M.S.C.E biology summary NOTES
Book 4
By uncle pofu

Chapter one: Tropisms

Tropism is a growth movement whose direction is determined by the direction from which the stimulus strikes the plant. In other words, it is the growth of plants towards the direction of stimuli. Examples of the stimuli are, water, gravity, light, and chemicals. The growth movement can be categorized into two and described below;

- Positive tropism = the plant, or a part of it, grows in the direction from which the stimulus originates.
- Negative tropism = growth away from the stimulus

Types of tropisms

There are many types of tropisms some of which are;

1. Chemotropism, movement or growth in response to chemicals
2. Geotropism (or gravitropism), movement or growth in response to gravity
3. Heliotropism, movement or growth in response to sunlight
4. Hydrotropism, movement or growth in response to water
5. Phototropism, movement or growth in response to lights or colors of light (e.g.- the sunflower)
6. Thermotropism, movement or growth in response to temperature
7. Electrotropism, movement or growth in response to an electric field
8. Thigmotropism, movement or growth in response to touch or contact

Phototropism

Phototropism is directional growth in which the direction of growth is determined by the direction of the light source. In other words, it is the growth and response to a light

stimulus. Phototropism is most often observed in plants, but can also occur in other organisms such as fungi (*Phycomyces)*. The cells on the plant that are farthest from the light have a chemical called auxin that reacts when phototropism occurs. This causes the plant to have **elongated cells** on the farthest side from the light. Phototropism is one of the many plant tropisms or movements which respond to external stimuli.

The plants below show phototropism

Importance of positive phototropism

The growth of the shoot towards light exposes the leaves to light for photosynthesis.

Note:

- Growth towards a light source is a **positive phototropism**, while growth away

from light is called negative phototropism (or Skototropism).

- Most plant shoots have positive phototropism, while roots usually exhibit negative phototropism, although gravitropism may play a larger role in root behavior and growth.
- Some vine shoot tips exhibit negative phototropism, which allows them to grow towards dark, solid objects and climb them.

Geotropism (Gravitropism)

This is a turning or growth movement by a plant or fungus in response to gravity. In most plants the roots show positive geotropism while most stems exhibit negative geotropism. That is, roots grow in the direction of gravitational pull (i.e., downward) and stems grow in the opposite direction (i.e., upwards). However, they are other plants like the one below where by its stem shows positive geotropism.

Example of Gravitropism; A roman villa in the Archeologic Park in Baia, Italy

Importance of positive geotropism

It helps the plant to absorb water and other nutrients from the soil by using the roots.

Hydrotropism

Hydrotropism (*hydro* = water; *tropism* = involuntary orientation by an organism, that

involves turning or curving as a positive or negative response to a stimulus) is a plant's growth response in which the direction of growth is determined by a stimulus or gradient in water concentration. A common example is plant roots growing in humid air bending toward a higher relative humidity level. This is of biological significance as it helps to increase efficiency of the plant in its ecosystem.

Note:

Hydrotropism is difficult to observe because of the following two reasons;

- ✓ Roots grow in the ground.
- ✓ Root gravitropism is usually more influential than root hydrotropism.
- ✓ Water is not as strongly directional factor as gravity for gravitropism.
- ✓ Water readily moves in soil and soil water content is constantly changing so any gradients in soil moisture are not stable.

Plant hormones in Tropism

Plant hormones are chemicals that regulate plant growth. They are sometimes called ‘plant growth substances'. These hormones are produced by the plants themselves. However, the plant is able to regulate the rate at which it is produced. Since the plants do not contain glands as in animals, each cell is capable of producing hormones. It should be noted that hormones are not nutrients.

Functions of plant hormones

- ✓ They regulate cellular processes in targeted cells such as metabolism.
- ✓ Hormones also determine the formation of flowers, stems, leaves, the shedding of leaves

- ✓ They also help in the development and ripening of the fruits.

In summary, plant hormones shape the plant, affecting seed growth, time of flowering, the sex of flowers, senescence of leaves, and fruits. They affect which tissues grow upward and which grow downward, leaf formation and stem growth, fruit development and ripening, plant longevity, and even plant death. Hormones are vital to plant growth, and, lacking them, plants would be mostly a mass of undifferentiated cells.

How do hormones move in plants?

The hormones move from one part of the plant to the other through the following methods.

- Cytoplasm streaming thus within the cell.
- Diffusion.
- Vascular bundles thus the xylem and phloem.

Classes of plant hormones

There are different kinds of hormones and the notable ones are *auxins, ethylene, gibberellins, abscisic acid (ABA) and cytokinins.*

Auxins

This is the most important hormone in plants.

Function:

- ✓ Influence cell enlargement, bud formation and root initiation.
- ✓ They also promote the production of other hormones and in conjunction with cytokinins.
- ✓ They control the growth of stems, roots, and fruits, and convert stems into flowers.

They affect cell elongation by altering cell wall plasticity. They stimulate cambium, a

subtype of meristems cells, to divide and in stems cause secondary xylem to differentiate.

CHAPTER TWO: RESPIRATORY SYSTEM

This is the process by which glucose is broken down to release energy in the cells.

Types of respiration

i. Aerobic respiration

This is the type of respiration which uses oxygen to breakdown glucose to release energy. The reaction in which glucose is combined with oxygen is called oxidation. The energy which is produced is in the form of ATP (Adenosine Triphosphate). The ATP are large molecules that are used for energy storage.

Glucose (oxygen (carbon dioxide(water (2898kJ of energy

Food substances like carbohydrates and fats contain chemical energy which is converted into ATP during respiration. The energy stored in ATP is used for the following;

- Muscles contraction
- Nerve impulse conduction
- Production and secretion of enzymes
- Repair of worn out cells.
- Production of new cells.
- Active transport

ii. Anaerobic respiration

This is the type of respiration which breaks down glucose to release energy in the absence of oxygen. In this type of respiration less energy is released ie 210kJ. When it occurs in plants the by products are Ethanol and Carbon dioxide. When it occurs in animals muscle cells the by products is lactic acid.

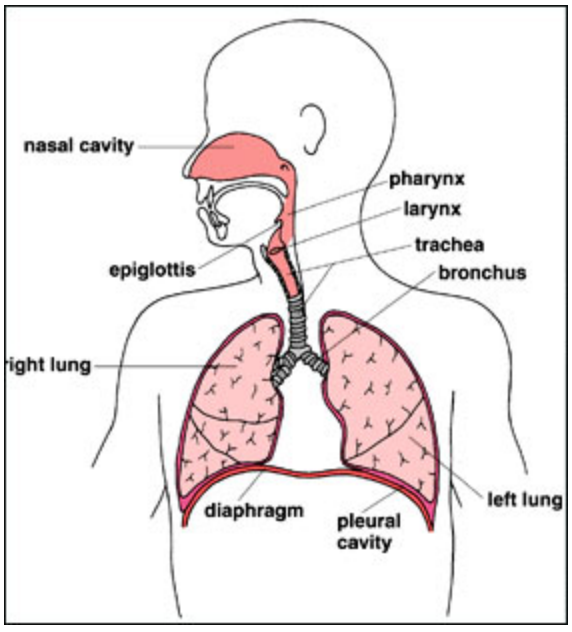
In plants; Glucose (ethanol (Carbon dioxide(210kJ of energy

In animals; Glucose(lactic acid(150kJ of energy

Breathing in man

- Breathing is the taking of air in and out of the lungs.
- During breathing, oxygen is taken into the lungs to be used in respiration while carbon dioxide produced during respiration is taken out.
- The gaseous exchange is important because it ensures supply of oxygen and removal of carbon dioxide.

The human respiratory tract

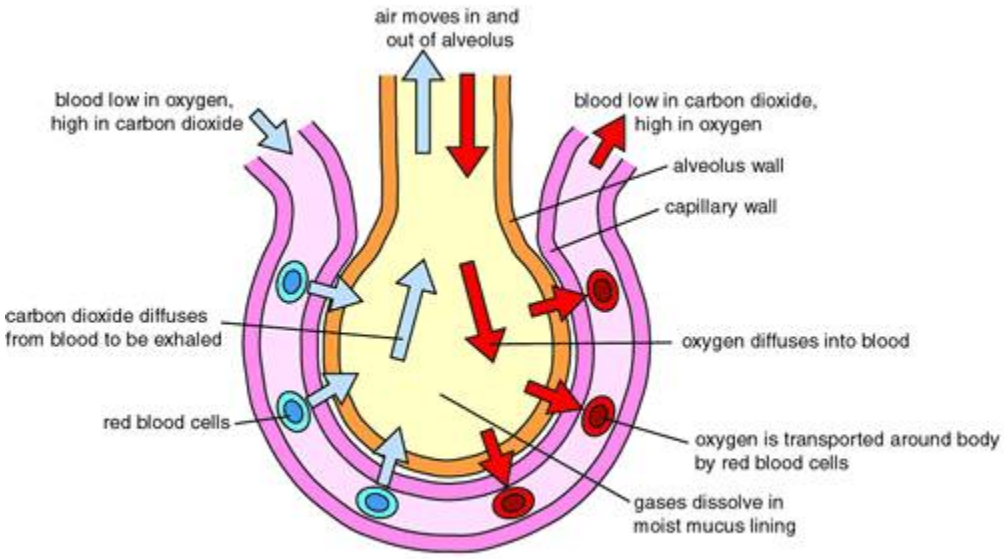


- **Nasal cavity;** this is the passage of air from outside. It has got hairs which filter the air by trapping germs and the dust. It also has cells that produce moisture

which moistens the air. The cells also supply heat which makes the air to be come warm.

- **Trachea;** this is a tube that is connected to the nasal cavity. It is joined to the mouth cavity. The top part has got a soft and a flap of cartilage called the epiglottis which prevents food being swallowed from the mouth from going into it. The trachea is made up of rings of cartilage which always keep it open. The inner lining has got which produces mucus which traps germs and dust. There is also presence of cilia which always beat upwards to remove the dust and germs.
- **Bronchi;** these are two tubes which branch from the trachea. Each bronchi goes into each lung. These are also made up of ring of cartilage which makes them to remain open all the time. They also have cilia and mucus which filters the air.
- **Bronchioles;** these arise from the bronchi. They also branch repeatedly and end up into smallest spaces in the lungs called **alveoli.** The bronchioles are so numerous that they reach each and every space called the alveolus.
- **Alveolus;** this is the smallest cavity in the lungs where gaseous exchange of oxygen and carbon dioxide takes place with the blood. It has a very thin wall and is surrounded by a network of blood capillaries. Gaseous exchange occurs through **diffusion**. Oxygen is picked up by haemoglobin on the red blood cells. Carbon dioxide is transported by the plasma.

Structure of the alveolus



Features that facilitate efficient diffusion of gases in the alveolus

- **Very thin wall;** the alveolus has a very thin wall. This makes diffusion to occur rapidly since there is a short distance for gas to move across.
- **It is surrounded by a dense network of blood capillaries**. These blood capillaries bring a lot of blood into which oxygen diffuses and carbon dioxide comes out.
- **A thin layer of moisture;** the inner lining has got a layer of moisture into which oxygen diffuses. The oxygen is therefore brought very close to the alveolar wall for easy diffusion across the wall.
- **Maintenance of diffusion gradient for oxygen and carbon dioxide;**
    - This is so because; breathing in maintains high concentration of oxygen in the alveolus than in the blood. Diffusion then occurs easily.
    - Breathing out maintains a lower concentration of carbon dioxide in the alveolus than in the blood. Carbon dioxide then diffuses easily out of the blood into the alveolus.
    - Continuous flow of blood maintains a low concentration of oxygen in the blood. It also maintains a high concentration of carbon

dioxide in the blood than in the alveolus.

Changes in composition of breathing air

	Inhaled air	Exhaled air
Oxygen	20.93%	16.4%
Carbon Dioxide	0.03%	4.1%
Nitrogen	79.04%	79.04%
Water vapour	Variable	saturated

Breathing mechanism

Breathing is regulated by the medulla oblongata. It works in conjunction with the hypothalamus which detects the level of carbon dioxide in the blood.

One breath is made up of inhalation (breathing in) and exhalation (breathing out)

Inhalation

When breathing in the external intercostals muscles contracts therefore pulling then ribs up and outwards. This increases the volume of the chest cavity. The diaphragm also contracts and moves downwards thereby increasing the volume of the chest cavity. Due to the increase in the volume of the chest cavity, the air pressure in the lungs decreases. Air from outside rushes into the lungs.

Exhalation

When breathing out, the internal intercostals muscles contract and pull the ribs down inwards. The diaphragm relaxes and moves upwards. These cause the volume of the chest cavity to decrease. Due to the decrease in the chest cavity, the air pressure in the lungs increases. As a result air rushes out of the lungs to the atmosphere.

Lung capacity

The total volume of the lungs when fully inflated is about 5.0 litres in an adult. An adult can have 5.0 litres of air in the lungs when there is deep breathing in.

- Tidal air; this is the small amount of air that is breathed in and out when at rest or asleep.
- Complemental air; this is additional air which is breathed in during deep breathing.
- Supplementary air; this is the additional air which is breathed out during deep breathing.
- Residual air this is the amount of air which is always left in the lungs during deep breathing.
- Vital capacity; this is the additional amount of air that is breathed in and out during physical exercise.

Breathing rate

- This is the number of breaths per minute. At rest breathing is low and shallow while when conducting physical exercise it becomes deep and fast.
- Fast breathing removes as much carbon dioxide from the lungs as possible and also supplies as much oxygen to the lungs as possible.

Graph showing breathing rate when at rest

Graph showing breathing rate during a physical exercise

Carbon monoxide poisoning

- Carbon monoxide is a product of incomplete combustion. When breathed in it is attracted by the haemoglobin on the red blood cells instead of oxygen. This causes the body cells fail to receive oxygen. This causes carbon monoxide poisoning.
- Carbon monoxide poisoning can be treated by giving the patient a lot of air and by conducting mouth to mouth resuscitation.

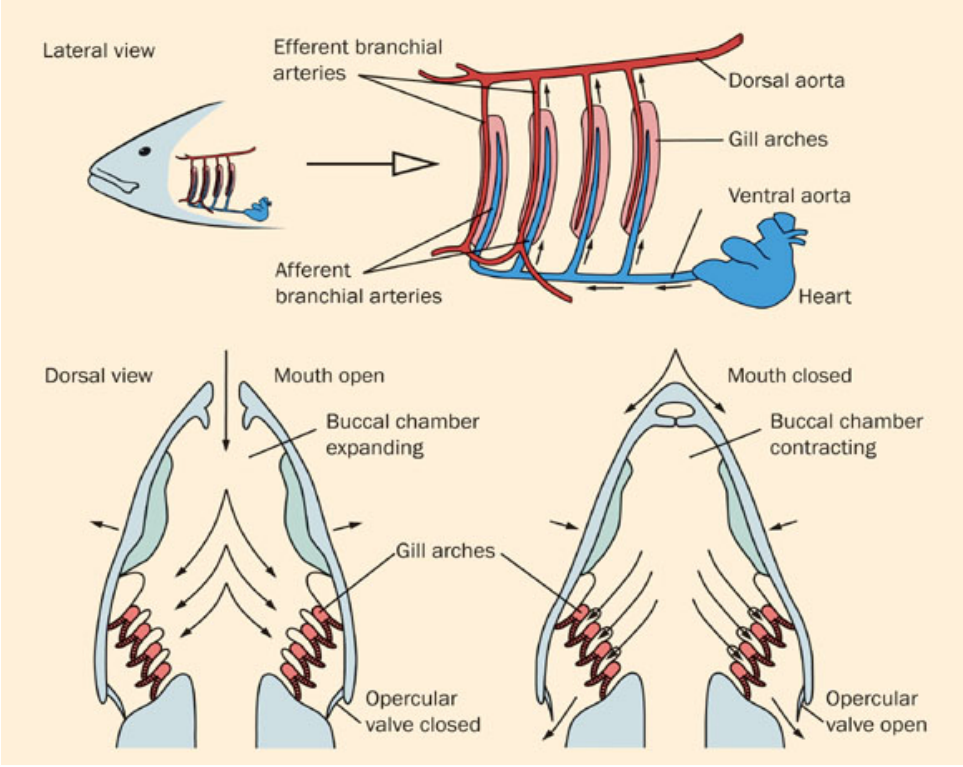
Effects of smoking on the lungs

- Smoking cause lung infections like bronchitis
- Smoking can lead to development of lung cancer.
- Smoking in pregnant mothers makes the babies born to have stunted growth.
- Smoking can lead to addiction.

Respiration in fish

- Fish is an example of an organism which live in water. They also require oxygen for energy production. They get the oxygen from the water that dissolves in it from the atmosphere. Fish extract the oxygen from the water by using the gills.

Structure of the gills



Functions of the part of the gills.

- **Gill bar (gill arch);** this is a bony structure that supports the gill.

- **Gill rakers;** these are thick projection found on the inner part of the gill bar. They trap the solid particles taken together with the water. The particles are then swallowed as food.
- **Gill filaments (lamellae);** these are thin projections found on the outer part of the gill bar. This is a place where gaseous exchange occurs in fish.
- **Operculum;** this is bony structure which covers the surface of the gills. It protects the gill from external damage.

Adaptations of gill lamellae for gas exchange

- They are very tin; this provides a short distance through which gas diffuse.
- They have a very good supply of blood capillaries. These maintains diffusion gradient of oxygen and carbon dioxide.
- They have a large surface area for maximum absorption of oxygen.
- They are always moist so that they do not stick to each other.

During breathing in water is drawn into the mouth cavity while during breathing out water is drawn out. The water that is drawn in has the following functions;

- It supplies oxygen to the gills as the water flows over the surface of the gills.
- It takes carbon dioxide away from the fish as it flows over the gills.
- It supplies food to the fish.
- It helps the fish to move forward.

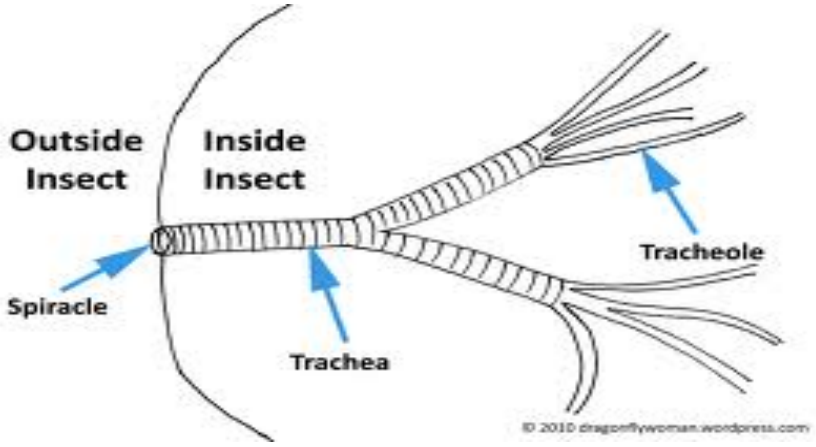
Respiration in insects

Gaseous exchange in insects takes place by using the **tracheole system.** Insects have got openings called **spiracles** on the segments in the thorax and abdomen. Each segment has got a pair of spiracles.

Each spiracle opens into a tube called the **trachea.** The trachea is made up of a ring of

chitin. Chitin is a tough substance which prevents the trachea from collapsing when the insect body contracts. As the trachea gets deeper into the body it divides further into small tubes called **tracheoles.** These tracheoles lead the air directly into the tissue cells. This is where gaseous exchange occurs through diffusion. Tracheoles have no chitin instead they have a thin wall and moisture for oxygen diffusion

Diagram of a tracheal system



Insects suck in air by relaxing muscles of the abdomen which leads to the increase in volume of the trachea system. Air is pushed out when the abdomen contracts to squeeze the air out.

Note; insect blood has got no haemoglobin hence it does not transport oxygen. Oxygen diffuses directly into the cells. The blood transports digested food substances.

CHAPTER THREE :Excretory SYSTEM

Excretion is the removal of unwanted substances made by cells in the process of metabolism. Metabolism is the chemical reactions that occur in a cell. The process of excretion takes place in both plants and animals.

Excretion in plants

During the process of photosynthesis, glucose and oxygen are produced. The plant then uses the glucose and oxygen in different ways such as respiration but also the general growth of the plants. The excess oxygen is removed from the plants through the stomata. This removal is called excretion.

Excretion in animals

Unlike plants animals are very complicated organisms. In the body of multicellular animals such as people different organs carry out the process of excretion. The table below summarises the organs and the products that they excrete.

Excretory product	Organs
Urea	Kidney, skin
Water	Skin, kidney
Carbon dioxide	Lungs
Mineral salts e.g. sodium chloride	Skin, kidney

The kidneys

These are bean shaped and are found in the body of most multicellular animals such as people. The inside of the kidney has three regions namely; the outer cortex, the inner medulla and the pelvis. Urine is made in the cortex and the medulla and then collects to the pelvis before moving into the ureter on its way to the bladder.

Fig 1: Parts of a kidney

Functions of the kidneys

- ✓ It ensures osmo regulation; osmoregulation is the management of blood water and salts concentration. The kidneys adjust the water salt content in the blood.
- ✓ It also helps in adjusting the pH of the blood by eliminating excess acids and bases.

The kidneys and the process of urine formation

Deamination

After absorption in the small intestines the amino acids are carried to the liver via the hepatic portal vein. Only enough amino acids carries on while the excess one is deaminated by the liver.

Deamination is the removal of amino group from amino acids. After deamination urea is sent to the kidneys for excretion.

Functions of the liver

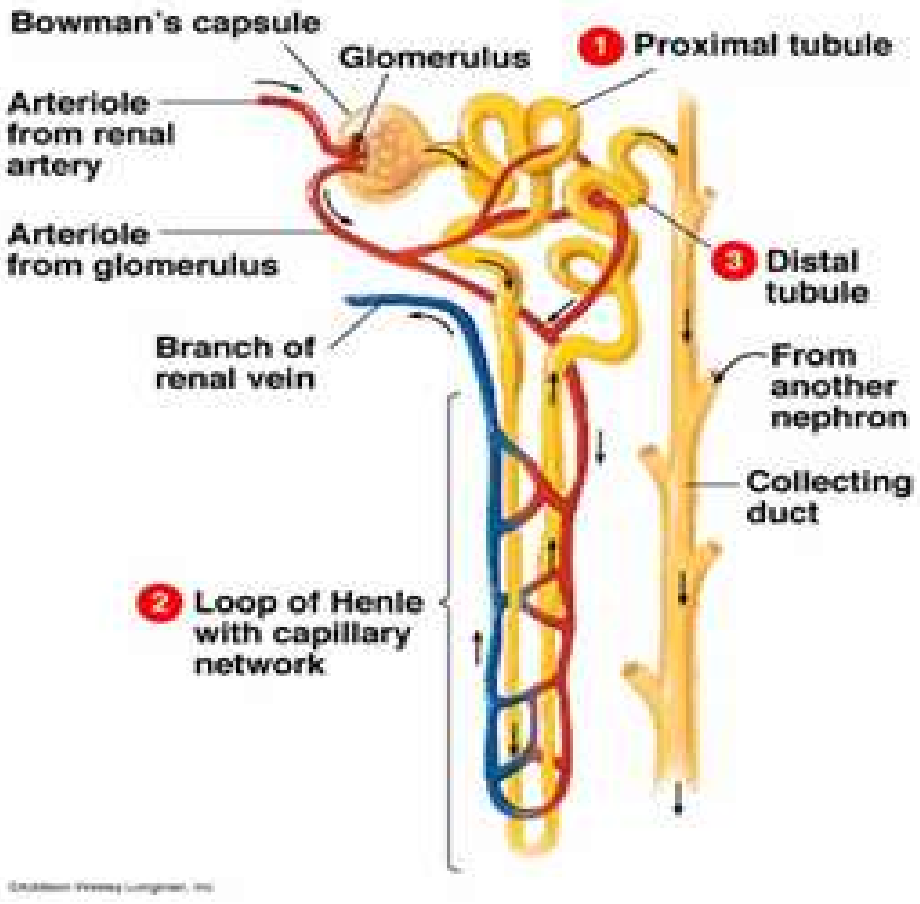
- ✓ It stores food such as excess glucose which is changed to glycogen.
- ✓ Detoxification of different substances such as alcohol.
- ✓ Food processing
- ✓ Heat production due to metabolism.

The kidneys Nephron and the process of urine formation.

As already stated the kidney has three parts namely, the outer cortex, medulla and the pelvis. Urine is made in the cortex and the medulla and collects in the pelvis to ureter. The functional unit of the kidney is the **nephron.** It should be noted that they are millions

of these nephrons. A nephron is simply defined as a single glomelurus with renal capsule, renal tubule and blood capillaries.

Fig 2; The Nephron



Urine formation

Urine is formed in respect to **three** processes, namely

a. Ultrafitration

b. Selective re absoption

c. Secretion

1. *Ultrafitration (glomerular filtration)*

Urine formation begins with the process of **ultrafiltration**, which takes in the cortex of the kidneys. As blood courses through the glomeruli, much of its fluid, containing both useful chemicals and dissolved waste materials, soaks out of the blood through the membranes (by osmosis and diffusion) where it is filtered and then flows into the Bowman's capsule. The water, waste products, salt, glucose, and other chemicals that have been filtered out of the blood are known collectively as glomerular filtrate. The glomerular filtrate consists primarily of water, excess salts (primarily Na^+ and K^+), glucose, and a waste product of the body called **urea**. Urea is formed in the body to eliminate the very toxic ammonia products that are formed in the liver from amino acids. Since humans cannot excrete ammonia, it is converted to the less dangerous urea and then filtered out of the blood. Urea is the most abundant of the waste products that must be excreted by the kidneys.

Note:

- ✓ Water, glucose, amino acids, salts urea and uric acid are small hence they easily pass through the cells of the glomelurus and the Bowman's capsule. Blood cells and proteins are large substances hence they are not filtered.
- ✓ Pressure that is exerted by the pumping heart, creates pressure in the glomelurus hence causing substances to diffuse from the blood in the Bowman's capsule. Furthermore the vessel from which the blood is coming is bigger than in the glomelurus.

2. *Selective reabsorption*

This is the movement of substances out of the renal tubules back into the blood capillaries located around the tubules. Substances that are reabsorbed are water, glucose and other nutrients, and sodium (Na^+) and other ions. Reabsorption begins in the proximal (first) convoluted tubules and continues in the loop of Henle, distal (second) convoluted tubules, and collecting tubules. The process of selective reabsorption is necessitated by three other process namely osmosis, diffusion and active transport.

Note. There are other substances that are not reabsorbed; these include urea.

Examples on selective reabsorption

Large amounts of water (more than 178 liters per day) are reabsorbed back into the bloodstream from the first convolution because the physical forces acting on the water in these tubules actually push most of the water back into the blood capillaries. In other words, about 99% of the 180 liters of water that leaves the blood each day by glomerular filtration returns to the blood from the proximal tubule through the process of ***passive reabsorption****.*

The nutrient glucose (blood sugar) is ***entirely*** *reabsorbed back into the blood from the first convolution. Normally none of this valuable nutrient is wasted by being lost in the urine. However, even when the kidneys are operating at peak efficiency, the nephrons can reabsorb only so much sugar and water. Their limitations are dramatically illustrated in cases of diabetes mellitus, a disease which causes the amount of sugar in the blood to rise far above normal. As already mentioned, in ordinary cases all the glucose that seeps out through the glomeruli into the tubules is reabsorbed into the blood. But if too much is present, the tubules reach the limit of their ability to pass the sugar back into the bloodstream, and the tubules retain some of it. It is then carried along in the urine, often providing a doctor with her first clue that a patient has diabetes mellitus.*

3. *Secretion*

This is third important process in the formation of urine. **Secretion** is the process by which substances move into the distal (second convolution) and collecting tubules (duct) from blood in the capillaries around these tubules. In this respect, secretion is reabsorption in reverse. Whereas reabsorption moves substances out of the tubules and into the blood, secretion moves substances out of the blood and into the tubules where they mix with the water and other wastes and are converted into urine. These substances are secreted through either an **active transport** mechanism or as a result of **diffusion** across the membrane. Substances secreted are hydrogen ions (H+), potassium ions (K+), ammonia (NH3), and certain drugs. Advantage of secretion is that plays a crucial role in maintaining the body's acid-base balance.

Function of Anti Duiretic Hormone (ADH)

- ADH is produced by the pituitary gland.

Function: Influence the reabsortion of water (maintains osmoregulation)

As blood passes the brain, the hypothalamus detects the concentration of water. If the concentration is high it directs the pituitary gland to produce less ADH. Less ADH travels in the blood to the kidneys and they absorb less water. In so doing, more urine is produced and the water level of the blood decreases. In other words, the kidneys excrete the excess water through the process of ultrafiltration removes the excess water.

When the concentration of water is low in the blood, a message is sent to the pituitary gland which releases more ADH into the blood. More ADH the travels in the blood to the kidneys and make them to reabsorb more water. This result in less urine to be produced and the water level in the blood increases. After this the person feels thirsty and drinks more water.

Kidney problems

Kidneys encounter different problems which may cause it not to function normally. Some of the causes of the problems are;

- ✓ Age
- ✓ Accidents
- ✓ Chemicals such as poison
- ✓ Diseases such as diabetes

Remedies to problems of the kidneys

1. Kidney transplant

This includes transplanting a working kidney from a donor. The damaged kidney is replaced by the working kidney.

Drawbacks of kidney transplant

- ✓ It is difficult and expensive to be conducted.

Point to consider in kidney transplant

There should be a perfect match of the kidneys to prevent rejection. Rejections means that the T lymphocytes treat the antigens in the kidney as foreign materials and destroys them.

In summary, there should be a perfect match in the blood group and Rhesus factor (Rh)

2. Dialysis machine

A dialysis machine is also called an “artificial kidney” because it carries the work of the kidney in ensuring osmoregulation by getting rid of the waste substances.

A model of a dialysis machine

How the machine works

The blood is taken from an artery and passes through an artificial capillary into the dialysis machine. In the dialysis machine the diffusion gradient are set so that:

- ✓ All waste substances such as urea are passed.

- ✓ All the glucose is retained in the blood.
- ✓ The water and salts are adjusted

Note:

- ✓ As in kidneys, the blood cells and proteins are held back because they are large to pass through the dialysis membrane.
- ✓ It takes up to 12 hours for osmo regulations and adjustment of substances to complete by the machine.
- ✓ The patient is supposed to under go the treatment 2 to 3 times a week.

CHAPTER FOUR: Coordination

- Coordination is the linking together of various processes in the body
- It is brought about by the nervous system and the endocrine system

- Coordination brought about the nervous system is called nervous coordination while coordination that is brought about by the endocrine system is called chemical (hormonal) coordination.

The nervous system

It is made up of three parts namely;

i. The central nervous system **(CNS)** it is made up of the brain and spinal cord.

ii. The autonomic Nervous System **(ANS).** This is made up of nerves that link all internal organs to the brain and the spinal cord.

iii. The Peripheral Nervous System **(PNS);** it is made up of a network of nerves linking the brain and the spinal cord to all parts of the body.

The central Nervous System (CNS)

The brain

- It is located in the head in the skull which protects it from external forces.
- It is surrounded by three membranes called **meninges.** These membranes protect it from shock.
- The meninges are separated by a fluid called **cerebrospinal fluid** which brings nutrients to the brain

The brain is the organ that controls most of the activities in the body. It is divided into three parts;

a. Cerebrum

- It is the largest part of the brain.
- It occupies the anterior part of the brain.
- It has grey matter outside and white matter outside.
- It is highly folded on the surface to increase the surface area.
- It is divided into two halves by a deep fissure which runs from the front to the back.
- The two halves are called hemispheres or lobes i.e. therefore there is a left lobe/hemisphere and the right lobe/hemisphere joined together by a

bundle of nerves called the corpus collosum.

Functions of the cerebrum

- It controls memory, thinking and emotions. These three makes up intelligence.
- It also controls reasoning
- It interpret sensory messages e.g. sight, taste, smell, touch and pain.

b. Cerebellum

- It is the second largest part of the brain.
- It is located behind or just below the cerebrum.
- It is less folded hence has a smaller surface area.
- It also has grey matter outside and white matter inside.

Functions

- Maintains muscle tone for balance.
- Controls muscular co ordination during walking, dancing, running etc.
- It controls posture.

c. Medulla Oblongata

- It is the smallest part of the brain.
- It is located below the cerebellum.
- It has got white matter and grey matter.
- It is not folded on the surface hence has got a very small surface area.

Functions

- It controls most of the vital processes in the body such as breathing, heart beat, blood pressure, regulation of body temperature, etc. therefore any damage to the medulla oblongata leads to death.

Spinal cord

- It arises from the base of the brain (medulla Oblangata). It runs through the vertebrae up to the last bone in the pelvis.

- The back bone provides protection to the spinal cord.
- The spinal cord is also surrounded by the meninges which are also separated by the cerebrospinal fluid
- In the spinal cord there is white matter out side and grey matter inside.
- At the centre of the spinal cord there is a hole called the central canal which contains cerebrospinal fluid.
- The spinal cord is joined to nerves that link various part of the body.
- The nerves enter through the Dorsal root and leave through the ventral root.
- On the dorsal root there is a swelling called "The Ganglion" which is made up of cell bodies of the nerve cells.

Functions

- To conduct impulses from the sensory nerves to the brain.
- To control reflex actions of all organs below the head.
- To conduct impulses from the brain to motor nerves linking organs below the head.

NERVE CELLS

- A nerve is a thread like structure which conducts impulses in the body.
- Nerves that carry impulses from sensory organs to the central nervous are called sensory nerves.
- Nerves that carry impulses from the central nervous to the muscles or organs that carry out a response are called Motor Nerves.
- In the brain and spinal cord there are nerves that link the sensory nerve to the motor nerve these are called Association or relay Nerves.
- Each nerve fibre is made up of small units called Nerve cells or Neurones.

Structure of a Neurone

Functions of the parts of a neurone

i. **Dendrites;** these are structures that radiate from the cell body. Their function is to trap impulses crossing the synapse. Once trapped the impulses is transported

to the cell body.

ii. **Cell body;** this receives impulses from the dendrites. It coordinates them and send them out to the axon. It contains a nucleus which controls all the activities of the neurone.

iii. **Axon;** it is an elongated structure that is joined to the cell body. It carries impulses away from the cell body.

iv. **Myelin sheath;** this is a layer of fat cells that cover the axon. Its function is to provide insulation to the axon so that impulses are not conducted by other body cells. This insulation also helps to increase the speed at which the impulses are conducted.

v. **Node of Ranvier;** this is a gap between myelin sheaths. It is used as a point where food and oxygen are supplied to the axon.

vi. **Dendron;** this is the longest dendrite. It carries impulses towards the cell body.

How impulses Cross a Synapse

- A synapse is a gap between neurones.
- Impulses travelling through a neurone have to cross a synapse to reach another neurone.
- When impulses reach the end plate of an axon, a liquid called **the Neurotransmitter (acetylcholine)** is secreted into the synapse. Acetylcholine is a good conductor of impulses.
- Therefore the impulses are transported across until they are picked up by dendrites of the next neurone. After impulses have crossed the synapse, the Acetylcholine is later destroyed by enzymes.

Reflex actions

A reflex action is a rapid and automatic response to stimulus.

Most reflex actions are carried out to protect the body from injury.

They are usually carried out before the brain could interpret the impulses. Interpretation of the impulses involved in a reflex action occurs after the response has been carried out.

Examples of reflex actions are blinking of the eye, knee jerk, withdrawal of a hand from

a hot object, sneezing.

Types of reflex actions

There are two types of reflex actions

a) **Cranial reflexes**; these are reflex actions that are carried out by organs in the head region. Examples of cranial reflexes are blinking and sneezing. Cranial reflexes are controlled by the brain.

b) **Spinal reflexes;** these are reflex actions that are carried out by organs below the head. They are controlled by the spinal cord. Examples include; knee jerk and withdrawal of a hand from a hot object.

Reflex arc

This is a path that is followed by impulses in a reflex action. The reflex arc is made up of the following components.

Receptor; this is sensory organ that detects the stimulus. When the stimulus has been detected, nerve impulses are produced and are carried by the sensory Neurones.

Sensory neurones; these are nerve cells that carry impulses into the brain and the spinal cord.

Association Neurones; these are found in the brain and the spinal cord. They pick up impulses from the sensory neurones. Instead of sending impulses straight to the brain for interpretation the impulses are sent to the motor neurones.

Motor neurones; these pick up the impulses from the association neurones. They send the impulses to the effectors.

Effectors; An effector is an organ or tissue that carries out a response. Examples of effectors include muscles.

A diagram showing a simple reflex arc

Conditioned reflexes

These are reflex actions which come about after a period of learning or training. In most cases conditioned reflexes, the responses are not related to stimulus. Examples are, fear of white gowned nurses by children, fear of the lizard, riding a bicycle etc.

Conditioned reflexes usually develop into behaviour.

Steps that are involved in a conditioned reflex

Observation (learning/training (behaviour

Effects of drugs on the nervous system

A drug is a substance which changes the way in which the body works. There are four groups of drugs, namely;

Painkillers; these are drugs that suppress the part of the brain responsible for interpretation of pain. Examples are heroine and morphine which are usually given to people in great pain.

Stimulants; these speed up the rate at which the brain works. They make the brain more alert. Examples are cocaine, nicotine and caffeine.

Sedatives; these are drugs which slows down the brain and make a person feel sleepy. Examples include valium and piriton.

Hallucinogens; these are drugs that causes hallucinations or illusions when taken. A hallucination is an imagination of something that may be felt but does not exist. Examples are cannabis and marijuana.

Dangers of drugs

- They may impair the person's judgement and make him/her clumsy. A persons takes longer to respond e.g. alcohol.
- They may injure the body by damaging cells. E.g. alcohol kills cells in the brain and liver. Marijuana kills cells in the brain.
- They may make a person to become addicted. A person can not do without taking the drug.

CHEMICAL COORDINATION

This is a type of coordination that is brought about by hormones. Hormones are chemicals that are produced by the endocrine glands and transported by the blood to target organs where they produce an effect. Endocrine glands are also called ductless glands because they do not have tubes that link them to the blood vessels.

Endocrine glands

1. Pituitary gland

This is located in the head if the base of the brain. It is small in size, the size of a pea. It produces the growth hormone, Anti Diuretic Hormone (ADH) and a group of other hormones called Trophic hormones.

- **Growth hormone;** this is a hormone that controls growth in a person. When the hormone is produced in excess a person becomes a giant and if the hormone is under produced a person becomes dwarf.
- **Trophic hormones;** this is a group of hormones which controls the functioning of other endocrine glands. The pituitary gland is called the master glands because it controls other endocrine glands.
- **Anti diuretic Hormone (ADH)** This is a hormone which helps in regulation of the amount of water in the body. It works in conjunction with the kidneys. When there is less water in the body, ADH is produced and it makes the kidneys to reabsorb the water filtered out of the blood back into the blood. When there is too much water in the body, no ADH is produced and the kidneys do not reabsorb water back into the blood.

2. Thyroid gland

- It is located in the neck region in front of the voice box (larynx).
- It produces a hormone called thyroxin. This is a compound of iodine. Without iodine, the hormone can not be produced and the gland swells forming a simple goitre.
- Thyroxin helps in cellular metabolism such as respiration. Too much thyroxin increases metabolism. The person becomes overactive, thin has protruding eyes. Too little thyroxine reduces metabolism. The person becomes sluggish, fat and mentally retarded.

3. Pancreas

This is a gland that also produces digestive enzymes. It also has special groups of cells called Islets of Langerhans which produces hormones.

Insulin; it is produced when the blood sugar level rises. It makes the liver to absorb glucose from the blood and store it as glycogen. Lack of insulin leads to a sugar disease called Diabetes Mellitus which can be treated by administration of insulin

tablets or intravenous injection.

Glucagon; this is another hormone that is produced by the pancreas. It main function is to increase the sugar level in the blood when it is low. It makes the liver to release glycogen back into the blood as glucose.

4. **Adrenal gland**

These are hormones that are located just above the kidneys. Each gland produces a hormone called adrenaline. This hormone prepares the body for action i.e. either running away or to fight. Because of this the hormone is therefore referred to as a **fight or flight hormone.**

The body is prepared by; making the pupil in the eye to dilate to improve vision.

The heart beat increases to supply as much oxygen as possible to the muscles.

The blood vessels dilate to carry a lot of blood with oxygen and glucose.

CHAPTER FIVE: Immunity

This is the ability by the body to defend itself against infections. Infections are caused by germs which feed on the body or produce toxins which affect the body.

Ways how the body defend itself

There are three ways in which the body defends itself. These are;

- It prevents the germs from entering the body.
- It kills the germs that have entered the body.

- It neutralises toxins.

Types of immunity

There are two types of immunity namely; natural and artificial immunity.

a. Natural immunity

This is the defence that the body develops against infections on its own. The body has got ways and mechanisms that it uses to defend it self against infections. These ways and mechanisms form the **first line defence**. Below are some of the first line defence of the body;

- **The skin;** it prevents the entry of germs into the body because it is water proof. The dead cells on the skin surface are softened by **sebum** produced by the sebaceous glands. This oil also prevents multiplication of germs on the skin. Blood clotting on the wound on the skin also prevents entry of germs into the body.
- **The nose**; it has got hair which traps germs. It produces mucus which also traps germs. In the trachea there are cilia (hair like structures) which continually beat out the germs. All this is done to prevent germs from entering the lungs.
- **Digestive track**; germs taken together with food are killed in the stomach by the hydrochloric acid produced by the gastric wall. Pepsin also digests the germs.
- **Tears**; these are used for cleaning the eye surface. The front part of the eye is exposed to dust and germs. We blink in order to remove the germs and dust. Tears keep the eye surface moist and it also contains an enzyme called **lysonzyme** which kills germs in the eye.
- **Ear wax**; Sebaceous glands in the ear produce ear wax which traps and kills germs in the ear.

Once in the body germs are attacked by the **second line of defence.** This is made up of **lymphocytes** and **phagocytes**.

- **Phagocytes**; these are white blood cells which defend the body by swallowing (engulfing) germs. They move on their own, hence they are found in areas where there are large numbers of germs. They are also mostly found attached to lymph nodes in readiness to engulf germs that have been filtered

- **Lymphocytes**; these defend the body by producing antibodies. Production of the antibodies is stimulated by the protein found on the germ called the **antigen.** Antibodies produced circulate in the blood for sometime destroying the germs.

Types of antibodies

i. **Lysins**; these are antibodies which dissolve the coat of the germ. The germ breaks down and then dies.

ii. **Agglutinins**; these antibodies make the germ to stick together. They therefore fail to move and reproduce. They are then easily swallowed by phagocytes.

iii. **Opsonins**; these are antibodies which cover the surface of the coat of a germ. They make it to become inactive and are easily swallowed by phagocytes.

iv. **Antitoxins**; these are antibodies which neutralize the poisons produced by germs.

b. Artificial immunity

This is a kind of immunity which is brought about by the activities of man. The body is stimulated to produce antibodies which can fight against infections. Artificial immunity can be produced by using vaccines and ready made antibodies.

- **Vaccines**

  A vaccine is a dosage of killed germs or weakened germs or inactive to colds or germs similar to disease causing germs. A vaccine is administered through an intravenous injection or by swallowing. The aim of vaccine is to stimulate the body to produce antibodies in readiness for infections. The process of introducing vaccine in the body is called inoculation or immunisation. Immunisations stimulate the body to produce specific antibodies for specific germs. This type of immunity is called **active acquired artificial immunity.** It is called active because the body produces antibodies on its own.

- **Ready made antibodies**

Ready made antibodies from some animals or people are introduced into the body of a person to protect them from infections. The body fails to produce antibodies to fight against **tetanus.** As such ready made antibodies from serum of a horse are administered into the body of a person. Pregnant women are vaccinated against some diseases. The mother's body produces antibodies which are passed on to the child to protect it from infection before it can begin to produce its own antibodies. This type of immunity is called **passive artificial immunity.**

Blood groups

Blood groups in human beings are determined by the type of protein present on the red blood cell. The protein present on the red blood cell is called **antigen.** There are two types of antigens, namely antigen A and antigen B. blood is therefore divided into four groups depending on the type of antigen present on the red blood cells. The table below shows the four blood groups;

Blood group	Antigen present
A	A
B	B
AB	AB
O	NONE

The blood plasma contains antibodies which fight against antigens on the red blood cell. A person with A antigen has antibody, Anti B in the plasma, one with B antigen has Antibody Anti A. These antibodies cause agglutination when different types of blood are mixed with different antigens.

Blood group	Antigen present on RBC	Antibody present in plasma
A	A	Anti B
B	B	Anti A

AB	AB	None
O	None	Anti A and Anti B

Some important terms

- Compatible blood groups are blood groups which do not agglutinate when mixed during blood transfusion.
- Incompatible blood groups are blood groups which agglutinate when mixed together during a blood transfusion.
- Universal donor; this is where one blood group can be given to all blood groups without causing an agglutination. Blood group O can be donated to all the other blood groups without an agglutination. This is because it has got no Antigens on its red blood cells.
- Universal recipient; this is a blood group that receives blood from all other blood groups without agglutination. Blood group AB is a universal recipient because it has got no antibodies in its plasma.

Rhesus factor

This is another protein which is either present or absent in the blood. If the factor is present, the person is Rhesus positive (Rh +ve) while if the factor is not present the person is Rhesus negative (Rh –ve)

Factors to consider before blood transfusion

Blood transfusion is the act of giving blood to a person who has lost blood through an injury or an infection. There are many factors that need to be considered before blood transfusion. Some of them are explained below:

- **ABO blood groups**; Blood of the donor and the recipient are tested in the laboratory to make sure that it is compatible. Incompatible blood is not transfused to avoid death of the recipient through agglutination.
- **Rhesus factor**; the presence or absence of the factor is established because presence of the factor in the donor's blood may trigger the production of antibodies in the recipient which can cause agglutination.

- **Infections**; the blood of the donor is screened for infections. This is done to prevent the recipient from getting diseases from the donor. Examples of infections that are screened include HIV/AIDS, Syphilis, Hepatitis etc.
- **Anaemia**; this is the shortage of red blood cells in the body. A donor who has less than the normal amount of red blood cells is not allowed to donated blood.

CHAPTER SIX: CANCER

Meaning of cancer

The body cells and tissues are repaired once damaged. This means that new cells are produced by cell division. The process of cell division is controlled. Sometimes the process of cell division may occur without apparent reason and also without being controlled. The new cells will then accumulate to form a ball of cells called a tumour. These tumours are categorised into two depending on the rate at which they multiplying. Some tumours are slow growers and often stop after a while, meaning that they do not invade and affect the surrounding tissues or cells. This is called benign. Another category of tumour is called malignant or cancer. These tumours never stop growing and often take over important organs, preventing them from working properly. Therefore cancer is referred to abnormal multiplication of cells.

Causes of cancer

- Cancer is mainly caused by mutations which lead to abnormal multiplication of cells in the body.
- Some chemicals which make the cells to begin multiplying abnormally. These chemicals are called carcinogens.

Types of cancer

The type of cancer depends on the organ that is attacked, e.g.

- Lung cancer
- Liver cancer

- Prostate cancer
- Breast cancer
- Cervical cancer etc

Effects of cancerous cell in the body

- Competition for nutrients; the increase in number of cells due to abnormal multiplication causes competition in the body between cells.
- Malfunctioning of organs; the cancer cells may block some of the organs to functions properly.
- Cancer may lead to death.

Factors that increases the risk of cancer

Substances that are capable for causing cancer are called carcinogens

- Smoking
- Over drinking alcohol
- Over exposure to radiation
- Some viral infections
- Some chemicals

Ways of preventing and controlling cancer

- Avoid exposure to radiation such as X rays
- Avoid excessive beer drinking
- Avoid smoking
- Exercises
- Immunisation (e.g. liver cancer is related to hepatitis B)

What are the treatments for cancer?

Usually treatment begins as soon as the cancer has been diagnosed. Some of the treatments include;

- *Surgery*

In this case much or all the cancerous cells are removed.

- *Radiotherapy*

This is the use of radiation to destroy the cancer cells. It should be noted that most cancer cell are sensitive to radiations such as X rays. This treatment is painless but can have side effects such as red itchy skin.

- *Chemotherapy*

This is the use of strong drugs such as cytotoxic drugs which destroys the rapidly dividing cells. These drugs do not kill the normal cells because they only target the cells that divide rapidly. The side effects include; nausea, tiredness and sometimes hair loss

Chapter seven: Evolution

It refers to the adaptation of organisms to change in the environment through natural selection.

It also refers to the gradual change in organisms

Charles Darwin (1809 – 1882)

Charles Darwin is the most famous biologist and the father of evolution. He is the one who came up with the theory of evolution by natural section. He used different materials he collected and observations he made while travelling around the world on his HMS Beagle. His work was then published in 1851 in a book titled “Origin of species”.

The theory of natural selection is explained in five steps as follows;

i. All organisms produce a large number of off springs than actually can survive. Most of the off springs die or get killed. For example, a frog lays 2000 eggs, but only few of these will end up mature adult frogs.

ii. The individuals or organisms that are best adapted to the environments survive. He called this as survival of the fittest.

iii. Population numbers tends to remain constant over a long period of time

iv. Sexual reproduction ensures that all the off springs are slightly different from each other. This is called variation.

v. These variable characteristics are inherited from parents.

What does theory of evolution states?

It states that all living things evolved from common ancestors over along period of time.

Evidence of evolution

- *Fossil records*

  Fossils are the preserved remains of dead organisms. In this case the scientists are able to study the fossils that were buried millions of years ago. But due to the movement of the earth these fossils are exposed for the scientists to study them.

- *Comparative anatomy*

  This looks at the skeletal make up of different organisms. So far the forelimb of some organisms is described as pentadactyl (five fingered). Examples include the legs of reptile, the legs of the extinct dinosaurs, the human arm, the bat wing and even the flippers of the whale. This shows that the organisms have evolved from a common ancestor. The modification occurred in order to adapt to different modes of locomotion

- *Embryology*

  The embryos of many organisms such as chickens, fish, man and turtle are similar. This suggests that these organisms originate from a common ancestor. But as they keep on growing the genes took over control making them to differ.

- *Geographical distribution*

The study of geographical distribution of organisms is called biogeography. Geographically the world had one continent. However due to the movement inside the earth division occurred. Despite this we expect that the animal that are found in the

southern hemisphere (southern America, southern Africa and Australia) should be the same because they lie on the same latitude. Contrary to this, the distribution of the organisms is different.

Natural selection

The genes are classified as dominant and recessive. In an environment the weak genes fails to survive. In other words they are eliminated while the stronger ones will be able to survive. Therefore the process where by weak organisms are eliminated and strong organisms are able to survive is called selection. But in cases where the selection has occurred naturally it is called natural selection. Due to industrial revolution humans have also come up with artificial selection in plants and animals.

Examples of natural selection

Sickle cell anaemia

Peppered moth

At first, the peppered moth had an excellent camouflage on the bark of trees. This was before the industrial revolution in the late eighteenth centuary. During this time it was hard for birds to spot the moths. But during the industrial revolution, pollution from factory chimneys turned the bark of the tree almost black meaning that the moths were no longer camouflaged and were likely eaten by the birds. However, the black one survived and produced and some of the off springs were black

Drug resistance

When different drugs are used to kill different organisms,

Speciation

Speciation is the formation of new species. A species is a group of living organisms which are all similar to one another and which can be interbred successfully with one another.

Relationship with evolution.

According to the theory of evolution all the species that exist have all originated or evolved from already existed species.

What causes speciation?

Sometimes a species may get separated into two groups. The main cause is the physical barrier such as sea, mountain ranges or deserts. Once this occurs, natural selection ensures that these groups evolve independently. Therefore, two new species will be produced when the two groups changes to an extent that they can not reproduce with each other. However, this process is gradual.