors can make us sick or put us at risk. We have just looked at how our bodies sense and respond to changes in environment using the nervous and endocrine systems. Now we will look at how our bodies respond to two other types of threat: disease and radiation.

Threats are not always obvious from weak signals—pathogens in the air, bacteria on food, a virus from the person next to you, and even physical injury.

Investigating pathogens

Pathogens, as you discovered at the beginning of this chapter, are responsible for illness. They are organisms that cause disease. You might include types of viruses, bacteria, fungi, protozoa, helminths, and parasites.

10. a. Pathogens are responsible for the disease that spreads through the nervous system. This system is composed of two parts: the central nervous system, which includes the brain and spinal cord, and the peripheral nervous system, which is composed of nerves and nerve networks throughout the body.

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

12. Student responses will vary.

Ethical behaviour

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

Critical and creative thinking

14. Student responses will vary; however, students should understand that structure is linked to function. The function of a typical neuron is to transmit information to the nervous system to the rest of the body.

Apply

15. Answers will vary. The endocrine and nervous systems work together to coordinate the body’s activities and functions. The human nervous system is composed of two parts: the central nervous system, which includes the brain and spinal cord, and the peripheral nervous system, which is composed of nerves and nerve networks throughout the body.

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

Investigating pathogens

Students may be aware of diseases, but not the pathogens that cause them. This could be a source of discussion and then researched as a source of information.
The immune system

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

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

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

First line of defence

The first line of defence against pathogens is to stop the pathogens from getting inside our bodies (Fig. 5.28).

First line is to protect people against foreign invaders by physically stopping them from entering our body and shedding off any harmful message to others. Your immune system has three lines of defence against diseases, each with a different role.

Second line of defence

Vaccines, such as bacterins, contain a protective coating that allows them to enter easily through the first line of defence. If a pathogen gets inside the body, the body tries to remove it in one of two ways.

First, a general ‘seek and destroy’ approach is taken. This occurs regardless of the type or structure of the pathogen. This is called a non-specific immune response. The key parts of the non-specific immune response are:

- Blood clotting, to stop additional infection through skin cuts
- Inflammation, to increase the amount of blood reaching an infected area
- Fever, as high temperatures reduce the growth rate of many pathogens: colds and viruses

Second, white blood cells (a special immune system) are produced by the body to destroy pathogens. An increase in the amount of blood reaching an infected area of the body in response to these chemicals means that more white blood cells are available to attack the pathogens. The white blood cells are also immune substances that increase the amount of fluid in the substances, causing swelling. These are two different types of white blood cells that help to protect our body. Only some white blood cells types deal with the non-specific immune response. These are called phagocytes, and the body comes from living white blood cells called ‘white blood cells’. A pathogen can be engulfed by a phagocyte, and when parts of the phagocyte are damaged. This process is called phagocytosis. Phagocytosis is an example of acquired active immunity.

Third line of defence

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

The specific immune response involves antibodies. Antibodies are protein molecules that bind specifically to a target called an antigen. Antibodies can be found in the blood plasma in areas such as chest, abdomen, and intestine in the lining of a pathogen.

When a person is infected with a pathogen, specific antibodies and produced generalised the pathogen, the body produces an efficient immune response and the pathogen antigen. The body may look for a week, the antibodies directed to that specific antigen. With a weak recovery, one pathogen takes place. These the body has learned how to make the pathogen but not this antigen. It will be destroyed before it reaches the infection in the lung. The person is now said to be immunised.

Other immune abilities outside the body are:

- Wound healing
- Antibodies against certain toxins.
- Antifreeze activity.

Lymphocytes are also passed to a new mother in the placenta. Unborn babies obtain some antibodies across the placenta.

The immune system can be divided into two types.

1. Non-specific immunity
2. Specific immunity

Students could investigate immune diseases/disorders. Some suggestions are rheumatoid arthritis, multiple sclerosis and AIDS.

Activity

Students could investigate immune diseases/disorders. Some suggestions are rheumatoid arthritis, multiple sclerosis and AIDS.

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

Fig 5.40 The process of phagocytosis.

➔ Fig 5.41 (a) Antibodies have regions that are specific to a particular pathogen. Antibodies are proteins and are in the mother’s breast milk. They are passed onto the child through the placenta and are in the mother’s breast milk.

Fig 5.42 Natural passive immunity is obtained by mother’s antibodies to a baby from its mother. The mother’s antibodies are specific to a particular pathogen and are given to a person.

Fig 5.43 Immunity can be acquired by vaccination.

➔ Fig 5.44 When an illness takes place, the body will produce more white blood cells to attack the pathogen.

➔ Fig 5.45 Immunity can be acquired by vaccination.

➔ Fig 5.46 Immunity can be acquired by vaccination.

➔ Fig 5.47 Immunity can be acquired by vaccination.
OVERARCHING IDEAS

Antibiotics

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

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

Answers

What do you know about the immune system?

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

Responding to radiation

Exposure to radiation can cause damage to one or more of the following: if you receive medical treatment for skin cancer, such as surgery or radiotherapy; if you work in an environment where you are exposed to radioactive substances; if you work in an environment where you are exposed to high levels of radiation.

Interpreting scans

Interpreting scans

What do you know about the immune system?

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

Responding to radiation

Exposure to radiation can cause damage to one or more of the following: if you receive medical treatment for skin cancer, such as surgery or radiotherapy; if you work in an environment where you are exposed to radioactive substances; if you work in an environment where you are exposed to high levels of radiation.

Interpreting scans

Interpreting scans

1. How much radiation is emitted by the body?
2. What part of the body is most vulnerable to radiation exposure?
3. What tissue is the body most sensitive to?
4. How can radiation damage the body?

PRACTIVITY 5.6

Interpreting scans

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

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

MRIs are used to view soft tissues of the body, making them especially useful in imaging the brain, muscles, the heart and cancers.

CT scans enable radiologists to more easily diagnose problems such as cancer, cardiovascular disease, infectious disease, appendicitis, trauma and musculoskeletal disorders. They produce multiple, cross-sectional images or pictures of the inside of the body.

X-rays are used in the detection of pathology of the skeletal system as well as some disease processes in soft tissue.

Answers

What do you know about responding to radiation?

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

oBook

ID05.34 Video link: Antibiotics

Video demonstrating the effect of viruses on the body and how antibiotics are used. Useful for immune system/antibodies content.
5.4 HOW DO WE RESPOND TO THREATS?

Remember and understand

1. How does our body respond to threats?

Remember and understand

1. Apply threats?
2. Activate special proteins in the blood. These are white blood cells.
3. Generate an immune response. The immune system can detect a pathogen and stop it from infecting the body.
4. How does the specific immune system respond?
5. What are the major features of the body's first line of defence?
6. How is immunity achieved?
7. What are active immunity and passive immunity?
8. What factors contribute to the development of specific immunity?
9. How does the immune system protect the body from diseases?
10. How does the immune system attacks cells that are infected with a pathogen?

Apply

1. Apply threats?
2. Generate an immune response. The immune system can detect a pathogen and stop it from infecting the body.
3. How does the specific immune system respond?
4. What are the major features of the body's first line of defence?
5. How is immunity achieved?
6. What factors contribute to the development of specific immunity?
7. How does the immune system protect the body from diseases?
8. How does the immune system attacks cells that are infected with a pathogen?

Apply

1. Analyse and evaluate
2. Evaluate the effectiveness of specific immune responses in humans. How do you think this stops the pathogens from causing disease?
3. Analyse and evaluate
4. Evaluate the effectiveness of specific immune responses in humans. How do you think this stops the pathogens from causing disease?
5. Analyse and evaluate
6. Evaluate the effectiveness of specific immune responses in humans. How do you think this stops the pathogens from causing disease?

Analyse and evaluate

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

11. Antibodies can stop pathogens causing disease by attaching to them in an antibody- antigen complex. By doing this, antibodies can cause pathogens to stick together and become harmless. After antibodies become attached to antigens on the surface of invading cells, they activate special proteins in the blood. These special proteins then break down the invading cells so that they cannot do any harm.

12. Tumours can interfere with the healthy functioning of the human body by causing physical blockages in the body or interfering with certain chemical processes.

13. Student responses will vary.

Ethical behaviour

14. Student responses will vary. Both sides can be argued successfully. On one hand, nuclear power plants should not be located in areas where there are many people. On the other hand, nuclear power plants provide a clean and reliable source of energy.

Key words

- Antibody
- Antigen
- Passive immunity
- Active immunity
- Specific immunity
- Non-specific immunity
- Autoimmune disease
- Allergy
- Hypothyroidism
- Hyperthyroidism
- Cerebrum
- Somatic nervous system
- Autonomic nervous system
- Hormone
- Feedback mechanism
- Vasopressin

Ethical behaviour

15. Ethical behaviour

16. How do we respond to threats?

17. Analyse and evaluate

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

19. Analyse and evaluate

20. Summarise the role of the immune system in fighting off infections. What is an autoimmune disease? How do autoimmune diseases occur?

21. Analyse and evaluate

22. Summarise the role of the immune system in fighting off infections. What is an autoimmune disease? How do autoimmune diseases occur?

23. Analyse and evaluate

24. Summarise the role of the immune system in fighting off infections. What is an autoimmune disease? How do autoimmune diseases occur?

Reflect

1. Reflect

2. Reflect

3. Reflect
Connecting Ideas

A life with no pain

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

The body is a complex system and our understanding of its intricacies is still not complete. Variations possible within the human genome extend to 10^6, so it is entirely possible that many genetic diseases are not yet known or understood. Other diseases are so rare that studies and treatments are difficult to undertake.

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

Activity/Assessment task

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

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