

The nervous system

Think about how your body works. Right now you are reading this page, but you are not telling your eyes to read the text; more importantly, you are not consciously reminding your heart to keep beating or your lungs to keep breathing. These are automatic processes that your body completes without conscious thought or instruction. But how does this happen? Your body needs to coordinate communication between all of its organs, systems and muscles, and this is where your central and peripheral nervous systems are involved.

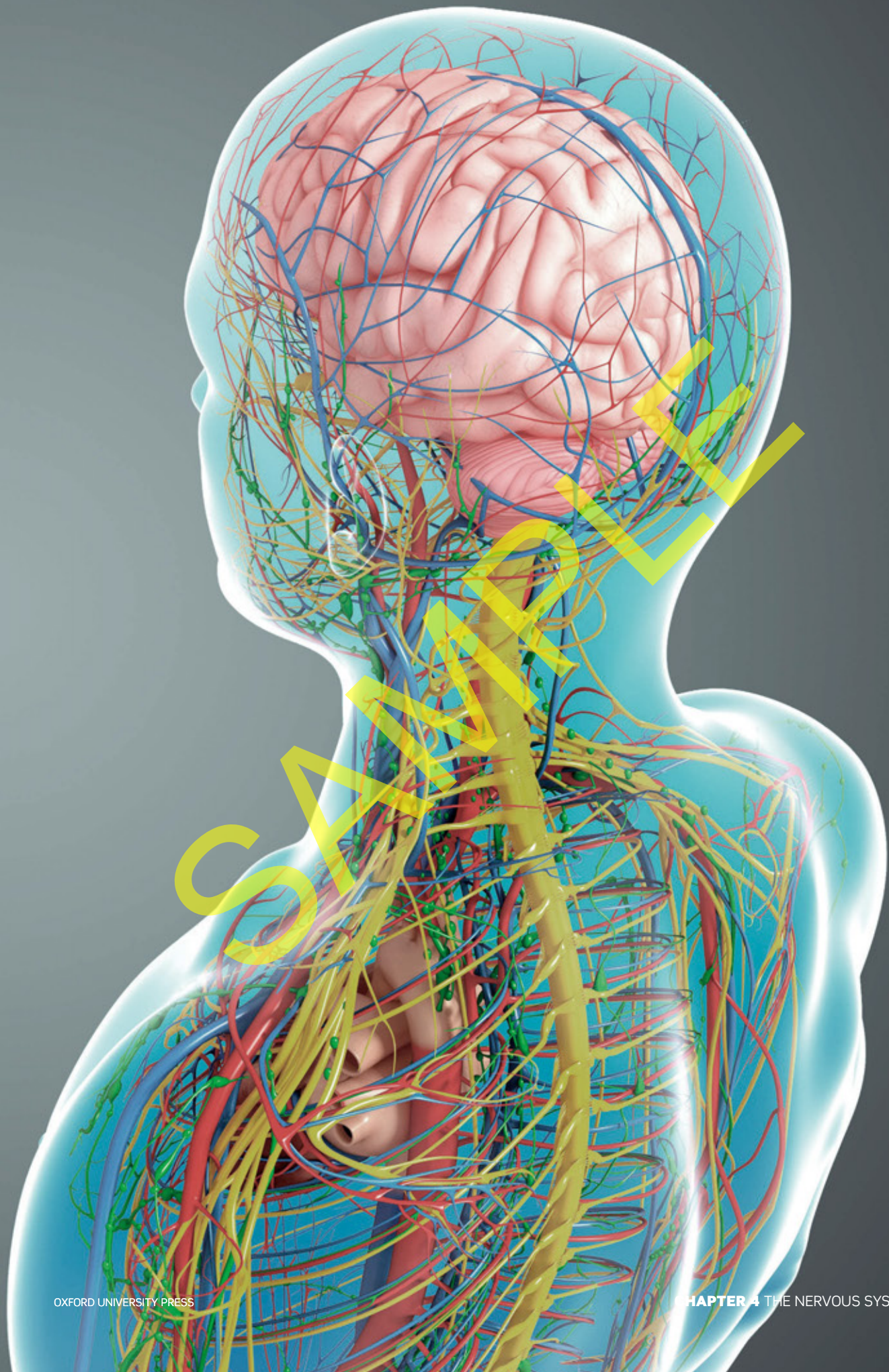
When studying the roles of the central and peripheral nervous systems as communication structures between the internal and external worlds, it is easy to consider them separate entities with individual responsibilities. However, this is not how the human nervous system operates in reality. The peripheral nerves connect all of the parts of the body with the central nervous system.

OBJECTIVES

- Recognise the basic structure and function of the human nervous system, including the central (i.e. brain and spinal cord) and peripheral (i.e. somatic and autonomic) nervous systems
- Construct a diagram of a neuron, including the axon, dendrites, the cell body and synapses
- Distinguish between sensory, motor and interneurons

Source: *Psychology 2019 v1.3 General Senior Syllabus*
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FIGURE 1 Digital rendering showing the brain and spinal cord (components of the central nervous system)



4.1

The nervous system

KEY IDEAS

In this section, you will learn about:

- ✦ the basic structure of the human nervous system
- ✦ the central and peripheral nervous systems
- ✦ the somatic and autonomic nervous systems.

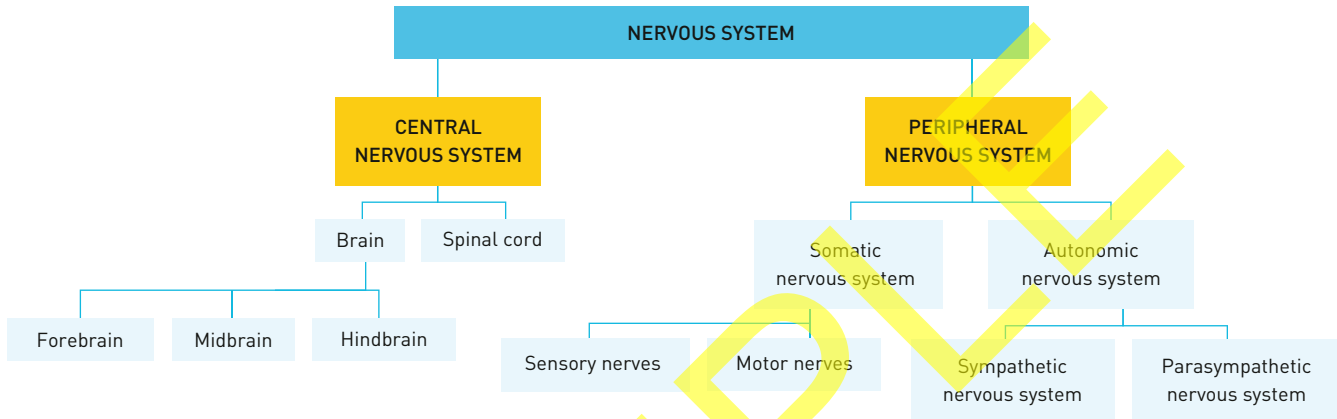


FIGURE 1 The human nervous system

central nervous system (CNS)

composed of the brain and the spinal cord and controls the body by processing and responding to sensory input from the peripheral nervous system

peripheral nervous system (PNS)

composed of all the nerves and ganglia outside the brain and spinal cord that communicate information to and from the central nervous system

somatic nervous system

transmits sensory information to the CNS and carries motor commands from the CNS to the skeletal muscles

The human brain does not act in isolation. It needs to receive information from the body's sense organs – the eyes, ears, skin, nose and tongue – which are constantly receiving information from the environment. The brain is also connected with the muscles and glands in the body so that an organism is able to respond to and act on its current environment.

The two major divisions of the nervous system are the **central nervous system (CNS)** and the **peripheral nervous system (PNS)**. The CNS comprises the brain and spinal cord. It controls the body by processing and responding to sensory input from the peripheral nervous system. The PNS is made up of the nerves and ganglia outside the brain and spinal cord that communicate information to and from the central nervous system. The peripheral nervous system also has two subdivisions: the **somatic nervous system** and the **autonomic nervous system**. The somatic nervous system transmits sensory information into the central nervous system and carries motor commands from the CNS to the skeletal muscles. The autonomic nervous system is responsible for communications between the body's non-skeletal (visceral) muscles and the internal organs and glands that regulate bodily functions, such as heart rate, digestion, respiratory rate, pupillary response, urination and sexual arousal. It operates without voluntary control or conscious awareness and consists of two branches known as the **sympathetic nervous system** and **parasympathetic nervous system**. The sympathetic branch of the autonomic nervous system serves an important adaptive function by helping prepare the body for intense physical activity, often referred to as the 'fight-flight-freeze response'. The parasympathetic branch of the autonomic nervous system serves to relax the body and inhibit, or slow, many high-energy functions, such as heart rate, breathing and some glandular functions. Figure 2 illustrates the nervous system and its divisions.

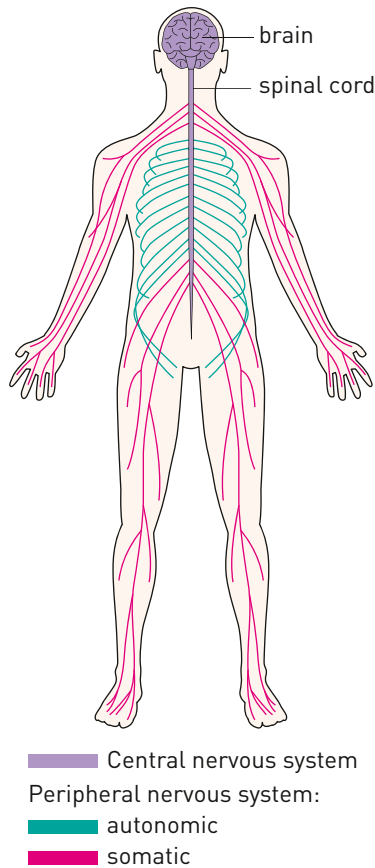


FIGURE 2 The human nervous system includes the central nervous system (brain and spinal cord) and the peripheral nervous system (somatic and autonomic nervous systems).

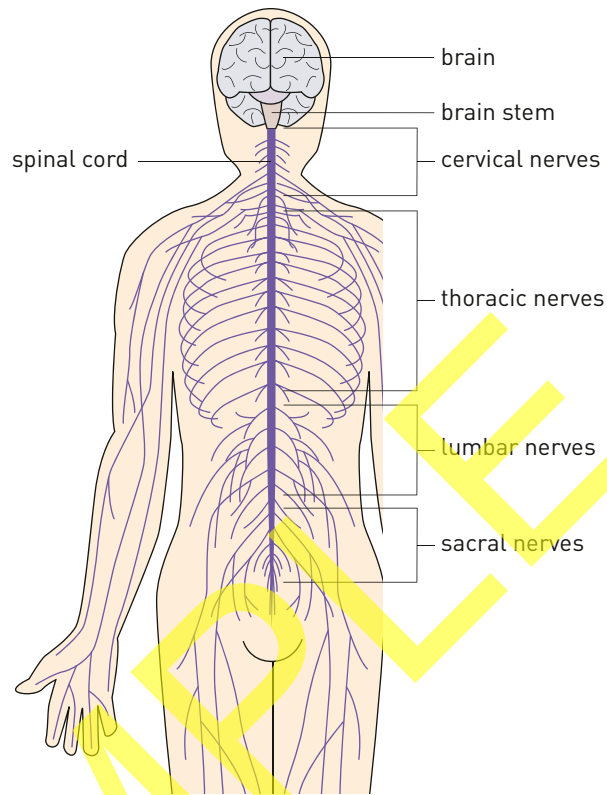


FIGURE 3 The upper section of the spinal cord is responsible for communication between the brain and upper parts of the body, while the lower section is responsible for communication between the lower parts of the body and the brain.

autonomic nervous system

responsible for communications between the body's non-skeletal muscles and the internal organs and glands that carry out bodily functions

sympathetic nervous system

branch of the autonomic nervous system that activates the fight-flight-freeze response

parasympathetic nervous system

branch of the autonomic nervous system that is responsible for maintaining day-to-day functioning of the body, such as digestion, heart rate, breathing and some glandular functions

Central nervous system

The CNS comprises the brain and the spinal cord. The spinal cord runs from the base of the brain (the **brain stem** connects the brain to the spinal cord) inside the bones of the spine (**vertebrae**) to the lower middle section of the spine. It enables the brain to communicate with the rest of the body by conveying messages from the brain to the PNS, and from the PNS to the brain (see Figure 3). The spinal cord is segmented, with the upper section responsible for communication between the brain and the upper parts of the body, and the lower section responsible for the lower parts of the body, such as the legs, toes and feet (see Figure 2).

brain stem

part of the brain that connects the brain to the spinal cord

Peripheral nervous system

The peripheral nervous system has two functions:

- to communicate information from the body's organs, glands and muscles to the CNS, from both the outside world (such as environmental temperature and sensation on the skin, via sensory neurons) and the inside world (such as aches and pains)
- to communicate information from the CNS to the body's organs, glands and muscles, via motor neurons.

The peripheral nervous system has two subdivisions: the somatic nervous system and the autonomic nervous system.

Somatic nervous system

The somatic nervous system is responsible for the voluntary movement of skeletal muscles (striated or 'striped' muscles). It is a network of nerves that communicates sensory information to the CNS and motor information from the CNS.

The somatic nervous system receives sensory information from sites around the body, including the skin and muscles. This sensory information is carried to the CNS by sensory neurons (sensory nerves). Motor information is carried from the CNS via motor neurons (motor nerves). Neurons are covered in more detail in Section 4.2.

CHALLENGE 4.1

Fight, flight or freeze?

The sympathetic nervous system serves an important adaptive function by helping prepare the body for the fight-flight-freeze response to emergencies. What are some of the likely sympathetic responses activated when you experience a threat or intense anxiety?

Autonomic nervous system

The autonomic nervous system of the PNS is mostly responsible for the communication of information between the CNS and the body's non-skeletal muscles (also known as 'smooth' or 'visceral' muscles), as well as the internal organs and glands that carry out the basic bodily functions necessary for survival, such as digestion and heartbeat. Because the autonomic nervous system operates without voluntary control or conscious awareness, it enables the organism to have the cognitive resources to pay **attention** to other matters, such as responding to threats or other survival needs in the external environment.

The autonomic nervous system controls the function of internal organs (viscera) through the following:

- adrenal medulla (adrenal gland)
- blood vessels (smooth muscle)
- eyes (the iris; smooth muscle)
- gall bladder
- gastrointestinal tract
- glands
- heart (cardiac muscle)
- liver
- muscles
- pancreas
- skin (around hair follicles; smooth muscle)
- stomach, intestines and bladder (smooth muscle)
- sweat glands

Even though the actions of the autonomic nervous system are usually involuntary, some, such as breathing and blinking, can be voluntarily instigated. For example, you are generally

attention

narrowing the focus of awareness to a stimulus of interest

unaware of each time you inhale and exhale, but you can deliberately hold your breath during a medical examination and breathe out on demand.

The sympathetic and parasympathetic branches of the autonomic nervous system

The autonomic nervous system is further divided into two branches: the sympathetic nervous system and the parasympathetic nervous system. These two systems work together in complementary ways but have different roles.

The sympathetic nervous system is like an emergency system that becomes active when an organism perceives itself to be in danger or is stressed. It readies the body in response to a threat by increasing heart rate, dilating pupils, stopping digestion and redirecting blood away from the stomach to the muscles to ensure extra oxygen is available for an urgent response (Burton, Westen, & Kowalski, 2015).

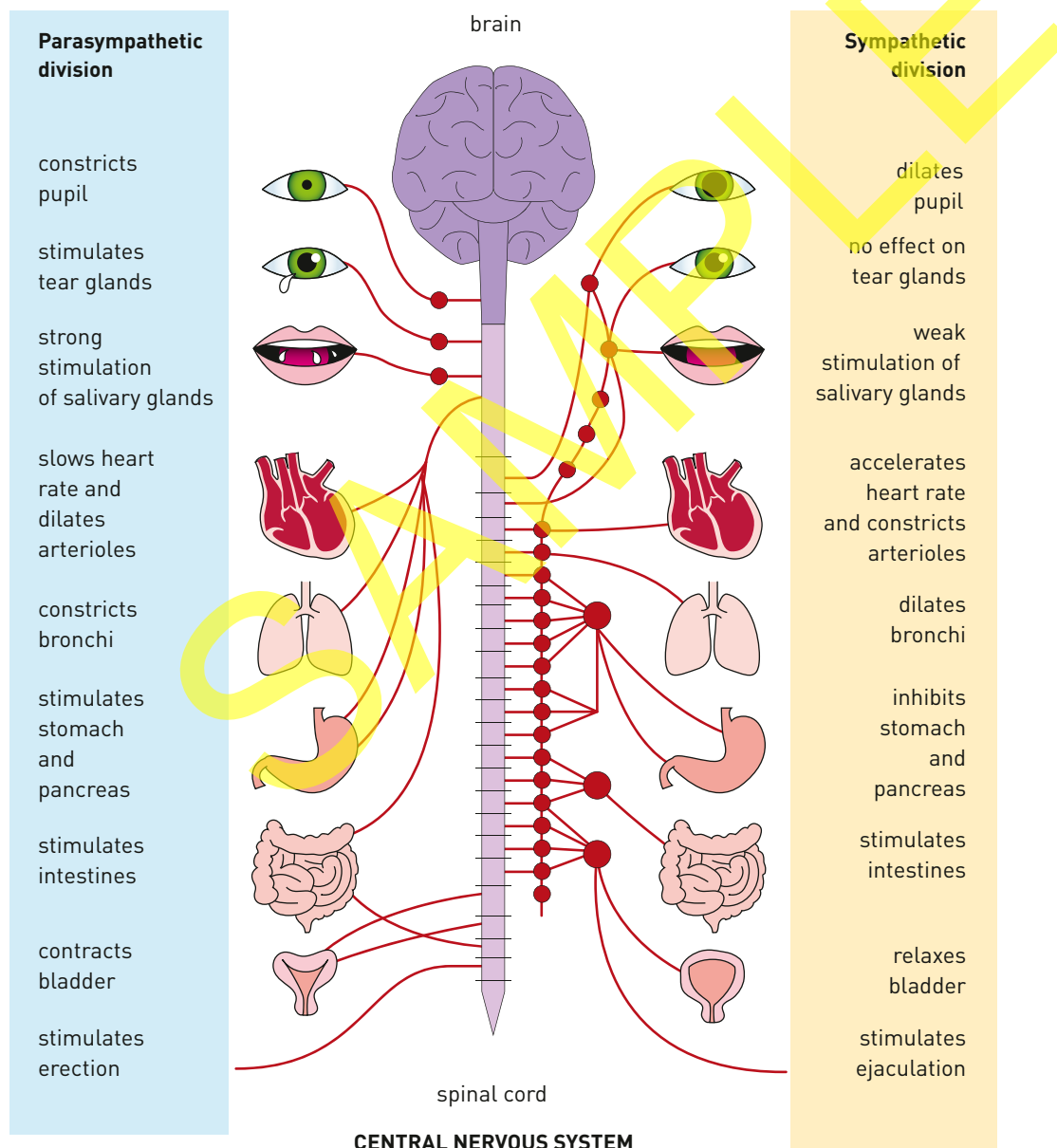


FIGURE 4 The role of the autonomic nervous system during different levels of arousal

fight-flight-freeze response

a physiological response to stress that causes an organism to react in a combative manner (fight), by removing themselves from the situation (flight) or by not reacting at all (freeze)

homeostasis

the state of balance in the body's metabolism

This is known as the **fight-flight-freeze response**, a physiological response to stress that causes an organism to react in a combative manner (fight), by removing themselves from the situation (flight) or by not reacting at all (freeze). It is more commonly known as the fight-or-flight response.

In contrast, the parasympathetic nervous system operates in circumstances where it is relatively calm. It is responsible for maintaining automatic day-to-day bodily functions, such as digestion, normal heart rate and normal breathing. This regular bodily functioning is also known as **homeostasis**.

Both the sympathetic and parasympathetic nervous systems affect the same tissues and organs, but in the opposite way. While the parasympathetic nervous system allows us to go about our everyday tasks, and keeps our bodily functions in a state of balance, the sympathetic nervous system prepares the same organs to deal with threats or stressors.



FIGURE 5 The fight-flight-freeze response: the threatened animal's sympathetic nervous system is activated.



FIGURE 6 Homeostasis: the animal's parasympathetic nervous system maintains the body's metabolic balance during times of low arousal and no threat.

CHECK YOUR LEARNING 4.1

Describe and explain

- 1 **Explain** the difference between the central nervous system and the peripheral nervous system.
- 2 **Describe** the autonomic nervous system.
- 3 **Explain** what happens in the fight-flight-freeze response.
- 4 **Explain** the role of the somatic nervous system.

- 5 **Construct** a labelled diagram (similar to Figure 3) to illustrate your understanding of the structure and function of each component of the human nervous system. Make sure that you include:
 - a the central nervous system, peripheral nervous system, somatic nervous system and autonomic nervous system (sympathetic; parasympathetic)
 - b the role of each system (you can use dot points).



Check your obook assess for these additional resources and more:

» Student book questions

Check your learning 4.1

» Challenge

4.1 Fight, flight or freeze?

» Weblink

Nervous system anatomy

» Weblink

Fight, flight or freeze

4.2

Structure of a neuron

KEY IDEAS

In this section, you will learn about:

- ✦ the structure of a neuron.

As outlined in Section 4.1, the somatic nervous system is part of the peripheral nervous system (PNS). The somatic nervous system is responsible for the voluntary movement of our muscles, organs and reflex movements. These reflexes include the blinking reflex, knee-jerk reflex, gag reflex, and the startle and rooting reflexes in infants. The somatic nervous system helps our body adjust to external stimuli through voluntary movement of the skeletal system.

Neurons receive information from other neurons, process this information and then communicate it to other neurons. In other words, neurons receive, process and transmit information to each other. Neurons generally comprise three elements: **dendrites**, the **soma** and the **axon**.

dendrites

branch-like segments of a neuron that receive signals from other neurons or sensory receptors via the synapses and deliver these to the soma

soma

the cell body and largest part of the neuron; controls metabolism and maintenance of the cell

axon

the part of a neuron along which the electrochemical nerve-impulse is transmitted

synapses

the junction between two neurons

Structure	Description
Dendrites	A neuron can have hundreds or thousands of dendrites that look like branches coming off the soma. The dendrites receive information from other neurons, which they carry from the synapses to the soma.
Soma	The largest part of the neuron is the soma or cell body. It controls the metabolism and maintenance of the neuron. In most neurons, the soma receives messages from other neurons.
Axon	The axon is a nerve fibre that extends from the soma and carries information towards the cells that communicate with that neuron. Some axons have two or more offshoots, and some can be up to a metre long.
Myelin	The axons of most neurons are covered in a myelin sheath, which is a coating of cells that facilitates the transmission of information to other neurons. Axons with myelin are white rather than grey. Myelin protects the axon from potential chemical and physical interference to the electrical impulses that travel along it. The insulation provided by the myelin sheath also enables information to travel much faster – up to 400 kph.
Axon terminals	Axon terminals are found at the end of the axon branch and transmit messages to the next neuron. Axon terminals have terminal buttons. These terminal buttons have sacs that secrete a chemical called a neurotransmitter whenever electrical impulses are sent down the axon. Although they never actually touch, the axon terminals of one neuron link with the dendrites of the next neuron.

TABLE 1 The structure of a neuron

Dendrites

Dendrites look like trees (the word *dendron* is Greek for ‘tree’). They receive information from other neurons or sensory receptors via **synapses** (the connection between two neurons) and deliver this to the cell body or soma.

Soma

The soma is the cell body. It is the largest part of the neuron and controls the metabolism and maintenance of the cell.

Axon

The axon is a nerve fibre that carries information away from the soma at their ends towards other cells in contact with the neuron. This information is carried as an electrical impulse, referred to as an 'action potential'. The end of each axon has terminal buttons that secrete chemicals called **neurotransmitters**, which help the communication across nerve synapses whenever information is sent down the axon in the form of electrical impulses (see Figure 1).

neurotransmitters
chemicals that help the communication across nerve synapses

glial cells

cells that play an important role in supporting neurons by surrounding and holding them in place, supplying nourishment and oxygen, removing dead neurons and insulating neurons to increase the speed of nerve impulse transmission

myelin

a white fatty, waxy substance that covers the axon to insulate it from the surrounding fluid and from other neurons

myelination

the production of myelin, which insulates a neuron's axon, speeds transmission and aids coordination

Glial cells

The **glial cells** are cells that are not part of the neuron but have an important role in supporting neurons. There are four identified functions of glial cells:

- 1 They surround neurons and hold them in place.
- 2 They supply nourishment and oxygen to neurons.
- 3 They remove dead neurons.
- 4 They insulate one neuron from another and increase the speed of transmission of nerve impulses. To do this, glial cells produce myelin.

Myelin

Myelin is a white, fatty, waxy substance that covers the axon to insulate it from the surrounding fluid and other neurons, protecting it from electrical interference from other neurons. This increases the efficiency of transmission of nerve impulses. Only the axon is covered, not the cell body. Myelin is produced in the brain and spinal cord by glial cells in a process called **myelination**. Myelinated neurons are faster in conducting messages as they move through the nervous system.

Survival of an organism is dependent on how quickly messages can move through the nervous system: for example, processing spoken language quickly or pouncing on prey.

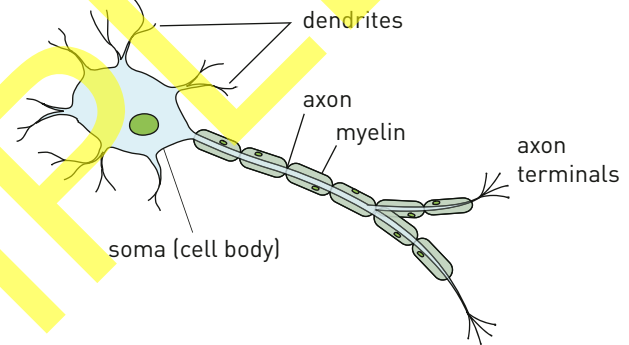


FIGURE 1 Structure of a neuron

CHECK YOUR LEARNING 4.2

Describe and explain

- 1 **Explain** what the following elements are responsible for in a neuron.
 - a dendrites
 - b soma
 - c axon
 - d synapse

Apply, analyse and interpret

- 2 **Compare** the axon and axon terminals.
- 3 **Consider** the effects if myelination didn't occur.



Check your **obook assess** for these additional resources and more:

» Student book questions

Check your learning 4.2

» Interactive The neuron

» Weblink Neuron structure

» Weblink Neurotransmitters

4.3

Types of neurons

KEY IDEAS

In this section, you will learn about:

- + types of neurons
- + communication between neurons
- + reacting to our senses.

As discussed in Section 4.2, neurons have a basic structure that they all follow. This section will cover the different types of neurons and their roles. It will also introduce communication between neurons. For instance, sensory neurons can carry nerve impulses from sensory stimuli towards the brain and spinal cord (afferent neurons), and motor neurons can carry neural impulses away from the CNS and the brain towards the body to cause movement (efferent neurons).

Neurons operate as part of the somatic nervous system. They are how the body receives information from the outside world and responds to this action with movement. Sensory neurons play an important part in our lives by transmitting sensory information from our environment to our brain. Our abilities to touch, taste, see, hear and smell all come from a process beginning with our sensory neurons registering an external stimulus, and then relaying that information to the CNS. Motor neurons can then carry signals from the brain and spinal cord to the muscle fibres so that our bodies can respond to the stimulus.

Types of neurons

Motor neurons

motor neurons
neurons that communicate messages from the CNS to the particular muscles that an organism intends to move at any particular moment

Motor neurons are neurons that communicate messages from the CNS to the particular muscles that an organism intends to move at any particular moment and are referred to as efferent neurons. The CNS and PNS work together to enable an organism to interact with the environment. For example, in Figure 1, when a child pats a dog, the motor neurons are responsible for initiating the movement. These neurons carry information from the child's brain to the muscles in her arm and hand that allow her to move to pat the dog.

Sensory neurons

sensory neurons
neurons that carry sensory information from the body and from the outside world into the CNS

Sensory neurons are neurons that carry sensory stimuli from the body and from the outside world into the CNS. Sensory neurons that carry nerve impulses from sensory information towards the CNS and brain are referred to as afferent neurons. In Figure 1, these convey the sensation of the dog's fur – detected by sensory receptors on the skin of the child's hand – to the brain. Here, this information (the sensation of the touch of the fur) would be processed as feeling soft.

Study tip

Remember neurons as SAME and I: Sensory Afferent, Motor Efferent, and Interneurons.



FIGURE 1 When this child pats her dog, the movement is initiated by motor neurons, while sensory neurons carry information about the feel of the dog's fur.

interneurons

neurons that transmit information between motor and sensory neurons and the CNS

Interneurons

Interneurons carry information between the motor and sensory neurons in the CNS. Interneurons are especially important in transmitting impulses between other neurons as part of a reflex arc. For example, if a sensory neuron sends a message that a hand is touching a hot plate, the interneuron will send the message to the motor neuron that the hand needs to move quickly.

CASE STUDY 4.3

Motor neuron disease

Motor neuron disease (MND) is a debilitating illness that attacks nerve cells throughout the human body that are responsible for muscle control. It can affect a person's ability to move, speak, breathe and swallow. MND is fatal, with no known cure at this stage.

MND is the group name for several diseases that cause muscle degeneration. These diseases include amyotrophic lateral sclerosis (ALS), progressive muscular atrophy (PMA), progressive bulbar palsy (PBP) and primary lateral sclerosis (PLS). MND can be difficult to diagnose, as the symptoms are often mistaken for other conditions; also, symptoms do not always present the same way in each individual. Diagnosis of MND is made through blood tests, nerve conduction studies, electromyography (EMG) and MRI scans.

The early symptoms may be mild and include:

- stumbling, or weakness of leg muscles
- weakness in hand muscles that makes it difficult to hold objects
- slurring of speech or swallowing difficulties.

Later symptoms may include:

- breathing difficulties
- fatigue caused by muscle exhaustion
- insomnia
- changes in cognition
- pain and discomfort.

Like many diseases that affect the nervous system or neurons, MND can affect anyone – even people who are incredibly fit and active. One of the first prominent sufferers of the disease was Lou Gehrig, a famous American baseball player in the 1930s (the name Lou Gehrig's Disease is often used interchangeably with ALS).

However, in more recent times, a notable case is Australian Neale Daniher. Daniher played AFL football for Essendon in the 1980s and later went on to coach the Melbourne Demons AFL team.

Through his public profile, Daniher has helped to bring attention to the disease through events such as The Big Freeze fundraiser which is held at the MCG each year. The Big Freeze involves members of the AFL community sliding into a pool of icy water to raise money to help find a cure for MND. To date, The Big Freeze has been able to contribute over 20 million dollars to research and care for those diagnosed with MND.

Communication between neurons

A synapse is the junction between two nerve cells. This minute gap between two neurons is where the end of the axon, called **terminal buttons** of the presynaptic (before the synapse) neuron, comes into close proximity with the receptor sites on the dendrites of a postsynaptic (after the synapse) neuron.

terminal buttons
bulb-like structures at the end of the axon that release neurotransmitters

The process of neurons communicating with other neurons is known as synaptic transmission. The neurotransmitter that is secreted from the presynaptic neuron affects the activity of the postsynaptic neuron with which it communicates. In other words, neurons communicate via a chemical process.

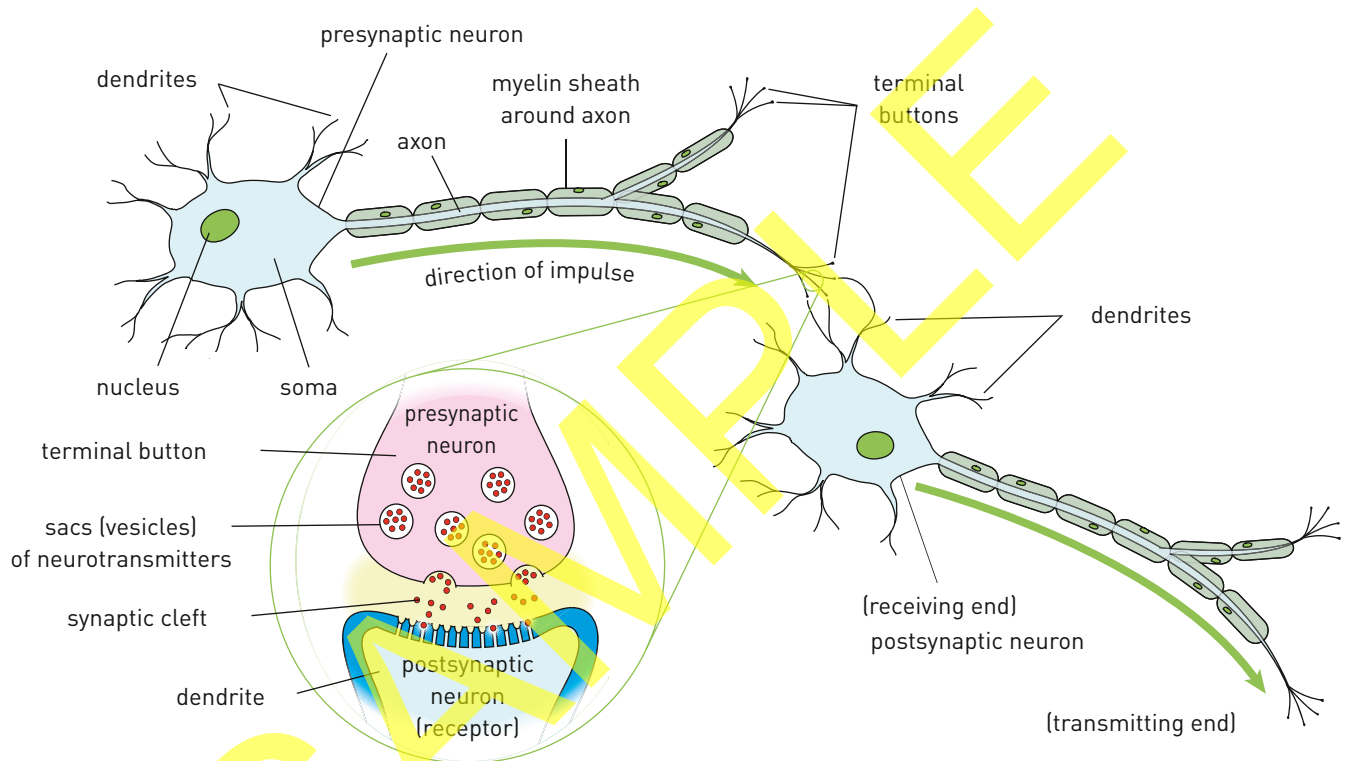


FIGURE 2 Information received by dendrites travels along the axon to terminal buttons.

It is important to remember that the neural structure of the brain is very complex. In reality, synapses can be located at several points along a neuron (at dendrites, the axon or the soma), and many terminal buttons can form synapses with a single neuron.

However, it is easier to think of communication as starting with the dendrites receiving information (neurotransmitter) from the synapse, the information being passed as electrical impulses through the soma along the axon, and a neurotransmitter being secreted from the terminal buttons to a synapse shared with the dendrites of another neuron.

These pathways are known as **neural pathways** and allow one part of the nervous system to communicate with another. A neural pathway can carry messages from the body to the brain (afferent pathways), from the brain to the body (efferent pathways) or within the brain itself.

neural pathways
bundles of neurons that provide connections between one part of the nervous system and another

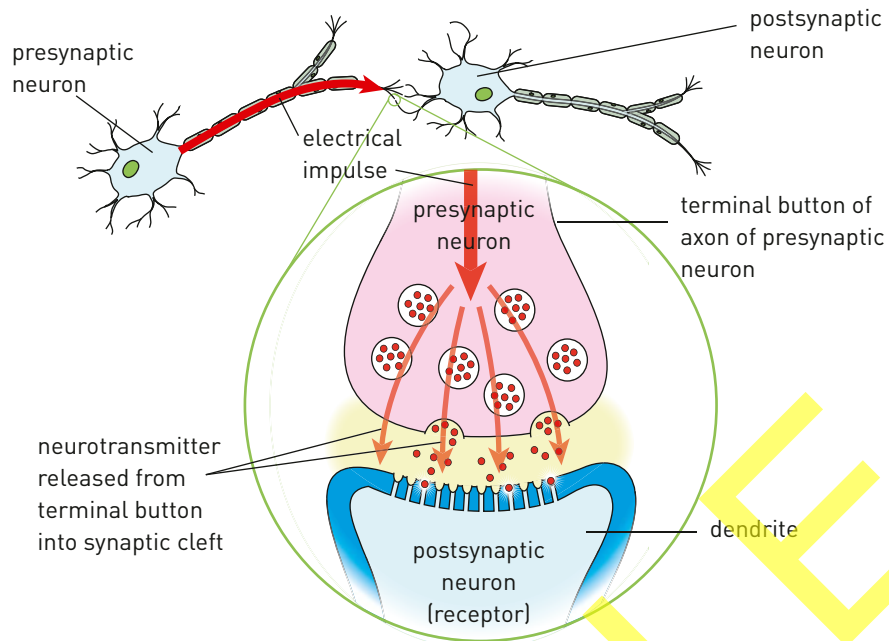


FIGURE 3 A synapse is the junction between two neurons. The presynaptic neuron releases molecules of neurotransmitters, which then fit into receptor sites on the postsynaptic neuron. The charge builds up until a signal, the 'action potential', is sent down the postsynaptic axon.



FIGURE 4 Axon of a neuron sending an electrical impulse to stimulate the release of neurotransmitters, which cross the synapse and attach to receptors on the next cell, passing the message along

Reacting to our senses

Our reaction time is the time it takes to intentionally or voluntarily respond to an external stimulus: from the time it is received by our sensory neurons, to the time we react or change our behaviour. For instance, when our arms feel the cold, our reaction may be to rub our skin in an attempt to warm them or go put on a jacket.

Our ability to detect stimuli through the sensory neurons gives our brains an opportunity to consciously respond to hazards in our environment. Our ability to process sensation can also bring us enjoyment, such as the taste of chocolate on our tongue or the sound of beautiful music.

Reaction times, of both voluntary and involuntary responses, can be studied in psychology. With factors such as preparation, practice and strength of a stimulus among the variables that can impact on a person's reaction time, it is possible for us to improve our reaction times in certain circumstances.

Studies have found that athletes have faster visual reaction times than non-athletes (Akarsu, Caliskan, & Dane, 2009). Even professional gamers, who physically sit all day at a screen, have been found to have faster reaction times than the average person because they spend so much of their time reacting to visual stimuli in their games.

A study by the University of Rochester (Green, Bavalier, & Pouget, 2010) found that experienced gamers had developed a heightened sensitivity to external stimuli, which ultimately improved their ability to make good decisions quickly.



FIGURE 5 Highly trained athletes, such as Chris Lynn who plays for the Brisbane Heat in the KFC Big Bash League, have much faster reaction times than the average person.

CHECK YOUR LEARNING 4.3

Describe and explain

- 1 **Explain** the difference between a sensory and a motor neuron.
- 2 **Describe** an interneuron.
- 3 Alex picked up his sister's hair straightener when it was still hot. **Identify** what neurons would be involved.

Apply, analyse and interpret

- 4 **Consider** human survival and daily life without interneurons.

Investigate, evaluate and communicate

- 5 Read Case study 4.3. **Investigate** treatment options for people diagnosed with motor neurone disease (MND).

Check your obook assess for these additional resources and more:

» Student book questions

Check your learning 4.3

» Video

Neuron type and structure

» Weblink

Reaction test time

» Weblink

Motor neuron disease

Review

Summary

- 4.1**
- The nervous system comprises two main components: the central nervous system, which includes the brain and spinal cord, and the peripheral nervous system, which includes the remainder of the body (e.g. limbs, facial nerves, skeletal muscles, organs and glands).
 - The peripheral nervous system is further divided into the somatic nervous system, which controls voluntary movement of skeletal (striated) muscles, and the autonomic nervous system, which controls involuntary muscles (smooth muscles), organs and glands.
 - The autonomic nervous system is further divided into two branches: the sympathetic nervous system, responsible for activating the body in times when alertness or arousal is required (for example, the fight-flight-freeze response), and the parasympathetic nervous system, which is involved in maintaining the body's regular, day-to-day levels of arousal and homeostasis.
- 4.2**
- Neurons are generally composed of three elements: soma, axon and dendrites.
 - The soma is the cell body.
 - The axon carries information away from the soma. The end of each axon has terminal buttons that release a neurotransmitter whenever information is sent down the axon in the form of electrical impulses.
 - Dendrites receive neurotransmitters from the synapse where they have been released from other neurons.
 - The process of nerve impulse transmission involves neurons receiving, processing and sending information from one cell to another through the release of neurotransmitters into the synapses. A synapse is the space between the end of one neuron and the beginning of a neighbouring neuron.
- 4.3**
- Our senses work by sensory neurons transmitting information from an external stimulus to the CNS. Motor neurons engage a response to the stimulus by carrying signals from the brain back to muscle fibres.

Key terms

- attention
- autonomic nervous system
- axon
- brain stem
- central nervous system
- dendrites
- fight-flight-freeze response
- glial cells
- homeostasis
- interneurons
- motor neurons
- myelin
- myelination
- neural pathways
- neurotransmitters
- parasympathetic nervous system
- peripheral nervous system
- sensory neurons
- soma
- somatic nervous system
- sympathetic nervous system
- synapses
- terminal buttons

Revision questions

Multiple choice

- The central nervous system consists of which two parts?
 - the brain and spinal column
 - the autonomic and somatic nervous systems
 - the brain and spinal cord
 - the cerebral cortex and the spinal cord
- The peripheral nervous system consists of which two parts?
 - the brain and spinal cord
 - the automatic and somatic nervous systems
 - the sympathetic and parasympathetic nervous systems
 - the somatic and autonomic nervous systems
- Moving your leg is an action that is made by which system?
 - somatic nervous system
 - autonomic nervous system
 - sympathetic nervous system
 - parasympathetic nervous system
- Motor neurons enable us to:
 - feel the silky coat of a puppy
 - smell the scent of a flower
 - play the piano
 - see a ball when it is thrown.
- Sensory neurons in your toes are part of which nervous system?
 - central
 - peripheral
 - autonomic
 - sensory
- Which of the following is true of the sympathetic nervous system?
 - In normal daily life, it has nothing to do; it is responsible for the fight-flight-freeze response when a person is confronted by a threat.
 - In normal daily life, it works all the time to ensure that the body's metabolic systems are in balance.
 - It operates at a level of conscious awareness.
 - It is part of the somatic nervous system that operates on the body.
- Which of the following is a true statement about the parasympathetic nervous system?
 - In normal daily life, it has nothing to do; it is used to return the body functions to their normal levels after sympathetic arousal.
 - In normal daily life, it works all the time to ensure that the body's metabolic systems are in balance.
 - It operates at a level of conscious awareness.
 - It is part of the somatic nervous system that operates on the body.
- What is the function of glial cells in the brain?
 - They act as glue to stick the neurons together.
 - They produce myelin to insulate axons.
 - They remove dead and damaged neurons.
 - All of these are correct.
- To transmit nerve impulses, neurotransmitters are released into the:
 - synapse
 - soma
 - dendrite
 - axon
- The molecules of neurotransmitters fit into receptor sites on the _____ of the postsynaptic neuron.
 - terminal button
 - dendrite
 - soma
 - axon
- Without myelin, a neuron would not:
 - have coated axons
 - deliver messages between neurons quickly
 - be protected from chemical and physical interference
 - all of the above.
- Interneurons would be responsible if:
 - you stepped on something sharp and pulled your foot away before you realised
 - you noticed that your hand was holding onto ice and you pulled it away because it hurts
 - you were holding onto a hot tray, despite knowing it is too hot
 - you felt rocks beneath your back while camping and chose to move your sleeping bag.

- 13** The PNS has two main functions. These are to:
- communicate information from the body's organs, glands and muscles to the CNS from both the outside world and the inside world, and communicate information from the CNS to the body's organs, glands and muscles via motor neurons
 - communicate information from the body's organs, glands and muscles to the CNS from both the outside world and the inside world, and segment the spinal cord
 - communicate information from the body's organs, glands and muscles to the CNS from both the outside world and the inside world, and to communicate information from the CNS to the body's organs, glands and muscles via sensory neurons
 - communicate information from the CNS to the body's organs, glands and muscles via motor neurons, and enable the brain to communicate with the rest of the body.

14 Neurons communicate via:

- the myelin sheath
- a chemical process
- the soma
- glial cells.

Short answer

Describe and explain

- ★★ **15** Mel was baking cupcakes for her friend's birthday on the weekend. She was distracted talking to her mother and picked up a hot tray. Before Mel had time to think about what she was doing, she had dropped the tray. **Explain** how Mel was able to react so quickly.
- ★★ **16** Rasmus has been bullied by people at school for a while. As soon as Rasmus sees the bullies, his heart starts to race, his pupils dilate and he feels the need to urinate. **Identify** which system is responsible for this reaction.
- ★ **17** In the peripheral nervous system, the _____ nervous system involves voluntary activity, whereas the _____ nervous system is involuntary.
- ★★ **18** **Summarise** the myelination process.

★ **19** **Describe** the two functions of the peripheral nervous system.

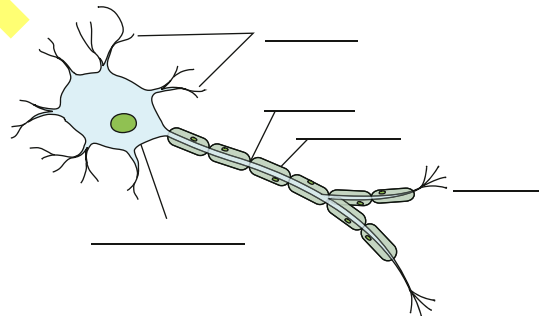
★ **20** **Describe** a neural pathway.

★ **21** **Identify** two characteristic features of someone who is experiencing the fight-flight-freeze response.

★ **22** Complete the following table to **explain** and **describe** the function of each component of a neuron.

Structure	Description	Function
Dendrites		
Soma		
Axon		
Myelin		

★ **23** **Identify** and label the components of a neuron:



- ★★ **24** Daniel has been outside for the last three hours. As the sun begins to set, Daniel realises it is getting colder. **Identify:**
- the neuron responsible for alerting Daniel to this
 - which part of the parasympathetic nervous system will be active to relieve this feeling.
- ★ **25** Sensory neurons communicate via _____ pathways, and motor neurons communicate via _____ pathways

Apply, analyse and interpret

- ★★ **26** Communication between neurons can be interrupted by substances, such as alcohol and pain relief medication. **Consider** the implications of disrupting neuron communication. In your response, acknowledge the advantages and disadvantages.
- ★★★ **27 Differentiate** between sensory nervous, motor nervous and interneurons.
- ★★ **28** When Jeanna was feeding her fish last night, she realised that the water temperature was too warm when her hand touched the water. **Determine** how Jeanna knew this.
- ★★ **29 Compare** the central nervous system with the peripheral nervous system.
- ★★★ **30** People often emphasise the importance of the sympathetic nervous system as it is the survival system. **Consider** what may happen if the parasympathetic nervous system were malfunctioning.

Investigate, evaluate and communicate

- ★★ **31 Discuss** the following statement: 'Without functioning interneurons, humans would not be able to survive'.
- ★★★ **32** The parasympathetic nervous system maintains our general bodily functions, such as breathing, heart rate and digestion. **Assess** what the consequences may be if these processes were not automatically controlled by the parasympathetic nervous system.
- ★★★ **33 Evaluate** the following statement: 'The peripheral nervous system is more important than the central nervous system'.
- ★★ **34 Design** a method for how you would scientifically measure the fight-flight-freeze response.
- ★★★ **35 Predict** what may happen if a postsynaptic neuron were unable to receive the neurotransmitters that were released into the synapse.

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