



DEPARTMENT OF EDUCATION

GRADE 11

BIOLOGY

MODULE 5



RESPONSE TO STIMULI



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**Writer**

Jerald Bablis

**Content Editors**

Science Department

Subject Review Committee

**Language Editor**

Dr. Steven Winduo

**Course Format Editor**

Anna Liza Cale



# **GRADE 11**

## **BIOLOGY**

### **MODULE 5**

#### **RESPONSE TO STIMULI**

**IN THIS MODULE YOU WILL LEARN ABOUT:**

**11.5.1: TROPISMS IN PLANTS**

**11.5.2: NERVOUS SYSTEM**

**11.5.3: ENDOCRINE SYSTEM**



### **Acknowledgements**

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**DIANA TEIT AKIS**  
PRINCIPAL



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## SECRETARY'S MESSAGE

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Achieving a better future by individual students and their families, communities or the nation as a whole, depends on the kind of curriculum and the way it is delivered.

This course is a part of the new Flexible, Open and Distance Education curriculum. The learning outcomes are student-centred and allows for them to be demonstrated and assessed.

It maintains the rationale, goals, aims and principles of the national curriculum and identifies the knowledge, skills, attitudes and values that students should achieve.

This is a provision by Flexible, Open and Distance Education as an alternative pathway of formal education.

The course promotes Papua New Guinea values and beliefs which are found in our Constitution, Government Policies and Reports. It is developed in line with the National Education Plan (2005 - 2014) and addresses an increase in the number of school leavers affected by the lack of access into secondary and higher educational institutions.

Flexible, Open and Distance Education curriculum is guided by the Department of Education's Mission which is fivefold:

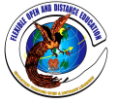
- To facilitate and promote the integral development of every individual
- To develop and encourage an education system satisfies the requirements of Papua New Guinea and its people
- To establish, preserve and improve standards of education throughout Papua New Guinea
- To make the benefits of such education available as widely as possible to all of the people
- To make the education accessible to the poor and physically, mentally and socially handicapped as well as to those who are educationally disadvantaged.

The college is enhanced to provide alternative and comparable pathways for students and adults to complete their education through a one system, many pathways and same outcomes.

It is our vision that Papua New Guineans' harness all appropriate and affordable technologies to pursue this program.

I commend all those teachers, curriculum writers, university lecturers and many others who have contributed in developing this course.

**UKE KOMBRA, PhD**  
Secretary for Education



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## MODULE 11.5                      RESPONSE TO STIMULI

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### Introduction

In the last module we learnt about respiration and how animals and plants respire (breathe) and exchange gases when they are breathing. When animals and plants exchange gases they normally take in oxygen and release carbon dioxide as a waste product. The process in which animals and plants **respire (breathe)** is also one of the characteristics of living things. There are a total of eight (8) major characteristics of living things: (1) **Eating**, (2) **Excreting (getting rid of waste)**, (3) **Responding to Stimuli**, (4) **Moving**, (5) **Reproducing**, (6) **Growing**, (7) **Being made out of Cells**, and (8) **Respiring (Breathing)**.

In this module we will learn another characteristic of a living thing known as “response to stimuli”. A plant responds to stimuli. A stimulus is something that affects a plant’s growth in the surrounding environment which includes **sunlight, gravity, touch, and water**. When a plant grows towards sunlight it is called **phototropism**. It can also be called **positive phototropism**.

When a plant grows towards the pull of gravity it is called **geotropism**. Hormones in a plant trigger some of these stimuli. Hormones in plants are **internal factors** that affect the growth and development of a plant. Sunlight, gravity, and water are **external factors** that also affect the growth and development of a plant.

Hormones that trigger a particular response in animals are **testosterone** (example, causes boys to grow their moustache). Testosterone is a hormone produced in males to give them their **secondary sexual characteristics** or simply make them grow from boys to men. Likewise, women have their own hormones that make them become girls or women.

The organs in the body that produce hormones are called **endocrine glands**. For example, the organ in male body that produces testosterone is called the **testis**. The testis is a gland that is part of the **endocrine system**. **Hormones** mostly have a long lasting effect on the body. There are also signals in the body that have rapid effects on the body. These signals are called **electrical impulses**. The **nervous system** produces electrical impulse of short-term effects.

Hormones are found in both plants and animals. Plant hormones trigger a particular response to a particular stimulus. Animal hormones trigger a particular response on the body. These responses have long term effects. The endocrine system produces these responses. On the other hand, the nervous system triggers a particular response on the body. Its effects are instantaneous (occur rapidly).



### Learning Outcomes

After going through this module you are expected to:

- list five (5) main plant hormones and describe their functions.
- explain the difference between phototropism and geotropism.
- identify at least four (4) other examples of tropisms or plant responses.
- compare and contrast the central nervous system (CNS) and the peripheral nervous system (PNS).
- differentiate between the voluntary and involuntary reflexes.
- compare and contrast the nervous system and the endocrine system.
- identify the ten (10) endocrine glands and one hormone that each of them produce.



### Time Frame

Suggested allotment time: **8 weeks**

If you set an average of three (3) hours per day, you should complete the module by the end of the assigned week. Try to do all the learning activities. Compare your answers with the ones provided at the end of the module. If you do not get a particular exercise right in the first attempt, you should not get discouraged. Instead, you should go back and attempt it again. If you still do not get it right after several attempts then you should seek help from your friend or even your tutor.

**DO NOT LEAVE ANY QUESTION UNANSWERED**



### Terminology

#### Abscissic acid

A plant hormone that causes the stomata to close up.

#### Affector neurons

These are nerve cells that carry electrical impulses from the body's organs to the brain to process it. They are also called sensory neurons.

#### Anabolism

Is the buildup of food molecules inside the cell.

#### Autonomic nervous system

It is part of the nervous system that carries electrical impulses to the organs to action it without the brain processing the information.





	It is also known as the involuntary nervous system.
<b>Auxin</b>	A plant hormone that enables a plant to grow towards sunlight.
<b>Axon</b>	A threadlike structure covered by the myelin sheath that electrical impulses travel through.
<b>Axon terminals</b>	The end of the nerve cell.
<b>Cell</b>	The fundamental unit of life.
<b>Cell body</b>	Part of a nerve cell that surrounds the nucleus.
<b>Central nervous system</b>	Is part of the nervous system that is mainly concerned with the brain and spinal cord.
<b>Characteristics of living things</b>	A something that an organism has or does that defines it as a living organism. For example, eating, excreting, responding to stimuli, moving, reproducing, growing, being made out of a cell and breathing.
<b>Catabolism</b>	The breakdown of food molecules for the cells of body to use up.
<b>Connecting neurons</b>	These are nerve cells that connect both affector neurons and effector neurons. It is also known as interneurons.
<b>Cytokinins</b>	A plant hormone that causes the growth of fruits such as strawberries or bananas.
<b>Dendrite</b>	The nerve cells that come out of the cell body.
<b>Effector neurons</b>	These are nerve cells that carry electrical impulses from the brain to the body's organs to action it. These are also called motor neurons.
<b>Effector organs</b>	These are organs of the body that action the information that comes from the brain.



<b>Electrical impulses</b>	These are the transmission of electrical signals to the brain or away from the brain.
<b>Endocrine glands</b>	These are the male or female hormonal organs. They produce hormones that have a prolong effect on the body.
<b>Estrogen</b>	One of the female hormones that enables a girl to become a woman.
<b>Ethylene</b>	A plant hormone that ripens a fruit. It also causes the fruit to smell.
<b>External factors</b>	These are stimuli that come from outside the body of a plant or animal.
<b>Flexor withdrawal reflex</b>	It is an involuntary reflex that enables the leg to be lifted away from a sharp object before the brain can process the information.
<b>Geotropism</b>	The growth of plant part in the direction of gravity. An example, is the roots of plants. Another term for gravitopism.
<b>Gravitropism</b>	This is a growth response by the plant in the direction of gravity. An example of this is the roots of plants. Another term for geotropism.
<b>Gibberellins</b>	A plant hormone that promotes the elongation or growth of the stem.
<b>Hydrotropism</b>	The growth of plant part towards water. An example, is roots growing towards an area of soil that has a lot of water.
<b>Internal factors</b>	These are stimuli that come from inside the body of a plant or an animal.
<b>Involuntary reflexes</b>	These are actions done solely by the body, without the brain. It can also be called the automatic response.
<b>Metabolism</b>	All the chemical reactions in the body. This includes both anabolism (build up) reactions and catabolism (break down) reactions.

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<b>Motor division</b>	Part of the nervous system that is concerned with the nerve cells that allow electrical impulses to travel through it and towards the muscles to action the impulse.
<b>Myelin sheath</b>	The covering of the axon that prevents the escape of electrical impulses.
<b>Nervous system</b>	The system in the human body that enables electrical impulses to travel through it in order to cause movement.
<b>Negative phototropism</b>	The growth of a plant part away from sunlight. For example, the roots of a plant.
<b>Negative geotropism</b>	The growth of a plant part away from the direction of gravity and towards sunlight. An example is the leaves of plants.
<b>Negative gravitropism</b>	The growth of plant part away from the direction of gravity and towards sunlight. An example is the leaves of plants.
<b>Neurons</b>	Another name for nerve cells.
<b>Nucleus</b>	The brains of the cell. The central part of a nerve cell that contains general and responsible for controlling the activity of the nerve cell.
<b>Ovary</b>	Female reproductive organ.
<b>Parasympathetic nervous system</b>	This is part of the nervous system that increases the rate of action by the body's organs. An example would be to open airways, open blood vessels, increase heartbeat and opening the bladder.
<b>Patella reflex</b>	It is an involuntary reflex that occurs when a the knee is hit with a blunt object and causes the lower leg to move upwards without the brain processing the information.



<b>Peripheral nervous system</b>	Part of the nervous system that is concerned with the nerve cells outside of the brain and the spinal cord.
<b>Positive geotropism</b>	The growth of plant parts in the direction of gravity. For example, roots of plants.
<b>Positive phototropism</b>	The growth of plant part towards sunlight.
<b>Phototropism</b>	Is the growth of a part of a plant towards sunlight.
<b>Respiration</b>	A chemical process that produces energy.
<b>Sensory division</b>	Part of the nervous system that consists of nerve cells that allow electrical signals to travel through it and towards the brain.
<b>Secondary sexual characteristics</b>	These are male/female traits such as deep voice for men, breast enlargement, facial hair, widened hip and aggressiveness in males.
<b>Stimuli</b>	An internal or external factor that makes an organism responds positively or negatively. A positive response is a growth of plants towards sunlight. A negative response is letting go of a hot jug if hot.
<b>Somatic nervous system -</b>	It is part of the nervous system that carries electrical impulses from the brain to the organs that will action the information. It is also known as the voluntary nervous system.
<b>Somatic sensory neurons</b>	These are nerve cells that carry electrical impulses mainly from outside the body (such as the eyes and skin) and towards the brain.
<b>Sympathetic nervous system</b>	This is part of the nervous system that slows down the body's organs. For example, slowing heartbeat, constricting airways or blood vessels and contracting the bladder.
<b>Synapse</b>	The gap between one nerve cell and the other nerve cell. (The gap between two nerve cells).

**Testosterone**

It is male hormone that causes secondary sexual characteristics in boys. Examples of the secondary sexual characteristics are facial hair, deep voice, aggressiveness and competitiveness.

**Testes**

The male reproductive organ.

**Thigmotropism**

It is a growth of a plant part as it feels its way around objects. An example includes the growth of vanilla around a tree or beans growing around the stem or branch of a plant.

**Tropism**

The growth of a plant towards or away from a stimulus.

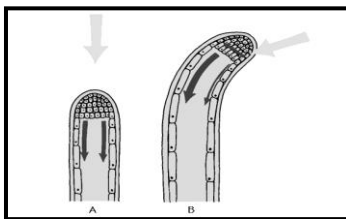


### 11.5.1: Tropisms in Plants

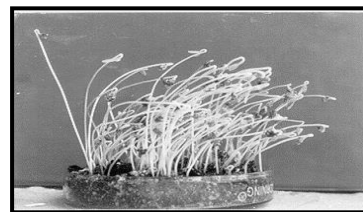
#### Plant Responses

When you think of a plant, certain internal and external factors affect its growth and development. From the time it begins to germinate (grow) to the time it produces its fruit it is affected by both internal and external factors. For example, a strawberry plant is affected by these two factors that influence its growth and development. In terms of **internal factors** it is the hormones that affect its growth and development. In plants there are generally five (5) hormones that affect a plant's growth. They are as follows: (1) **Auxins**, (2) **Cytokinins**, (3) **Gibberellins**, (4) **Abscissic Acid**, and (5) **Ethylene**.

In terms of plants growing towards light, it is the auxins that have a direct influence on the growth of the plant. Auxins move away from sunlight, and where they accumulate it increases the length of those cells. Over a couple of days, it makes the plant bend towards the direction of sunlight. Auxins move to the left side of the shoot and enable the left side to grow faster, thus bending the shoot towards the direction of the light as shown on the diagram B below. This is known as **phototropism**.



The tip of a shoot (stem) growing when light is present and afterwards when light has caused the shoot tip to bend.



Young shoots growing after long periods of time exposed to sunlight coming from one particular location. As you can see the shoots are bending towards the light.

Plants do not only respond to internal factors but also **external factors** as well. External factors include, **light, touch, water, chemicals, gravity, and daylight variability**.

The external factors determine the direction the plant will grow towards. There are six (6) major external factors that determine a plants' directional growth:

1. Phototropism - When a plant responds to light and grows towards it, is known as **phototropism**.



The plants in these two diagrams show shoots growing in the direction of sunlight.



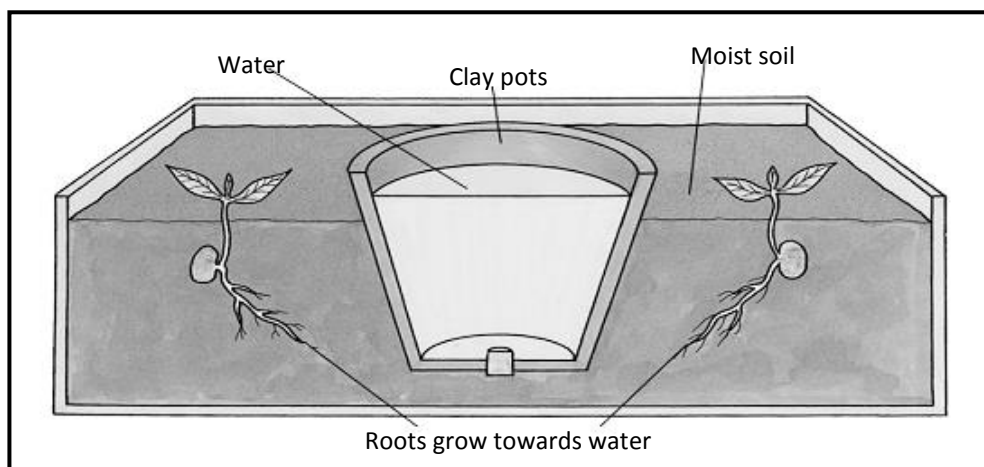
Plant growth that is growing towards the light source is also known as **positive phototropism**. When a plant grows away from the source of light it is known as **negative phototropism**.

2. Thigmotropism – The growth of a plant as it feels its way around a structure and attaches itself to it.
3. Hydrotropism – The growth of a plant towards water. Plants that respond and grow towards water are said to be displaying **hydrotropism**



The plants in these two diagrams show beans growing around structures as they feel their way around it.

For example, the roots of cabbages that are placed in a container will grow towards water. In fact any plant growing will want to grow where there is a lot of water. Water is essential because it helps the nutrients in the water to be absorbed by the plant. Without water the plant will become dry and eventually die.



The roots of the beans growing in the direction of water are called hydrotropism.

4. Chemotropism – The growth of a plant towards certain chemicals that assist it to grow.
5. Geotropism - Plant growth in response to gravity is known as **geotropism** or **gravitropism**.

Plant parts towards the ground are said to displaying **positive geotropism** or **positive gravitropism**.



6. A plant part that is growing away from the pull of gravity is said to be **negative geotropism** or **negative gravitropism**.
6. Photoperiodism – The growth of a plant in response to various lengths of day and night.



The roots of this mangrove are generally growing towards the water source, which is the sea. Therefore, they are displaying hydrotropism.

### Plant's response to touch

Plants that respond to touch and grow accordingly as they feel their way as they are growing are said to be displaying **thigmotropism**. These are plant growth in relation feeling their way around an upright object as they are growing. The pictures below show a demonstration of thigmotropism in action.



A vine growing around an object, as it grows higher in length. The plant is also using the object as a support. This is also an example of thigmotropism.



A strangler that grows around a tree and will eventually kill the tree. This is an example of thigmotropism.

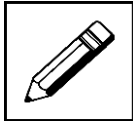




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It is now time for you to complete Learning Activity 1. Remember, learning activities are not sent in for assessment. However, this learning activity will help you complete Assignment 1 (which you will send in for assessment).

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### Learning Activity 1



30 minutes

**A. Circle the most appropriate answer from the four (4) options.**

1. How many plant hormones are there?

- (a) 3 (c) 5  
(b) 4 (d) 6

2. Which type of factors are plant hormones?

- (a) side (b) internal  
(c) external (d) uncontrollable

3. When a plant shoot grows in the direction where light is coming from, and then it is called \_\_\_\_\_.

- (a) geotropism (b) gravitropism  
(c) phototropism (d) negative phototropism

4. Which hormone is responsible for phototropism?

- (a) Auxin (b) Ethylene  
(c) Gibberellins (d) Abscissic Acid

5. What is another way of saying phototropism?

- (a) geotropism (b) positive geotropism  
(c) positive gravitropism (d) positive phototropism



**B. Underline TRUE if the statement is true and False if the statement is false. Write the correct statement if it is false.**

1. Plants that are growing towards the ground are said to be showing negative phototropism.  
(True/False)
2. Roots display the response known as positive geotropism.  
(True/False)
3. The opposite of positive geotropism is negative geotropism.  
(True/False)
4. When a plant responds to gravity that is called phototropism.  
(True/False)
5. Geotropism is the same as positive geotropism.  
(True/False)

**C. Answer the following questions.**

1. Describe the external factor that stimulates plant responses? Name some of these factors.

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2. Define the three (3) main types of tropisms.

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3. Describe the differences and similarities between positive and negative phototropism.

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4. Describe the differences and similarities between positive and negative geotropism.

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Thank you for completing your Learning Activity 1. Check your work. Answers are at the end of this module.

**It is now time to complete your Assignment 5 in your Assessment Book 5 before going on to the next topic.**



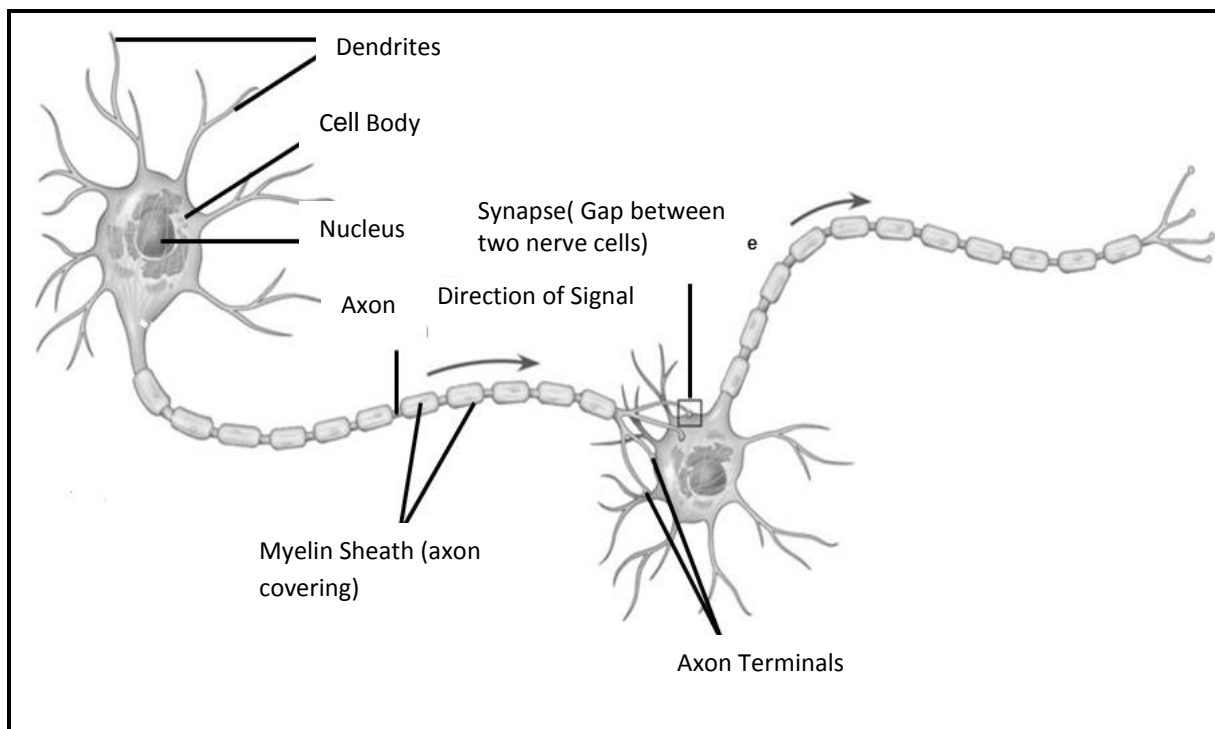
## 11.5.2 Nervous System

The nervous system is responsible for making us think, act, and move. Generally, the **nervous system** is responsible for movement, response to environmental stimuli, intelligence, self-awareness, thought, and emotion. The nervous system is composed of the **brain, spinal cord**, and the other smaller **nerve cells**. The messages that are sent through the nerve cells are in the form of electrical signals or impulses. These electrical signals travel very fast.

### Structure of a nerve cell

Cells are the fundamental unit of life. This means most living organisms are made up of cells. The nervous system is no exception because it is made up of cells that are called nerve cells. The nerve cell is the longest type of cell in any organism. It is made up of the **dendrite, axon, myelin sheath, cell body, nucleus**, and **synaptic terminal**.

When an electrical signal travels, it begins with the dendrite and ends at the synaptic terminal. Once it reaches the synaptic terminal it goes through a gap called the **synapse** (gap between two nerve cells) before it starts again with the dendrite. The diagram below clearly shows how the electrical signal travels from the dendrite to the synaptic terminal.



The nerve cell is composed of the dendrite, cell body, nucleus, axon, myelin sheath and axon terminals.



### Functions of nerve cells

The primary role of nerve cells is to carry information in the form of **electrical signals**. It can also be thought of as **electrical impulse**.

The electrical signal travels in a split second so that when we react it can be actioned as soon as possible. When signals are travelling through the nerve cell it means that we are trying to quickly respond.

The **location and size of the cell body** will indicate what type of nerve cell it is. Furthermore, **how the electrical signal travel** will also reveal what type of nerve cell it is.

1. If the cell body is large and located at the end of the nerve cell it is known as a **motor nerve cell**.
2. If the cell body is locate at the centre of the nerve cell then it is known as the **sensory nerve cell**.
3. If the cell body is large in the centre with dendrites all around then it is known as the **inter-neurone**.

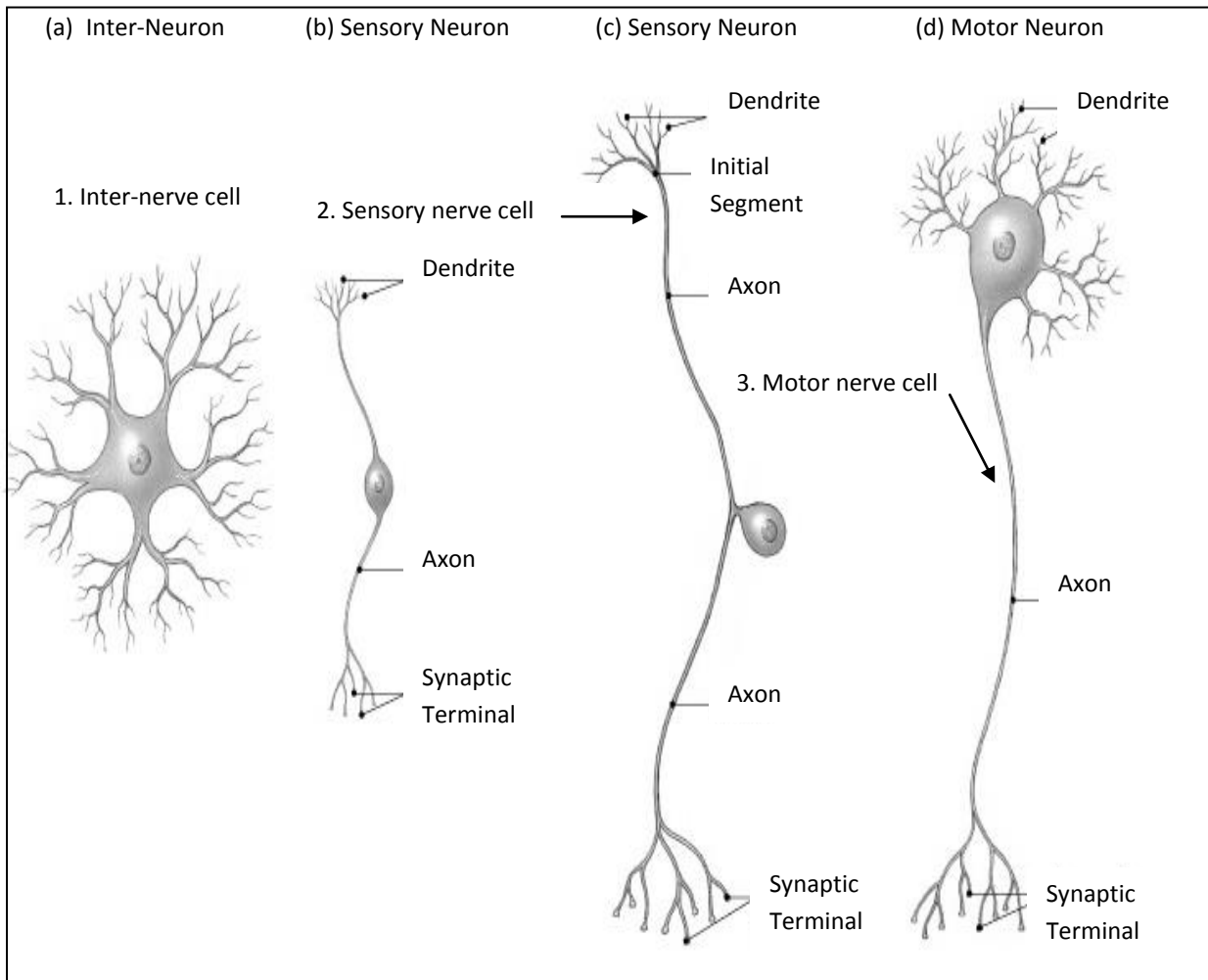
Moreover, if electrical signals are sent to the brain then they are called sensory nerve cells. If signals are sent from the brain to a location on the body to action then they are called motor nerve cells, and if the nerve cell is only facilitating the movement of the information from one nerve cell to other then they are called inter-nerve cells.

### Types of Nerve Cells

Nerve cells are called **neurons**. There a three (3) types of nerve cells:

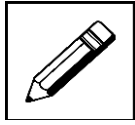
- (a) **Affector neurons**, which are also known as **sensory neurons**.
- (b) **Effector neurons**, which are also known as **motor neurons**.
- (c) **Connecting neurons**, which are also known as **inter-neurons**.

Diagrams of the different types of nerve cells are shown the next page.



The inter-nerve cell connects both the sensory and motor nerve cells. The sensory nerve cell carries information to the brain while the motor nerve cell carries information to the body part that will action this information.

It is now time for you to complete Learning Activity 2. Remember, learning activities are not sent in for assessment. However, this learning activity will help you complete Summative Test 5 (which you will send in for assessment)



## Learning Activity 2



20 minutes

Answer the following questions.

1. a) Name the part of the nerve cell (neuron) that insulates the axon?

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- b) What is the function of the part mentioned in a)?

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2. List the three (3) types of nerve cells.

i) \_\_\_\_\_

ii) \_\_\_\_\_

iii) \_\_\_\_\_

Thank you for completing your Learning Activity 2. Check your work. Answers are at the end of this module.

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## The Central and Peripheral Nervous System

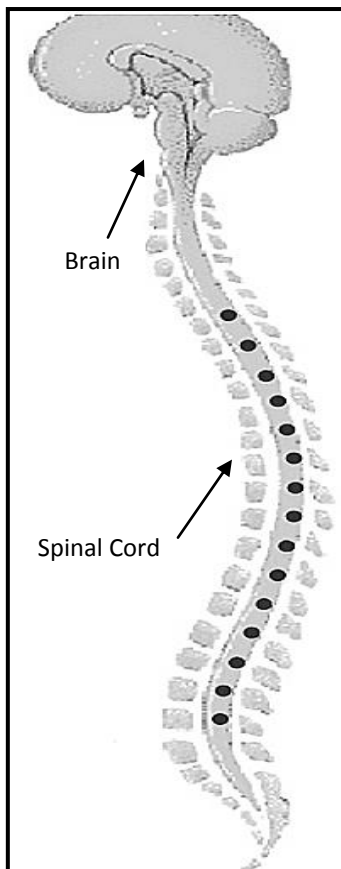
The Nervous system is divided into:

- (i) **Central nervous system**
- (ii) **Peripheral nervous system**

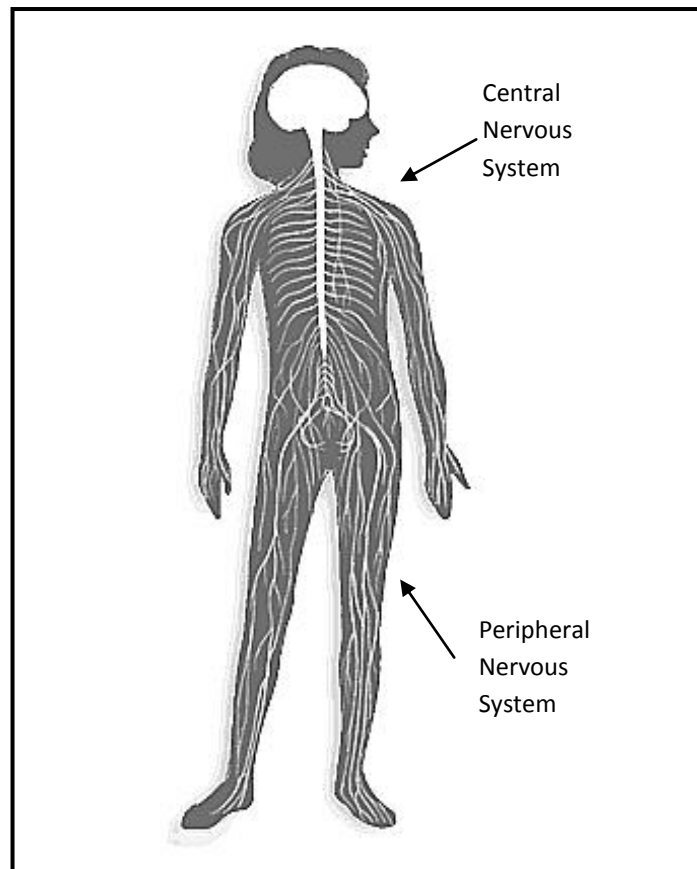
### (i) Central Nervous System

The Central nervous system is made up of the **brain** and the **spinal cord**. The brain is where the information is received, processed and sent to where the action will take place.

1. Brain – where information is received, interpreted and sent back for action.
2. Spinal cord – is made up of nerves that attach themselves to the brain.



The brain and spinal cord forming the central nervous system.

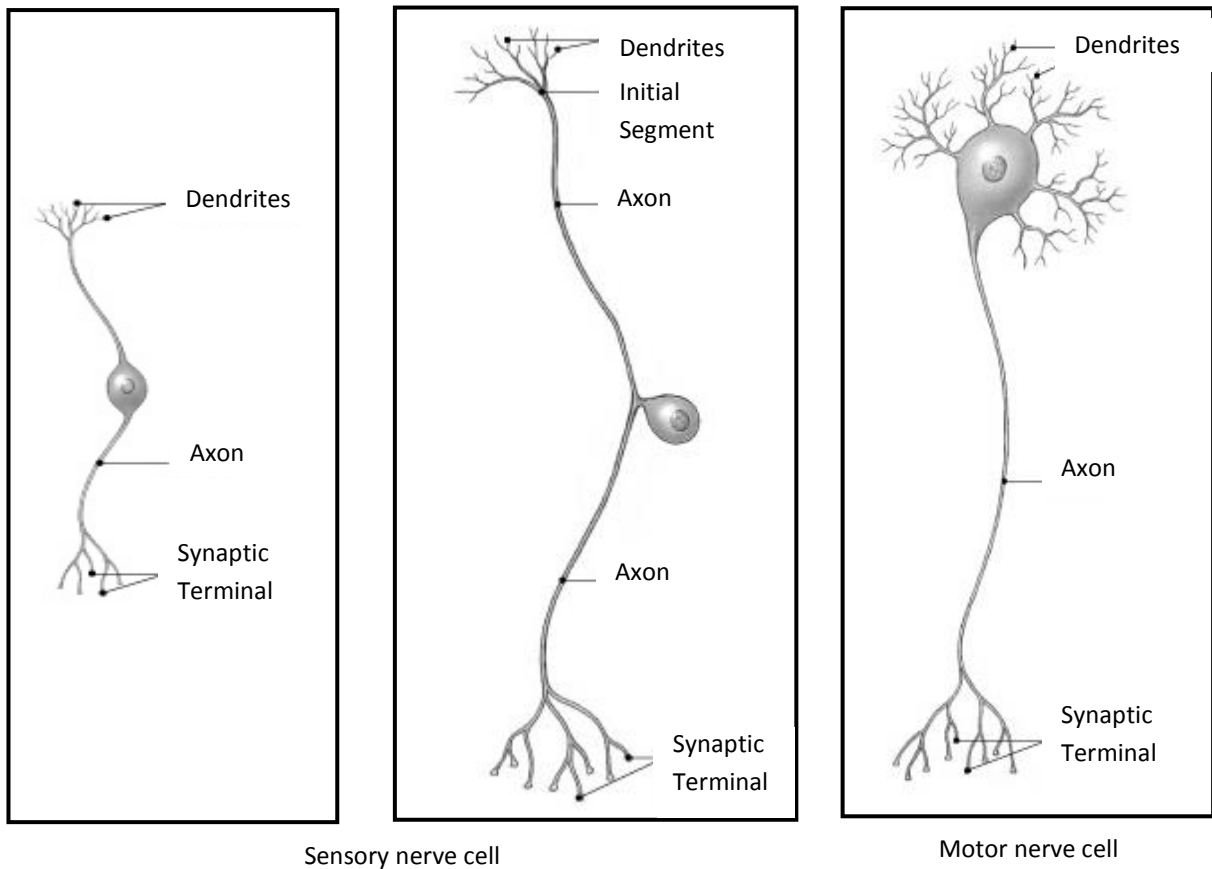


The arrow below indicates the peripheral nervous system.

## (ii) Peripheral Nervous System

The peripheral nervous system is made up of the nerve cells that are connected to the spinal cord. These nerve cells either send information in the form of electrical signals from where it was received to the brain or from the brain to where it will be actioned. The nerve cells that send electrical signals from where it is received to the brain are called the **sensory division** or **sensory nerve cells**. The nerve cells that send electrical signals from the brain to where it will be actioned are called the **motor division** or **motor nerve cells**.





The **sensory division** of the peripheral nervous system (PNS) monitors and informs the central nervous system (CNS) of events occurring both inside and outside the body. There are two (2) types of neurones that carry out this function:

- **Somatic sensory nerve cells** carry information to the central nervous system (CNS) from the external environment for examples from the eyes or skin.
- **Visceral sensory nerve cells** carry information to the central nervous system (CNS) from the internal environment; for example, from organs such as the heart, intestine, gall bladder, and stomach.

The **motor division** of the peripheral nervous system (PNS) transmits electrical signals away from the central nervous system (CNS) to the muscles and glands, which are called **effector organs**.

The motor division has two different systems; the **somatic nervous system** and the **autonomic nervous system**.

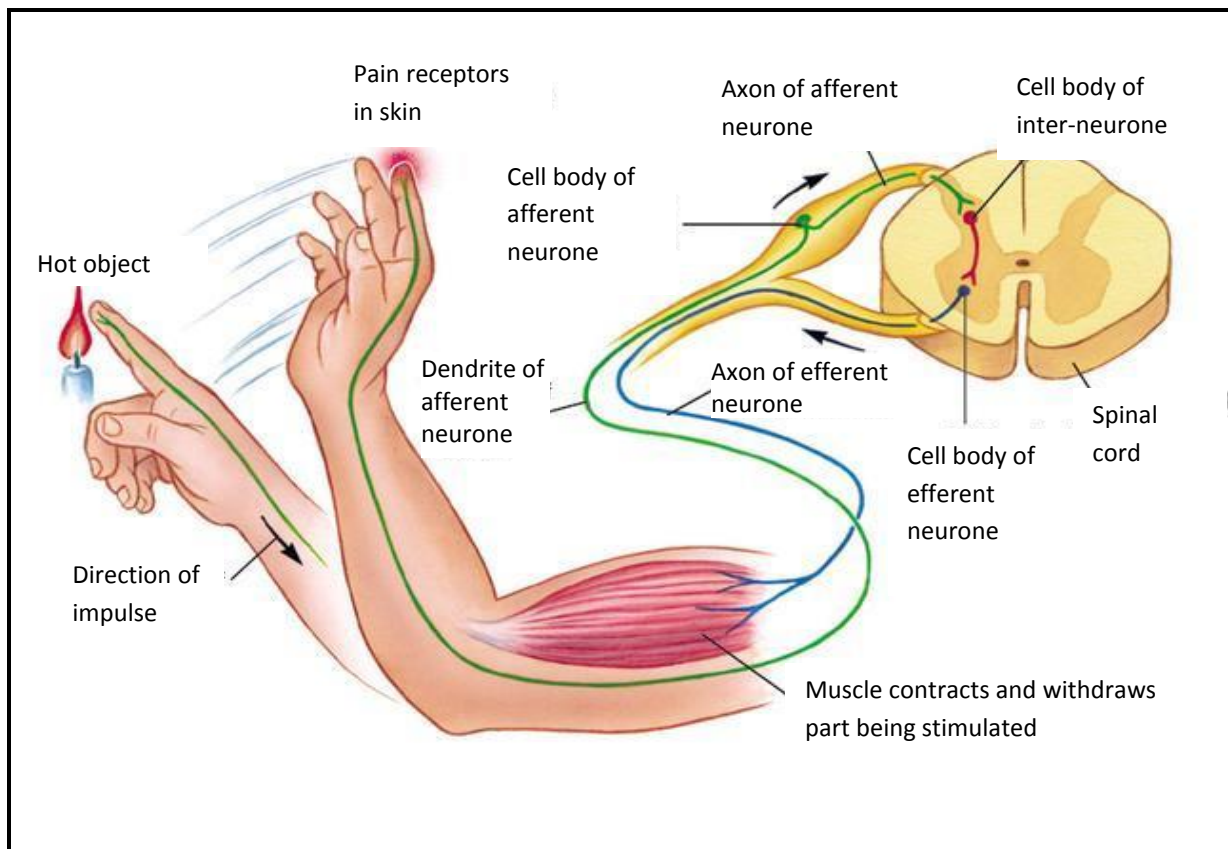
The **somatic nervous system** transmits electrical messages from the brain or spinal cord to the skeletal muscles. It is also called the **voluntary nervous system** because we can control our skeletal muscles by our brain.



The **autonomic nervous system** transmits electrical messages from our PNS to our body parts and not our brain. Therefore, if our brain does not process it, then it is not subject to conscious thought or thinking.

In this system we cannot control the electrical messages by our brain so it is also called the **involuntary nervous system**.

The diagram below is an example of an involuntary nerve cell.



The transmission of electrical impulse from the burning finger does not reach the brain. The muscle in the arm contracts and automatically withdraws the finger away from the flame. This is an example of how an involuntary nervous system works.

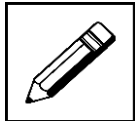


The autonomic nervous system can be further broken up into two (2) parts: the **sympathetic nervous system** and the **parasympathetic nervous system**. The sympathetic nervous system is the opposite of the parasympathetic nervous system.

For example, the sympathetic nervous system widens the blood vessels while the parasympathetic nervous system constricts the blood vessels. The sympathetic nervous system accelerates a heart and opens up a uterus while the parasympathetic nervous system slows the heart rate and contracts the uterus.

	<b>PARASYMPHATHETIC NERVES</b>	<b>SYMPATHETIC NERVES</b>
1	Closes the pupils of the eye	Opens the pupils of the eye
2	Makes the tongue to produce saliva	Stops the tongue from producing saliva
3	Closes the lungs	Opens the lungs
4	Slows the beating of the heart	Increases the beating of the heart
5	Begins the production of chemicals in the stomach to break down food	Stops the production of chemicals in the stomach from breaking down food.
6	Makes the liver to stop producing sugar from the liver.	Makes the liver to produce stored sugar from the liver.
7	Makes the gall bladder to break down fat.	Stops the gall bladder from breaking down fat.
8	Makes the stomach to begin to digest food.	Stops the stomach from digesting food.
9	Water comes into the bladder	Water exits the bladder

It is now time for you to complete Learning Activity 3 on the next page. Remember, learning activities are not sent in for assessment. However, this learning activity will help you complete Summative Test 5 (which you will send in for assessment)

**Learning Activity 3****20 minutes**

**A. Match the words on Column A with the definitions on Column B by writing the letter of the correct answer on the space provided before the number.**

**Column A**

- \_\_\_\_\_ 1. Nervous System
- \_\_\_\_\_ 2. Nerve Cells
- \_\_\_\_\_ 3. Central Nervous System
- \_\_\_\_\_ 4. Peripheral Nervous System
- \_\_\_\_\_ 5. Sensory Division
- \_\_\_\_\_ 6. Motor Division
- \_\_\_\_\_ 7. Somatic Sensory Neurons
- \_\_\_\_\_ 8. Visceral Sensory Neurons
- \_\_\_\_\_ 9. Somatic Nervous System
- \_\_\_\_\_ 10. Autonomic Nervous System

**Column B**

- A. It is the nerve cells that carry electrical impulses from inside the body, in kidneys and liver to the CNS.
- B. These are nerve cells that send electrical impulses from our spinal cord to our skeletal muscles without us controlling it. The action is done without us being in control.
- C. It is the nerve cells that carry electrical impulses from the outside the body only, such as the skin and eyes to the CNS.
- D. These are nerve cells that send electrical information from our CNS to our skeletal muscles and we control this action by our brain.
- E. This is the nerve cells that carry electrical impulses from the CNS to the muscles to action it.
- F. This is a structure that allows electrical impulses or information to travel through it.
- G. These are the nerve cells that are situated outside the CNS and make up the rest of the nervous system.
- H. These are the nerve cells that make up the brain and spinal cord only.
- I. It is the system that that makes you think, act and move.
- J. Carries electrical impulses both from inside and outside the body to the CNS.

**B. Circle the most appropriate answer from the four (4) options.**

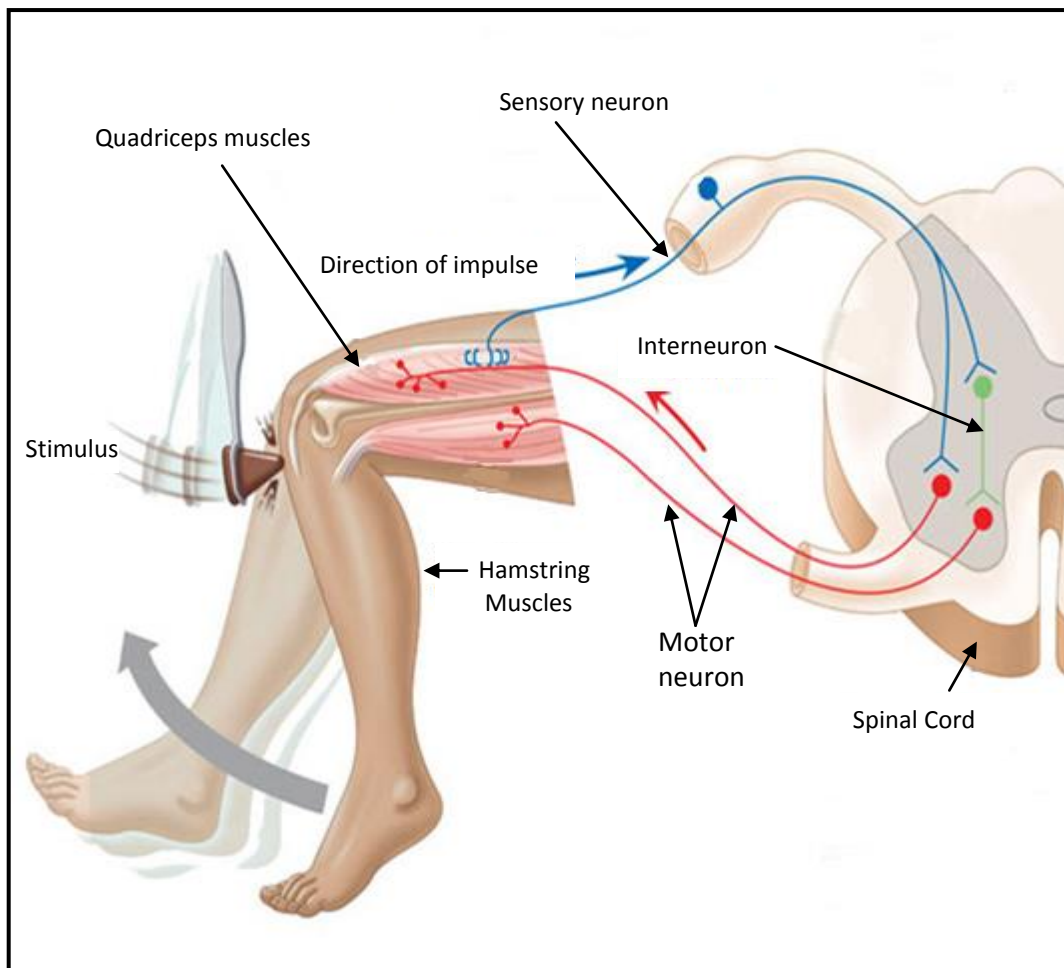
- The autonomic nervous system can also be called the \_\_\_\_\_ nervous system.
  - somatic
  - visceral
  - involuntary
  - voluntary
- The autonomic nervous system can be split into \_\_\_\_\_ part(s).
  - 1
  - 2
  - 3
  - 4
- The parasympathetic and the sympathetic nervous system both make up the autonomic nervous system. The parasympathetic nervous system would \_\_\_\_\_ pupils, while the sympathetic nervous system would \_\_\_\_\_ pupils.
  - open, close
  - close, open
  - open, open
  - close, close
- The parasympathetic and the sympathetic nervous system, both make up the autonomic nervous system. The parasympathetic nervous system would \_\_\_\_\_ heartbeat, while the sympathetic nervous system would \_\_\_\_\_ heartbeat.
  - increase, decrease
  - increase, increase
  - decrease, increase
  - decrease, decrease
- The parasympathetic and the sympathetic nervous system both make up the autonomic nervous system. The parasympathetic nervous system would \_\_\_\_\_ airways, while the sympathetic nervous system would \_\_\_\_\_ airways.
  - close, open
  - open, close
  - close, close
  - open, open

Thank you for completing your Learning Activity 3. Check your work. Answers are at the end of this module.



## Voluntary and Involuntary Reflexes

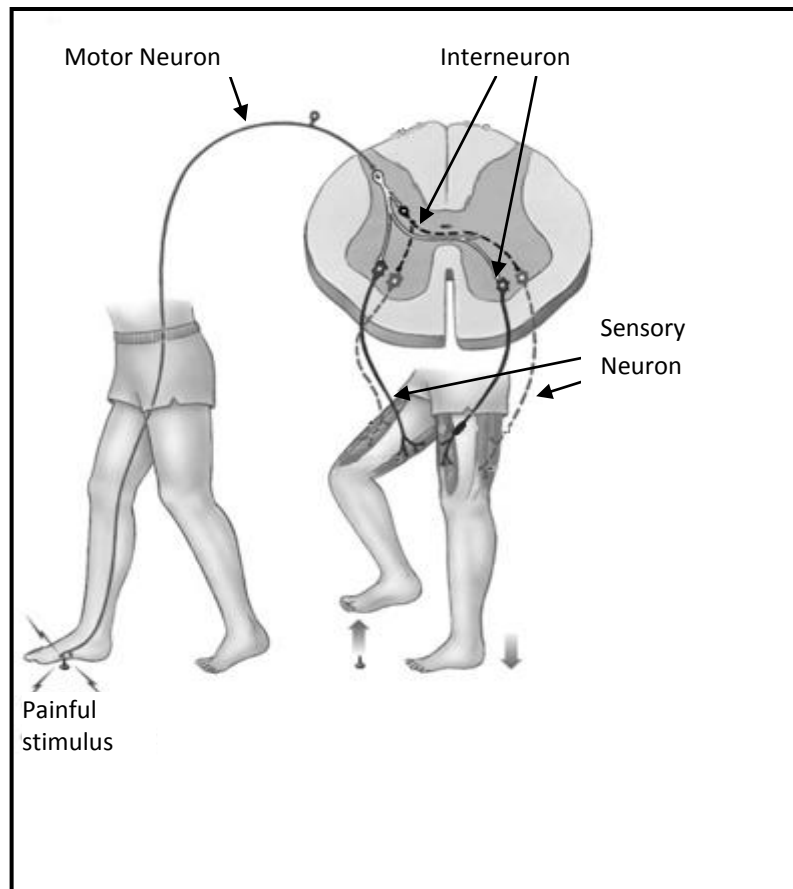
**Voluntary reflexes** are actions taken by the human body with information processed in the brain and the spinal cord. **Involuntary reflexes** are action taken by the human body without information from the brain or spinal cord. It is an **automatic response**.



The knee is hit to make the knee automatically rise up. The illustration shows how the direction of that impulse travels, without the brain controlling it. This is the patella reflex.

## Reflex arc

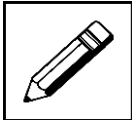
Voluntary reflexes include walking, picking up a rock, throwing, and swimming. The central nervous system controls all the actions. Involuntary reflexes include the **flexor withdrawal reflex** and the **patella reflex**. The flexor withdrawal enables you to lift up your foot before you even feel the pain of stepping on a pin.



The foot is hit and the reaction of the feet, immediately after it steps on the sharp object is immediate. It also clearly shows that the brain is not controlling the movement. This is known as the flexor withdrawal reflex.

Patella reflex is an action without the brain to enable the quick movement of the bottom leg upwards. This reflex occurs when knee is hit with a blunt object.

It is now time for you to complete Learning Activity 4 on the next page. Remember, learning activities are not sent in for assessment. However, this learning activity will help you complete Summative Test 5 (which you will send in for assessment)



### Learning Activity 4



20 minutes

**A. Match the words in Column A with the definitions in Column B by writing the letter of the correct answer on the space provided before the number.**

**Column A**

**Column B**

- \_\_\_\_\_ 1. Voluntary reflex
- \_\_\_\_\_ 2. Involuntary reflex
- \_\_\_\_\_ 3. Automatic Response
- \_\_\_\_\_ 4. Flexor Withdrawal Reflex
- \_\_\_\_\_ 5. Patella Reflex

- A. It is the reflex that makes the knee rise up when the knee is hit.
- B. It is a response done without the brain.
- C. A reflex when the leg is lifted immediately after stepping on sharp objects.
- D. A reflex done without the brain.
- E. A reflex done involving the brain.

**B. Short Answer**

Describe the differences and similarities between the voluntary and involuntary reflexes.

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Thank you for completing your Learning Activity 4. Check your work. Answers are at the end of this module.

**It is now time to complete your Practical Activity 5 in your Assessment Book 5 before going on to the next topic.**





### 11.5.3 Endocrine System

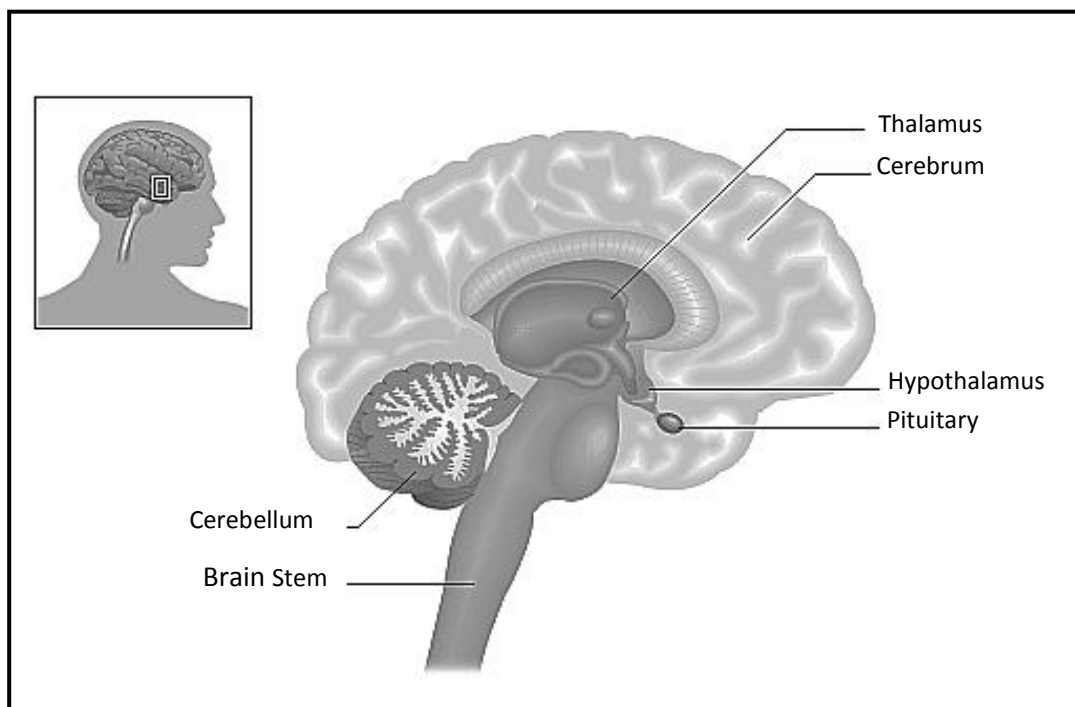
#### Components of the Endocrine System

The human **hormonal (endocrine) system** is similar to hormones in plants (such as auxin), which regulate the chemical reactions within the human body. Unlike the nervous system, the hormonal (endocrine) system takes time to set in. Hormones are produced by special structures called **endocrine glands**. There are about 10 endocrine glands and they are:

1. **hypothalamus**
2. **front and back pituitary gland**
3. **pineal gland**
4. **thyroid gland**
5. **parathyroid gland**
6. **pancreas**
7. **thymus gland**
8. **adrenal gland**
9. **ovaries**
10. **testes**

#### Endocrine Glands and their functions

1. The **hypothalamus** produces growth hormone-releasing hormone (GRH). This hormone tells the pituitary gland to start producing growth hormone. It also produces **gonadotropin** releasing hormone (GTRH). This hormone also tells the pituitary gland to start releasing luteinizing hormone (LH) and follicle stimulating hormone (FSH), which affects a woman's menstrual cycle.



The figure above shows the location of the hypothalamus and pituitary gland from inside the brain.

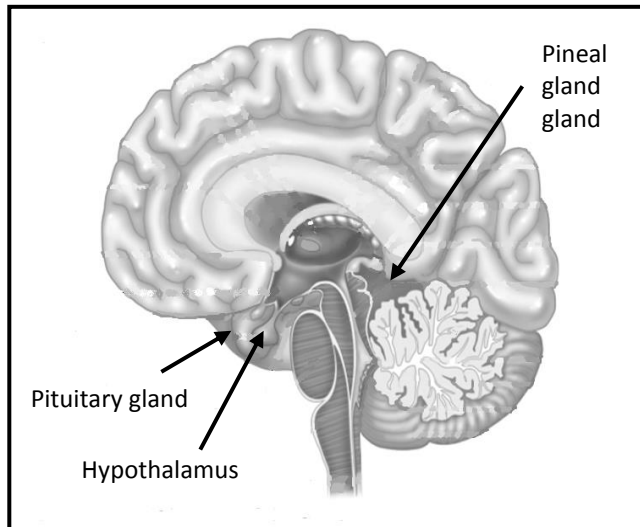


- The **pituitary gland** produces many important hormones such as growth hormone, which promote the body's growth and normal development.

Prolactin controls milk production and oxytocin gives the body a highly pleasurable feeling.

- The **pineal gland** is a small structure inside the brain that produces melatonin.

Melatonin helps a person to figure out if it is the morning, afternoon, or night time. It basically controls our body clock.

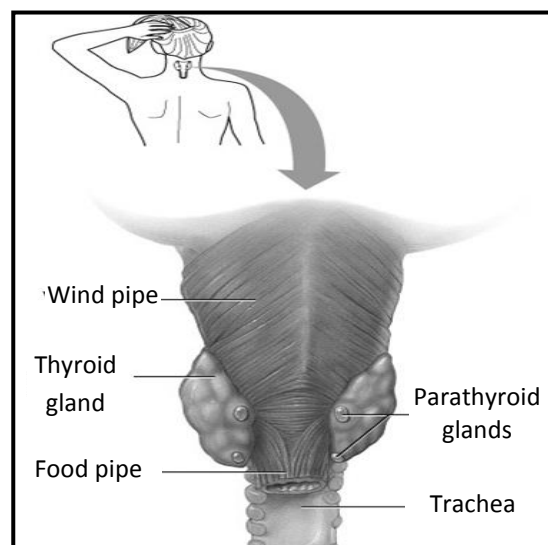
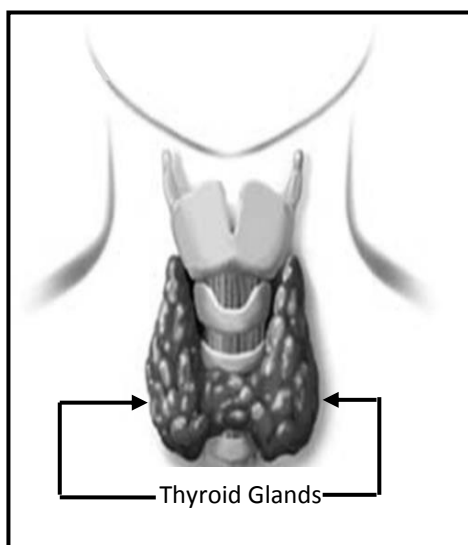


The location of the pineal gland. As you can see it is called "pineal" because it takes the shape of a pine nut.

- The **thyroid gland** produces thyroid-stimulating hormone (TSH). This hormone increases the rate of all the chemical reactions in the body and also helps with the growth and development.

The diagram below is showing clearly where the thyroid glands are situated. As you can see, it basically surrounds the wind pipe.

- The **parathyroid glands** produce parathyroid hormone (PTH). This hormone basically increases the calcium levels in the blood vessels.



The location of the parathyroid glands. They are small points surrounding the windpipe.



6. The **pancreas** is a glandular organ in the upper abdomen, situated between the two kidneys but really it serves as two glands in one: a digestive exocrine gland and a hormone-producing endocrine gland.

Functioning as an exocrine gland, the pancreas excretes enzymes to break down the proteins, lipids, carbohydrates, and nucleic acids in food. Functioning as an endocrine gland, the pancreas secretes the hormones **insulin** and **glucagon** to control blood sugar levels throughout the day. Both of these diverse functions are vital to the body's survival.

7. The **thymus gland** produces the hormone thymosine to cause a particular type of white blood cell to mature and become fully developed.
8. The **adrenal glands**, located at the top of each kidney, produce hormones that help the body control blood sugar, burn protein and fat, react to stressors like a major illness or injury, and regulate blood pressure. Two of the most important adrenal hormones are **cortisol** and **aldosterone**.

**Cortisol** is a life sustaining adrenal hormone essential to the maintenance of homeostasis. Called "the stress hormone," cortisol influences, regulates or modulates many of the changes that occur in the body in response to stress.

**Aldosterone**, a steroid hormone secreted by the adrenal glands. Aldosterone serves as the principal regulator of the salt and water balance of the body, also has a small effect on the metabolism of fats, carbohydrates, and proteins.

The adrenal glands also produce **adrenaline** and small amounts of sex hormones called **androgens**, among other hormones.

**Adrenaline** gives you an instant burst of superhuman strength and helps one escape in a life and death situation or fight for survival..

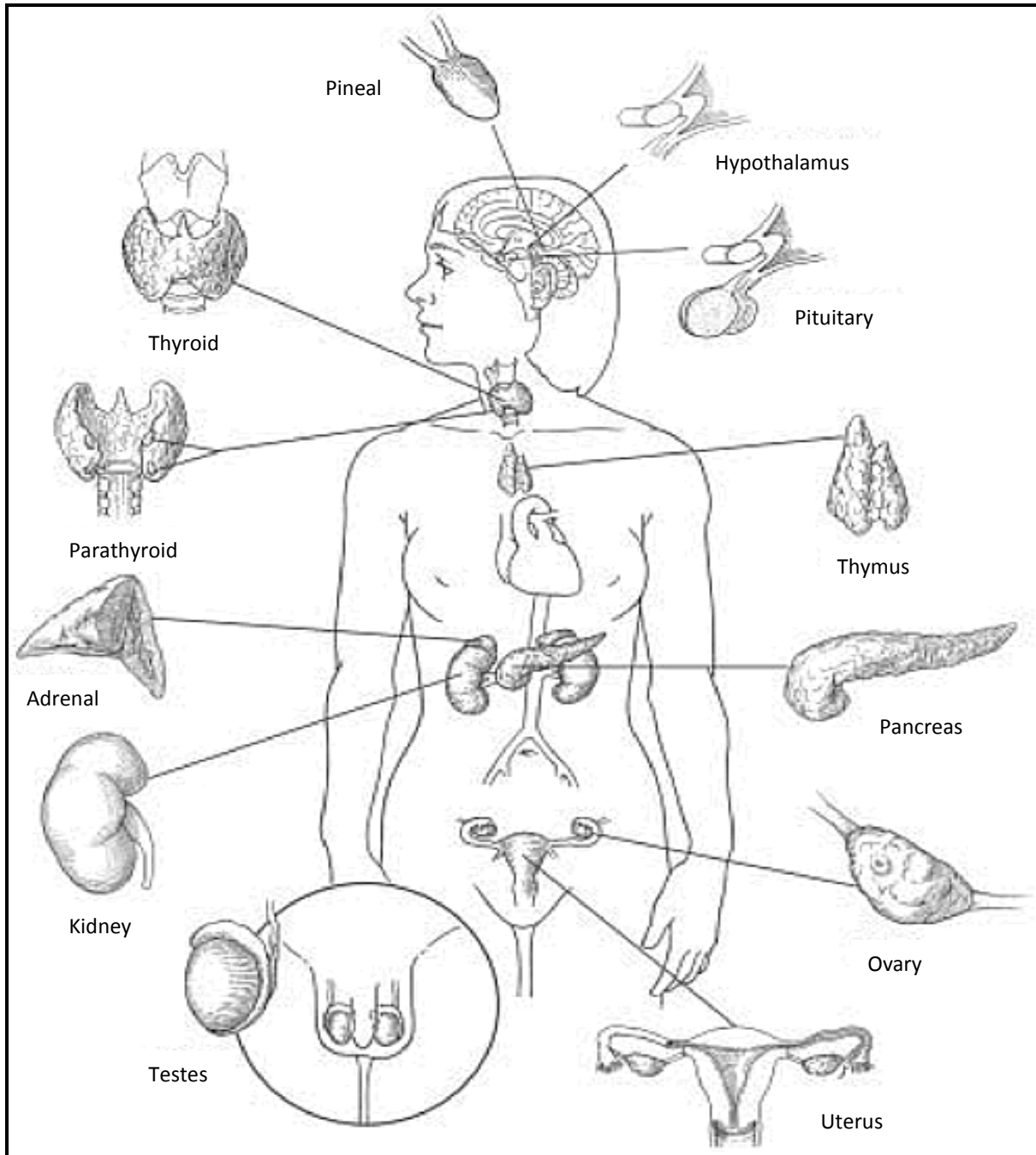
9. The **ovaries** produce two hormones, namely: estrogen and progesterone.  
**Estrogen** stimulates the normal development of the ovaries.  
**Progesterone** prepares a woman's womb for a baby and prepares a woman's breasts for breastfeeding.
10. The **testes** produce testosterone. **Testosterone** helps to produce sperm, develop the penis, and causes males to have a deep voice.

**Hormonal glands** can be classified according to them releasing their hormones to nearby cells or hormones being pumped directly into the bloodstream. If the hormones are released to nearby cells then they are called **exocrine glands/organs**.



Organs of this type have tubes that carry their output to nearby cells where it will act on, for example, liver, salivary glands in the mouth and the sweat glands in the skin. If hormones are released directly into the bloodstream then they are called **endocrine glands**.

Study the diagram below showing the locations of the ten (10) endocrine glands in the human body.



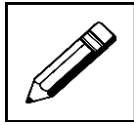
The locations of the ten (10) endocrine glands in the human body



The table below explains what hormones are produced by the glands and their effects are to the human body.

	<b>ENDOCRINE GLAND</b>	<b>FUNCTION</b>
1	Hypothalamus	The hypothalamus makes hormones that control the pituitary gland. In addition, it makes hormones that are stored in the pituitary gland.
2	Pineal Gland	The pineal gland releases melatonin, which is involved in rhythmic activities such as sleep-wake cycles.
3	Pituitary Gland	The pituitary gland produces hormones that regulate many of the other endocrine glands.
4	Thyroid Gland	The thyroid produces thyroxine, which regulates metabolism.
5	Parathyroid Gland	These four glands release parathyroid hormone, which regulate the level of calcium in the body.
6	Pancreas	The pancreas produces insulin and glucagon, which regulate the level of glucose in the blood.
7	Thymus	During childhood, the thymus releases thymosin, which stimulates T-cell production.
8	Ovary	The ovaries produce estrogen and progesterone. Estrogen is required for the development of secondary sexual characteristics and for the development of eggs. Progesterone prepares the uterus for fertilised eggs.
9	Adrenal Glands	The adrenal glands produce hormones, cortisol and aldosterone that help the body control blood sugar, burn protein and fat, react to stressors like a major illness or injury, and regulate blood pressure.
10	Testis	The testes produce testosterone, which is responsible for sperm production and the development of males secondary sexual characteristics.

It is now time for you to complete Learning Activity 6 on the next page. Remember, learning activities are not sent in for assessment. However, this learning activity will help you complete Summative Test 5 (which you will send in for assessment)

**Learning Activity 6****20 minutes**

Match the words on Column A with the definitions on Column B by writing the letter of the correct answer on the space provided before the number.

**Column A**

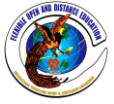
- \_\_\_\_\_ 1. Pineal gland
- \_\_\_\_\_ 2. Hypothalamus
- \_\_\_\_\_ 3. Pituitary gland
- \_\_\_\_\_ 4. Thymus gland
- \_\_\_\_\_ 5. Thyroid gland
- \_\_\_\_\_ 6. Parathyroid gland
- \_\_\_\_\_ 7. Pancreas
- \_\_\_\_\_ 8. Adrenal gland
- \_\_\_\_\_ 9. Testes
- \_\_\_\_\_ 10. Ovaries

**Column B**

- A. Produces oxytocin that gives the body a very desirable feeling. It is also one of the main glands.
- B. These glands produce testosterone that gives males their secondary sexual characteristics.
- C. This gland produces melatonin that affects our body clock.
- D. This gland produces PTH (parathyroid hormone) that regulates or controls the calcium levels in the blood.
- E. This gland produces adrenaline that gives humans superhuman strength to escape danger.
- F. This gland produces LH( lutenizing hormone)
- G. This gland produces thymosine, which causes certain types of white blood cells to fully mature.
- H. This gland works alongside the pituitary gland.
- I. Produces insulin that lowers blood sugar level.
- J. This gland produces TSH (thyroid-stimulating hormone ) that increases all the body's chemical reactions.

Thank you for completing your Learning Activity 3. Check your work. Answers are at the end of this module.

**REVISE WELL USING THE MAIN POINTS ON THE NEXT PAGE**



## SUMMARY

You will now revise this module before doing **SUMMATIVE TEST 5**. Here are the main points to help you revise. Refer back to module topics if you need more information.

- There are five (5) main plant hormones that affect the growth and development of a plant and they are: (1) Auxin, (2) Abscissic Acid, (3) Cytokinins, (4) Gibberellin, & (5) Ethylene.
- There are two main external factors that affect a plant's growth and they are light and gravity.
- There are two main plant responses: phototropism and geotropism.
- The four other external factors that affect a plant's growth are touch, water, chemicals, and varying lengths of daylight.
- The four other types of plant tropisms are thigmotropism, hydrotropism, chemotropism, and photoperiodism.
- The nervous system is made up of the Central Nervous System (CNS) and the Peripheral Nervous System (PNS).
- The peripheral nervous system (PNS) is made up of the sensory (afferent) nervous system and the motor (efferent) nervous system.
- The sensory (afferent) nervous system is made up of the somatic sensory neurons and the visceral nervous neurons.
- The motor (efferent) nervous system is made up of the autonomic nervous system and the somatic nervous system.
- The autonomic nervous system is made up of the sympathetic nervous system and parasympathetic nervous system.
- Nerve cells can be called neurons.
- There are three types of neurons: afferent (sensory) neurone, efferent (motor) neurone, and the connecting (interneurone) neurone.
- The main structures of a neurone (nerve cell) are the dendrites, cell body, axon, and myelin sheath.
- Voluntary reflexes mean the body does an action which is processed by the brain and involves conscious thinking.
- Involuntary reflexes mean the body does an action, but without the brain processing the information. Therefore, it is automatic.
- The endocrine (hormonal) system controls the internal body reactions by producing chemical substances called hormones.
- There are ten (10) main endocrine glands that produce hormones. They are the hypothalamus, pituitary gland, pineal gland, thymus gland, thyroid gland, parathyroid gland, adrenal gland, pancreas, ovaries, and testes.
- Nervous system and endocrine system work together to maintain our body at an optimum condition.
- The nervous system is rapid and only takes a few milliseconds, while the endocrine (hormonal) system takes time and effects are seen and experienced over an extended period of time.



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**NOW DO SUMMATIVE TEST 5 IN YOUR ASSESSMENT BOOK AND SEND IN TO THE  
PROVINCIAL COORDINATOR FOR MARKING**

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## ANSWERS TO LEARNING ACTIVITIES 1 - 6

### Learning Activity 1

- A.** (1) (c) (2) (b) (3) (c) (4) (a) (5) (d)
- B.** (1) False (2) True (3) True (4) False (5) True
- C.**
- (1) An external factor is anything that can affect a plant's growth from the plants immediate outside environment. These external factors include light, touch, water, chemicals, gravity, and daylight variability.
  - (2) The three (3) main types of tropisms are phototropism, geotropism or gravitropism and hydrotropism. Phototropism is the growth of a plant that is influenced by light and geotropism/ gravitropism is the growth of a plant that is affected by gravity. Hydrotropism is the growth of plants towards water.
  - (3) Positive phototropism and negative phototropism are both plant responses influenced by external factors. Positive phototropism is the growth of the plant, such as the leaves and stems, towards the direction of sunlight. Negative phototropism is the growth of the plant part, such as the roots away from light. That is why it is called negative. Hence, the roots grow towards the pull of gravity.
  - (4) Positive geotropism and negative geotropism are both plant responses influenced by external factors. Positive geotropism is the growth of plant part, such as the roots, towards the pull of gravity. Negative geotropism is the growth of a plant part, such as the stem or leaves, away from the pull of gravity. That is why it is called negative.
- 

### Learning Activity 2

- (1)
    - a) The myelin sheath
    - b) It controls the flow of the electrical impulse by not allowing some of the electrical signals to flow away.
-





- (2) In the motor division the effector (motor) division, the effector (motor) neuron and the interneuron. In the affector (sensory) division, the affector (sensory) neuron and the interneuron are both found. The voluntary and involuntary system is both part of the motor division.
- 

### Learning Activity 3

#### A.

- |      |       |
|------|-------|
| 1. I | 6. D  |
| 2. F | 7. C  |
| 3. H | 8. A  |
| 4. G | 9. E  |
| 5. J | 10. B |

#### B.

- (1) (c)                      (2) (b)                      (3) (b)                      (4) (c)                      (5) (a)
- 

### Learning Activity 4

#### A.

1. E                      2. D                      3. B                      4. C                      5. A

#### B.

- (1) The voluntary and involuntary reflexes are both part of the motor division. The voluntary reflex is an action done by the body that is controlled or influenced by the brain and subject to conscious thinking. For example, walking, running, jogging and picking up a stone. The involuntary reflex is an action done by the body that is not controlled by the brain and so is automatic. For example, when the knee is in a bent position and if it was hit by a small hammer, the knee will automatically move up, without the brain processing the information. This action is known as the knee jerk reflex.
- 

### Learning Activity 5

- |      |       |
|------|-------|
| 1. C | 6. D  |
| 2. H | 7. I  |
| 3. A | 8. E  |
| 4. G | 9. B  |
| 5. J | 10. F |
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## REFERENCES

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Judith Kinnear & Marjory Martin, Nature of Biology, Fourth Edition, Book 1, 2006, John Wiley & Sons Australia Limited, Australia.

Judith Kinnear & Marjory Martin, Nature of Biology, Third Edition, Book 2, 2006, John Wiley & Sons Australia Limited, Australia.

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homepage.smc.edu/...../nervoussystempp.....

<http://www.studyblue.com/...../10-biology....>

<http://www.innerbody.com/image/endo03.html>

<http://www.hormone.org/diseases-and-conditions/adrenal>

nervous system(www2.ku.edu/~lba/courses/...../6d.pdf

people.fmarion.cdu/..../236%20lab%20-....

pubs.niaaa.nih.gov/publications/...../153.p....

sinoemicalassociation.org.

web.calstatela.edu/faculty/...../reflexes.ppt

www.africangreyparrott.com/endocrines.....

www.azhosa.org/org/v2/...../nervoussystem.p.....

www.chatt.hdsb.ca/...../reflex%20arc.ppt?.....

www.lavc.edu/...../lecture%2025%20-%2.....

www.saylor.org/...../the-endocrine system....

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## FODE SUBJECTS AND COURSE PROGRAMMES

GRADE LEVELS	SUBJECTS/COURSES
Grades 7 and 8	1. English
	2. Mathematics
	3. Personal Development
	4. Social Science
	5. Science
	6. Making a Living
Grades 9 and 10	1. English
	2. Mathematics
	3. Personal Development
	4. Science
	5. Social Science
	6. Business Studies
	7. Design and Technology- Computing
Grades 11 and 12	1. English – Applied English/Language& Literature
	2. Mathematics – General/Advance
	3. Science – Biology/Chemistry/Physics
	4. Social Science – History/Geography/Economics
	5. Personal Development
	6. Business Studies
	7. Information & Communication Technology

### REMEMBER:

- For Grades 7 and 8, you are required to do all six (6) subjects.
- For Grades 9 and 10, you must complete five (5) subjects and one (1) optional to be certified. Business Studies and Design & Technology – Computing are optional.
- For Grades 11 and 12, you are required to complete seven (7) out of thirteen (13) subjects to be certified.

Your Provincial Coordinator or Supervisor will give you more information regarding each subject and

**Notes:** You must seek advice from your Provincial Coordinator regarding the recommended courses in each stream. Options should be discussed carefully before choosing the stream when enrolling into Grade 11. FODE will certify for the successful completion of seven subjects in Grade 12.

### GRADES 11 & 12 COURSE PROGRAMMES

No	Science	Humanities	Business
1	Applied English	Language & Literature	Language & Literature/Applied English
2	Mathematics -General/Advance	Mathematics -General/Advance	Mathematics –General/Advance
3	Personal Development	Personal Development	Personal Development
4	Biology	Biology/Physics/Chemistry	Biology/Physics/Chemistry
5	Chemistry/ Physics	Geography	Economics/Geography/History
6	Geography/History/Economics	History / Economics	Business Studies
7	ICT	ICT	ICT

### CERTIFICATE IN MATRICULATION STUDIES

No	Compulsory Courses	Optional Courses
1	English 1	<b>Science Stream:</b> Biology, Chemistry, Physics
2	English 2	<b>Social Science Stream:</b> Geography, Intro to Economics and Asia and the Modern World
3	Mathematics 1	
4	Mathematics 2	
5	History of Science & Technology	

### REMEMBER:

You must successfully complete 8 courses: 5 compulsory and 3 optional.