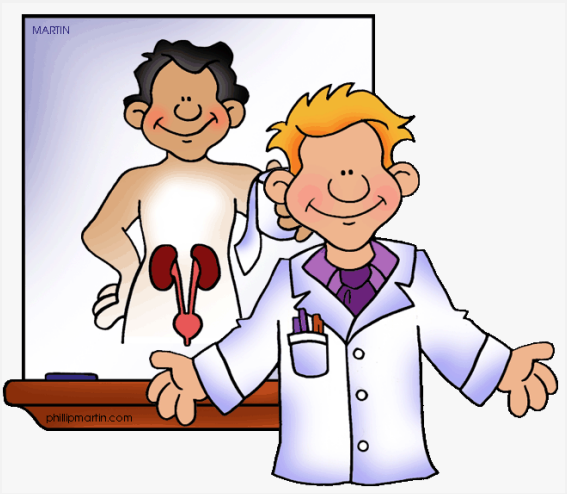

Mrs Lawrence's

9/10-1 Science

Control & Coordination

Theory & Assignment Booklet

Name: _____

HOW TO USE THIS BOOKLET:

- Read the information provided within this booklet
- Answer the guided activities
- Where you have the required equipment, try to complete the prescribed activities.

  This will make the lesson content much more interesting, and will help you to understand the concepts being covered.

- Complete the matching questions within this Theory & Assignment Booklet

  If you are having trouble answering them, you can:

  - ✓ *Call Mrs Lawrence at school on 6785 1184*
  - ✓ *Email Mrs Lawrence at Ariana.lawrence@det.nsw.edu.au*
  - ✓ *FB Messenger Mrs Lawrence as Ariana Lawrence*
  - ✓ *Arrange for a tutorial session with Mrs Lawrence at the school library*

- Submit the Assignment Booklet to Mrs Lawrence for Marking

DUE: 29th May 2020

Science
Stage 5
Response and coordination
Part 1

NSW GOVERNMENT Education & Communities

Distance Education Science Network

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Contents

Outcomes

By completing this unit, you are working towards achieving the following outcomes:

- analyses interactions between components and processes within biological systems
- explains how biological understanding has advanced through scientific discoveries, technological developments and the needs of society
- produces a plan to investigate identified questions, hypotheses or problems, individually and collaboratively
- student processes, analyses and evaluates data from first-hand investigations and secondary sources to develop evidence-based arguments and conclusions
- presents science ideas and evidence for a particular purpose and to a specific audience, using appropriate scientific language, conventions and representations

(Outcomes taken from the Board of Studies NSW Syllabus for the Australian Curriculum SCIENCE Years 7 - 10, 2013)

Content Statements:

1VA, 3VA, LW1, WS5.3, WS7.1, WS9

Resources

You will be sent a mini kit to use with this topic. You will also need to collect these items from home:

Part 1:

Jacket or heavy jumper
Methylated spirits or rubbing alcohol

MINI-KIT ITEMS

Please note that the mini-kit we have sent you contains the following items:

- **thermometer**

Icons

Here is an explanation of the icons used in this unit.

Write a response.

Compare your response with the one in the suggested answers section. Give yourself a tick if you were correct. Make any corrections.

Complete the Send-in exercises corresponding to the lesson.

Perform a practical task or investigation.

Glossary

The following words, listed here with their meanings, are found in the learning material in this part.

brain	main organ of the nervous system which controls all the systems of the body
brain stem	base of the brain which controls involuntary actions such as breathing and heartbeat
cells	basic unit of life
cerebellum	small crinkly part of the nervous system at the lower back of the brain which controls involuntary actions such as balance and coordination
cerebrum	largest part of the brain. It controls memory, speech and voluntary actions, and receives information from sense receptors
diaphragm	a muscular sheath under the lungs in mammals
endocrine glands	glands found in various places in the body which produce hormones and release them directly into the blood
hormones	chemical messages which control important processes of a living thing such as growth
multicellular	a living thing made up of many cells
negative feedback system	a system of control in the body in which the response acts as a stimulus to oppose the change caused by the original stimulus
neuron	basic unit of the nervous system, a nerve cell
neurotransmitter	a chemical released at the end of a nerve fibre
organ	made up of different tissues, for example, the heart is an organ
pH	the measure of acidity
reflex action	an automatic response to a stimulus without involving the brain
synapse	a junction between two nerve cells
tissues	cells grouped together, for example, muscle cells grouped together make muscle tissue in your thigh

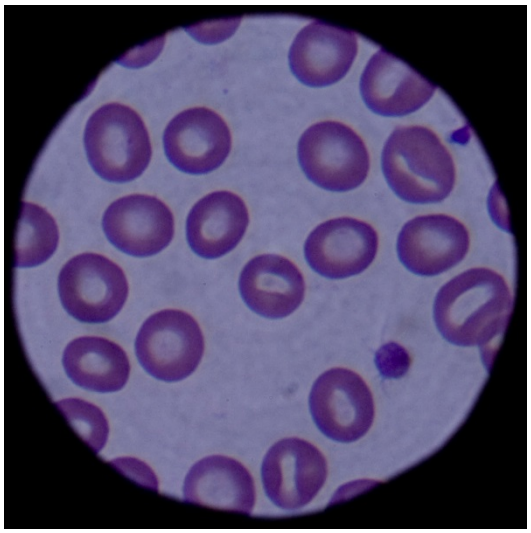
Lesson 1: Body systems

Cells and tissues

Organisms large enough to see without a microscope are made up of many cells.

Your body is made of millions of cells.

In your body there are many different types of cells. Each type of cell has its own shape and does its own job. All of these jobs go together to keep us alive.



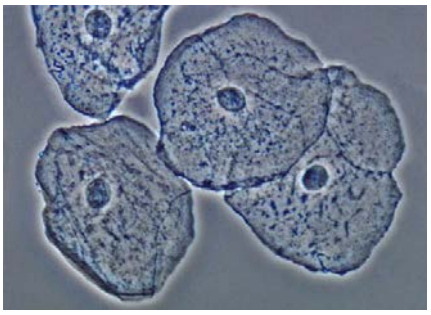
This is what stained blood cells look like when magnified by a microscope lens

For example, in your body there are:

- nerve cells to carry messages
- blood cells to carry oxygen
- muscle cells to enable movement
- fat cells to store fat

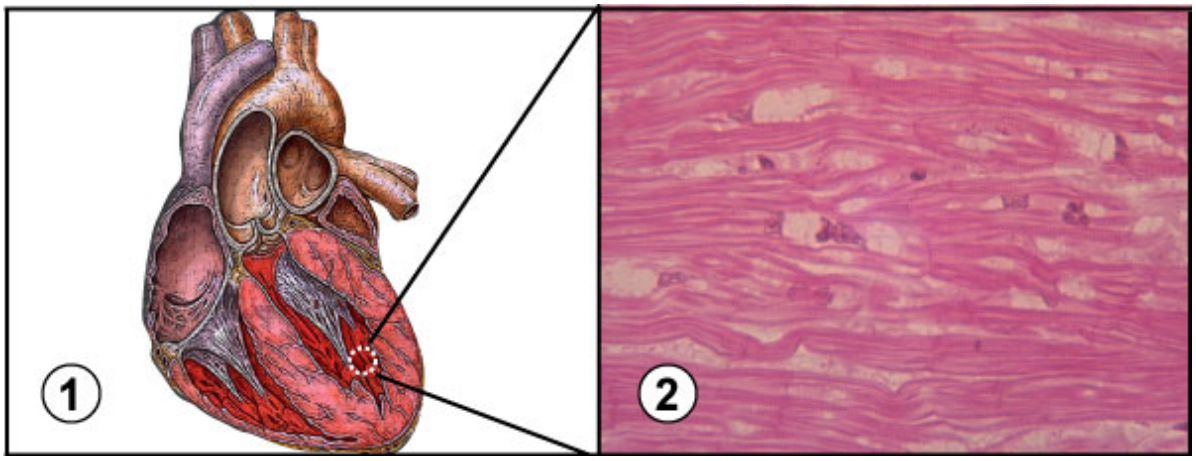
In an organism, cells of the same type are often found together. They work together to perform a function. A group of cells of the same type is called a **tissue**.

Cheek cells grouped together make up the tissue that lines the inside of your mouth.



If you were to scrape a layer of cells off the inside of your cheek and look at them under a microscope they would look like this

Many muscle cells grouped together make up muscle tissue like the muscle tissue in the heart.

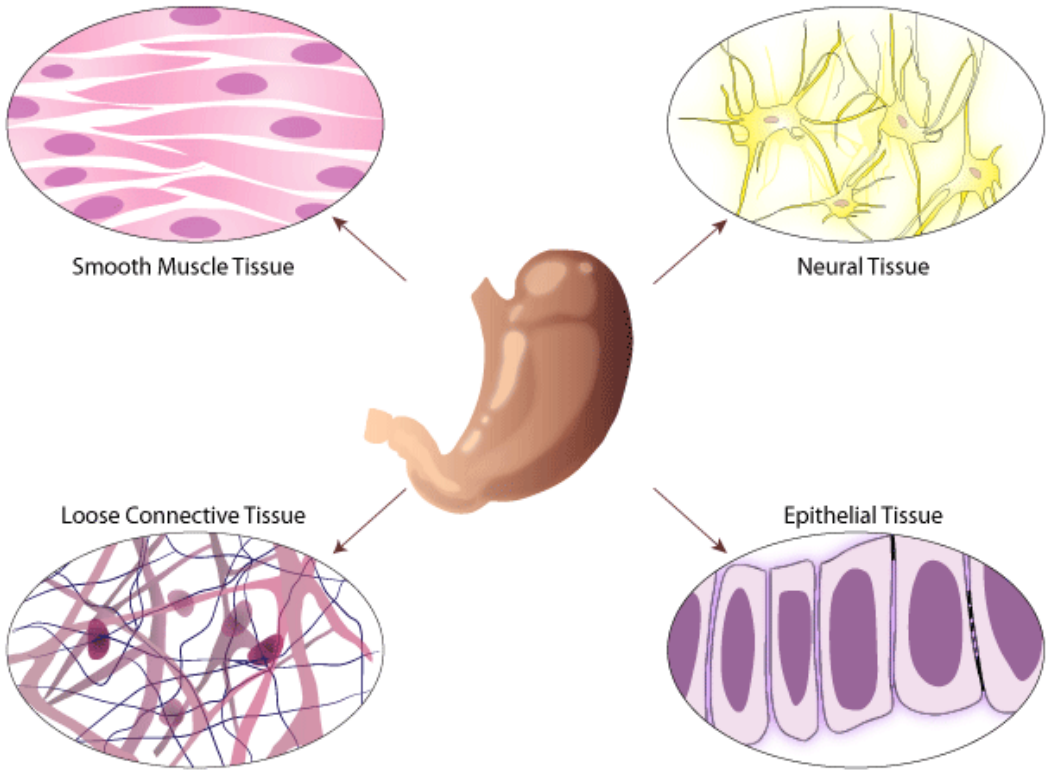


If you were to magnify this section of muscle tissue in the heart, the muscle cells would look like diagram 2

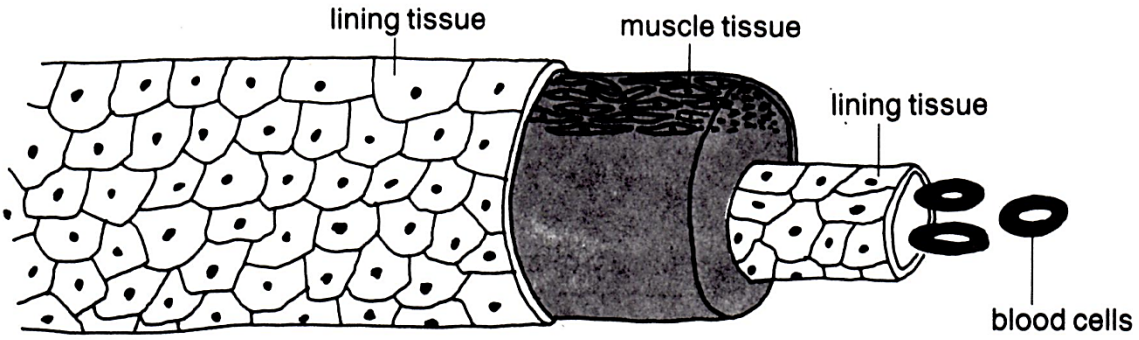
Organs

Organs are made up of groups of tissues.

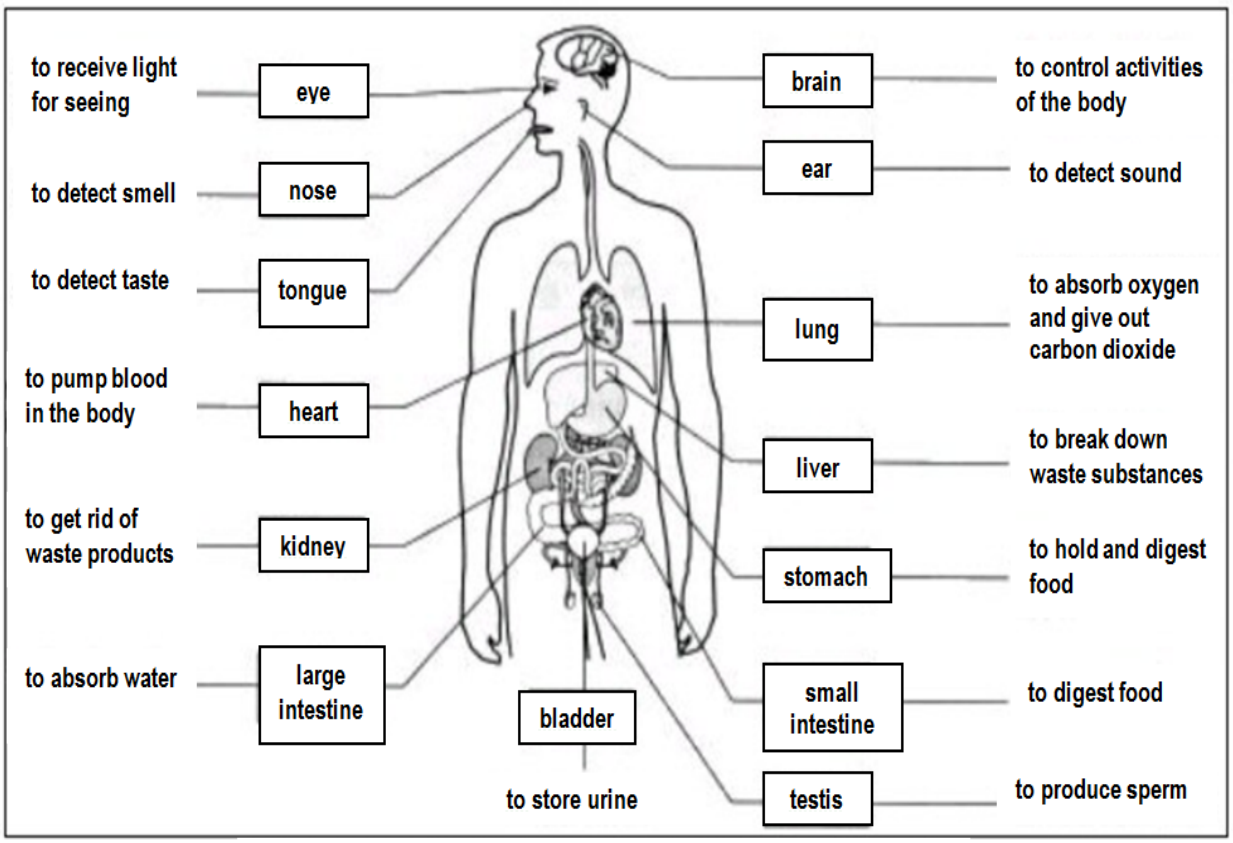
The stomach is made of four different tissues. These tissues together are needed to make the stomach organ function properly.



Arteries and veins are also organs. They are a collection of tissues.



This diagram shows the tissues that make an artery



Main organs and their function in the male human body

Systems

Systems are groups of organs.

Activity 1: Cells, tissues, organs and body systems

Answer true or false to the following statements.

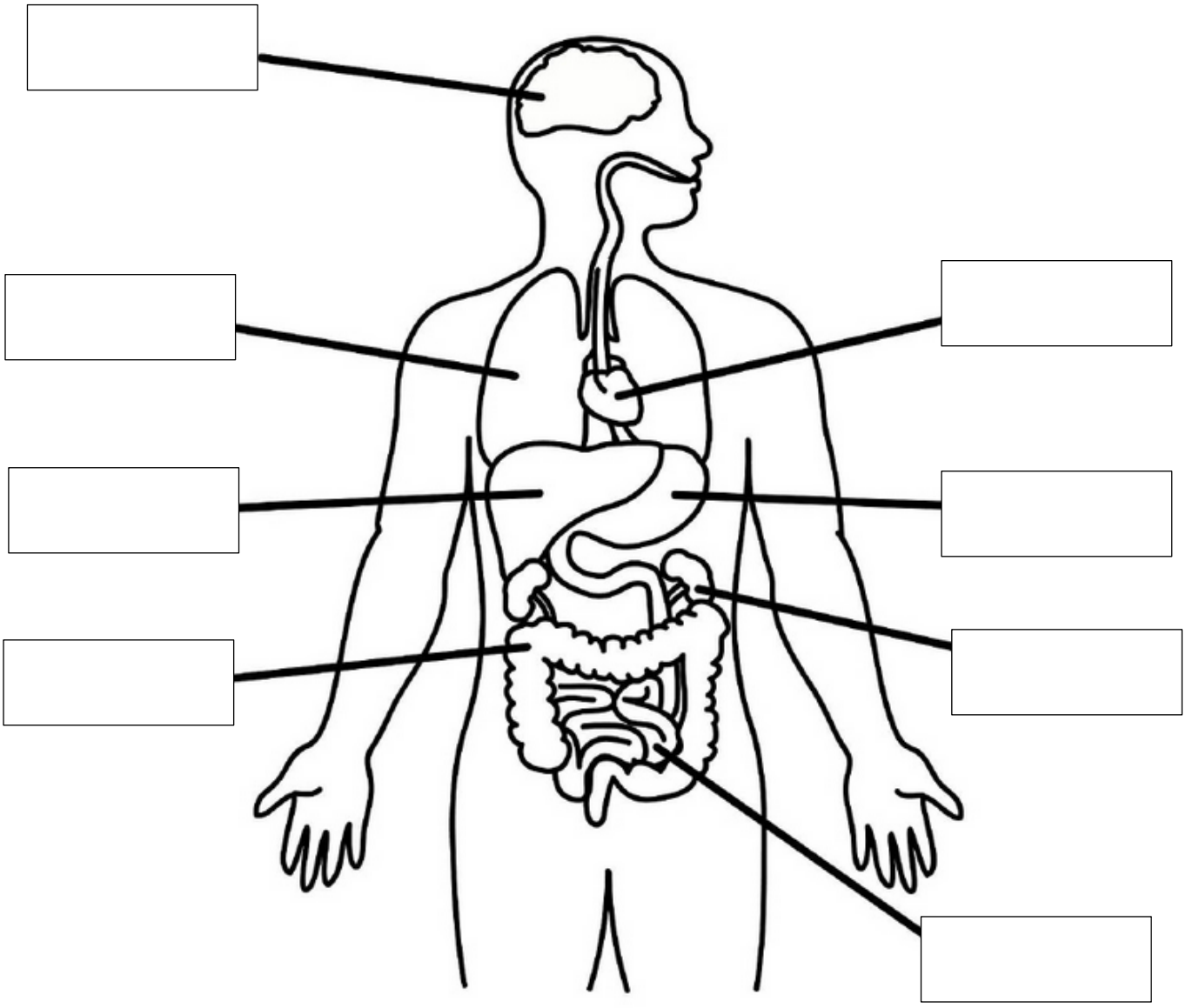
Statement	True / False
Humans are multicellular organisms	
The human body has one million cells	
The simplest part of our body are cells	
Tissues are made of many different types of cells grouped together	
A nerve cell serves the same function as a muscle cell	
Different types of tissues form an organ such as the heart	
Systems are organs working together	
The digestive system is an example of an organ	

Compare your responses with the ones in the suggested answers section

Activity 2: Main organs of the human body

Can you recognise the main organs of the human body?

Label the organs in the spaces provided below.



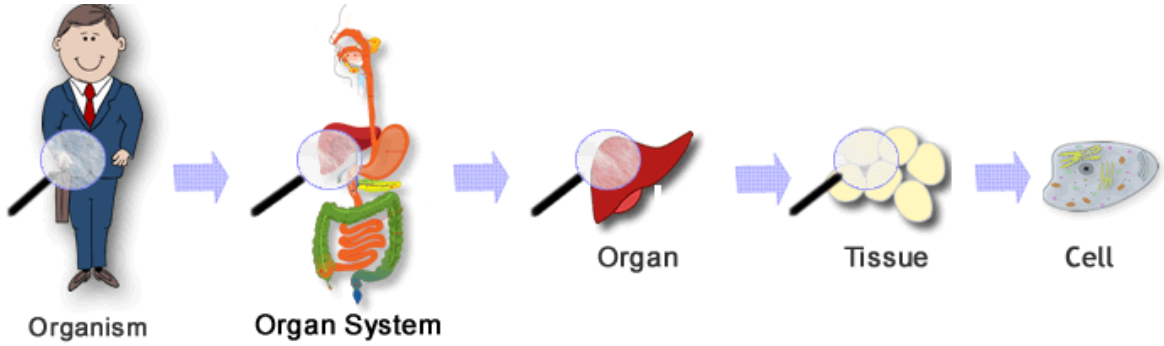
Compare your responses with the ones in the suggested answers section

Body systems

Examples of organs are the stomach, heart, lungs and liver. A group of organs working together is called a system. We have different systems to perform different jobs to keep us alive and healthy.

Examples of body systems are the circulatory system, the respiratory system and the nervous system.

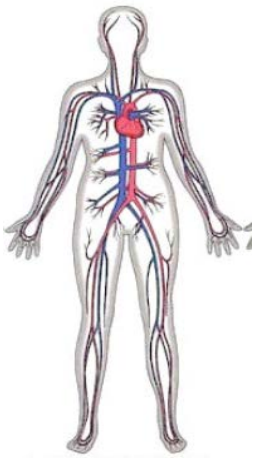
In the picture below, part of the digestive system is made of an organ called the liver which is made up of tissues and cells.



Main human body systems and their function

Muscular system
Consists of layers of muscles that cover the bones of the skeleton, extend across joints (tendons connect muscle to bones) and can contract and relax to produce movement

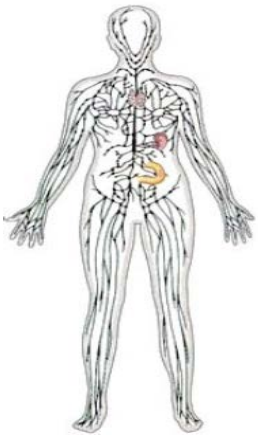
Skeletal system
A strong yet flexible framework of bones and connective tissue. It provides support for the body and protection for many of its internal parts



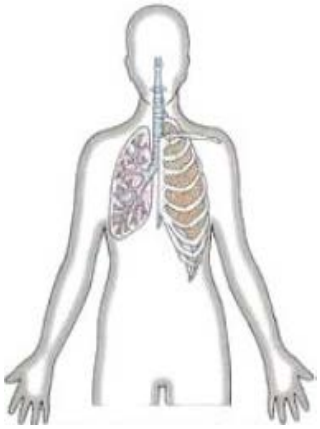
Circulatory system
Consists of the heart and a network of vessels such as arteries, veins and capillaries, that carry blood. It supplies oxygen and nutrients to the body's cells and removes waste products

Main human body systems and their function continued…

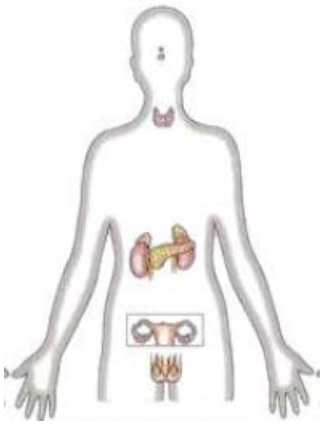
Nervous system
The nervous system is the body's main control system. It consists of the brain, the spinal cord and a network of nerves that extend out to the rest of the body



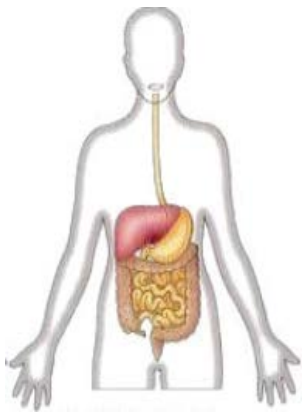
Lymphatic system
Also known as the immune system. It is a network of vessels that collects fluid from tissues and returns it to the blood. It also contains groups of cells that protect the body against infection



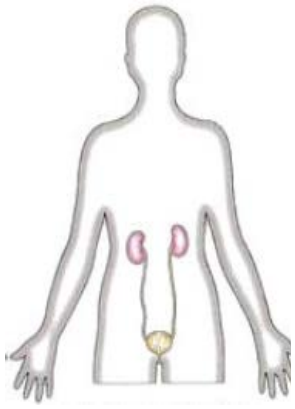
Respiratory system
The respiratory system consisting of lungs, bronchi, broncheoli and alveoli. which work to get life-giving oxygen into the blood. They also rid the body of a waste product: carbon dioxide



Endocrine system
Many body processes such as growth and energy production are directed by hormones. These chemicals are released by the glands of the endocrine system, for example, the thyroid gland.



Digestive system
Takes in the food the body needs to fuel its activities. It breaks the food down into units called nutrients and absorbs the nutrients into the blood.



Excretory system
Also known as the urinary system. The body's cells produce waste products, many of which are eliminated in urine. The job of the urinary system is to make urine and expel it from the body.

Reproductive system
The male part (testes) and female part (ovary) of the reproductive system produce the sperm and eggs needed to create a new human. They also bring these tiny cells together.

Activity 3: Body systems

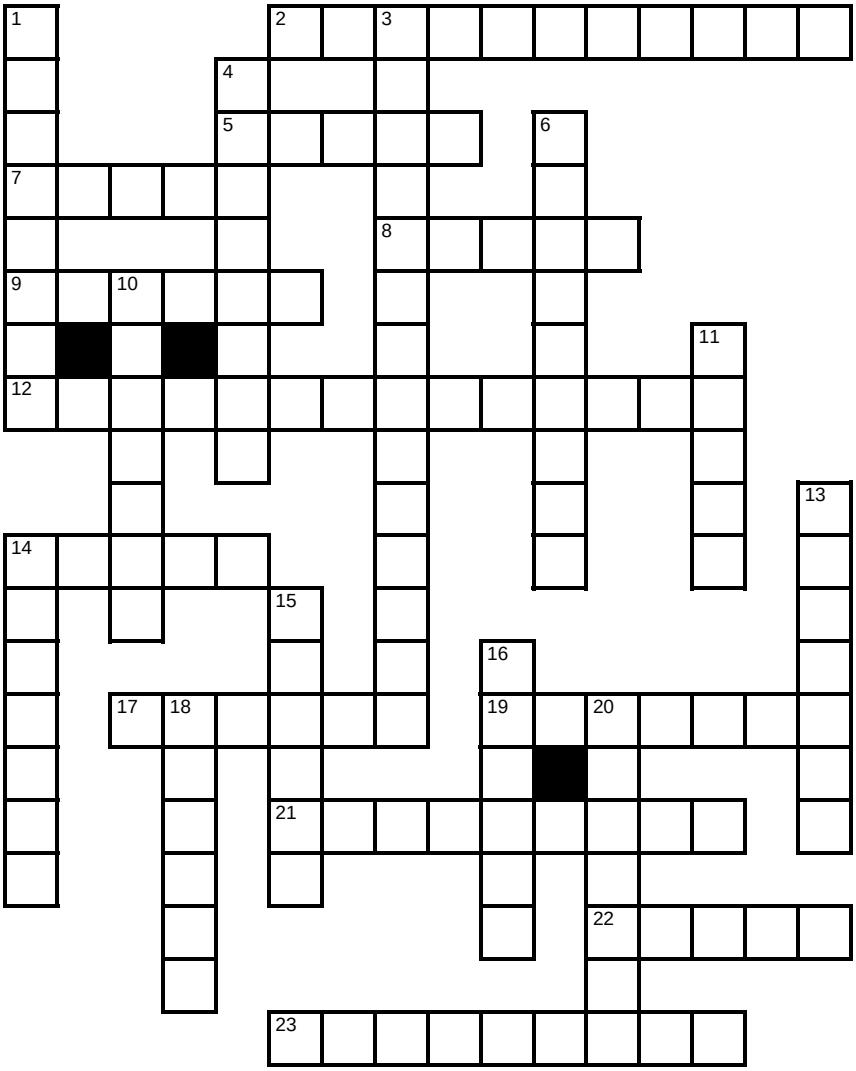
Put an 'X' in the correct box to show which system each organ belongs to. The first one is done for you.

Organ	Body System that organ belongs to						
	digestive	respiratory	excretory	reproductive	circulatory	nervous	endocrine
bladder			X				
brain							
heart							
ovaries							
liver							
large intestine							
kidney							
spinal cord							
lungs							
small intestine							
stomach							
mouth							
nerves							
testes							
thyroid gland							
arteries							
oesophagus							

Compare your responses with the ones in the suggested answers section

Activity 4: Crossword

Complete the crossword to revise the role of the different body systems



Word bank:

respiratory	nervous	cells	heart
skeletal	small intestine	artery	kidneys
liver	hormones	rib cage	large intestine
tendon	organ	lungs	digestive
skull	immune	bronchi	excretory
stomach	tissue	system	endocrine

Clues:

Across

2 Organ system that captures oxygen from the atmosphere.

5 The heart, liver and brain are all examples of an _ _ _ _ _.

7 Large organ that forms part of the digestive system.

8 Organs that help you breathe.

9 Tissue that connects muscle to bone.

12 Organ that reabsorbs water from food.

14 Bone that protects your brain.

17 Groups of cells with a similar function that work together.

19 Bones that protect the heart and lungs.

21 Organ system that removes waste from your body.

22 Basic building blocks of all living organisms.

23 Organ system that regulates growth by producing hormones.

Down

1 Organ system that gives your body structure.

3 Organ that absorbs nutrients from food.

4 The endocrine system produces these chemicals that help regulate growth.

6 Organ system that breaks down food for cells to use.

10 Organ system that controls muscle movement and your senses.

11 Organ that pumps blood.

13 Organs that gets rid of waste from blood.

14 Organ that contains acid and breaks down food.

15 A group of organs working together: organ _ _ _ _ _ _.

16 A blood vessel that pumps blood away from the heart.

18 Organ system that helps you to fight disease.

20 Small tubes within your lungs.

Compare your responses with the ones in the suggested answers section

EXERCISE

Complete the Send-in exercises for Lesson 1

Lesson 2: Heat activity

Have you noticed how your body responds to temperature changes both internally and externally?

In this lesson you will complete an activity that investigates the body's changes after exercising.

Activity 5: Body changes when exercising

Aim: To observe changes to your body after vigorous physical exercise.

Materials:

- thermometer (in the mini-kit) or a digital thermometer if you have one at home
- warm jacket or jumper

Do not complete this activity if you have a medical condition such as heart problems, bronchial problems or high blood pressure or infections like the flu or a cold or you have been advised by your doctor to avoid strenuous physical activity.

You could ask another person to do this activity for you and measure their results.

What to do:

a) Find your resting body temperature by placing the clean thermometer in your arm pit for 2 minutes.

b) Ask another person to measure your pulse rate. Measure your breathing rate whilst this person measures your pulse. This is the number of breaths you take in one minute (to make it faster, you could measure the pulse and breathing rate for 15 seconds and then multiply by 4 to get the rate for 1 minute). Also note the appearance of your skin on your face and how much you are sweating.

c) Record this information in the *Table 1: Before exercise (resting)*

d) Put on the warm jacket and exercise vigorously for 5 minutes without stopping. You could do step-ups, push-ups or sprinting.

e) Immediately after exercising, remove the jacket and measure your temperature, breathing rate and have another person take your pulse rate. Take note of the appearance of your skin on your face and how much you are. Record your results in *Table 2: After exercise*, at time 0 minutes sweating (you may need to get another person to record your results).

f) Repeat these measurements every minute for 7 minutes.

Results:

Table 1: Before Exercise (resting)

Temp (°C)	Pulse rate (beats/min)	Breathing rate (breaths/min)	Skin appearance	Amount of sweat

Table 2: After exercise

Time (min)	Temp (°C)	Pulse rate (beats/min)	Breathing rate (breaths/min)	Skin appearance	Amount of sweat
0					
1					
2					
3					
4					
5					
6					
7					

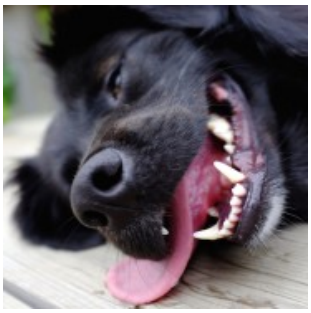
Analysing the data:

You will be completing the rest of the questions about this activity in the Send-in exercises.

EXERCISE
Complete the Send-in exercises for Lesson 2

Lesson 3: Body balance (heat)

Your body temperature stays around 37ºC. All chemical reactions in your cells work best at this temperature.



Mammals and birds have a set body temperature. The body temperature of dogs is about 42ºC while the body temperature of pigeons is 45ºC.

The body temperatures of some animals change with the outside temperature. For example, the body temperature of a snake could be 15ºC in the morning and reach 40ºC as it basks in the midday sun.

Our skin

Humans would not be able to survive if their core temperature went from 15ºC to 40ºC. We are able to regulate our body temperature to keep it at around 37ºC.

The skin is the main organ responsible for maintaining a steady internal temperature in humans.

Activity 6: Regulating body temperature

The two lists below describe ways in which our body can regulate heat.

Tick those that involve the **skin**.

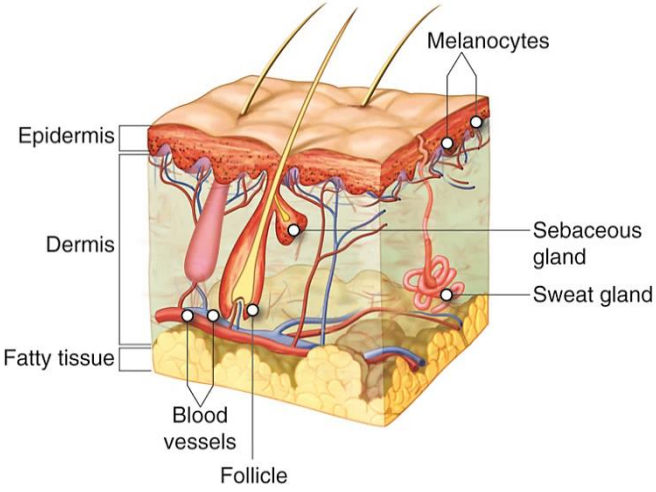
How heat is gained	Tick
A chemical reaction called respiration in cells releases heat	
Muscle movement	
Absorption of heat from the sun and the atmosphere	

How heat is lost	Tick
Evaporation of sweat from the skin	
Urine and faeces	
Radiation from the skin	
Breath released from the lungs takes heat with it	

Compare your responses with the ones in the suggested answers section

Heat loss through evaporation

Sweat is made in the coiled part of the sweat gland, deep in the dermis of the skin. It then oozes out onto the surface of the skin through sweat pores.



The skin is cooled as the sweat (which is about 99% water) evaporates. When water evaporates it changes from its liquid state to a gaseous state. This change requires energy. The energy comes from the heat in the skin. As water evaporates from the surface of the skin it takes heat energy away from the body.

Heat loss through radiation

The temperature of the air is usually lower than the temperature of the skin. Therefore, heat moves from the hotter skin to the cooler air by radiation.

What does the skin do to cool down?

Did you notice that your skin on your face was redder after exercise in the activity in Lesson 2?

When the body is hotter after exercise, blood vessels in the skin become slightly larger and more blood flows through them. Your skin looks redder when this happens. More blood flow through the vessels means more heat is able to radiate from the skin's surface.

What does the skin do to prevent heat loss?

Blood vessels

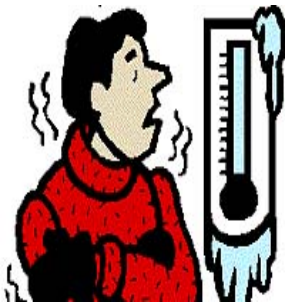
If the body has to conserve heat, the blood vessels in the skin become smaller. This reduces the blood supply and the skin looks paler. Since there is less blood flowing through the skin less heat is lost by radiation.

Hairs on the skin

Birds and mammals keep warm internally by fluffing up their feathers or fur. The hair of a mammal usually lies flat on its skin but when the outside temperature drops, the muscles attached to each hair shaft contract and pull the hairs upright. When this happens, more air is trapped between the hairs. Air is a good insulator and stops the heat from escaping.

Shivering

When you feel cold you start to shiver. Shivering is an automatic response by the body to try to increase its temperature. The body's sensors have detected that the body is cooling and tries to counteract the decrease in temperature. When you shiver your muscles move and produce heat.



Activity 7: Heat loss by evaporation

Collect the following materials to complete this activity:

Materials:

- Water
- Methylated spirits or rubbing alcohol

You must ask your supervisor before accessing and using methylated spirits or rubbing alcohol. These are highly flammable. Do not use near flames. Methylated spirits is also slightly toxic and prolonged contact with the skin should be avoided.

What to do:

a) Rub a drop of water on the back of your hand. Leave it for 30 seconds.

What do you feel?

_____

_____

b) Now gently blow on the spot of water that is on your hand. Now blow on the same spot on your other hand.

What differences can you feel?

_____

_____

How does blowing affect the time it takes for water to evaporate?

_____

_____

c) Rub a drop of methylated spirits on your hand,

What do you feel this time as the drop evaporates?

_____

_____

d) Imagine that you have just come out of a swimming pool and there is a breeze. Why do you now feel colder than before?

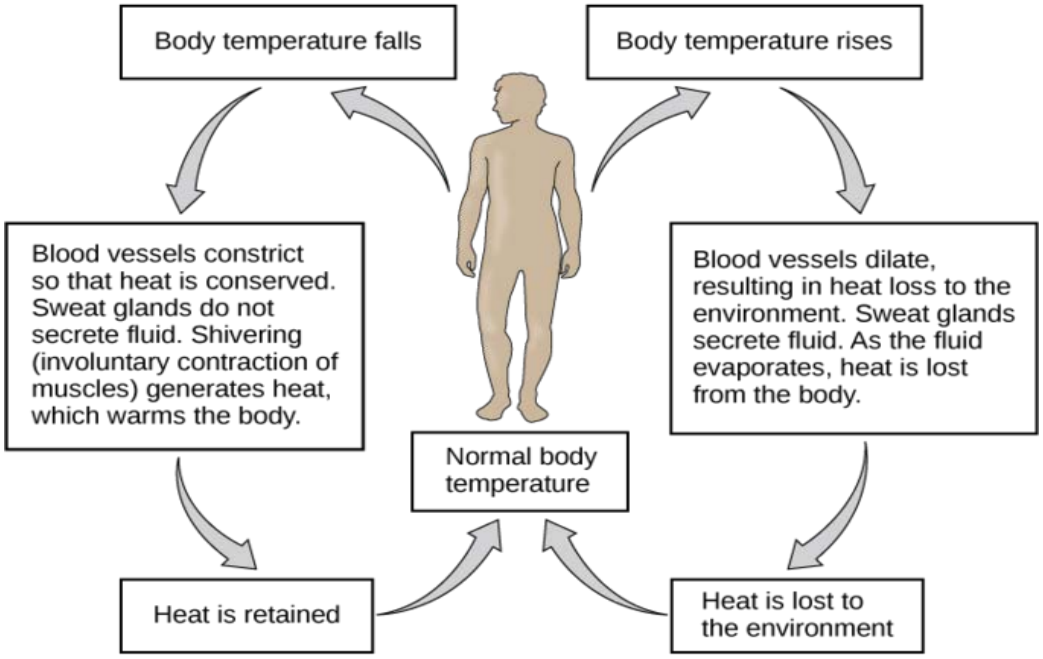
_____

_____

Compare your responses with the ones in the suggested answers section

Activity 8: Rise and fall of body temperature

The diagram below summarises how the body reacts when the body temperature rises or falls.



Complete the table of information below:

Body Temperature falls	Body temperature rises
Blood vessels _____	Blood vessels _____
Sweat glands _____ _____	Sweat glands _____ _____
Shivering generates _____ _____	Heat is lost from the body as _____

Compare your responses with the ones in the suggested answers section

EXERCISE

Complete the Send-in exercises for Lesson 3

Lesson 4: Body balance (water)

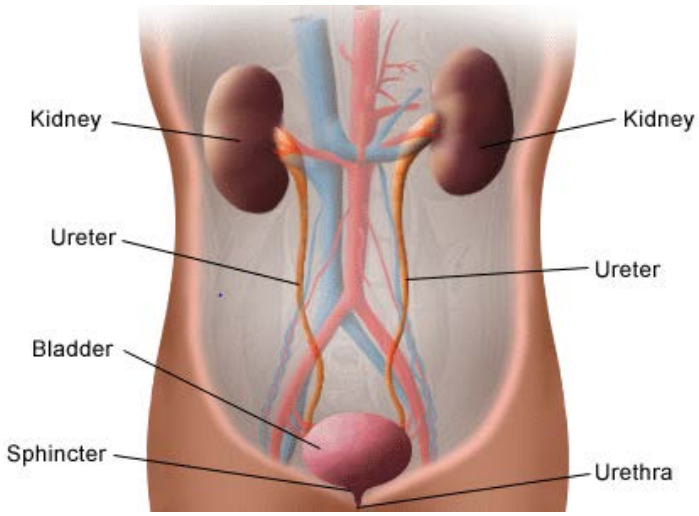
About 70% of your body is made up of water and more than half of this water is inside your body cells. Water is used in chemical reactions inside your cells. Water is needed to carry dissolved substances, such as sodium or potassium, through the body. Tissue fluid, that surrounds tissues and cells, is mostly made of water.

Your body continually loses water. You lose water in the air you breathe out, in sweat, in urine and some in your faeces. Most of the body's water is lost in urine.

You are able to replace most of the water lost through drinking water. Foods, like fruits and vegetables, also have water in them. When these foods are digested, water is absorbed through the large intestine. Some cell reactions also produce water.

Controlling water in the kidneys

About 1 litre of blood passes through the kidneys every minute, so in the next 5 minutes all of the blood in your body will pass through your kidneys.



As the blood passes through the kidneys the water level in the blood is adjusted. The water level in the blood can be adjusted by the kidney filtering out water or reabsorbing it.
The filtered water is collected in tubes (ureter) which lead to the bladder and urine is produced.

The kidneys control how much water is lost from the blood. If the amount of water in the body is low then the amount of urine produced is small. If you drink a lot of water then a larger amount of urine is produced.

Activity 9: Kidneys

Answer true or false to these questions.

a) Most water is lost from the body as sweat ________

b) The kidneys control how much water is lost from the blood ________

c) The skin regulates the amount of water in the blood ________

d) Water is filtered out of the blood in the kidneys ________

Compare your responses with the ones in the suggested answers section

Activity 10: Secret message

Find the words in the following wordsearch. Use the left over letters to find a secret message.

ADJUSTED	BLADDER	BLOOD	CONTROL	FILTER
KIDNEYS	URINE	WATER		

A	K	I	D	N	F	E	K	Y	E
S	D	C	O	I	N	I	T	B	N
R	O	J	L	L	D	T	L	L	I
H	E	T	U	N	A	A	O	M	R
O	E	U	E	S	D	R	N	B	U
R	T	Y	O	D	T	F	W	L	A
T	S	E	E	N	R	E	I	O	N
O	U	R	O	R	B	L	D	O	O
O	D	C	R	E	T	A	W	D	.

Hidden message:

__ __ __ __ __ __ __   __ __ __ __ __ __ __   __ __ __   __ __ __ __ __ __

__ __   __ __ __ __ __   __ __   __ __ __   __ __ __ __ __ .

Compare your responses with the ones in the suggested answers section

Lesson 5: Coordination systems

Cells in the human body cannot survive independently of each other. They both depend on each other and work together. Working together depends on organisation, coordination and control.

The different systems of the body work together to maintain a stable internal environment. The temperature, pH and concentrations of oxygen, carbon dioxide, glucose and water need to be in a particular range for you to survive. Your body detects when changes in these factors occur and responds to bring the factor back to a normal range.

The detection and response pathway in humans can be summarised as:

Two systems are responsible for coordination of this detection and response pathway – the nervous system and the endocrine system. Both these systems use signalling to communicate messages in the body.

The action of each coordination system is summarised in this table:

Messaging	The nervous system	The endocrine system
How?	electrical impulses along nerves and neurotransmitters across synapses	hormones (chemicals) in the blood
Speed of message	fast	slow
Speed of response	immediate	usually slow
Duration of response	short	long lasting

Activity 11: Detection and response

a) Write down, or draw a summary, of the detection and response pathway.

_____

_____

_____

b) Which two systems are responsible for the coordination of detection and responses in the human body?

_____

c) Compare the speed of messaging of these two systems.

_____

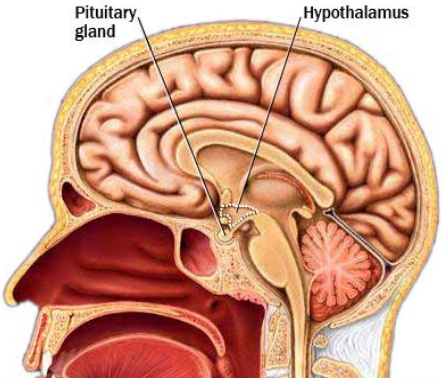
_____

_____

Compare your responses with the ones in the suggested answers section

Coordination systems - regulating temperature

Do you remember learning about the body's responses when you get too hot or cold in Lesson 3? How do the coordination systems control these responses?



During exercise your muscles generate heat which increases the temperature of the blood.

Glands

The heated blood travels through your body and goes through blood vessels in the brain. It passes through the hypothalamus and pituitary glands in the brain. These glands have receptors that monitor the temperature of the blood and are sensitive to changes in temperature of the blood. They also send out nerve impulses to the skin and sweat glands.

By sweating and radiating heat, your body temperature reduces.

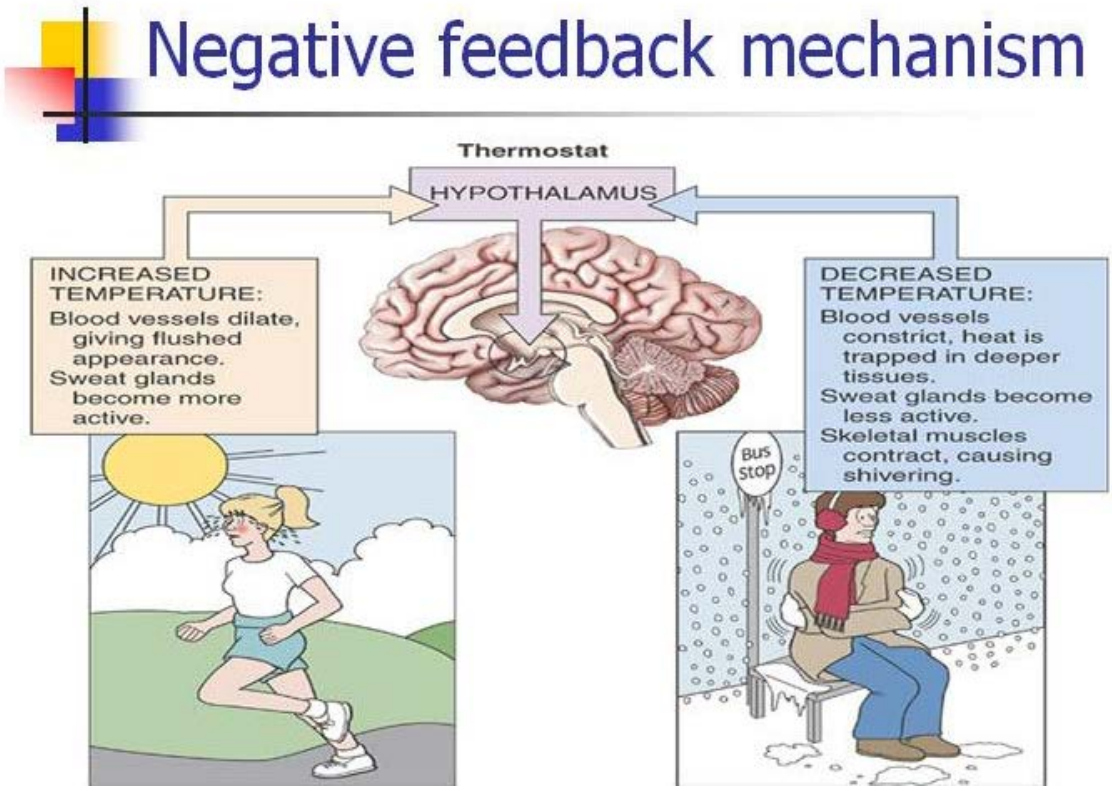
What do the glands do when the temperature is reduced?

The heat receptors in the brain are able to detect a reduction in blood temperature and send nerve signals to the skin and sweat glands to reduce the heat loss. This sensing and correction through messaging is how your body maintains a near constant core body temperature.

Negative feedback system

This system of control is called a negative feedback system.

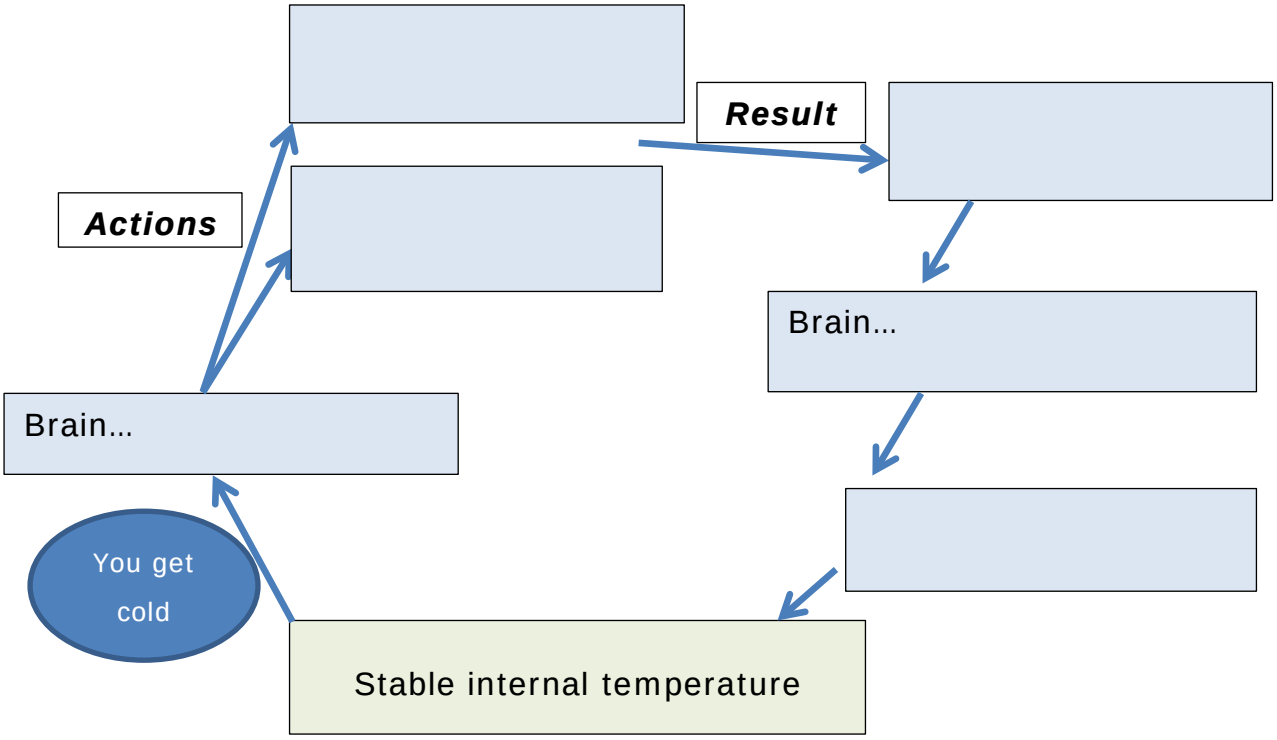
a) The original **stimulus** is the higher blood temperature.
b) The body's **response** is to activate the skin and sweat glands to lower the temperature.
c) The lower blood temperature then provides a **feedback stimulus** to **oppose** the original action caused by the higher temperature (*and so is called a negative feedback*).
d) The body's **response** is to stop the action of the sweat glands.



Activity 12: Maintaining constant internal temperature

a) Summarise the process of maintaining a constant internal temperature by labelling this diagram below with the following labels:

- Brain detects increased temperature
- Brain detects decreased temperature
- Blood vessels near skin constrict (become smaller)
- Blood vessels return to normal
- Muscles shiver
- Body temperature rises



b) Label the diagram above with asterisks (*) where the brain sends messages to the body to cause a response.

c) How does the process shown describe a negative feedback system?

_____

_____

_____

Compare your responses with the ones in the suggested answers section

Kidneys and water in the blood

In lesson 4 you learnt about the role of the kidneys in controlling the amount of water in the blood through filtration and reabsorption.

How do the coordination systems of the nervous and endocrine systems regulate this system?

The amount of water lost from the kidneys is controlled by nerves and hormones. Receptors in the hypothalamus are sensitive to changes in the amount of water in the blood.

For example, on a hot day you lose a lot of water as sweat.

These receptors in the hypothalamus detect a lower amount of water in the blood and send an impulse to the pituitary gland (also in the brain).

The pituitary gland releases a hormone called ADH into the blood stream. When the brain detects the blood water level is low then more of this hormone is released. The hormone then travels to the kidneys and stops the action of those parts of the kidney that let water out and decreases the amount of water filtered from the blood.

Human kidney

Over time the water level in blood gradually increases because the kidney is no longer filtering water out of the blood. The hormone has decreased the amount of water leaving the blood.

The increase in the amount of water in the blood is detected by receptors in the brain. These receptors send a message to the pituitary gland in the brain to release less ADH hormone. The action of the hormone on the kidneys reduces and the kidney filters and reabsorbs water in the blood normally.

Activity 13: Maintaining water levels

a) Summarise how the body responds when it detects a low level of water in the blood.

_____

_____

_____

_____

_____

_____

_____

_____

b) Describe the negative feedback response that occurs after the blood water level returns to normal.

_____

_____

_____

_____

_____

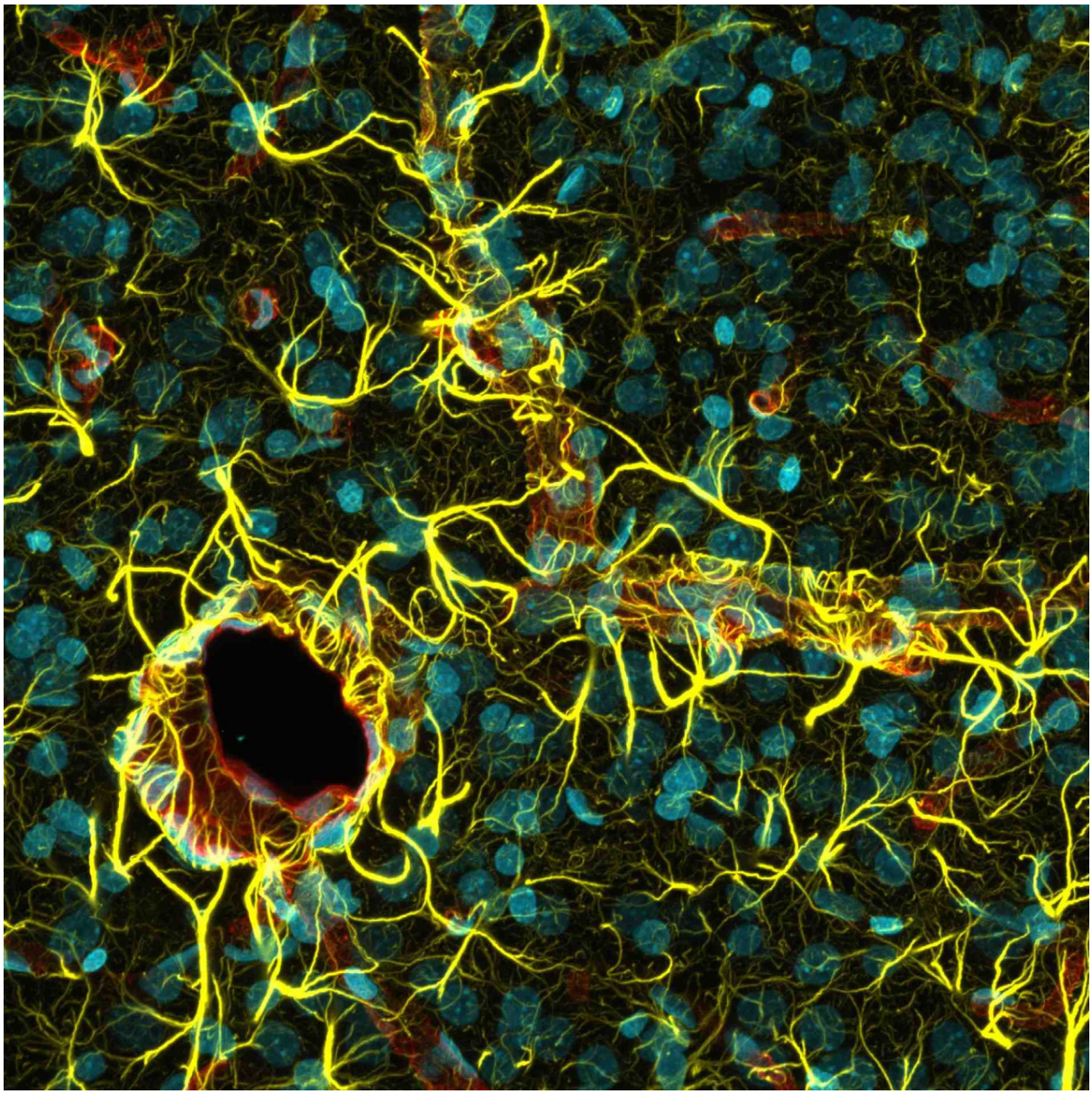
_____

Compare your responses with the ones in the suggested answers section

EXERCISE

Complete the Send-in exercises for Lesson 5

Science
Stage 5
Response and coordination
Part 2



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Contents

Outcomes

By completing this unit, you are working towards achieving the following outcomes:

- analyses interactions between components and processes within biological systems
- explains how biological understanding has advanced through scientific discoveries, technological developments and the needs of society
- produces a plan to investigate identified questions, hypotheses or problems, individually and collaboratively
- student processes, analyses and evaluates data from first-hand investigations and secondary sources to develop evidence-based arguments and conclusions
- presents science ideas and evidence for a particular purpose and to a specific audience, using appropriate scientific language, conventions and representations

(Outcomes taken from the Board of Studies NSW Syllabus for the Australian Curriculum SCIENCE Years 7 - 10, 2013)

Content Statements:

1VA, 3VA, LW1, WS5.3, WS7.1, WS9

Resources

You will be sent a mini kit to use with this topic. You will also need to collect these items from home:

Part 1:

Jacket or heavy jumper
Methylated spirits or rubbing alcohol

Part 2:

No further items required

MINI-KIT ITEMS

Please note that the mini-kit we have sent you contains the following items:

- **thermometer**

Part 3:

No further items required

Icons

Here is an explanation of the icons used in this unit

Write a response.

Compare your response with the one in the suggested answers section. Give yourself a tick if you were correct. Make any corrections.

Complete the Send-in exercises corresponding to the lesson.

Perform a practical task or investigation.

Glossary

The following words, listed here with their meanings, are found in the learning material in this part.

brain	main organ of the nervous system which controls all the systems of the body
brain stem	base of the brain which controls involuntary actions such as breathing and heartbeat
cells	basic unit of life
cerebellum	small crinkly part of the nervous system at the lower back of the brain which controls involuntary actions such as balance and coordination
cerebrum	largest part of the brain. It controls memory, speech and voluntary actions, and receives information from sense receptors
diaphragm	a muscular sheath under the lungs in mammals
endocrine glands	glands found in various places in the body which produce hormones and release them directly into the blood
hormones	chemical messages which control important processes of a living thing such as growth
multicellular	a living thing made up of many cells
negative feedback system	a system of control in the body in which the response acts as a stimulus to oppose the change caused by the original stimulus
neuron	basic unit of the nervous system, a nerve cell
neurotransmitter	a chemical released at the end of a nerve fibre
organ	made up of different tissues, for example, the heart is an organ
pH	the measure of acidity
reflex action	an automatic response to a stimulus without involving the brain
synapse	a junction between two nerve cells
tissues	cells grouped together, for example, muscle cells grouped together make muscle tissue in your thigh

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Lesson 1: The nervous system

In Part 1 you learnt about the responses and coordinated efforts of the body to maintain a constant internal environment. You also learnt that the nervous and endocrine system coordinate these responses and control all body systems in the body.

This week you will be focusing on the nervous system.

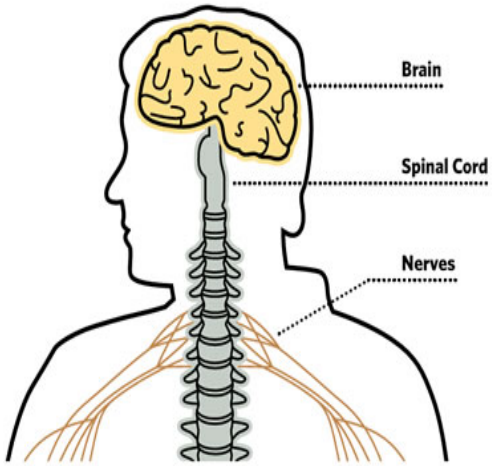
What is the nervous system?

The nervous system consists of the brain, the spinal cord and nerves which run to all parts of the body.

What does the nervous system do?

The nervous system controls

- muscle movement
- senses (sight, hearing, pain, taste, smell)
- heartbeat
- breathing
- digestion
- memory
- speech



Nervous System

The nervous system allows living things to **detect** what is going on around them. A change which the nervous system detects is called a **stimulus**.

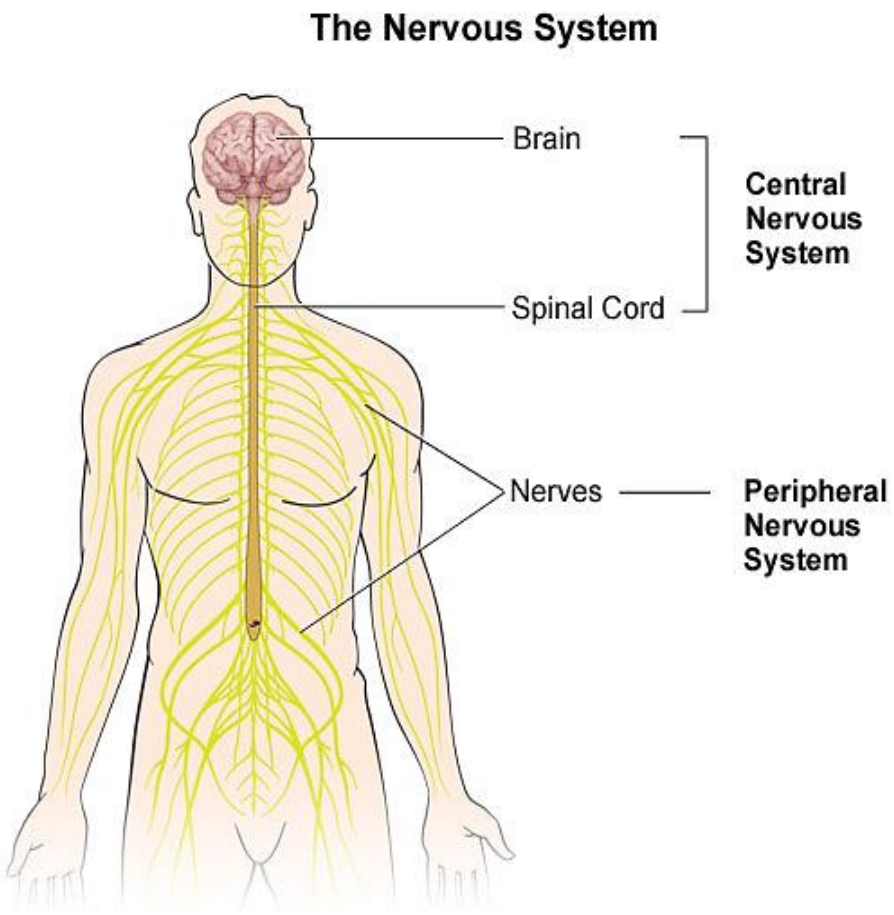
The nervous system processes the information and then a gland or muscle reacts. This is called a **response**.

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

The central nervous system includes the brain and the spinal cord. It controls many involuntary responses.

The peripheral nervous system is a network of nerves that spread throughout the body. The peripheral nerves relay information from your brain and spinal cord to the rest of your body and from your body to your brain and spinal cord.

Your peripheral nervous system consists of 12 pairs of cranial nerves, which emerge from your brain and mainly serve your head and neck. It also contains 31 pairs of spinal nerves which branch off from your spinal cord and supply the rest of your body.



Activity 1: Crossword

Across

2. The nervous system allows the body to d_____ what is happening around us.

4. The s_____ c_____ is part of the nervous system.

7. The peripheral nervous system relays _____ from the brain and spinal cord to the rest of the body

8. Nerves spread _____ the body.

9. A gland or muscle is acted upon by nerves to produce a r_____.

10. The nervous system controls m_____ movement.

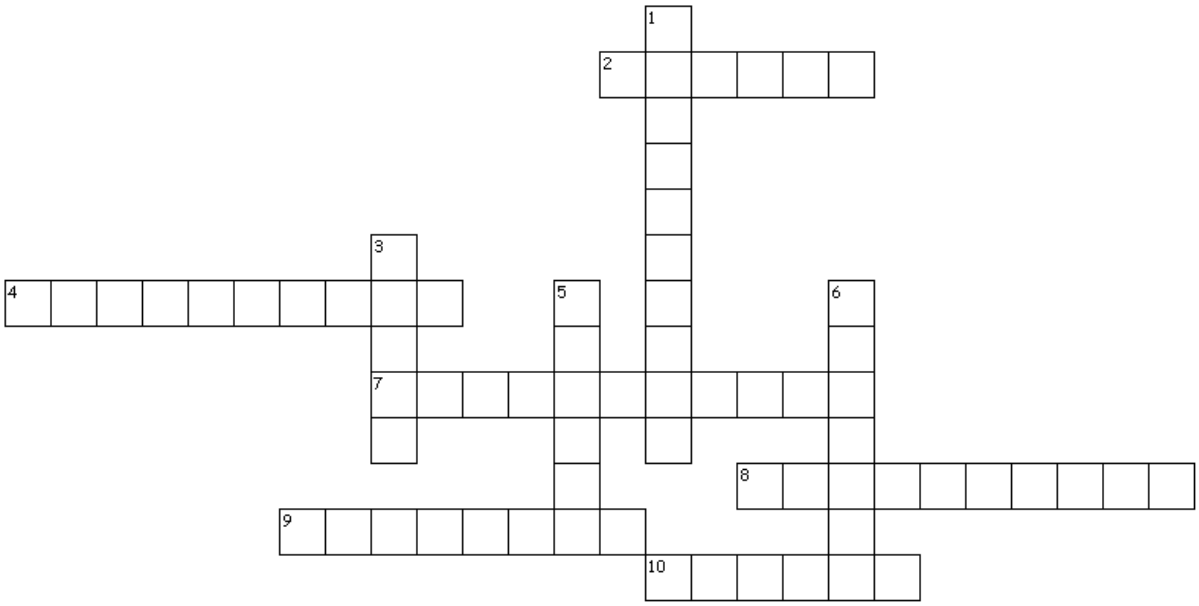
Down

1. The p_____ nervous system is a network of nerves.

3. The b_____ is part of the nervous system.

5. N_____ are also part of the nervous system.

6. The c nervous system includes the brain and the spinal cord.



EXERCISE

Complete the Send-in exercises for Lesson 1

Lesson 2: Responses

Voluntary and involuntary actions

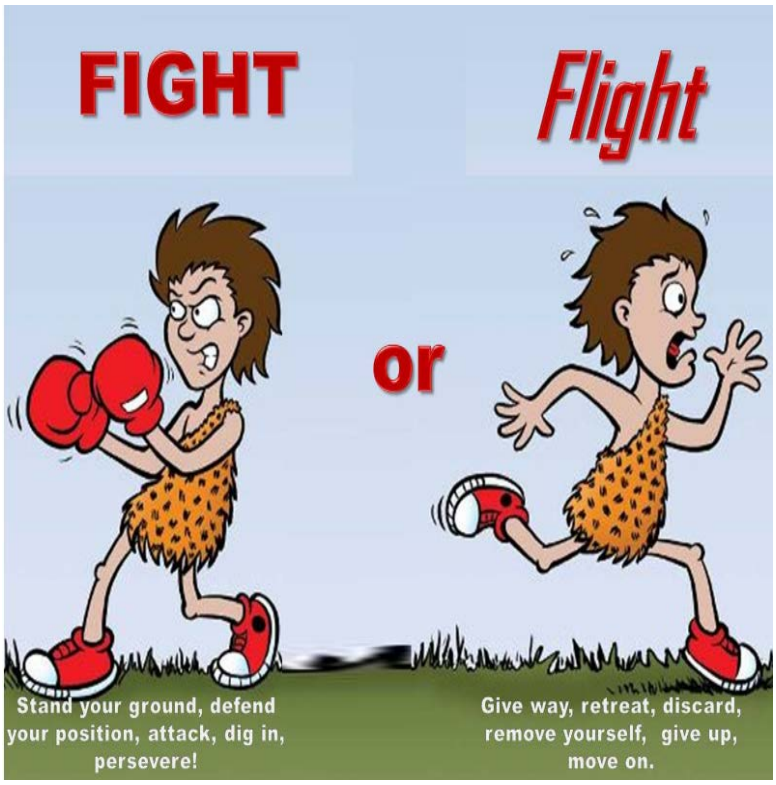
Have you noticed that some functions of your body occur without your conscious thought? You keep breathing, digesting food and can balance when standing without purposely directing thought to these actions.

With the help of your peripheral nerves, you are able to carry out voluntary and involuntary actions.

If you pick up a mug, clap your hands or lift weights in the gym, you are performing **voluntary** actions. You are conscious of what you are doing. Your brain receives nerve impulses and analyses them before you decide what to do next.

In contrast, your heart beats and your intestines digest food without your conscious control. **Involuntary** actions such as these are regulated by your peripheral nervous system. These involuntary actions, which are controlled by your nervous system, ensure all your internal organs and glands function smoothly.

Involuntary actions controlled by the peripheral nervous system also control your 'fight-or-flight' response. When your body senses a dangerous situation, it moves blood to your muscles and increases your blood pressure, heart rate and breathing rate, enabling you to cope with the stressful situation.



Activity 2: Voluntary and involuntary actions

a) How does the nervous system control voluntary actions?

_____

_____

b) Give two examples of involuntary actions controlled by your nervous system.

_____

_____

Compare your responses with the ones in the suggested answers section

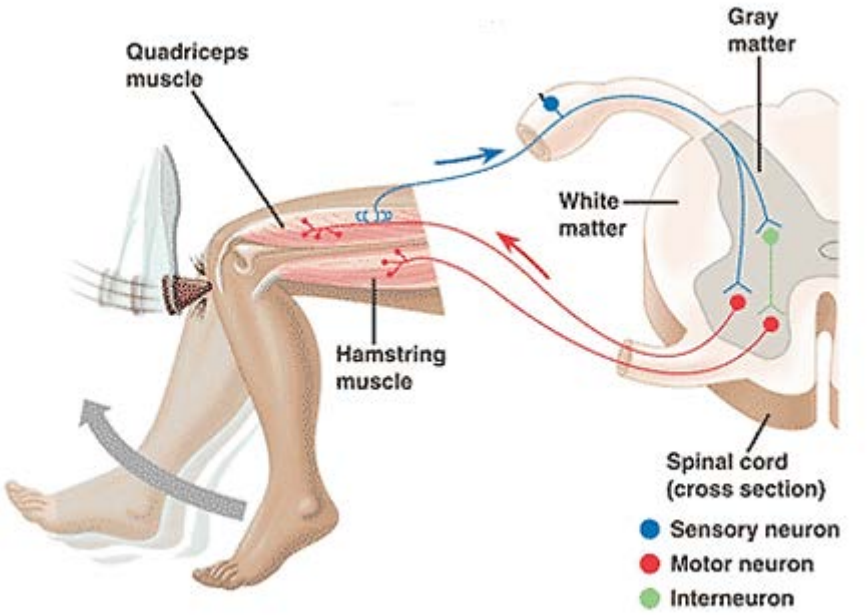
Involuntary actions - reflex

Your nervous system receives information from the sense organs like the tongue, ear and eye and also from pressure and temperature receptors in the skin. This information is processed in the brain and then a response is made.

Sometimes the information from the receptors is not coordinated in the brain. Sometimes a nerve impulse takes a short cut to the spinal cord and then back to a response. This is called a reflex action. A reflex action is an example of the action of the involuntary nervous system.

These actions are very fast and do not involve any decision making by the brain. Examples of reflex actions are blinking to protect your eye when an object approaches your eye, moving your arm away from a hot frying pan to avoid getting burnt, and coughing when crumbs go down the your trachea.

The reflex action is sometimes called the reflex arc. An example is shown in this diagram:



You can see the arrow which shows that the leg was lifted up after the doctor's hammer hit the knee. Follow the steps below showing the reflex arc.

- The doctor's hammer hit the knee.
- The sensory nerve (or neuron) sent an electrical impulse (message) to the spinal cord.
- The message goes through the spinal cord and to a motor nerve (or neuron)
- The electrical impulse (or message) moves from the spinal cord to the quadriceps and hamstring muscles. The nerves message the quadriceps to contract and the hamstring to lengthen and so the leg is moved up.

Did you notice that the message did not go to the brain in this reflex arc?

This is an example of an involuntary response. A quick action is needed in some situations and the nervous system acts like this for our safety. The brain is sent a message from the spinal cord but it is after the response has already happened.

Activity 3: Reflex actions

a) Explain why reflex actions are an important involuntary response.

_____

_____

b) What does your body do when a fly is flying straight at your face? Refer to the reflex arc in your explanation.

_____

_____

_____

_____

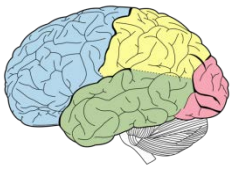
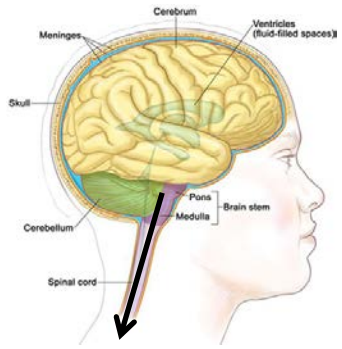
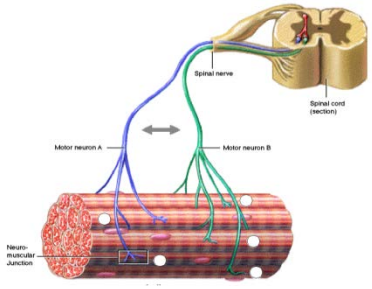
Compare your responses with the ones in the suggested answers section

Voluntary actions

Look at the picture below:

The girl riding her bike suddenly sees the boy riding in front of her. Her body recognises that there is a danger that she could collide with him.

What changes is her nervous system making in her body?

	Her sense organ (the eye) senses the boy on his bike.
	A message is sent to the brain by a sensory neuron (or nerve). The brain sends messages around the different parts of the brain responsible for this decision. It makes a decision.
	The brain sends a message down the spinal cord.
	The spinal cord sends a message to the muscles in her legs through motor neurones (or nerves).
	Certain muscles contract and others lengthen to coordinate her feet pushing down on the pedal brakes. These muscles are called an effector.

This was an example of a voluntary response as the brain considered stimuli from sensory organs and nerves and then made a decision and effected a response.

Activity 4: Voluntary action flowchart

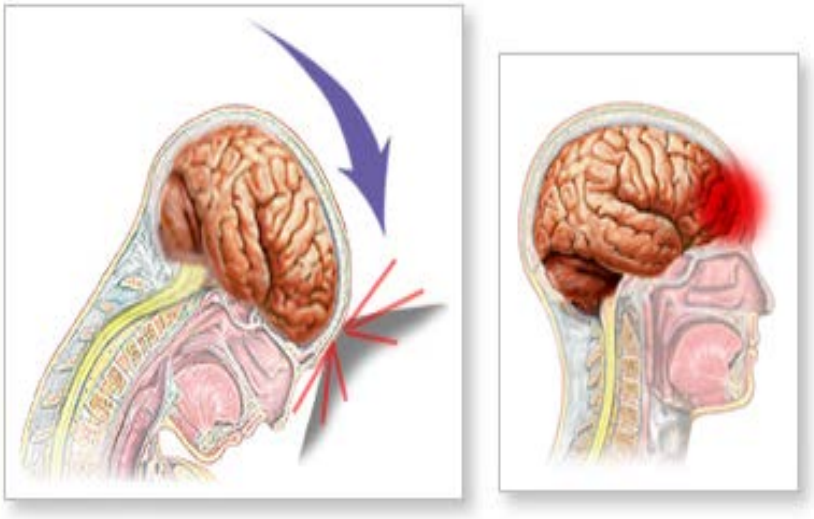
Draw a flowchart to summarise the voluntary action and response of the girl in the example on the previous page.

Compare your responses with the ones in the suggested answers section

Concussion

Concussion is a disturbance in the brain's ability to receive and process information. The reduced function of the brain is a reflection of damage to nerve cells (neurons).

The neurons can be damaged by a direct blow to the head, which cause the brain to rotate and/or move forward and backward.



Concussion is a violent jarring or shaking that results in a disturbance in brain function

Indirect impact to the body can transfer a force to the brain which also can damage neurons. It is similar to the effect experienced by passengers when a car quickly accelerates or stops.

A person does not have to have been unconscious to have concussion. A person with concussion will appear unresponsive, have upper limb muscle rigidity and spontaneous movement, have difficulty balancing, and may suffer from confusion and disorientation.

Later a person may experience a headache, nausea, vomiting, blurred vision and memory loss. Weeks later they still may suffer from sleep difficulty, a persistent low grade headache and have poor attention and concentration.

Research has shown that concussed footballers are more likely to get knocked down again within the next 7 to 10 days as their neurons have not fully recovered and sometimes there is brain swelling.

Playing whilst still having a damaged brain reduces the brain's ability to process information at its normal rate. The footballer's reaction rate would be slower as the damaged neurons would produce a weaker signal when transmitting signals.

A soccer study

In soccer, approximately 4% of all injuries are head injuries that cause concussion. The most common type is player-to-player head clashes. A Norwegian scientific study found that a high percentage of the ECG brain wave patterns of first-division players were abnormal. The abnormal brain wave patterns reflect damaged brain nerve signal pathways and faulty brain functioning.

The repeated low-intensity impacts of heading a soccer ball may be similar to concussion.

Activity 5: Concussion

a) What is concussion?

_____

b) Why should players rest after a concussion?

_____

_____

_____

c) Infer whether there would be more neurological problems in goalies or forwards in soccer. Explain your reasoning.

_____

_____

_____

_____

Compare your responses with the ones in the suggested answers section

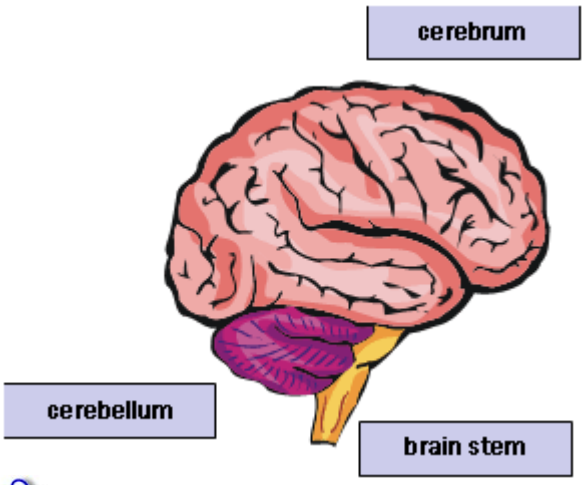
EXERCISE

Complete the Send-in exercises for Lesson 2

Lesson 3: The brain

The brain is the control centre of your body. It is a soft mass of white and grey nerve tissue that rests in the skull. The brain sends and receives messages to every part of the body through nerves. It uses the five senses to determine what is happening outside your body.

Parts of the brain



The brain has three main parts:

- cerebrum
- cerebellum
- medulla or brain stem

Activity 6: Brain parts

What are the three parts of the brain?

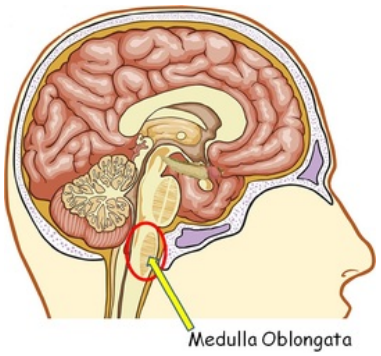
_____

Compare your responses with the ones in the suggested answers section

The medulla

Location: Lower part of the brain stem

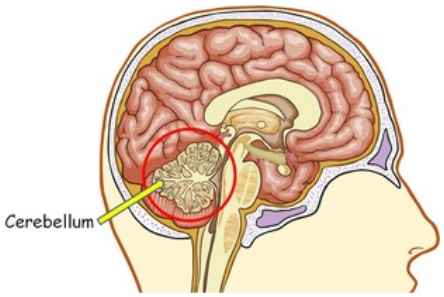
Function: Carries out and regulates life sustaining functions such as breathing, swallowing and heart rate.



These functions are involuntary, or done without thought.

We would not be able to live without the medulla because of the crucial tasks it performs including regulating blood pressure and breathing. As a part of the brain stem, it also helps transfer messages from the brain to the spinal cord.

The cerebellum



Location: Lower area of the brain

Function: Responsible for balance and coordination of muscles and the body

The cerebellum allows us to perform everyday voluntary tasks such as walking and writing. It is also allows us to stay balanced and upright. Patients who have suffered from damaged cerebellums often struggle with keeping their balance and maintaining proper muscle coordination.

Activity 7: The cerebellum

Which of the following activities would be hard to do if a person had an injured cerebellum? *(Circle your choices)*

i) Running in a race or marathon.

ii) Talking and listening to a friend.

iii) Playing baseball in the park.

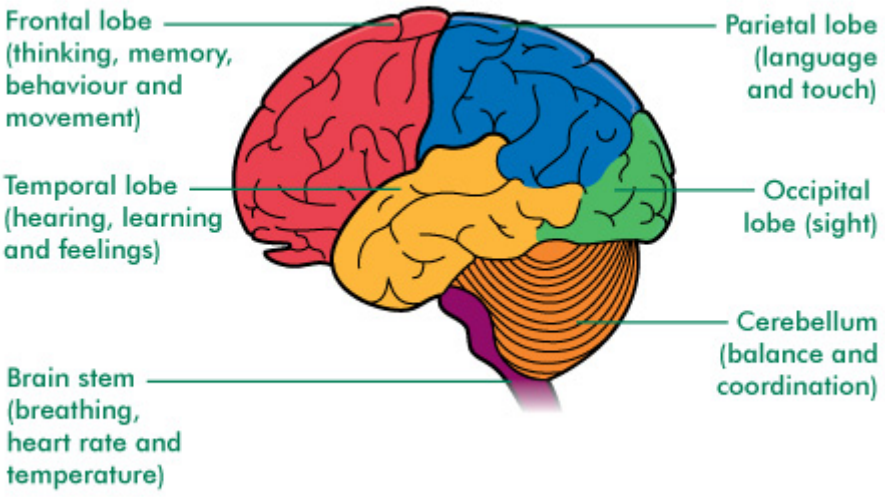
iv) Swimming or diving in a pool.

v) Singing a song out loud.

The cerebrum

The cerebrum is the largest part of the brain. It controls memory, muscle movement, speech, and sensations such as touch and sight. The cerebrum also controls voluntary actions such as walking, running and jumping.

There are different parts of the cerebrum called lobes. The different lobes are responsible for different functions.

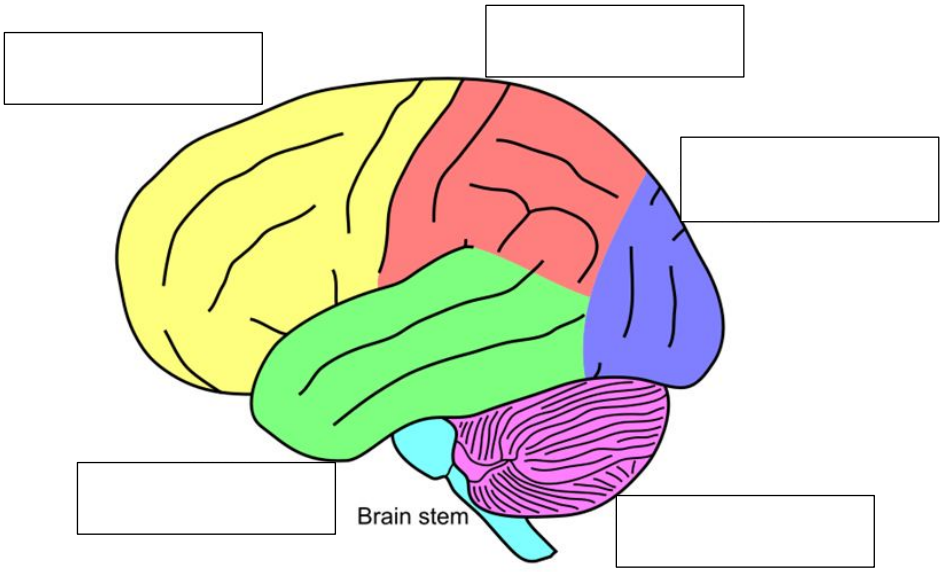


Activity 8: The cerebrum

a) Fill in the following table:

Lobe	What does it control?
Temporal	
Occipital	
Frontal	
Parietal	

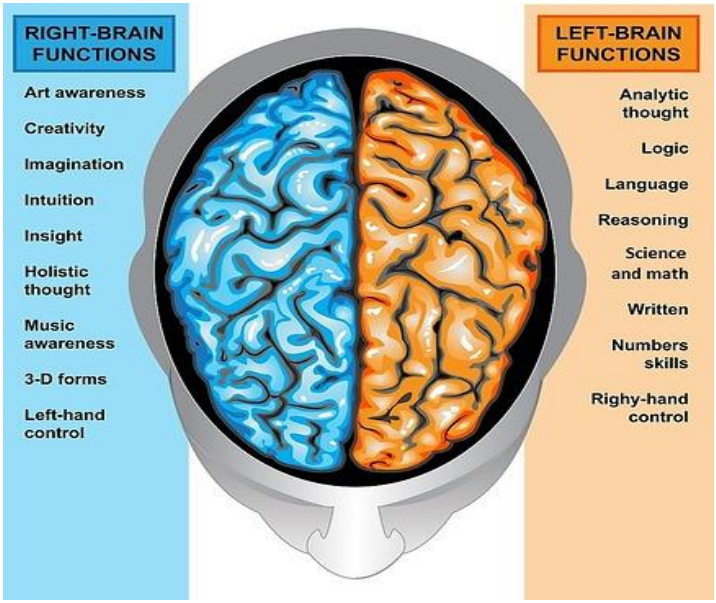
b) Label the following diagram:



Compare your responses with the ones in the suggested answers section

Hemispheres of the brain

If you were to split the brain right down the middle into two equal parts, you would have a right and left hemisphere. Although equal in size, these two sides are not the same, and do not carry out the same functions.



The **left side** of the brain is responsible for controlling the right side of the body. It also performs tasks that have to do with logic, such as in science and mathematics.

The **right side** coordinates the left side of the body, and performs tasks that have do with creativity and the arts.

Activity 9: Left and right hemispheres

Name the hemisphere (left or right) being used in each of the following tasks.

i) Drawing a picture of an imaginary castle. _____

ii) Doing your mathematics homework. _____

iii) Daydreaming when you should be studying. _____

iv) Talking to a friend. _____

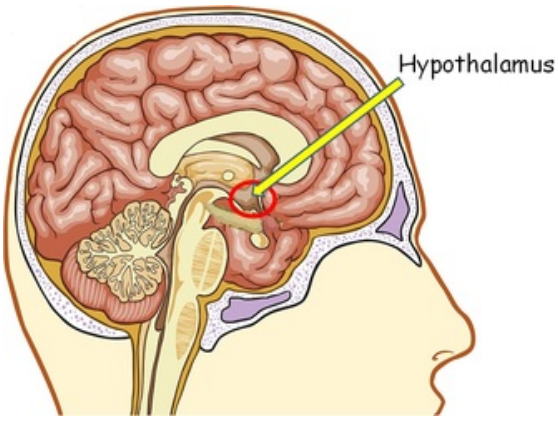
v) Listening to a parent or teacher. _____

Compare your responses with the ones in the suggested answers section

The middle of the brain

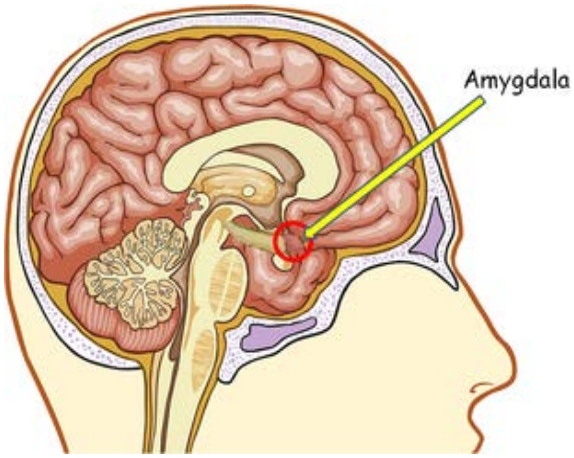
If you were to cut open the brain and look at the top of the brain stem you would see a region separate from the cerebrum. It contains the hypothalamus, pituitary gland, amygdala, hippocampus and pons.

The hypothalamus



The hypothalamus is mainly responsible for motivational behaviour. It is the reason we know when we are hungry or thirsty. The hypothalamus also helps our body maintain a constant temperature. Beneath the hypothalamus lies the pituitary gland. The hypothalamus controls the pituitary gland, which is the master gland that controls all the other endocrine glands in the body. Therefore the hypothalamus plays a key role in connecting the endocrine system with the nervous system.

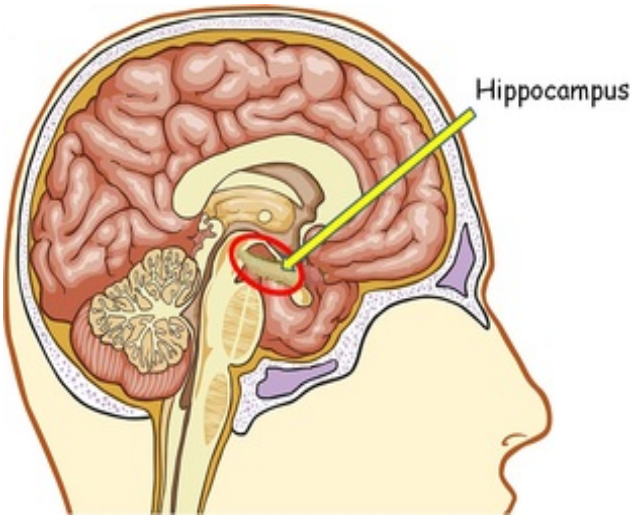
The Amygdala



The amygdala is the reason we are afraid of things outside our control. It also controls the way we react to situations that we see as potentially threatening or dangerous.

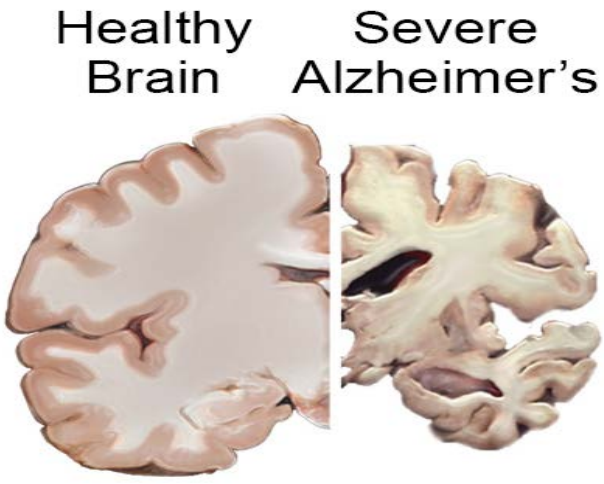
Scientists have removed this part of the brain in rats. After the operation the rats showed no fear or memory of what to fear. They even climbed over cats!

The Hippocampus



It assists with the storage of long term memories and emotions. It is also responsible for the memory of the location of objects or people.

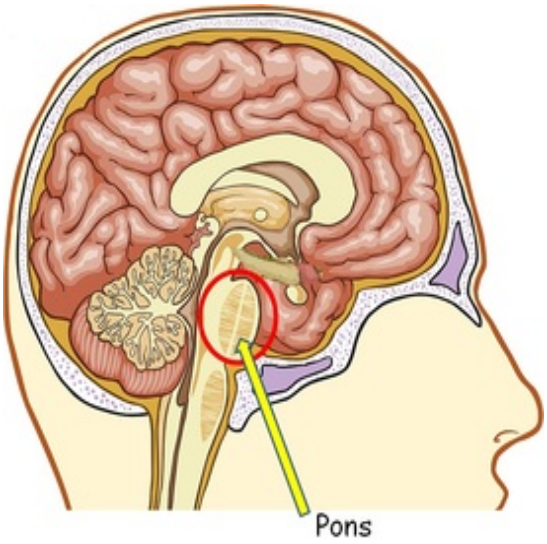
We would not even be able to remember where our house is without the work of the hippocampus!



People with Alzheimer's disease have this area of the brain damaged.

The Pons

The Pons is a message station to relay messages between different parts of the brain and also plays a key role in sleep and dreaming.



Activity 10: The middle brain

Complete the table below showing parts of the middle brain and their function:

Name of part of middle brain	Function
The Amyglada	
	Responsible for long-term memories and emotions including location of objects or people
The Pons	
	Responsible for motivational behaviour and helps to keep the body at a constant temperature

Compare your responses with the ones in the suggested answers section

EXERCISE

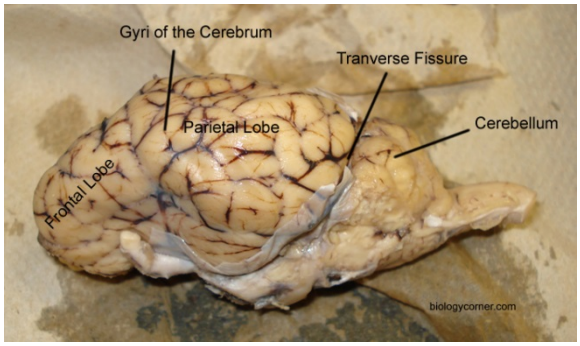
Complete the Send-in exercises for Lesson 3

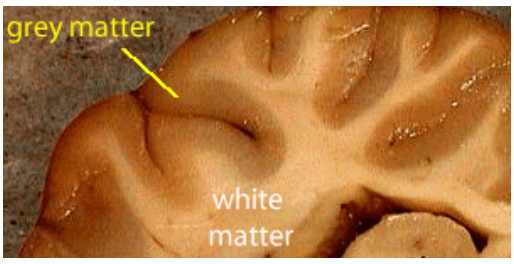
Lesson 4: Dissecting a sheep's brain

A sheep's brain is often used when students complete a dissection of the brain as its structure and functions are similar to a human brain.

Activity 11: Brain dissection

Look at the following pictures and descriptions of a sheep brain dissection.

Step 1		The sheep brain is enclosed in a tough outer covering called the dura mater. This is carefully removed.
Step 2		You can see the lobes of the brain. You are looking down on the top and side of the brain.
Step 3		This is a view from the back of the brain. The student is holding the cerebellum down.

Step 4	 	The brain was cut in two – down the hemispheres. You can see the cerebrum, cerebellum and spinal cord. You can also identify the structures in the middle of the brain as discussed in lesson 3.
Step 5	  	A section of the cerebrum is cut away to see the difference in white and grey matter. The 'grey' matter is the cell bodies of the neurons. The 'white' matter gets its colour from the axons with the myelin sheath. The axons carry the electrical signals from one neuron to the next.

a) What risks would be identified and minimised in this dissection?

Hazard	What is the risk?	How to control risk	Action if the risk occurs
Biological hazard (bacteria, other microorganisms)			
Scalpel and other dissection tools			

b) Your observations: How is the sheep brain similar and different from the pictures of the human brain that you have seen in Lessons 1 to 3?

Similar:

_____

_____

Different:

_____

_____

c) What does a spinal cord look like?

If you want to, you can watch a dissection of a cow's spinal cord by going to the following youtube video:

https://www.youtube.com/watch?v=dLMoP5bTvI8

Compare your responses with the ones in the suggested answers section

EXERCISE

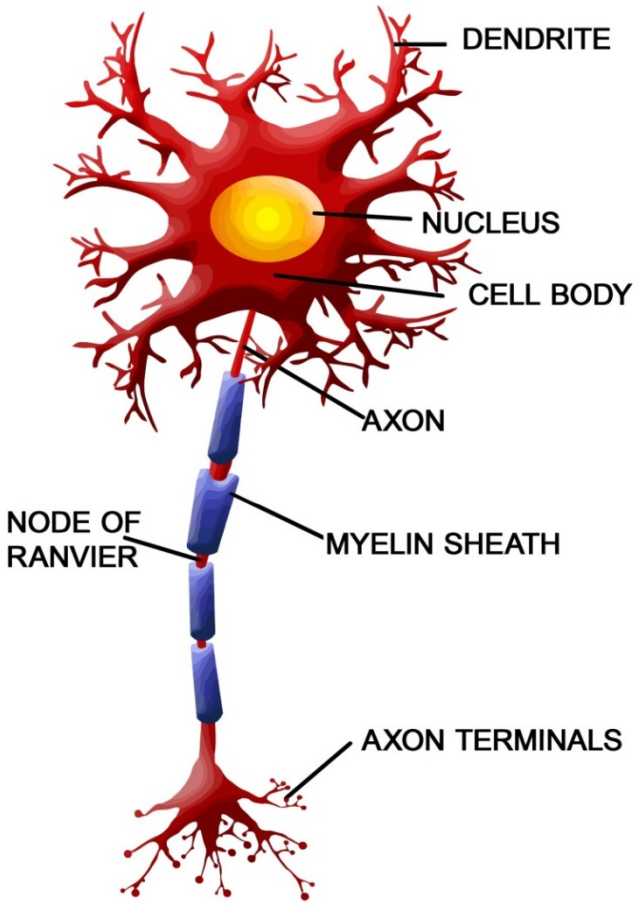
Complete the Send-in exercises for Lesson 4

Lesson 5: Nerves

The basic unit in the nervous system is a nerve cell. A nerve cell is called a **neuron** (*pronounced new-ron*).

A neuron is a specialised cell and is different from every other cell in the human body. Our brain has approximately 100 billion neurons.

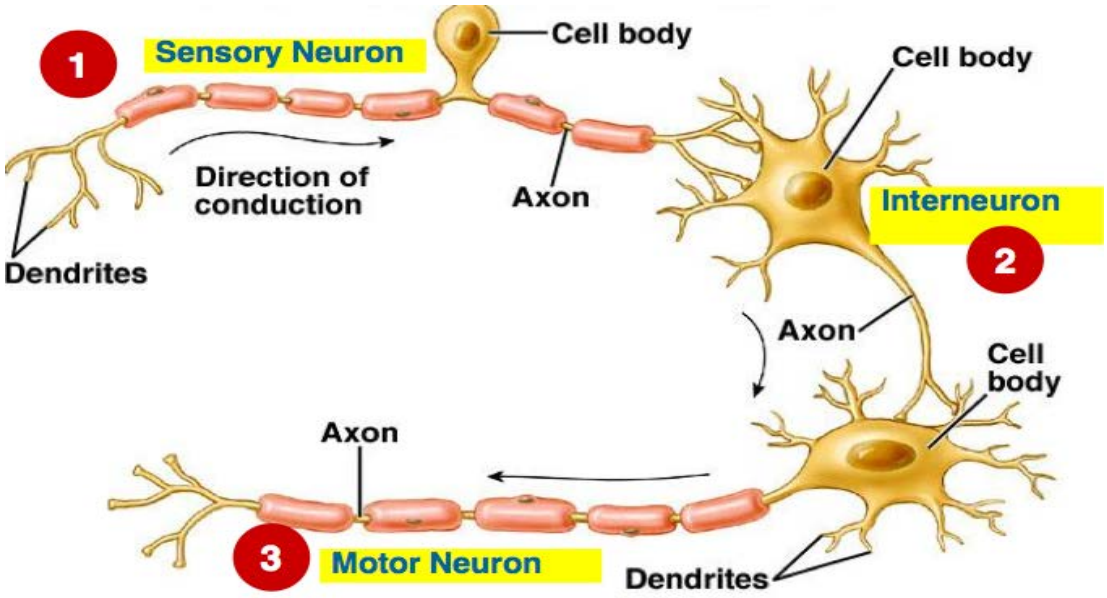
This is a representation of a neuron:



Neurons differ from other cells in the body because they have specialised cell parts called **dendrites** and **axons**. Electrical signals come in via the dendrite and out via the axons to send information to either the next neuron, effector muscle, gland or organ.

Neurons also contain some specialised structures called synapses. Synapses are the junctions between two nerve cells consisting of a minute gap across which impulses pass by diffusion of a neurotransmitter. The axon terminal of a neuron can produce chemicals called neurotransmitters which stimulate the dendrite of the next neuron.

There are 3 types of nerve cells or neurons.



1: Sensory neuron

Sensory neurons pass electrical signals to the spinal cord and brain from the body's receptors. These receptors are attached to one end of the neuron and detect external stimuli like light, pressure or temperature or internal stimuli such as the level of carbon dioxide in the blood or the fullness of your bladder. Did you notice that the nuclei of these neurons are not located within the dendrites?

2: Interneuron

This neuron is found in the spinal cord. It connects the sensory neuron to the motor neuron

3: Motor neuron

The motor neuron receives electrical messages from the interneuron. The electrical signal moves along the motor neuron until it reaches the muscle or gland it is connected to. In the picture did you notice that the nucleus in this neuron is in the dendrite?

Activity 12: Neurons

a) What is a neuron?

_____

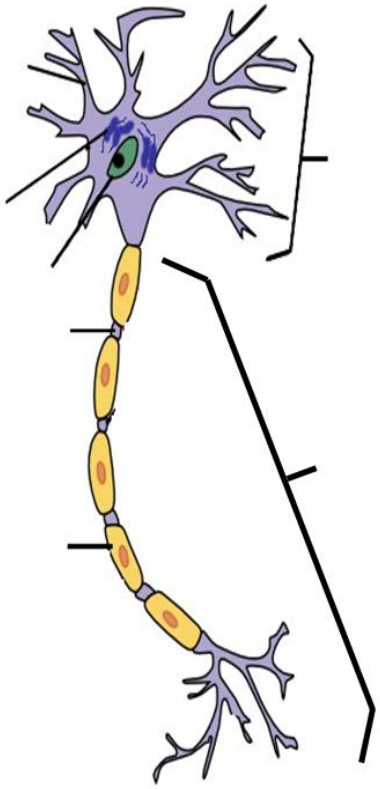
b) Describe the general function of neurons.

_____

_____

_____

c) Label the diagram below of a neuron.



d) What type of neuron is shown in the above diagram?

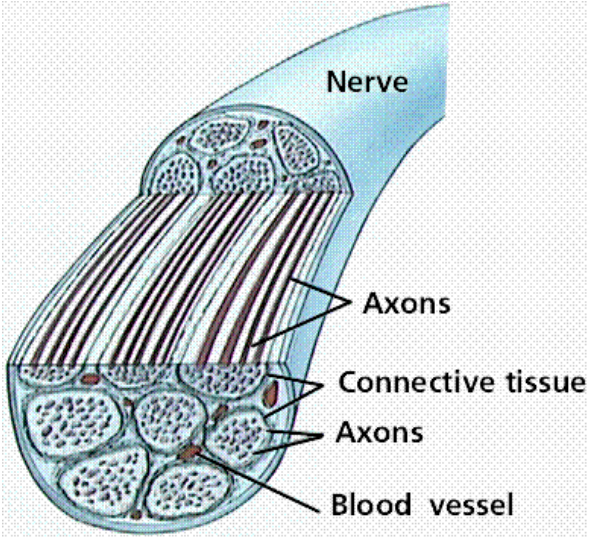
_____

Compare your responses with the ones in the suggested answers section

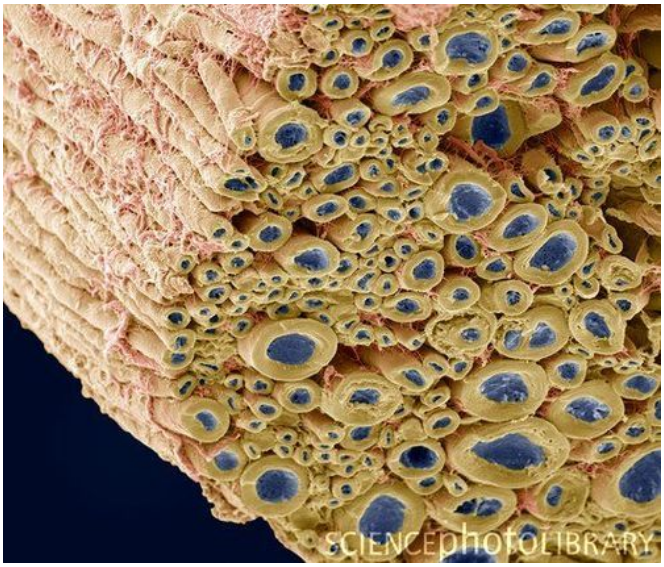
What are nerves?

How are neurons arranged in the body? Axons (the long fibre coming from the dendrite) are bundled together as they go from one part of the body to another. Neurons are bundled together to form the spinal nerve that goes down the spinal cord. We call this bundle of axons from many neurons a **nerve**.

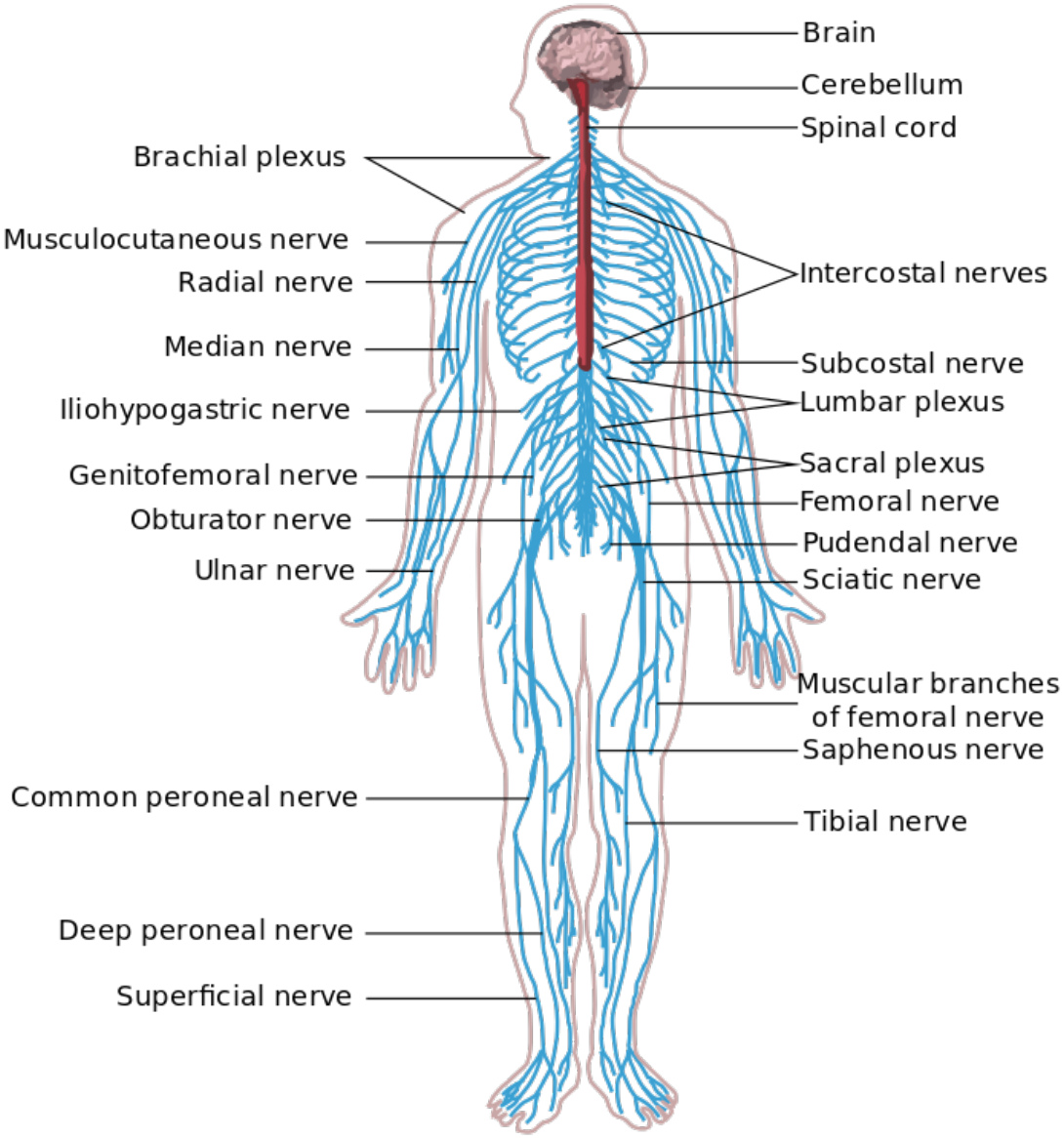
This picture is a representation showing a nerve which has been cut across and the axons bundled together can be seen. This is very similar to telephone or internet cables that are buried underground!



This is a highly magnified image of a nerve using a scanning electron microscope. The axons bundled together are shown in blue. The myelin sheath that surrounds the axon is shown in yellow.



The diagram below shows the position and name of the major nerves of the human body.

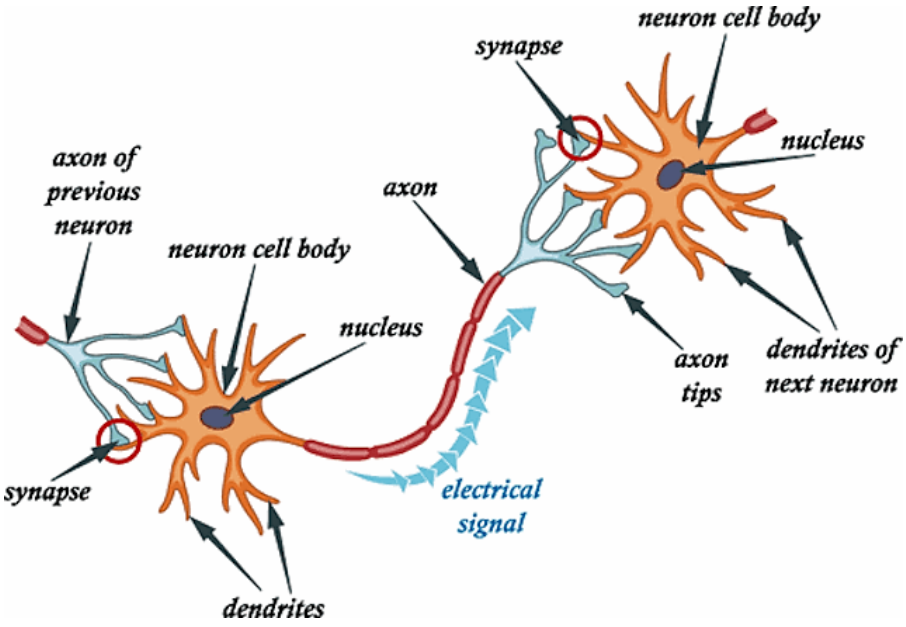


How do nerves pass on a message?

- The electrical signal passes along the axon until it reaches the end of the neuron (this is called a synapse).
- When the electrical signal reaches the synapse at the end of the neuron, chemicals called neurotransmitters are released.
- These chemicals travel to the dendrite of the next neuron.

- The arrival of the chemicals then activates an electrical impulse in the next dendrite which moves forward along this next neuron.
- This happens a few times and then the message reaches its destination.

Can you follow the process in this diagram?



The electrical signal travels from the dendrite (in orange) and moves along the axon (in red). Chemicals are released at the end of the axon (labelled ‘axon tips’ in this picture) and travel across the synapse to the next neuron. The chemicals cause an electrical signal to start in the next dendrite and move along the axon of the next neuron.

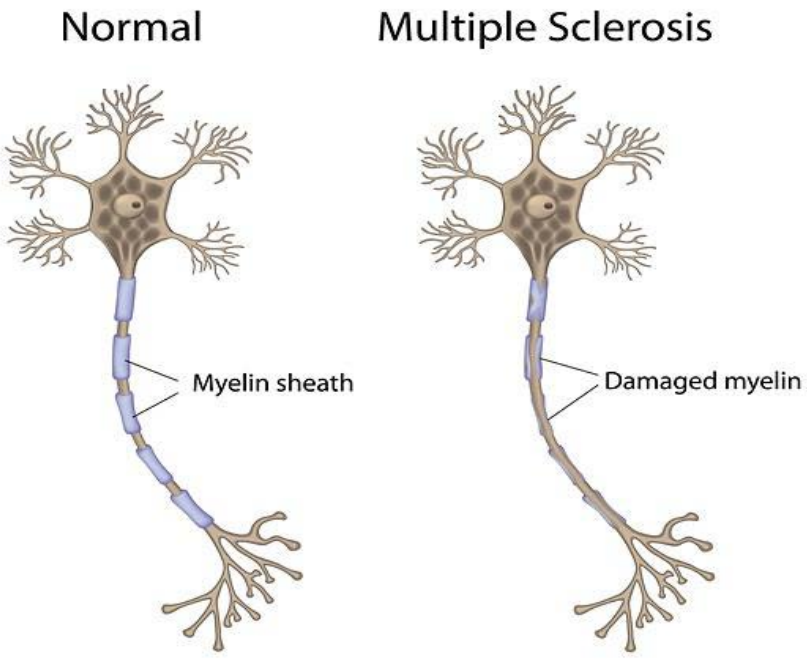
Multiple Sclerosis (MS)

MS is caused by damage to the myelin sheath – the protective covering around the axon. The damage is caused through inflammation when the body’s own immune system attacks the nervous system.

Damage can occur to any nerve in the brain, spinal cord or optic nerve. It can then affect many parts of the body. If MS occurs in nerves that lead

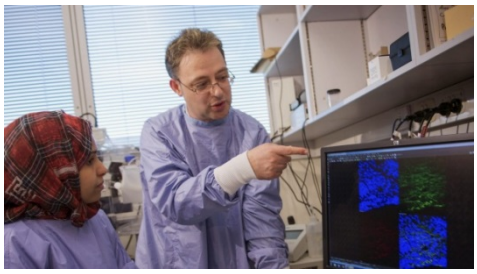
to muscles then symptoms may include a loss of balance, muscle spasms or problems walking and moving limbs.

The diagram below shows the deterioration of the myelin sheath in MS sufferers.



The electrical impulse will be distorted or weakened when it travels along an axon with no proper myelin sheath. Messages would not be sent reliably or even reach some parts of the body. The nervous system would not able to detect changes and control the body.

MS research



Steven Petratos (shown in the picture) is a Neurobiologist. He researches MS. His grandfather had the disease and Steven says that is one of the reasons he wanted to study the disease. His research team are investigating the effect of stem cell therapies on the disease.

Activity 13: Parts of the neuron

Match the word on the left to its correct description on the right by drawing a line.

neuron	Electrical signal starts here and goes to the axon.
dendrite	The covering around an axon. This is degraded in MS.
axon	A type of neuron connected to a muscle.
nerve	A nerve cell
sensory neuron	A long thin fibre that extends from a dendrite.
myelin sheath	Neuron that relays information from sensory receptors to the central nervous system.
motor neuron	Bundles of axons.
electrical signals	Messages are passed along as _____.

Compare your responses with the ones in the suggested answers section

EXERCISE

Complete the Send-in exercises for Lesson 5

Send-in exercises:
Response and coordination Part 2

Lesson 1: The nervous system

What is the nervous system? Use these words to describe the action and parts of the nervous system:

peripheral	central	nerves	brain	spinal cord
detect	response	stimulus		

_____

_____

_____

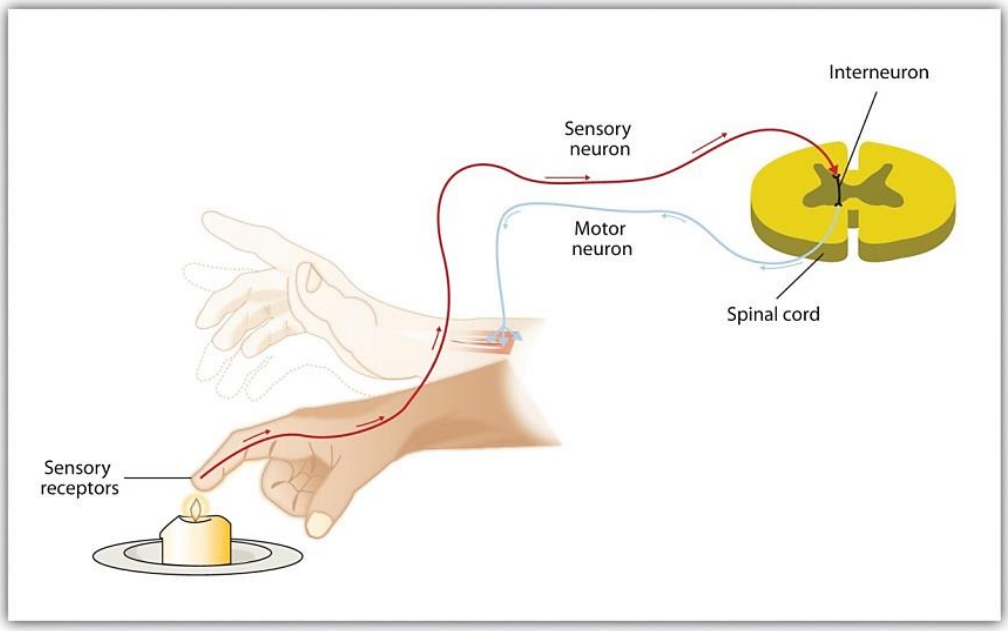
_____

_____

_____

_____

Lesson 2: Responses



1. Use what you have learnt in Lesson 2 to describe what is happening in the picture above.

_____

_____

_____

_____

2. Explain the difference between voluntary and involuntary actions using examples.

_____

_____

_____

3. Why is it important for our bodies to have involuntary and voluntary actions?

_____

_____

_____

Lesson 3: The brain

1. *"The brain is the control centre of the body"*

Explain why this statement is true using what you have learnt in Lesson 3.

_____

_____

_____

_____

_____

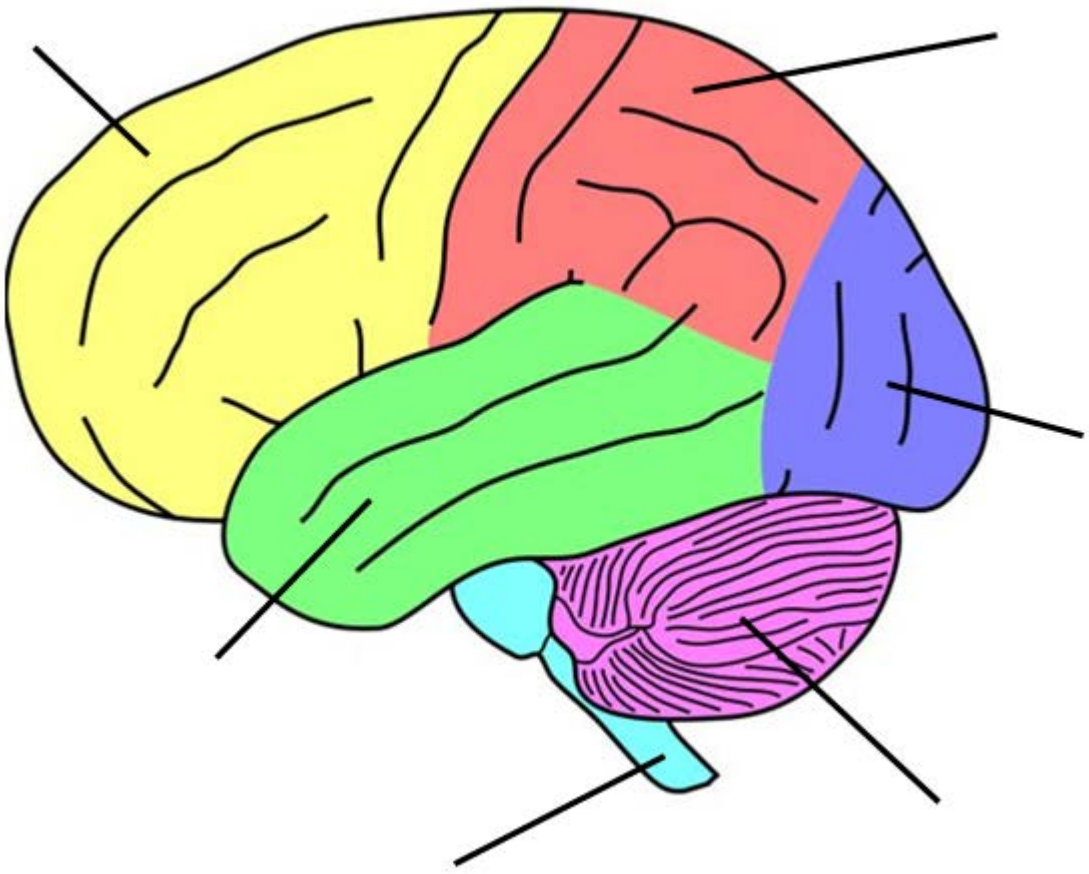
_____

_____

_____

_____

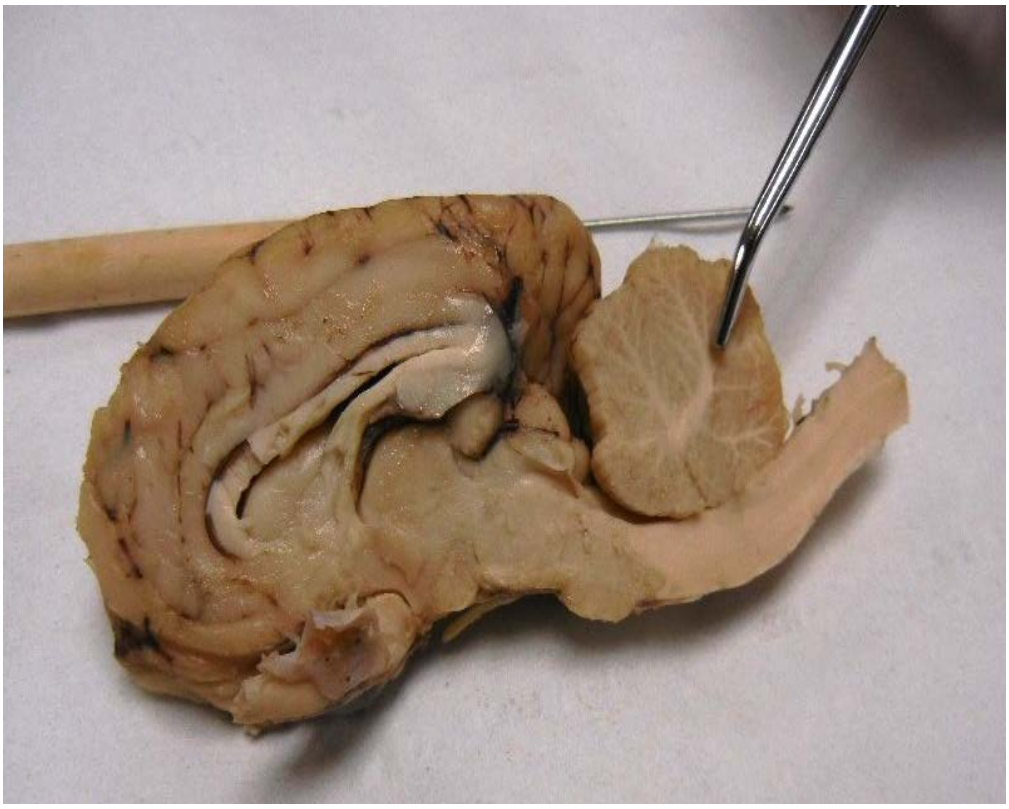
2. Label the parts of the brain



Lesson 4: Dissecting a sheep's brain

1. Use the following words to label the picture of a dissected sheep brain.

cerebrum	cerebellum	spinal cord
white matter		grey matter



2. What is the difference between white and grey matter in the cerebrum?

_____

_____

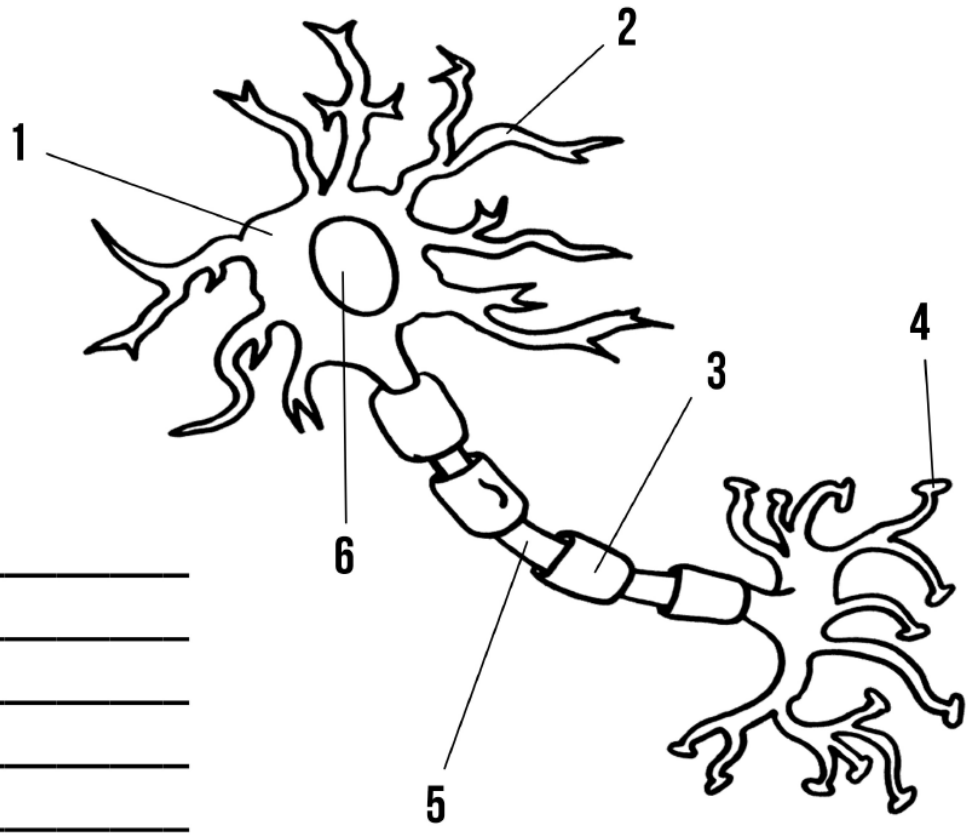
_____

_____

Lesson 5: Nerves

1. Label the diagram of a nerve cell using the following words

cell body	axon terminal	nucleus
axon	dendrite	myelin sheath



1._____
2._____
3._____
4._____
5._____
6._____

2. Why do some MS sufferers have problems moving their legs?

_____
_____
_____
_____
_____
_____
_____

Send-in exercises:
Response and coordination Part 1

Lesson 1: Body systems

a) List four different tissues that make up the stomach.

_____

b) How are organs different from body systems?

_____

_____

c) Match the body system with its main function by drawing a line to the matching dot point.

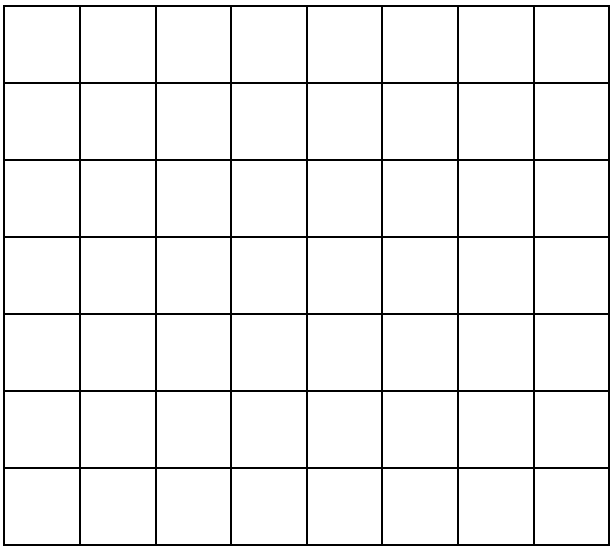
Body system	Function
Nervous system	• Makes sperm and egg needed to create a new human
Lymphatic system	• Controls body processes such as growth and energy production via hormones
Reproductive system	• Strong and flexible framework of bones and connective tissue
Excretory system	• Body's main control system
Respiratory system	• Make urine and expel it from the body
Endocrine system	• Contains a network of vessels that collect fluid from tissues; fights infection
Skeletal system	• Breaks down food into nutrients that can be absorbed by the blood
Muscular system	• Puts oxygen into the blood and removes carbon dioxide waste
Circulatory system	• Consists of layers of muscles that cover the bones of the skeleton
Digestive system	• Carries blood that supplies oxygen and nutrients to the cells

Lesson 2: Heat activity

a) Draw a line graph of temperature against time for the data you collected after you finished exercising.

Give your graph a heading, number and label the axes including units, plot the points and draw a line.

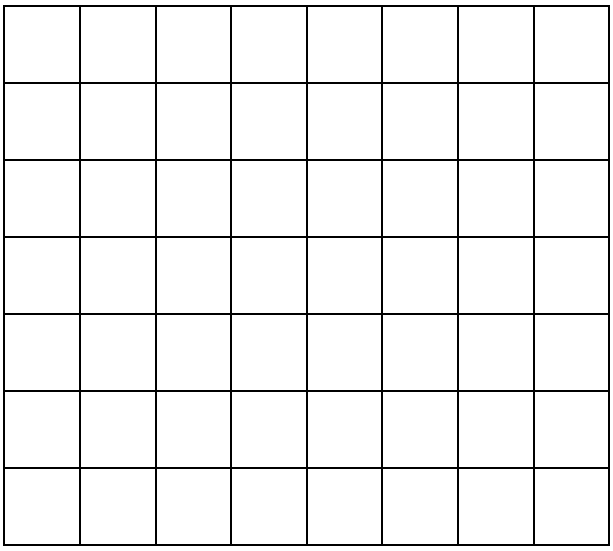
Heading: _____



Time (min)

b) Draw a line graph of your pulse rate against time.

Heading: _____



c) Draw a line graph of your breathing rate against time.

Heading: _____

d) Using your results, describe what happens to your body immediately after completing exercise?

_____

_____

_____

_____

e) (i) Compare the results with the resting temperature, resting pulse and resting breathing rates.

_____

_____

_____

(ii) Suggest why the temperature did not vary as much as the pulse and breathing rate.

_____

_____

Lesson 3: Body balance (heat)

Your body responds to changes. List three things that occur to change the temperature back to normal in each picture.

Lesson 5: Coordination systems

a) Describe the action of the nervous and endocrine system in coordinating the body's response to an increase in temperature.

_____

_____

_____

_____

_____

_____

b) What would our body do if it detects there is too much water in the blood? Infer the stimulus-response and negative feedback that would occur.

_____

_____

_____

_____

_____

_____

_____

Science
Stage 5
Response and coordination
Part 3

Scanning Electron Microscope image of blood vessels of the pituitary gland

Acknowledgments

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Whalley, K et al *Science Focus 3* 2nd Edition Pearson Australia Victoria 2009
http://kidshealth.org/teen/your_body/body_basics/endocrine.html
Stannard P & Williamson K *Science World 9* Macmillan Victoria 2001
Calcium regulation & Parathyroid
gland http://science.kennesaw.edu/~jdirnber/Bio2108/Lecture/LecPhysio/PhysioNervous.html
Pituitary gland Activity 3.2 http://www.discoverreflexology.ca/the-pituitary-gland-why-does-it-hurt/
Problems with pituitary gland http://www.slideshare.net/promotemedical/disorders-of-pituitary-gland-7815739
Diabetes treatment http://kidshealth.org/parent/medical/endocrine/treating_type1.html#
Four-year-old girl makes history in world-first attempt to prevent type 1
diabetes http://www.smh.com.au/nsw/fouryearold-girl-makes-history-in-worldfirst-attempt-to-prevent-type-1-diabetes-20150527-ghaw0o.html

BOSTES NSW Science K-10 Syllabus 2013

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Contents

Outcomes

By completing this unit, you are working towards achieving the following outcomes:

- analyses interactions between components and processes within biological systems
- explains how biological understanding has advanced through scientific discoveries, technological developments and the needs of society
- produces a plan to investigate identified questions, hypotheses or problems, individually and collaboratively
- student processes, analyses and evaluates data from first-hand investigations and secondary sources to develop evidence-based arguments and conclusions
- presents science ideas and evidence for a particular purpose and to a specific audience, using appropriate scientific language, conventions and representations

(Outcomes taken from the Board of Studies NSW Syllabus for the Australian Curriculum SCIENCE Years 7 - 10, 2013)

Content Statements:

1VA, 3VA, LW1, WS5.3, WS7.1, WS9

Resources

You will be sent a mini kit to use with this topic. You will also need to collect these items from home:

Part 1:

Jacket or heavy jumper
Methylated spirits or rubbing alcohol

Part 2:

No further items required

MINI-KIT ITEMS

Please note that the mini-kit we have sent you contains the following items:

- **thermometer**

Part 3:

No further items required

Icons

Here is an explanation of the icons used in this unit

Write a response.

Compare your response with the one in the suggested answers section. Give yourself a tick if you were correct. Make any corrections.

Complete the Send-in exercises corresponding to the lesson.

Perform a practical task or investigation.

Glossary

The following words, listed here with their meanings, are found in the learning material in this part.

endocrine glands	glands found in various places in the body which produce hormones and release them directly into the blood
fight-or-flight response	a short-term stress response that ensures increased amounts of glucose and oxygen are available to muscle cells for cellular respiration, which results in increased available energy for use by muscles
hormones	chemicals released into bloodstream to affect specific cells to control important processes of a living thing such as growth
negative feedback system	a system of control in the body in which the response acts as a stimulus to oppose the change caused by the original stimulus
pituitary gland	gland in the brain which controls a lot of the other glands

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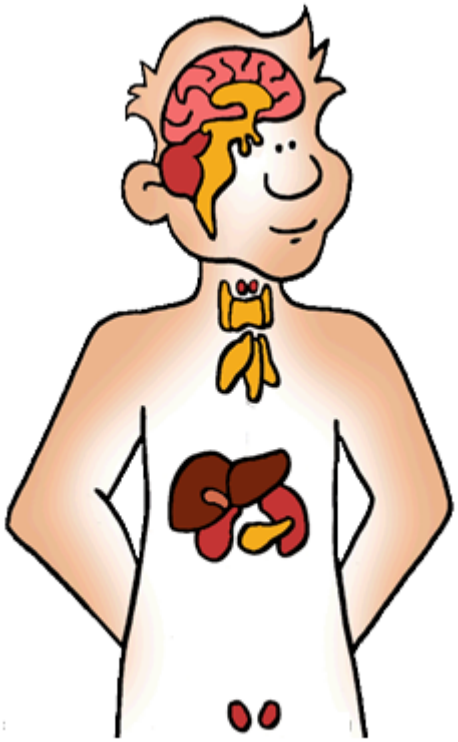
Lesson 1: The endocrine system

In Part 1 you learnt about the responses and coordinated efforts of the body to maintain a constant internal environment. You also learnt that the nervous and endocrine system coordinate these responses and control all body systems in the body.

This week you will be focusing on the endocrine system.

What is the endocrine system?



The endocrine system is a system of glands which excrete hormones. The hormones which usually travel in the blood stream cause a response in another part of the body. There are many different hormones that travel through the bloodstream at the one time, but each type of hormone is designed to affect only certain cells.

What does the endocrine system do?

The endocrine system influences almost every cell and organ in our bodies. It regulates our mood, growth and development, metabolism, reproductive processes and cell growth.

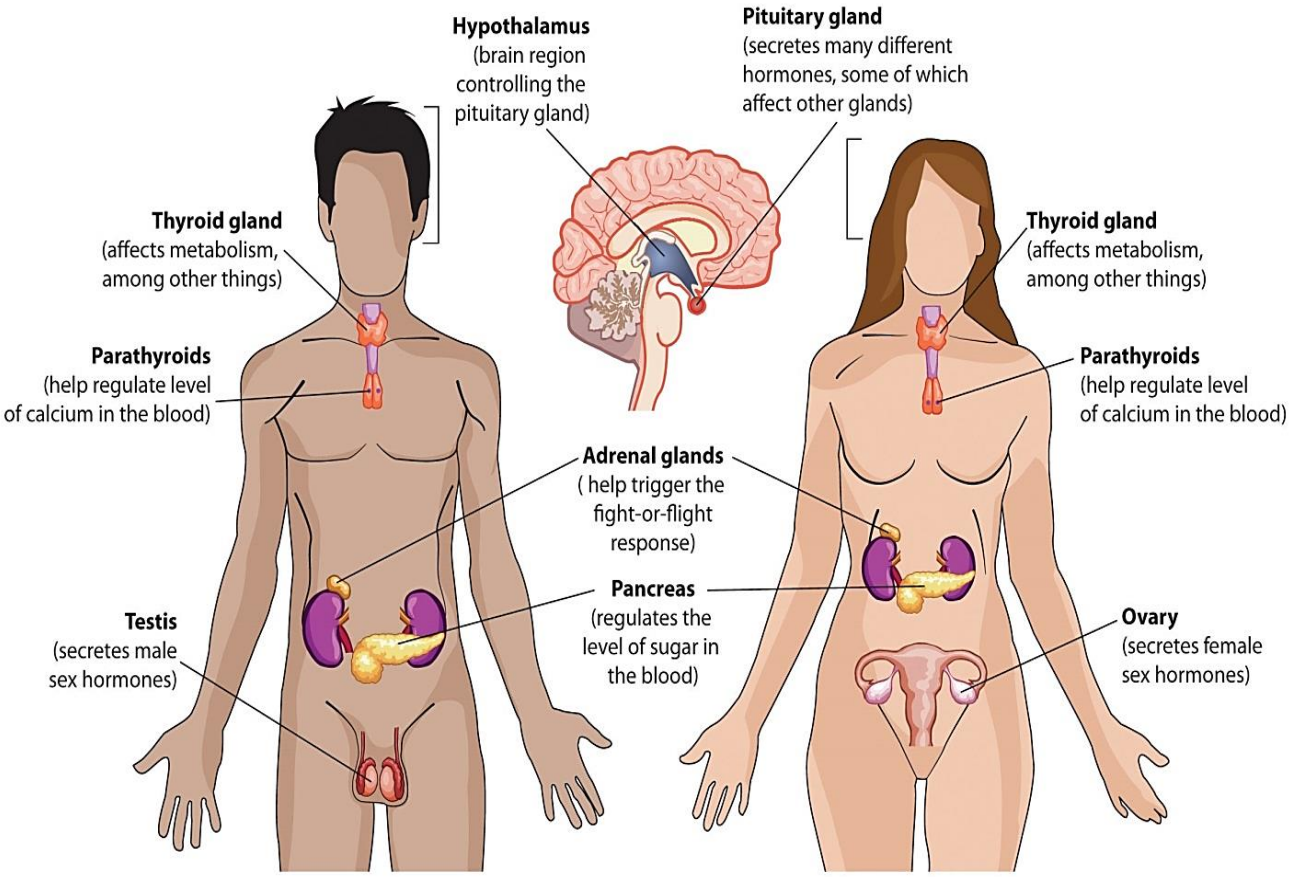
In general, the endocrine system is in charge of body processes that happen slowly. Faster processes like breathing and body movement are controlled by the nervous system.

Remember that even though the nervous and endocrine systems are separate systems they often work together to help the body function properly.

Glands

Hormones are chemicals which are made in endocrine glands. These glands are different from other glands in the body, like sweat glands, as the chemical produced by the endocrine glands are released directly into the bloodstream.

This picture shows the different glands in the endocrine system.



Activity 1: Endocrine glands

a) What is the endocrine system?

_____

_____

b) What are hormones?

_____

_____

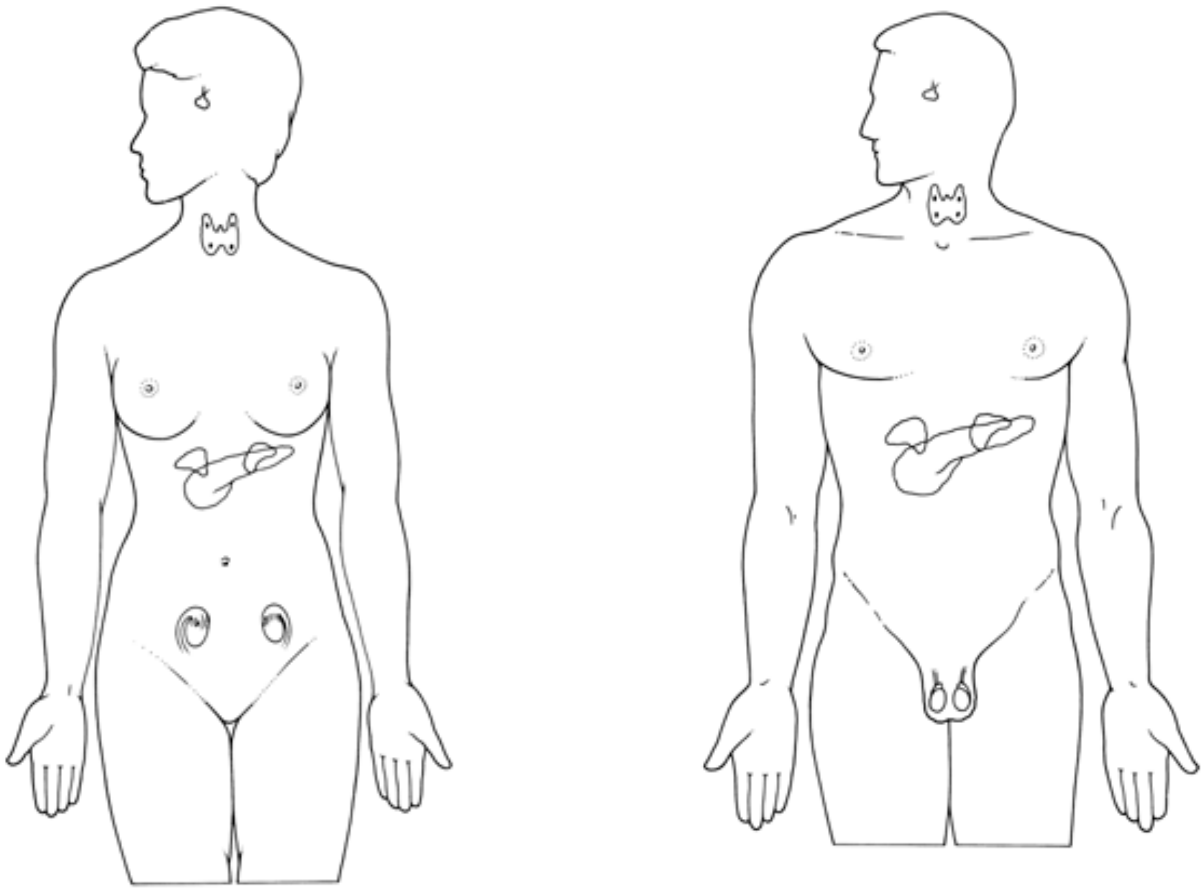
c) Fill in the following table using the information in the diagram.

Glands in the endocrine system		
Gland	Located near…..	What does it control?

Compare your responses with the ones in the suggested answers section

Activity 2: Location of endocrine glands

Label the glands of the endocrine system in the diagram below.



Compare your responses with the ones in the suggested answers section

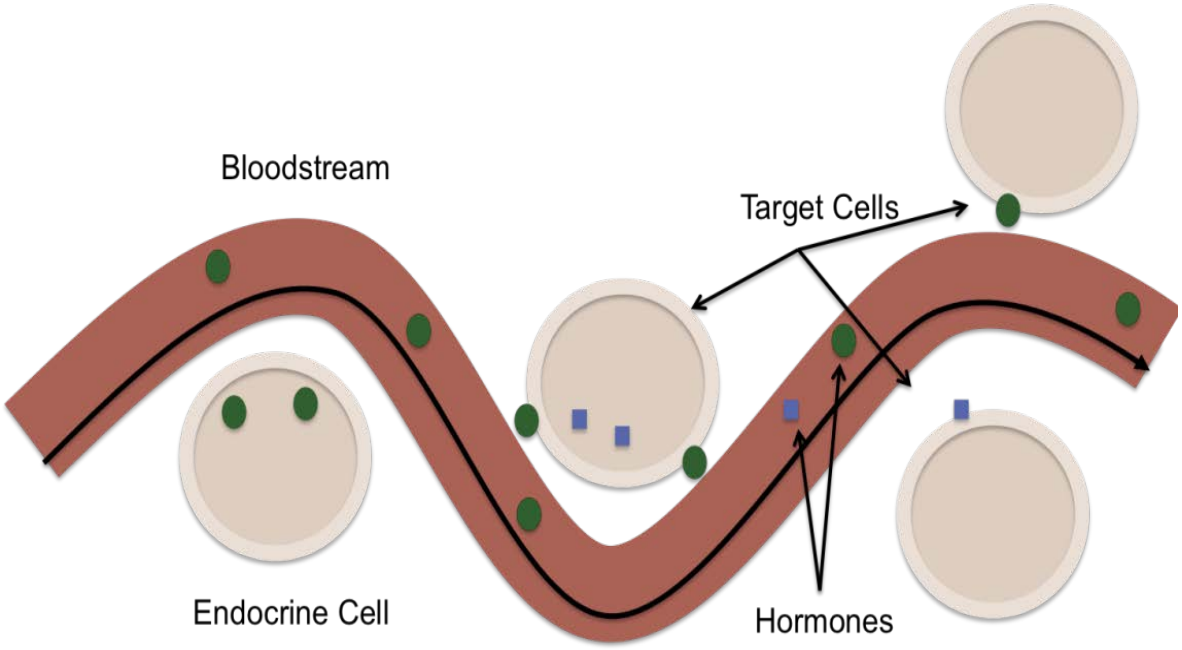
EXERCISE

Complete the Send-in exercises for Lesson 1

Lesson 2: Hormones cause responses

Secreted hormones

Once a hormone is secreted from an endocrine gland it travels through the bloodstream to the cells designed to receive its message. These cells are called target cells.

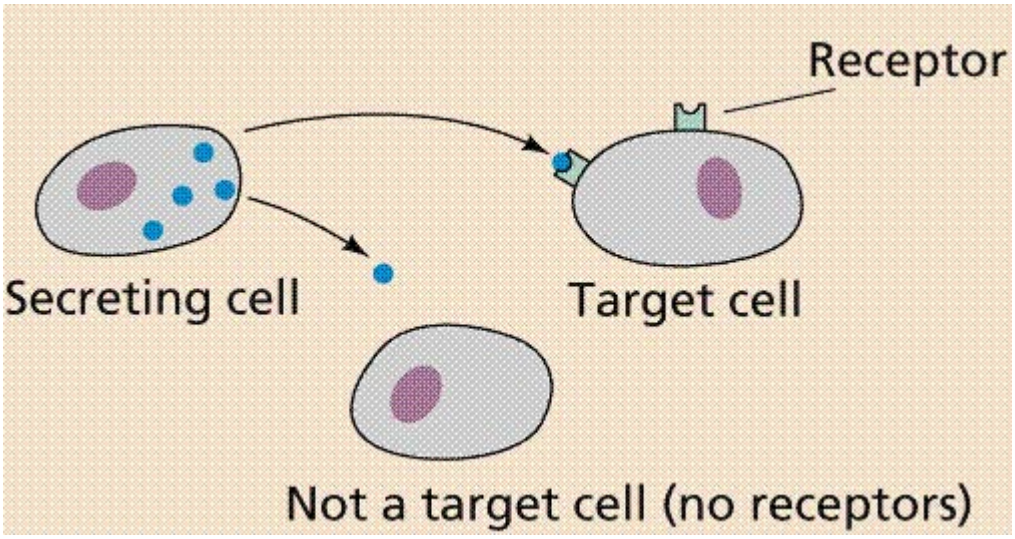


As the hormone travels through the bloodstream special proteins bind to some of the hormones. These proteins act as carriers that control the amount of hormone that is available for the cells to use.

At the target cell

The target cells have receptors that latch on to only specific hormones. This means only a specific hormone will communicate and cause a response with a specific cell. Once the hormone reaches its specific cell it transmits specific chemical instructions to the inner parts of the cell. This specific action of hormones and target cells ensures that hormones can tightly control the actions of cells throughout the body.

The diagram below shows that the blue coloured hormone only affects a cell with the specific receptors for that hormone. Not every cell will be affected when hormones are released by a gland.



Activity 3: Target cells

a) How does a secreted hormone travel to a target cell?

_____

_____

b) Why does a hormone not affect all cells when it is released?

_____

_____

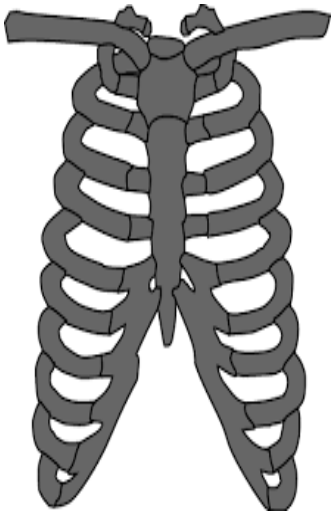
_____

Compare your responses with the ones in the suggested answers section

Negative feedback systems

The endocrine system also monitors the amount of hormone released. This is important if the effect of the hormone in the body is to be maintained and the body's internal environment kept constant.

The amount of calcium in your blood



Calcium is a mineral that is used in our nervous system, muscles, heart and bones. It is important for overall health as it is used in almost every cell.

Our bodies store calcium in bones and absorb calcium from food. Our bodies like to keep the amount of calcium in our blood at a certain level.

If your body detects that you have a **lowered** amount of calcium in your blood the following will occur:

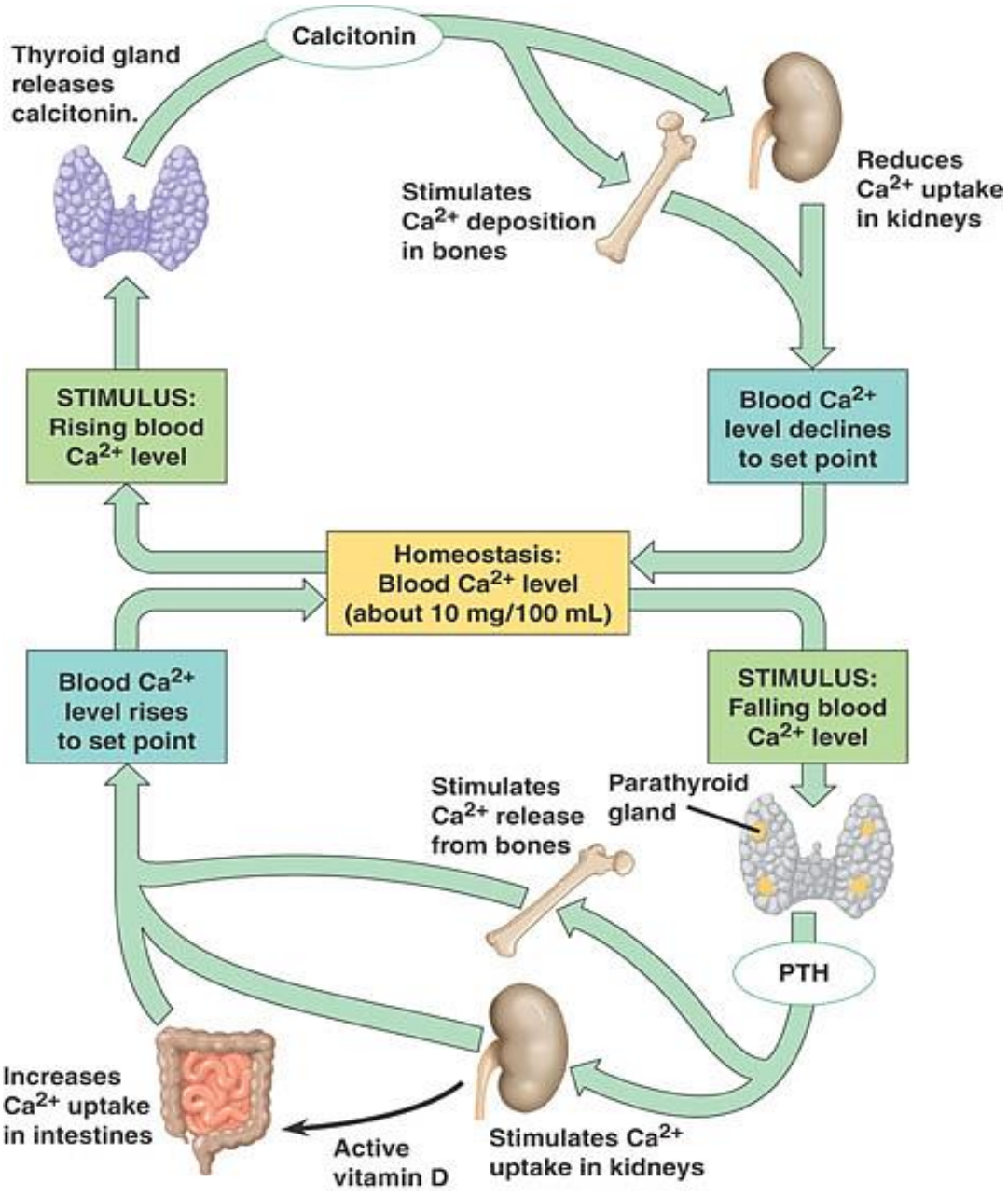
- The parathyroid hormone increases the level of calcium in the blood.
- When the level of calcium in the blood increases, the parathyroid glands sense the change and reduce their secretion of the hormone.

This reduction, after receiving feedback, is called a negative feedback system.

In addition, another gland releases a hormone called calcitonin to act on the body to drop the level of calcium in the blood.

Activity 4: Calcium levels in the blood

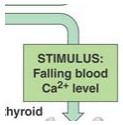
Look at the diagram below:



a) What is the normal concentration of calcium in the blood?

_____

b) What does your body do when calcium (Ca^{2+}) levels in the blood fall?

Hint: Look for this in the diagram: 

]

The _____ gland releases a hormone called _____.

PTH stimulates _____ uptake in the kidneys, _____ calcium uptake in the intestines and stimulates calcium release from the _____.

This causes the blood calcium level to _____ to a set point.

c) What does the body do when the level of calcium in the blood rises?

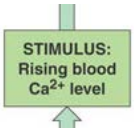
Hint: Look for this in the 

diagram:

The _____ gland releases a hormone called _____.

This causes the kidneys to _____ calcium uptake and stimulates _____ deposition in the bones.

This causes the blood calcium level to _____ to a set point.

Compare your responses with the ones in the suggested answers section

When nerves and hormones are involved

Do you remember learning about involuntary actions of the nervous system in Part 2? Many things like breathing are under the control of the nervous system but we are not conscious that these processes are occurring all the time.

One such involuntary action is the **'flight-or-fight'** response. These responses prepare your body for immediate action.

What is happening in your body when faced with this?

What happens when you suddenly come across a spider?

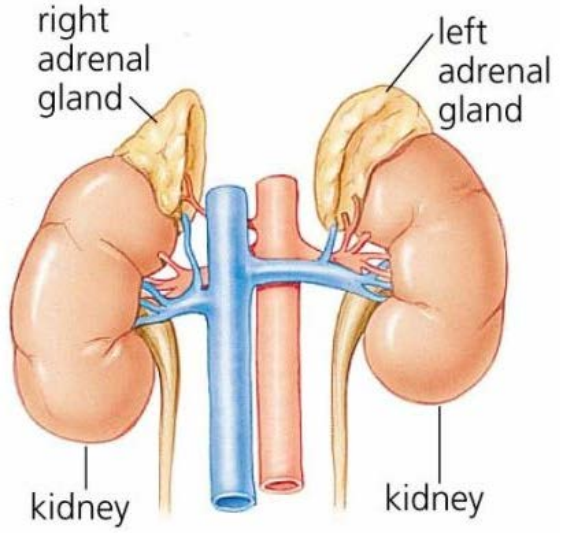
Do you jump or move away, scream or shout, and suddenly feel wide awake?

Normally your body also responds by opening your eyes wide, making you put your hands up and speeding up your heart rate.

A hormone called **epinephrine** (also called **adrenaline**) is released into the body to prepare it for fight-or-flight.

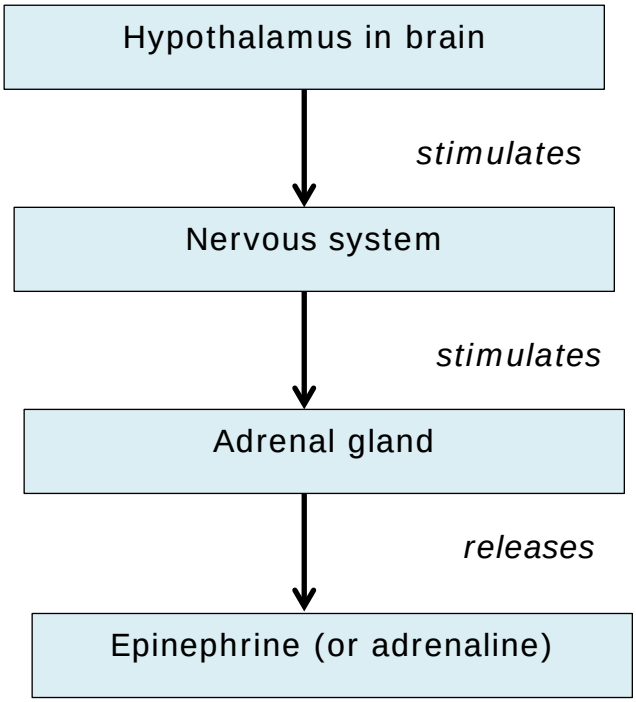
How adrenaline is released

Adrenaline is released in response to stressful events to prepare the body for the 'fight or flight' response. A message is sent along the nerves until it reaches the adrenal glands which sit on top of the kidneys.



The nerve message to the adrenal glands triggers the secretion of adrenaline into the bloodstream. This process happens relatively quickly, within 2 to 3 minutes of the stressful event being encountered. When the stressful situation ends, the nerve impulses to the adrenal glands are lowered, meaning that the adrenal glands stop producing adrenaline.

This flow chart shows how adrenaline is released:



The adrenal glands are also activated by a hormone released by the pituitary gland.

What does epinephrine (or adrenaline) do?

Epinephrine is an efficient messenger that signals many cell types throughout the body with many effects.

- In the lungs, epinephrine binds to receptors on muscle cells causing the muscles to relax to allow more oxygen into the blood.
- In the heart, epinephrine stimulates pace maker cells to beat faster. This increases the rate at which other chemical signals, glucose and oxygen are circulated to the cells that need them.
- Epinephrine also contracts specific types of muscle cells below the surface of the skin, causing beads of perspiration and raised hairs at the surface.

Activity 5: Adrenaline

a) Describe how the hormone adrenaline is released?

_____

_____

_____

b) Why is this hormone released?

_____

_____

_____

_____

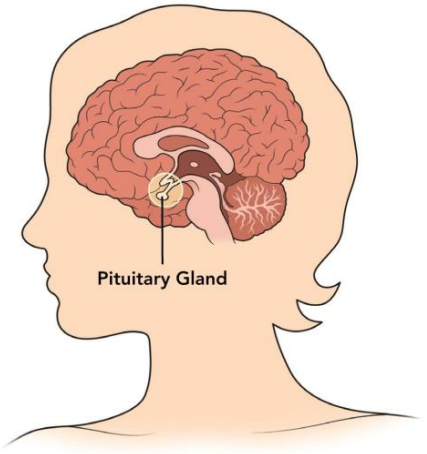
Compare your responses with the ones in the suggested answers section

EXERCISE

Complete the Send-in exercises for Lesson 2

Lesson 3: The master gland

The pituitary gland



The pituitary gland is the master gland in your body. It controls other endocrine glands. It is located in the brain.

The pituitary gland releases a number of hormones that stimulate other endocrine glands.

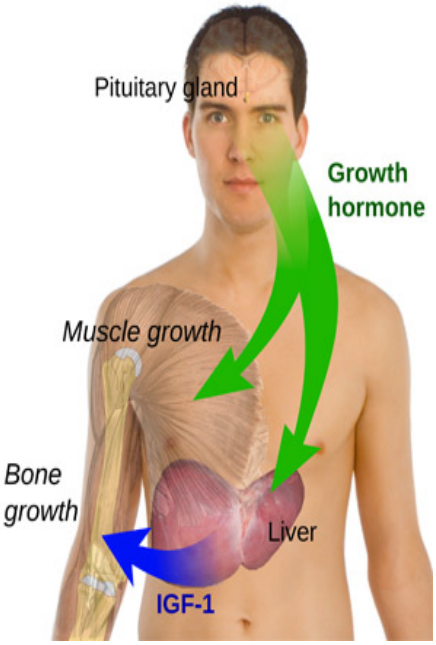
For example – the release of the hormone from the thyroid gland in your neck is controlled by a thyroid stimulating hormone from the pituitary.

Growth and development

The pituitary gland also releases hormones which affect the reproductive organs.

The pituitary gland acts in the following way:

- *Before puberty*: The main physical growth of a person is under the control of the pituitary gland which releases growth hormone. The growth hormone acts on bone and muscle cells and stimulates the body to make proteins and increase cell division.



This picture shows the release of growth hormone from the pituitary gland. The growth hormone acts on target cells in the liver which release another hormone called IGF-1. This hormone then causes bones to grow longer in 10 to 15 year olds.

- *Between 10 to 15 years after birth*: The pituitary gland begins to release hormones which affect the reproductive organs. Major changes occur in the body due to the onset of puberty.

  - In males, the pituitary gland releases a hormone which then causes the testes to make sperm. Another hormone is released by the pituitary which acts on the testes to make a hormone called testosterone. Testosterone stimulates the growth of facial and body hair and is responsible for rapid muscular growth.

  - In females, one pituitary hormone leads to egg production in the ovaries and also the production of oestrogen. Oestrogen causes body hair to grow, the growth of fat cells under the skin and the development of breasts. Another hormone released by the pituitary gland acts on the ovaries and is responsible for the start of the menstrual cycle.

Activity 6: Pituitary gland

a) Why is the pituitary gland important?

_____

_____

b) What changes do hormones released from the pituitary gland make as children develop into adolescents?

_____

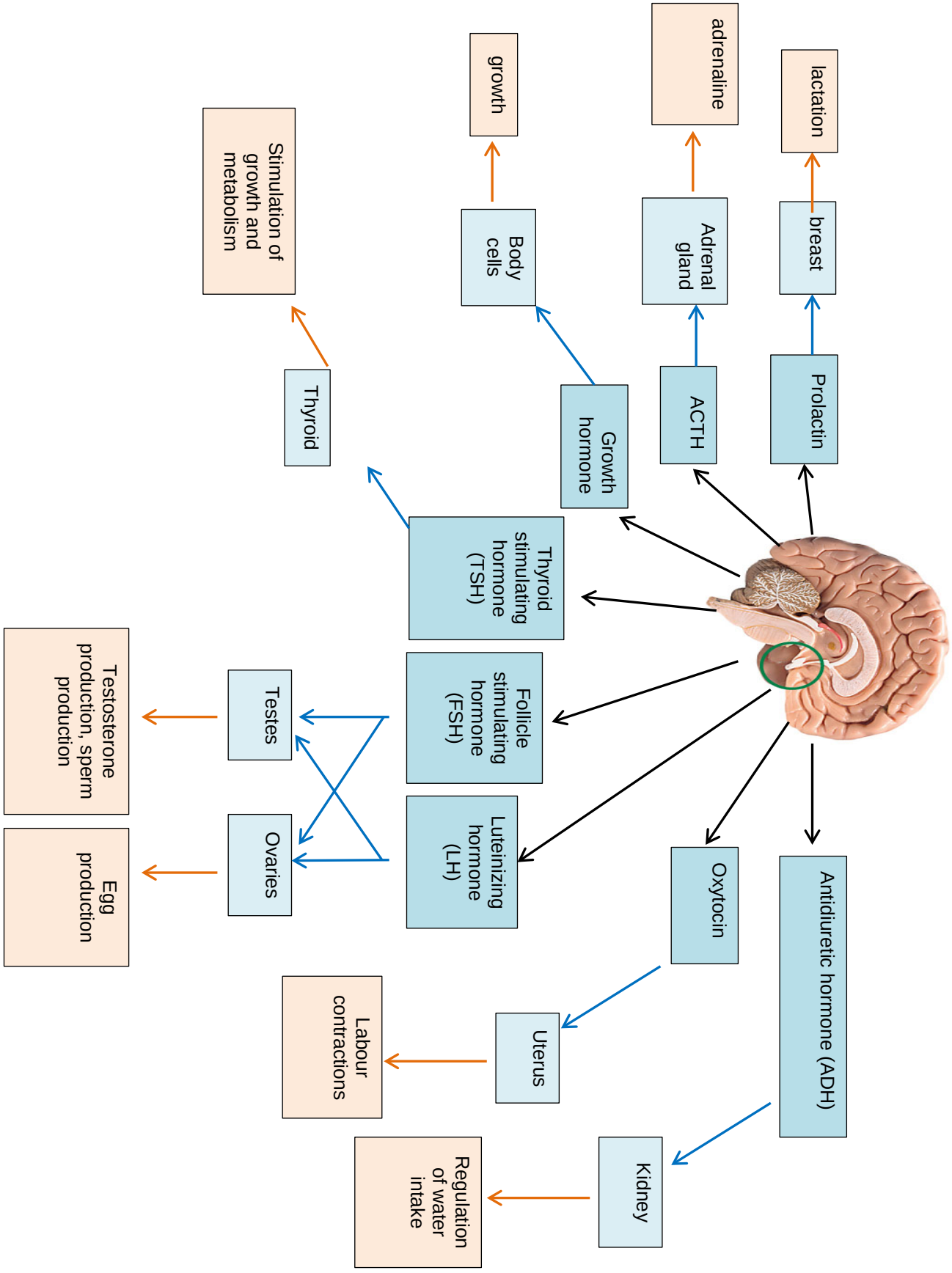
_____

_____

_____

Compare your responses with the ones in the suggested answers section

Figure: The effects of hormones released by the pituitary gland



Activity 7: Pituitary gland summary table

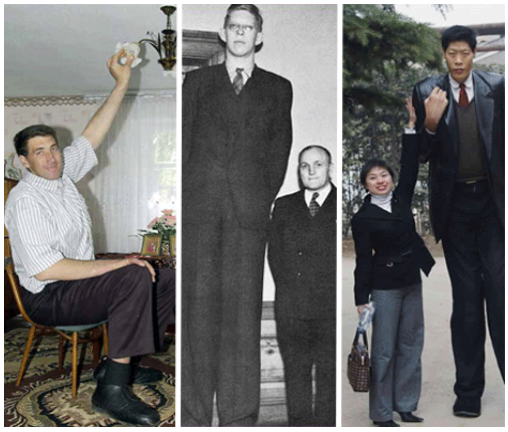
From the previous diagram, you can see the pituitary gland is a master gland. Summarise the actions of the hormones released from the pituitary gland in this table.

Hormone released by the pituitary gland	The target cells	What happens?
• prolactin	Milk producing cells in breast	Lactation (milk production)

Compare your responses with the ones in the suggested answers section

When things go wrong - disorders of the pituitary gland

You have seen that the pituitary gland controls many parts of the body and affects many important processes. What happens when the functions of the pituitary gland are affected?



- **Gigantism**

This disorder is caused by the over-secretion of growth hormone from the pituitary gland in childhood or in the pre-adult stage of life. It could also be caused by a tumour in the pituitary gland.

- **Cushing's Disease**

This is a rare disease. Symptoms are obesity and the deposition of fat at the back of neck and around the face.

Sufferers also show reddish/purple stripes on their abdomen. They also have a weakening of muscles, osteoporosis (weak bones), hypertension and a weaker immune system.

- **Dwarfism**

This disorder leads to stunted growth due to a reduction in growth hormone during childhood.

It may be caused by a tumour or by disorders that reduce the amount of hormone released.

EXERCISE

Complete the Send-in exercises for Lesson 3

Lesson 4: Diabetes

Do you know someone who has diabetes?

Before they were diagnosed they may have had these symptoms:

Diabetic checking blood sugar levels

- more thirsty than usual
- passing more urine
- feeling tired and lethargic
- slow-healing wounds
- itching and skin infections, particularly around the genitals
- blurred vision
- nausea and vomiting
- weight loss
- mood swings

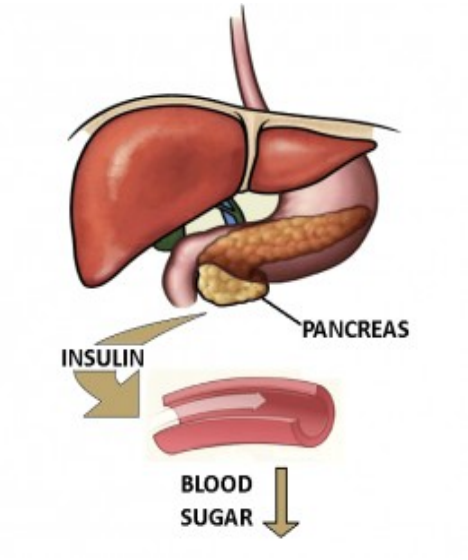
Diabetes is a serious disease, which, if not controlled, can be life threatening. It is a disease that occurs because the hormone **insulin** is not being produced, or body cells cannot use insulin.

There are two types of diabetes: Type 1 diabetes and Type 2 diabetes.

- **Type 1 Diabetes** occurs when the body stops making insulin. This type of diabetes occurs mainly in children. It cannot be prevented and is treated by daily insulin injections.

- **Type 2 Diabetes** is the most common type of diabetes. It occurs mostly in people over 40. It can be treated by careful diet and exercise, regular checking of glucose levels in the blood and medication.

Not enough hormone



Diabetes is caused by the body not producing any or enough of the hormone **insulin**. In humans, insulin is made in specialised cells in the pancreas. The diagram opposite shows that the pancreas is an organ which is located at the beginning of the small intestine.

Insulin is produced by the pancreas and released into the blood when you eat food. It is absorbed into the bloodstream with glucose and travels to cells to be used in chemical reactions. Insulin helps the glucose enter the cells. It also acts on liver, fat and muscle cells to make them store glucose you don't need straight away. The level of glucose in the blood is

Activity 8: Insulin

a) What causes diabetes?

_____

_____

b) What are the target cells for insulin?

_____

_____

c) What is the effect of insulin in a person without diabetes?

_____

Compare your responses with the ones in the suggested answers section

What happens if diabetes if left untreated?

In a person with diabetes the levels of glucose in the blood are not reduced. The high levels of glucose in the blood can cause serious problems in the body. The blood vessels and nerves are most affected. The walls of the small blood vessels thicken and block the blood supply. This causes problems in a person's eyes, kidneys, legs and heart.

Damage to the blood vessels in the retina in the eye can cause a disease called diabetic retinopathy. The picture on the left is what a person would see with normal vision. The picture on the right shows what a person with diabetic retinopathy would see of the same view.

Treating diabetes

At the moment there is no cure for diabetes so diabetics manage the glucose level in their blood by:

• taking insulin as prescribed

• eating a healthy, balanced diet, paying special attention to the amount of carbohydrates in each meal

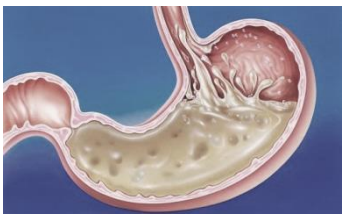
• monitoring blood sugar levels several times a day

• getting regular physical activity

Taking insulin

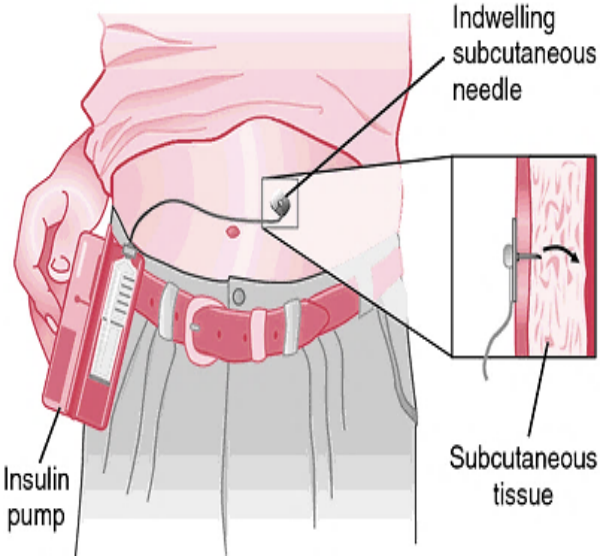
Insulin is the only medicine that can keep the blood sugar levels in a healthy range in diabetics.

Most children with Type 1 diabetes require two or more **injections** every day to keep blood sugar levels under control. Usually, they inject a combination of different types of insulin to handle the sugar that circulates in the blood after eating and in-between meals.



The acids and digestive juices in the stomach and intestines can break down and destroy insulin if it is swallowed, so it can't be taken as a pill.

The only way to get insulin into the body now is by injection with a needle or with an **insulin pump**.



Getting insulin injections today is nearly painless as smaller needles are used. Insulin is usually injected into the fatty layer under the skin of the abdomen, hips/buttocks, or thighs.

Insulin pumps, which deliver insulin through a small tube that is placed just under the skin, cut down on the number of injections needed.

New research

Diabetes is a serious disease and every day new cases are being diagnosed. Researchers all over the world are working to find a cure for diabetes.

Scientists are focused on researching ways to make the **treatment** of diabetes easier and more effective by:

- developing insulin to be available in pill, patch, and spray forms.
- improving the results of pancreas transplants.
- developing an artificial pancreas - a device that senses blood sugar levels and gives insulin.

Scientists are also researching how to prevent Type 1 diabetes. Read this newspaper article from the Sydney Morning Herald (28/5/15) below:

Four-year-old girl makes history in world-first attempt to prevent type 1 diabetes

Isla Robinson is a very special little girl. At four years old she might not be old enough to understand it, but on Wednesday she made scientific history.

Isla was the first person in the world to be injected with blood stored from her umbilical cord when she was born in an effort to prevent her developing Type 1 diabetes.

Researchers hope the blood, rich in immune cells, will help reboot her immune system to prevent the condition, which occurs when the body attacks and kills its own insulin-producing cells.

Isla's family were chosen to be included because her half-brother has type 1 diabetes. She and her sister Ruby, 6, both had blood tests to look for antibodies in their blood that indicated the condition was developing.

Ruby was diagnosed with type 1 diabetes only days after her first blood test. Since then, Isla has had tests every six months and the medical team went ahead with the transfusion this week after she went from having only one to three of the four possible antibodies in her blood that put her at a very high risk of developing the condition.

"All the studies suggest she will actually develop it one day, so if we can stop that it would be fantastic," said study leader Maria Craig. "I'm hoping we can completely switch off that autoimmune process and she will never get it."

Another possibility is that the cord blood, and in particular the high amount of immune cells called T-cells it contains, will not prevent diabetes in the long-term, but will significantly delay the age at which Isla develops it.

"It could be many years while it dampens down her immune response," Professor Craig said. "Even if it could delay it to adolescence, until she is older, that would be fantastic because that also buys us time for other therapies that are being developed."

The blood had been collected from Isla's umbilical cord, and cryoprotective agents added so it could be stored in temperatures below minus 160 degrees. On Wednesday, it was defrosted, washed and diluted and then slowly infused back into her body over a period of nearly half an hour.

But Isla's sister Ruby, who has already developed type 1 diabetes, knows it won't be too bad if her little sister develops it as well – she says life with diabetes is just "normal".

Picture: Isla Robinson in hospital

Activity 9: New research

a) Why is it important to treat diabetes?

_____

_____

_____

b) How is diabetes treated?

_____

_____

_____

c) Outline how scientists are researching ways to improve the treatment or prevention of diabetes.

_____

_____

_____

_____

_____

Compare your responses with the ones in the suggested answers section

EXERCISE

Complete the Send-in exercises for Lesson 4

Lesson 5: Sugar Control

Controlling the amount of sugar in the blood

You have seen that it is vitally important to control the amount of sugar in the blood. The hormone insulin, the liver and pancreas play vital roles in controlling the amount of sugar in the body.

Activity 10: Video: Diabetes Effects on Body Animation 3D

Watch the following video about the way your body regulates the amount of sugar in your blood and about diabetes.

You can watch this video by clicking on the link in elearning or by scanning this QR code with your mobile device.

If you cannot watch the video then read the transcript of the video in the Appendix.

Answer the following questions using the information in the video or the information in the transcript found in the Appendix.

a) What does insulin do at muscle cells?

_____

_____

b) Why do people with undiagnosed diabetes go to the toilet a lot and are thirsty?

_____

_____

_____

_____

_____

c) Explain why glucose cannot get into cells in people with Type 2 diabetes and what then happens in the body.

_____

_____

_____

_____

Compare your responses with the ones in the suggested answers section

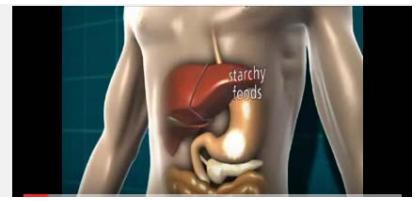
Appendix

Transcript: Diabetes effects on the Body (3D animation)

In this film we going to explain how your body processes the food you eat in order to provide all your body cells with the energy they need and also what happens when you have diabetes.

When you eat foods that contain carbohydrates, it's broken down in the stomach and digestive system into glucose which is a type of sugar.

We need glucose from food because that's what gives us energy.

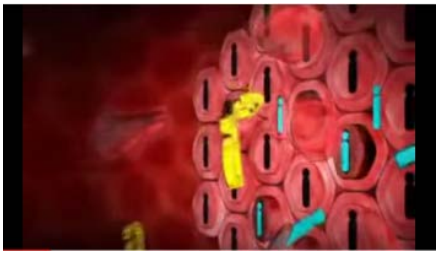


Carbohydrate containing foods are things like starchy foods, sugary foods, milk and some dairy products and fruit.

This glucose then moves into the bloodstream and the body detects that the blood glucose level is rising. In response to that, the pancreas, which is a little gland that sits just beneath the stomach, starts to release a hormone called insulin, and it's insulin that helps the body get the energy from the food we eat.

The bloodstream then takes the glucose and the insulin to every cell in our body that needs it.

To make this easier to understand let's look at the muscle cells.

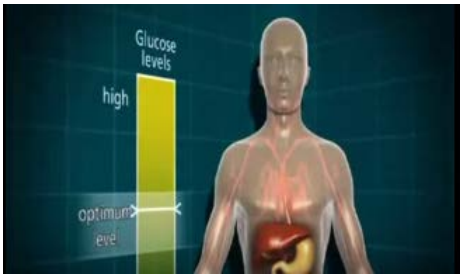


At the muscle cells it's insulin that allows the glucose to get into the cells where it can be used for energy. It's a bit like insulin is the key unlocking the door to the cells so the glucose can get in. That way the blood glucose level starts to drop.

But the blood glucose level can be topped up at any point by the liver releasing extra glucose that has been stored.

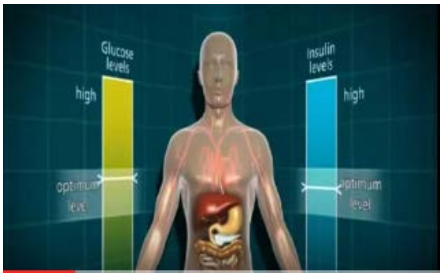
The blood glucose rises back up again, and again the pancreas produces more insulin to move with that glucose through the blood stream, to the muscle cells, open the doors and let the glucose in.

The body functions best with the blood glucose at an optimum level.

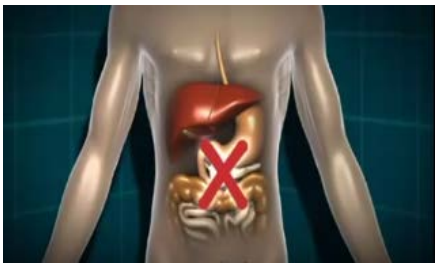


The body doesn't like it if the blood glucose level rises too high.

Normally there's a cycle within the body which balances out the glucose and the insulin level and this is achieved by the food you eat, the pancreas and the liver.



However in some people the system doesn't work properly and they develop diabetes.



There are two main types of diabetes: type 1 and type 2.

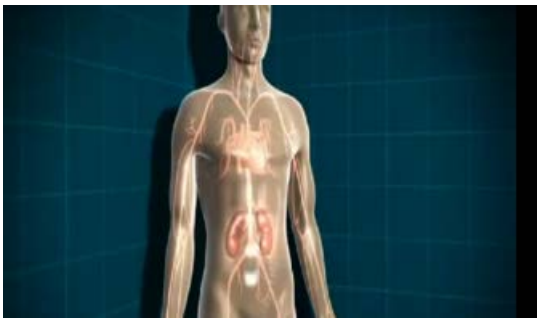
In type 1 diabetes the body isn't making any insulin at all. This is because of an autoimmune response whereby the body has destroyed the insulin producing cells in the pancreas.

We don't entirely know why that happens in some people and not in others. Type 1 diabetes accounts for about 15 percent of all cases.

It's most often found in the in the under forties and it's by far the most common type of diabetes found in childhood.

In type 1 diabetes the carbohydrate containing food is broken down into glucose as normal. That glucose then moves into the bloodstream. Normally the body would produce insulin to let that glucose into the cells, but in Type 1 diabetes there is no insulin being produced, so the glucose can't get into the body cells at all, so the level of glucose in the blood rises.

The body tries to lower the level of glucose, tries to get rid of the glucose through the kidneys. That's why people who have undiagnosed type 1 diabetes tend to go to the toilet a lot to pass urine.



As the kidneys filter the glucose out of the blood they also take a lot of water with it so the person with diabetes will get very thirsty.

The urine contains a lot of glucose and that creates an environment where it's quite easy for bacteria to thrive so it's also quite common to get thrush or genital itching.

In the same way, the blood contains a high level of blood glucose as well, so more bacteria than usual will tend to breed in flesh wounds and they might be slow to heal.

Glucose can also build up in the lens at the front of the eye causing the liquid in the lens to become cloudy. That can mean that some people with undiagnosed Type 1 diabetes can have blurred vision.

Because the glucose can't get into the cells to be used for energy, somebody who's got undiagnosed Type 1 diabetes is going to start feeling very tired, lethargic and unable to go about their normal daily routine.

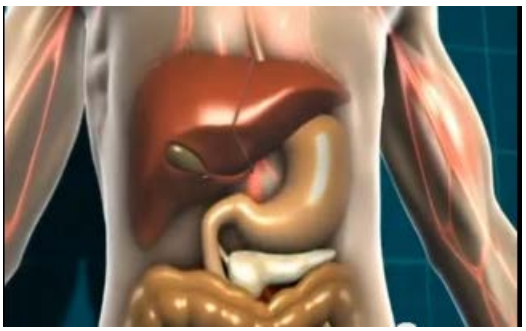
But the body still needs an energy source in order to work properly. So what it does is that it starts to break down its fats stores and that can lead to weight loss.

So the main symptoms have type 1 diabetes are going to the toilet a lot, thirst, thrush or genital itching, slow healing of wounds, blurred vision, tiredness and weight loss.

These symptoms generally happen quite quickly, often over a few weeks and can be reversed once the diabetes is treated with insulin.

Type 2 diabetes accounts for about 85 percent of all cases in the population. It is most common in the over 40 age group in the white population and in the over 25 age group in the black or south asian population.

Type 2 diabetes is a little more complex because there are slightly more processes at work. Either the body isn't producing quite enough insulin or the insulin it is producing isn't working properly. That can be due to being overweight because a build up a fat can in fact stop insulin doing its job properly.



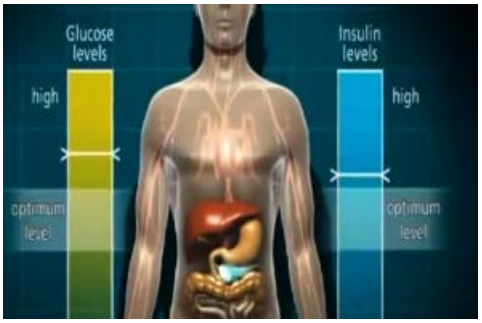
But it can also happen in people of a healthy weight.

So, in Type 2 diabetes, the carbohydrate containing food that is broken down into glucose in the stomach and digestive system is normal and that glucose then

moves into the bloodstream. The pancreas starts to produce insulin which moves with the glucose through the bloodstream to all the body cells which need glucose for energy.

However, the glucose can't always get into the cell because the locks to the cell doors have become filled up with fat deposits.

That means that the insulin can't open the cell doors properly so the level of glucose in the blood continues to rise.



In response to this, the pancreas produces even more insulin, so the blood glucose levels continue to rise and the insulin levels continue to rise.

The situation is further complicated by the cells who are desperate for energy, sending out emergency signals to the liver to release stored glucose.

The blood glucose level goes up and up and the pancreas produces more and more insulin until it can't cope anymore and it wears out.

As with Type 1 diabetes, the symptoms of type 2 diabetes are going to the toilet a lot, thirst, thrush or genital itching, slow healing of wounds blurred vision, tiredness and weight loss in some people.

The symptoms for type 2 diabetes come along very slowly and some people don't have any symptoms at all.

So for that reason people can live with type 2 diabetes for up to 10 years before they realize that they have it.

Type 2 diabetes can be treated in a number of different ways. Initially it may be sufficient to make changes to the food you are eating and to take extra physical activity or lose any weight that may be appropriate but Type 2 diabetes is a progressive condition and most people need some form of medication to treat it.

Send-in exercises:
Response and coordination Part 3

Lesson 1: The endocrine system

a) Using the words below, describe how the endocrine system controls the body.

hormone, endocrine gland, cells, blood stream

_____

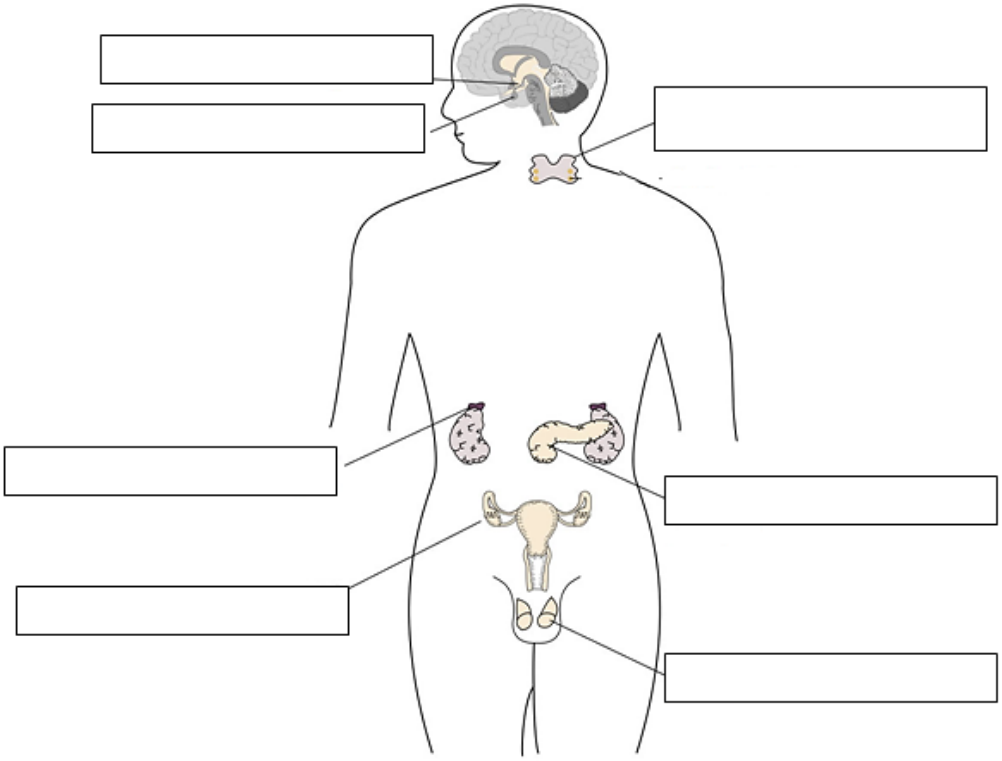
_____

_____

_____

b) Label the glands in the endocrine system.

(Note that both male and female reproductive organs are shown in this one diagram).



c) Complete the table below by naming the gland responsible for the following functions.

Gland	Function
	Produces changes in the male body
	Controls the amount of calcium in your blood
	Controls how fast your body uses energy
	Affects the kidneys and helps the body react to emergency situations
	Produces changes in the female body
	Controls other glands and body growth
	Controls the body's level and use of sugars

Lesson 2: Hormones cause responses

a) What happens when a hormone is released from a gland?

_____

_____

b) What happens when a hormone reaches a target cell?

_____

_____

_____

c) Using the production of adrenalin as an example, explain how the nervous and endocrine system work together to bring about a response to a stimulus.

_____

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To EXPLAIN something

- What is it?
- What does it do?
- How does it do it?
- What does it lead to?

Give examples.

Linking words: therefore, because, however

Lesson 3: The master gland

a) Using examples, explain why the pituitary gland is an important gland.

_____

_____

_____

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_____

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b) Name and describe two disorders of the pituitary gland.

_____

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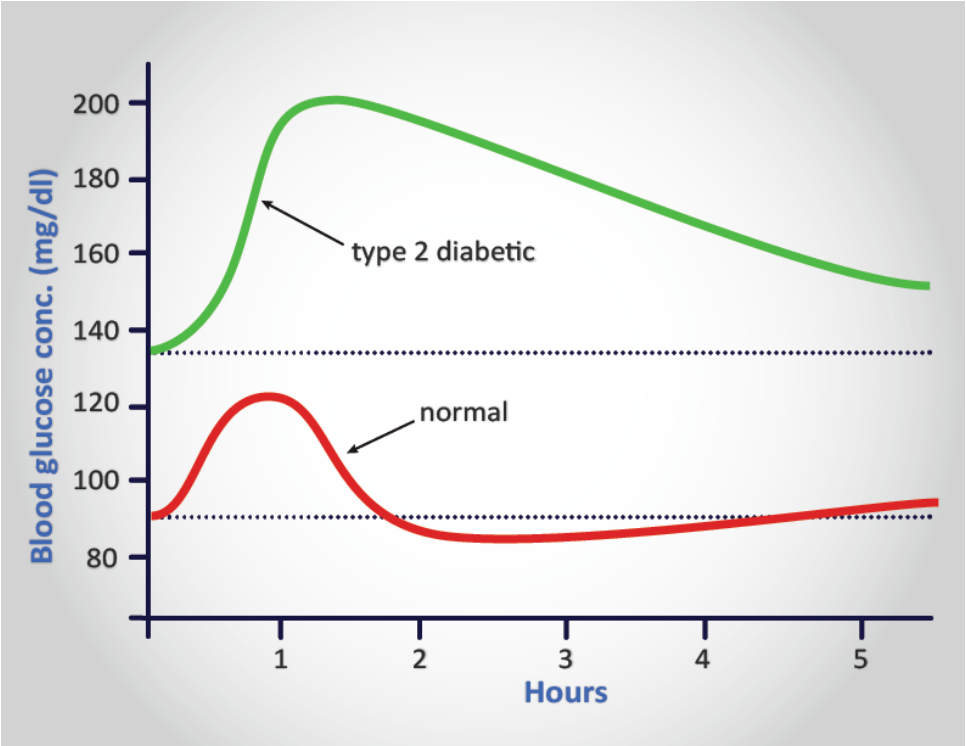
Lesson 4: Diabetes

a) This graph shows the concentration of glucose in the blood for an insulin dependent diabetic and non-diabetic person just after they have eaten. The dotted lines show the *range* of glucose concentration expected in a non-diabetic person.



Describe the **trends** (*the shape of the graph over time*) shown in the graph for:

i) the type 2 diabetic

_____

_____

_____

ii) the non-diabetic

_____

_____

_____

b) Using what you know about the action of insulin and diabetes explain the trends shown in the graph.

(Hint: Explain the different levels of glucose over the time shown, explain the shape of the graph with reference to what happens to glucose in diabetics and non-diabetics, explain why the graph for the non-diabetic goes below dotted line and rises again by discussing negative feedback systems)