SYSTEMATIC "A" LEVEL BIOLOGY.
Basic and simplified revision notes.

STANDARD TEACHING SYLABUS:

Cytology/ cell biology

Is a branch of biology that deals which deals with the study of the structure of cells using a microscope.

The cell.

A cell is the basic unit of life. It is the basic functional and structural unit of an organism. All living organisms no matter their size are made of cells. Cells are responsible for carrying out all body processes such as respiration, excretion, osmo regulation, lomotion, circulation etc in the body of the organism. Cells aggregate (unite) in groups to form body structures. When studying the detailed structure of the cell, an instrument called **a microscope** is used.

The microscopes.

The term **microscope** is derived from two Geek words; ***mikros*** meaning ***small*** and ***skopein*** meaning ***to see*** or ***to examine.*** Cells are studied using a microscope. There are two main types of microscopes:

i) The light microscope. These are also divided into two: **a simple microscope** e.g a hand
lens and **a compound microscope** with many lenses.

ii) The electron microscope.

The light microscope.

This type of microscopes uses light to illuminate the specimen under investigation or that has been placed on the stage. The simplest form of a light microscope is the one with a single lens that has low power magnification. This is known as **a hand lens (a magnifying lens).**A compound microscope uses two types of lenses ie the eye piece and the objective lens. Light from specimen passes through the first lens called objective lens and produces a magnified image. This image acts as the object of the second lens the eye piece which magnifies it further.

The structure of a light microscope

The magnification in a compound microscope.

Magnification is the number of times an image is made bigger or smaller compared to the to the object. The total magnification of both lenses is the product of objective lens and magnification and the eye piece lens magnification. For example if the eye piece has the magnification of X10 and the objective lens has X40, then the total magnification is;

Total magnification = eye piece magnification X objective lens magnification.

= (X10) x (X40)

= X400.

The resolution (resolving power) of the light microscope.

This is the ability of the microscope to distinguish between two separate and very close objects so that they are distinct. It can also be defined as the degree to which the details of the objects are shown or a measure of clarity of the image. If two separate objects cannot be resolved, they will be seen as one object. The difference between the magnification and resolution of a microscope is that magnification can be changed (i.e increased or decreased) while resolution is always the same. The resolving power of the light microscope is always lower (200nm) compared to that of an electron microscope (0.5nm). This resolution is limited by the wave length of the visible light used to illuminate the object. the light microscope can magnify effectively to a bout 1000 times the of the actual specimen since greater magnification a above this increases blurredness.

Advantages of a light microscope;

It is cheaper and easier to operate when compared to the electron microscope.

It can used to observe living specimens directly since it does not require a vacuum like the electron microscope.

It does not result in the destruction of cellular organization like the electron microscope.

Disadvantages of a light microscope;

It has a low resolving power.

It has a low magnifying power.

Modifications of the light microscope.

Type of microscope	Mode of operation	Main use
Ultra violet microscope	Uses quartz lenses	Study chromosome changes during cell division
Dark field microscope	Uses light at right angles to its optical axis and depends on the scattering of light by different particles.	Study very small particles about 8nm

Phase contrast microscope	Depends on the refraction of light by parts the cell basin on their refractive indices.	Study transparent cell parts e.g cytoplasm.
Polarizing microscope	Uses polarized light.	Study layer-like structures in the cell e.g spindle fibres, myosin filaments in stratified muscle, cellulose in cell wall etc.

Electron Microscopes.
In electron microscope a beam of electrons is used. Electrons are negatively charged particles that can be found in orbit around nucleus of atoms.
Under certain circumstances they can behave as waves. They have two great advantages over light ie they have extremely short wave length, about the same as X- rays and the beam electrons can easily be focused through specimen using electro-magnets. This involves bending the beam of electrons just as glass lenses are used to bend light with electron microscope magnification have x250,000 are commonly obtained with biological materials.

Resolution and magnification.
Resolution is the ability to distinguish between 2 separate objects. Magnification can be increased but the resolution of the photograph stays the same. We enlarge the photographs in order to see them more clearly but if we go too far the picture bright less up in 2 separate blood dots. The resolution is much greater than electron-microscope, the shorter the wave lengths are said to greater resolving power than those of light.
Structure of electron microscope.

Advantages of electron microscope.
- High resolution (0 – 5nm in practice).
- It magnifies very tiny objects.

- **Disadvantages of electron – microscope.**
- The specimen must be dead because it is viewed in vacuum.
- It is difficult to be sure that the specimen resembling a living cell in all its details because preservation and staining may change or damage the structure.
- Expensive to buy and run.
- Preparation of material is time consuming and requires expert training.
- The specimen is gradually detoriates in the electron beam photographs must there fore be taken it future study is required.
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- **Comparison between a light and an electron microscope.**

(i)Similarities between a light and an electron microscope.

- In both, specimens are magnified to be seen clearly.
- In both, specimens to be observed are illuminated.
- Both have an eye piece where an observer views the specimen.
- Both have a condenser to control the amount of illuminating agent.
- Both have a stage.
- Both have lenses.
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- **(ii) Differences:**

• Light microscope.	• Electron microscope.
• Uses light to illuminate the specimen.	• Uses electron to illuminate the specimen.
• Has low magnifying power (x1500).	• Has high magnifying power (x300, 000).
• Produces images in their natural colours.	• Produces all images in black and white.
• Small and portable.	• Very large and only operated in a special place.
• Not affected by magnetic field.	• Affected by magnetic field.
• Has low resolving power (200nm).	• Has high resolving power (0.5nm).
• Used to view living and non-living specimens.	• Used to view non – living specimens.
• The specimen is supported by a glass slide.	• The specimens supported on a small copper grid in a vacuum.
• Uses glass lenses.	• Uses electromagnetic coils as lenses.
• Operates in the wave length of about 400-700mm	• Operates in the wave length of about 0.005mm

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- **Types of electron microscope**
- Scan electron microscope.
- Transmission electron microscope.
- Phase contrast microscope.
- Scan electron microscope.

- Scanning electron microscope the electron beam is scanned to and from across the specimen and electrons that are reflected from the surface is collected. They are used to form aTY- like image on a cathode ray tube.
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- **Advantages**
- Surfaces of structures are shown.
- Great depth of field, meaning that a large part of the specimen is in focus at the same time. This gives a very striking three-dimension.
- Much larger samples can be examined than with TGM.
- **Disadvantages;**
- Resolution (0.20nm) is not as great as with aTGM (0.5nm).
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- **Techniques in microscopy.**

Preparation of material for the microscopy.

Biological specimens may be examined in a living or preserved form. In the preserved form specimens can be sectioned for closer examination and treated with a wide variety of stains to reveal and identify the different structures. Preparations of freshly killed material may be temporary or permanent. Permanent is a form of preparation in the specimen can be prepared and after examination its stored for future use. A temporary preparation is a form of preparation in the specimen can be prepared once and later discarded after the experiment.

- Techniques used in permanent preparation;
- **Fixation;** This is the preservation of material in its life like state, the tissues are fleshly killed and vapidly made sliced/ cut in to small pieces. Chemicals are then used (fixative) to maintain the natural state and this process is called **fixation**.
- **Dehydration;** *is the removal of water from the material after being prepared*. If the specimen is to be viewed when in its dry state. Dehydration is always done gradually and carried out by a series of increasing ethanol or water or promption etc finished in absolute ethanol.
- **Clearing;** *This is the process of making specimen clear when viewed in the microscope*. A clearing agent is then added to specimen that has been already imbedded in the mounting median. The clearing image makes the image clear and transparent.
- **Embedding** *is a technique of suspending the specimen in a mounting medium or supporting medium.* A light microscope embedding involves impregnating material with more 10 watts and is then allowed to set. A hardened is also used for an electron microscope because thin specimen is used and so move liged support is required when cutting.
- **Sectioning:** This is the technique where specimen is cut in to sufficient light pass through during
- investigation. It's usually important to cut very small slices of material and this always used razor
- blade or microtone. Hard sectioning is carried out by a razorblade.
- **Staining:** This is the addition of the staining agent of the specimen that would be originally
- transparent and hence made coloured in order to view the different parts of the specimen. Examples
- of staining materials are:
- Methylene blue.

- Neutral rate.
- **Mounting:** this is the way of placing of the specimen on a microscope slide and then
- Covering it with its cover.
- Types of mounting
- Temporary mounting for temporary preparation.
- Permanent mounting for permanent preparation.
- Temporary preparation.
- This usually done for investigation using a light microscope. The stages involved include;
- Fixation, staining and mounting however sectioning occurs before fixation.
- **Differences in preparation of materials for light and electron microscope.**

Light microscopes.	Electron microscopes.
Its fixation is 99 of ethanol; 1part glacial ethanoic acid (alcohol / acetic), or 70% ethanol(but this causes shrinkage and damage to delicate structures)	Its fixation, glutaraldehyde or mixture of glutaraldehyde and osmic acid (O_5O_4) is often used. O_5O_4 also stains lipids and hence membranes, black, smaller pieces of materials fixed for more rapid and better preservation of fine structure.
Its dehydration is ethanol or propane series.	Ethanol or propane series.
It is embedded by wax.	By resin (e.g avaldite, epon) or plastic.
It is sectioned by metal knife.	Only diamond or glass, knives are sharp enough to cut, the ultration sections required.
It is stained by coloured dyes (reflect visible light).	Heavy metals, e.g compounds of osmium, uranium, lead (reflect electrons).

- **Recording by biological drawing.**
- **Purpose.**
- To provide a record of work for future reference.
- To encourage you to study more fully and accurately the specimen that you are investigate.
- To aid memory of what you see by actively recording.
- Principles used in recording biological drawings.
- Drawing paper of suitable quality must be used. It must be capable of standing some rubbing out of incorrect pencil lines.
- Pencils should be sharp and of HB quality. No coloured pencils should be used.
- Drawing must be large enough, accurate, drawn with lines sharp and labelled.
- Make two drawings if necessary, i.e a simple drawing of the main features, and details of small parts only.
- Draw what you see and not what you think you should see.
- Every drawing should have a title.
- Label lines should finish exactly at the structure names.

The cell theory.
The cell theory states that:

All living organisms are composed of cells.
All new cells are derived from already existing cells.
Cells contain the hereditary materials of an organism which is passed from the parent to the daughter cells.
All metabolic processes take place with in the cells. The function of the organism as a whole is the out come activities and interaction of the cells.

- **Classes / types of cells.**
- Namely we have prokaryotic cells, eukaryotic cells. Organisms are also divided in to 2 major groups depending on this type of cells.

(i) **Prokaryotes;** *these are organisms that contain prokaryotic cells.* Prokaryotic cells are cells which have no distinct nucleus and their DNA material is not enclosed with in the nuclear membrane.
The prokaryotic cell.
Pro means ***before*** and ***karyo*** means ***nucleus***. These were the first forms of life on the earth. The genetic material DNA in this cell is concentrated with in a region called the nucleoid but there is no membrane that separates this region from the rest of the cell. Examples of organisms with prokaryotic cells are bacteria and blue green bacteria.
The structure of a prokaryotic cell is shown below.

The parts of the prokaryotic cell and their functions.

Cytoplasm	It's where other granules are suspended.
Cell wall.	Protects inner parts against mechanical damage. Controls entry of the some substances.
Ribosomes	For tissue respiration.
Pilli	for sensitivity and attachment on to surfaces.
Flagellum.	Movement of the cell.
Circular DNA	Control all activities of cell.
Mesosome.	Site for respiration. May be involved in cell division and DNA up take.
Chromosome/ DNA.	Contains genetic information required to replicate new cells.
Plasmids.	Contains genes that aid survival of the bacteria in the adverse conditions.
Glycogen granules	Store carbohydrates for respiration.
Storage membrane	Storage of food materials e.g starch.

Capsule	It protects the cell against mechanical damage.
Lipid droplets	Store lipids for respiration.
Chloroplasts.	For photosynthesis.

Advantages of having chloroplasts within the outer plasma membrane of prokaryotic cell;

Many metabolic processes involve enzymes that are embedded in the membrane and when the cell becomes larger, the proportion of membrane area to the volume is reduced. This can be increased by the presence of organelle membranes.

Containing enzymes for a particular metabolic path way increases the rate of metabolic reactions since the products of one reaction are always in close proximity to the next enzyme in the sequence.

The rate of any metabolic path way inside an organelle can be controlled by regulating the rate at which the membrane surrounding the organelle allows the first reactant to enter.

Potentially harmful reactants or enzymes can be isolated inside an organelle so that they donot damage the cell.

(ii) **Eukaryotes;** these are organisms that contain eukaryotic cells. Eukaryotic cells are cells which have a distinct nucleus and their DNA material is bound by a membrane.

The eukaryotic cells.

Eu means ***true*** and ***karyo*** means ***nucleus.*** These cells have a true nucleus enclosed a nuclear membrane. These cells evolved from prokaryotic cells. The development of eukaryotic cells from prokaryotic ancestors involved considerable changes. The entire region between the nucleus of the cell and the plasma membrane is called cytoplasm. The cytoplasm consists of a semi fluid called cytosol in which there are suspended organelles of specialized form and function. Examples of organisms that contain eukaryotic cells are protists, fungi, plants and animals.

Structure of eurokaryotic cell under light microscope.

Comparison between prokaryotes and eukaryotes.
(a) Similarities;
Both contain DNA molecules.
Both contain ribosomes.
Both have a cell wall.
Both contain protoplasm bounded by a selectively permeable membrane.
Both contain lipid- protein membrane surrounding the protoplasm.
In both, energy is produced in form of ATP.
(b) Differences;

Prokaryotes	Eukaryotes.
No membrane bound nucleus.	Have membrane nucleus.
Lack membrane bound organelles except ribosomes.	Have membrane bound organelles.
DNA is found in the cytoplasm.	DNA is found in the nucleus.
DNA is not associated with protein in chromosomes.	DNA is associated with protein in chromosomes.
DNA is single stranded.	DNA is double stranded.
Contain small amount of DNA.	Contain larger amount of DNA.
Energy production occurs on the cell membrane.	Energy production occurs in the mitochondria.
Lack endoplasmic reticulum.	Have endoplasmic reticulum.
Photosynthetic pigments are bound to the cell membrane.	Have chromatophores are enclosed in plastids with in the cytoplasm.
Lack cell vacuoles and cytoplasmic membrane system.	Have vacuoles, cytoplasmic membrane system and cytoplasmic strands.
Are small in size (1-10 μm)	Are large in size (10-100μm)
Flagella donot have 9+2 arrangement of the fibril.	Flagella have 9+2 arrangement of fibril.
No mitosis or meiosis occurs.	Both mitosis and meiosis occur.
Have smaller ribosomes.	Have larger ribosomes.

Why cell are very small?
Most cells are microscopic. The size and shape of cells are related to their functions. The size depends on what the cell must do to survive;
Cells take in food and other materials through the plasma membrane.
Inside the cell, substances must move to the correct locations in the cell where they are converted to other forms.
Once the correct molecules are formed they must be transported to proper sites with in the cell for use.
Waste products from various metabolic reactions must be transported out of the cell before they accumulate to toxic levels.
It is there fore important to note that the distance materials move is very short. This will speed up the cellular functions. Since these materials and waste products have to pass through the plasma membrane, the larger the surface area the faster a given

amount of a substance can pass through it. The factor that determines the cell size is the ratio of its surface area to volume ratio, since the volume increases more rapidly than its surface as the cell becomes large. This places the upper limit on the size of the cells. Above that size, the number of molecules required by the cell could not be transported into the cell fast enough to sustain its needs.

The structures of the cell.

(a) Cell membrane. *This is an outer surface which covers the cytoplasm of the cell*; it consists of lipids and proteins together with carbohydrates. There are different theories have been put forward to explain the structure of cell membrane.

Theories about the structure of the cell membrane.

1. Charles Overton.

According to him, cell membranes are made up of lipids; basing on his observation the lipids that have soluble molecules enter the cell move than those in form of insoluble molecules. Phospholipids are mostly dependant on lipids in cell membrane and have both hydrophobic and hydrophilic ends and are there fore said to be Amphipathic molecules.

2. E. Gotter & F. Grendel (1925).

Suggest that plasma membrane is made up of lipids by layers which are Fibo molecules thick. It does not give note to the position of the proteins.

3. H. Davson & J. Daniel (1935). Suggested the molecular modal of the cell membrane and this modal a phosphor lipid bilayer is arranged between two layers grabular proteins.

Diagram

Problems with Davson-Daniel model;

- It generalizes all cellular membranes as identical. This was challenged by the development of the electrons micro plasma membrane 7-8nm thick and thin. The inner membrane of mitochondria is only 6nm thick and it has a substantially greater lose of proteins than the plasma membrane.
- There are differences in the specific kinds of lipids and other lipids present. It also follows that membranes with different functions differ in chemical composition and structure.
- Placement of the proteins is disputed. Unlike the proteins dissolved in cytoplasm, member proteins are not very soluble in water. They are amphipathic as their phospholipids partner in membranes if proteins were layered on the surface of the membrane, their hydrophobic part would be in an aqueous environment.
- Secondly, this arrangement the proteins separates the hydrophilic heads of the phospholipids from water.
- 4. S.J Singer and G. Nicolson (1972)
- These scientists proposed the **fluid mosaic model** of a cell membrane. According to this model the cell membrane consists of a fluid phospholipid bilayers; whose surfaces contain protein molecules; floating about them to a fluid mosaic pattern; the phospholipid layer contain phospholipid molecule;

that are arranged such that their hydrophobic tails face each other, in wards; and their hydrophilic heads face out wards;Some protein molecules extend into the phospholipid layers up to a certain level (integral or intrinsic proteins); while others penetrate through the membrane (trans membrane proteins); some protein molecules occur on the surface of the phospholipid layer (peripheral or extrinsic protein molecules); Proteins are dispersed and immersed in a phospholipid bilayer which in is a fluid state. the same surface or peripheral protein molecules have branching carbohydrate portion or chains to form glycoprotein; and some lipid molecules also have branching carbohydrate chains to glycolipids; The membrane also contains cholesterol that distort the close packing of phospholipids to keep them more fluid; Cholesterol also increases stability and flexibility of the membrane so that in its presence; the membrane cannot breakup;

- The diagram below shows the fluid mosaic model of membrane.

Note; The fluid mosaic model is now our most acceptable working model of the structure of a cell membrane. The plasma membrane of a cell and membranes of the various organelles have unique connections of proteins. These proteins are dispersed and immersed in the phospholipids bilayer in an irregular arrangement.

- Functions of the membrane proteins.
- They transport proteins i.e proteins that spans a membrane may provide selective circulation and some transport proteins, hydrolyze ATP as energy source to actively pump substance across the membrane (active transport).
- It act as enzymes where by it carries out sequence steps of a metabolic pathway.
- Proteins act as receptor sites.
- It is an intercellular junction which ensures that tissues and organs are formed.
- It enables cell-cell recognition.
- It is an attachment on the cytoskeleton and extra cellular matrix. Although animals lack cell walls they do have an elaborate extra cellular matrix whose main ingredients are glycol-proteins. These form very strong fibres out side the cell and these are the advantages of extra cellular matrix; They provide support and they control activities of the genes in the nucleus.
- It networks glycoprotein which transmits mechanical stimuli from extra cellular matrix.
- NB. In animals, there are three main types of intracellular junctions;
- Tight junction.

- Desmosarries.
- Gap junctions.
- Fluidity of the membrane.
- Membranes are not static sheets of molecules locked rigidly in space. This is because the phospholipids and some of the proteins are held together by hydrophobic interactions that allow the molecules in the membrane to drift about laterally in the plane of the membrane. Flip-flop movement where the phospholipids switch from layer to another is rare but possible. Lipids move along the plane of the membrane rapidly at an average speed of $2\mu ms^{-1}$. Proteins are much larger than lipids and they move more slowly but some do drift about. Many membrane proteins are un able to move far because of attachment to cytoskeleton. A membrane remains fluid as the temperature rises until finally at same critical temperature, it solidifies. The temperature at which membrane solidify depends on its lipid content or composition. It will remain fluid to a lower temperature if it is rich in phospholipids with unsaturated hydrocarbon chain eveats attains which doesnot allow phospholipids to closely pack together.
- Functions of plasma membrane.
- It allows exchange of materials between the cell and its surrounding.
- It contains protein molecules which act as carrier molecules for certain materials e.g mineral ions across the membrane.
- Impulse transmission in nerve cell occurs along the cell membrane.
- It offers protection to the inner parts against mechanical injury.
- It splints up at the centre during cell division to give rise to daughter cells.
- It also act as a sight in which certain reactions occur e.g in prokaryotes photosynthesis and respiration occur in cell membrane.
- It helps in re-organization of foreign bodies during body defence.
- It also plays a role in energy transfer since it contain protein molecule.
- The chocostrol in it acts like a plug to reduce further escape on entry of polar molecules through the membrane.
- The glycol protein in the molecules act as antigens or cell identity makers, this enables the cells to recognize other cells and behave in organized way.
- The protein molecules in the membrane specific shape that enables them to act as specific receptor molecules. a chemical signaling between the cells e.g neural transmitters the chemicals which enable the impulse to pass from one cell to the other, have specific receptor molecules in which other receptors can fit.
- The proteins at times act as enzymes e.g microvilli on epithelial cells lining some parts of the gut contains some digestive enzymes their surface membrane.
- It also separates the content of the cell from its surrounding.
- Properties of the cell membrane.
- It is selectively permeable; this implies that it allows only small sized parts such as glucose, amino acids, fatty acids, mineral irons etc.
- It is made up of proteins and lipids each phospholipids consist of polar head contain the phosphate
- and 2 non-polar carbohydrate chains from fatty acids.
- The head is hydrophilic (water loving) while the head is hydrophobic (water hating). The phospho
- Lipids there fore gives the membrane its fluid nature and being dynamic.

- Adaptations of cell membrane.
- It has globular proteins which are in constant motion to determine its flexibility.
- It contains some poves particularly in protein molecules to allow passage of materials in and out side. The poves are of particular size to allow only small sized particles and this makes the membrane to be selectively permeable.
- The membrane is thin and this reduces the distance over which materials diffuse.
- The membrane has a receptor size on its extrinsic proteins recognition by other cells.

The Cytoplasm

This is a jelly like matrix with in the cell in which cell organelles and structure are suspended. It's a fluid like substance also called cytosol and among other structures, which are found in the cytoplasm are; proteins fibres in form micro fibres and micro tubules, nucleus, chloroplasts for plant cell, Golgi apparatus, ribosomes, endoplasmic. The cytosol is a homogeneous solution but its highly organized structure that surrounds the organelles.

The Cyto-skeleton;

This is the lattice network of the cytoplasm of the cell that consists of microfilaments. Intermediate filaments and microtubules, the micro filament consists of actin and myosin proteins; the actin filaments are associated with fibre involved in the movement of the cells and its organelle. They interact with moto molecules. The micro tubules consist of alcohol and better tubulings. The cytoskeleton its not rigid but capable of quit rapid movement and reorganization.

Functions of Cyto-skeleton.

- It gives support to nuclear membrane and other organelles.
- It takes part in formation of cell junction.
- It is highly dynamic and can easily a symbol and di-symbol depending on the condition on which the cell is.
- It also aids in the amoeba movement.
- The micro-tubules in it and centrioles form spindle fibres used to pull chromosomes to the opposite role.
- The micro-tubules also form flagella and cilia which are used for locomotion.
- The micro-tubules also act as tracks along which the organelle moves.
- It maintains the shape of the cell

The cytoplasm of same cells contains certain chemicals in aggregates e.g inclusions like glycogen granule in liver, ciliated muscles, melanin granules on skin, triglycerides in a pose cells.

Membrane bound organelles.

These are organelles found in the cell that are bound by membranes, some are single membrane bound organelles, and others are double membrane organelles.

The mitochondria.

These are found in the cytoplasm of the eurokaryotic cells.

Structure;

A Mitochondrion has a sauce-shaped structure whose size varies and it's a double membrane bound. When view in a transverse section its spherical/ round of about 0.2mm but in the side view its elongated of about 5m in length. Its surrounded by an inner membrane outer membrane separated by inter membranous space. The

outer membrane is smooth which the inner membrane is highly folded inner wards to give rise to extensions called clistea. The inside of the mitochondria is made up of semi-rigid material contains proteins, lipids and traces of the DNA.
Longitudinal section of mitochondrion;

Transverse of mitochondrion.

Functions of the mitochondria;
It is an organelle where a process of respiration takes place particularly around its clistae.
Adaptations of mitochondria to its functions;

- The inner membrane of mitochondria is highly folded to cristea where by increasing the surface area for production of large aunts of energy (DNA).
- Mitochondria contain many enzymes, hydrogen acceptors and electron transport system that are used in energy production. Enzymes such as sillinale dehydrogenase etc realize energy production with in the matrix.
- Mitochondria contain small ribosomes which carry out protein synthesis by providing a firm support to messenger DNA.
- The chloroplast:
- This is an organelle found in a plant cell.
- Structure:
- It is double membrane bounded organelle. It consists of outer membrane which is transparent and inner membrane which is also transparent. The two membranes are separated by small space. The membranes enclosed jelly like colourless matrix called the stroma in which other structures and food reserves are embedded/ suspended. Its where the dark stage of photosynthesis takes place because it lacks chlorophyll. It also consists starch granules, oil globules, circular DNA and small sizedribosomes. Starch granules are temporary stores for starch containing enzymes like RUBP carboxylase. It also contains RUBP (rubo carboxylase) used in the photosynthesis. The stoma also contains system of interconnected system pilled and closed and flatted sac-like structures called thyllakoids, one pile of these thyllakoids form a granum, the thyllakoids contain a photosynthetic coil called pigments and they form a site where a light stage of photosynthesis takes place to some of the thyllakoids have tubular extensions called inter-granular lamellar which connect the adjacent grana.

- A longitudinal section of chloroplast.
- Function of chloroplast;
- It's an organelle where process of photosynthesis takes place.
- Adaptations of chloroplast to suit its function;
- It's surrounded by transparent membrane to allow light pass through.
- Its thyllakoids contains green pigment called chlorophyll.
- It has ocavacy ground matrix called stoma where the dark stage of photosynthesis takes place.
- The stoma contains starch granules which acts as temporary store for starch.
- The thyllakoids are also numerous in numbers to increase surface area where the light stage of photosynthesis takes place.
- There is a colourless fluid in middle of the membranes.
- The grana are inter-connected with intergranal lamellae to increase the surface area further more for process of photosynthesis.
- The grana give structural support and determine the shape of the chloroplast.
- NOTE: chloroplast belongs to a group of organelles called **plastids.**
- A plastid is an organelle that contains either pigmous or stored food material. The flow chart shows

plastids

`Chromo plasts (chloroplast) leucoplasts (colourless)

Amyloplast protoplast lipidoplast
(Store carbohydrates) (Stored proteins) (Stored lipids).
(e.g starch).

Qn. Compare a mitochondrion to a chloroplast.
Similarities;

- Both are double membrane organelle.

- Both have sized ribosomes.
- Both contain circular DNA.
- Both contain colourless ground matrix.
- They both have storage granule.
- Differences;

• Mitochondria	• Chloroplast
• The mitochondria contain cristea. • It does not contain starch grain. • The inner membrane is highly folded. • It is a sauce shaped. • It is an organelle where respiration takes place. • It's found in both cells. • It does not have an internal membrane system.	• It does not contain cristea. • It contains starch grain. • Its un folded. • Has oval shape. • It forms a site for manufacture of food by process of photosynthesis. • It's found in plant cell. • It contains internal membrane that consists of thyllakoids and grana.

- Endoplasmic Reticulum.
- This is a network membrane of parallel lines running through the cytoplasm, it is a sheet like structure of a flattened membrane band sacs called cristerea, they are of two types namely;
- Rough endoplasmic reticulum
- This type has its sternae covered with ribosomes. This is concerned with synthesis and transport of proteins. Proteins are made in ribosomes. A receptor in the membrane of endoplasmic recticulum provides a channel in to which proteins passes in to the end or as the proteins pass through the cisternae, they are modified in the root e.g converted into glycoprotein which travels to the Golgi body from where they are removed from the cell or passed to other organelle to other cells.
- Smooth endoplasmic reticulum;
- This is the type of endoplasmic recticulum with in ribosomes on the membrane. The cisternae are move tubular and the main function of this type is to synthesize lipids e.g in the epithelium of small intestinal cell, the smooth endoplasmic recticulum synthesis form fats and glycerol absorbed form the gut and passes them to Golgi body. other functions are:
- It also makes steroids which are hormones e.g corticoid steroid made form adrenal cortex of the adrenal glands and sex hormones they are also steroids.
- Muscle cells have specific endoplasmic recticulum called sarco plasmic recticulum which helps in muscle contraction.
- They also play part in metabolism of carbohydrates.
- De-toxication of drugs and other poisons from other cells.
- They give structural support to the cell organelles.
- Structure of Rough endoplasmic recticulum.

- Structure of smooth:
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- This consists of bubbled convinces containing fused protein form of rough endoplasmic recticulum and lipids in form of smooth endoplasmic recticulum in transit to the Golgi body for internal processing.
- Differences;

• Smooth endoplasmic	• Rough endoplasmic
• Have no ribosomes. • Smooth transports cystoids/ lipids. • They are few in the cytoplasm	• Have ribosomes. • Transports proteins. • They are widely spread in the cytoplasm.

- Golgi apparatus.
- It’s a complex structure that consists of several flattened sacks made of membrane. These sacks have cavities called cisternae in each sack. One side of the sack faces the endoplasmic recticulum that contains cellular products. There is only one Golgi apparatus in each animal but in plant cells there is large number of stacks called dicotysomes. Its position and size varies from one cell to another but its well developed in secretory cells and neurons together and small in muscle cells all produced bi-endoplasmic recticulum are passed through Golgi apparatus in a particular sequence, cis Golgi network which returns endoplasmic recticulum any protein wrongly exported by it, they then pass through stack of cisternae which modify the proteins and lipids and add labels that allow them to be identified and sorted at the next stage. The trans Golgi network where lipids and proteins are sorted and services to their final destination, the opposite size at the Golgi-starch of sacks faces towards the plasma membrane. The cellular membrane are then released that are budded off the sack depending on the nature of specific products, the vessels that lead to Golgi complex may become lysosomes, storage granules, secretary resides in addition to plasma membrane resides in addition to plasma membrane.
- Functions of Golgi apparatus;
- The Golgi body produces secretary vessels as swellings.
- Bud off the apparatus and usually contain enzymes, anti-bodies, hormones etc.
- It secrets carbohydrates eg of the new cell walls of cell membrane, such carbohydrates include amylo pectin, pectin and cellulose etc. some times the Golgi apparatus after budding off have occurred forms lysosomes, containing hydrolytic enzymes for cellular defence.
- It is also involved in the internal secretion of different chemicals such as glycoprotein like mucus.
- It’s involved in transporting and transmitting lipids.
- It’s involved in packaging and shipping vessels.

- It's also involved in separating different types of proteins busting in their function and destination e.g protein to be excreted incorporated and introduced in to the bysomes.
- Structure of Golgi apparatus;
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- Lysosomes.
- These are simple spherical/ sack-like bodies with a diameter between 0.1-1.0nm and are surrounding a single membrane. They contain digestive enzymes mostly hydrolyses enzymes in acidic region or solution. They isolate enzymes from the remainder of the cell and by doing so; they prevent the enzymes from acting upon other chemicals and organelle from the cell. A primary lysosome is the one that contains only digestive enzymes with in an environment that is moved in acidic than that surrounding the cytoplasm. A primary lysosome may fuse with food vacuole or another organelle to form a secondary lysosome in worn out organelles and the product of phogal-cytosis can be digested. Enzymes containing the lysosome are synthesized and transport the Golgi in which are budded off as vessel.
- Functions;
- They digest materials that enter the cell in a white blood materials digested are bacteria, fungi.
- They also digest out the won out organelles.
- Its to release enzymes out side the cell into the process called exytosis.
- It breaks down the toad pole tail during metamorphosis of an amphibian.
- They release lytic enzyme that resolves the membrane during fertilization.
- Micro bodies (peroxisomes).
- These are also membrane bound organelles with a diameter between 0.5-1.5NM containing several specific enzymes that promote oxidative reactions and don't have internal structure. They are present in most cells particularly large and active cells in deliver. They contain one or more hydrogen from a particular organelles and transferred to form hydrogen peroxide hence oxidizing the molecules e.g alcohol is oxidized to acetaldehyde by deliver perixozome. They contain catalyses enzyme which prevents excessive accumulation of hydro-peroxide.
- The nucleus.
- This is a prominent organelle that's oval in shape, its bounded by a nuclear/ envelope that consist of two membranes that are fused at intervals forming nuclear pores. It contains various materials such as ribosomes, DNA (Deoxyribo nucleic acid).A chromatin is organized into structures called **chromosomes**. The DNA its association with histon proteins, it also contains spherical body that's not bounded by numerical body called **nucleolus**.
- Functions of nucleus:
- It controls all other activities of the cell e.g cell division, growth and development, respiration.

- It contains the DNA material that determines the nature of an organisms or organisms of a given species.
- The nuclear membrane allows the exchange of materials.
- It contains ribosomal RNA required for photosynthesis.
- Structure of a nucleus:
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- Ribosomes (non membrane bound organelles).
- These are small or round structures found free in a cytoplasm and also located on the surface of rough endoplasmic recticulum. Each ribosome is made up of two sub-units i.e the bigger unit and the smaller one. Each ribosome is composed of ribosomal RNA and proteins. Ribosomes are divided into two major parts i.e 70s and 80s. The prokaryotes contain ribosomes 70s while Eurokaryotes contain ribosomes 80s, each ribosome is roughly containing equal amount of RNA and proteins.
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- Cell vacuoles.
- These are fluid filled sacks bounded by a single membrane called tonoplast, they are usually found in plant cells, in a nature cell there is lengi muscle called the cell vacuole which is always centrally located with in the cytoplasm. The vacuole contains a mixture of proteins commonly called cell sap which contains water, mineral acids and waste materials.
- Functions of cell vacuole:
- It contains food reserves and materials for the cell.
- It is also important in osmo regulation e.g fresh water animal.
- It also enables the cell to gain stability which brings support in non woody plant.
- It stores temporary non waste materials but they are taken out of it and transferred the other parts.
- It also contains lytic enzyme and acts as a lysosome to carry out autolysis of fallen particles.
- It may also contain pigments in solution form e.g anthocyanins which are red, blue and purple and other related compounds which are shaded, that determines colour of fruits, leaves and flowers.
- Cell walls.
- Plant cells, like those of prokaryotes and fungi are surrounded by a relatively rigid wall which is secreted by the living cell (the protoplast) with in. plant cell walls in chemical composition from those of the prokaryotes and fungi. The wall laid down during cell division of plant is called the

primary wall. This may later be thickened to become a secondary wall. Formation of the primary wall is described in this section and an early stage of wall formation.

- Structure of the cell wall:
- The primary wall consists of cellulose fibrils running through a matrix of other polysaccharides, the matrix consists of polysaccharides which are usually divided for convenience into pectin and are usually divided for convenience into pections and hemicelluloses; pections are acidic and have a relatively high solubility.
- Cell-wall-middle lamella: structure:
- Functions of the cell wall:
- Mechanical strength and skeletal support is provided for individual cells and for the plant as a whole.
- Cell walls are fairly rigid and resistant to expansion and there fore allow the development of turgidity.
- Orientation of cellulose micro fibrils limits and helps to control cell growth and shape.
- The system of interconnected cell walls is major path way of movement for water and dissolved mineral salts.
- Cell walls develop a coating of waxy outin, the cuticle on exposed epidermal surfaces reducing water loss and rise of infection.
- The walls of xylem vessels and sieve tubes are adapted for long-distance translocation of materials.
- The cell walls of root endodermal cells are impregnated with suberin that forms a barrier to water movement.
- Some cell walls are modified as food reserves as in storage of hemicelluloses in some seeds.
- The Cilia and Flagella.
- Cilia and flagella are organelles that have identical structures, although flagella are longer. They are out growths from cells which can beat either in one direction (cilia) or like a wave (flagella).
- Cilia and flagella are responsible for movement of cells and materials. Cilia in paramecia beat rhythmically to propel the cell in a particular direction while flagella in bacteria and sperm cells beat side by side to propel the cells forward. Cilia living the respiratory tract beat rhythmically to expel foreign bodies preventing them from reading the lungs. The oviduct is lined by ciliated epithelial cells whose cilia beat rhythmically to propel armature egg towards the uterus.
- Transverse section of a cilium / flagellum.

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- Longitudinal section of a cilium or flagellum.
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- The Centrioles.
- They are hollow, cylinders about 0.2mm in diameter. They arise from a distinct region of the cytoplasm called the centrosome that contains only two centrioles. At cell division, the centrioles replicate and migrate to opposite poles of the cell where they synthesize the microtubules which form the spindle fibres.
- Functions.
- The spindle fibres perform two functions during cell division.
- They the chromosomes in position at the equator.
- They contract and shorten to pull the chromosomes towards the opposite poles.
- Microfilaments.
- *They are very thin, long strands about 6mm in diameter.* They consist of protein molecules known as **actin** and a small proportion of **myosin**. There fore there are two types of microfilaments and myosin microfilaments. These microfilaments are involved in middle contraction and relaxation. The myosin filaments move over the actin filament in skeletal muscles in order 8to cause contraction of the muscle there fore there by bringing about movement of the different parts of the body.
- Microfilaments also occur in the tail of sperm cell where they contract and relax because side by side lashing of the tail in order to propel the cell. Microfilaments exist in sieve tubes of phloem vessels in woody plants. They are involved Cyto plasmic steaming i.e the filaments are in constant motion with in the sieve tubes. Intermediate filaments are smaller than microtubules. They are made up of myosin proteins.
- Questions;
- 1. Explain the role of microfilaments and microtubules in movement.
- 2. Compare the structure of Eukaryotic and prokaryotic cells.
- 3. State the role of cell membrane in prokaryotic cells.
- Micro villi.
- They are tinny finger like projections. They are found on the membrane of certain cells such as those of the epithelium and proximal convoluted tubules of the kidney nephron. Cells that bare micro villi are responsible for material absorption. The micro villi increase the surface area for absorption of sufficient amounts of materials.
- Structure of the micro villi.
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- Occurs in cells of
- Ileum wall.
- Pot wall.
- Absorption of digested food.
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- Cell diversity

• Type of cell	• structure	• Function
• Animal cell	•	•
• Epithelial cell	•	• It posses and form that makes it more suitable for it lining the surfaces of body organs and cavities e.g the gut.
• Glandular cells.	• • • • • •	• They are responsible for producing some kind of body secretions e.g mucus hormones, antibodies etc. such cell have a prominated Golgi body.
• Fibro plasts.	• • • • • •	• They secrete protein fibres that make up the connective tissue for holding the tissues and organisms together.
• Chondrio blasts and osteoblast	• • • • • •	• They produce cartilage matrix and bone matrix respectively.
• Erythrocytes (RBCS).	• • • •	• They are responsible for conveying oxygen through out the body.

	• •	
• Leucocytes (WBCS).	• • • • • •	• They are generally amoeboidal and defend the body against infection.
• Nerve cells.	• • • • • • •	• They are slender and arm-like; they transmit impulses through out the nervous system. • They don't under go cell division e.g rods and corns.
• Sensory cells (Neurons).	• • • • • •	• They are capable of elastic activity generated by specific stimulation e.g sound, light etc.
• Muscle fibre	•	• They contain actin and myotin proteins (skeletal muscles). • They are capable of electric conduction. • They have elongated cells which electrical activity is accompanied by contraction.
• Spermatozoa.	•	• A single cell with an elongated tail containing a 9+2 arrangement of microtubules. • The flagellum tail is capable of power indulation hence the super metazoan cell in propelled forward.
• Chromatophores	• • • • • • •	• They are responsible for colour changes. • They are stellate cells containing a pigment whose concentration changes hence changing the skin colour e.g in the skin of amphibians and replies there are many chromatophores.
• Frame cells.	• • • •	• They are found in flat worms e.g liver flukes, fascola hepatica. • These cells are used for osmoregulation in flat worms.

• Nematoblast cells (stinging cells).	• • • • • • •	• They are thread like and contain a toxic fluid capable of placing and poisoning prey hence mobilized for easy capture e.g in jelly fish, hydra and sea animals.
• Ovum (egg cells).	• • • • • • •	• This is a reproductive cell incapable of movement, lack flagella and its large.
• Plant cells.	•	•
• Photosynthetic cells.	•	• They are packed with chloroplasts. • They contain chlorophyll a green pigment that traps light energy. • They perform the function of building up complex sugars of CO_2 and H_2O.
• Parenchyma cell.	•	• They are packed tightly together to fill up any spaces between tissues. • They are living cells responsible for food storage e.g starch.
• Epidermal cells.	• • • • • •	• The outer walls possess a waxy cuticle that minimizes excessive water loss.
• Root hair.	• • • • •	• Absorb water and mineral salts from the soil. They are long, have thin epithelium and are tapering.
• • Collenchyma cells and sieve tube.	• • • • • • •	• Both are elongated and Collenchyma is concerned with strengthening the plant while sieve tubes transport soluble, food materials with in the plant. They are also hollow.

• Guard cells.	• • • •	• Control closing and opening air spaces like stomata, they are concentrated on the lower epidermis of the leaf.
• Vessels (traches and fibres).	• • • • •	• Strengthen stems of higher plants, however tracheal transports water from roots to leaves as well as vessels.

- THE DNA STRUCTURE, GENETIC CODE AND PROTEIN SYNTHESIS.
- CELL DIVISION:
- Cell division is the splitting of armature cell to form daughter cells. There are two types of cell division i.e
- Mitosis.
- Meiosis.
- Mitosis;
- This is also known as replication cell division. This is the splitting of armature cell (parental cell)
- to form two identical daughter cells each containing exactly the same number of chromosomes as
- *the parent cell.* Mitosis takes place through out the growth period of an organism. Mitosis occurs
- in four stages i.e
- Prophase.
- Metamaphase.

- Anaphase.
- Telophase.
- Before the cell undergoes mitosis, it undergoes a preparation stage known as interphase.
- Interphase;
- This is called the resting stage but the actual sense the cell is not veoling because there are many activities that occur in preparation of the cell for division. These activities include;
- Production of ATP through cellular respiration to provide sufficient energy needed for cell division.
- Synthesis or formation of more organelles such mitochondria, chloroplasts, Golgi bodies, centrioles, endoplasmic reticular etc. this ensures equal distribution of cell contents between the daughter cells.
- Replication of genetic material, DNAreplicates, leading to doubling of chromosomal number so that the parental chromosomal number is maintained in the daughter cells.
- Chromosomes are long than (thread like) hence not clearly seen and they are highly called for easy packing in the nucleus.
- Prophase;
- This has two sub stages i.e early prophase and late prophase. During early prophase, centrioles migrate to opposite poles of the cell spindle fibres are then synthesized by the centrioles and radiate to the nuclear membrane.
- Chromosomes shorten and thicken hence easily seen.
- They un coil and appear to have centromeres.
- Late prophase;
- Chromosomes condense further and split vertically to form chromatide which remain attached at the centromere.
- In this case, the chromosome is said to duplicate.
- Each chromosome forms the chromatide.
- NOTE: A chromatide is a duplicate or half of a chromosome.
- Nucleolus disintegrates i.e breaks down and disappears.
- Nuclear membrane also degenerates and disappears and thus mounts the end of prophase.
- **Metaphase:** This consists of two sub stages i.e early metaphase and late metaphase.
- Early metaphase:
- The spindle fibres completely form
- The chromosomes that are made up of chromatides assemble/ align at the equator singly i.e each chromosome is attached to a single fibre.
- During the alignment the chromatides face the opposite poles.
- The chromatides are attached at the equator by the spindle fibres being attached at the centromere.
- Late metaphase:
- During late metaphase;
- The chromosomes are pulled along the centromere by the spindles as spindles begin to contract.
- The centromere therefore splits in to two to form independent chromatides that are still held close.
- **Anaphase:** This consists of two sub stages i.e early anaphase and late anaphase.
- Early anaphase:

- The spindle fibres contract further using energy provided by ATP generated by mitochondria.
- The chromatides are separated completely.
- The independent chromatides migrate to opposite poles, being pulled by spindle fibres as they shorten.
- During the movements the centromere leads i.e faces the pole.
- Late anaphase;
- Chromatides reach their destination (opposite poles).
- **Telophase:** When the chromatides arrive at the poles, nuclear membrane reforms:
- Nucleolus also reforms.
- Chromatides become long, thin, coiled hence not easily seen.
- Spindle fibres disintegrate and disappear.
- **Note:** All the above events we have been describing lead to the splitting of the nucleus into two hence nuclear divisions.
- **Qn:** Describe the events which occur in the nucleus during mitosis.
- After nuclear division, cytokinesis/ cytoplasmic cleavage occurs. In an animal cell cytokinesis occurs when the cell membrane constricts at the centre i.e along the equator to divide the cytoplasm of the cell into two equal halves each half consisting of a complete nucleus. As a result, two daughter cells are formed and these are identical to the parent cell. However in a plant cell, cytokinesis occurs by formation of a cell plate along the equator. During its development, cellulose is deposited in the cell plate to form a cellulose cell wall for each of two identical daughter plant cells.
- **Tissue regeneration;** Some animals are able to regenerate whole part of the body, such as legs and arms in star fish production of the cells involves mitosis.
- Diagrams showing the appearance of cells during mitosis.

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• Differences between mitosis in animals and plants.

• Animals	• Plants
• Centrioles are involved.	• Centrioles absent hence not involved.
• Cyto plasmic damage occurs by cell membrane constriction.	• Cytoplasmic damage occurs by formation of cell plate made up of pectins.
• There is aster formation.	• Aster absent.
• Occurs in any part of the body.	• Occurs only in meristematic tissue.

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• Importance/ significance of mitosis.

• **Genetic stability:** Mitosis produces two nude having same number of chromosomes as parental nucleus. There fore ensuring that genetic information remains constant i.e no variation occurs.

• **Growth:** Number of cells in organisms increases by mitosis hence increasing the size of the tissue and hence the organism as a whole. This is the basis of growth. Mitosis produces exact copies of the parent cell in multicellular organisms which causes uniform growth of the tissues.

• **A sexual reproduction:** In unicellular organisms such as Amoeba, the parental organisms divide into two. During binary fusion in amoeba, the organism divides into two independent organisms. This is a form of mitosis.

• **Cell replacement;** new cells replace the worn out cells a process called cell replacement that occurs during healing. Cell replacement involves mitosis, cells are constantly dying and being replaced, an example is the skin, cavity around the mouth etc

• **Tissue regeneration;** new tissues are formed from pre-exiting tissues to give rise to new organs.

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• **MEIOSIS**.

• This is a type of cell division which involves splitting of a mature cell into four daughter cells each containing half the number of chromosomes of the parent cell. In this case, the daughter cells are said to be haploid. Meiosis involves two successive divisions (phases) namely;

- Meiosis one (I) (first meiotic division).
- Meiosis two (II) (second meiotic division)
- divides meiotically, it undergoes a preparatory stage known as **interphase I.**
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- **MEOISIS I**
- Before the cell Interphase I
- During interphase I, several activities occur to prepare the cell for effective division. Such activities include:
- Replication of genetic material (DNA) making them to double;.
- Production/ synthesis of ATP (Adenosine Triphosphate) which is a source of energy required for cell division.
- Formation of more cell organelles such as Golgi body, centrioles, mitochondria etc.
- The cell increases in size.
- During interphase the chromosomes are uncondensed i.e coiled, long, thin and not easily seen.
- **Nuclear division:**

Nuclear division of meiosis I involves the following stages:
- Prophase I.
- Metaphase I.
- Anaphase I.
- Telophase I.
- This is there fore followed by cytokinesis/ cytoplasmic cleavage.
- Prophase I.
- This is the longest phase of meiosis and it is subdivided in to five phases i.e
- Leptotene (single chromosomes).
- Zygotene (synapsis).
- Pachytene (duplication of chromosomes).
- Diplotene (crossing over of chromatids).
- Diakinesis (repulsion of chromosomes to nuclear membrane).
- Leptotene:
- Chromosomes appear to be single stranded without centromeres. They are relatively long.
- Zygotene:
- The chromosomes continue to shorten and thicken hence easily seen.
- Centrioles more to opposite poles and spindles start forming.
- Synapsis occurs i.e homologous chromosomes pair up to form bivalents.
- Homologous chromosomes donot join but lie side by side.
- Homologous chromosomes appear to have centromeres.
- **Homologous chromosomes:** are pairs of similar chromosomes formed which contain genes that
- determine particular characters.
- **Bivalent:** is a pair of homologous chromosomes formed by synapsis at zygotene of prophase I.
- Pachytene:
- Each of the chromosome splits vertically into two to form two chromatids. This is called chromosomal duplication.

- The chromatids are still attached to the centromere of chromosomes.
- Diplotene:
- Chromosomes coil around one another.
- Homologous chromosomes tend to draw apart there by breaking proportions of non-sister chromatids.
- The portions then rejoin uncorrectly there by leading to exchange of genetic material between homologous chromosomes a condition known as **crossing over**.
- **Crossing over** there fore is the exchange of portions of chromatides of homologous chromosome at points called **chiasmata** leading to exchange of genetic material between homologous chromosomes or non sister chromatids.
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- Importance of crossing over.
- Crossing over results in to formation of new gene combinations which promote genetic variation among organisms of the same parents very important in evolution of species.
- Diakinesis.
- Internal coiling occurs and chromosomes repel each other to far distances between them.
- The homologous chromosomes push them selves to the periphery of nucleus close to the nuclear membrane.
- As a result of this opposite movement of chromosomes the number of chiasmata reduces because of breaking up in the process.
- However, chiasmata formation remains at the tips of the chromosomes.
- The nucleus disintegrates by shrinking and disappears.
- Nuclear membrane also disintegrates and disappears; this marks the end of prophase I.
- Metaphase I
- Centrioles reach opposite poles.
- The spindle fibres form completely.
- Bivalents arrange themselves at the equator with each of the pair facing opposite poles.
- The alignment of the bivalents at the equator is completely random in comparison to other bivalents leading to formation of new gene combinations resulting into genetic variation.
- The spindles attached to the centromere contract slightly pulling homologous chromosomes slightly apart there by breaking chiasmata if present.
- Anaphase I.
- Spindles continue to contract and shorten.
- Homologous chromosomes part company and migrate to the opposite poles of the cell.
- The contraction of spindle fibres and migration of chromosomes require energy provided by the numerous mitochondria in the cell.
- Telophase I.
- Chromosomes reach their respective poles.
- Chromosomes become long, thin hence not easily seen.
- Nucleolus reappears and nuclear membrane reappears.
- Spindle fibres may completely or partially disappear.
- The centrioles replicate.
- Finally, cytokinesis occurs to form two daughter cells.

- In plant cells, meiosis doesnot include Telophase I and interphase II. From anaphase I, the dividing cell enters prophaseII directly. But in animal cells Telophase I and interphase II occur. In animals Telophase I gives rise to two primary sprematocytes in males and in the females, division of cytoplasm gives rise to a primary oocyte and polar body.
- Diagrams of cells during Meiosis I.
- Prophase I
- Metaphase I
- Anaphase I
- Telophase I
- Meiosis II
- Interphase II
- After Telophase I, daughter cells enter interphase II, to prepare for meiosis II. During interphase II
- there is no DNA replication. This occurs so as to maintain the haploid state in the gametes there fore
- maintaining diploid state in the off springs.
- Prophase II
- Centrioles migrate to opposite poles.
- Spindle fibres are then synthesized by centrioles but arranged at right angles to the spindle of meiosis I.
- Chromosomes shorten and thicken hence easily seen.
- Chromosomes condense further to split and form chromatids.
- The chromatids are still attached at the centromeres.
- Nucleolus degenerates and disappears.
- Nuclear membrane also degenerates and disappears.

- Metaphase II
- Spindles form completely.
- Chromosomes are aligned at the equator singly.
- During alignment, the chromatids face opposite poles.
- Chromosomes are held in position by the spindle fibres slightly contract.
- As a result of centromere splits to form independent chromatids that are still too close to each other.
- Anaphase II
- Spindles contract further and completely separate the chromatids.
- Independent chromatids migrate to opposite poles being pulled by spindle fibres.
- During chromatide movement the centromere face opposite poles.
- Finally chromatids reach their destination.
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- **NOTE:** Migration of chromatides requires energy provided by ATP hydrolysis.
- Telophase II
- When chromatides arrive at the poles, a new nuclear membrane forms around each pole surrounding the chromatids.
- Nucleolus also forms.
- Chromatids become long, thin hence not easily seen as chromosomes.
- Spindle fibres disintegrate and disappear.
- Cytokinesis occurs to form four haploid daughter cells collectively called a **tetrad**.
- In animals, meiosis occurs in germinal cells or tissue of multicellular organisms leading to production of gametes. In males germinal cell are found in the testis and when they under go meiosis, and Telophase II produces secondary sprematocytes which differentiate into spermatozoa (male gametes). In females however, germinal cells are found in ovaries in which Telophase II produces a secondary Oocyte that matures into a functional egg/ovum and a smaller polar body. In flowering plants meiosis occurs in Anther heads to produce pollen grains and in females: embryo sac / ovaries to produce eggs / ovules.
- **NOTE:** Spermatozoa and ova are haploid productive cells and Pollen grains and ovules may be haploid, diploid, tetraploid or triploid.
- Diagrams of cells during meiosis II.
- Prophase II
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- Metaphase II
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- Anaphase II

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- Telophase II
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- Significance of meiosis.
- Meiosis is important following ways:
- **Genetic variation**; meiosis provides opportunity for new combination of genes to occur in gametes and consequently in the off springs. This is possible in two ways.
- **Crossing over:** During crossing over in prophase I segments of chromatides are exchanged leading to formation of new gene combinations which are the basis of variation in the offspring.
- **Independent assortment of chromosomes;** At metaphase I of meiosis, random orientation of bivalents at the equator occurs resulting into formation of new gene combinations passed to gametes and finally 9to the off springs at fertilization hence genetic variation.
- **Sexual reproduction:** Meiosis leads to the production of gametes in plants and animals. The gametes formed are then used in sexual production.
- Meiosis ensures that gametes formed are **haploid** in order to maintain **diploid** state of organisms after fertilization.
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- Differences between meiosis and mitosis.

	Mitosis	Meiosis
Prophase	• Homologous chromosome remains separate. • No formation of chiasmata. • No crossing over.	• Homologous chromosomes pair up. • Chiasmata form. • Crossing over may occur.
Metaphase.	• Pairs of chromatides line up on the equator of the spindle.	• Pairs of chromosomes line up on the equator.
Anaphase.	• Centromeres divide. • Chromatides separate. • Separating chromatides identical.	• Centromeres donot divide. • Whole chromosome separate. • Separating chromosomes and then chromatides may not be identical due to crossing over.
Telophase	• Some number of chromosomes present in daughter cell as parent cells. • Both homologous chromosomes present in daughter cells if diploid.	• Half the number of chromosomes present in daughter cells. • Only one of each pair of homologous chromosomes present in daughter cells.

• .Occurrence.	• May occur in haploid, diploid or polyploid cells.	• Only occurs in diploid or polyploid cells.

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- ***Similarities between mitosis and meiosis.***
- Spindles are formed during the prophase stage in both.
- In both there is disintegration of the nucleoli during prophase.
- In both chromosomes line up at the equator attached by the centromere.
- In both, the centrioles replicate.
- In both, spindles disappear during Telophase.
- In both, the nuclear envelope and nucleolus reappear during Telophase.
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- ***Differences between nuclear division and cell division.***

• **Nuclear division.**	• **Cell division.**
• No cytokinesis.	• Cytokinesis occurs.
• Only the nucleus divides.	• The whole cell divides.
• No constriction of the cell wall.	• Constriction of cell wall.

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- Questions.
- 1. Explain the significance of meiosis in causing genetic variation.
- 2. (a) Give an account of mitosis in an animal cell.
-    (b) Compare mitotic anaphase and anaphase I of meiosis.
- 3. How is genetic variation achieved in organisms?
- 4. Outline the events involved in nuclear division during meiosis I.
- 5. State the stages of meiosis where the following occurs.
- (i) Crossing over.
- (ii) Synapsis.
- (iii) Independent assortment.
- (iv) Cytokinesis.
- (b) State the role of genetic variation in organisms.

PART II
Cell division and the cell cycle
From the cell theory, new cells arise from the pre-existing cells by the process of cell division. The cell cycle is a sequence of events which a cell goes through from the time it is formed until when if divided again. The cell cycle involves 3 main stages i.e.
Interphase.
Nuclear division.
Cytokinesis/cytoplasmic division.

INTERPHASE:
This is called the preparation for action phase it is a stage of intersive metabolic activity during when the cell prepares for nuclear division and cytoplasmic division. Though it is mistakenbly called a resting stage, it is a stage of various activities. It is divided into 3 phases,
First growth phase (G_1) which involves intensive cellular synthesis i.e. rm of ATP and the cell increases in size i.e. it undergoes growth.
Synthesis phae (s) during when DNA replication occurs such that each of the daughter cells can get its copy of the DNA.
Second phase (G_2). This involves intensive cellular synthesis including duplication of the centrioles where spindle fibres arise. Centrioles act as microtubules organising centres (MTOCS). Moreenergy stored micotolria and ceroplastic divided and spindle fibres begin to form.At the end of interphase, the cell appears as below.

MITOSIS:
This is a process in which the parent cell divides to form two daughter cells each containing the same number of chromosomes as the parent cell.In organisms, body cells are having a diploid set of chromosomes, so during mitosis, the daughter cells are diploid. Before a cell under goes mitosis, it goes through the preparation for action phase called interphase during when energy stores are building up, DNA replication occurs, duplication of orgammelles occurs and division of the centioles takes place.Mitosis is divided into 4 stages, i.e prophase, metaphase and telophase. Each of the stages has an early and late phase.

PROPHASE:
During early prophase, chromosomes become visible. They shorten and fatten shifting from the thread like nature as ia the case during interphase. The nucleus and the nuclear membrane begin to dis intergrate centriales move to the opposite roles of the spindle and spindle fibres start to inform with formation of aster rays.

Diagram:

During late prophase, chromosomes continue shortening and fattening and each is seen to have a pair of chromatides joined at the centromere. The nucleolus disappears completely and the nuclear membrane breaks down.

METAPHASE:
Chromosomes arrange themselves at the equator of the spindle during early metaphase and they do so in a single.

Diagram:

During late metaphase, the chromosome divides longitudinally through the centamere and slightly pulls apart due to contraction of the spindle fibre.

Diagram:

ANAPHASE:
During early anaphase, sister chromatids part company and move to the opposite poles of the spindle with the centromere leading them.During late anaphase the chromotides have reached their final the opposite poles of the spindle.

TELOPHASE:
During early telophase, the cell starts to constrict across the middle or the equations.During late telophase, constriction of the cytoplasm continues until when two daughter cells are obtained.The chromosomes regain their thread like nature, the nuclear membrane reforms, nuclears reforms spindle fibres dis intergrate.
Diagram.

NB: In plant cells, there are no centrides, so there is no aster ray formation but there are still spindle fibres which move the chromosomes. This provides evidence that spindle fibres are not made by the centrides.During telophase in plant cells,cytoplasmic division is achieved by formation of a cell plate starting from the middle of the cell moving outwards along which cellulose is deposited.

SIGNIFICANCE OF MITOSIS:
It is important during growth e.g development of the zygote into a new multicellular individual.
Aservual reproduction e.g binary fission, multiple fission all occur by mitosis.
Cell replacement i.e repair of tissues after damage occurs through mitotic cell division.
Regeneration organisms can regenerate whole body parts through production of new cells by mitosis.
It ensures genetic stability by maintaining a diploid number of chromosomes in all body cells.

MEIOSIS:
This is the process by which a parent cell divides into four daughter cells each with half the chromosome number of the parent cell. It consists of two successive division i.e,
First meiotic division (meiosis I)
Secondary meiotic division (meiosis II)

MEOSIS I

This separates the homologous chromosomes and therefore halves the chromosome number.It is divided into four sub – stages each with a suffix of I to indicate the 1st meiotic division i.e. I.

PROPHASE I:

This is the longest phase and is divided into sub stages i.e leptotene, zygotene, diplotene, pachytene and diakineris. During leptotene, the nucleolus and nuclear membrane disintergrate, centroles move to the apposite poles and spindle fibres begin to appear. The chromosomes shorten fatten and thicken shifting from the thread like nature to become clearly visible.During zygotene, homologous chromosomes are seen to have a pair of chromatids joined at the centromere. The homologous chromosomes associate with each other and come to lie side by side a process called synapsis forming bivalents.

Diagram:

During diplotene, homologous chromosomes exchange portions through crossing over by forming chiasmata. Crossing over is the basis of variation in sexually produced off springs.

Diagram:

During diakiness, the homologous chromosomes separate after exchanging portions in the process of crossing over.

METAPHASE I:

Homologous chromosomes arrange themselves on the equator of the spindle in double raw as bivalents.

ANAPHASE I:

Homologous chromosomes part company and move to the opposite poles of the spindle being led by the centromere as a result of contraction of the spindle fibres. Finally during late anaphase,the homologous chrosomoses reach their final destonation.

TELOPHASE I

Chromosomes have reached the opposte poles and cell constriots across the middle as in mitosis.

Diagram:

The cell divides to give two daughter cells each with half the chromosome number. There it is the 1st meiotic division that divides the chromosome number to half the usual number.

MEIOSIS II

In some cells where after telophase , interphase occurs the nucleolus reappears, nuclear envelope develops again, spindle fibres disintegrate.Following interphase, the cell now undergoes prophase II which is a very short phase compared to prophase I.During when the nucleolus disappears in nuclear envelope break done and where centricles are present as in animal cell. They divide and move to the opposite poles.The poles of prophase II are at right angles to the plane of the previous cell division and therefore the spindle fibres develop at right angles to the spindle axis of the previous cell division.In those cells which do not undergo interphase, the cell enters the second meiotic division at the stage of prophase II with chromosomes thick and the former spindle still present.

METAPHASE II

The chromosomes arrange themselves on the equator of the new spindle.The spindle fibre attach to the centromere of each chromosome.
Diagram:

ANAPHASE II:

Centromeres divide and the chromatids part company and move to the opposite poles being pulled by the spindle fibres.
Diagram:

TELOPHASE:

Chromosomes have reacted their final destination and each cell divides along the equator giving a total of two cells at the end of meiosis called a tetrad of cells. The x-matid unwinds and regains their thread like structure.The nuclear envelope and nucleolus are reformed.The spindle fibres disintergrate and the centrioles get close to the nucleus at only one site.

SIGNIFICANCE OF MEIOSIS:

It occurs during formation of gametes.
It ensures that each gamete is haploid and maintains the diploid chromosome number in the zygote when the male and the female gametes fuse.
It is the basis of genetic variation which can analyse as a result of
Crossing over which occurs during prophase I of meiosis.
Some variations also arise as a result of independent assortment and random distribution of chromosomes during metaphase I of meiosis.
Variations also arise when parental genotypes are mixed to form a zygote.
When chromosomes come to the equator during prophase , they arrange themselves randomly.

Differences between meiosis and mitosis.

MITOSIS	**MEIOSIS.**
Two daughter cells are formed	Four daughter cells are formed.

Chromosome number is maintained as the parental cell chromosome number.	Daughter cells have half the number of chromosomes of the parent cell.
Occurs in somatic cells.	Occurs in germ/reproductive cells.
Single division of chromosome and nuclear.	Single division of the chromosomes but double division of the nucleus
No association of homologous chromosomes	Homologous chromosomes associate during prophase I to form divalent.
Crossing over neither occurs so no variation.	Crossing over occurs at the charismata.
One stage is involved during cell division.	Two stages i.e meiosis one and two.
Chromatiod move to the opposite poles during telophase.	Chromosomes move to opposite poles during anaphase I.
Chromosomes arrange themselves in asingle role at the equator.	Chromosomes arrange themselves in a double role at the equator during metaphase I.
It is a brief process, takes 1 – 2 hours.	It is long process e.g information of the egg cell in humans it can take up to a month while a sperm cell it can take 24 days.

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- **HISTOLOGY:**
- Tissues.
- *A tissue is a group of cells performing specific function*. Groups of cells of a similar function and structure are assembled together. The study of tissues is called histology. There are two main categories of tissues i.e animal tissue and plant tissue.
- Animal tissues.
- These are found in animals. They include the following;
- Epithelial tissue.
- Reproductive tissue.
- Blood tissue.
- Connective tissue.
- Nervous tissue.
- Skeletal tissue/ muscular tissue.
- Epithelial tissue.
- Is a tissue consisting of one or more layers of cells lining all the body surfaces, cavities and tubes.
- Major roles of tissues.
- Most of tissues are involved in ;

- Absorption of materials.
- Secretion of body fluids.
- Protection, support and movement.
- Epithelial cells are closely bound to one another by a variety of specialization of the cell membrane and a cementing substance called hyaluronic acid which is a carbohydrate derivative. All epithelium are supported by a basement membrane of variable thickness made up of collagen fibres. The basement membrane separates epithelia from the underground surfaces.
- Classification of epithelia.
- Epithelia are classified according to their morphological appearance.
- (i) The number of layers. Epithelia consist of one tissue called simple epithelium while epithelium with more than one layer of cells is called compound epithelia.
- (ii) Shapes of the compact cells as seen in a sectron at right angles to the epithelial surface incase of stratified epithelia, the shape of the outer most layer of cells is considered in determining the shape of the cell. The shape of the nuclei is also used to determine the shape of the cell.
- (iii) The presence of surface specialization e.g Keratin hence keratinified epithelia, cilia hence ciliated epithelia etc.
- Epithelia.
- Simple epithelia. Compound epithelia.
- Squamous. - Stratified epithelia.
- Cuboidal. - Transitional epithelia.
- Columnar.
- Ciliated.
- Pseudo-stratified.
- Simple squamous epithelia.
- These consist of flattened cells that form a thin and continuous layer of cells. The cells form a strong sheet like structure consisting of flattened nuclei with little cytoplasm. All cells originate from the basement membrane and are connected from end to end. These cells are always smooth.
- Diagram;
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- Location;
- Found lining the Bowman's capsule in the kidney.
- They line the alveoli in the lungs.
- They line blood vessels.
- They line pleural cavity.
- They line the pericardial cavity.
- Functions.
- Facilitates diffusion of materials e.g in the lining of the alveoli and in the bowman's capsule of the kidney. This is made possible because of the thinness of the epithelium.
- It allows smooth passage of fluid in blood vessels and chambers of the heart. This is made possible because their surfaces are smooth.

- Facilitates passage of fluid in pericardial, pleural cavities. This is made possible because the cavities are smooth.
- Cuboidal epithelia.
- Diagram;
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- Location;
- It is found lining small ducts and tubules where it performs excretory or absorptive functions.
- Collecting ducts of the kidney.
- Salivary glands.
- Thyroid glands.
- Sweat glands.
- Mucus glands.
- Pancreatic duct.
- Simple columnar.
- This consists of two elongated cells which contain elongated nuclei. They are usually with finger like projections called microvilli. They are often associated with mucus secreting cells called globiet cells.
- Diagram;
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- Location;
- Found lining highly absorptive surfaces like the small intestines. Here the microvilli greatly increase the surface area over which absorption takes place.
- Found lining secretory surfaces like stomach where the globlet cells secret mucus which protects the stomach lining from the acidic contents of gastric juice and from digestive enzymes like pepsin.
- It lines the intestines and the globlet cells secret mucus which protects the intestinal wall and also helps to lubricate the passage of the food.
- Simple ciliated.
- It is a simple columnar epithelium which has got specialization in form of cilia. It is usually associated with globlet cells which produce mucus.
- Function:
- Cilia helps to (propel) generate the current in the fluid provided by the mucus. This helps to propel fluid or particles over the epithelial surface.
- Location;
- It lines the oviduct (fallopian tube) where the cilia propel the ova towards the uterus. Ventricles of brain and spinal canal.

- Diagram;
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- Simple pseudo stratified.
- It is a simple epithelia tissue with the cells arranged in such a way as to make them appear to be more than one layer. The nuclei are located at different levels. All the cells rest on the basement membrane but not all of them reach the terminal surface. Some have cilia on their surfaces.
- diagram;
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- Compound epithelia.
- Stratified squamous.
- It consists of a variable layer of cells that undergo morphological and functional transition from Cuboidal base layer to the extreme surface layers. The degenerate surface cells are continuously replaced by the dipper layer by mitosis. Because of this, the tissue is well adapted to with stand moderate abrasion.
- Location;
- Found lining the pharynx, oesphogous and vagina, urethra in females, cornea in eye all of which are subject to moderate mechanical abrasion which the stratified squamous epithelium can withstand. In some areas the stratified squamous epithelia may be keratinized. In such a case, during maturation, the cells undergo a process called keratinisation leading to a formation of tough non-cellular layer on its surface made up of a protein layer called keratin.
- It is found in skin.
- It is found under the backal cavity (mouth).
- Diagram;
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- Stratified Cuboidal.
- It is a thin stratified epithelium consisting of two or more layers of Cuboidal cells. The cells near the basement retain the Cuboidal shape but those near the surface loose this shape and retain the nucleus.
- Location;
- Found lining large excretory ducts of exocrine glands like the sweat glands, pancreas, salivary glands, somniferous tubules and ovarian follides.
- Diagram;
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- Stratified columnar:
- This consists of 2-3 layers of cells.
- Location:
- It found in the Urethra, pharynx, epiglottis, large secretory ducts e.g mammary glands.
- Diagram;
- Transitional epithelia:
- It is made up of more than one layer of cells. It has some features which are intermediate between stratified Cuboidal and stratified squamous epithelia when is relaxed state, it appears to be 4,5 cell layers thick where the basal cells are Cuboidal, intermediate are polygonal and surface cell are larger, rounded and contain two nuclei. When in stretched state, it appears to be 2-3 layers thick, intermediate and surface layers being flattened. Surface cells donot break off. All cells are able to modify their shape in different positions.
- Location.
- Epithelium is found almost exclusively in the urinary tract in mammals where it is highly specialized to accommodate a great degree of stretch and with stand the toxicity of urine. The ability of tissue to modify its shape enables it to accommodate considerable.
- Diagram;
- Glandular epithelia.
- There are individual granular cells which secret certain substances e.g globlet cells. In another epithelia, there may exist aggregates of granular cells and these form multicellular glands. Cells develop from the epithelia become specialized and arrange them selves to form glands. There are two types of glands which include;
- Exocrine and endocrine glands.
- Exocrine glands.
- Are types of glands whose excretions are released to the surface of the epithelia. They are classified according to two major characteristics;
- Structure of the gland.
- Method of discharge of secretory products from the cell.

- Qn: Describe how epithelial tissues are adapted to their function.
- Solution;
- Epithelial tissues tough and hard to serves protection of underlying tissue from mechanical injury, desiccation and chemical injury;
- Epithelial tissue has compact cells with tight junctions to form an impervious barrier;
- Epithelial tissue is made up of several layers of cells impregnated with keratin in some parts of the body to enhance strength of cover;
- Epithelial lining of the gut has numerous villi to increase surface area for absorption;
- Epithelial tissue contains secretary columnar cells to secrete useful material like mucus and digestive enzymes;
- The epithelial lining of the uriniferous tubules in the kidneys, genital tract and respiratory tract consist of cilia to aid in excretion, conduction of the gametes, fluid and mucus respectively;
- Epithelial tissue is modified into several exoskeletal structures such as nails, scales, hairs, feathers, claws hooks or beaks for protection against enemies, heat loss or feeding;
- The epithelial lining of alveoli in the lungs is thin , of one layer thick to allow easy diffusion of respiratory gases during gas exchange;
- Epithelial tissue have hairy structures which serve as sensory structures eg hair on the skin, in nose; which receive stimuli and convey impulses to the central nervous system;
- Epithelial cells provide pigmentation to to the body eg human skin has melanocytes to produce melanin to give the skin;
- Some epithelial tissues have infoldings under lining surfaces to form channels or ducts through which they pass their secretions eg lands;
- Transitional epithelium in renal pelvis, ureter, urinary bladder and parts of urethra, has few layers of less flattened cells which are mobile over each other to help in distention of these organs;
- Structure of a gland.
- Under this classification, the glands are either simple or compound.
- (a) Simple glands.
- These have got a single un branched duct. They include;
- (i) Simple tubular.
- Diagram;
- These have got single straight and tubular secretory portion e.g crypts of lieberkuhn in the ileum and large intestines.
- (ii) Simple coiled tubular.
- Diagram;
- Each gland consists of a simple tube which is highly coiled e.g sweat glands in the skin of man.

- (iii) Simple branched tubular:
- Diagram;
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- Each gland consists of several tubular proteins which converge in to a single branched duct. E.g Brunner's gland in the wall of the small intestines in mammals, gastric glands in the wall of mammalian stomach.
- (iv) Simple alveolar (secular).
- Diagram;
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- Here each gland is a secretory portion and is round or like sac-like e.g mucus secreting glands in the urethra of the penis and mucus glands in the skin of the frog.
- (v) Simple branched alveolar
- Diagram;
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- Each gland consists of several secretory acids which empty into a simple excretory duct. Examples; sebaceous gland in a mammalian skin.
- COMPOUND GLANDS:
- These are exocrine glands with a branched duct system. Their secretory portions have similar structural forms to those of the simple glands with the exception looth adnar and tubular forms may be found together draining into the same duct system, they include;
- (i) compound tubular gland.
- The secretory portions of these are of tubular form which is branched e.g salivary glands, Brunner's glands in mammalian bodies.
- Diagram.
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- (ii) Compound adnar(seccular).
- Have round secretory units which drain in to a branched duct. E.g mammalian glands, exocrine gland of pancreas.
- (iii) Compound tubulo-alveolar
- Diagram;
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- These are got in secretory ducts which consist of branched tubular components, branched alveolar components with alveolar end piece called ……..,,
- Method of discharge of secretory products from cell glands can be referred to as; merocrine, apocrine and holocrine.
- Merocrine.
- in this case, the secretion is passed through the cell membrane, no cytoplasm is lost. The secretion in this process is a process of exocytosis e.g exocrine region of pancreas, sweat glands and simple globlet cells.
- Apocrine.
- This involves discharge of free broken membrane bound vessels containing secretory products. Part of the cell cytoplasm it lost during the secretion of mammary glands..
- Holocrine.
- Here the whole secretory cell disintegrates to release the secretory products. It can however be reconstructed from the epithelial layer e.g sebaceous glands.
- Endocrine / ductless glands.
- These are glands without ducts. Their secretions are released directly in to the blood stream. These glands consist of clumps of secretory cells surrounded by a network of blood capillaries. The secretory products are released into the extra cellular fluids surrounding the capillaries from where they are absorbed in to the blood stream e.g thyroid gland ovaries, testis, islets of langerhans of pancreas, placenta, parathyroid glands attached to the thyroid gland etc.
- Connective tissues.
- This is the basic type of tissue which provides a structural and metabolic support to other tissues and organs throught the body. It binds the organs and tissues together. It consists of cells and extracellular fibres embedded in a gel-like ground substance (matrix) rich in tissue fluid. The connective tissue has the following functions;
- Defence.
- Heat regulation.
- Water metabolism.
- Support.
- Composition;
- It is generally composed of three elements.
- (i) Ground substance (matrix).
- (ii) Fibres (elastic and collagen fibres).
- (iii) Cells.
- Cells are the only living components. Matrix and fibre form the supporting component. They are of different types.
- Types of connective tissues.
- (a) Loose connective tissue (Alveolar tissue).
- **(b)** Dense connective tissue.
- Collagen and elastic tissue (yellow elastic).
- Collagen are white fibrous.
- **(c)** Adipose tissue.
- Loose connective tissue

- It is the most important type of connective tissue and found all over the body. E.g beneath the skin connecting organs together and filling spaces between adjacent tissues. It is constituted by the following;
- (a) Glycoprotein matrix consisting of four types of cells and two types of protein fibres.
- Four types of cells.
- **Fibroblast.** It produces the collagen and elastic fibres.
- **Mast cell:** Secret matrix and an anticoagulant.
- **Fat cells.** Store fats.
- **Macrophage**: Provide defence against foreign bodies by phagocytosis.
- Chromatophores, mesenchyma cells may also be present.
- Two types of fibres.
- **Collagen fibres**: Are white and inelastic.
- **Elastic fibres:** Are yellow and elastic.
- Diagram:
- Elastic tissue
- It has semi opaque matrix containing a net work of yellow and white fibres. Due to the fibres, this tissue is greatly elastic and flexible compared to hyaline tissue and allows the tissue quickly recover its shape after distortion. It is found in the external ear, epiglottis and supporting the eustesthian tube and the external auditory meatus.
- Diagram;
- Collagen tissue (white fibrous tissue).
- It consists of large numbers of bundles of densely packed collagen fibres embedded in the matrix. These fibres provided the tissue with great tensile strength and small degree of flexibility as compared to hyaline tissue.
- Diagram;
- It is found in the intervertebral disc where it provides a cushioning effect. It is found in the region between the two pubic bones of the pelvis (pubic-symphysis). Here it allows partition without complete breakage.
- Adipose (fatty tissue).

- This is a tissue made up of specialized cells for the synthesis and storage of fats. Its matrix consists of only densely packed fatty fluid cells called adipocytes. Each cell is mostly filled with a centrally located fatty goblet which displaces the nucleus and cytoplasm aside.
- Diagram;
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- (a) White adipose tissue:
- This forms about 20% of the total body weight in normal well nourish of male adults and up to 25% in females.
- Location:
- Found in catenous tissue in the skin, cheeks, neck region, breasts and anterior and lateral aspects of thighs etc.
- Functions:
- It is an energy store.
- Acts as an insulator against heat loss where it occurs under the skin.
- Provides protection against mechanical shock where it occurs around the delicate internal organ like part
- (b) Brown adipose tissue:
- This occurs in new born mammals and hibernating mammals where it helps in temperature regulation.
- Specialized connective tissue:
- Cartilage.
- Bone.
- Dentine.
- Haemopoletic tissue e.g red bone marrows, spleen and lymph nodes.
- Skeletal tissues.
- In vertebrates, skeleton tissues are made up of two major components i.e bone and cartilage. Both are specialized forms of connective tissue.
- Cartilage:
- It is semi rigid type of specialized tissue. It consists of cell called chondrocytes and extracellular fibres which are collagen and elastic embedded in a gel-like matrix made up of glyco proteins which contain a high portion of sulphated polysaccharide units. This type of matrix makes the cartilage solid but flexible. Cartilage is characterised by absence of blood vessels, lymphocytes and nerves. The collagen fibres may contain, resist any tension making cartilage able to resist strains and absorb mechanical shock. The outer surface of mature cartilage contains a zone of collective tissue called perichondrium which contains chondroplasts.
- Location:
- It is found generally in the following areas with in adults body;
- Nosal area.
- Ears (pinna and outer ear).
- Ends of bones.
- In cartilaginous fish e.g shark, dog fish, skates etc.

- Cartilage forms the first skeletal tissues in embryos which later becomes in a process called ossification during development.
- Formation of cartilage.
- Cells called chondroplasts deposit in the matrix called chondrion. The chondroplasts become enclosed in a space called lacunae to become chondrocytes. Perichondrium forms a fibrous layer around the tissue and this contains chondroplasts from which new cartilage is laid down.
- Types of cartilage.
- Hyaline cartilage.
- Elastic cartilage.
- Fibro cartilage.
- Hyaline cartilage.
- The matrix of the tissue consists of a translucent material called chondrion which is mainly a muco polysaccharide with combined sulphate group. It is a firm bluish white and some what elastic material. It has peripheral chondrocytes flattened in shape and those suited internally are glandular. Each chondrocyte is contained in a lacunae and each lacunae may enclose 1,2,4,or8 chondrocytes and its found in the skeleton of the embryo and mammals at one stage which is gradually replaced by bone in most parts and remaining in the following areas;
- End of bones.
- In the nose and air passage of respiratory system.
- Parts of the ear.
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- Diagram;
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- It is the most common type of cartilage in the body. It has a semi transparent matrix called chondrion. The chondrocytes are enclosed in a lacunae in clusters of 1,2,4 or 8 chondrocytes each. The chondrocytes in the lacunae can exchange materials in the matrix by diffusion since there are no blood vessels like bones.
- Location and function of hyaline cartilage.
- It is found at the ends of ribs articulating with sternum.
- It forms articular cartilage at joints where it often offers protection to the bones from abrasion.
- It is the type of skeletal material found in cartilaginous fish.
- Elastic cartilage (yellow elastic cartilage).
- It is yellow because it contains yellow elastic fibres. The elastic fibres are arranged in all directions with in the matrix. The elastic fibres are responsible for making it have greater elasticity and flexibility as compared to hyaline cartilage. It enables the cartilage to regain its shape quickly once it has become distorted.
- Location.
- It is found in the pinna of the ear, epiglottis, eustachian tube of ear, pharynx, and auditory canal of the ear.
- Diagram;
-

- Fibro cartilage:
- Consists of bundles of white collagen fibres in its matrix. This tissue has got greater tensile strength and a small degree of flexibility as compared to the hyaline cartilage.
- Location:
- Forms intervertebral discs between vertebrae of the vertebral column.
- Found in pubic symphysis.
- Forms articular cartilage.
- Occurs in association of with dense connective tissue in joint capsules, ligaments and connections of some bones to tendons.
- Diagram;
- The bone.
- This is the tough, hard and un flexible skeletal tissue which is in form of connective tissue and is highly classified. It contains collagen fibres in the organic materials which form 30% of the matrix. It also contains in organic salts, these form 70% of the matrix. The major component of organic salts is the hydroxyl- apatite $Ca_{10}(PO_4)_6(OH)_2$. Other minor components include; sodium, magnesium, potassium, fluorine, chlorine, hydrogen carbonates and citrate ions. The matrix contains cells called osteoblasts located in spaces called lacunae. The osteoblasts are responsible for laying down the organic components of bones. Bones exist as spongy and compact.
- Compact bones (transverse).
- It consists of a number of concentric cycles called **lamellae;** and each surrounds a central canal called **Haversian canal** containing an artery, This helps in the conduction of nutrient and respiratory gas. a vein, lymph vessels and nerve fibres; The lamellae contain spaces called **lacunae;** occupied by bone cells called **osteoblasts/ osteocytes**; there are also fine channels called canaliculi that link lacunae and may contain cytoplasm; The system of lamellae around one haversian system; Compact bones forms structure of great strength with minimum mass due to various inorganic components that may be deposited in it;.
- Transverse section of compact bone to show Haversian canal.
- Spongy bone.
- This consists of a mesh work of thin interconnecting bony strusts called trabeculae. It contains less inorganic material in its matrix compared to the compact bone. The spaces between the trabeculae contain soft marrow tissue.

- Location.
- Found in the embryo, growing animals and epiphysis of long bones like the femur.
- Structure of a long bone.
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- Long bones have got long wholly shaft called diaphysis and expanded ends called epiphysis. Diaphysis is composed of compact bone while the epiphysis is composed of mainly spongy bone. The epiphysis contains red bone marrow which is responsible for production of red blood cells. Diaphysis contains fatty yellow marrow which produces white blood cells.
- Functions of bone:
- Manufacture of blood cells (red blood cells and certain white blood cells).
- Provides surfaces for muscle attachment.
- Provides the frame work which supports the weight of the body.
- Offers protection to the delicate organs of the body e.g heart, lungs, spinal cord etc.
- Bone act as a reserver for calcium and phosphorous salts and this helps in maintaining their level in blood.
- Comparison between bone and cartilage.
- Similarities:
- The matrix in both is of organic origin (i.e a mucopolysaccharide).
- Both may be impregnated with collagen and fibrin.
- Both originate from primitive mesenchyma cells.
- In both the cells are located in lacunae.
- Differences:

• Bone	• Cartilage.
• Consist of a solid matrix called ostein. • • Produced by star shaped osteoblasts. • Impregnated with calcium and phosphorous. • • Has a marrow. • Highly vascularised. • Has Haversian system in compact bone. • It is innervated.	• Consist of relatively and flexible matrix called chondrion. • Produced by round chondroplasts. • Not impregnated of calcium and phosphorous. • Marrow absent. • Not vascularised. • There is no haversian system. • Not innervated.

• Osteoblasts are arranged in concentric layers around lamellae perforated by canal /curls. • Surrounded by tough periosteum. • • Is structurally differentiated into spongy and compact bone. • Is an active tissue with metabolic activity which synthesis blood cells and plays a role in calcium homeostasis.	• Chondroplasts are randomly arranged in the matrix and occur in singles or • Surrounded by a less tough and flexible perichondrium. • It is structurally differentiated into fibro and elastic cartilage. • Is not an active tissue. •

- Muscular tissue:
- This is a type of tissue derived from the contractile cells and it is specialized for contraction. Muscles are made up of elongated units known as muscle fibres with a capacity of to contract and relax. The muscle fibres are bound in a frame work of connective tissues. The muscles are supplied with blood and nerves.
- Types of muscles:
- Skeletal muscles.
- Smooth muscles.
- Cardiac muscles.
- Skeletal muscle.
- Is a type of muscle found covering the skeleton. It is connected to bone by a tendon. It is striated (stripped) muscle. Skeletal muscles are voluntary nervous system i.e motor nerves from the CNS. It contracts quickly and is fatigued quickly. Each muscle is made up of numerous muscle fibres which are cylindrical in shape and varying in length. Each fibre is surrounded (bound) by a membrane called **sarcolemma.** Each fibre contains numerous **myofibrils** each containing two protein **myofilaments** which are **actin** and **myosin**. The cytoplasm of myofibril is called **sarcoplasm** and contains a system membranes called cytoplasmic reticulum and also consists of tubules called the **T-system** which run transversely a cross the fibre and between fibrils. It is also in contact with sarcolemma and cytoplasmic reticulum. The T-system and cytoplasmic reticulum have a high concentration of calcium ions.
- Diagram:

- The myofilament has got alternating dark (amostrophic) bands also called **A**, bands and light (isotrophic) band also called **I-bands**. The I-bands has got a line called **Z-line** passing through its centre. The distance between adjacent **Z-lines** forms **a sarcomere**. This is a unit of contraction. H-zone is a zone in the A-band which contains only myosin filaments. In between the H-zone there is the **M-line** which joins adjacent myosin filaments together.
- Myosin filaments.
- Myosin filaments are thick and have got two regions (two parts) long rod shaped fibre myosin head 10mm in diameter, 2.5mm length.
- Diagram:
- Actin filaments.
- These are made up of thin filaments of about 5mm in diameter and 2.0mm in length. Each filaments consists of ;
- Two helical straits of globular actin molecules twisted around one another.
- Two associated proteins these are;
- **Tropomyosin**. This forms a fibrous rod shaped strand around the actin filaments. Its function is to switch on and off the contractile mechanism.
- **Troponin** it is a globular protein consisting of three sub units which are **troponin C**, **troponin Y**, **troponin I.** All of them participate in the contraction of muscle fibre.
- Actin filaments.
- Smooth muscle:
- These are unstripped muscles. They are innervated by the autonomic nervous system by two sets of nerves. There fore the sympathetic and the other form parasympathetic. It is involuntary, contracts slowly and fatigues slowly. It is found in walls of tubular organs where they help e.g in bladder, blood vessels, ureter, and vasdeferens and in the intestinal tracts. The cells are un nucleated and spindle shaped. They are held together by connective tissue consisting mainly of collagen fibres. The fibres are oriented in parallel such as circular and longitudinal muscle whose act as antagonistic.
- Longitudinal section of muscle in stomach.

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- Functions of smooth muscle:
- Dilation and constriction of blood vessel.
- Movement of materials in the uterus and ducts of the reproductive tissues.
- Dilation and constriction of ducts.
- Cardiac muscle:
- They are striated muscles, muscle fibre consist of one or two nuclei and are branched. Fibres are connected to form a dense network by a series of intercalated discs. Its innervated by the ANS but can also contract on its own. There fore it is a myogenic muscle. It is an involuntary muscle, doesnot get fatigued.
- Location:
- It's found exclusively in the heart.
- Diagram:
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- Qn. (a) Compare skeletal to cardiac muscle (10 marks).
- (b) What are the general functions of a skeletal tissue? (05 marks).
- (c) Compare a bone to cartilage. (10 marks).
- Solutions.
- (a) Similarities; skeletal (voluntary) and cardiac muscles.
- Both are specialized but voluntary muscle is most highly specialized and the cardiac is more specialized than the involuntary.
- Both have a nucleus.
- Both of their cytoplasm contains mitochondria, SER, network of tubules, T-system.
- Both contain sarcolemma.
- Both contain microfilaments/ micro fibrils.
- Both have cross striations.
- Differences:

• Voluntary/ skeletal.	• Cardiac.
• Other names: striated, stripped, skeletal. • Mostly highly specialized. • Very long cells, usually called fibres, subdivided into units called sarcromeres. Fibres bound together by vascular connective tissue. • Under control of the voluntary nervous system via motor nerves from the brains and spinal cord (neurogenic).	• Heart. • More specialized than involuntary. • Cells terminally branched and connected by intercalated discs. Arrangement of fibres is three dimensional. • • Myogenic but rate of contraction can be influenced by the automatic NS.

• Intercalated discs are absent. • Powerful, rapid contractions, short refractory period, therefore fatigues quickly. • • Attached to the skeleton in the trunks, limbs and heads.	• • Present. • Rapid rhythmical contraction and relaxation, long refractory period, therefore does not fatigue, contraction not sustained. • Found only in the walls of the heart chambers.

- (b) See notes above.
- (c) See notes above.
- Blood tissue.
- Blood is a circulating tissue consisting of three types of cells suspended in fluid called **plasma.** Most numerous cells are the **red blood cells** (erythrocytes) whose main function is to transport respiratory gases, less numerous are the **white blood cells** (leucocytes) which are of different types and they collectively defend the body against diseases by destroying pathogens that might entered the body and then **platelets** which are minute fragments and play an important role in the process of blood clotting.
- Nervous tissue.
- This consists of densely packed nerve cells called **neurons** which are specialized for conduction of nerve impulses from one part of the body to the other. The nervous tissue is enclosed by connective tissues which contains blood vessels. The nerve cells are interconnected together to form a network whose function is to transmit and some times to store information. Nervous tissue is derived from embryonic neucoderm.
- Reproductive tissue.
- This tissue is concerned with production of gametes ie the eggs and sperms respectively. The reproductive tissue is divided into female reproductive system and male reproductive system.
- Male reproductive tissue.
- The reproductive tissue in males is found in the seminiferous tubules of the testis to produce the male gametes (spermatozoa) commonly referred to as sperm. These tubules are suspended in the connective tissue containing **allugenea** cells.
- Diagram.
- Female reproductive tissue.
- It is composed of paired ovaries and fallopian tubes, the uterus, vagina and external genitalia. The ovaries consist of outer **cortex** and inner **medulla** surrounded by a connective tissue sheath, the **tunica allugenea**. The outer layer cells of the cortex are composed of **germinal epithelial cells** from which gamete cells are produced. The cortex is composed of developing follicles and the medulla is composed of stroma, containing connective tissue, blood vessels and mature follicles.

- Diagram.
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- Plant tissues.
- **(a) Simple tissues:** These consist of only one type of cell. They include; parenchyma, Collenchyma, sclenenchyma.
- **(b) Compound tissues:** Tissue consisting of more than one type of cells. They vascular tissues of plants i.e xylem, phloem.
- Primary plant structure.
- Transverse section of dicot stem.
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- Transverse section of monocot stem.
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- Transverse section of monocot root.
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- Transverse section of dicot root.
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- Parenchyma tissue.
- These consist of spherical cells. The cells are elongated in longitudinal section. Their cell wall contains cellulose, pectin and hemicellulose. They are un specialized tissues, they consist of living cells. Tissue has got large intercellular air spaces.

- Functions:
- Forms the bulk of packing tissue in the plant body.
- May be used for food storage.
- Helps in gaseous exchange due to large intercellular air spaces.
- Provides support when the cells are turgid especially in the herbaceous plants.
- Transverse section of parenchyma tissue.
- Longitudinal section of parenchyma tissue.
- Some parenchyma is specialized e.g the one responsible for photosynthesis is referred to as Collenchyma forming the mesophyll cells of the leaves i.e palisade mesophyll and spongy mesophyll. Others specialized to form …………. some parenchyma to form the endodermis. This forms a selective barrier to metabolites entering or leaving the conductive tissue.
- Location:
- Epidermis of roots and certain stems.
- Collenchyma tissue:
- This consists of living cells. Cells are polygonal in outline and elongated in the longitudinal section. The cell wall has extra deposition of cellulose and pectin in the corners. They have thin cell wall made up of cellulose, pectin and hemicellulose.
- Location:
- Outer regions of cortex, just below the epidermis in stem.
- Function:
- Provide support in young plants and leaves due to the thickened cell wall especially at the corners and the close packing.
- Transverse section of Collenchyma tissue.
- Sclerenchyma tissue:
- These are dead cells of two forms;
- Fibres.
- Sclereids.

- **Fibres:** Are elongated and polygonal cells with interlocking ends. Their cell wall is highly lignified. They also contain hemicellulose and proteins. The cells are closely packed with no air spaces between them.
- Transverse section of fibres.
- Longitudinal section of fibres.
- Location:
- They are found in pericycle, outer region of the cortex also found in xylem and phloem.
- Function:
- They provide mechanical support.
- **Sclereids:** These are spherical or irregularly shaped cells. They have lignified cell walls which also contain pectin, hemicellulose and cellulose. They have branched pith.
- Transverse section of Sclereids.
- Location:
- They are found occurring singly or in groups of leaves, fruits and seeds.
- They may also be found in stems.
- Functions:
- They offer mechanical support. They are known to offer great tensile strength due to their tightly lignified cell walls.
- Compound tissues:
- These are tissues made up of different types of cells. They include; xylem and phloem which are vascular tissues.
- **Xylem:** Is a vascular tissue which is made up of different types of cells.
- Vessel elements.
- Tracheids.
- Others include; xylem fibres and xylem parenchyma.
- **Tracheids** are dead single cells. They are elongated and tubular. They have lignified walls. These ends overlap. The cell wall has got lignin, cellulose, pectin and hemicellulose. Cell content are absent. The adjacent cells are connected by means of pits.
- Longitudinal section of Tracheids

- Functions:
- Provide mechanical strength and support to the plant.
- They form the primitive water conducting tissues of the plant body.
- Vessel element:
- Xylem vessel are dead cells, they are elongated and tubular. They fuse to form several cells called xylem elements. Their cell wall contains cellulose, pectins, hemicellulose and lignin. They are of two types i.e proto xylem and meta xylem.
- **Proto xylem:** Are small cells and inner most. They have the annular and spiral types ofd lignification. They are the first vessels to form.
- Diagram;
- Functions:
- Support (mechanical).
- Water and mineral salt transport.
- **Meta xylem:** They are large and are outer in location. They are formed after extensive lignification of the proto xylem. Their lignification is in three patterns which are;
- Scalariform.
- Reticulate.
- Pitted.
- They form long empty tubes.
- Diagrams:
- All vessels are made up of cells whose cross walls have broken down resulting in long tubes ideal for carrying water. Xylem parenchyma are living cells with cell wall bade up of cellulose. They are used for storage of food, radial transport of food and water, they also facilitate gaseous exchange.
- **Xylem fibres:** They have thick walls, narrow lumen and overlapping ends. They offer additional mechanical strength.
- Transverse section of xylem:
- phloem:
- Is made up of five different types of cells and these include;

- Sieve tube elements.
- Companion cells.
- Others;
- Parenchyma.
- Fibres.
- Sclereids.
- Sieve tubes.
- Elements are elongated and tubular structures with cell walls containing cellulose, hemicellulose and pectin. They are formed by fusion of sieve elements end to end. They are developed from
- Procarmbrial strands. They lack nucleus when mature. They remain with very little cytoplasm. They are in close association with companion cells. They have perforated end walls to form sieve plates. They contain thin cytoplasmic filaments.
- Comparison cells.
- These are living cells, their cell wall contains cellulose, pectin and hemicellulose, and has dense cytoplasm. They have prominent nucleus, have numerous mitochondrion.
- **Parenchyma:** are elongated and are living.
- **Phloem fibres are;** thick walls, interlocking ends are elongated cells, have a narrow lumen.
- Longitudinal section of phloem.
- Transverse section of phloem.
- Function.
- Phloem translocates the products of photosynthesis e.g sucrose from leaves to other parts of the plant.
- Qn:
- Describe briefly the structure and functions of the following tissues in plants;
- (a) Xylem tissue.(10marks)
- (b) Phloem tissue.(10 marks)

- LEVELS OF ORGANISATION.
- There are four major levels of organization, most of the animals e.g mammals fall under organ level of organization that is their body functions are carried out by organs and organ systems.
- These levels of organizations include;
- Unicellular level of organization.
- Tissue level of organization.
- Organ level of organization.
- Colonial level of organization.
- Unicellular level of organization.
- This is exhibited by protists such as amoeba, paramecium etc. the functions which are carried out in higher forms are also carried out by organelles in unicellular organisms. In some protists such as ciliates like paramecium, intracellular activity is more elaborate.
- Diagram of paramecium.
- Paramecium is comparatively large fresh water ciliates.
- Paramecium has a specialized organelle for the intake of food, contractile vacuoles for expellinary excess water out of the cytoplasm and elaborate system of thread like interconnecting structures known as cilia.
- Cilia are connected to the basal bodies beneath the cell membrane and are used for locomotion.
- Macro nucleus is responsible for controlling all metabolic functions such as growth and cell division.
- Micro nucleus is responsible for sexual reproduction control.
- Paramecium has two contractile vacuoles for osmo regulation. These absorb excess water from the cytoplasm and expand then move by cytoplasmic streaming towards the cell membrane fusing with it to release the excess water to the outside. At the same time a few chloride ions are lost.
- Cilia around the oval groove beat rhythmically creating water currents to cause food move and soak into the oval groove.
- The food passes along the gullet like cavity into the food vacuole at the base of Cyto pharynx.
- Lysosomes release digestive enzymes on to food in the vacuole hence digested.

- The products of digestion are absorbed in the cytoplasm and the undigested food materials are exocytosed through the oval pore of the cell membrane called cyteproct.
- The trychocysts along its cell membrane are tinny explosive like structures containing needle shaped thread like structures used for defence and immobilization of prey e.g prey such as water flukes.
- The oval groove and Cyto pharynx of paramecium are equivalent to the mouth and humans.
- The cyto or anal pore is equivalent to the anus of humans.
- The contractile vacuoles are equivalent to the kidneys in humans.
- Tissue level of organization
- Between the organ level and cellular level, are primitive multicellular animals which belong to tissue level of organization. Most physiological processes of these organisms are carried out mainly by cells. Animals that fall under tissue level of organization include cnidarians such as hydra, sea anemone.
- Hydra;
- The body of a hydra is a simple sack like structure composed of seven different types of cells arranged into sheet like layers include the ectoderm and endoderm. Apart from ovaries and testis the hydra has no structures that can be described as organs. However most of the cell types particularly the musculo-epithelial cells and nerve cells integrated to form tissues.
- Structure of the body wall of hydra (magnified).
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- The hydra is a multicellular organism with interdependent cells to some extent; these cells are integrated by the nervous system. Hydra feeds on small water fleas and bacteria. The food is immobilized by the stringing cells in case of water fleas. These cells pierce and poison the pray for easy phagocytosis and the food particle is then pushed in to the mouth by the help of the tentacles which beat rhythmically on reading the body cavity, the glandular cells are secreted to secret digestive enzymes on to the food for extra cellular digestion to occur. These foods may be digested completely or partially. The undigested food particles phagocytically are absorbed in to the musculo-epithelial cells. Musculo-epithelial cells with beat their flagella rhythmically to circulate the food nutrients to the different cell with in the wall. Food with musculo-epithelial cells is enclosed in a food vacuole lysosomes surround the food vacuole and secret digestive enzymes onto the food hence digesting it. The products of digestion are absorbed with in the cytoplasm. This is known as intracellular digestion. There fore within the musculo-epithelial cells, digestion is completed. Sensory cells have sensory terminals. These cells are responsible for detection of stimuli from the external environment (water). The sensory cell on detecting changes in water fires impulses to the nerve cells which then transmit the messages to the different types of cells for efficient coordination of the cellular activities.
- NOTE: The nerve cells are located in the mesogloea. The interstitial cells are located between the intercellular spaces i.e between the wall cells. These undergo mitotic cell division to produce other cells of the body wall.

- Colonial level of organization.
- This level of organization consists of mainly the sponges some organisms are composed of many cells which are functionally much more isolated from one another i.e the cells are not co-ordinated and therefore they work in isolation e.g in sponges.
- Sponge.
- These are organisms which occur colonies of very many single and isolated cells. Therefore these organisms are not multicellular despite the fact that they have many cells. This is because these cells are functionally isolated i.e the cells lack a coordinating system. A sponge consists of five types of cells that are not coordinated hence they work in isolation from each other. These cells include;
- (a) **Flattened epithelial cells.** These line the external / outer surface of the body.
- (b) Hollow pore cells. These line the pores through which water containing food particles is drawn in to a sponge.
- (c) Numerous flagellated collar cells. These are numerous and line the internal body cavity using their flagella, they maintain water flow which the cavity and circulate nutrients to all body cells.
- (d) Spicule secreting mesenchyma cells. These secret spicule materials to strengthen the wall of the sponge in order to minimize mechanical damage and bacterial attack.
- (e) Amoeboidal cells / Amoebocytes. These are phagocytes. They engulf food materials and bacteria for body defence. They move about spaces between other cells engulfing food materials that enter with the water in the hollow cavity.
- NOTE:
- All the above cells functions independently from one another.
- They can therefore exist on their own or as small isolated groups.
- There is no any simple nervous system to co-ordinate their activities.
- Organ level of organization.
- In this level, organs aggregate to form organ systems such as circulatory, excretory, digestive systems etc. These usually occur in complex organism with large sizes e.g mammals. The different organ systems which exist in these animals are well co-ordinated by an efficient nervous system.
- Advantages of being multicellular:
- Development of better muscles and skeleton which give the animal greater strength and enables it to move faster.
- Being multicellular allows increase in size as a result of specialization where each cell is specialized for one formation.
- The division of labour permits greater efficiency and enables the organism to exploit environments that are denied to simpler forms.
- Having specialized cells also means that more sophisticated physiological mechanisms can be developed which allow a constant body temperature to be maintained independent of the surrounding temperature.
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- 3. CLASSIFICATION OF LIVING ORGANISMS.
- Classification is the science of placing or organisms and then assigning their names. This is important because there is diversity of life. There are so many living organisms living in water, on land, in air and in and on animals and plants. To understand these organisms we place them in different groups depending on their characteristics.
- Importance of classification.
- It helps us to understand a variety of life to which different organisms belong.

- It helps the biologists to communicate effectively about the nature of organisms.
- It enables us to classify new species when they are discovered basing on their characteristics.
- It helps us to solve other biological problems e.g the origin and spread of disease causing germs.
- It also allows us to generalize the groups about the organisms in the same group.
- CHALLENGE OF CLASSIFICATION.
- Although classification is a way of ensuring order on the diversity of life placing every organism in a specific category it belongs, it has often proved that organisms cannot be placed in the same group and hence placed in different groups and this has led in to splitting of some groups into particular groups.
- Using two kingdom systems plants and animal kingdom left out many organisms that could not be placed any where accurately. Classification is divided into two major groups i.e taxonomy and sytematics.
- **Sytematics** is the grouping of organisms into different groups depending on levels of organisms.
- **Taxonomy** is the grouping of organisms into different groups depending on similarities or differences in their characteristics.
- **Nomenclature** is the assigning of names to organisms. The modern nomenclature is the one that was proposed by lineous carlorus in his system called binomial nomenclature.
- **Binomial nomenclature** is a system in which an organism is given two names, namely genetic name and specific name. The genetic name describes the genus to which the organism belongs. The names given to living organisms are called scietic names e.g homo, sapiens is a scietic name of man.
- Rules used in assigning names to living organisms.
- Each organism is given a name that has two parts i.e genetic and specific part.
- The 1st part indicates genes. The 2nd part indicates the species.
- Both names and written in italics or underlined separately when unwritten.
- The 1st letter of the genus name must be in capital and all letters of the specific name are all small.
- The name of the genus is used in the same species but not in the same genus.
- The specific name can be shared by a number of organisms in the same species but not in the same genus.
- All names are written according to Roman alphabet as used in English. The genus name can be used alone to represent all spps in genus but the specific name is not used alone.
- Identification.
- Is a process of sorting out of organisms basing on their basic characteristics from a bigger group called Taxon (taxa). A Taxon is a group of organisms with similar characteristics, kingdom, phylum, class, and species. Identification of organisms can be done using **biological keys** or **Dichotomous keys. A Dichotomous key** *is a key which consist of pairs of contrasting statements that are numbered leading to isolation of individual organisms from bigger groups*.
- Each statement has a feature of difference in relation to the specific characteristics of organs in the group.
- For identification of specimens using a dichotomous key a table of characteristics is constructed then a flow chat is also drawn to show the difference and the total number of contrasting pairs of statements.

- The number of contrasting pairs of statements is given by the formula (n-1) where n is the number of specimens provided.
- If n is equal to five then the number of contrasting statements is four.
- **Example;** Use the following specimens to construct a dichotomous key.
- A – House fly.
- B – Work bee.
- C – Wasp.
- D – Tick.
- E – Termite.

• Specimen.	• Wings.	• Mouth parts.	• Body division.	• Legs	• Texture of the body.
• A	• 2pair membranous.	• Sucking/ proboscis.	• 3	• 3pairs	• Hairy.
• B	• 2pair membranous	• Sucking.	• 3	• 3 pairs.	• Hairy
• C	• Outer heard, inner	• Mandible.	• 3	• 3 pairs.	• Hairy
• D	• No wings.	• Sucking.	• 2	• 4 pairs.	• Smooth
• E	• No wings.	• Mandibles.	• 2	• 3 pairs.	• Smooth.

- Dichotomous key.
- 1
- (a) Has mandible…………..…. C and E go to 2.
- (b) Has proboscis…………..... A, B and D go to 3.
- 2
- Has hairy body………..…. C.
- Has smooth body………… E.
- 3
- Have wings………………. A and B go to 4.
- No wings…………………..D
- 4
- Has large broad abdomen ..A.
- Has short lateral abdomen ...B
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- VIRUSES.
- A virus is a tiny pathogen composed of a core having nucleic acid enclosed by a cuspid. This is in turn covered by a protein coat. A virus is characterised by total dependence of the living host cell and are obligatory parasites.
- Structure of a virus.
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- Characteristics of viruses.
- The x-tics of viruses can be divided into two categories depending on whether living or non living organisms and for this reason they have given scientists great difficult to identify them and therefore placed at a boundary of living and non living.
- Characteristics of viruses as livings.
- They posses nucleic acid DNA or RNA that is possessed by other living cells.
- They carry out respiration.
- 2they reproduce but inside the host cell.
- They are known to respond to stimuli when subjected to unfavorable conditions they die.
- They can undergo mutations.
- Characteristics of viruses as non living things.
- They don't have enzyme system.
- They donot reproduce dependently.
- They posses either RNA or DNA but not both.
- They can crystalise out side the cell.
- They are too tiny to be living.
- The viruses which attack the bacterial are called Bacteria phage. These feed on bacteria after getting attached onto the surface of the bacterial cell.
- The viral DNA enters the bacterial cell and suppleses the activities of the bacterium and sends instructions in to the bacterial cell to make more of viral DNA.
- Diagram showing the viral attack of the bacterium and the complete cycle.
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- Human immunal virus (HIV).
- It is a spherical virus with a core Corrine two molecules of single RNA. The enzyme reverse transcriptase enclosed by a protein cuspid. The cuspid is surrounded by an envelop consisting lipid bilayers deprived from a cell membrane of the previous host cell. The envelop carries glycol proteins that bind the virus to specific receptors on the tissue cells.
- Economic importance of virus.

- They cause disease to humans, live stock and plants, examples measles, matosis, flue influenza, swine fever, foot and mouth disease in animals, tobacco mosaic virus, and cassava mosaic virus in plants.
- Viruses can be used in biological control of pests.
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- Five kingdom system of classification.
- Originally two kingdoms are plants and animal kingdoms were the first to be recognized. After the discovery of a light microscope other new organisms…….. In 1888 a German scientist Haredt Hakis proposed a third kingdom called **Protista** where all microscopic organisms were included. In 1969 RH witaler expanded the kingdom systems to 5 kingdoms and these are kingdom
- Animalia.
- Plantea.
- Protista.
- Monera.
- Fungi.
- Organisms when placed in these kingdoms basing on the following features.
- Type of the cell i.e prokaryotic cell or Eukaryotic cell.
- Levels of organization are either unicellular or multi cellular.
- Type of nutrition some organisms feed autotrophically by photosynthesis, some saprophitically and other as heterotrophically i.e they feed on other organisms.
- Kingdom Monera.
- They are said to be prokaryotes. It ids made of bacteria and they are the most aciens of all living organisms.
- X-tics of Monera kingdom.
- They are all prokaryotes i.e they lack nucleus.
- They are microscopic single called organism with a variety of size and shape.
- They contain circular DNA attached to the cell wall.
- They have a few membrane bound organelles.
- Their cells are made up of a cell wall made up of a polysaccharide called peptidal gelican.
- They reproduce both a sexually and sexually depending on whether the conditions are favourable or not. Asexual reproduction is by binary fission while sexual is by trans-duction.
- Some bacteria live a parasitic mode of life through out.
- Bacteria are found almost every where e.g in soil, water, on body of organisms and with in bodies of organisms.
- Diagram;
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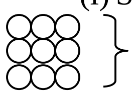
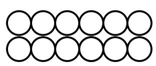
- Functions of the parts.

- Photosynthetic membrane: This contains chlorophyll to trap solar energy required for photosynthesis.
- Mesosome: It acts as a site where respiration takes place.
- Circular DNA: This controls the activities of a bacterial cell.
- Mucilage: Offers protection to the cell and also enables the cell to adhere or to get attached on to the cell.
- Cell wall: Rigid to give shape to the cell and protects the inner parts.
- Different shapes of bacteria.
- **(a) Cocci:** These have a spherical shapes and are of different forms i.e
- (i) Stapheloo coccus: These exist in a clustered form as a bunch e.g those that cause pneumonia.



Staphylo Cocci.

- (ii) Strepto cocci: These are spheres in chains e.g those which cause sore in the throat.



- **(b) Bacilli bacteria:** These are rod shaped bacteria and also exist in different forms.
- (i) Single rods e.g Escherichia coli that live in the gut and synthesize vitamin B and K, solmonella typh that causes typhoid.
- (ii) Those with rods in chains e.g Azotobacter used for nitrogen fixation, bacillus anthracite that cause anthrax in cattle.
- **Spirilla:** These are spiral shaped bacteria e.g Treponma pollidon that causes syphilis.
- **(d) Vibros bacteria:** These have a comma shape e.g vibro chollerae that causes cholera.
- Conditions in which bacteria can survive are
- Optimum temperature.
- Availability of nutrients.
- Suitable PH.
- Presence of oxygen for aerobic bacteria.
- Economic importance of bacteria.
- Uses of bacteria.
- They fix nitrogen in the soil e.g azotobacter, nitrosomonous.
- They decompose organic matter to release nutrients in the soil and hence improve on soil fertility.
- In milk industry they are used in the production of Ghee, cheese, yoghurt etc.
- In leather industry they are used in leather turning.
- The bacteria found in the gut make vitamin B and K.
- Bacteria are also important in digestion of cellulose in some organisms.
- Used in production of antibiotics and vaccines.
- Used in treatment of sewage in the process called biodegradation in the study of genetics.
- They are also good producers in aquatic ecosystem.
- Harmful effects of bacteria.
- They spoil food e.g milk can change to sour milk as a result of bacteria.

- Bacteria also damage underground pipes made up of metals.
- They cause disease to plant and animals e.g pneumonia, syphilis, gonorrhea, typhoid, cholera, yellow swine fever in pigs.
- Kingdom protista.
- General characteristics.
- They are single called eurokaryotic organisms.
- Some contain chlorophyll and make their own food others feed heterotrophically.
- A few individuals are multicellular and colonial in organization.
- Some have flagella others cilia for locomotion.
- They are divided in to three major groups.
- Plant-like protests.
- Fungus-like protests.
- Animal-like protests.
- Animal-like protests
- These are commonly called protozoa.
- X-tics of protozoa.
- They are single called organisms.
- Some move by pseudopodia, some by cilia and others by flagella.
- They don't make their own food and feed heterotrophically.
- Some are parasites and like on or in the bodies of organisms.
- Some have single nucleus, others have two nuclei. Micro and macro nuclei.
- They store food in form of glycogen the phyla of protozoa.
- The phylum zoomostigna.
- These are flagellated single called organisms e.g trypanosome, euglena.
- Phylum sarcodina.
- These are single called organisms which move by pseudopodia e.g amoeba.
- Phylum cilliophora:
- These are single called organisms which use cilia for movement e.g paramecia.
- Phylum sporozoa.
- These consist of organisms which donot have any locomontary structure e.g plasmodia.
- A diagram of Euglena.
- A diagram of Amoeba.
- A diagram of paramecium.

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- Plant-like protists.
- These are known as algae.
- Characteristics of algae.
- They contain chlorophyll pigment and hence feed autotrophically.
- Their body is flat and undifferentiated.
- They donot contain true tissues.
- They either produce by sexual means or a sexually.
- Their body structure varies from unicellular to phylumantous up to colonial.
- They store food in form of starch.
- Divisions in this group are mainly three main divisions namely:
- **Division chlorophyll.** These contain a green pigment called X-rophyl A and there fore their own food. They may be filamentous or thyroid e.g spirogella, chlamydomonas, cilia etc.
- Diagram showing the structure of spirogella.
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- The structure of chlamydomonas.
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- Division rodophyla.
- This is a form of algae which a red photosynthetic pigment. They are mainly multicellular and also make their own food.
- Division phaeophyta.
- This division consists of organisms which contain a brown pigment called xanthophyl together with chlorophyll A and C e.g focus, ascophylum, laminaria etc. they are mainly multicellular. Their cell wall has got alginic acid.
- Adaptations of algae to their habitats.
- They contain pigments for trapping solar energy.
- They have mucilage around their cell walls to make them slimy and hence protecting them against their predators.
- Some have got pyrenoids which stores food in form of starch.
- Their body surface has a large surface area for trapping solar energy.
- Economic importance of algae.

- Uses of algae.
- They act as fertilizers hence supply nutrients to the gardens.
- There producers in aquatic ecosystem and there fore make oxygen available for other organisms.
- They are used in production of drugs.
- They are also used in industries for manufacture of perfumes, shoe polish, tooth paste etc.
- Some algae are edible to man and can be eaten.
- They are also used in purification sugar and petrol.
- Harmful effects of algae.
- They pollute water environment.
- They can cause corrosion of concretes and metal walls.
- They damage tea leaves i.e the parasitic form of algae.
- They can broke water supply systems.
- kingdom fungi.
- This is a kingdom of fungi which range in size from microscopic to very large forms.
- General characteristics of fungi.
- They are heterotrophic i.e they donot contain chlorophyll and therefore feed saprophitically or parasitically.
- Their body is thaloid or flattened i.e not differentiated into leaves, stem or roots.
- Their basic unit is a hypha.
- Their cells are surrounded by a cell wall made up of chitin as a strengthening material.
- They reproduce by spore formation or sporalation or budding or fragmentation.
- They donot have cilia or flagella at any stage of their life cycle.
- They like in moist soil, on bodies of other organisms.
- Examples of fungi include mucor, Rhizopus, mushroom, yeast, permicilium, and aspergious.
- Diagram of permicilium.
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- A diagram of mushroom.
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- Divisions of fungi.
- There are four major divisions i.e
- **(i) Oomycota:** These are fungi that produce flagellated spores which swim in water using their spore to meet the egg.
- **(ii) Zygomycota:** These reproduce by their sporangium produce spores using conidia e.g the Rhizopoe.
- **(iii) Ascomycota:** These reproduce by a sexual means by producing spores in a conidia e.g saccomyces (yeast), asperagillous and penicilion.
- **(iv) Basidiomycota:** Sexual reproduction is by formation of basidia e.g agricus corpestris, agricus corprimus.

- Economic importance of fungi.
- Uses.
- Production of drugs e.g permicilium.
- Brewing of alcohol by fermentation using yeast.
- Also in bakery using yeast.
- They decompose organic matter.
- Production of some food stuffs e.g in soda like citric acid to act as preservative.
- Used in scientific research e.g in genetics.
- Some are used in sewage treatment as decomposers.
- Harmful effects.
- They also cause diseases to both plants and animals e.g tomato bright in tomatoes, ring worm, Candida.
- They make food to become spoiled.
- They also destroy natural materials like leather.
- Kingdom plantae.
- This is a very wide kingdom varying from very primitive plants e.g mosses to very big plants e.g trees which are highly adapted to both life and land. Plants are placed in four main divisions and these are;
- Division filicinophyta e.g ferns.
- Division angiospermae e.g spermatophyte.
- Division gynospermae.
- Division Corniferophyta.
- General characteristics of kingdom Plantea.
- They are autotrophs i.e they make their own food.
- Their cell wall is made up of cellulose.
- They lack contractile fibre and cannot locomote.
- They have a life cycle showing alternation of generation.
- Division bryophyte.
- This division contains plants called bryophytes.
- X-tics.
- Their body is thallus made up of mainly parenchyma cells i.e it is only differentiated into simple leaves and stem but they lack roots through they have root like structures called rhizoids.
- They have very small conducting tissues.
- They live mainly in moist places e.g damp soil.
- They show alternating of generation in their life cycle. The gametophyte is the most dominants generation.
- Their body is divided in to two main parts i.e germatopite and sporophyte
- Their anthrozoids are biflagellate.
- A diagram showing a structure of a moss.

- Alternation of generation.
- It is the change in the form/stage of a plant in its life cycle. Bryophytes show alternation of generation between their gametophyte stage and sporophyte stage. During alternation of generation, the gametophyte is the gametae producing stage since it contains the male and female parts with in the leaves. The female rosette contains a structure called archegonium that produces the female gametae ovum and the male reproductive part called anthedrium that produces the male gamete called anthroids. The male gamete has a flagella and swims in a film of water into the female organ archegonium. It then fuses in the ovum to form a zygote. During saprophyte generation, a saprophyte that produces spores is involved. The diploid zygote formed during gametophyte generation develops into a saprophyte to obtain nutrients from it. The mature sporophyte then develops a capsule in which spores are produced by meiosis and when the capsule matures, it splits to release the spores. Spores are small structures or bodies which when randed on suitable environment germinate and develop into a microscopic structure called protonema which later develops into a gametophyte and the gametophyte generation alternates to the sporotophyte.
- Diagram:
- Differences between sporophyte and gametophyte.

Gametophyte phase.	Sporophyte
Haploid state.	Diploid state.
Gametes are produced by mitosis.	Gametes are produced by meiosis.
Gametophyte self supporting pond.	Depends on gametophyte for support and nutrition
Gametophyte takes the largest phase of the life cycle.	Takes the shortest phase of the cycle.
Made up of leaf like structures.	Made up of a capsule and its stalk.

- Why bryophytes are poorly adapted on land.
- They like in only moist habitats and due to this they are described as "amphibians" of the plant kingdom.
- They lack the conducting tissues such as the xylem and phloem and the movement of materials in them is by diffusion.
- They depend on water for their sexual reproduction especially during the movement of the sperm from the male reproductive organ to effect fertilization.
- They lack true roots and support in them is mainly by simple rhizoids.
- Filicinophyta division.
- This is also called division pteridophyta.
- General x-tics of pteridophytes.
- They are non flowering plants.

- They are terrestrial plants which grow in moist places.
- Their sporophyte has true leaves, roots and stem. It also has muscular tissues, the xylem and phloem.
- Their gametophyte is a very small structure reduced to a simple prothallus.
- They produce anthrozoids which have a single flagellum.
- They also show alternation of generation in which sporophyte is the most dominant generation i.e the gametophyte depends on the sporophyte.
- Examples: Ferns.
- Diagram showing the structure of the fern.
- Life cycle of pteridophytes e.g ferns.
- Ferns also show alternation of generation i.e sporophyte generation being dominant. The fern plant is the diploid sporophyte and its life cycle alternates between sporophyte and gametophyte. The sporophyte produces spores by meiosis in the sporogium. Many sporogia clusters underneath the leaf forming sori. A sporogium is protected by a covering called inducium where mature the sporogium splits or raptures and releases haploid spores which follow on moist soil and germinate into prothallus which is the gametophyte. It is a very small structure and doesnot contain any tissue. It later develops rhizoids on its underside to gain support in the soil. The gametophyte contains both male and female sex organs called anthridium and archegonium respectively. The anthridium produces haploid sperm (spermatozoids) by mitosis while the archegonium produces a haploid ovum also by mitosis. The sperm cell has flagella and moves in water into the archegonium. It then fuses with the ovum in the archegonia to form a diploid zygote. The diploid zygote then develops into a diploid sporophyte as a fern plant that can survive independently.
- Diagram;
- Comparisons between the life cycles of pteridophytes and bryophytes.
- Similarities.
- Both show alternation of generation between the diploid sporophyte and haploid gametophyte.
- In both the spermatozoids produced are motile.
- They both live in moist conditions.
- In both gametes produced are haploid.
- Both reproduce sexually and a sexually.
- In both the haploid spores are produced by meiosis.

- In both the gametophytes are supported by rhizoids.
- In both the female gametae is immotile.
- In both the gametophyte doesnot contain roots.
- Differences.

• Bryophytes	• Pteridophytes.
• The gametophyte is the dominant generation and supports its self. • They lack true roots. • They lack vascular tissues e.g xylem and phloem. • The gametophyte is made up of simple leaf like structures. • The sporophyte consists of a capsule on a stalk. • The gametophyte develops into a protonema.	• The sporophyte is the dominant generation. • • Have true roots. • They have vascular tissues both xylem and phloem. • The gametophyte has a simple heart sharped structure. • The sporophyte is a complete plant with roots, stems and leaves. • The gametophyte develops into a prothallus. •

- Adaptations of pteridophytes to their life on land.
- They have vascular tissues to conduct water, mineral salts and organic products for photosynthesis.
- They have true roots for firm support in the soil and for absorption of water and mineral salts.
- The surface of the leaves is covered by a waxy cuticle which is a water repellent to minimize water loss.
- In fern trees, secondary growth takes place leading to thickening of the girth hence offering more support. However, the fern are poor adapted to their life on land.
- They still depend on water for fertilization.
- They mainly like moist areas to avoid desiccation or drying up.
- They lack xylem vessels but only have Tracheids which are inefficient for transportation of materials for a long distance.
- Division Corniferophyta.
- This is a division of cone bearing plants.
- General x-tics of Corniferophyta.
- They have vascular tissues but xylem has only Tracheids and their phloem lacks companion cells.
- They have long narrow niddle…..
- The reproductive parts are born in cones.
- They are monoecius with both reproductive organs are located on the same plant but different parts.
- They undergo single fertilization.
- They produce resern to protect them.
- They produce necked seeds i.e their seeds are not enclosed in the ovary.
- They donot have a fruit since they don't have ovaries.
- They bear seeds.

- They also show alternation of generation.
- Examples are pine trees, conifers fir, cuppressus, cycads, yews.
- Division of spermatophyta.
- These are also seed-bearing plants.
- X-tics of spermatophyta.
- They bear seeds.
- They have a gametophyte much reduced.
- They produce pollen grains and ova by meiosis.
- They also show the alternation of generation in which the sporophyte is the most dominant.
- They undergo double fertilization.
- The male and the female gametes produced in them are non motile.
- They have vascular tissues comprising of xylem vessels and Tracheids and phloem with tubes and companion cells.
- After fertilization their ovary develops into a fruit.
- The seeds produced are enclosed in the ovary.
- Their body is differentiated in to roots, leaves and stems.
- They undergo secondary growth.
- Life cycle of a flowering plant.
- Flowering plants also show alternation of generation between sporophytes and gametophytes. Sporophyte is the dominant phase but gametophyte is much reduced and is a gamete producing phase with in a flower. The male gametes are produced on the anthers while the female gametes are produced in the embryo sac by meiosis. The male gametes are called the pollen grains or microspore but the female gamete is called the ovum produced in the embryo sac. The male gamete moves with the pollen tube to female gamete in the embryo sac to effect fertilization to form a diploid zygote. The second male nucleus also fuses with polar nuclei to form a triploid endosperm hence this form of fertilization is double. When the seeds mature they germinate so that the zygote develops into embryo and finally into a sporophyte plant and the cycle repeats.
- Diagram.

- This division is divided into two classes namely monocotyledonae and dicotyledonae.
- Differences between two classes.

• Dicots	• Monocots.
• Have two dicotyledons surrounding the embryo. • Has network venation. • Undergo secondary growth. • Have vascular bundles in concentrated ring. • • They have got a tap root system. • The seeds donot contain endosperm. • Their flowers are then insect pollinated. • The floral parts are fikes. • The calyx and corolla of flower are densitinal. • Pollen grains produced has a spiky surface and has 3 pores. • Have solid leaf stalk.	• Has one cotyledon surrounding the embryo. • • Has parallel venation. • Do not undergo secondary growth. • Have vascular bundles scattered in ground tissue. • Have fibrous root system. • Seeds contain endosperm. • The flowers are often wind pollinated. • The flowers are in threes or multiples of 3. • The calyx and corolla are not distinct and refer to as perianth. • The pollen grains are singular and smooth. • • Have a sheathed leaf stalk.

- Examples of monocots.
- Mainly grass, Maize, Rice, Wheat,Wild finger millet, Oat etc.
- Examples of dicots.
- Beans. nuts, Butter cup,Jack fruits,Coffee,Cotton etc.
- Animal kingdom.
- The kingdom Animalia includes all animals. Organisms are placed in this kingdom because they have some common characteristics.
- General characteristics of kingdom Animalia.
- They are all multicellular.
- The cells which up their body are eurokaryotic i.e they lack a true nucleus.
- Fertilization in these animals occurs by fusion of gametes.
- The zygote formed after fertilization usually divides by mitosis.
- They have a nervous/ coordination system to respond to changes in the environment.
- They show division of labour i.e particular shells performing particular functions.
- Some animals are a symmetrical i.e they cannot be divided into two equal parts others are symmetrical i.e can be divided into two equal parts in any plan.
- Criteria for classifying animals.
- When grouping the animals, we base on the features they have in common to put them in the same group. There are many features used in classifying animals. These include:
- **Body symmetry;** bodies of animals are either asymmetrical, radiality symmetrical or bilaterally symmetrical e.g sponges or echinoderm and animals respect.
- **Body layers:** Some organisms have two main layers and they are called diploblastics. Others have three main body layers and they are called triploblastics.

- **Body cavities:** Some animals contain a fluid filled cavity called a soelom others donot have cavities.
- Phyla in animal kingdom.
- They are approximately 34 animal phyla but we shall consider only 9 which include:.
- Phylum porifera.
- Phylum cnidaria.
- Phylum plate helminthes.
- Phylum nematode.
- Phylum arthropoda.
- Phylum mollusca.
- Phylum echinodermata.
- Phylum chordata.
- Phylum porifera.
- This is a phylum of sponges.
- X-tics of sponges.
- They are sessile.
- They have a definite shape.
- Some have asymmetrical body others are symmetrical.
- Their body has many pores called ostia and a canal through which water is circulatorated.
- Their body is composed of independent cells with little coordination between them and they lack tissues.
- Digestion in them is intracellular i.e it occurs inside the cell.
- Gaseous exchange is by simple diffusion.
- Their sexual reproduction is by formation of egg and sperm while their asexual reproduction is by budding.
- They are hermaphrodites i.e have both sexes.
- They contain a skeleton made up of careous/ silicious/ spicules.
- They are all aquatic mainly marine but a few are found in fresh water.
- They are multicellular which cellular differentiation only.
- Examples; Ascon, sycon, leucosolenia, Euspngia etc.
- The structure of a sponge.
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- Phylum cnidaria/ phylum coelentrata.
- It is a phylum of cnidarias.
- Characteristics.
- They are diploblastics.
- They have true tissue but no organs.

- Their body is radially symmetrical.
- They have two forms i.e polyp and medusa.
- They have a digestive cavity with one opening.
- They have a simple nerve network to coordinate muscle in tales.
- They reproduce sexually by planula a ciliated larva and asexually by budding.
- They don't contain a coelome and they are coelomate.
- They have tissue level of organization.
- They have tentacles for capturing food.
- They show some form of alternation generation.
- Examples are: Jelly fish, hydra, obelia, physalia, sea anemone, coral etc.
- A diagram of a hydra.
- Phylum platyhelminthes.
- This is a phylum of flat worms.
- X-tics
- They are triploblastics i.e their body is formed from three body layers.
- They are bi-laterally symmetrical.
- They are dorsal ventrally flat.
- They are acoelomate.
- Digestive system where present, it is branched and has a single opening.
- They have simple sense organs and a nervous system.
- They reproduce both sexually by formation of gametes since they are hermaphrodites asexually fragmentations.
- They are parasitic or free living.
- Excretion is by flame cells.
- Central nervous system is placed anteriorally.
- The body is not segmented except in tape worms.
- Examples; tape worms, planaria, liver fluke, blood fluke etc.
- This phylum is divided into 3 classes i.e class cestoda, class trematoda, class turbellaria.
- The structure of planaria.

- Phylum nematoda.
- This is a phylum of round worms.
- X-tics.
- They are triploblastics.
- They are pseudocoelomate.
- They are thread like with a protective cuticle.
- They donot have a circulatory system, gaseous exchange.
- Their excretion is by diffusion.
- They undergo sexual reproduction since they contain separate sexes.
- They are free living in terrestrial or aquatic habitats or as parasites.
- They have two openings i.e mouth and anus.
- They have hydrostatic skeleton for movement.
- They have a central nervous system.
- They also unsegmented.
- Examples: round worms (ascaris), rhabditis maupasi, filarial banerofit etc.
- A diagram of ascaris-round worm.
- Phylum anelida.
- X-tics of Anelida.
- They have a thin cuticle covering the body.
- They are triploblatic.
- They are coelomate animals. Their body contains a fluid filled cavity called coelome.
- Gaseous exchange is by way of diffusion through the skin and gill.
- They have a simple excretory system consisting of excretory organs called nephridice.
- Some undergo asexual reproduction by budding, others undergo sexual reproduction and in some internal fertilization take place.
- They posses a simple blood circulatory system.
- They have simple eyes.
- They have a central nervous system.
- They have central parapodia.
- Classes;
- Oligo chaetae e.g earth worm.
- Class polychaetae e.g rag worm, tube worm.

- Class hirudae e.g leeches.
- Diagram;
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- Phylum Arthropoda.
- X-tics of phylum Arthropoda.
- They have jointed legs.
- They have segmented body.
- They are binately symmetrical.
- They are triploblatic.
- They have a hard exoskeleton up to the chitin.
- They are coelomate through their coelome is much reduced.
- They have a dorsal heart with open vascular system.
- Their excretory system consists of green glands or malphigian tubules which open into digestive system.
- They have sensory organs such as compound eyes or simple eyes and antennae.
- They also lack taste receptors or sound receptors.
- They undergo sexual reproduction and internal fertilization.
- The aquatic forms undergo external fertilization.
- Most arthropods are oviparous while some are viviparous.
- Their gaseous exchange is through trachea.
- Classes.
- Class insecta.
- X-tics.
- They have three main body parts i.e the head, thorax and abdomen.
- They have three pairs of jointed legs.
- They have modified mouth parts for sucking and chewing or biting.
- They contain tracheal system for gaseous exchange.
- Examples: Cockroach, butterfly, locusts, housefly, tsetse fly.
- Class Arachinida;
- X-tics.
- They have two main body parts.
- They have four pairs of legs.
- Respiration is by gills or book lungs.
- They have simple eyes.
- They don't have antennae.
- They have a thick cuticle covering.
- Examples: ticks, spider, scorpion, termites.
- Their circulatory system.
- Class Crustacea.
- X-tics.
- Body is divided into two main parts i.e cephalo thorax and abdomen.

- They have five or more pairs of legs.
- Have two pairs of antennae.
- One pair of stocked compound eyes.
- They have separated sexes.
- Three pairs of mouth parts.
- They have exoskeleton.
- They are mainly aquatic.
- Respiration is by gills.
- Examples: Crab, prawn.
- Diagram;
- Class Dipropoda.
- X-tics.
- They have segmented body.
- They have one pair of antennae.
- Gaseous exchange is by means of trachea.
- There is covered by a steel integument made up of calcium.
- They have a pair of biting and chewing mandible.
- They have a pair of jointed legs per segment.
- Mainly terrestrial.
- Examples: Millipedes.
- Class chiropoda.
- X-tics.
- Have segmented body.
- Each body segment has one pair of walking legs, one pair of antennae.
- Gaseous exchange is by trachea.
- Have a pair of poison claws on the head.
- Body is covered with smooth elastic integument.
- Alimentary canal (gut) is a straight tube with salivary glands at the anterior end and malphigian tubules at the posterior end.
- They are nocturnal.
- They have only simple eyes.
- They are carnivorous in nature and they feed on slugs and earth worm.
- They have mandibles for chewing and two pairs of maxillae.
- Examples: Centipedes.

- Phylum mollusca.
- X-tics.
- They are triploblatic i.e their body is divided into three longitudinally.
- They are coelomate. They have a body cavity in their body.
- They are non segmented.
- Their body is divided into the head, the foot and viaceral mass.
- They undergo sexual reproduction since both sexes are separate.
- They have an open circulatory system.
- Classes;
- Class cephalopoda e.g octopus, squids, cuttle fish etc.
- Class bivalia e.g morsel, scallop.
- Class gastropoda e.g garden snail, limpet etc.
- Garden snail.
- phylum echinodermata.
- These are spine skinned animals
- X-tics.
- They are triploblastics.
- They are coelomate.
- The adults are radially symmetrical.
- Their body is not segmented.
- They have water vascular system with tube feet used in gas exchange.
- They have simple gut.
- They don't have the head.
- They reproduce asexually by fission and sexually since some have separate sexes.
- They donot have excretory system. Their nervous system and sensory system is not well developed.
- They are mainly found in marine water.
- Most of them are sessile but the motile ones use the tube feet to croll slowly.
- Most can regenerate the lost part.
- External fertilization takes place.
- Examples: Star fish, sea urchin, jelly fish, sea cucumber.
- Diagram of a star fish.

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- The body is composed of five regulating arms.
- Phylum chordata.
- This is a phylum of chordates.
- X-tics.
- They have a notochord as a dorsal node at some stage of development.
- They have a pharyngeal gills at some stage of their development.
- They are bilaterally symmetrical.
- They have a post anal tail at some stage in their development.
- They are triploblastics.
- They are coelomate animals.
- They have a narrow nerve cord that is a dorsal to the gut.
- They have a closed circulatory system with a heart which is a ventral to the gut.
- They also have segmented muscle blocks.
- Phylum chordata is divided into two sub phyla namely;
- Sub phylum craniata.
- Sub phylum acrania.
- Sub phylum craniata (vertebrata).
- X-tics.
- They are a vertebral column surrounding the mortal chord which is replaced by a vertebral column.
- They have an endoskeleton of bones and cartilage.
- They have two pairs of appendages.
- They have a well developed nervous system.
- They reproduce sexually and have separate sexual organs.
- They have a body cavity called coelome with two regions called pericardial cavity and perivesceral cavity.
- Their brain is enclosed in the skull or cranium.
- They have a clearly differentiated head with sensory organs, eyes, ears and olfactory organs.
- They have a well developed excretory system with the excretory organs of kidney.
- Classes of sub-phylum craniata.
- Class agnatha e.g sea lamprey, lung fish.
- Class piscies.
- X-tics
- They are mainly aquatic i.e some are marine others are found in fresh water.
- They stream lined body with a muscular propulsive tail.
- They have paired pectoral and pelvic fins.

- They have endoskeleton.
- The respiratory organs are gills born on branchial arches.
- They have a prominent lateral line.
- They have mucus secreting glands in the skin to make the body shiny and hence reduce friction.
- They are ectothermic or poikilothermic.
- Sub-classes.
- Sub-class chondrichthytes.
- X-tics.
- They have exoskeleton of placoid scales.
- They have a cartilaginous skeleton with a flexible body.
- They have gill slits and their operculum is not covered.
- They have a well developed sense of smelling but with poor vision.
- They have a vertebral mouth.
- They don't have an air bladder or swim bladder.
- They have broad horizontal paired fins.
- Examples: sharks, mud fish, skates, dolphin, rays, cartilaginous fish.
- Osteichyes (bony fish).
- X-tics.
- They have a bonny endoskeleton.
- They also have bonny scales covering the skin.
- They have an operculum.
- They have a well developed colour vision.
- Their mouth is located at the terminal anterior end.
- They have got a swim bladder.
- They have a variety of fins e.g pelvic fin, pectoral fins, tail fin.
- They have numerous jaw bones.
- They undergo external fertilization.
- Examples: tilapia, Nile perch, eels, African lung fish.
- Class amphibian.
- X-tics.
- They are ectothermic and poikilothermic animals.
- They have a moist skin except the terrestrial ones.
- They have teeth which are of uniform size a condition called homodation.
- They don't have external ears.
- They excrete urea and ammonia.
- Some are found in aquatic fresh water others are terrestrial.
- They have a cloaca.
- They don't have scales.
- There two orders namely: **Urodura** e.g newts and salamanders and **Anura** e.g frogs and toads.
- They undergo metamorphosis and have lungs when adult.
- Class reptalia.
- X-tics.
- They are ectothermic.

- They don't have hairs or feathers.
- They have a water proof skin which is always dry with no secretory glands.
- They have scales around their bodies in the majority.
- They have lungs for gaseous exchange.
- They have a vertebral column.
- Class Aves (Birds)
- X-tics.
- They have instinctive behaviour.
- They excrete uric acid.
- They are endothermic.
- They have lungs.
- They have a water proof skin.
- They have fore limb modified for flight.
- They have no teeth.
- They have no pinna.
- They have got light bones for flight.
- They also have cloaca.
- They undergo external fertilization.
- Examples: Fringilla coelebs, barn owl, green wood pecker, sparrow hawk etc.
- Class mammalia.
- X-tics.
- They are endothermic animals.
- They are water proof hairy skin.
- They have lungs for respiration.
- They are heteredont.
- They excrete urea.
- They undergo internal fertilization.
- They have a well developed brain.
- They have jaws.
- They have epiphyses.
- Sub-classes.
- Sub-class monotremata (egg-laying mammals).
- X-tics.
- They produce shelled eggs.
- They no true teeth.
- They have cloaca.
- They have variable temperature.
- Milk secretly.
- Examples: duck-billed platypus, spiny ant-eater.
- Sub-class marsupialia.
- X-tics.
- They have no placenta.
- They have no milk teeth.

- They have two destimet uteri.
- Examples: mice, carnivorous, cats etc.
- Sub-class Eutheria (placental mammals) e.g wild rabbit.
- Main orders of Eutherian mammals.
- Insectivora.
- X-tics.
- Feed on insects.
- Usually nocturnal.
- Nervous teeth e.g hedgehogs, moles, shrews.
- Chroptera.
- X-tics.
- Adapted for flying.
- Usually nocturnal.
- Feed on insects.
- Fore limbs.
- Sleep in clusters.
- Single off spring.
- Examples: Bats.
- Primates.
- X-tics.
- Omnivorous and herbivorous.
- Teeth are unspecialized.
- Tail if present may be prehensile.
- Pinnae reduced.
- Tend to live in family groups, tribes etc.
- Examples: lemurs, monkeys, apes, humans etc.
- Mating occurs throught the year. Great development of cerebral hemispheres. Highly intelligent capable of reasoned thought.
- Lagomorpha.
- X-tics.
- Herbivorous.
- Large caecum.
- Examples: rabbits, hares.
- Rodentia.
- X-tics.
- Usually small sized gnawing mammals.
- Primarily herbivorous but some omnivorous.
- Very widely distributed in diverse habitats.
- Breed and multiply rapidly.
- Examples: rats, mice, voles, squirrels.
- Heading:
- X-tics.
- Usually medium/ large-sized carnivorous hunters.

- Long string canine teeth forming fangs.
- Keen senses of smelling and hearing and sight may also be well developed.
- Cunning and courageous behaviour.
- Examples: dogs, cats, weasels, foxes, wolves.

PARTII
DIVERSITY OF LIVING ORGANISMS.
Classification is the science of placing organisms in groups and then assigning them names. This is important because of diversity of life.

There are so many organisms some living in water, others on land both plants and animals. To understand these organisms better they must be placed in groups and their characteristics studied.

Classification is divided into two major groups i.e. Taxonomy and systematic.

Taxonomy: involves assigning names to organisms well as SYSTEMATIC involves placing organisms in particular groups which include from the largest to the smallest kingdom – Phylum – Class – Order – Order . Genus – Species the smallest natural showing group is the species.

A Specie is a group of organisms with a lot of characteristics in common capable of interbreeding to produce fertile off-springs.

In the assignment of names during taxonomy, the system used in biological nomenclature is one designed by Linnaeus which uses a binary system tach organism is given to names i.e. the geneno name and a specie name.

The generic name begins with a capital letter while a specific name begins with a small letter and the two names uses are underlined separately e.g Homo Sapiens.

However if you are working with a computer underlining is committed and names are written in italics the name of organisms are divided from Latin and if not they are Latinized; the importance of this is to avoid confusion of using local names and ensure effective communication for all biologists which over.

Specimens are given names depending on several factors.

Habitant of the organisms' e.g the common housefly lives in domestic homes and therefore it is called Musca domestica.

Discoverer of the specimen e.g the wild grass, it is called Pixine kateidie

Origin of the specimen e.g the mango is known to have originated fro India and therefore it is called Mangitera India. Similarly the first large wackroach was discovered from America, so it is called Periplaneta Americana.

According to chemical composition for example Oxalis latiforia.

In classifying organisms simply observable structural x-tics are used such as presence or absence of hairs, number of appendages, shape of the structure e.t.c. x-tics like size and colour are not used since size changes with age and colour changes with environment.

In classifying organisms, biological keys are used and most common is the Dichotomous key.

The dichotomous key is made up of paired statements which are numbered and each statement opposes the other showing dictomy i.e if one statement says presence of a structure, the other opposes it by saying absence of the structure.

Each statement has a point of reference unless it is used for classification of the specimen. It is at this point of reference that is numbered on the right that further classification occurs until a specimen is fully identified. The number on the left is less by one number of the specimen used.

Illustration: use the specimen A-E to construct a simple dichotomous key to identify them.

A – Housefly B- Worker bee. C –Warps D – Tick
E – Termite.

(a) Have wings …………………… 2 (A, B, C)
(b) Have no wings ……………… 3 (D, E)
(a) Sting on last abdominal segment ……………………
(b) Sting on last abdominal segment ………………….
(a) Two main body parts ………………………………
(b) Three main body parts ……………………………
(a) Hairy body …………………… B
(b) Body not hairy ………………C

Basing on the above dichotomous key specimen C for example can be identified as the body is not hairy; it has a sting on the last abdominal segment and has wings, and most key a war

VIRUSES:

A virus is a tiny pathogen composed of a core having nucleic acid enclosed by the cuspids and in turned caspid by the protein coat A virus is characterised by total open dency one living lost cell. Therefore they are obligate parasite.

STRUCTURE OF A VIRUS:

Protein coat
Genetic material
(DNA or RNA)
But not both
Core
Caspid

X – TICS OF VIRUSES;

They are smallest living organism without cellular structures.
They reproduce only in side the host cells.
They can only survive inside the host cell therefore they are obligate parasites.
They are at the borderline between living and non-living things.
They are highly specific to their host i.e. each virus will recognise a specific host.

Viruses are sometimes classified as living because;
They possess a nucleic acid RNA or DNA possessed by other living.

They carry out respiration, an x-tic of living organisms.
They reproduce like all living organisms.
They die when subjected to unfavourable conditions
They are known to respond to stimulus.
Some times viruses are classified as non- living because;
They do not posses reproduce independently i.e. they only reproduce inside the host cell.
They posses RNA or DNA but not both.
They appear crystalline under very unfavourable conditions.
They are tiny to be living.

THE BACTERIOPHAGE;

The bacteriophage feeds on bacteria. It gets attached onto surface of the bacterial cell. The viral DNA enters the bacterial cell and suppresses the activities of the bacteria but instead it instructs the host cell DNA to make viral DNA.

HUMAN IMMUNO DEFFICIENCY VIRUS (HIV)
It is a spherical virus with a core carrying to molecules of single stranded RNA and the enzyme reverse trans
Proteins caspids. The caspid is surrounded by an envelope consisting of lipid bi layer divided from the cell membrane of the previous host cell.
The envelope carries glycoprotein's that bind the virus of two specific receptors on tissue cells.

Structure of influenza virus

It's a spherical virus with a core of single stranded RNA and polymerise enzyme enclosed by a protein caspids.
The outer surface of the liquid membrane carries two types of protein spike i.e. the H- spike for attachment to the host cell and the NP spike for boring through the cell membrane to enter the host.

ECONOMIC IMPORTANCE OF VIRUSES:
Cause diseases to humans, livestock and crops.
Can be used in biological control of pests e.g. the Myxomatosis

Ways used to control rabbits in Australia.
Rabbits were formerly not in Australia but when introduced they found the environment favourable and increased in number becoming a menace to the people.

Viral diseases in animals include influenza flue measles, swivel fever, chickenpox, foot and mouth disease of the cattle

The common plant viral diseases include tobacco mosaic, cassava mosaic e.t.c. that can be prevented by burning the crop remains.

THE FIVE KINGDOM SYSTEMS OF CLASSES:

kingdom monera / prokaryote.

The kingdom is made up of the bacteria and the are the most ancient of living organisms. They occupy many areas such as dust, water, air in and out the animal in hot springs as well as in areas of freezing temperatures.

Some bacteria live a parasitic mode of life through out obligate parasites while others live a parasitic life today and a free life tomorrow (facultative parasites and others are free living bacteria.

Structure of a bacterium.

FUNCTIONS OF THE PARTS.

Photosynthetic membrane; contains chlorophyll for topping solar energy required for photosynthesis.

Mesosome; important in respiration.

Circular DNA; important in cell division and controls activities of the cell.

Mucilage; Associated with protection and enabling the bacteria to stick together and onto surfaces.

Cell wall; important in protection and is a polysaccharide (murem) as the strengthening material plant cells are made up of the polysaccharide cellulose as the strengthening.

Different forms of bacteria.

Coccid (singular coccus); these are spherical shaped bacteria and are of different forms.

Strophes loccoculs; these look like a bunch of grapes.

They live in the naral passage where they cause diseases

Like pneumonia caused by pneunococcus.

Streptococcus; these are where in chains. They live in the upper respiratory tract where they cause sore throat.

Bacilli (singular Bacillus); they are rod shaped bacteria and take up a vairet of forms.

Single rods e.g. Escherichia coli.

This lives in the guts and is a friendly bacterium which synthesises Vit.B and K.

24) Salmonella tpyhi; causes typhoid.

Rods in chains e.g i) Azotobacter species, used in nitrogen fixation
2) Bacillus anthracis causes anthrax
.
Spirilla (single spirillum); these are spiral shape e.g. Treponema pallidum

Vibios; these are comma shaped
e.g. vibro cholera causes cholera.

POPULATION GROWTH IN BACTERIA.
Nutrient availability.
Suitable PH.
Oxygen for aerobic bacteria.
Absence of O_2 for anaerobic bacteria.
On reaching a certain point / stage which cannot be controlled by the nucleus, the bacteria reproduce asexual by binary fission.
The growth pattern of bacteria is shown by the graph below;

The a above wire is called a normal sigmoid growth curve with five regions.
Lap phase; phase at which growth is proceeding at its minimum there is a gradual increase in population size this is because bacteria are getting used to their new environment and growth has not yet achieved its maximum growth way few bacteria have attained the required size to divide by binary fission. The bacteria are still synthesizing new enzymes to digest the wide spectrum of nutrients available in the medium.
Log phase; this is the phase at which at which growth is proceeding at its maximum. The bacteria have got under the new environment they have already made the enzymes required to digest the food nutrients and many have attained the required size to divide. There is almost no death causing a rapid increase in the population.
Self – retarding phase; there is a decrease in the overall rate of population growth i.e. the number of new cells produces per unit time decreases causing a retardation growth. There are co many bacteria cells competiting for essential nutrients to set in for aerobic bacteria cells oxygen is no longer enough and space is becoming

limited causing death of some bacteria cells. Their own taxic wastes begin to accumulate causing a decrease in the rate of population growth.
Stationary phase; at this point growth rate is zero rate of pro of new cells is counteracted by death of some number of the cells so no net is a result of many factors including; - Exhaustion of essential minerals
- Accumulation of own toxic wastes. – Stiff competition for space. - Oxygen for aerobic bacteria.
Decline phase; Death rate increases exceeding birth rate due to total exhaustion of nutrients and oxygen for aerobic bacteria. There are too much wastes and there is lack of space.

ECONOMIC IMPORTANCE OF BACTERIA.
Bacteria are decomposers hence release nutrients back to the system there by improving on and properties such as soil aerobic soil structure, soil water, holding capacity e.t.c. .
Bacteria's are decomposers remove organic mater preventing its occumulation in the environment there by acting as dust bin of nature.
Bacteria in industries are useful in leather turning cheer butter, yoghurt manufacture.
Bacteria fixing nitrogen in the soil e.g. the living bacteria.
Azotobacteria and the symbiotic bacterium Rhizobrum (living in root nodules)
The bacteria E. coli lives in the gut of some animals where t makes vits K nad B
KINGDOM PROTISTA;
Very big kingdom consisting of many phylam e.g. phylum prophuta e.g. the green algae; phylum phaephylum Rhotophyta e.g. Red algae, phylum Baccteriaphyto e.g. Diatms phylum Euylonedea e.g Euglena, phylum protozoo.
They range from single celled to multicellular;
Phylum protozoa; this comprises of four classes.
Class flagelleta; these are the flagellets such as trypanasoma. They use the flagellum for locomotion.
Class ciliatat; this includes the ciliates e.g. parameciem. They use atia for locomotion.
Class Rhyzophoda; including the Amoeba which use the pseudopodia for locomotion.
Class sporozoa; including the plasmodium.
Phylum chlophyata (green algae); these are the green algae and their body appears threw like orfilamentous it is multi cellular but cells are not specialise within each cell these are x- tensive structures including a central nucleus with a nucleu membrane, cytoplasmic strands and a spiral chloroplast with food reserves inform of starsh in the phrenoids

Structure of abactrium

Adaptation to habitant
It has chloroplasts with chrolophll, rapping solar energy for photosynthesis.
Has a mucilage making it slimy not to be eaten by animals.
The filament is very long increasing surface area to trap solar energy for photosynthesis.
LIFE CYCLE:
Reproduces both asexually and sexually
Asexual reproduction is by fragmentation during when the filament breaks into pieces called fragments are favourable.During unfavourable conditions, the algae reproduce sexually by conjugation.To actjument filaments develop conjugation tube through which the nucleus from the donor filament passes and fusses with the nucleus of the receiver nucleus forming a diploid zygote.Under unfavourable conditions the zygote develops a thick wall forming a resistant zygoshore which remains domant until the conditions become favourable the diploid zygosphere undergoes meiosis which develops into new algae.

KINGDOM FUNGI:
The fungi range in size from microarobic to the very large fungi such as toad stools, mushrooms, puffballs and broat fungi which can be easily seen by the naked eye.
Structure:
Fungi are made up of thread like structures known as hyphae forming a branching network. The hyphae may be septtate or aseptate.Septate hyphae have cross walls called septa which didvide the cytepalsm into cells containing one nucleus. Septa are absent from aseptate hyphae and the cytoplasm contains very many nucles

Classification of the kingdom.
The four important phyla are;-
Phylum Oomycota; tis is a water mould and produces flagellated spores which swim in water using their wings.
Phylum Zygomycota; for example brewmoulds, Reazoohus made up of numerious hyphae which are asepta

STRUCTURE:

The spores are produced in the spore capsule called the sporangium on top of the sporangiosphare.
The hyphae are of three types i.e.; Rosting linking and sponrangio which collectively form the mycelium
Phylum Ascomycota:

Produces asexual spores called condia formed in chain onto of the conidiosphore.

Phylum Basidiomycota; include musrooms, toadstools, puff balis, bract fungi very large fungi and reproduce by forming large spores.Sexual reproduction e.g. in brea mould.Two hypae that are participating is sexual reproduction come together and develop extentios where they exchange their nudei. The two hyphae are denoted ae negative and positive.
The positive being the donors and the negative being the receivers.When nuctei join, they form aeveloped zygote which developes a thick layer azygospore. The zygosphore undergoes meicsis to restore the normal chromosome name.When conditions become favourable, the zygosphore germinates into a new hyphae.

ECONOMIC IMPORTANCE OF FUNGI
Some fungi are parasites and cause diseases to both plants and animals for example in human, Ringworms and Athlet foot are fungal infection, in plants, potato blight caused by Phyphtoptora infestans.
Saprophytic fungi such as bract fungi attack timber of wood causing dry root. This may make the roof collapse.
Fungi such as pencillium and Erythromycile are important in the synthesis of antibiotics e.g. ppencililline and Enthromycine respectively.
The fungus yeast (saccharomycele) is useful in boking and fermentation.
Some fungi are used in cheese manufature. The fungus fermen the milk sugar lactose forming lactic acid which converts soluble milk protein caseunagen to the insoluble curd casein which forms the cheese.

KINGDOM PLANTAE:
This is a very diverse kingdom ranging from very primitive plants the mosses to very huge trees which are high adapted to life on land.

Classification:
There are 4 important phylum including phylum Bryophyta e.g. the Mosses and live worts, phylum filicinophyta including the ferns, phylum coniferophyta including the conifers or the corn bearing plants and phylum spermatophyte including the higher plants both flowering and non-flowering.

Phylum Bryophyta; the Bryophytes are considered to be the first plants to colonise land and are still poorly adopted to land conditions in that they are confined to moist shade places.

The plants body is differentiated into simple leaves and a stem but lacks true roots instead it is supported by the rhizoids. It is very small and conducts conducting times of xylem and phloem.

Plant body is made up of two parts;
Gametophyte which has male and female rossetters within the leaf.
The female rosetter contains aflask shaped structure which produces immotile female gametes
The male resette contains a structure called Anthendia which produce motile flagellated male gametes which swim in a fall of water after a rain splash or morning dew.
The male gametes enter the Archgonia and fertilize the egg cell forming a diploid zygote.
Sperophyte; carries out asexual reproduction of the life cycle, the diploid zygote after fertilization develops into a sporophyte which remains attached to gamete phyte to obtain nutrients. In the spore capsule spores are produced by meiosis and when released, they germinate into a small structure called protonema which later develops into a gametophyte. Notice that agametophyte generation alternates with the sporephytes
This is called alternation of generation
Differences between the ganetophtic and sporophytic phases of the moss life cycle.

Gametophytec phase	Sporophytic phase
hocploid	- Diploid
produces gametes by mitosis	produces gametes by meiosis
self support	depends on gametophyte for support and nutrition
takes up the largest phase of the cycle	Takes up the shortest phase of the cycle.
made of leaf – like structure	Made up of the spore capsule and the stalk.

WHY BRYOPHYTES ARE POORLY ADAPTED TO LIFE LAND?
They still live in only moist habitats and because of this, they are described as the "amphibians" of the plant kingdom.
They lack conducting tissues such as xylem and phloem. So movement of materials is by diffusion which is a slow process.
They still depend on water to transfer the sperm cell during fertilization.
They lack true roots so support is provided by simple inizoids.
PHYLUM PTERIDOPHYTA / FICILINOPHYTA
Ferns are basically terrestrial that grow well in moist places.
The plant body is sporophyte which has true roots, stem, leaves and vascular tissues (xylem and ploem).
The plant body is rhizome with an underground STEM and fibrous / adventurous roots.

Ferns range from simple plants to tree ferns with compound pinnate or bipinnate leaves depending on the species.
The vascular leaves have only xylem trahieds without vessel.
The ganoatophyte is a very small structure reproduced to asimple prothalus

LIFE CYCLE
Ferns also show alternation of generations with the sporophytis generation being dominant. The fern plant is the diploid sporophyte and the life cycle alternates between the sporophyte and the gametopyte.

The sporophyte produces spores by meiosis in the sporangium. Many sporagia clusters underneath the leaves forming soil.
The sporangium is protected by a protective covering called indusium.
When mature, the sporangium raptures and releases the haploid spores which on falling on moist soil, they germinate into a heart-shaped prothalus which is indeed the gametophyte.
It is a very small structure and does not contain any vascular tissues. It develops rhizoids on the underside which support it in the soil.

The gametophyte has male and female sex organs called Antheridia and Archegonia respectively. The antheridia produce haploid sperms by mitosis while the archegonia produce haploid egg cell by mitosis.
The sperm cell is flagellated therefore it is motile in a film of water during a rain splash or even morning dew, the sperm cell swims towards the archegonia where it fuses with the egg cell forming a diploid zygote. The zygote develops into a young sporophyte which later develops into a nature sporophyte or a plant which is independent and can grow for years.

Similarities between bryophytes and pteridophyte life cycle.
Both life cycles show alternation of generation between the diploid sporophyte and the haploid gametophyte.
In both the sperm cells are motile.
They both live in moist environment.
In both the haploid gametes are formed by mitosis
Both produce haploid spores by meiosis.
Both reproduce sexually and asexually.
Both the male and female gametes are produced in the antheridia and archegonia respectively.
In both the gametophyte is supported by rhizoids.
In both the female gamete is immotile.
In both the gametophyte lacks vascular tissues.
In both the female gamete is immotile.

DIFFERENCES BETWEEN BRYOPHYTES AND PTERIDOPHTYES LIFE CYCLE

BRYOPHYTES	PTERIDOPHYTES
Gametophytes is the dominant generation and is self supporting Lack true roots Lacks vascular tissues i.e. xylem and phloem. Gametophyte is made up of simple leaf-like structures. Sporophyte is made up of a spore capsule on the stalk. Gametophyte sporophyte develops from the protonena.	The sporophyte is the dominat generation. Has true roots The sporophyte has vascular tissues i.e. (xylem and phloem) Gametophyte is a simple heart-shaped structure. Sporophyte is a complete plant with roots, stem and leaves. Gametophyte develops from the prothalus.

Advantages of pteridophytes to life on land:
They have vascular tissues which conduct water, mineral salts and organic products of photosynthesis.
They have true roots for firm support in the soil and for water/mineral salt absorption.
The gametophyte is highly reduced to a heart – shaped structure.
The surface of the leaves is covered with a waxy cuticle which is water repellent minimising water loss.
In tree ferns, there is secondary growth forming wood (secondary xylem for support against wind.
However ferns are still poorly adapted on land because it:
They still depend on water for fertilization.
Moist ferns live in moist environment and may not survive dry environment.
They lack xylem vessels and have only trachieds trachiest an inefficies in transporting water for long distances.
Phylum spermatophta:
These are the seed bearing plants. These have a gametophyte much reduce and it produces the pollen grains and the egg cell by the process of meiosis. The main plant body is the sporophyte and the gametophyte depends on the sporophyte. It is divided into two sub visions;
Gymnospermatophyta; which are the non-flowering plants. They have the following characteristics;
They have naked seeds called cones which are not ended in the ovary.
They xylem tissue is made up of only trachieds but lacks the vessels.
The phloem tissue lacks companion cells.
They do not produce fruits since they have no ovaries.
They have two types of spores i.e. the mega spores (ova) and micro-spores i.e pollen grains.

They are perennial plants which form large trees and can grow for year's examples include conifers and the pine tree.

Angiospermatophyta.

There are the flowering palnts and they have the following characteristics:

Their seeds are enclosed in the ovary and are not naked.

They produce flowers which act as gametophytes producing both male and female gametes.

After fertilization, the ovary develops into a fruit.

Their conducting elements are fully developed with the xylem having both trachieds and vessels while the phloem tissue having companion cells. Therefore the companion cells and the vessels are distinguishing characteristic of angiosperms.

Some form wood as a result of secondary growth while others are simple herbs and shrubs.

They show double fertilization with one of the male nucleus fusing with the polar nuclei forming a triploid endosperm tissues and the other fusing with the egg cell forming a diploid zygote

Life cycle of angiosperm

Flowering plants show alternation of genegrations between the sporophyte and the gametophte. The sporophyte is the dominat phase while the gametophyte is much reduced and the gamet producinh parts are found within the female gamets are produced from the embryosac. Both are produced by meiosis. The male gamets called the pollen grains contain two male nuclei and the female gametes are the egg cells. Male gamets are motile but the female are immotile.During fertilization, one male nucleus fuses with the polar nuilai forming a triploid endosperm. The zygote formed after fertilization developes into an embryo which is surrounded by the endosperm. Both of these forming the seed.

ADVANTAGES OF ANGIOSPERMS TO LIFE ON LAND:

The gametophyte is much reduced and is protected by the sporophyte.

They have xylem vessels increasing efficiency in transportation of water and mineral salts.

They produce seeds which can undergo dormancy when conditions are unfavourable and germinate when conditions become favourable.

They have companion cells with numerous mitoihondria for active transport of sugars.

Fertilization is independent of water but dependention agents like wind and insects.

The aerial epidermis of the leaves is partorated forming stomata for gaseous exchange.

They undergo secondary growth forming wood for support.

Their roots are modified variously for support, absorption of water, reproduction and food storage.
Their leaves are modified to survive in dry environments such as being spiny, succulent, rolled, hairy e.t.c.
The cells of their cells are highly lignified for extra support.
There fore two classes in the divition angiospormatophyta. These include;
Class monocotyledonae.
Class dicotyledonae
Diagram:

Monocot differences between monocots and dicots

MONOCOTS	DICOTS
Have parallel leaf venation.	Have net-work leaf venation.
Leaf petiole modified into a sheath	Leaf petiole fern a stalk.
Have a linear lamuna or are elongated.	Broad lamina or divided lamina.
Fibrous root system.	Tap root system.
One cotyledon in the seed.	Seeds have two cotyledons.
Undergo hypogeal germination tissues on the stem.	Undergo epigeal germination
Vascular bundles are scattered.	Vascular tissue is the stem form a ring.
They lack the vascular cambium.	They have the vascular cambium.
Do not undergo secondary growth so they don't form wood.	They undergo secondary growth and form wood.
Flowers are usually wind pollinated.	Flowers are insect pollinated.
Food is stored in the endosperm.	Food is stored in the cotyledon.

KINGDOM ANIMILIA.

The animal is made up of multcallular organism which are heterotrophic some are motile since they have locomotary organs whilt others are inimotile since they lack lomotary organs such as the sponges which are firmly attached on the substractum like the rock.
All animals have the following characteristics.
They are all multicallular and eukaryotic.
They are all heretrophic i.e. feed on ready made food.
They have nervous system or a co-ordination system and respond to changes in the environment except the sponges which lack nervous system.
They show divition of labour i.e. particular cells performing particular functions.
The cells in multicellular organs are organised into cells, tissues, organsystems and the organisms. The body may take up different shapes or forms. The shape taken

up by the body is called its sysmmetry. Some animals are symmetrical i.e. they can not bedivided into two equal halves in any plane e.g the sponges are mirror images of each other.
Some animals have a radial symmetry both internally and externally and their bodies can be divide into two equal halves in any plane e.g. in the hydra.

Diagram:

In the star fish, the symmetry is penta-radial i.e. the body can be divided into two equal halves in 5 planes.

In higher animals the symmetry is bilateral externally i.e. the body can be divided into two equal parts right and left which are mirror images of @ other externally.
This is not true for the internal organs since some are not poured in bilateral symmetry the animals show various sides or surfaces including the anterior ?(front end), posterior (hind end), dorsal surface (upper surface), rental surface (lower surface) and the lateral surface (side surface).

COELOM:

The coelom is the space or body cavity present between the body wall and the digestive system.
The body wall is made up of 3 layers; ectoderm, mesoderm and endoderm. Some animals may not have a true coelom and are called acoelomates e.g the sponges and the flat worms. Others have a true coelom and they are called coelomes such as the higher animals while others have a pseudo coelem called a haemoceal e.g in arthropodes.

FUNCTIONS OF THE COELOM:
It enables the activities of the body wall to operate independent of each other.
In lower organisms, the coelom if fluid and the fluid acts on a circulating media for exchange of materials.
It provides space for enlargement of internal organs.
It acts as a shock absorber preventing mechanical damage to internal organs.
PHYLUM PORIFERA e.g sponges.

This includes the sponges.

The body is covered with cavities connected to the outside environment by pores hence the name porifera.
They are non-motile and firmly attached onto the sub-stratum in water unlike other animals, sponges lack a nervous system. They reproduce by budding.

PHYLUM COELENTERATA e.g hydra; jelly fish, sea anemone. The body has 2 layers and is described as diploblastic i.e. the endoderm and ectoderm with a radial symmetry.
The two layers are separated by a small cavity called Mesogloea. In hydra there are two forms, the polyp and medusa so it shows polymorphism.

Diagram:

The hydra shows a tissue level of organisation.
Atissue is a group of inter-connected cells performing specific functions. The nerve cells respond to stimulus; the flougellate cells use the flagella to circulate water for the hydra to obtain food.
The pseudopodial cells are phagocytic and they engult the food particle by phagocytosis.
The glandular cells are secretory and they secrete digestive enzymes which break down the complex food substrate into soluble products.
The stinging cells contain nematoblasts which are used to paralyse the prey. The interstitial cells are non-specialised and can develop into any other cell. The muscle cells are used to contract the body during locomotion.

PHYLUM PLATYHELMINITHES:
These are the flat worms and most of them are parastic. They have obilateral symmetry and lack atruecoelo e.g Tanea soleum (pork) tape worm, planaria (free living flat worm), lanes sarginata (beef tape worm).

PHYLUM NEMATODA (TRUE WORMS)
These are the round worms with a bilateral symmetry and they have pseudocoelom. Most of them are parasites e.g Asianis limbiloide (intestinal worms), Enterobius Vermicularis (pinlseat worms), Ancylastoma duodenale (look worm), filarial worms (cause elephantiasis)

PHYLUM ANNELIDA (SEGMENTED WORMS).
These are the segmented worms. The body is elongated with awell developed coelom. Examples include; the earthworms, leach worm, hug worms. They have a hydrestotic skeleton.

PHYLUM MOLLUSCA.
These include the molluscse.g squids, snails, octopus, e.t.c. the body is un segmented, soft and a coelom is present some like the land snails have ashell made up of cilium used for protection.

PHYLUM ARTHROPODA.

This includes the arthropods and they are the larges group of animals. They have the following characteristics
They have a segmented body.
They have jointed legs.
They have an exo-cutile made up of a polyssacharide chitin.
Body coelom is a haemoceal.
They have a dorsal heart with an open circulartory system.
They excrete uric acid through malpighian tubules.

REASONS FOR THE SUCCESS OF ARTHROPODS:
Possession of an exo-cutile which protects the animal from mechanical damage prevents excessive water loss and makes up the wings which are used for light.
Excretion of uric acid which requires little or no water for its elimination.
Some arthropods have large compound eyes for proper vision.
The phylum arthropoda is made up of many classes
Class Arachida e.g spiders, ticks (order aranea)
The body is divided into cephalo thorax and abdomen.
They have 4 pairs of jointed legs.
They have simple eyes.
They breathe through the tracheod system.
They lack anternnae but use pedipulps for sentitivity.
b) Class crustacean:
These include the crabs, lobster, crayy fish, water flee e.tc.
The body is divided into cephalo thorax and abdomen.
They have 5 pairs of jointed legs or both the cephalo thorax and abdomen.
Majority are aquatic and breathe through gills.
They have 2 pairs of antennae.
They have a pair of compound eyes.
Class insecta.
The body is divided into head, thorax and abdomen.
They have 3 pairs of jointed legs.
They have a pair of segmented antennae.
The thorax is divided into 3 segmented. These are prothorax, mesothorax and metathorax; each with a pair of jointed legs.
They have a pair of large compound eyes.
They respire through the tracheal system.

Common orders of class insecta include.
Order Dictyoptera e.g. cockroach.
Orthoptera e.g. grass hoppers, locusts and crickets.
Looptera e.g. Ants and termites.
Pepidoptera e.g butterflies and moths.
Coleopteran e.g Beetles.
Diptera e.g the house flies, mosquitoes, drassophila.
Hymenoptera e.g bees and wasps.

Class chilopoda:

This includes the centipedes;

They have one pair of legs on each segment and usually they have 10 – 30 pairs of legs.

They are carnivorous with poisonous clows.

They respire through the tracheal system.

They have a pair of antennae on the head.

Compound eyes absent, they have only simple eyes

Body divided into the head and many segments

Class diplopoda:

This includes the millipedes with the following characteristics;

They have 70 – 100 segments.

They are herbivorous and feed on rotting leaves.

Respiration is through the tracheal system.

They have a pair of antennae on the head.

They have simple eyes and compound eyes are absent.

Body is divided into the head and many segments.

PHYLUM ECHINODERMATA. e.g star fish, sea urchin and sea cucumber.

All of them are marine and they have a spiny skin.

PHYLUM CHORDATA.

The phylum contains the highly developed animals and they share the following common x-tics:

They develop a natochard at one stage of development but in veterbrates, the notahard developes into the dorsal nerve chord in the adult stage. However in the extinct amphioxus, the notochord was persistent even in the adult stage.

They have a past –anal tail at one stage of development but this disappears in the adult stage for some for some chordates.

Possession of the gill slits at one stage of development of their embryo. The gill slits in most mammals develop into the enstactean tube but in the fish persist to perform the functional gills.

Possess oxygen carrying pigment haemoglobin in their red blood cells.

Possess segmented muscle blocks called myotomes.

Classification of the phylum chordate:

The phylum chordata is divided into a sub phylum.

Sub phylu aeraniata:

These lack the cranium and their brain is naked. Their notochoral is persistent even in the adult stage e.g the extinct Anphovou.

Extinction is when the last surviving member of species dies.

Subphylum cranata; which includes all those chordates with a brain case or cranium and their notochord disappeara in the adulty stage leaving the dorsal nervechord. The sub-phylum craniata is divided into two super classes;

(a) supper class Agnatha; which are the jawless fishes.

(b) Super – class Grathastomata: these are chordates with well developed jaws. This severrals classes including:

Class reptilian:

These are the reptile's e.g lizards, snakes, crocodiles, turtles, alligators, tortoises e.t.c.

They have scales covering their bodies. Scales are important in minimising water loss.

They carry out internal fertilization and lay a deidoicegg (shelled egg) suchanegg can overcome the dry land environment.

They sue lungs for gasesous exchange.

They excrete uric acid which is loss toxic and requires little or no water for its elimination.

They are ectothermic i.e. their body temperature changes with environment temperature.

Class Pisces:

This includes the fishes. It is divided into two sub classes i.e.

sub-class Osteichythyses

This includes the bony fish.

Sub class chondrichthyses:

This includes the cartilagencous fish.

Fishes have the following genera characteristics:

They excrete ammonia which is highly toxic and requires a lot of water for its elimination.

Gaseous exchange i.e. through gills.

They have a two chambered heart.

Locomotion is by use of fins.

They are exothermic.

Class Amphibia e.g. toads, newts, and salamanders.

They have the following general x-tics:

They have a moist skin which they use for gaseous exchange.

They have a 3 chambered heart.

They use 3 types of gaseous exchange i.e. the skin, the mouth and the lungs.

Fertilization is external.

They are exothermic.

Class eaves:

This includes the bird; they have the following x-tics

Body is covered with feathers for insulation.

Fore limbs are modified to form wings for flight.

They have a 4 chambered heart so they can maintain a high blood pressure.
They lay a cheidoic egg which can survive in the environment.
Gaseous exchange is through lungs.
They excrete uric acid which is less toxic and requires little or no water for its elimination.
They are endothermic so they can maintain a high and constant body temperature.
They show a high degree of parental care and demonstrate cart ship prior to mating which involves nest building.

Class mammalian;

This includes the mammals and they are the most highly developed chordates. They share the following characteristics.
They produce their young ones at an advanced stage of growth
They nourish their young ones on milk rich in nutrients essentials.
They show a high degree of parental care and they train their young ones how to avoid predation and how to hunt for food.
They show extensive courtship prior to mating. This prevents wastage of gametes since species identification is possible.
Fertilization is internal reducing until a stage when it is produced at an advanced stage when it is produced at an advanced stage of growth and development.
Body is covered with fur for insulation.
They have external earlobes or pinnae.
They have different types of teeth (heterodont) due to difference type of diety. They have two sets of teeth the milk and permanent set (diphodont).
They have a 4 chambered heart and therefore they can maintain a high blood pressure.
They are endothermic therefore can maintain ahigh and constant body temperature.
Their mature Red Blood Cells (RBC's) lack anuleus except in horses.

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- 4. TRANSPORT OF MATERIALS IN PLANTS AND ANIMALS.
- Movement of materials in and outside the cell.
- There is need for exchange of materials between the cells and the surroundings. The materials might be required by cells as essential materials e.g water, glucose, amino acids, irons etc. some may be excretory materials which to be passed out of the cells e.g carbondioxide. Some materials are synthesized with in the cells but are utilized outside the cell e.g extracellular digestive enzyme. In this case, the materials are secreted by the cells. All above movement occur across the cell membrane which acts as a selective but between the cell and the environment. The mechanism of process of movement across the membrane can be categorized as passive mechanism, this don't require energy.
- Passive mechanism.
- (a) Diffusion.
- Simple diffusion.
- Facilitated diffusion.
- (b) Osmosis.

- Active mechanism.
- (a) Active transport.
- (b) Endocytosis.
- Phagocytosis.
- Pinocytosis.
- (c) Exocytosis/ secretion.
- DIFFUSION.
- *Diffusion is the movement of particles or molecules from a region of high concentration to the region of low concentration.* Diffusion occur along a conc gradient in fully permeable membrane and continues until an even distribution of molecules is achieved. It can occur across membranes, liquids and in gases.
- (a) Simple diffusion.
- In simple diffusion, non polar (uncharged) molecules and fat soluble molecules pass through the cell membrane easily and un aided. This is due to the lipid bilayers with in the cell membrane.
- Facilitated diffusion.
- This is the process by which the irons and polar molecules are passed across the cell membrane by acting as a specific molecule. The specific molecule will be in form of protein channels. Some times there is a carrier protein combines with a molecule at one side of the membrane and releases it on the other side e.g movement of red blood cell, movement of ADP in to mitochondria and ATP out of the mitochondrion.
- Examples of diffusion in living organisms.
- Gaseous exchange over respiratory surfaces in animals.
- Gaseous exchange via stomata in plants.
- Absorption or production or digestion like glucose and amino acids across epithelial lining of the ileum.
- Exchange of waste materials and between tissue fluids and cells in tissues.
- Exchange of materials i.e gases, nutrients and wastes in the organism and the environment in single called organisms like amoeba.
- Factors affecting the rate of diffusion.
- Concentration gradient.
- Diffusion distance/ thickness of the membrane. This refers to the distance over which diffusion occurs. The shorter the diffusion distance, the higher the rate of diffusion. The rate of diffusion is inversely proportional to the diffusion distance.
- $d \propto \frac{1}{L}$ d – rate of diffusion.
  L – diffusion distance.
- Temperature.
- Size of diffusing molecules or particles.
- Permeability of the membrane. The more permeable, the higher the rate of diffusion.
- Surface area across which diffusion occurs. The higher the surface area, the higher the rate of diffusion.
- Density of the medium. The higher the density of the medium, the lower the rate of diffusion.
- OSMOSIS.
- Osmosis is the process by which solvent molecules move from a region of their high concentration to the region of their low concentration across a semi permeable membrane. is the

movement of solvent molecules from a dilute solute to a concentrated solution across a semi permeable membrane.

- Water potential.
- This is the capacity of the solution to give out water in a system and the free energy of pure water at atmospheric pressure and a defined temperature. Water potential is expressed in pressure units (Pascals). Pure water has the highest water potential of zero at atmospheric pressure. Solutions have negative water potentials and the more concentrated a solution is, the lower (or more negative) is the water potential.
- Solute potential.
- *This is the measure of water potential of a solution due to the presence of solute molecules.* The more solute molecules present in a solution, the lower (negative) is the solute potential. For a solution at atmospheric pressure, the water potential is equal to the solute potential i.e Ų= Ųs.
- **Osmotic pressure.** This is the hydrostatic pressure required to resist the osmotic flow of water into a solution, separated from pure water by a partially permeable membrane. The more conc the solution, the higher is the osmotic pressure. **Osmotic pressure** can be defined as a tendency of a soil to take in water when separated from pure water by a selectively partially permeable membrane.
- **Pressure potential:** *This is the pressure exerted by the protoplast against the cell wall as the cell takes in water*. It is also known as **turgor pressure.** It has a positive value. Can also be negative in the xylem of transpiring plant where the column of water is under tension. The relation ship between water potential, solute potential and pressure potential is as follows
- Ų = Ųs + Ųp.
- Hypotonic solution.
- This is a solution of higher water potential or solute potential than the cell sap of the cell it surrounds. A cell placed in such a solution will take in water by osmosis.
- Hypertonic solution.
- This is a solution of lower water potential than the cell sap of the cell surrounding it. A cell placed in such a solution will lose water to the solution by osmosis.
- Isotonic solution.
- This is a solution with the same water potential / solute potential as the cell sap of the cell surrounds. A cell placed in such a solution will experience no net osmosis.
- Osmosis in plant cell.
- The cell has got cell sap or vacuolar sap which contains solute. The solute makes it un osmotically active aqueous solution bound by a membrane called tonoplast. The cell surface membrane, cytoplasm and tonoplast act together as one partially permeable membrane. On the outside of the plant cell is the cell wall which is freely permeable to aqueous solution i.e it is porous.
- Plant cell placed in a hypotonic solution or pure water.
- The cell will take in the water by osmosis. The protoplast will extend and begins to press against the cell wall exerting a pressure called pressure potential (also turgor pressure). The cell wall exerts an equal but opposite pressure called wall pressure against the protoplast. As the cell continues to take in water, the pressure potential increases. Water potential also increases and solute potential also increases and the cell wall said to be turgid. If the cell is in pure water, pressure potential will increase to the maximum. The cell at this point is said to be fully turgid. The pressure potential/ turgor pressure will be equal to the osmotic pressure. Pressure potential or turgor pressure will be maximum when the amount of water leaving the cell equals that entering. There is no net uptake of water. The cell wall is equilibrium with the surrounding solution.

- Water potential of solution == water potential of the cell.
- Ųs == Ųcell.
- Diagrams:
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- Plant cells placed in a hypertonic solution.
- The cell will take in water by osmosis, the protoplast will extend and begin to press against the cell wall exerting a pressure called pressure potential (turgor pressure). The cell wall exerts an equal but opposite pressure called wall pressure against the protoplast. As the cell continues to take in water, the pressure potential increases and the water potential increases, the cell is said to be turgid. For a cell placed in pure water, pressure potential will increase to the maximum and the cell at this point is said to be fully turgid. The pressure potential (turgor pressure) will be equal to the osmotic potential. Pressure potential, turgor potential will be maximum. The amount of water living the cell will be equal to the one entering the cell. There is no uptake of water. The cell is in equilibrium with the surrounding solution i.e
- Ųsolution == Ųcell
- Water potential solution = water potential of cell.
- Plant.
- The cell will use water by osmosis. The protoplast will shrink, the cell wall will become plasmolysed. The point when the protoplast has just stopped exerting a pressure on the cell wall is called incipient plasmolysis. At this point, the following will occur;
- Pressure potential (turgor pressure) is equal to zero.
- Water potential of cell = solute potential of cell.
- Ųcell = Ųs cell
- Water potential solute potential o the cell
- Solute potential of cell = solute potential of solute.
- Ųcell = Ųs cell
- The cell is flaccid as the cell continues to love water; its volume begins to decrease. Its water potential decreases, solute potential decreases. A point is reached when the protoplast crowns off and becomes completely detached from the cell wall. The cell is said to be fully plasmolysed. The space between the cell wall and protoplast will be occupied by the bathing/ surrounding solution.
- Osmosis in animal cell.
- Animal cells are partially surrounded by a partially permeable cell membrane. Most of the solutes in the cell are located in the cytoplasm. The animal cells like the plant cells will take in or loose water across cell membrane depending on the solute concentration of the cell and that it's surrounding medium. The only difference is that animals can't withstand gaining or loosing too much water to become fully turgid or flaccid respectively due to lack of a cell wall.
- Example.

- Osmosis in red blood cell.
- (a) Red blood cell placed in pure water (solution of higher water potential). The cell takes in water by osmosis, swells and bursts due to capturing of its cell membrane. This is termed as a haemolysis.
- (b) Red blood cell placed in solution of lower water potential. The cell loses water by osmosis and shreds. The cell membrane shrinks, this is termed as cremation/ lacking. To prevent the two above situations from happening animal cells exist in isotonic nature in the tissue fluid and plasma. This is achieved through osmoregulation.
- Importance of osmosis.
- Up take of water from the soil by root hairs of plat roots.
- Movement of water from cells in plants.
- Re absorption of water from the kidney tubules.
- Uptake of water from surrounding mediums by micro organisms.
- Responsible for turgidity which provides support in herbaceous plants and young plants.
- Enables absorption of water from the alimentary canal.
- Helps in bringing about opening and closing of stomata.
- Active transport.
- This is the active movement of ions across a membrane against the concentration gradient energy. (A.T.P) is required for this movement. The movement is against the concentration gradient as well as the electrostatic attractions. Therefore active transport involves the movement of ions / molecules against their electrochemical gradient. Active transport takes place by means of carriers in the cell membrane. The carrier molecule is a membrane which spans the entire membrane. Transportation is ought to occur as follows;
- The substances to be transported are attached to the carrier on one side of the membrane.
- The configuration of a carrier molecule changes in such a way that the substance is moved through it from the other side of the membrane hence energy comes from the hydrolysis of A.T.P.
- Importance of active transport.
- Uptake of mineral salts by root hairs.
- Secretion and uptake of ions in chloride secretory cells in gills of fish.
- Loading of sucrose into sieve tubes across the plasma membrane of transfer cells.
- sodium -potassium pump.
- This is an example of active transport where sodium ions are actively pumped out side the cell while potassium ions are actively pumped in.
- A.T.P is required for the process. A protein in the cell membrane becomes the pump, its thought to work as follows;
- The protein accepts sodium ions and A.T.P.
- The A.T.P is hydrolyzed and the protein acts as a phospho relation of proteins).
- The protein configuration changes leading to release of sodium ions to the outside.
- Outside the cell the protein accepts the potassium ions.
- Potassium causes the release of phosphate from protein (desphospho relation of proteins).
- Protein configuration changes leading to release of potassium ion to the inside.
- Importance of sodium potassium pump.
- It maintains the electrical activity in active cells, i.e creating resting potential for nerve transmission.

- It's also responsible for maintaining electrical coordination of cells.
- Controls osmoregulation in cells, when sodium ions are pumped out, water molecules follow by osmosis.
- Absorption of glucose along the intestinal lining. As sodium ions are pumped out by the sodium potassium pump, the sodium ions try to diffuse back into cell in contact with glucose aided by the carrier protein in the membrane. Any co-Acid absorption occurs similarly.
- Selective reabsorption of glucose and sodium from primal convulent tubule and active sap secretion of potassium ions in the glomerular filtrate in the distal convoluted tubule.
- Evidence in active transport.
- Many essential substances occur at much higher concentration inside cells from outside. This type of movement only occurs in living systems that are actively producing energy.
- The rate of movement of substances is affected by temperature and oxygen concentration.
- Both are factors known in affect the rate of transportation.
- It is inhibited by metabolic poisons like cyanide an indication that it depends on metabolic energy.
- The cells involved in active transport have very high concentration of mitochondria.
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- Endocytosis (phagocytosis and Pinocytosis).
- This is the bulk movement of materials into the cell. It involves;
- Phagocytosis (cell eating).
- This is the mechanism were the cell takes in solid particles leading to the formation of small vesicles called phagocytic vesicles or food vacuoles. The vesicles move to the centre of the cytoplasm where lysosomes fuse with them. The solid food particles are then digested by enzymes in the lysosomes. The vesicles migrate to the cell membrane fusing with releasing the undigested materials to the outside.
- Example of phagocytosis;
- White blood cells engulfing and digesting bacteria.
- Amoeba feeding on solid food material.
- Diagram;
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- Pinocytosis (cell drinking).
- This is the mechanism where a cell in liquid material leading to the formation of small vesicles called micro pinocytic vesicles. The rest is similar to phagocytosis.
- Examples of Pinocytosis.
- Amoeba taking in liquid material.
- White blood cells.
- Taking up of fat droplets by micro villi.
- Exocytosis.

- This is the bulk movement of materials out of a cell. The materials to be taken out are packed in vesicles which are fused with the cell membrane. Exocytosis is therefore the opposite of endocytosis.
- Examples include;
- Removal of undigested material by amoeba or white blood cells.
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- TRANSPORT IN PLANTS.
- In simple organisms e.g unicellular organisms and small multicellar organisms, transport may occur by simple diffusion. This is due to the short distance moved by the materials and has a large surface area to volume ratio which favours diffusion. In complex organisms however, the distance to be moved by materials is too great and they have a low surface area to volume ratio. Diffusion and other mechanisms of movement of materials cannot be adequate for movements of materials in these complex organisms. The complex organisms evolved in specialized transport systems which are capable for moving materials rapidly along the body. The transport systems developed by complex organisms are able to achieve the following;
- To link the organisms and its cells to the surrounding in order to receive metabolites and eliminate metabolic wastes.
- To move metabolites and wastes rapidly to cope with body's demands.
- The materials being transported are separated from other materials which the organism. This brings about fast movement.
- Transport of materials can occur without loss of water since the external part of the body surface is kept impermeable.
- Comparison between vascular systems in higher plants and circulatory systems in mammals:
- Similarities:
- Materials transported may be inorganic or organic.
- Channels of transport constitute mainly of a system of tubes with various modifications to suite particular needs.
- The medium of transport is either water or major components with water.
- Movement of materials requires and depends on energy. For animals, energy is required for the pumping of the heart while in higher plants, transport depends mainly on transpiration streams whose operation greatly depends on light energy.
- Differences:

• Higher plants.	• Mammals.
• Medium of transport is water. • No pumping organ involved. • Medium doesnot circulate. • Xylem transports water and salts, phloem transports products of photosynthesis. • Xylem and phloem are the conducting vessels. • No valves are involved.	• Medium of transport is blood and lymph. • Pumping organ i.e heart is involved. • Medium circulates. • All vessels can transport same materials. • • Arteries, veins, capillaries and lymphatics are the conducting vessels. • Valves are present to prevent back flow.

- Movement of water from the soil to the leaves.
- Water is absorbed from the soil by root hairs, it moves across the roots to the xylem. It moves upwards from the xylem of the stem to the xylem of the leaf.

- Root hairs.
- These are slander and flexible outgrowth from single cells in the peliferous layer. They have thin walls and lack a cuticle. They have cell sap with lower water potential than the cell solution.
- Adaptations to their functions.
- Being slander and flexible, they provide a large surface area and penetrate between soil particles.
- They lack cuticle which enable them to be permeable to water.
- They have a lower potential than the soil solution which enable them to absorb water by osmosis.
- They are numerous and provide a large surface area for absorption.
- **Qn:** How root hairs are adapted to their functions.
- Root:
- The outer most layers of cells is made up of peliferous layer in which root hairs arise. Next is the cortex which is made up of Collenchyma cells. The endodermis follows. The cells of endodermis contain a numerous starch gains. Its referred to as starch sheath. Around the radial and horizontal walls of each endodermal cell is a deposition of suberin (water proof materials). This forms a casparian strip. In the endodermis is the pericycle which together with endodermis forms a ring around the vascular bundle.
  - The xylem:
- This consists of vessels and Tracheids.
- **Vessels.** A vessel is formed from a chain of elongated cylindrical cells placed end to end. A mature vessel has no end walls between the cells and lack protoplasmic contents resulting into a hollow tube. The walls of vessels are lignified making them strong. Walls are perforated by numerous pits to allow lateral movement of water in and out of the lumen to cells around the vessel.
- Diagram;
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- Tracheids:
- These are hollow structures with tapering end walls which have pits. Their walls are lignified and have pits to allow lateral movements. Vessels and Tracheids of roots, stems and leaves connect with one another to form a continuous system of water conducting channels serving all parts of the plants.
- Diagram.
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- **NB:** In addition to conduction, the xylem provides support and strength to plants. This is due to the high lignification of its walls.
- Adaptations of the xylem to water conduction.
- The vessels and Tracheids consist of long cells joined end to end which allow water to flow in a continuous column.

- The vessels and Tracheids are hollow and the end walls of vessels are broken down. This allows uninterrupted flow of water from the roots to the leaves. Even in the Tracheids where the end walls are present, large bordered pits reduce the resistance to the flow caused by the presence of end walls.
- There are pits at particular points in the lignified walls which permit lateral flow of water.
- The walls are lignified making them mechanically strong and rigid to prevent them from collapsing under tension in the xylem setup by the transpiration pull.
- The lumen of vessels and Tracheids is narrow and this increases capillarity.
- The lignification of the cell walls increases the adhesion of water molecules which helps the water to rise by capillarity.
- Uptake of water by root hairs.
- Water enters the root hairs from soil solution by osmosis. This is because the cell sap of the root hairs has a lower water potential (contains more dissolved solutes) than the soil solution. The movement of water to the root hair cells occur through 3 pathways;
- Apoplast: water moves along cell walls.
- Symplast: water moves through cytoplasm.
- Vacuolar: water moves through the cytoplasm and vacuole. The most important of these pathways is the apoplast while the vacuolar is the least important.
- Movement of water across the root.
- When the water enters the root hair cells, the root hair cell potential increase above that of the
- neighbouring cortex cell. Water moves from cell to cell across the root to the xylem along the water
- potential gradient. This is because the xylem has a low water potential than the soil solution.
- Movement across the cortex is by apoplast, Symplast and vascuolar pathways. For apoplast, water
- flows within the cell walls of adjacent cells and through the small intercellular spaces between them
- by diffusion. For Symplast pathway, water flows from cell to cell via plasmodesma and through
- cytoplasm. For vascuolar pathway, water moves from one to the next through the cytoplasm by osmosis.
- The apoplast pathway is considered to be the most important because it offers least resistance to the flow of water. When water reaches the endodermis, it cannot cross it by apoplast pathway because the radial and horizontal walls are impregnated with suberin which is impermeable to water. Movement of water is diverted mainly to the Symplast pathway. Some is diverted to the vascuolar pathway. After crossing the endodermis and pericycle, water enters the xylem through which it moves upwards.
- Diagram;
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- Movement of water up the xylem.

- Water moves upwards through the conducting elements of the xylem called vessels and Tracheids. These are adapted to their functions in the conduction of water upward. There are two major theories (forces) used to explain the movement of water up the plants.
- Cohesion (Tension theory), Transpiration pull.
- Root pressure theory.
- Cohesion/ tension theory.
- According to this theory, when water evaporates from the mesophyll cell boarding the substomata air into the air space, the water potential of these cells is reduced. These cells then gain water by osmosis from the neighbouring cell. This continues until water is drowned from the xylem sac has the highest water potential. This setup, the tension in the column of water in the xylem and thin tension is transmitted down the stem to the roots. The tension in the xylem builds up a force called transpiration pull capable of pulling a column of water upwards by mans flow referred to as the transpiration stream. The column of water is maintained by the force of attraction between the water medium cohesion fun. This is because the water molecules are polar and attract each other. The column therefore doesn't break. The column of water is supported by adhesion between water molecules and the walls of the xylem. The heavy lignification of the xylem vessels enables them to withstand the forces. The narrow lumen of the xylem vessels together with adhesion and cohesion contribute to capillarity which contributes to the upward movement of water in the xylem. The cohesion – Tension is considered to be the main force responsible for the upward movement of water especially in tall plants.
- Criticism of the theory.
- The ability that the pressure gradient develops as a result of evaporation is not enough to move water at the observed rate.
- Not always is continuous column of water maintained e.g any break in the water column or any introduction of an air bubble like when a branch of a tree breaks doesnot stop water movement.
- Root pressure theory:
- This is the force originating from root due to high hydrostatic pressure which develops there. It occurs as follows;
- The cells of the endodermis actively secrete ions into the xylem vessels. The ions are prevented from leaking back into the endodermis by the casparian strip. The water potential of the xylem is lowered, water is then drowned from the endodermal cells into the xylem vessels by osmosis. A high hydrostatic pressure develops in the xylem vessel which can only be released by water moving upwards through the xylem. Root pressure is an active process because it occurs only in living cells of plants. It is affected by the factors affecting respiration in living cells like oxygen supply, temperature and presence of metabolic poisons.
- Criticism of root pressure theory.
- Its magnitude is too small to account for ascend of water up in tall trees.
- Transpiration continues if a plant without roots is immersed in water.
- The process is slow and cannot keep pace with water lost by transpiration.
- Root pressure is observed to be highest when transpiration is lowest.
- In many plants, root pressure is absent or extremely weak at certain times of the year.
- If a cut is made into the xylem under a dye, solution, the dye moves in the xylem upward and down wards from the cut. This slows that sap is not under positive pressure but under tension.
- Movement of water from the xylem of a leaf across the leaf cells to the atmosphere.

• Water movement from the xylem into the mesophyll cell of the leaf is initiated by the evaporation of water from the mesophyll into the substomata air space. From the substomata air space, vapour diffuses to the atmosphere via stomata in a process called transpiration. When water evaporates from the mesophyll cells bordering the substomata air space into air space, the water potential of these cells is reduced. The cells gain water from the neighbouring cells by osmosis. This movement of water continues along the water potential gradient until water is drawn from the xylem sac to the leaf which has the highest water potential. The movement of water across the leaf is along the apoplast, Symplast and vascuolar pathways as in the casein the roots.

• **Qn:** Describe the movement of water in a tall plant.

• Uptake and transport of mineral ions by the plant.

• Uptake of mineral ions from the soil is by two processes;

• (i) Diffusion.

• (ii) Active transport (active / selective uptake).

• Diffusion:

• This has little contribution to the uptake of mineral ions. It occurs where the internal concentration of the ion is less than the external concentration. The contribution of diffusion is said to be little because most ions absorbed by the plant cells are already at a higher concentration inside the plant than outside.

• Active transport:

• This contributes greatly to the uptake of mineral ions from the soil. The ions are selectively absorbed by active transport. The absorption is related to the requirements of the plants for a particular ion in active transport is involved where ions are at higher concentration inside the plant than outside while selectivity is due to the plants needs of the particular ion. Different ions have been observed to occur at different concentration in water/ soil. And are absorbed at different rates by different plants.

• Histogram showing the relative concentrations of different ions in the cell sap of the green Alga Nitella (Evidence for selective uptake).

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• Ion concentration in pond water.

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• Ion concentration in cell sap Nitella.

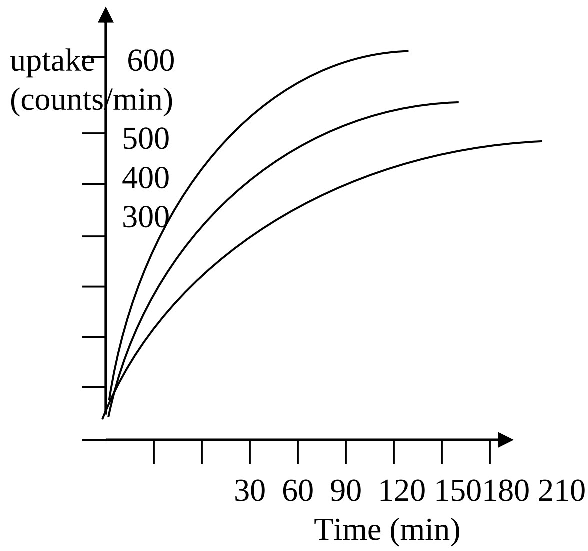
• Interpretation of the histogram.

• The concentration of certain ions may be many times greater in the plant sap from the surrounding water suggesting that they are absorbed by active transport. Certain ions are more concentrated than others suggesting that ions are selectively absorbed.

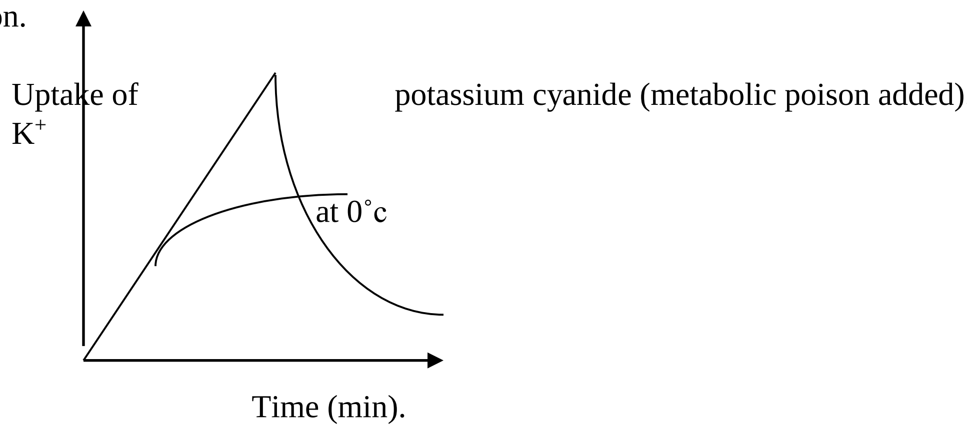
• Conclusion: Ions are selectively absorbed by active transport with certain ions being preferred more than others.

• Evidence for active uptake of ions.

• Barley plants were provided with sulphate labelled with radioactive sulphur S and the amount taken up by the plants were established by means of Geiger counter. In Aerobic conditions and anaerobic conditions, also in aerobic conditions with addition of metabolic poison. The results obtained were used to plot the graph below.



- From the above graph, it is observed that absence of oxygen and addition of metabolic poison reduces the ion uptake greatly.
- Conclusion: Ion uptake is an active process depending on respiratory energy. Any condition that affects uptake of ion e.g temperature, oxygen concentration and presence of metabolic poison.
- The graph below shows the absorption of potassium ions by young cereal plant in aerated solution.



- N>B: Uptake of mineral ion is a combination of both passive uptake (diffusion) and Active uptake (Active transport). If it was active uptake alone, the following would be true.

TRANSPIRATION

Is a process by which plant lose water from its surface in form of water vapour.

The mechanism of transpiration can be explained cohension-tension theory for maintaining water flow from the roots to leaves by transportation stream.

Solar energy drives the process of transpiration by……liquid to vapour, of surface of mesophyll bounder sub-stomato chamber.More than 99% of water absorbed by plant is lost by transpiration and less than 1% is used by the plant.

Types of transipiration.

There are three types of transpiration

Stamata-transpiration

This is where water vapour is lost through the stomata which are small pores in the epidermis of the leaves and younger even stem.

Caticular transpiration

This is where water is lost through the cuticle that covers the epidermis of lower and younger plant.

Lenticular transpiration

This is the loss of water by plant through the lenti cell that are present in the cork of the woody stems. This is the main root through which water is lost from deciduous trees after shading off their leaves.

Importance of transpiration

- Cooling effect to the plant. Evaporation from the root to the leaves cools the plant to the leaves due to lantent heat of evaporation which is characterized from the plant.
- Absorption of mineral salts and their distribution.
- Absorption of water and its movement in the plants.

Disadvantages of transpiration

Excessive loss of water from plants cause wilting, descation and often lead to death of plant therefore it is considered to be harmful to plant.

Transpiration as a necessary evil

Transpiration is described necessily evil because its an inevitable but potentially harmful.The rates (Stamata) through which water is lost is the same rate used for gaseous exchange which is essential for photosynthesis and respiration.

Water stress

A plant is said to be suffering from water stress when it cases more water through transpiration than it can take up through its roots resulting into wilting.The loss of water from the leaves raises the tension of the water columns in the xylem and the water potential gradient from the soil to the xylem increases. This results into roots taking up more and more water from the soil. If this continues stomata rapidly close causing reducing in water loss to minimize level (Abscisic acid) situated from cells of wilted leaves is known to bring about the response of stomata.Closing of stomata reduces the rate of photosynthesis due to reduced update of carbondioxide. If there is adequate soil water but the plant loses more than it can take. The result is temporary wilting. This is observed during wet and dry seasons. The plants normally recover at night when its stomata is dated and transpiration is reduced or even condition become unfavourable for transpiration.

If all the water that the plant can absorb from the soil is exhausted, permanent wilting occurs ie permanent wilting point is reached and the plant dies.

Factors affecting transpiration

Temperature. The higher the temperature the higher the rate of transpiration in the mesophyll of the leaf and vice verser.

Humidity. The low humidity out side the leaf encourages the rate of transpiration, that is to say if there is low humidity out side the leaf transpiration is high and vice versa.

Air movement. The low wind in the atmosphere carries away moisture on the surface of a leaf but when there is high wind, it will close the stomata hence low transpiration.
Lights. Light intensity increases the photosynthesis to take place and hence during the stomatas opens during day and closes at night.
Availability of water. Reduction, in availability of water to the plant results in reduction of water potential gradient between the cell and the leaf, therefore supply of water to the plant the water potential gradient increases between cell and the cell.
Leaf surface. The increase in the surface area of the leaf increases the rate of transpiration since increased surface of the leaf has numerous stomata however when the surface area of the leaf is reduced, it reduced the rate of transpiration.
Cuticle. This is a waxy covery over a leaf surface this reduces of rate of water loss. When the cuticle is thin, the rate of cuticle transpiration reduces but when its thin, the distance moved by water vapour reduced.
Number of stomata. The increased number of stomata increases the rate of transpiration. But when the number of stomata reduced also reduces the rate of transpiration.
Distribution of stomatas. In most plants the leaves are positioned when their upper surfaces towards light, the upper surfaces are subjected to greater light than of loss aveining to the all effect of sunlight. Transpiration is therefore greater for are surface. Many plants therefore maintain their stomatas entirely on lower surface of the leaf.
STOMATAS

These are small pores found on epidemics of the leaf and stems at stoma is turmed a specialized epidermal cell called guard cells. The guard cells are not evenly thickeness is their walls surrounding the fore is thicker than the one furthest to the pore. Their walls have different elastic.
The wall next to the pore (ventral wall) is less elastic than the one furthest from the pore this is brought about the arrangement of cell micro fibule making up these cell walls. Their cytoplasm contains chloroplasts unlike other pilerma cell.
Transpiration in stomata
When open the stomata occupies 1-2 percent of the total leaf surface area but all 50-60% of diffusion occur if the, mesophyll cell had no barter covering them this is because of the rate of diffusion through the stomata is proportion to the perimeter but not their area.
The smaller the area the greater of proportions water molecules evaporating from the leaf form a zone in the still air next to the leaf. Water vapour must diffuse through making air before sweept away.
The thicker the layer of stationary layer the higher the rate of transpiration.
Each stoma has a diffusion gradient forming over it. In the zone of still area at the edge of each park. The different gradient is so great.
When the spaced pores are more effective in allowing different pores than closely failed pores because they cause outer lap of diffusion shows and over laps reduced the rate of transpiration.

ILLUSTRATION

Mechanism of stomata opening and closure many theories have been put forward to explain the mechanism of stomato opening and closure.

Starch conversion theory

Mineral iron accumulation in a plant cell

Thugor pressure theory.

Stomatas occupy/formed in the epidermis of the leaves, they are mainly more adapted on lower surface than upper surface.

Turgar pressure theory

According to this theory opening and closing is brought about by turdigity.

Opening of the stomata

During this phase the guard cells take in water and become turgid due to an equal thickness and elasticity of the walls of guard cell, the dorsal or outer way stretches more easily than the inner wall leading to the cell acquiring a semi-circular shape. The pore is left between the ventral wall and the stomata opens.

Closing of stomata

When the guard cell lose water, they become fracid their inner inner walls tend to pull each other and the stomata closes.

Opening

ILLUSTRATION

Closure

ILLUSTRATION

Sugar conversion theory

According to this theory the irreversible starch sugar conversion is characterized by pit sensitive enzymes during day, photosynthesis takes place leading to reduction of CO2 concentration (rise in PH^1 in side the leaf. This favours the conversion of starch to glucose.

Accumulation of glucose in the guard cells leaves their water potential and taken in H2O by osmosis and the stomata opens, at night photosynthesis doesn't occur but the CO2 concentration rises inside the glucose to starch. The xxxx of guard cells then rises and they lose water to the neighbouring cell by osmosis, this is then causes flaccid the stomatas closes.

Summary

$$\text{Starch} \underset{\text{Low PH}}{\overset{\text{High PH}}{\rightleftharpoons}} \text{glucose}$$

Mineral ion theory

When potassium and chloride ion enter the guard cells, their water potential is lowered. Water then enters into the guard cell by osmosis, this resists into stomata opening. K^+ may enter in response to switching on an epitase found in the surface membrane. This stimulates epitase to conversion of A+P to ADP so that it can pump out hydrogen ion or proteins from guard cell, this proton return on a carrier which also brings in acid ions.

II Closures

In darkness the stomata closes, the potassium ions move out of the guard cell to the surrounding epidemental cell, water potential of the guard cell increases water moves out of the guard cell by osmosis. The loss of pressure makes the guard cell change shape again and the stomata close.

TRANSLOCATION

Structure of a phloem

This phloem is a vascular tissue constuiting of sieve tubules, companion cells, parachyana and fibres, translocation occurs in the sieve tubes.

Sieve tubules

These are made up of elongated thin walled cells called sieve element which are marxxx end to end, the end wall are performed by numerous pores aiming a sieve plate. This allows passage of materials from one sieve plate to next.

EVIDENCE TO SHOW THAT TRANSLOCATION OCCURS IN PHLOEM

Evidence is obtained from one of experiment.

Ringing experiment

In this experiment a ring of the back of the tree is striped off a tree truck.

Observation.

The sugar concern above the ring immediately increases while that below the ring reduces, this shows that a conduction of sugars down wards is interrupted. The upper part of the ring grows more than lower part because the lower part receives less or no nutrients axxx pipette. A fluid is then analyzed in laboratory.

It is found out that is contrains amino acids and sugars. This substances come from the phloem. Further confirmation can be obtained by cutting sections of part of the stem which has stylets and from this it can be observed that stylets pierces into a single element.

Mechanisms of translocation

The mechanism of translocation of organism is not well known however a number of theories have been put forward the way it occurs.

Mass flow/pressure flow

Cytoplasmic streaming

Electoral osmosis

Mass flow

Is the movement of materials in a collective bulle called a mass due to different in turgor pressure in plants atosynthesis take place with in the life. According to this theory or hypothesis materials move from region of high turgor pressure ie in the leaf due to accumulation of organic products of atsynthesis eg sucrose to a region of low hydrostatic pressure ie in the root due to convention of sucrose of inactive from eg starch on sugar being utilized in metabolism eg respiration. The turgor/hydrostatic pressure gradient the sowee and seek drives organic food material dissolved in water as a mass flow as sugar continues to be formed at the source and being used up at the seek or root. The turgor pressure difference is maintained together with xxxxx flow.

Illustration of mass flow by mucho
Source
Sink
Phloem
Xylem
Water is absorbed by osmosis creating a high hydrastatic pressure which causes the solution to move A-D vice the by mass flow, water is forced out to which by hydrostatic pressure developed.
Weakness of the process
When an equilibrium is attained when the concentration of A and B is equal and flow of the material sizes, this however doesnot happen in plant where continous movement is maintained by continued active secretion of sugar into the sieve tubes at the sources and its removal at the seek.
Sugar and amino acids have been examined from traneer envidende to move at different speed and in different direction with in sieve tube.
There is no rule followed
The tugor pressure can not be so high to create a divercing force as to account for movement of solid.
The turgor pressure calculated could be insufficient to overcome consideration resistance caused by sieve pores.
Some times translocation has been observed to take place towards region of high turgor pressure.
EVIDENCE TO SUPPORT THE MASS FLOW
When the phloem tissue is daurage, there is exudation of sap by mass flow.
Appropriate gradient in concentration of sugar between the seek and the source has been established various plant.
Prolonged exudation of sucrose from the aphid stylets when cut, is an renudence of hydrostatic pressure in sieve tube.
Movement of certain viruses occurs during the phloem translocation stream indicating mass flow since viruses are incompable of locomotion.
CYTOPLASMIC STREAMING
It is the movement of material or organic materials of Atosynthesis a long the protein filaments in sieve tubes by streaming, some filaments convey solutes down wards others down wards. Energy for process is obtained from the companion cells and it is suggested that the filaments under go contraction sweeping the materials in wave like motion of the filaments.
A diagram illustrating cytoplasmic stream
Evidence to support cytoplasmic stream
It a/c the bi-direction of material observed a long the individual sieve tubes. Streaming the the cytoplasm have observed using a phase constrasting microscope.
Weaknesses of the theory
Streaming has been observed only in mature sieve tubes.
Streaming movement are not fast enough to a/c for the observed rate of movement in the phloem.
(III) ELECTRONIC OSMOSIS

Is the movement of water across a charged membrane, it is suggested than an electoral potential difference is created across the sieve plate with the lower side being negatively charged relative to upper side, the potential difference is maintained by the companion cells actively pumping in potassium ion in up-ward direction. Polar water molecules together with dissolved solutes flow from the upper side of the plate to lower side which is negatively changed by electoral static attraction.

An illustration of electro osmosis

Weakness/cristisms

There is no envidence supporting this mechanism

It doesn't offer an explanation for the movement between the sieve plate with in the sieve element.

(IV) SURFACE SPREADING THEORY

According to this theory it is suggested the translocation by solid. Solute spreading over the interface between two different cutoplasmic. The formed molecular film is maintained molecules being added at one end and removed another.

Loading and unloading of sieve tubes

Loading and unloading is actively carried out by special parachyama cells called transfer cells, these cells are close to the sieve tubes.

They possess the regular primary cell wall and plasma membrane the intuckings provide increased surface area of the cell surface membrane.

In the leaves, the transfer cells carryout active uptake of solutes from the neighboring Atosythetic cell and active load them into the adjacent flura the plasmatimat.

In the roots, storage organs and growing regions transfer cells remove the solute from the sieve tube and pass them over to cells which utilize them, the………….and unloading of sieve tubes, using energy from numerous mitochordria in other cytoplasm, transfer cells are thought to be responsible for loading and unloading of the xylem with water and mineral salts. Transfer cells are not common in all plants, they all occur in peas family and some other families in those plants with no transfer cells, it is thought that active loading ……….is by active specific carrier molecules in the cells of surface membrane or campanion membrane.

ILLUSTRATION

TRANSPORT IN ANIMALS

In simple animals like protozoa, inidarcans and plant. Platylelminthisis, transport the materials have to move the body surface to the intension of the body including the inner most cells, these S

These simple organisms also have large surface area to V2 ratio that favours digestion. However in complex organisms there are many tissues in the body, diffusion organisms there are many tissues in the body, diffusion distance is long, they also low surface area to VL ration and this doesn't favour simple diffusion.

Complex animals therefore acquire atp system to be able to move materials rapidly around the body.

CIRCULATORY SYSTEM

This is a system in which materials suspend in a fluid medium are moved.

CHARACTERISTICS OF A CIRCULATORY SYSTEM
There is a circulatory medium fluid is called blood
There should be a pumping organ, the heart which causes pressure difference for movement which with bloal.
There are channels in which circulatory medium moves and these are blood vessels; these carry, bloods towards the tissues and from the tissues back to heart.
The channels posses values to prevent back flow of blood.
The blood vessels some times are of different types ie the arteries, veins and capillaries to improve on the efficiency of materials and separate materials in transit.
TYPES OF CIRCULATORY SYSTEM
There are two major types
Open circulatory system
Closed circulatory system
OPEN CIRCULATORY SYSTEM
This is the type of circulatory system in which blood is not confined is distinct blood vessels but instead moves in body cavity called <u>heamoceal.</u>
This type of body circulating system blood moves freely over the body tissue with in body cavity eg anthropods like insects.
BLOOD CIRCULATION IN INSECTS
Insects the open circulation is has a result of how anthropods develop. In most animals, the embryological canvity called ceanom that becomes a main, body carvity at the expense of a cavity called <u>blastocoels</u> which eventually forms the blood vessels, however in insects, the reverse takes place ie the coelomic cavity remains small and the blastocytes becomes the main cavity.
The coerom grows faster fouring a circulatory system insects have a tubular heart perforated by small pores small <u>Ostia</u> at the anterior end,
The heart has got a blood vessel called <u>aorta</u> which opens. The heart is suspended by slender liganess attachment of pericudium memorane at one end and on the body wall at other end. The heart extends from the abdomen to the thorax. It has small chambers which are in form of dilations at positions corresponding to this chambers in the pericardial membrane are muscles called <u>Alleny muscles</u> responsible for audity and expansion of the heart after its contraction.
Heamockal is divided by transverse membranes called percadial and sterna mernbrane, the cavities in the heamoceal area.
Pericardial cavity
Penivesceral cavity
Sterna cavity
It is through these cavity that blood before it returns back to the heart.
Diagram of an insect showing an open system
T.V section showing the open circulatory system
MECHANISM OF BLOOD CIRCULATION IN INSECTS
It involves both contraction and relation of the heart referred to as **systole** and diastole respectively.
Blood is propended forward through the heart by contraction of……………..

During systole the values in the Ostia are closed so that blood can't pass through them, blood then flows forward into the aorta and then enters the heamoceal in the heamoceal blood flows slowly and slanglshey bus its movement is innenced by contraction of the gut and muscular wall. The movement of blood out of the heart is also due to contract as the ……..

During diastole: This is the relation of the heart blood flows back and to the exterior ends and re-enters the heart through the ostia which are then open. This takes place in the following ways.

The alley muscles in the penicadial membrane contracts and causes the suspensory ligaments to pull the heart out wards there by increasing its internal volume. This then causes a decrease in pressure with in the heart. Much blood then enters the heart through the Ostia at the end of diastole, systole begins and the cycle is repeated.

NB: In insects blood is colourless and contains no heamoglobin hired blood cells and its not responsible for the transport of respiratory gases. However blood kin insects contains.

White blood cells and hence carries out the function of defence by engulfing foreign particles which enters the body of an insect.

Functions of circulatory system in insects

Transport of food

Transport of excretory and secretory substances like acids and enzymes.

Defending the body using the UBC called phagocytes which engulf the foreign particles.

Disadvantages of open circulatory system

Blood pressure and speed of blood curt be maintained in all circulation.

The slow or sluggishness of blood flow in the system limits the activities of the insects ie blood cant carry materials at the required rule to meet the body demands

It is difficult to maintain the direction of flow of blood especially in heamoceals where there are valves.

CLOSED CIRCULATORY SYSTEM

It is a type of circulatory system where blood is confined to blood vessels.

This type of circulatory system blood does come direct to blood tissues eg vertebrate and some invertebrates like anerids eg earth warms. Closed circulatory system is divided into 2 types namely

Single closed circulatory system

Double closed circulatory system

SINGLE CLOSED CIRCULATORY SYSTEM

This is a type of circulation in which blood flows through the heart once in one complete circulation or circle eg in earth worms and fish.

SINGLE CLOSED CIRCULATORY SYSTEM IN FISH

The single closed circulatory system in fish, it consist of the heart with one antenium and one ventrical.

The anterious receives blood that is returning back to the heart through the veins while the ventricle receives blood through entrium and pumps it to the gills on its may to the body tissue as shown in the diagram below.

ILLUSTRATION
De-oxygenated blood returning from the body tissue enters the antnium and then flows to the ventrical. It is then pumped to the gills to become oxygenated. After oxygenated it flows to all parts of the body from where it then returns to the heart as de oxygenated.
Blood flow in the fish is in such that to make a complete cycle as it flows in to the heart once, that's why its called a single circulatory system. This type of circular.
Disadvantages of single circulatory
It is inefficient because blood flows through two capillarily systems ie that of the gills and that of the body tissues and as a result blood flow is slungish and at low pressure especially at various sites to overcome this challenges blood vessels which lead blood from tissues to the heart are naturally very large so that to offer little resistance to blood flow such blood vessels are synasises.
Double closed circulatory system
This is a type of closed circulatory system in which blood passes through the heart twice in one complete cycle around the body. She system consist well developed blood vessels. It involves two types of circulation namely:-
Major or systematic
This is a type of double closed circulatory circulatory system where blood is pumped from the heart to all parts of the body except the lungs and the back to the heart.
Minor or pulmonary circulation
This is the type of circulation in which blood is pumped from the heart to the lungs and then back to the heart.
To facilitate double circulation, the heart is divided into two different parts especially in higher animals like mammals. The two parts do not allow movement of blood from one to the other.
The right side of the heart carries oxygenated blood while the left part carries de-oxygenated blood. Examples include: mammals and amphibians. In mammals there is completely divided heart.
A diagram to show circulation in a mammal.
In amphibian the heart is partly divided with two circules atria one undivided ventricle. Blood from the body returns to the heart through the right atria while from the lungs the left………………blood from the auricles passes into a single ventricle and then pumped to the lungs. For oxygenation. In this type of double mixing of deoxygenated and oxygenated blood. With in a single ventricle however it has been found out that the level of mixing of de-oxygenated and oxygenated blood is not very high and this due to folding which ensure that there is little mixing of oxygenated and de-oxygenated blood. The partial separation of oxygenated and deoxygenated in the ventricle of amphibian may act for its inactive way of life compared to mammals.
A diagram showing double circulatory system in amphibians
Advantages of closed circulatory system

Blood flow is faster to ensure high supply and removal of materials to and from organs or tissues there is direct supply of blood.
The rate of blood supply can be regulated according to the need of organisms.
Blood pressure is maintained through out circulation
The direction of blood flow is always maintained.
There is less mixing of oxygenated and deoxygenated blood especially in mammals
Disadvantages of blood closed circulatory system
The system requires expenditure of energy especially during the pumping of the heart.
Blood pressure may rise to high a level of resit into high transmission
Differences between single and double circulatory system eg between that of a mammal and insect.

Stable closed circulatory system	Single closed circulatory
High blood flow	Low blood flow
Blood flows at high pressure	Blood flows at low pressure
There is high level of separation of de-oxygenated and oxygenated blood.	There is low level of separation
The heart is either three chambered in amphibian or four chambered.	The heart is double chambered

Similarities
In both circulatory medium is blood
In both systems blood flows n blood vessels
In both there is pumping organ the heart
Both circulatory system there is blood heamoglobin
Open and closed
Similarities between open and closed circulatory system
Both provide means of transportation
In both the circulating medium is forced to move under pressure
Both contain the heart
Differences between open circulatory systems and closed.

Closed circulatory	Open circulatory
Blood is confined in blood vessels	Blood is not confined in blood vessels
Blood enters the heart through the vein	It enters through the Ostia
The cardiac muscle causes the contraction and relaxation of the heart	Allary muscles cause contraction and relaxation
Blood flow to the tissue is controlled	Blood flow to tissues is less controlled
The heart is either four chambered or three chambered.	The heart has several chambers
The heart is located in the thoracic cavity	It extends from the abdominal cavity to thorax
The blood is pigment	The blood is not pigmented
Blood flows under high pressure	Blood flows under low pressure
The heart is myogenic	The heart is nuerogenic

Greater volume of blood is in circulation	Less volume of blood is in circulation
Contraction of diaphragm and intercoastal muscles causes an increase in blood which aids in blood flow	The contraction of allony muscle pulls pericardial hence increase pressure in perechardia cavity hence increasing blood flow from prevescenal to penecardial cavity.

THE MAMMALIAN CIRCULATORY

Mammals have a well developed circulatory system consisting of circulatory medium blood, a completely divided heart and blood vessels.

BLOOD VESSELS

These are of three types ie the arteries, veins and capillaries.

Arteries

These are blood vessels which carry oxygenated blood from the heart to the body tissues. The largest artery is called aorta and 2nd largest artery is called pulmonary artery. The largest artery then further branches in small arteries called arteriole which forms the arteriole part network.

Structure of the artery

It is composed of three main lawyers ie the endothelium, a layer of cologne fibre and a layer of elastic fibres, these layers relatively surrounds small rumen.

Characteristics of arteries

The arteries have got muscular walls

Have much elastic tissue

Capable of undergoing constriction

Their wall one not permeable to materic

Don't contain values along their length except at the base of pulmonary artery and aorter.

They army oxygenated blood except pulmonary artery

They carry blood under very high pressure

Blood in them moves in pulses

Blood in them flows rapidly

T.V section of an artery

Adoptions of the arteries to suit their function

They have thick muscular wall t prevent bursting due to high pressure of blood.

They have a narrow lumen to allow blood move at high pressure

They don't contain valves along their length to allow smooth flow of blood.

They have elastic tissue to carry large volumes of blood in a shorter time.

The major structure of blood circulation

VEINS

These are blood vessels which carry blood from the tissues back to the heart. The largest veins are vena cava and pulmonary vein. These further divide to form fine vessels called **venules** these form part o capillarity network.

Structure of the vein

It also consists of three main layers ie endotheir… a layer of elastic fibre and a layer of collagen fibres. These layers surround a large lumen.
A T.V section of a vein

Characteristic of a vein
It has thin muscular wall
Has large lumen
Has valves along their length
Not capable of constriction
Carry de-oxygenated blood except pulmonary vein
Blood in them flows under low pressure
Blood in them flows slowly
Blood doesn't move in impulses
Carry blood to the heart from the body tissues
Have thin elastic tissues
Their walls are impermeable to materials
Adaptations of the veins
Have wider lumen for smooth flow of wider VL of blood
Have values to prevent back flow of blood
THE CAPILLARIES
These are thin walled vessels which form a network to link up arteries to veins.
The structure of capillary
It consists of large lumen surrounded by thin flattered cells that form the endotherium. The endothelium is permeable to materials and it forms a thin wall.
A T.V section of a capillary

Structure of capillary network
Characteristics of capillaries
They are narrow
They are thin walled ie one cell thick
They don't have valves along their length
They don't have muscles
They don't have muscles
They don't have elastic tissues
They have large lumen relative to diameter
Their wall is permeable to materials
Link up arteries to veins
Blood in them flows slowly
Blood in them doesn't flow in impulses
They are not capable of constriction.
Adaptation
They are thin walled ie their cell is one cell thick to allow exchange of materials by simple diffusion and osmosis.
They lack valves to allow steady flow of blood
THE HEART

This is a muscular organ responsible for pumping blood through out the body. It lies in the thorax and it is enclosed by a membrane sac called pericardium. It has four chambers ie two thin walled atria and two thick walled ventricles. The atria acts as the receiving chambers of the heart while the ventricles act as distributing chambers of the heart.

The chambers on each side are connected through arteriale ventricular valves called **tricuspid and bicuspid valves.** The tricuspid valve lies between the right atrium and right ventricle while the bicuspid valve lies between the left atrium and left ventricle. The values stops back flow of blood during pumping action of the heart.

There are also other valves known as semi-circular valves between the ventricles and pulmonary artery or aorta. These values present back flow of blood during relaxation of the heart.

Diagram showing the structure of the heart

The heart is made up of specific type of muscle tissue called cardiac tissue. This type of muscle can withstand patic of continuous contraction and relaxation with which is iniated from with in the heart and therefore is said to be mulgenic.

PUMPING ACTION OF THE HEART

The mechanism of the pumping action of the heart is also divided into two phases ie contraction, relaxation. The heart it is said to have completed called **cardiac cycle.** The cardiac cycle in man is about 74 beats………………initiated from with in the heart its self and it is refered to as mulgenic contraction.

During diastole the heart relaxes its size increases due to filling up by blood. On the right side of the heart, de-oxygenated blood from all parts of the body except the lungs enters the right atrium and the tricuspid valve is closed.

When the atrium is full of blood, the presence of blood forces the tricuspid valve to ope and blood enters the right ventrical.

On the left side of the heart oxygenated blood from the lungs enters the left atrium through the pulmonary vein and the bicuspid valve is closed.

When left atrium is full of blood, blood pressure forces the bicuspid valve to open and blood flows to the left ventricle, the heart contracts and expels blood which enters during diastole.

During systole the atria are full of blood and contract at the same time forcing blood into the ventricles. The two ventricles also contracts at the same time, the bicuspid and tricuspid valves then close to prevent back flow of blood into the atria. Blood from ventricles is forced out of the heart.

Blood from the left ventricle moves through the aorta to other parts of the body while that from the right ventricle moves through pulmonary vein to the lungs.

When the ventricles are contracting the atria relax and at the end of systole blood again enters the heart through the atria and the cycle repeats.

Diagrams showing diastole and systole during heart

Diastole

Artrial systole

Ventricular
The control of the heart beat
The control of the heart beat is done in two ways
Myogenic control and Nervous control
Myogenic control.
Due to the nature of cardiac muscle the contraction of the heart is intiated from with in the muscle itself and this feature of muscle contraction is described as myogenic. The heart is able to contract at different rates but the uniform. Ethemic contraction all over the heart is called the **sino-atrial node** which is also called the pace maker.
SAN is located in the right atrium closed to their area where greater veins enter the heart. SAN is the one which initiates and determines the rates at which the heart beats. When the right atrium is filled with wood, the SAN is stimulated and initiates electrical excitation secretes with in the walls of the atria causing them to contract at the same time. In the atria, ventricular junction is another node called **atria-ventricular node** called AVN in this node there is a tissue called **purkyne tissue** which continues to transmit electrical excitation into the walls of the ventricles especially the ventricular septum when the AVN is excited, if picks up the excitation and spreads it through the tissue towards the tip of the heart and then causes the ventricles to contract.
Diagram showing location of sino-atria node and atrio ventricular node.

From the diagram above the pace marker sends out rhythmic waves of excitation which are transmitted in the atrium and then via AVM, Purkyene tissue to the ventricles, this spread of electrical excitation is accompanied by the muscular contraction of the heart.
NEUROGENIC CONTROL OF HEART BEAT.
The nervous control of heart beat is through nerves but are connected to the heart ie the vagus nerve which decelerates the heart beats both and the sympathetic nerves which accelerates the heart beats both the nerves are connected to SAN of the heat. When stimulated, the sympathetic nerve arises the rate of heart beat.
NB: these nerves don't initiate the heart beats but modifies by accelerating or lowering it. The nervous control of the heart beat is important because it incolves the organs to delevere materials in blood to tissues and he moves waste products according to the demand of the body eg intense muscular activity stimulates the body eg intense muscular activity stimulates the sympathetic nerve to accelerate the beat of the heart, so that respiratory gases like oxygen, cobondioxide are carried to and from the tissue respectively.
There are two regions in the brain which control the rate of heart beat. The cardiac inhibitally centre which reduces the rate of heart and the cardiac acceleration centre which stimulates the rate of heat beat.
The inhibitally centre is connected to vagus nerve while the cardiac centre is connected to sympathetic nerve. These nerves lead to SAN and AVN and bundle of HIS.

Impulses along the vagus nerve are sent to the SAN to reduced on the rate of heart beat, when the acceletion……………..impulses to the SAN and AVN to accelerate the rate of heart beat.

HORMONAL CONTROL OF HEART

A number of hormones affect the rate of heart beat either directly or indirectly, the most important of this is Adrenal hormone which is seacted by the medulla of the adrenal grand. The adrenal medulla also secretes small amount of norodrenaline which has similar effect to advenaline is more effective. Cardiac out put and blood pressure are increased by increasing rate. The two hormones also have other effects on the body which prepare the body for fright and fight.

Another hormone is thyrocine hormone produced by thyroid gland this has the effect of raising basal metabolic rate and this in turn leads to greater metabolic activity with greater demand for oxygen and production of more heat as a result, visal dilation of blood followed by blood ie this in turn leads to cardiac out put and increased heart beat.

Other factors controlling heart beat.

Health status of the organism

Age and size of the animal

Chemicals such as adrenaline/norademinolic

High level of CO2

External and internal temperature.

Measurement of blood pressure

Blood pressure is measures in milmeters of mercury (mmHg) using **Sphygmomanometer** because the blood pressure changes from systole to diastole, it is usually recorded as 2 no. the first is the figure for pressure during systole which is called systolic pressure and its called diastolic pressure for an adult individual the blood pressure during normal condition is given 120/80.

120-systole

80- Diastolic

Graphs illustrating pressure volume changes during cardiac cycle

From the fig. above pressure changes were measured from left atrium, left ventricle and aorta. Volume changes were measures for both ventricles the electrical heart wall which is electrocadium and heart sounds (phonocadiagram) as recorded from the human subject are also recorded. The action of different points of the graph as follows.

A

The atrium contracts and blood flows into the ventricles

B

The ventricles begins to contract

The ventricular pressure exceeds the atria pressure so that the AVN (atrio ventricular valves) close.

C

Ventricular pressure exceeds aortic pressure forcing the oartic semi lung value to open.

Blood flows from the ventricle to aorta and ventricular volume decreases.

D
Ventricular pressure falls below aorta pressure resulting in closure of aortic valve but opening of bicuspid valve.
The ventricular volume starts to rise as more blood flow into it.
E
Ventricular pressure continues to fall below aortic pressure so that blood flows from the atrium to the ventricles. The volume of the ventricles rises rapidly.

F
The atrium is being filled with blood from pulmonary vein atrio-pressure exceeds the ventricular pressure so that blood flow atrium to the ventricle.
ELECTRO CARDIOGRAM
P wave corresponds to the wave of excitation spreading over citrium during atrial systole from the SAN to AVN. The Q & S complex wave corresponds to the wave of excitation spreading over ventricles during ventricular **systole.**
The T waves corresponds to ventricular dicistole or repolarisation.
PHONO CARDIAGRAM
The 1st and 2nd heart sounds are due to sound obsure of the atrio ventricular and aortic valve respectively.
Cardiac out-put
Is the amount of blood flowing from the heart over a period of time and it depends on the volume of blood pumped out of the heart at each beat.
Stake volume
Is the volume of blood expelled at each heart beat at a given period of time.
The heart rate
Is the number of heart beats per given minute.
C. out put = store volume x Heart rate
The graph below variation of stroke volume the cm^2/min verses cardiac out put.
BLOOD
Blood is a specialized fluid tissue that contains cellular and non cellular component buxxx in non liquid substance called plasma.
Components of blood
Blood is composed of very many components which include
Blood plasma. This is liquid part of blood in which other components are suspended, these include
Water. This forms 90% of plasma and it's a solvent in which other substances dissolve.
Dissolved products of digestion/food material: The include glucose, vitamins, amino acids etc are being transported from alimentary carnal to other parts, other products are dissolved excretory products eg urea from the liver to kidney for excretion, skin and lungs.
Mineral salts/ion such as sodium, k+, mg2+, cl- etc which are responsible for maintenance of pH in blood and its osmotic pressure, regulating muscles and nerve cells sensitivity and other effects on body cell eg calcium ions are required for blood clotting, hormones which are carried from glands to target organs.

Plasma proteins : which are produced in the liver and perform various function eg fibrinogen important in blood clotting, globulins involved in specific functions around the body, albumin which binds plasma calcium.
Respiratory gases eg carbondioxide and oxygen.
Cellular components of blood
Red blood cells (Euthrocytes)
These are small cell about 7-8 mm in diameter with a circular bi-concave disk shape and contain a red pigment called heamoglobin, they don't have a nucleus.
Surface view of a red blood cell
They are produced in the red-borne marrow by a process called haemopoiesis in a tissue called haemopietic tissue of short bones eg ribs, scapular, skill, vertebra, sternum and the peuris. In young individuals all bones contain harmopotetic tissue and manufacture red blood cell.
Blood contains about 5-6………….per/mm^3 of blood, old mature red blood cells are destroyed in the spleen and liver in the following ways.
The protein quotient of hemoglobin is broken down into amino acids
The rest of the pifment is broken into biliverdin and billrllbin which are temporally stored in gall blade to form bile pigment that is removed from the body when bile is released into the duodenum. The life span of red blood cell is about 90-120 days and is said to be short due to absence of nucleus.
Functions of Red blood cell
To transport oxygen and carbondioxide
WHITE BLOOD CELLS/LEUCOCYTES.
These are larger cells compared to red blood cells and certain nuclei. They are fewer than red blood cells for about 7000mm^{3}Hg of blood, they don't contain hemoglobin. Their cytoplasm is colourless.
Types of white blood cells
White blood cells are divided into two main groups depending on whether the cytoplasm is granular or not. These categories are;
Granulycytes.
These consists of granules in their cytoplasms that can be stained by acidic or alkaline dyes.
They are regular in shape and have lobbed nuclei
They are divided into three types
Neutrophils
These are most numerous of all red blood cells constituting about 70%.
They can be stained by acidic or alkaline dye
They have a multi lobbed nuclei
Functions
They destroy disease causing germs by phagocytosis.
Eosnophils.
This can be stained by red easin, they form about 1.1% of red blood cells but their number increases in an individual with allergic reactions eg **Athma** and also with response to parasitic affections, they help to control allergic reactions by secreting enzymes that inactive estimation.

They have abilobed nucleaus and can also be called aeidophil
A structure of Eosimophil
Basophils
These have a cytoplasm that is stained blue, they have an S shaped nuclei take about 0.5 % of the total red blood cell.
Function
It secretes large amount of histamine to deal with allergic reactions and heparin which is anti collaguler.
Agranucytes. These are white blood cells which don't contain granules, they are produced in leaf spleen and bone marrow. They include Lymphocytes and monocytes.
Monocytes. Are the largest of all white blood cells and form only 4% of the total white blood cells. They originated from bone marrow and stain 2-3 days before moving to tissues.
Function
Defend the body by phogocytosis, antibodies to boast the immune system
Structure of amonocyte
Lymphocytes. These are cells with spherical nuclei and have small cytoplasm, they make about 24% of the total leucocytes. They originated from bone marrow but migrate to lymph nodes, spleen and thymus where the mature from. They have a long spin of 10 years or more in humans.
Function
They also provide defence by boosting the immune system and turmor cell leilling
PLATE-LETS (THRONOBICYTES)
These are cell fragments formed from the cytoplasm of light bone marrow cells called mega carryocytes.
They don't have a nucleus
They are about 250,000mmHg of blood, they are colourless.
They are granular round oval or bi concave disk
They are colourless
Function
They participate in blood clotting
MAMMALIAN BLOOD CLOTTING
It is the formation of a mesh network of fibrin fibre around the damaged tissue to trap the damaged blood cells and hence prevent further loss of blood.
When a given part of body is damaged and platelets are exposed to air, they break up to produce a substance called thromboplastin that contains an enzymes catalyses the xxxxx of prothrombin-thrombin is presence of V+K and calcium ion.
The thrombin acts as an enzyme that converts or catalyses the conversion of plasma protein fibrinogen into the insoluble fibrous protein called fibrin. The fibrabin then forms a network of fibres and the wounded part to make the blood cell................of injury. The clotting then prevents further bleeding ad then it dries up it forms a scan that prevent bacterial infections.

Functions of the mammalian blood

Transport function

Transportation of waste products tissues to excretory organs.

Transportation of any product of digestion from alimentary canal to the liver.

Fatty acids and glycerol from alimentally lymphatic and then to general circulation.

Transportation of plasma protein from the live to general circulation

Transportation of respiratory gases ie oxygen from the lungs to tissues and carbondioxide from tissues to lungs.

Regulatory functions

Osmotic pressure of blood and tissue fluid is determined by plasma concentration of ions in plasma proteins. This then regulates water between blood and tissues.

Distribution of hormones to various parts of the body where they regulate physiological process.

It is through proteins, salts and blood that a suitable solvent is always provided by forming tissue.

They body temperature is regulated by distribution of heat from organism which produce excessive heat to other part of the body.

PH is maintained which is carried out by blood buffer system eg hydrogen carbonate and phosphate equilibrium and also by haemoglobin and plasma protein.

Defensive function of blood

Through blood clotting which prevents entry of disease causing germs through the damaged part of the body.

By phagocytosis where the white blood cells attack the disease causing germs by engulfing them.

By anti body production which destroy the disease causing germs in the body.

OXYGEN TRANSPORT

Oxygen is transported in blood by a pigment called haemoglobin that is present in red blood cells.

Adaptations of red blood cell to suit their physiological

They have a thin plasma membrane which allow easy diffusion of gases.

Lack nucleus to give more space for hemoglobin

Contain hemoglobin which high afinity for oxygen

It has a biconcave disk shape to increase surface for diffusion of gases and flexible.

They are very small to enable them pass through narrow lumen of blood vessels.

They are very numerous to increase surface area for diffusion of respiratory gases.

HAEMOGLOBIN

This is a complex protein containing for hemogrobin which are prothetic groups. A heam group is a pophym containing an iron ion a the centre, the haemo group is the part of the hemoglobin which is a site for oxygen transport each haem group have four polypeptide chains ie 2 x and 2B chains attached to it.

HEAM GROUP

CARRIAGE OF OXYGEN

In the lungs, oxygen diffuses into red blood cells and combines with haemoglobin to form oxyhaemolobin each of molecule of oxygen to form oxy-haemoglobin. In this form or state, oxygen is transported to the tissues where the oxy-haemoglobin de-sociated to release oxygen

$$Hb + 4O_2 \underset{\text{Tissue}}{\overset{\text{Lungs}}{\rightleftharpoons}} HbO_8$$

Haemoglobin oxy-haemoglobin

Oxygen diffus capillaries into the intercellular spaces where it dissolves in the tissue fluid. It then diffuses into the cells where it is used in aerobin reproduction.

NB:

When O_2 combines with in a haem-group

Iron 2 (Fe2) is not oxidized in the process since the combination is not chemical

Oxygen dissociation curve

This is a curve drown to show the activity of haemoglobin for oxygen. The results are obtained from an experiment where samples of blood are exposed to air containing different partial pressures of oxygen. The percentage circulation of each sample with blood is determines.

A graph or curve of oxygen circulation varying with partial pressure of the oxygen is ploted. The carve obtained is called oxygen dissociation curve.

The curve is sigmoid curve or S shaped the steep part of curve corresponds to the range of partial pressures with in the tissue, here a small fall of partial pressure of…..

The flat part it corresponds to partial pressure of lungs where haemoglobin remain saturated despite a small fall in oxygen partial pressures. In oxygen dissociation curve facilitates both the loading of haemoglobin with oxygen as well as unloading ie the flat part of the curve represents loading in lungs while the steep part represent unloading in the tissue.

The efficiency of taking up oxygen can be understood if a linear relation between % saturation of haemoglobin and partial pressure of oxygen (along the doted line) is considered at a partial pressure of about 6Kg. haemoglobin is 90% saturated with oxygen while for a linear relationship, it would be only be about 45% saturation.

The S-shape of dissociation curve is due to binding of oxygen to haemoglobin when one of the for polypeptide chain receives an oxygen molecule in the lungs, its structure alters or changes in a such a way that the remaining three polypeptide chains accept oxygen more easily in other wards haemoglobin takes up more oxygen more readily if it has taken up one and conversely releases it releases oxygen more rapidly if it has released one or more molecules. The transfer of oxygen to the tissues depends on the speed at which saturated haemoglobin dissociates when the partial pressure of the falls. The gexxx circulation of blood with oxygen is not always 100% because

Not all hemoglobin combines with oxygen at the respiratory surface.

The oxyhaemoglobin in most cases it releases its surface oxygen as fast as it picks it up

Effects of carbindioxide on oxygen dissociation curve

From the graph above the increase of CO2 partial pressure shifts the O2 dissociation curve down wards to the right and this is called Bohr's effect, CO2 leaves the affinity of hemoglobin for oxygen ie hemoglobin is less efficient at taking up oxygen but more efficient at releasing up oxygen especially at the tissues.

Under this condition the hemoglobin must be exposed to much partial pressure to become fully saturated but they equally releasing oxygen at high partial pressure. The release of oxygen in the tissue is favoured when or where the partial pressure of carbondioxide is naturally high in other wards the partial pressure of carbondioxide is low in the lungs or with continued release to atmosphere during exhalation and this conditions uptake of oxygen from the lungs.

NB: Bolm's effects is not necessary due to partial pressure of carbondioxide but its due to hydrogen ion resulting from its presence.

$CO_2(g) + H_2O(aq) \rightleftharpoons H_2CO_3(aq) \rightleftharpoons H^+(aq) + HCO_3(aq)$

The hydrogen ions formed than cause the dissociation of oxyhaemoglobin.

Physical significant of Bohr's effect…and the partial pressure of carbondioxide in the tissues increases. A high partial pressure of carbondioxide makes hemoglobin less efficient at taking up oxygen but more efficient at leasing it in oxygaemoglobin.

Effect of PH on oxygen dissociation curve.

As the PH increase the oxygen dissociation curve shifts down words to the right. This is because a decrease in PH has an effect of matching haemoglobin less efficient in taking up oxygen but more efficient in releasing it. The physiological significancy of this is that in the tissues carbondioxide is released from respiration and has it accumulates of oxyhaemoglobin and less uptake of oxygen by haemoglobin.

NB: The decrease in the PH of blood has the same effect as the increase of corbondioxide partial pressure on the oxygen.

Effect of temperature on the dissociation curve

These increase in temperature shifts the oxygen dissociation curve to the night and down wards. The significancy of this is that in the tissues due to metabolic heat is generated and this increases the temperature. Increased temperature makes haemoglobin less efficient at picking up oxygen reduces oxygen haemoglobin then dissociates to release oxygen to the respiring tissues for respiration.

NB: Ice fish in very cold regions of the world are the only vertebrates without haemoglobin however they obtain oxygen because at low temperature oxygen is more soluble in H2O their metabolic rate is low and hence their body demand for oxygen is also low.

Effect of size of organisms on oxygen dissociation curve.

The decrease in size of organisms displaces the oxygen dissociation curve to the right, the reason is that the smaller the size of organisms the larger the surface area to volume ratio. Such animals have high metabolic rate to generate enuf heat energy to maintain their constant body temperature. Their hemoglobin has high affinity for oxygen and releases it oxygen more readily so as to generate the required energy.

These animals like rat can there fore like in an environment high low oxygen tension since their hemoglobin gets saturated at very high oxygen tension. However big animals their hemoglobin gets saturated with oxygen at low oxygen tension and therefore have low metabolism.

Effects of environment on oxygen dissociation curve

Graph

The dissociation of the pigeon lies to the right to that of the human. The pigeon's hemoglobin has got low affinity of oxygen than that of human ie has high loading and unloading tensions, when the pigeon is fright, its muscles have high oxygen demand due to high metabolic rate, its hemoglobin can therefore easily lose oxygen in the tissues to cope up with high demand for oxygen.

The lung worm has dissociation curve to the left of the human. Its hemoglobin has a high finity for oxygen and not very active. It obtains its oxygen pumped into the buurduxx and their hemoglobin can easily lead oxygen and transport it to the tissues, this enables them to live in areas of low oxygen partial pressure.

Dissociation curve for material and foetal hemoglobin

Graph

The dissociation curve of the foetal hemoglobin lies on the left of that of the mother, this indicates that the foetal hemoglobin has high affinity than the mothers hemoglobin. The reason is that the foetal blood has the pick up oxygen from the mother's blood across the placenta. This is possible if hemoglobin has high affinity than that of the mother.

Other pigments in animals include; myoglobin chloronuonin, haemoerythnin, haemocyanin.

The dissociation curve of haemoglobin and that of hyoglobin.

Graph .

Myeglobin is a conjugated protein chemically semi to hemoglobin. It is particulally common in selectal muscle of mammals and bids responsible for the red colour of fresh or especially in all vertebrates.

Myoglobin has high affinity for oxygen than hemoglobin as seen from the dissociation curve due to this, mycglobin is able to act as oxygen store in muscle tissues and only releases oxygen when the supply of oxyhemoglobin has activities when the muscle cells results to un aerobic respiration when the oxygen……………

Effects of altitude on oxygen carrying capacity of blood.

Mammals living at a high altitude like ……….adopted to live in areas with low partial pressure of oxygen in atmosphere. They have high red blood cell court and high contruction of hemoglobin. Their hemoglobin has high affinity for oxygen and therefore their dissociation and shifts to the left than those which live in low altitude.

At higher altitude there is reduced atmospheric pressure which means that its more difficult to load hemoglobin with oxygen, some human settlement exists at higher altitude and the inhabitans have become acculamitised in the following ways.

1.Adjustment of blood PH, the reduced loading of hemoglobin leads to deeper breathing called hyper ventilation in an attempt to compensate for lack of oxygen in blood, this leads to excessive removals of carbondioxide and arise in blood PH, the nervours responses are triggered causing reduced depth of breathing xxxx in circumstances.

In accumulatised individual hydrogen carbonate ions can be removed from the kidney, hence restoring blood to the normal.

2.Increased oxygen up take by the lungs as a result of an improved capillary networks in lungs and deeper breathing.

3. Increased transport of oxygen to tissues, this is the result of

a) increased red blood cell concentration which rises from 45%-60% of the total blood volume.

Increased haemoglobin concentration in red blood cells by about 20%

4. Changes in haemoglobin affinity the oxygen dissociation curve…………release of oxygen to tissue.

5.Increased myoglobin concentration in muscles with its higher affinity for oxygen this facilitates exchange of oxygen from blood to the tissues.

TRANSPORT OF CARBONDIOXIDE

Carbondioxide is produced during respiration and it diffuses from the tissues into red blood cells where it combines with water to form carbonic acid. This is normally avery slow reaction in the red blood cell but it is greatly accelerated by the presence of an enzyme which also causes more carbondioxide to enter the red blood cell rather than remaining in blood plasma, the carbonic acid dissociates to form hydrogen ion and hydrogen carbonate ion. The hydrogen ions with acidity the cell and kill it out they are efficiently removed by haemoglobin itself when it combines with the ions to form hemoglonic acid (H.Hb)

The hydrogen carbonate ions ($HCO^-{}_3$) diffuses out of the cell into plasma, here they combine with Na+ from the dissociation of sodium chloride ($NaCl^-$) leading to formation of $NaHCO_3$. Since the cell membrane is permeable to negative ion but relatively impermeable to positive ions, the inside of RBC will acquire a net positive charge.

Chlorid ions (Cl^-) then move into the RBC to restore the electro neutrality of the cell and this movement is called **<u>chloride shift.</u>**

On reaching the lungs the high partial pressure of oxygen causes the reaction above to go in the reverse direction and oxygen is taken up by RBC while carbondioxide is released.

2.In comb

A diagram to show a summary of transport of carbondioxide in form of HCO3

2:Ass combined with hemoglobin. About 10% of CO2 combines with polypeptide chains of haemoglobin to form carbonic hemoglobin. On reaching the lungs the reverse reactions occurs to release carbondioxide and oxygen taken up.

3: In solution form. About 5% of CO2 dissolves in plasma to form carbonic acid which dissociates to form hydrogen ion and HCO_3^-, the plasma proteins carry out the buffering action of H+ to form weak proteinic acids.

Carbonmonoxide as a respiratory poison

Haemoglobin has greater affinity for carbondioxide than oxygen.

In the presence of carbonmonoxide in inhaled air haemoglobin combines with it at the site for binding with oxygen. Oxygen is therefore not taken up when carbonmonoxide is combined with hemoglobin a steady compound……………. That is carried to respirating tissues. These carbonmoxide on reaching tissues it damages them and the cells become deprived of O2 resulting in death from a condition called **asphyxia**.

LYMPHATIC SYSTEM

This is an alternative system in addition to blood circulatory system in mammals. It consists of a series of small vessels called lymphatics, lymph vessels and big vessles called lymph ducts. It drains tissue fluid from different parts of the body and diffects then into blood circulatory system before the blood enters the heart.

The lymph from different part of the body is direct into two major lymphatic ducts ie thoracic duct which opens into the left subdavian vein and the right lymph duct which opens into the right subclaviar vein.

Lymph is then drained into the circulatory system in the neck region, lymph from the right side of the head, neck, thorax and right arm collects in the right lymphatic duct. This drains into the right subdavian vein.

Lymph from the rest of the body ie legs, lactile, the intestines, left side of the head, left arms collects in the thorax duct thus collects into the left subordixxxx.

Functions of lymphatic system

It transports fatty acid absorbed in lactin of the villi to xxxx

It has lymph nodes on lymph lands which filters out pathogens, lymph joins the blood circulatory system.

The lymph nodes also produce lymphocytes which are added to the blood circulatory system to defend the body.

It acts as alternative route for excess tissue fluids and excretory products back to blood circulatory system.

It transports most of the hormones from the endocrine glands to blood stream

Diagram of lymphatic system

Functions

It drains tissue fluid from vessels and this hip to keep the pressure in the spaces between the tissue cells below that of the capillary in order to allow osmotic action to occur between blood and the cells.

The lymph forms a barrier in spaces between tissues of the injured part to prevent inflammation affecting the unaffected tissue close to the injured part.

Comparison between lymphatic system and abdomenxxx system

Similarities

Both contain vessels

Both transport materials

Both have vales to stop back flow of blood

Both contain white blood cells, water, salts

Both carry hormones

Lymphatic system	Blood circulatory system
Transport medium is lymph	Circulating medium is blood
Doesn't contain hemoglobin	Contain hemoglobin
Lymph moves in one direction to the heart	Blood circulated around the body ie from the heart and back
Contains any white blood cells	Contains both eurocytes and leucocyte

Contains lymph nodes	Does not contain lymph nodes
Contains fats, glucose and waste products	Contains less fats, more glucose proteins and waste products.
Valves are present through out the lymphatics	Valves are present in vein and at the base of pulmonary artery and aorta
There is no pumping organ	The heart is present as pumping organ
Lymph flows slowly	Blood flows faster
Contains more antibodies	Contains less antibodies

BODY IMMUNE SYSTEM
Immunity is the ability of the body to resist disease causing germs, it involves the recognisation of foreign materials and production of chemicals which help to destroy them. These chemicals are called antibodies and are produced by a group of WBC of two leinds, the T-lymphocytes which are found in the bone marrow but mature in thamus gland and the B-lymphocyte which are found and mature in bone marrow.
The antibodies, antigens, T and B cells
An antibody is a molecule that is produced by animal cell in response in presence of foreign material in body called antigens. East antibody is a protein molecule called an immune globulin its structure consists of the heavy chains (H-chain) and two light chains (L- chains the antibody has a content and veriable part acting some times like a key which fits into a lock, the Human body can produce a million of very many antibodies recorgans different tends of foreign substances including many the body has never met, it does this by shuffling different sections of parts of genes which produce different regions.
A structure of anti body molecule
An antigen; is a molecule which can cause antibody formation when it enters the body. All cells posses antigens int heir surface cell which acts as markers enabling the cell to recognize each other. Antigens are usually proteins or glycoptein ie proteins with carbohydrate fail, although almost any complex molecule can be antigenic. The body can distinguish between its own body antigen (self) from the foreign antigen (known self) and normally only makes the body against known cell antigens. Micro organisms carry antigens on their surface.

IMMUNE RESPONSES
An immune response is the production of antibodies………………represented by a specific anti body, there are two types of immunity that are developed by mammals ie
Self immediate immune response
Humoral-immune response. The two types involves development of two types of lymphocytes ie the T and B cells. Both types rise from presurson cells in the bone marrow the thamus gland is essential in the formation of T cells and hence the name, T-Cell.
The B cell de develop from bus, a branch of gut in birds and hence the name B cell.

Each type of the cells has the capacity to recognize millions of antigens that exists, when an antibody – antigen reaction occurs, it prevents in variaty of ways, the antigen or antibody possessing organ from acting upon the body in harmful way.
Cell mediated response
The T cells attack in the following ways
Cells that become infected by a micro organism, most commonly a virus.
Transparented organs and tissues
Concern causing cells
The whole cell is involved in the attack and this type of immunity is called cell immunated response. The T-cells don't release antigens.
Humoral response
B-cells release antibodies into blood plasma, tissue fluid and a lymph as the antibodies are released into the fluid and they attack on micro organisms takes place in the fluid, this type of immunity is called humoral (term humoral means fluid). The B-cells attack both bacteria and some viruses.
T-cells and cell-immediated response
The stem cells of the bone marrow which give it rise to T-cell pass through the tissue of thanus gland before they become fully function. Here they develop into cells called thamocytes. At this storage the cells that recognize self (body's own antigens) are destroyed so that the body does not attack itself later, some of the thermocyte mature into T-cell, they leave thamus gland into blood stream where some stay and others migrate to tissue fluid, lymph node and organs like the spleen.The cell surface membranes of T cell contains specific receptions with particular shapes similar to anti bodies. However these receptors don't recognize all the antigen like.They bind only to figments of antigens or other foreign molecules which are presented to them by other cells often microphages.The mature T cells possess a T molecule (T_4 cells) or aT_8 molecule (T_8 molecule) which gives them different function.The T4 cells are called helper cells eg the HIV virus which causs aids affects mainly T helper cells.There are two types of T helper cells
Supressor cells
Killer cells
Each type produces different types of lymphokynises which are small peptide molecules, the T4 cells then produce large amount of lymphokynies.
Which stimulates, T cells to multiply
Promote inflation
Stimulate B cell to produce antibodies
The killer cells produces smaller amount of lymphotines to kill which has become infected bu viruses. This is done by chemical attack by punching holes into the cell. The activities of all types of white blood cell in increased by lymphoteines which are secreted by supresor cell relative numbers of these two cells regulates the immune response.
The B cells and Humoral response
The action of B cells is simple and each B cell has a function to recognize a particular antigen and produce antibody that will bind to it.

The cell surface membrane which B cell contain an antigen receptor whose specific shape is similar to antibodies that can body make.
All receptors in one cell are identical so a given cell can maintain one type of antigen when it binds to an antigen the cell is activated to itself from different copies of itself. Activation requires presence of lympholeines secreted by cells as well as antigens.
Two types of B cell formed namely, memory cells and effector cells, these secrete a large lymph effector cells survice for few days while a memory cell stays for long time and enable rapid response to any future effection. Once an antibody has reacted with an antigen-baring destruction is brought about in a number of different ways, the most common is to identify antigen as a target fro action of phagocytes, phagocytes have receptors that bind to the tail of Y shaped tail. The memory cell one important if the 2nd infection of an antigen occurs the number of memory cell is much longer than the number of B cells from which they come, the response to 2nd infection is called secondary immune response which is much more rapid and is greater than primary response.
The primary response may not be rapid enuf to prevent the person suffering from an infection but if the person survives, he/she will realy suffer again from the same infection because of the greater secondary response with each exposure the response gets more infection. This is a basis of vaccination or immunization.
The graph showing primary and secondary responses to the initial and later doses of agents
Explanation for graph days
During the first exposure called the primary response a single B cell, specific for the measles virus is activated, which divides repeatedly to give a dore of cells which can produce identical antibodies against measles, virus, since a single B cell is activated during the primary response, the antibody title is low and increases gradually to a lower peak.
Some of the B cells produced during the first exposure become memory cells on 2nd to produce a large population of B cells. Each B cell is capable of forming a done of other B cells that can produce a very high conservation of antibodies/high antibody titre, hence the 2nd exposure it measles virus produces a higher concentration of antibodies rapidly to attain a high peak because it starts with a single B cell but with a large number of memory cells.
WAYS OF PROTECTING THE BODY AGAINST PATHOGENS
Secretion of tears by tear glands
Tears contain lysosomes which produces lytic enzymes to prevent eye infection, saliva contains lysosome also produce lytic enxyme to destroy bacteria in the mouth that would have entered with food and drinks.
Alimentary canal contains HCL t kill bacteria that would have entered with food.
Respiratory tract is lined with mucus and cilia to prevent foreign particles from reaching the lungs.
By phagocytosis, this is done by a group of WBC called phagocytes. This engulf the disease causing germs and destroy them.

Types antibody-antigen interaction (ways by which antibodies perform their functions).

Agglutination The antibody has two different binding sites that joins to two antigen on two different pathogens in these way the pathogens can be making them able to attack more volummate other types of anxxx.

Pericipitation This is done by antibodies called pericipitants ie these cause aggregation of many antigen molecules farming a pericipitate an insoluble clump which can be engulfed by phagocytes.

Neutralisation. This is done by anti taxins which are soluble antibodies, they render the soluble antigens so that they can be safely excreted. In doing so neutralize their harmful effects.

Due to the action of enxymes produced by antibodies antibodies called lysen lock up into the antigen in the protective wall of capsule surrounding the morguns causing distengration by digesting its wall.

Opsonis. This is absorbed from the surface of the bacteria making it easy for the pragocytes to engulf it.

TYPES OF IMMUNITY AND IMMUNIZATION

There are two basic types of immunity namely

Passive immunity

Active immunity. These two are further divided into two others

Active immunity

This is the type of immunity that is initiated with in the body an exposure to an effectious agent.

Types of active immunity

Natural immunity is divided

Natural active immunity

Artificial active immunity

Natural active immunity

This is a type of immunity which is obtained as a result of an infection when a body manufactures its own antibody an exposure to an infection, on due to the memory cells produced on exposure to 1st infection, they are able to produce to massive of antibody when exposed to some antigen again, this type of immunity is most effective and generally persist for long.

Artificial active immunity (immunization)

This is a type of immunity that is acquired by injection or oral administration, small quantities of antigen called vaccine into the body of an individual in the process called immunization/vaccine. The germs or organisms used are first weakened or attenuated before the vaccine is introduced into the body, when introduced ion body the antigen stimulates the body to manufacture antibodies against it often a second boaster insect is given and this will stimulate a much quicker production of antibody which is long lasting.

Several types of vaccine are used eg to toxoid which contain tetnus and diphtheria bacteria

Liver vaccines

Leilled organisms eg leilled bacteria eg flue vaccines

Antinurated bacteria for TB, German measles, Polio etc
Small pox vaccine which contain live vaccine
Chlorella vaccine
PASSIVE IMMUNITY
This is a type of immunity in which antibodies from one individual are passed to another person and they give immediate protection against disease infection.
Types of passive immunity
Natural passive
This is a type of passive immunity that is acquired naturally eg antibodies from the mother can pass through placenta and enter the foetus. In this way they provide protection to the body until its own immune system is fully function.
Passive immunity can also pass through breat and the baby absorbs the antibodies through its gut.
Antifical passive immunity
This is where antibodies that have been formed from one individual are …………may or may not be the same species, the antibodies injected provide immediate protection if the person is likely to be exposed to disease eg specific antibodies used to control tetanus and deptheria and are obtained from horses and injected into humans.
Antibodies against rabbies and some snake venoms are also available.
Antibodies against humus rhesus are used for some rhesus which mothers when
THE RHESUS FACTOR
The rhesus factor of the total population 85% possess red cells containing an antigen called the rhesus factor and are termed rhesus positive. The remainder of the population lack the rhesus antigen and are therefore described as rhesus negative antibodies in its plasma. However if rhesus positive blood enters a rhesus negative individual the recipient respond by manufacturing rhesus antibodies.
The practical importance of this is made obvious when a rhesus negative mother bears a rhesus positive child. The rhesus factor is inherited (Rhesus positive is dominant and rhesus negative recessive). During the later stages of the pregnancy, fragmers of the rhesus positive red blood cell of the fetus may enter the mother's circulation and cause the mother to produce rhesus antibodies, these can pass a cross the placenta to the fetus and destroy feto red cells.
Normally the antibodies are not formed in large enuf quantities to affect the first born child, however, subsequent rhesus taxe children can suffer destruction of their red blood cells. A rhesus body is usually premature anaemic and Jaudieced and its blood needs to be completely replaced by a transfusion of healthy blood. The condition is known as harmolyytic disease of the new born.
It can be fatal especially if the baby is born premature as often happens. Although a blood transfusion can now be undertaken with the baby is still in the womb with modern screening methods the problem can be avoided as explained.
Protection against the rhesus reaction
If an intravenous injection of anti rhesus antibodies called anti-D is given to a rhesus negative mother with in 72 hrs of her giving birth, sensitization of the rhesus –ve mother by rhesus –ve fetal cells is prevented.

The anti-rhesus antibodies attach themselves to the rhesus antigens on the fetal cells which are in the mother's circulation and prevent them from being recognized by the mother's antibody forming cells. Hence the antibody process prevention obviously depends on careful screening of all pregnant women. Testing blood groups is part of antenatal care in the UK.
If a rhesus –ve mother of blood group O is carrying a rhesus +ve child of any blood group other than O, the problem will not arise. This is because if fetal cells enter the mothers circulation the mothers A and B antibodies will destroy the blood cells before the mother has time to manufacture anti rhesus antibodies.
BLOOD GROUPS SYSTEM
When a patient receives a blood transfusion it is vital that they receive blood that is compatible with their own. If it is incompatible, a type of immune response occurs. This is because the donor's red cells membranes possess gycoproteins (known as agglutinoges) which act as antigens and react with antibodies (agglutinins) in the recipients plasma. The result is that the donor's cells are agglutinated in other words, the cells link or attach to each other when the entity on their surface interact with the antibodies. Two antigens on A and B, the complxxx plasma all the time, they are not produced in response to the donor's antigen as is the case in the immune reactions already studies. A person with a specific antigen in the red cells does not possess the corresponding antibody in the plasma for example, any one with antigen A in the red cell membranes has no antibody A in the plasma and is classified as having blood group A. if only B antigens are present the blood group will be AB, if both antigens are present the blood group is O.
When transfusion occurs it is important to know what will happen to the cell of the donor. If there is a likelihood of them being agglutinated by the recipient's plasma antibodies then transfer should not take place.
Individuals with blood group O are termed universal body donors because their blood can be given to people with other blood groups. It possess cells which will not be aggluminated by the recipients plasma antibodies. Although group O possess a and b antibodies.

Blood group	O	A	B	AB
Antigen	-	A	B	A+B
Antibody	a+b	b	a	-

4.CHEMICALS OF LIFE: BIOCHEMISTRY.
This is the study of chemicals of life which are important in biochemical processes.Chemicals of life include: Simple molecules such as; carbon dioxide, water and oxygen. Water is an important solvent, medium of Biochemical reactions, coolant making the body cool in hot weather e.t.c.Carbon dioxide is a key molecule in photosynthesis, a process by which plants make food consumed by both plants and animals. Oxygen is used during soil respiration to release energy to run Biochemical reactions in the body. Chemicals of life may include: complex organic molecules e.g. proteins, lipids, carbohydrates, vitamins, nucleic acid e.t.c.
Water as an important chemical of life:
water.It has many properties which make it an excellent chemical of life.

Solvent properties;
Water is a solvent for polar and ionic substances such as sodium chloride. This is possible because the water molecule is polar.In aqueous solution the sodium in chloride have become surrounded by a shell of water molecule. The separation of sodium ions (Na^+) from the chloride ion (Cl^-) enables sodium ions to perform their Biological role in nerve impulse transmission whereas the chloride ion is used as an activator of enzyme amylase.
Freezing properties:
When liquid water freezes to form ice the density is lowered and ice floats on the surface of the liquid water. This is used during winter when only the surface of the water body is frozen but underneath water is a liquid and can support aquatic life.The ice layer on top acts as an insulator preventing heat loss from the water below keeping the water warm to support life.
Heat capacity of water:
The specific heat capacity of water is defined as the heat required to raise one gram of water by 1^0c. This amount heat is $4200Jg^{-1}\ k^{-1}$. The high specific heat capacity ensures that the water temperature does not vary significantly and the temperature of the protoplasm remains constant despite changes in the environmental temperature.This ensures that enzyme controlled reactions can proceed in aqueous medium with minimum temperature variations.
High heat of vaporisation :
Heat of vaporisation is the heat given out when a liquid is converted into vapour. A lot of heat is given out in converting liquid water into vapour. This is important in evaporative cooling. On a hot day when sweat is converted into vapour it goes along with a lot of heat from the body and in the process the body is cooled
High cohesive forces:
Because of the polar nature of water molecules they attract one another via strong cohesive forces called hydrogen bonds. The strong cohesive forces maintain the water molecule together and this is important during transpiration where the stream of water is unbroken during transpiration pull.
Water is incompressible;
This is important in locomotion and support in organisms with hydrostatic skeleton. When you apply pressure to water, it can not be compressed therefore these soft boded animals have fluid filled cavity (coelom) over which muscles press creating hydrostatic pressure forcing the fluid back wards but giving the animals forward push.

Complex organic molecules:
1. carbohydrates;
These are complex organic compounds containing the elements carbon, hydrogen and oxygen with the general formula $C(H_2O)_y$ hence the name hydrates of carbonThey are made up of many hydroxyl groups so they are defined as Poly hydroxyl organic compounds. Carbohydrates are divided into monosaccharides, disaccharides and polysaccharides depending on the number of sugar units making up carbohydrate.

monosaccharides:

These are single sugar units with a general formula $(CH_2O)_n$ where n is a variable whole number ranging from 3 – 7. if n is 3, the sugar is triose ($C_3H_6O_3$). If n is 4, the sugar is tetrose ($C_4H_8O_4$). If n is 5, the sugar is apentose ($C_5H_{10}O_5$). If n is 6, the sugar is hexose. If n is 7, the sugar is heptose ($C_7H_{14}O_7$).However the most common are trioses, pentoses and hexoses. Monosacchraides belong to two groups of organic compounds. i.e. aldare and ketose. Considering the trioses, there are two isomeric forms; an aldose and another aketose sugar.

Diagram:

Pentoses also exist in two isomeric forms; ketose and another one an aldose.

Diagram:

The most common pentoses are ribose (aldose) and ribulose (ketose). Ribose sugar is important in building up the nucleic acids, DNA and RNA whereas ribulose act as acarbondioxide acceptor in photosynthesis.

Diagram:

Pentose sugars form five sided rings.

Hexases have two isomeric forms also i.e. the ketose and aldose. In addition to the straight chouns, they form 6 sided rings.Hexases include galactose, fructose.

Glucose exists in 2- structural isomeric forms named as 3- glucose and 2 - glucose. They are isomers with the same molecular formula but differ in the structural arrangement of some atoms or groups of atoms for 2- glucose, the oH group at carbon number 1 projects below the ring while for - glucose, it projects above ring.

2 – glucose is the building block for the polynsacharides;starch and glycogen while - glucose is the building block for the polyssacharide cellulose. Starch and glycogen are strong carhydrates which are folded making them compact to take up small space in the cells storing them. Cellulose is a structural polyssachride making up the plant cell walls and cellulose fibres are straight.These differences are brought about by the difference in the building blocks.

importance of monossacharides:

Ribose sugar which is a pentose is a building block for nucleic acids, DNA and RNA.

Ribulose also a pentose acts as carbon dioxide acceptor in the dark stage of photosynthesis.
Hexoses like fructose and glucose are used as fuesl i.e they are respires to release energy.
Hexoses like 2 – glucose and B – glucose are building blocks for polyssacharides i.e. starch, glycogen and cellulose.

Dissacharides:
These are made from two monosacchride sugar units usually hexoses combined bymeans of a chemical reaction called condension involving loss of a water molecule.

The backward reaction is called hydrolysis and involves condition of a water molucle to the dissacharide formed to break it down into units monossachrides. The linkage or bond between the two monosaccharide units is called a gylcosidic bond and is formed between C_1 and C_4 of the adjacent monossacharide units forming the 1 – 4 carbon linkages.

Examples of the dissacharides include; maltose (malt sugar) built from 2 - glucose units, sucrose (cane sugar) built form glucose and fructose and lactose (milk sugar) built from glucose and galactose. Dissacharides are sweet; some are crystalline and are soluble in water.

(d)POLYSACCHARIDES:
Polysaccharides function as food and energy stores e.g. starch in the body of plants, arthropods and some bacteria such polysaccharides are called structural polysaccharides e.g. cellulose makes up the plant cell walls, chitin is a component of the exoskeleton of arthrodes while mureins si a strengthening polysaccharide in the cell walls of the bacterium.

Formation of a polysaccharide:
They are formed by continous polymerisation of monosaccharides like - glucose for starch and glycogen or beta – glucose for cellulose with loss of water molecules in a reaction called condensation reaction. The result is a long chain of glucose residues.

Polysaccharides include;

(i) starch:
This is a polymer of - glucose and is the storage substance in plants but absent in animals. Starch may be amylase or amylopectin. It is amylase when it is made up of - glucose residues in a straight chain having only 1 – 4 carbon linkages.
It is amylopectin when it has branches along the 1 – 6 linkages in addition to the straight chain.

(ii) Glycogen:
This is made up of many - glucose residues. It is very similar in structure to amylopectin but has more branching. Both glycogen and amulopectin have more glucose residues than amylase and because of the branching, they are compact taking up little space in cells storing them.
(iii) Cellulose:
This is the most abundant organic compound on earth built from - glucose and makes upthe cell walls of plant cells. It is a polymer of - glucose and is formed by condensation reaction with establishment of glycosidic bonds when two molecules of - glucose line up, the OH group on C_1 can only lie alongside the OH of C_4 if one of them is rotated through an angle of 180^0 along its horizontal axis. Rotation is repeated for every glucose molecule after the other and cellular have different structure x – tics.

Rotation of the glucose residue is important in the
The rotation OH groups at C6 to project on opposite sides of the chain bonding creating cross linkages. The association of many cellulose chains forms cellulose fibres as in sisal and cotton. This increases the strength of cellulose cell walls. Because the OH groups at C6 in starch project on only in side, there are no cross linkages but the chain folds around itself

Structure of starch and glycogen related to their role:
Starch and glycogen are storage polysaccharides. Starch is stored in plant cells while glycogen is stored in animal cells. A perfect storage substance must have some x-tics including;
(i) They have a high formula weight making them insoluble in gaseous solution so they don't exert any osmotic influence in cells sto
(ii)They are made up of many glucose residues such that when hydrolyred to release back the glucose molecules and the glucose respire a lot of energy inform of ATP is produced.
(iii)Their glucose dic bonds can easily be broken by enzymes such as amylase release the monosoccharide unites which are repired to release energy.

Structure of cellulose related to function:
Cellulose is a structural polysaccharide making up the plant cell walls.
a) It is made up of - glucose residues whose 1 – 4 carbon linkages make cellulose chains straight making them suitable to make up the cell walls which are straight.
b) The OH groups on C_6 project on either side of the chain such that chains associate with each other though hydrogen bonding providing extra strength.
c) The chains associate in groups forming cellulose fibres with high strength contributing to rigidity of the cell wall.

Lipids;
Lipids are fats and fat-like substances such as oils, waxes and steroids. They contain the elements of carbon hydrogen and O_2 although they have less O_2 compared to $C(H_2O)_n$. There are 3 groups of lipids;
(a) True fats / natural fats;
These are the triglycerides consisting of 3 molecules of fatty acids and 1 molecule of glycerol formed through a condensation reaction involving loss of 3 water molecules with establishment of enter bond.
Glycerol + 3 fatty acids Triglyceride

There are two types of fatty acids
1. Saturated fatty acids.
These have their carbon atoms within the chain having at list 2 hydrogen atoms attached with no multiple bonds. Such fatty acids are solids at room temperature are used to build up the fats. They have negatively high melting point.
2. Un saturated fatty acids:
These have their carbon atoms with the chain connected to multiple bonds with some carbon atoms having less than 2 hydrogen atoms. They are liquids at room temperature and are found mainly in plants. They are used to build up oils and they have a low melting point.
Phospholipids:
These make up part of the cell membrane and therefore they play structural role. They have a phosphoric acid residue attached in the place of the third fatty acid.
Glycolipids:
These are associations of lipids with carbohydrates. They are found in the cell membrane where they play a structural role.
Functions of lipids in living things.
They form both structural and physiological roles.

(i) Structural roles:
Phosphal lipids and glyolipids are components of the cell membrane.
Fats make up the sub continuous layer of the skin.
They make up the waxy cuticle of the insects where they minimise water loses.
They make up the waxy cuticle of the plant leaves.
Physiological roles:
When respired, they provide energy to run biochemical reactions in the cells.
Under the skin , they insulate the body against heat loss
When respired, they release metabolic water which is used in biochemical.
Properties of lipids as storage food substances.
They are compact taking up small space in cells storing them.
They are insoluble in water so they do not contribute to osmosis cells storing them.
They have a high caloric value i.e. yield a lot of energy when respired.
They are light reducing on the weight of the animal storing them.
They are easily hydrolysed when needed for respiration.
Proteins.
Proteins contain the elements carbon, hydrogen, oxygen, nitrogen and sulphur and some times phosphorus. They are large molecular composed of 20 commonly occurring amino acids An amino acid is made up of an amino group which is basic in character

Where R may be hydrogen or an group.Amino acid may be essential or non essential. Essential amino acids are those that can not be made by the body and are provided from the diet. Non essential amino acids are linked together by a peptide bond. If to amino acid combine, they form a lipeptide with loss of a water molecule in a conversation reaction. Continuous addition of amino acids forms polypeptide. Continuous condensation reactions results into of along chain of amino acids forming a polypeptides

Bonds in protiens
1. Ionic bond;
Amino acids have basic and acid properties hence they are amphoteric in very acid solutions, the amino group of the amino acid becomes positively a larged giving the amino acid anet change of +1

In very alkaline solutions, the carboxylic acid group becomes negatively charged acquiring a net charge -1.In a neutral medium, both acidic and basic terminals become charged giving anphions with anet charge of 0. In aqueous solution the ionic bond sare very weed and can easily be broken by changes of PH or adding asalt solution to the protein. This explains the disruptive effect changes in PH as on the protein structure for example addition of an acid to the milk protein caseinogens makes it curdle because the ionic bonds that were maintaing the structure are being broken causing insolubility of protein.

2. Peptide covalent bond:

This is formed by condensation are between amino acids forming the polypepide.

This is a very strong covalent bond and it is rarely broken by changes in PH but can easily be broken by excessive temperature.

3. Disulphide linkages:

Some amino acids contain third group (SH) in their chains. Two chains of polypepitioles they get linked to each other by disulphide due to loss of hydrogen atoms or the same chain of amino acid may fold due to disulphide linkages.

The disulphide linkages are stronger than ionic bonds but weaker than the peptide bonds.these bonds maintain the giobular shape of enzymes and proteins hormones but they are easily broken by excessive heat making the chains to unfold and the enzyme is to be denatured.

4. Hydrogen bonds.

These occur between the hydrogen atom of the amino group and the oxygen atom of the carboxyl group .These bonds are weak and can easily broken by excessive heat .

Classes of proteins.

Biochemistis classified proteins into for levels of organisation ie primary, secondary, tertiary and quaternary**.**

(a) Primary structure.

This is linear sequency of amino acids forming long polypeptide chain s .

The only form of bonding is the peptide covalent bonds eg the fibrous proteins making up musile tissue.

(b) Secondary structure.

This involves testing of the polypeptide around itself. In addition to the peptide bond, the conic, hydrogen and disulphide linkages maintain the twisting.

(c)Tertiary structure:

This is formed by folding of the chain maintained by mainly disulphide linkages. This gives the globular structure of the protein as in enzymes and hormones.

(d) Quaternary structure:
Two or more polypeptide chains associated with one another and with anon- protein component called a prosthetic group.For example in haemoglobin, there are 2 …….polypeptides chain. Folding around each other and associating with Fe.
They are maintained by all the four types of bonds in proteins.
Properties of proteins:
1. Colloidal nature.
All proteins in living cells are colloidal because of their high formula mass which makes them insoluble in solution. Proteins exist in phase system in which the solid particles of the protein are suspended in the aqueous medium.
2. Amphoteric nature:
Proteins are made from amino acids with both acidic and basic properties hence amphoteric and can dissolve in both acids and bases
Proteins in electrolytes:
In aqueous medium amino acids exist as amphions with positive and negative charges therefore they can conduct an electric current in solution form.
specificity:
Proteins such as enzymes are highly specific in their mode of action because they have specific shape of the centre and can work only on a particular substrate.
5. Denaturation:
This is the loss of the specific shape of the protein molecule. The change may be temporary or permanent but the sequence of amino acids remains unchanged because the strong peptide covalent bonds are not easily broken. If denaturation occurs the molecule unfolds and the protein can no longer perform its biological roles.The agents which cause denaturation include; heat/radiations, changes in PH, presences of heavy metals, presences of salts.
(a)Heat/Radiations:
An increase in temperature increases the kinetic energy of the protein molecules making its atoms to vibrate. When the vibrations become to vigorous, the bonds such as ionic, hydrogen, sulphide linkages break and the protein molecule unfolds spontaneously losing its shape.
(b)Strong acids, alkalis and salt solutions:
Here ionic bonds are disrupted and the proteins coagulated. Spontaneously the protein molecule unfolds losing its shape. The peptide bonds are rarely broken by changes in PH but if the protein is allowed to remain mixed within acid of base, the peptide bonds can also be broken.
(c)Ions of heavy metals such as $Pb^{2+,}$ Hg^{+} e.t.c
This disrupts the ionic bonds by forming strong bonds with negatively charged terminal of the amphions. This reduces the polarity of the protein and becomes insoluble in water.
(6) Renaturation.
This is the spontaneous re folding of the denatured protein molecule into its original shape provided conditions become favourable. Removal of the denaturing agent may cause renaturation.
(7) Hydrolysis:

Proteins under go hydrolysis and complete hydrolysis yield amino acids. This is done by enzymes that break down peptide bonds called peptidases.

Types of proteins: There are three major types;

(a) Fibrous proteins:

These are made up of many long chains of amino acids running parallel to one another linked by cross bridges of hydrogen, conic or disulphide linkages.This makes fibrous proteins very stable and can perform a structural role in the body.

They make up muscle fibres which are composed of the proteins acting and myosin, collagen fibres made up of the protein collagen yellow elastic fibres made up of the protein elastic, spindle fibres made up of the protein tubulin.

(b)Globular proteins:

In globular proteins, the polypeptide shown fold forming a globular shape maintained by disulphide linkages in addition to the conic and hydrogen bonds. They are very insoluble compared to the fibrous proteins.Examples includes: enzymes, hormones, channel proteins in the cell membrane e.t.c Because they are unstable, they are readily denatured by increase temperature or changes in PH.They play a physiological role in the body e.g. enzymes acts as Bio-catalyst, hormones as informational molecules, channel proteins as career proteins changing materials across the cell membrane.

(c) Conjugated proteins:

These are proteins which associate with other chemicals in their structure These chemicals are non-protein in nature but important in the functioning of the protein e.g. glycoproteins of proteins and CH2O5 and they are casein-protein + phosphoric acid.

Examples:

Important as recognition sites in the cell membrane. Recognition of the cells is important in tissue formation. Other examples include; lipo proteins which are association of lipids and proteins which are associations of nucleic acids with proteins. Sometimes proteins associate with metal atoms or inorganic compounds e.g haemoglobin is an association of a protein with iron and casein (milk proteins) is an association of phosphoric acid with a protein.

Functions of proteins:

Proteins perform structural, physiological and storage roles

(a) structural roles:

Actin and myosin are structural proteins present in muscle tissue.

Proteins make up a layer of the cell membrane.

Needed for muscle contraction e.g actin and myosin.

It gives structural support to the bones e.g ossein.

It gives strength with flexibility in tendons and cartilage e.g collagen.

It gives strength with elasticity to ligaments e.g elastin.

It gives protection to other parts of the body in form of scales, claws, nails, hooves, skin e.g keratin.

Provides strength to insect exoskeleton e.g sclerotin.

(b) Physiological roles:

Globular proteins like hormones act as informational molecules.

Haemoglobin and myoglobin carry respiratory gases around the body.
Some proteins in the cell membrane are known as career proteins and are involved in exchange of materials across the cell membrane either by diffusion or active transport.
Proteins receptors such as the cones and rods in the eye are useful in perception of light.
In blood clotting e.g prothrombin/ fibrinogen.
It keeps the respiratory surface moist e.g mucin.
In defence of the body aginst diseases e.g antibodies.
In arrangement of chlorophyll molecules in position to receive maximum sunlight e.g fibrous protein in the granal lamella.
In digestion of food material e.g trypsin catalyses thse hydrolysis of proteins to polypeptides, amylase catalyses the hydrolysis of starch to maltose and lipase catalyses the hydrolysis of fats to fatty acids and glycerol.
Control of blood pressure e.g vasopressin hormone.
Plant pigments in controlling flowering , germination e.g phytochromes;
It induces milk production in mammals e.g prolactin hormone.
It forms horns and antlers for sexual display during court ship e.g keratin
(c) Storage roles:
Casein is a storage protein in milk.
Ovalbumen is a storage protein in egg albumen.
Storage of oxygen in muscles e.g myoglobin.
Strorage form of proteins in seeds.
vitamins:
Vitamins are a range of substances necessary for good healthy.They affect a variety of body functions and if lacking, they result into deficiency systems.Vitamins are required in small quantities.Some vitamins are soluble in fats while others are water soluble.Fat soluble vitamins are absorbed from the gut when dissolved in lipids.They can be stored in the liver and need not to be consumed regularly.Water soluble vitamins are absorbed from readily excreted in urine and sweat and most there be consumed regularly.
(a) Fat soluble vitamins:
(i)Vitamin A:
Made from the plant pigment B- carotene therefore; it is found abundant in carrots which store that pigment. It is needed in the synthesis of visual pigment found in rods called Rhodopsin.Rods are useful to see at night since rod can not function without rhodopsin, one is unable to see objects clearly at night a condition called night blindness.
(ii) vitamin D:
It is made by the action of U.C light of the skin.The vitamin stimulate absorption of calcium from the gut .Deficiency of the vitamin causes farlure of calcium ion absorption but increasing its loss from the body.Calcium ions are important in normal bone development and lack of the vitamin D, cause poor bone development and malfunition of the skeleton, a condition called rickets which occurs in children.
(iii)vitamin E:

The function is not very dear in humans but thought to be concerned with muscle development since its deficiency results in degeneration of muscle tissue.In rats, the vitamin is called a fertility vitamin and its deficiency causes sterility. It can be obtained by eating the live or spleen.

(iv)Vitamin K.

Necessary during blood clotting during when vitamin k together with calcium ions convert the inactive prothrombin to the active thrombin which later convert the soluble plasma protein fibrinogen to the insoluble fibrin.Fibin forms a net work of fibres which entangle red blood cells around the area which has been damaged preventing further blood clotting. Deficiency of the vitamin results into delayed blood clotting.It can be obtained by eating the liver.

(b)Water soluble vitamins:

(i)vitamin B.

This is a complex of several vitamins most of which are components of co-enzymes.

(ii)vitamin B_1(Thiamine)

This part of the co-enzyme I cellular respiration. It is important in the normal function of the nervous system. Deficiency results into nervous disorderscalledBeriberi x-tirised by paralysis and heart failure. It can be obtained ffrom the liver, legumes, yeast, wheat and rice.

(iii)Vitamin B_2 (Ribo flavin);

This part of the co-enzyme FAD and is a hydrogen acceptor in cellular respiration.

(iv)Vitamin B_{12} (Nicotinic acid):

This is part of the co-enzyme NADP and acts as a hydrogen acceptor in respiration.Deficiency cause nervous disorders and general body weakness.

(v)vitamin C:

This is obtained from citrus fruits e.g. lemons, oranges and is important for the normal development of the gum.Deficiency results into bleeding of gums acondition called survy.The vitamin is very unstable at high temperatures and is readily altered or destroyed by excessively high temperatures. Therefore fruits having vitamin C should be eaten fresh of unboiled.

Inorganic nutrients:

These participate in a wide variety of body functions and essential for the normal function of the body such that when lacking in the deity, results into deficiency symptoms.Some minerals are called macro-nutrients which are needed in small quantities.However both macro and micro-nutrients one can take in large amounts, they exert toxic effects.

(a)Macro – nutrients:

(i) Sodium ions (Na^+)

These are the most abundant cations in plasma and tissue fluid. They are very important in nerve impulse transmission.

(ii)Potassium ions, K^+

These are the most abundant cations in the cell cytoplasm and lia sodium ions, are involved in nerve impulse transmission. Both of those ions can be obtained from table salt which is mainly with some little RCL.

(iii) Calcuim and phoshorus:
These are the main componets of bone and teeth. Calcium is also required in muscle contraction, nerve impulse transmission and blood clotting. They can be obtained by eating the egg white, cartilage and bone.
(b)Trace/micro-elements:
(i) Iodine:
This is a compound of a hormone thyroxine important in regulating basal metabolic rate (BMR).This is the metabolic activity thatoccur in the body at rest. The hormone thyroxine is made by the thrioid gland located around the neck region.Lack of Iodine in the diety causes the gland to develop many and larger cells that can take up the little iodine available.This result into swelling in the neck region called simple goitre.Too much iodine is toxic and will stimulate the thyroid gland to divide repeatedly so as to remove all the iodine from the blood stream.The result is enlargement of the thyroid gland again accompanied by protrusion of eyes;Because of too much iodine, a lot of hormone thyroxin is made which raises B.M.R beyond normal and vitamin becomes over active.
(ii)Iron, Fe:
This is a component of haemoglobin and myoglobin which are oxygen carrying pigments.These are components of the Red Blood Cells (RBCs) and lack of iron in the diety reduceses the number of Red Blood Cells per unit volume resulting into anaemia Fe can be obtained by eating green vegetables.
(ii) Zinc, zn:
This is activator enzymes including carbon anhydrase.This enzyme catalyses the combination of CO_2 and H_2O forming a weak carbonic acid during CO2 transprt.

$CO_2 + H_2O \rightleftharpoons H_2CO_3$

(iii) Copper, Cu:
Used as a prosthetic group in the enzyme cytochrome oxidase important in respiration.

ENZYMES:
Enzymes are complex 3-dimensional globular proteins that control the rate of biochemical reactions without themselves being used up in the reaction.Enzymes may control reactions within cells in which they are made.These are called intra-cellullar enzymes. Others control excess outside the cells from which they are made.These are called extracellular enzymes e.g. all enzymes of the digesive system.Enzymes are made up of a specific region having a specific shape of configuration called the active site.It is at the active site where the occurs

Enzymes and activation energy:
Biochemical, like ordinary chemical are limited by an energy barrier called activation.It's the minimum amount of energy reactant molecules need to over come if they are to form products.Reaction of molecules must possess the same amount of energy if they are to over come the active energy.An enzyme works by lowering activation energy such that many reactant molecules can overcome it with

minimum amount of energy.The same amounts of products are made in presence of an enzyme as in its absence only within a shorter time.

Mode of action of enzymes:
Enzyme work by forming enzyme substrate complex. This is made possible because the enzyme has aspecific site called the active site where the substrate can fit. When the enzyme approaches the substrate, they interact briefly and approach each other with minimum amount of energy called activation energy.Usually the enzyme lowers the activation energy such that many substrates can be transformed into products.When they approach each other, the bonds within the substrates lengthen and become weaker, so can easily be broken to form products.There are two mechanism enzymes employ in controlling biochemical path ways.

Lock and key mechanism.
According to the lock and key hyponthesis, an enzyme is a three dimentional organic molecule which is capable of binding substrate molecules, there by speeding up their rate of reaction.In its structure, an enzyme has athree portion whose configuration can only allow binding of substrate with specific compartible conformational structure. These are called **active sites.** Asubstrate bwith a complementary configuration binds to the active site of an enzyme to form the enzyme-substrate complex, just in a similar way a key fits in a lock.
In this position, bonds and other reacting components of the substrate are brought closer to one another and react to form the enzyme- product complex.
The configuration of the product becomes incompatible with that of the active site of the enzyme and the product is released from the enzyme. This leaves the enzyme free to combine with more substrates molecules.
Control of enzyme action;
Bio-chemical path ways involve a number of linked reactions each catalysed by a specific enzyme. In some cases accumulation of one poduct formed near or at the end of the chain inhibits the action of an enzyme used in one of the earlier reactions.

Accumulation of glucose which is the end product of the path way may slow down the end product inhibition and it does so through the negative feed back mechanism called inhibition by negative feedback. This ensures optimum utilization of starch by preventing unnecessary manufature of glucose if the demand is low.

Factors affecting enzyme activity:
1. Co-factors
Anything that facilitates an enzyme to effectively and efficiently carry out its catalytic role is called a co-factor.
(i) Prosthetic groups (activators).
This is an essential co-factor rightly attached to an enzyme.Prosthetic groups are metal ions like Cu, Zn, Mg which facilitate enzyme action e.g. zinc is used as a prosthetic group by the enzyme carbonic and hydrase which catalyses carbon dioxide and water forming a weak carbonic acid during carbon dioxide transport.

$CO_2(g) + H_2O(l) \longrightarrow H_2CO_3(aq)$
Cytochrome oxidase, an important enzyme in respiration uses copper as the prosthetic group.Enzymes fail to work if the prosthetic group is removed so these essential co-factors are called enzyme activators
(ii) Co-enzymes:
Some enzymes use co-enzymes as the co-factor. Co-enzymes are non protein organic compounds not attached to the enzyme but very important in functioning of enzymes such that when removed, the enzyme fails to work. Co-enzymes are vitamin B derivatives such as NAD (Nicotinamide Adenine Dinucleotiole), NADP (Nicotinamide Adenine Dinuleotiole Phasphate.)Both of which are devided from Nicotinic acid and FAD (Flavin Amide Dinucleotide) devided from Rboflavin (V1t1B2).NAD,FAD, AND NADP carry out their roles as co-enzymes by functioning as hydrogen acceptors in rxns catalysed by dehydrogen enzyme.
2. Inhibitors.
These are substances which slow down or stop the action of enzymes .They fall into two categories
(a)Reversible inhibitor
(b)Non reversible inhibitor
(a)Reversible inhibitor.
These are substances which prevent enzymes from combining with their normal substrate molecules. However, activity of enzyme is restored when the inhibitor is removed.They fall into two categories;
(ii) Competitive inhibitors
(ii) Non-competitive inhibitors
Competitive inhibitors;

These have a molecular structure similar to that of the normal substrate such that molecular structure of both the substrate and inhibitor is complimentary to the active site of the enzyme. Both inhibitors and the substrate begin to compete for some active site of the enzyme slowing down the rate at which the enzyme losing up its normal substrate.An example is the enzyme those catalyses the removal of hydrogen atoms from succinate (succinate dehydrogenase) which is inhibiteg by malnate. Malnate and succinate have a similar molecular structure which is complimentary to the active site of the enzyme saccinate dehydagenase

Inhibition comes in because the active site of saccinate dehydrogenise are occupanied by malnate rather than the normal substrate succinate.In effect, malnate and saccinate are competing for the activate site of the enzyme.The degree of inhibition can be reduced if the substrate concentration is very high compared to the concentration of the inhibitor.

Non- competitive inhibitor;

In non-competitive inhibition, the inhibitor becomes attached to the enzyme at a position other than the active site of the enzyme (Allosteric site)**.**Inhibition occurs by the inhibitor distorting the shape of the active site such that the substrate can not fit anymore in the active site hindering enzyme activity.This type of inhibition is called Allosteric Hinderance.The degree of inhibition can not be reduced by increasing number of substrate molecules and inhibition entirely depends on concentration of the inhibitor.Organo Non-competitive inhibitors do not bind strongly on the enzyme and can be removed to restore the normal enzyme activity.They include ions f heavy metals such as lead, mercury e.t.c

Non-reversible inhibitors:

Organo-phosphates and organo – chlorides such as DDT are examples of non-reversible inhibitors. They become firmly and permanently bound to the active site of the enzyme such that the substrate molecules can not bind to the enzyme any more. The activity of the enzyme is permanently stopped.

DDT permanently in activates the enzyme (chloline sterase) which is important in the normal functioning of the nervous system causing nervous disorders such as paralysis.DDT (Dichloro Diphenyl Tetra-chloro)

Importance of enzyme inhibitors:

- Provide important information about shapes and properties of the active sites of the enzyme.
- Used to break particular reactions there by enabling biochemists to construct metabolic path ways.
- Can be used in medicine and agriculture e.g as drugs and pesticides respectively.
- Control metabolic path ways by regulating the stages in threat.

3.Temperature:

Heat supplies kinetic energy to the reacting molecules causing them to move rapidly. The chances of molecular collisions taking place are therefore increased at high temperature. Therefore it is more likely that enzyme-substrate complex are formed at high temperatures than at low temperatures

However heat energy also increases the vibration of the atoms making up the enzyme molecules.If the vibrations become too vigorous, chemical bonds in the enzyme molecules break particularly conic; hydrogen and disulp hide linkages making the enzyme molecule to lose its shape inessential for normal enzyme activity.At the stage, the enzyme is said to be denatured.An enzyme controlled rxn increases with increase in temperature until the optimum beyond the rxn declines.

Very low temperatures inactivate the enzyme molecule by lowering the kinetic energy which lowers the mobility of the enzyme molecular such that no collisions occur between the substrate and the enzyme. An increase in temperature increases kinetic energy and more enzyme molecules become activated to move then collide with their substrates.Enzymes work within arrange of 20 – 40^0c and the optimum is 37^0c in the human body.

4.The PH

Enzymes work within a specific range of PH. Some work in acidic media e.g. pepsin.Others work in alkaline media e.g. trypsin while some work in neutral or slightly alkaline media e.g. pt catalyse, amylase e.t.c.In general, all enzymes catalysed rxns in neutral media not optimumly accept stomach enzymes whose PH is about 1.5 – 2.5. When the PH is altered, the conic bonds break resulting into un folding of the enzyme molecule and the enzyme is said to be denatured

5.Enzyme concentration:

Enzymes catalyse rxns very rapidly even at very low enzyme concentration.This is because enzyme molecule form complexes with substrates only very briefly forming enzyme – substrate complexes with breakanges or formation of bonds. Then the enzyme releases the substrates and is free far futher activity.The rate at which enzymes use up their substrate is called the Turn over number. i.e. the number of substrate molecules acted up on by an enzyme each second for some enzyme.The turn over number is very high e.g catalase has a turn over number of 40,000 molecules of H_2O_2 each second. even slowest enzymes have turned over numbers of locoibot rates / molecules each second.

Substrate concentration:

At low concentration of the sbstrates, an increase in substrate concentration corresponding increase in the rate of rxn because some of the active sites are still. This occurs antile a certain point is when the rxn rate remains constant with its substrate conic showing that all the active sites are energy with substrates.

Graph.

Along AB, some active sites are free and substrate concentration is the limiting factor such that when increased the rate of rxn also increases.Along BC, all actie sites are saturated with substrates and the rxn rate remains constant.Enzymes concentration becomes the limiting factor and the rate of km is rxn can be increased by adding more enzymes. Point km is called michealis constant and is x-tic of every enzyme. It is as the amount of the substrate remaining when the rate of an enzyme controlled rxn is half its maximu rate. A high km value indicates that the enzyme has less affinity for its substrates and is less efficient in utilizing its substrates.A low km value indicates that the enzyme is very efficient in utilizing its substrates so it has a higher affinity for its substrates.

Classification of enzymes:
The internal union of Biochemistry has recommended a system of enzyme classification and nomenclature.According to the kinal of reaction they catalyse. The following groups/classes are known so far.
hydrolases:
These catalyse hydrolytic reaction i.e. those involving addition of a water molecule and the xrn involved is a hydrolysis rreaction. During hydrolysis, the hydrogen atom from the water molecule enters are of the products and the hydroxyl group join the other product. Hydrolyses or hydrolytic enzymes are involved in the hydrolysis of proteins, lipids C(H2O) into their building blocks and they include, proteins, lipases carbohydrates.
Oxido – reductases.
These catalyse reactions involving simultaneous oxidation andreduction.They fall into two categories;
(a)Oxidases:
These catalyse the transfer of hydrogen atoms from the substrate molecules to oxygen. In the process, the substrate becomes reduced and the hydrogen becomes oxide to water.

$$AH_2 + \tfrac{1}{2} O_2 \longrightarrow A + H_2O$$

Subtrate oxygen oxide reduced

An example is cytechrome oxdase which is important in respiration catalysing the rxn leading to information of water which is the final product of respiration.
(b)Dehydrogenases:
These catalyse the oxidation of substrates by transferring the hydrogen atoms to co-enzymes, NAD, FAD and NADP e.g.

$$AH2 + NAD \longrightarrow A + NADH2$$

(substrate) (co-enzyme) (substrate co-enzyme
Oxidised reduce
e.g. the enzyme succurate dehydrogenase that catalyses the removal of hydrogen atoms from succanate forming fumarate during respiration
3. Transferases:
These catalyse the transfer of chemical groups from one substrate to another e.g
AB + C $\longrightarrow$ A+BC
Forexample the enzyme that catalyses the transfer of the phosphate group during the ealier rxn of respiration is called glucose phosphor transfer
Glucose + ATP $\longrightarrow$ Glucose phosphate + ADP.
4. Isomerases:
These control rxns involving the conversion of an isomer to another isomer of the same compound e.g

$$ABC \xrightleftharpoons{\text{isomerase}} ACB$$

5. Ligases:
These catalyse reactions in which new chemical bonds are formed e.g DNA and RNA ligases.
Lyases:
These break down complex substrates into simple products in sprocess called lysis.

$$AB \xrightleftharpoons{\text{lyase}} A - + B$$

Forexample the enzyme which catalyse the breakdown of H_2O_2 into H_2O and O_2. in these rxns, there is addition of a water molecule as is the care with hydrolytic rxns
6. Decarboxylases;
These catalyse reactions involving loss of CO2 molecules from the substrates e.g. in the reaction.

$$\text{Pyrurate} \xrightarrow[\text{Decaroxylase}]{\text{Pyrurate}} \text{ethanol} + CO2.$$

Deaminases:
These catalyse reactions involving removal of the amino groups from the amino acids forming residues.
Amino acid $\longrightarrow$ Amino acid residue + NH_2 (amino group)
NUCLEIC ACIDS;
DNA and RNA are the two types of nucleic acids.DNA is found mainly in the nucleus of the cell with some small amounts in cytoplasmic organell such as mitactondia in the cytoplasm particularly in the ribosomes.Both DNA and RNA are polymers and their building blocks are called nucleotides. Therefore nucleic acids are called polynucleotide.A typical nucleotide is made up of 3 parts i.e. a pentore sugar, organic base and a phosphoric acid group.In DNA, the sugar is De-oxyribose with one oxygen atom loss ($C_5H_{10}C_5$).In RNA, the sugar is ribose ($C_5H_{10}C_5$).n DNA, the organic bases include; Adenine and Guanine belong to a group of orhanic compound and thiamine (T).denine white cytocine and thaiamine belong to pymidines.In RNA, thiamine is absent and is replaced by clracil (U).In building up a nucleotide, the 3 components are joined together by chemical bonds with loss of

water molecules a condensation reactions.When 2 nucleotides are linked up, ade-nuecleotide is absent.

Structure of DNA:

After carefull observation, watron and crick suggested the structure of the DNA. They examine the DNA of a range of organsms and found out that in all DNA molecules, the number of thiamine molecules is equal to adenine molecules i.e. A = T or A/T = 1 or A : T = 1:1.Similarly the number of cytonine molecule is equal to the number of Guanine molecules i.e. C = G or C/G = 1 or C : G = 1:1.Therefore the ratio stranded molecule of the DNA such that Adenine can pair with thiamine and cytocine with Guanine.The two strands of DNA are linked to each other by organic bases and the bases are joined together by weak hydrogen bonds. The two strands are not the same but complimentary such that pairing is possible.The two strands are ant-parallel and run in opposite directions. The resultant double strand structure looks like an ordinary ladder with the prosphine acid and ssugar residues forming the upright of the ladder and the organic base pairs forming the cross bars. The exact DNA structure is not as simple as the ordinary ladder.x- ray studies have shown that the two strands are instead twisted around each other to form a double helix.

Qn: if the base sequency on one strand of DNA is; A

ACCTCGTA

TTCACTATAG

Determine the base sequency on the complentary strand in:

TGGAGCAT

AAGTGATATC

Essential role of DNA

The essential role of DNA lies in heredity and protein synthesis.DNA is material of inheritance and it is through the DNA that hereditary information is passed on from the parents to the off rings

Evidence that DNA is a genetic material

its ability to replicate:for any genetic material it must have the potential to replicate such that exact copies of the DNA are made.The proteins remain with their DNA and the off srings get DNA from the parents such that the information can be passed on.Watson and Crick proposed a model of DNA replicationAccording to them, the two strands of the DNA separate from each other in the same way one opens a zip. They suggested that the hydrogen bonds linking the base pairs are weak and breakages could easily happen.This is done the influence of the enzyme DNA polymerase. After the two strands have separated, bases become exposed on both strands such that free nucleotides can come along and take up positions along the exposed strands of the DNA. The base pairing rule is following i.e Adenine pair both thiamine and cyto one with Guanine pairing involves formation of new chemical

bonds and in catalysed by the enzyme DNA ligase which molecules along the exposed bases adding one nucleotide at a time until when all the exposed bases are occupied. The pontential strand acts as a template along which the new strand is constructed. Normaly there are some errors due to the enzyme DNA ligase inserting wrong base. Therefore after replication, repair enzymes move along the new strand removing wrong bases and inserting the correct bases. One strand of the daughter DNA is new while the other parental DNA which is conserve. There fore the mechanism of DNA replication is called Semi conservative mechanism.
Diagram;

Alternatively, DNA molecules may replicate by conservation mechanism.
In this mechanism DNA does not unzip and the two new strands of the daughter DNA are made alongside the parental DNA. The result is that two strands are conserved in one daughter DNA and in the other both strands are new.
Digrams.

Chromosome analysis:
Chromosomes only become visible during cell division suggesting that they carry an important information (DNA) which is to be shared by the daughter cells.
Metabolic stability.
Any material responsible for tranfering genetic information must be metabolically stable not break easily when not to alter the information.DNA does not break easily when exposed to chemicals
Location of DNA within the cell:
DNA is found in the nucleus where the environment is stable with little metabolic rxns taking place in the cytoplasm there are many biochemical rxns some of which release toxic waste products which may distort the structure of the DNA.
Correlation with mutagens;
Mutagens are agents which cause mutations. Some mutation is heritable and is passed onto the off springs by the DNA.
Experiments on bacteria transformations:
The bacteria pnecumoccus exists in 2 forms;
(i)The virulent/harmful form which causes the diseases pneumonia.
(ii)The harmless form which doesnot cause diseases.The living harmless form and the dead harmful form was injected into an experimental animal which later died of pneumonia. This is because the dead form has the information on how to make the toxin but being dead, it enables to do so. The harmless form lacks the information on how to go out making the toxin but when given chance to get the information towards the living form which started to make the toxin
Ribonucleic acid (RNA)

It is a single stranded polymer of nuclcotides with a pentose sugar as ribose and organic bases as Adenine, Guanine, Cytonine and Uracil but never thiamine.There are 3 basic types of RNA molecules known so far all of which are involved in protein synthesis.These RNA molecules are made by the DNA in the nucleus in the process called transcription. These include:
(i)Ribosomal (rRNA)
This is a single stranded polymer manufactured by DNA in the nucleus but found in the cytoplasm making up a very high percentage of the mass of ribosomes.
(ii)Transfer RNA (tRNA):
This is a small molecule which is single stranded made by the DNA in the nucleus but found within the cytoplasm. One end of the tRNA ends into the CCA sequence of bases and it is the binding site of amino acids during protein synthesis. The other end of tRNA is called the anti-codon which has a troplet of bases which varies from one tRNA to another and determines the amino acid that will bind with the tRNA moleculThere are 20 types of a a in the cytoplasm of each cell so there should be atleast 20 tRNA molecules since each is specific to aparticular a.a.
(iii)Messenger RNA (mRNA).
This is a long single stranded polymer manufactured by the DNA in the nucleus. It copies the information needed for protein synthesis from the DNA and takes it to the cytoplasm where proteins are made. After its manufacture from the nucleus, it passes through the nuclear pore to the cytoplasm and gets attached to the ribasomes where proteins are made from.
Differences between DNA and RNA:

DNA	RNA
- Double stranded polymer.	- Single stranded polymer
- The sugar is deoxyribose	- The sugar is ribose sugar
- Organic bases are Adenine, Guanine, Cytocine and thiamine	- Organic bases are Adenine, Guanine, cytocine and Uralic.
- located within the nucleus except some amount in the chloroplast and mitochondria.	- located in the cytoplasm.
- One basic type.	-Three basic types.
- High molecular weight	-Low molecular weight
- The ratio of A:T equals to C:G (A/T = C/G)	-The ratio of A/U and C/G is available

Similarities of DNA and RNA:
Both are polymers of nucleotioles.
Both are made up of the same phosphoric acid group.
Both are involved in protein synthesis
Both are kinds of nucleic acids.

Protein synthesis:
Three stages are involved;
Transcription.

Amino acid activation.
Translation.

1. Transcription:
This is a process by which mRNA copy is made from the specific region of the DNA molecule called the citron along the transcribing/sense strand of the DNA.A specific region of the DNA molecule unwinds as a result of breakage of the weak hydrogen bonds between the base pairs of the DNA.This is catalysed by the enzyme DNA helices. As a result, bases along the citron of the DNA are exposed and this portion acts as a template along while mRNA is made. Once the bases are exposed, free nucleotides take up positions and the base pairing rule is maintained i.e. A pair with U in mRNA and C with G.The nucleotides are joined together forming a polymer of mRNA under the influence of the enzyme RNA polymerase. As mRNA is being constructed, DNA rewinds behind where the information is already coped but unwinds in front copying more information. This continues until when triplets of bases called the nonsense cordons are reached and mRNA is pealed off the DNA.Being target passes through the nuclear pore to the cytoplasm and specifically to the ribosomes.
Diagrams.

Amino acid activation.
This is a process by which a specific acid combines with a specific tRNA molecule forming the amino acid tRNA complex. The xrn is energy intensive and requires energy obtained from ATP hydrolysis and is catalysed by the enzyme amino only tRNA synthesise. Each type of tRNA molecule binds with a specific a.a therefore seen i.e. there are 20 naturally occurring a.a in the cell cytoplasm, these should be at least 20 tRNA molecules. The triplets of bases called the anti-cordons are complementary to the triplet of bases on mRNA called the cordons.
Translation.
This is the process by which the genetic information in the DNA is transformed into a sequency of amino acids since DNA is in nucleus, the genetic information first copied by mRNA.During translation, the sequency of a.as in the polypeptide chain is made in accordance to the base sequency on mRNA. Once activated, the amino acid tRNA complexes move to the ribosomes where mRNA is supported. The rNA a.a complexes form cordon cent-cordon complexes and at any one time, the ribosome support 2 tRNA – amino acid complexes until when a peptide bond is established between the adjacent a.as.
Diagram:

Once the peptide bond is formed, the transfer RNA molecul is set free to the a.a. pool in the cytoplasm to pick another a.a mean while, the ribosome moves to support the 3^{rd} tRNA a.a. complex in its cordon anticordon complex formation.
This continues until a polypeptide chain is formed. The chain peals off when the nonsense cordons are reached. The polypeptide chain may remain as a linear sequence o as forming the primary structure of the protein or it may be around it's self forming th secondary structure or it may fold forming the tertiary structure.
In summary the process is as follows;(UNEB -1998 mar/apr)
Protein synthesis occurs in the cells of living organisms controlled by DNA which resides in the nucleus of the cell.
The genetic information for protein synthesis is contained in the DNA present in the nucleus of the cell.
In the nucleus, DNA unwinds to form two separate DNA strands. One of the DNA strand acts as synthesis of Mrna strand in the process of transcription.
The mRNA strand then leaves the nucleus through the pores to the cytoplasm where it attaches to the ribosomes on the rough endoplasmic reticulum (RER).
A tRNA molecule bearing a complementary anticodon toa mRNA codon, binds an amino acid in a reaction catalysed by the enzyme aminoacyl tRNA synthetase.The tRNA molecule is then said to be activated.
The activated tRNA molecule with a specific amino acid moves and binds to the specific codon on the mRNA molecule on the on the ribosome. The first amino acid is usually methionine.
In this way, amino acids are lined up in an order corresponding to the sequence of the base triplets in the mRNA. This sequence also depends on the genetic information conatained on the original DNA molecule.
Once aligned, peptidebonds are established between adjacent amino acid and apolypeptide chain is formed.
The tRNA molecule then detach them selves from the mRNA and return to the tRNA pool in the cytoplasm;
The energy for the synthesis of polypeptides comes from ATP;
The polytide molecule then peals off from the ribosome and is eleased into the cytoplasm.here it is modified into the necessary protein in the cell , functional or structural protein;
The genetic code
The genetic code is defined as sequence of bases that codes for a particular sequence of a.a.s. the information for the sequence of amino acids is contained in the gene or the DNA which is copied by messenger RNA in the process of transcription. There fore the sequence of bases on mRNA determine the sequence of a.a s.If a single a.a is coded for by a single base, the chain would contain only 4 a.as since there are only 4 types of bases. This is very unlikely because polypeptide chains are very long with many a.as. If a combination of 2 bases could code for an a.a, only i.e. a.a could be coded for leaving four a.as. the possible combinations would be.This gives the base triplet theory which states that, during translation, three bases on mRNA code for asingle a.a. the triplet of bases is called a codons. And the sequency of sequence of a.as in the protein molecule.

Characteristics of the genetic code:
It is universal i.e the same (triplet of bases) codes for the same a.a regardless of the form of life ranging from bacteria to human.
It is non overlapping from the starting of mRNA, the sequence of bases are read in blocks of three without any over lapping e.g. if the bases from the start are AUG, CAG, UGG, AGUG, the sequence of base is blocks of 3 isAUG/CAG/AGU/G without overlapping and 4 a.as would be coded for.

However, if there's overlapping, the sequency of codons would be;AUG, GCA, AGU, UGG, GAG, GUG giving a total of 6 a.as that could be coded for. However, this doesn't happen and no single base in the sequence takes past in the cordon.

The code is degenerate; this means that a single a.a is coded for more than once.These codons that code for a single a.a are called synonymous cordons and they differ only in the 3rd base e.g. GGA, GGC, GGU, GGG code for the a.a glycine.
The code for any a.a and act as full tops or punctuation marks indicating the termination of the polypeptide chain.

6. NUTRITION.

Autotrophic nutrition:
This is nutrition where organisms synthesis their own food from organic nutrients using energy from either the sun or from chemical reactions.Autotrophies use two methods. The autotrophies are;
Photosynthesis
chemosynthesis

Photosynthesis:
This is the process by which complex organic compounds are formed from carbon dioxide and water using energy trapped by chlorophyll and oxygen produced as a bi-product. It is summarised as a simple equation shown below.

$$6C0_2(g) + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{sunlight /u.v}} C6H_{12}O_6 + 6O_2$$

From the above equation, then following observations can be made:
The source of carbon in subsequent organic compounds come from CO_2
O_2 produced comes from H_2O and not CO_2
Hydrogen in the organic compounds produced comes from H2O and the sites of all photosynthetic reactions in plants i.e. chloroplasts

Chloroplasts:
This is a plastid in which photosynthesis is carried out:- the internal structure of the chloroplast.

Structure

The chloroplasts consists of a double membrane i.e. an outer and an inner membrane.
The inner membrane surrounds a fluid called the stoma. With the stroma are series of membrane systems that form flattened sacs called thylakoids.In some places these thylakoids are starched together forming groan (single geranium). This is because the looked like a pilla of coins stalked together. The space within each thylakeids is thought to be connected to a space within very other hydrated thereby forming an outer compartment /within the chloroplast called thylakeids space. The grana can be connected to other grana via intergranal lamella. The function of the thylakeids is to hold the chlorophyll molecules in a strategic position for trapping maximum amount of light. The stroma is an enzyme rich solution where CO_2 is first attached to an organic compound and then reduced to Carbohydrate therefore from the above absorption of solar occurs within the thylakeids membranes making up the grana while the reduction of CO_2 to carbohydrate occurs within the stroma (dark reaction occurs in stroma) .The leaf as an organ for photosynthesis leaves are the major organs for photosynthesis and are subsequently adapted to the process both externally and internally.

External adaptions:
The leaf is thin so as to minimise the distance over in diffusion of CO_2 has take place. This thinness also allows rapid penetration of light.
The leaf is flat and broad and therefore offers large surfaces are trapping light and for the exchange of gases.
Leaves of plants are usually arranged in a mosaic pattern i.e. they are arranged in such a way that they don't shade each other. This enables to trap as much light as possible.

Internal adaptions:
They are obtained from the internal structure of a leaf as shown (below) in the diagram below.
The leaf posses numerous chloroplasts in the mesophyll layer (both palisade and spongy mesophyll) hence it can absorb maximum light energy.
Most chloroplasts are located in the palisade mesophyll hence the best position to trap sunlight.
The presence of large intercellular air spaces that allow maximum circulation of gases e.g. CO_2 necessary for photosynthesis.
Presence of numerous stomata which allows entry of CO_2 and exit of O_2.
Presence of signs all over the leaf which not only support the lamina but also contain the xylem that delivers water, mineral salts while phloem transports a way all the manufactured organic compounds.

Diagram.

Photosynthetic pigments

These are various types of photosynthetic pigments in various parts of the plant. There are the chlorophyll and carotenoids.

The chlorophylls
The chlorophyll a
This is a blue-green pigment found in all green plants. It's the most a abundant absorbs light energy covering it into chemical energy
Chlorophyll b
This is a yellow-green pigment found in higher plants and green algae.

The carotenoids.(xanthophylls).
The carotenoids xanthophylls are orange and yellow pigments respectively. They are found in higher plants and some few algae because of their colours. They give diff colours to fruits. Flowers and few leaves.
These pigments are necessary pigments because;
They pass the light energy they absorbed onto chlorophyll.
They also protect chlorophyll from excess light and from oxidation by O_2 produced during photosynthesis.
The conditions required for photosynthesise are;

- CO_2 - light - chlorophyll
- H_2O - Temperature

Effects of light intensity. (Light)
Light is a form of electromagnetic radiation visible light only forms a small fraction of the electromagnetic radiations reaching the earth.Light falling on leaves may be absorbed, transmitter or reflected. This light absorbed affects photosynthesis variously.

Diagram

From the graph above the rate of photosynthesis arises rapidly as light intensity is increased and then levels off as the process reaches its maximum rate.
The cause for the sudden stop in the rise in photosynthesis due to;
Process is going on at its fastest possible pace and therefore no amount of light will make it go any faster no matter the circumstances.
There's insufficient CO2 available to allow the process to speed up any further.
The temperature is too low for the chemical reactions to go any faster

To determine the actual change for they levelling off the temperature and C02 concentration are raised diff staged the results of doing this are shown on a graph.

Diagram.

From the results above its evident that diff points, there area factors that limit the rate of photosynthesis from occurring at a faster rate. These factors are;
Described as limiting and the effects they bring about on the rate of photosynthesis can be summarised in a statement called the "law of limiting factors".

The law of limiting factors
It states that when a chemical process depends on moves than one essential condition being favourable its rate is limited by that which is nearest to its minimum value.

Light absorption by photosynthesis pigments.
The quality of light affects photosynthesis vigorously.
I this regard light quality can be looked at in terms of absorption spectrum and action spectrum.
Absorption spectrum
Its graph showing the amount of light absorbed by a pigment at diff wave lengths. It shows a measure of the extent to which a given pigment absorbs light of diff wave length. It's obtained by measuring the absorption of light of diff wave length by solution of each pigment.

Diagram.

Chlorophyll a absorbs light more effectively at both longer and short length than chlorophyll b and xanthophylls/carotenoids.
Bacteria chlorophyll can absorb infrared and ultra violet light.
Between 400 - 450x wave length = blue light
500 - 550x wave length = green light
550 - 600x wave length = yellow light
600 - 650x wave length = orange.
650 - 700x wave length = red
Beyond 700 = infrared.

Line graph above that all photosynthetic pigment absorb light mostly in 2 peaks with then light highest absorption peaks being in the range of 400 – 500nm of length. This is important because the shorter the wave the lower the energy required for absorption and vice-versa.
There's a low absorption of light by all pigments between wave lengths of 500 – 600nm. This wave of 500 – 600nm range corresponds to the green part of then light spectrum. Most light in this region is reflected and it explains why the majority of leaves appear green. (They don't utilise the green light).

The action spectrum.
This is a graph showing the effectiveness of the diff wave lengths of light in stimulating photosynthesis. The action spectrum therefore is used to rectify the pigments produced in photosynthesis.

A graph of the action spectrum.

From the graph above, it shows that red and blue light are the most effective wave length used in photosynthesis.
The region of most absorption corresponds to the highest rate of photosynthesis as shown in the graph below.

A graph of absorption spectrum and action spectrum.

The 2 graphs don't exactly the same shapes because not all the wave length of light from other parts of the spectrum and so they effectively increased the range of wave length from which plants absorbs light energy.

The mechanism of photosynthesis.
Photosynthesis takes place in 2 stages i.e.
The light dependant stage which is also known as a light stage.
The light independent stage a.k.a the dark stage.
More energy is produced when photosynthesis occurs in 2 stages than when it would have occurred in 1 stage at the same time more carbohydrate is produced due to the 2 stages.

The light stage of photosynthesis.
This takes place in the thylakeids of the chlorophyll.
The light reactions consist of two electron path ways known as (a) non-cyclic electron path way and the cyclic path way.
The non-cyclic electron path way utilises photosynthesis i.e. photo system I and II while the cyclic path way uses I photo system i.e. P.S.I

A photo system is one that consists of a pigment complex (chlorophyll a, b and carotenoids) and then electron accepted molecules in the thylakeids membrane.
The pigment complex serves as an antennae which is used for gathering solar energy.
After absorbing the solar energy, the pigment complex passes on the solar energy to a reaction centre made of a chlorophyll a molecule. In P.S.I the chlorophylla molecule (P 100) utilises light of wave length 700nm while in PSII the chlorophyll d molecules (Ps 30) utilises light of wave length 650nm.
Light energy is then used in each centre to raise electrons to higher energy level so as to enable them be taken up by electron acceptors.
The electron acceptors then carry those electrons through which series of electron carries and as this happens as energy molecule ATP is synthesized a long the way from ADP and inorganic phosphate (up).

The synthesis of ATP from ADP using light energy is what is known as photophosphorylation.

Non-cyclic photophosphorylation.

It involves 2 photo systems: i.e. PSI and PSII.

PSII is at a lower energy level than PSI and when it receives a proton of light, electrons in its reaction centre are existed, acquire energy and then are promoted to a higher energy level in this uphill process electrons are captured by an electron acceptor known as plastoquinone. This electron acceptor then carries these electrons down hill through series and as this happens, the electrons lose their energy. The energy lost by the electrons is then used in the formation of ATP from ADP and inorganic phosphates.

ADD + IP $\longrightarrow$ ATP.

The electrons are then taken up by PSI which is at a higher energy level.

Earlier on a proton of light (16) absorbed by PSI excited electrons in its reaction centre which are then promoted to an event higher energy level where they are accepted by terrodoxine.

These electrons together with the protons (from dissociation of water) from the split water molecules are then taken up to reduce a compound known as Nicotinomide Adenine dineleotide phosphate (NADP) to NADPH2 (Nicotinomide adenine dinudeotide phosphate hydrogen).

PSII regains its stability by receiving electrons from the photolysis of water. In this process the hydroxyl ions donate the electrons to PS II as shown below.

Electrons (structures)

The OH radicals formed then combine to form H2O and O2 which is produced as a by-product.

The net result of non-cyclic photosphosphasplohylation is produced of ATP, NAD and O2.

Cyclic photophosphorylation.

In this photophosphorylation, its only PSI involved the excited electrons from PSI accepted by terrodoxine and is recycled back to PSI via a chain of electron caries.

As the electrons pass down the chain of electron carries they lose their energy which is used to cover ADP to ATP.

In the process, no O2 is produced since no water is split for the same reason reduced, NADPH2 is not one of the productions, and the product here is ATP.

Non Cyclic Photospholiation (Z- scheme)

Diagram

Differences between cyclic and non-cyclic Photospholiation

Non – cyclic	Cyclic
The pathways of electrons is non-cyclic The 1st electron is water The last electron acceptors is NADP Products formed are ATP, $NADPH_2$ and O_2	it is cyclic ps1/chlorophylla is the 1st electron donor the last electron acceptor is chlorophyll a ATP is the only product formed

Similarities
Both transformation of solar energy to chemical energy is involved.
In both ATP is produced.

Differences between PS1 & PSII

PS1	PSII
Observer light of wave length 700nm i.e. higher energy level Involved in both cyclic and non – cyclic photophospholastion. When struck by light at the same time with PSII intermits electrons earlier than P.SII	Absorb light of wave length 680nm i.e. at a low energy level. Involved in only non-cyclic photophospholastion. Emits electrons.

Dark stages
This stage is independent of light and occurs in the stroma of chloroplasts. It's driven by a number of energy and it's endergonic in nature which requires energy. The energy required is provided by the ATP from the light state and $NADPH_2$.
The $NADPH_2$ provide the hydrogen ions for the reduction of CO_2. During the dark stage, CO_2 diffuses into the stroma and combines with a 5 carbon sugar tissue as rub lose biphosphate (RUBP) catalysed by RUBP carboxylase i.e. this is the CO_2 accepter forming a b carbon compound which however, breaks down immediately to form a 2 molecules of a D^3 carbon compound known as phosphoglaition acid (PGA) a.k.a glyacerate phosphate (GP). This reaction is catalysed by an enzyme called RUBP carboxylase which is present in large amounts in the stroma. The PGAGP formed in the 1st stable product of photosynthesis lost on each PGA undergoes phospharylation using part of the ATP derived from the light stage to form 2 moles of 1:3 diphosphogylecric acid which is then reduced by NADPH2 forming 2 molecules of phosphogycerialdehyde (PGAl) which is a iriphosphate (rp). It is the 1st carbohydrate made in photosynthesis. PGAL contains more energy than GP/PG.One of the molecules of PGAL is taken through series of reactions to regenerate RUBPY the other molecule is used to make organic compounds such glucose starch sucrose, e.t.c. through a series of condensation reactions.The above

cycle of events leading to formation of PGAC is known as the reactions of the Calvin cycle as summarised below.

Diagram

The dark reactions led to formation of mostly carbohydrates by however other substance such as lipids and proteins are both formed. It occurs in temperature plants e.g. ray i.e. pathway of CO_2 fixation.

C_4 plants

Some monocotyledonous plants e.g. maize, sugar cane, wheat, rice e.t.c. have the C02 acceptor as phasphenol phruvation (PEP) which is a 3 carbon compound. The compound formed when PEP fixed CO_2 is a 4C compound called oxaloacetic acid (OAA) since this has 4 carbon atoms, plants in which this takes place are referred to as C_4 plants.plants also contain bundle sheath cells that contain chloroplasts unlike C_3 plants.

Carbon dioxide fixation in C4 plants

The CO_2 in the mesophyll cell combines with PEP to form a C4 compound called OAA. This reaction is catalysed by the enzyme called PEP carboxylase. This occurs in the palisade mesophyll cells.

PEP has advantages over RUBP i.e.

It has a high affinity for CO_2 than RUBP.

Doesn't combine with O2 therefore it does not participate in photo respiration.

Once oxygen is formed, it is reduced to malic acid (malate). The malate is then shunted their the plasmodesmata of the palisade cells to the chloroplasts of the bundle sheath cells within the handle sheath cells, the malic acid is decarboxylated to form pyruvic acid and CO_2.

The pyruvate is then returned to the palisade mesophyll cells where it is phosphoriated by the ATP to form PEP, the reactions illustrated above as shown below.

In C4 plants, the bundle sheath cells are the sites of the Calvin cycle and these cells form a layer of cells on plant levers and stem which folds onto the sheath surrounding the vascular bundles O2 their outside is a layer of palisade cells arranged in a circular or ring surrounding the sheath cells.

This is what is referred to as the "krans anatory arrangement"

Krans anatory arrangement therefore ensures that palisade cells are in close contact with a bundle sheath cells so that the malic acid can easily pass to bundle sheath cells.The products of photosynthesis can be transformed from the bundle sheath to the adjacent phloem tissue of transport to other parts of the plants.

Diagrams

Differences between palisade mesophyll cell and bundle sheath cells

Palisade	Bundle sheath
They form the outer ring of cells Have large grana Have little starch grains on their chloroplasts Lack RUBP carboxylase in their chloroplasts CO2 fixation occurs in the cytoplasm by PEP	Form the inner ring of cells They have few grana/smaller They have abundant starch grains They have RUBP carboxylase Occurs in the chloroplasts by RUBP

NB: Carboxylation for PEP is a very rapid reaction since the enzyme PEP carboxylase has a very high affinity for $C0_2$ even when its concentration is low. This process readily provides the plant with the means of building up a large store of fluid CO2 and can later be reconverted to carbohydrates.
It also helps plants in dry conditions since it permits them to close their stomata during day time and still continue with photosynthesis.
C4 plants and their system operate co-efficiently at higher temperatures which makes them suitable for tropical conditions.

Advantages of C_4 over C_3 plants
They are more efficient in CO_2 fixation because PEP carboxylase has a very high CO_2 affinity and more food is manufactured than in C_3 plants.
In hot and dry conditions they are better adapted to survive and complete than CO_3 plants i.e. can close their stomata during the day to reduce water loss.
Can survive in areas of low water concentration and CO_2 concentration.
Grow faster than C_3 plants due to high food content manufactured.
There's no carbon wastage due to lack of very little photorespiration.

CAM PLANTS
These are C_4 plants in which CO_2 is taken during night when the stomata are open and fixed in malic acid.
During the day when the stomata are closed. The CO_2 is released from malic acid for use in the Calvin cycle. CAM means crassulacea Acid metabolism e.g. small saccades, pin apples, carrots which are in family crassulacea.
Mechanism of CO_2 fixation in CAM plants. These plants normally take up CO_2 during the night when the stomata are open and fix it into malic acid (malate). They then release it for photosynthesis during the day when stomata are closed. The CO_2 fixation into a fall in the PH of those plants. During the day when CO_2 is released from the malic acid for photosynthesis, the PH normalises. This makes such plants

else to live in very dry conditions because during the day their stomata are closed to reduce H_2O less from evaporation.

Differences between C_3 & C_4 plants

C_3	C_4
The 1st carbon dioxide acceptor is RUBP which is a 5 carbon compound.	The 1st CO_2 acceptor is PEPE with a 3 C compound.
RUBP carboxylase is the enzyme at catalyses co2 fixation	PEP carboxylase is the enzyme that catalyses CO_2 fixation.
1st stable compound of photosynthesis in the PGA or GP (3C compounds)	The fist stable product is the (4C compound)
CO_2 fixation occurs once.	Occur twice
CO_2 fixation has an effect of reducing the rate of photosynthesis as atmospheric O_2 can combine with RUBP i.e. photosynthetically efficient	The effect of photorespiration is negligible as affinity of PEP carboxylase for CO_2 is contained high i.e. little/no photorespiration occur.
The photosynthetic enzymes are more efficient at low temperature.	Are more photosynthetically efficient.
Compensation point is attained at high CO_2 concentration.	

PHOTO RESPIRATION

This is a metabolic pathway that occurs in plants in presence of high intensity in which carboxylase oxygenise (RUBISCD) accepts O_2 in the place of CO_2 resulting in formation of glycolate.

This is a light dependent reaction because the supply for RUBP is only available when the plant is photosynthesising. RUBP accepts both CO_2 and O_2 depending on which of them is at higher concentration. This completition reduces CO_2 fixation and hence reduces the rate of photosynthesis.

$$\text{RUBP} + O_2 \xrightarrow[\text{Oxygenase}]{\text{RUBP}} \underset{\text{(2c compound)}}{\text{phosphoglycolate}} + \text{PGA/GP}$$

Co_2

The form which above equation only one molecule of PGA/GP is produced compared to the 2 molecules of PGA that would ordinarily be formed if CO_2 was accepted alone. This essentially reduces the amount of carbohydrates formed.

The process is favoured by high temperatures and no ATP is produced. It mostly leads to the wastage and loss of ATP and $NADPH_2$. It therefore leads to loss yields and C_3 plants. Photorespiration involves 3 organelles namely;-

Chloroplasts

Paroxinoids

Mitochondria

Respiration, photosynthesis and compensation point.

Respiration in plants occurs throughout the day irrespective of light/dark condition resulting in the use of O_2 and the release of CO_2 and water. As low light intensity. Then rate of photosynthesis is low i.e. little CO_2 is formed compared to that consumed by respiration.
In order to sunulse plants must receive sufficient light intensities for long to replenish the loss of carbohydrate that was used up in respiration.
When photosynthesis and respiration proceed at the same rate so that there is no net bus of gain of carbohydrates, the plant is said to be at its compensation (point).
Compensation point is the light intensity at which carbohydrates production during photosynthesis is equal to its consumption during respiration.
At high light intensities above compensation point, carbohydrate production exceeds its consumption and this is very important it plants are to participate in the inevitable.
Sugar requiring processes like growth, respiration reproduction. Plants that grow in shades have a low rate of respiration and consequently their compensation point is quite low light intensities.

Photosynthetic bacteria

In these, the process of photosynthesis is almost similar to that described in green plants in having chlorophyll absorbs light of diff wave length from that of chlorophyll in green plants i.e. infrared and red wave length. Light of such wave lengths passes through weeds affected and is absorbed by these bacteria which are normally found under weeds at the bottom of lakes, rocks and ponds. In addition the source of H+ for reducing CO2 during photosynthesis in photosynthetic bacteria doesn't come from the splitting water instead from hydrogen sulphide which is abundant in rocks and ponds where those bacteria are found living. These bacteria are sometimes called sulphur bacteria. The hydrogen sulphide is supplied by the metabolism of an aerobic decay bacteria resulting from splitting of hydrogen sulphide deposited in the bacteria cells.

Difference between the light dependant and light independent

Light dependant	Light independent
Require light Occurs in the thylakoid Products are ADP and reduced NABP Water is split into H_2 and O_2 in the reaction	Don't require light Occur in stoma Products are T.P/CPGAL Carbon dioxide is reduced to carbohydrates

$$CO_2(g) + 2H_2S \xrightarrow[\text{bacteria chlorophyll}]{\text{light}} CH_2O + 2S + H_2O$$

Chemosynthetic bacteria.

Unlike green of plants and photosynthetic bacteria, chemosynthetic bacteria obtain their food from CO2 and H2O using energy obtained from the oxidation of various inorganic compounds such as ammonia, iron, hydrogen, sulphide e.t.c. e.g. nitrifying bacteria i.e. nitrosamines and nitrobacteria obtain energy by oxidizing Fe^{2+} salts to Fe^{3+} salts.

Heterotrophic nutrition
This is the type of nutrition in which organisms' feed on already made food i.e. breathing down complex organic compound to obtain. This nutrition falls under four (4) categories.
Holozoic nutrition
Saprophytic nutrition
Parasitic nutrition
Symbiotic nutrition

Holozoic nutrition
This is where organisms feed on other organs or form organic matter obtained from other organisms.
They have a digestive system where the solid food is ingested, digested and absorbed for assimilation.
They include herbivores, carnivores, omnivores and aerephagus feeders. All organisms above face problems selecting the food to eat and a mechanism to obtain.

HERBIVORES
These feed on grass and other vegetations.
This kind of food has a lot of cellulose that is hard to digest.
It also contains low nitric content. This makes herbivores to eat large amounts of food so as to obtain enough nutrients.
They also have a long alimentary canal to ensure that food spends time and effective digestion.
The non-ruminants like rabbits carryout caecopathy where they eat back their droppings and more effective digestion.
The non-ruminants also have cellulose digesting bacteria in the caesium and the appendix that help in digesting cellulose.
Ruminants have molar and premolars for have many crowns and enamel ridges thus provide a large surface area for grinding food.
During chewing, the lower jaw moves laterally and vertically which ensures effective grinding of food from the dental formular $i\,\frac{o}{3}$, $c\frac{o}{1}$, $pm\,\frac{3}{3}$, $m\frac{3}{3}$.
The upper jaw lacks incisors and a=canines which are replaced by horny pad used for plucking and ingesting food along with the incisors and canines in the lower jaw.
Other herbivores like insects such grass hoppers have mandible with carrated cutting edges. Termites also have cellulose digesting bacteria in their intestines called flagellated trichonympha.

DIGESTION IN RUMINANTS
Cellulose digestion in ruminants.

A ruminant is an animal which has a complicated digestive system in which the stomach typically has several chambers. Among the ruminant animals are the deers, cattle, giraffe and goats. The 1st chamber of the stomata is called rumen. It acts as a formation chambers where food is mixed with saliva undergoes fermentation by materialistic/ symbiotic micro organisms such as bacteria and fungi.
Many of these celluloses which digest cellulose, presence is very essential to the ruminant which is unable to manufacture cellulose itself, the end products of fermentation are carboxylic acids (particularly enharmonic pro panic, butanoic acid) carbon dioxide and methso the acids are absorbed by the host which then uses them as a major source of energy in respiration.
In fern, the micro organisms obtain their energy requirements through the chemical reaction of fermentation and have an ideal temperature in which to live.
The partially digested food (compound) is then sent to the 2nd chamber reticulum where its formed into pullets.
Its then regurgitated and thoroughly rechewed. This is called rumination/chewing the cud. The food is then swallowed and undergoes further fermentation.
Eventually the partial digested food is passed through the 1st 3 chambers of the gut to reach the abomasums which corresponds to the stomach in the humans from here on wards food undergoes digestion by the usual mammalian digestive enzymes.

Carnivores
These are animals that feed on flesh, blood or other animals. This food is mainly proteinous and easy to digest.
The problems experienced by carnivores are in digesting food but in hunting prey.
This makes them predators. They therefore have several adaptations which make them effective predators;
Possession of a strong vision coupled with precision timing.
Have a strong sense of smell needed for tracking prey.
Have a light speed of locomotion resulting from diff muscles and limbs hence can easily cattle space prey.
Have a strong, a long and sharp plant for capturing and holding prey.
Have long pointed and curved canines for piecing and killing prey.
Have the ability to use does e.g. footmarks, droppings and sound to follow and trap prey.
Have concealment predators other known mammals carnivores e.g. hydro may use sting cells to kill prey and tentacles to capture prey.
Soakers use venom and strong fungi for some purpose. Carnivores (insectivorous) plants trap using their leaves into which the insects prey fall.

Microphages feeders
These are aquatic organisms that feed on microscopic particles such as plank tom. Food collection by these organisms involves filtration and because of this they are referred to as filter feeders. examples include mussels which use their gills to filter food particles from water.

Omnivores

These are animals that feed on a variety of food including vegetation and flash such organism take in food in a solid state and have an efficient digestive system to extract nutrients from food eaten.

The digestive process in such organism begins with the solid food material being broken down into smaller soluble compounds that can be absorbed and assimilated by the organism.

The breakdown may be done physically i.e. involving the mastication action of the teeth and the rhythmical movement of the gut walls (peristalsis).

This is later followed by the chemical digestion which involves the action of enzymes.

Extracellular digestion is digestion that occurs in outside the cells e.g. in mammals and in fungi.

In mammals the digestion occurs in a specialised tube called a gut (gm).

Intracellular digestion is a primitive method of digestion where digestion occurs inside the cells as in the case of a amoeba. Here food is normally taken in by photo phagocytosis and digestion occurs in a food vacuole.

Digestion in man.

The diagram below shows a gut of h a human being. It shows that a gut is divided into region with specific functions.

Diagram;

The functions alluded to the above are geared towards achieving digestion and absorption of nutrients.

The human gut is divided into the following region.

1**. The mucosa**

This is the inner most layer of the gut and it consists of simple columnar epithelium which is folded into many ridges. The columnar contains many mucus producing cells called the goblet cells.

The mucosa is further divided into.

(a)Epithelium which secrets mucus.

(b)Lamina propria.

(c)Muscularis mucosa.

2**.The muscular externa**

This layer consists of involuntary muscles ie the longitudinal muscles and circular muscles. The circular muscle fibres are arranged in a circular pattern around the gut and their contraction causes the gut to become longer and thinner. The longitudinal muscles have their fibres arranged length wise along the gut walls and shorten. Between the longitudinal and circular muscles layers is the;aurebach's plexus" which consists of nerves from the autonomic(involuntary)nervous system that controls peristalsis from the ANS therefore controls the contraction of those muscles so that they form rhythmical waves called peristalsis that push food along the gut.

A plexus is a bunch of nerve fibres.
Between the circular muscles and the sub mucosa is another nerve called meissner's plexus which controls the secretion from glands in the gut wall.

3. The sub mucosa
This layer consists of connective tissue which collagen fibres, blood, lympative vessels and nerve fibres. It carries away absorbed food.
4. The serosa.
This is a connective tissues forming the onto covering of the gut. It protects the gut from injury that may be caused from other abdominal organs. It's mainly connected to the mesenteries.

Diagram showing the general plan of a gut structure.

The process of digestion.
All the organs that is responsible for the intake of food. Its digestion assimilation and the removal of the undigested material in mammals. Collectively from the digestive system i.e. the gut and associated organs.

(1) Buccal cavity.
This is the space that is formed by the most.
This cavity is separated from the nasal chamber dorsally by a palate. one anterior part of the palate is hard and born part called the hard palate while that at the posterior end is a fleshy part called the soft palate.vertically the buccal cavity has a tongue with a surface papillae which contains taste buds in them. The buccal cavity is normally kept wet by saliva secreted by three parts of salivary glands .i.e.
i). Sub lingus glands (lie below the tongue).
ii). Sub maxizallary glands (below the lower molars).
iii) Paretic gland (beneath the ear or above molars) embedded in both the upper jaws and lower jaws are the teeth in bite tear and chew food (mastication)
Man has a fixed upper jaw and movable lower jaw both with diff teeth types. Digestion begins in the buccal cavity where food is masticated by teeth and this constituent's physical digestion. This process enables food to be taken into smaller particles hence increasing the S.A for enzymes action.
Masticated food is mixed with saliva which consists of mainly water, mucus, enzyme salivary amylase and lysozymes mineral salts are also present. They contain chloride ions which speed up the activity of the enzymes lysozymes are enzymes which destroy any bacteria in food by swallowing the water softens the food while salivary analyse hydrolyses cooked starch into maltose. The mucus sticks the food particles together as well as lubricating the mouth.
Food in the by and cavity is rolled by the tongue into abduct and then pushed in the phargax, at this point, the epiglottis does the trachea, preventing food from

entering the respiratory system. At the same time, the soft palate closes the nasal cavity so that food does not enter the nose, then well lubricated by waves of peristalsis. In conclusion, the mouth region (buccal cavity) both physical and chemical digestion occurs.

2. IN THE STOMACH

This is a large muscular bag located below the diaphragm. It has got a ring of muscles at its anterior end, the cardiac splints muscles and at its possenor pyretic sphincter.
Food is allowed into the stomach from the oesophagus by the cardiac sphincter muscle. Arrival of food in the stomach sets off both chemical and physical digestion, then wall of the stomach is made of gastric glands composed of 3 types of cells i.e.
Mucus secreting goblet cells.
The oxyntial parental cells which secrete HCl.
Zymogene / chief cells / peptic cells which secret pepsinogen.
All the above cells are located at particular places along the gastric gland as shown in the diagram below.

A GASTRIC GLAND

Production of gastrine hormone by the stomach walls stimulates the gastric glands to produce gastric like that contains HCC, pepsinogen, rennin, mucus and water.
pepsin is produced in its inactive form called pepsinogen. This is because pepsin is aprotiolitic enzyme and may attack the tissues of the stomach when released in its active form.
Once its released its activated by HCL to form pepsin. Pepsin carries out chemical digestion in the stomach by hydrolysing protein to polypeptides.
Rennin mainly produced in infants where diet is acuminated by milk. Rennin works by coagulating milk /making insoluble the soluble milk protein caseinogens into an insoluble curd called casein. casein is then hydrolysed by pepsin into polypeptydes.The HCL produced not only activate pepsinogen into pepsin but also provides an acidic PH medium for the action of enzyme pepsin. The HCL also kills any bacteria that could have come along with food. It also at the same time stops the action salivary amylase. HCL sterilises the stomach by killing all the bacteria that came along with food. It also looses the

Fibrous components of tissues (meat actin) and bones in case of carnivores.
Physical digestion in the stomach occurs by rhythmical waves of contraction passing along the stomach. A little Cheam is released in small quantities into the duodenum controlled by the pyloric sphincter.

IN THE DUODENUM.
It forms the first loop of the small intestines and receives secretion from the gall bladder and pancreas.

The acidic Chyme released by the stomach is mixed with bile and pancreatic juice in this region.
The liver produces bile and stores it in the gall bladder connected to the duodenum by the bile duct. Bile is a mixture of variety of substances i.e.;

(a)Bile salts which include;
(i) Sodium taurochlorate.
(ii) Sodium glychlorate.
(iii) Sodium hydrogen carbonate.
Sodium taurochlorate and glychlorate the surface tension of hence emulsifying the fats so their surface area is increased for the action lipids lipase enzyme.
Sodium hydrogen carbonate neutralises the acidic Cheam and makes the duodenum alkaline hence providing a suitable PH that favours duodenum enzymes activities.

(b)Bile pigments which include;
(i) Bulverdin.
(ii) Bilirubin.
These pigments that normally result from the break down of Hb in the worn out RBC's in the liver. The pancreas is suited just beneath the stomach and is connected to duodenum by the pancreatic duct through which pancreatic juice is discharged.
Pancreatic juice contains four enzymes;- i.e.
Pancreatic lipase which hydrolyses lipids to fatty acids and glycerol.
Inactive trypsinogen it's first activated by an enzyme called enterolase which is produced by the intestinal walls. Trypsin is the active enzyme of trypsinogen.
Pancreatic amylase which converts hydrolyses remaining starch into maltose.
Inactive enzyme chymotrypsinogen.Its activated by Trypsin to form active chymotrypsin. Trypsin hydrolyses proteins to form polypeptides and peptides while chymotrypsin hydrolyses polypeptides to peptides and amino acids. Nucleus enzymes may also be released by the pancreas and these hydrolyse nucleic acids to nucleotides. Sometimes peptidase may be released. They hydrolyse peptides to amino acids.
The wall of the duodenum is highly folded forming a number of crypts called crypts lieberkunus.
Below these pits are coded glands know as Brunner glands that produce alkaline fluids and mucus.
The mucus protects the duodenal walls from damage by Trypsin and HCL from the stomach

Diagram (structure of micro villi)

Digestion in ileum.

Between the villa are tabular glands called the crypts of lieberkunn which have beneath cells that secret inessential juices called sucus entersue which consists of many enzymes and mucus as cutlined below.

Maltose: this hydrolyses maltose to glucose.
Invertase/sucrase: hydrolyses sucrose to glucose and fructose.
Lactase: hydrolyses lactose to glucose and galactose
Nucleotides: these split nucleotides into phosphate, pentose sugar and nitrogen bases.
Lipase: hydrolyses fats to fatty acids and glycerol.
Peptidases: hydrolyse peptide to amino acids.
Peristalsis of Ileum Brings Cheam In to Contact With the intestinal enzymes is brought about by the rhythmical contractions of the circular and longitudinal muscles within the gut walls. As a result Cheam is turned in to a water emulsion called Chile.

Absorption of digested food.
Absorption is the passage of nutrients from digested food through the lining of the gut into blood or lymph.
This absorption of food occurs through the extensive maser of the ileum. The small intestines therefore are well adopted for absorption of food. The process of absorption and active transport. Most of the absorption of digested food occurs by diffusion which depends on the concentration of gradient of the nutrients between blood and the mucosa of the ileum.
A significant portion of the nutrients are also absorbed by active transport which requires energy.
The nutrients cross the epithelium of the villa and are then transported through blood vessels to the live.
The compounds of fat digestion are insoluble in water and are not directly absorbed from the intestines as they are first incorporated into small spherical water soluble droplets called micelles which are aggregates of many molecules i.e. fatty acids, glycerines and steroids.
The micelles are then absorbed by the lymphatic system until they are transport by the diffusion into lacteal from where they are poured into blood through subcievian vein from here which eventually reactivate the liver where they are metabolised further.

In the colon (large intestines)
After the absorption of digestion forming in the indigested materials enter the colon. Here they water still present in the undigested material in reabsorbed together with water soluble vitamins e.g. Vit K and Vit $B_{12.}$
The remaining inorganic nutrients e.g. sodium, calcium ions are also reabsorbed at this point by active transport.
As a result of water absorption, the indigested food material is gradual concentration in a solid called faeces. Formation of faeces stimulates the walls of the colon to produce mucus that lubricate their movement to the rectum. The faeces are temporally stored in the rectum from where they are egested, defecated. Defication is controlled by the contraction and relaxation of anal sylincter muscle.

Control of digestion in man

The digestion of food materials involves the action of various digestive juices secreted by diff organ of the alimentary canal. To avoid the extremely waste for and constant product of those juices even in absence of food. There should be a proper co-ordination and control of digestive juice and enzymes therefore is under the control of the;

Nervous system

Hormonal endocrine system

The regulation of food intake in man is under the general control of two centres in the hypothalamus of the brain i.e.

The hunger centre.

Its stimulation causes individuals to seek and eat food.

The satiety centre

Its stimulation inhibits food intake both centres are stimulated a habited through the sympathetic nervous systems that originate from the hypothalamus.

Control of digestion in the buccal cavity

The secretion of saliva from the salivary gland is controlled by the nervous system under two reflex actions i.e. conditional and unconditional.

Unconditional reflexes

They occur when the food is in the buccal cavity i.e. tasting food. This stimulates the tasteful on the tongues which taste impulses to the medulla of the brain which in turn orders for saliva secretion.

Swallowing is triggered by the tactile stimulation of soft palate and walls of the pharys impulses are fired from this part to the medulla oblongata that controls this process.

Peristalsis in the aesepliagus occurs by the contraction and relaxation of the circular and longitudinal muscles in its walls which are in turn controlled by the autonomic nervous system.

Control of digestion in the stomach

The secretions of gastric juice occur in three phases namely;

Cephalic phase (nervous phase)

Gastric phase

Intestinal phase

Cephalic phase

This takes place before food reaches the stomach and therefore prepares the stomach to receive that food. The site smell, taste and thought of food and even its presence in the buccal cavity initiates this phase through conditioned reflexes. This causes the brain to send nerve impulses via the vague to the stomach.

These impulses stimulate the oxyntic cells to produce HCC and chief cells to produce pepsin.

As HCC is produced, the PH of the pyro region falls below to inhibiting gastric products. The nervous phase lasts between 30mins and 1 hour

The gastric phase
This occurs in the stomach and involves both nervous and hormonal control. When the food enters the stomach the stretch receptors in the walls of the stoma are stimulated. These receptors send impulses to the mesinous plexus in the submucosa which in turn also fires impulses to the gastric gland stimulating them to produce gastric juices.
The stretching of the stomach and the presence of food in it also stimulates special endocrine cells on the mucosa to secrete the hormone gastric. This hormone reaches the gastric glands via blood and stimulates them to produce gastric juice for approximately 4 hours.

The intestinal phase
There's both nervous and hormonal control

The nervous control
When acidic chime enters the duodenum, the receptors in the walls of the duodenum fire impulses to the brain. The brain in turn sends impulses to the gastric gland inhibiting them from secreting gastric juice and to slow the release of chime from the stomach. This prevents to mach food being released into the duodenum at once.
In addition to mucosa, of the duodenum produces to hormones namely
CCK (cholecytoknin pancreazymin)
Secretin
Secretin is produces in response to the acid (as a result of acidic chime) while CCK is produces in response to the presence of partially digested fats and proteins. These 2 hormones travel in blood and reach the stomach, pancreases and liver (target organs).
In the stomach, Secretin inhibits secretion of gastric juice while CCK inhibits stomach emptying.
In the liver, secretin stimulates production of HCO_3^- the same response occurs in the pancreas. The HCO_3^- makes pancreatic juice and bile more alkaline and in effect neutralise the acid from the stomach.
CCK on the other hand stimulates the synthesis of digestive enzymes by the pancreas. In the liver, it causes the contraction of the gall bladder and therefore enables it to release bile into the duodenum secretion control. This occurs during the nervous and gastric phases of gastric digestion where the vogues nerve stimulates the liver to secrete bile and pancrease pancreatic juice.

Assimilation of food
Is the process by which food nutrients are put to use in the body. The sugars and amino acids are taken to liver via hepatic petal vein where they may be further processed fats in the lymphatic vessels are drained into the left subcievian vein from where they are taken to the liver for metabolism. The liver therefore plays a very important role in the final metabolism of all nutrients.

Saprophytic nutrition
This is the type of nutrition where sapretrophs feed on dead decaying matter and eventually release nutrients from it. They are mainly bacteria and fungi. They are decomposers and do so by secreting digestive enzymes ever the dead organic material and therefore carryout Extracellular digestion of nutrients derived from this digestion are then taken up by their bodies.
In a natural habitat, the activity of sapretrophs is of yeast, ecological significance in that
The micro organisms in soil are supplied with nutrients derived out of decomposition.
The decomposition removes organic matter from the habitat and prevents it from accumulating.
The decomposition releases and recycles nutrients form the dead bodies of plants and animals there by increasing soil fertility.
The decomposition also improves many aspects of soil e.g. soil texture, drainage, water retention, organic matter content there.
Improves soil fertility leads to improved plant growth and also increases the biotic link between micro organisms and plants as well as the primary productivity of the habitat.
Increase in primary productivity of habitat will in hence the total energy flow to its biotic components and biomass which the habitat will support.

Symbiosis
Plants and animals of diff species often associate temporarily or permanently with each other. Associations therefore are often means of providing food for one or both the partners and in a broad sense they are referred to as symbiotic relationships.
Symbiosis therefore is the lining together association or interaction of two (2) or more organisms of diff species in which all partners benefits. It's a obligator (both benefit) mutualistic and symbiotic relationships.
Relationship between Rhizobium bacteria and plant roots of legumes. Rhizobium bacteria obtain their energy in a process of fixing nitrogen inform of ATP and shelter and plants get nitrogen.
Lichen (green alga and famous)
(Association between fungus and plant roots) mychorrhiza.
Association between termites and cellulose digesting bacteria. That's why termites eat wood which contains cellulose.
Association between ruminants and cellulose digesting bacteria

7.GASEOUS EXCHANGE.

Specialised respiratory surfaces:

Gaseous exchange takes place across specialised surface in the body and the mechanism by which it occurs varies from one organism to another depending on the body size of an organism and where it leaves.

Small organisms have there gaseous exchange taking place across there body surfaces.

This is because they posses large surface area to volume ratio which enhance rapid diffusion of gases directly across there body surfaces.

On the other hand, large animals posses small surface area to volume ratio and there surfaces are not good for gaseous exchange e.g.

a. **Exterior surface of a body**
   Diagram.

e.g. protis, annelids, coelenterates but protis lack gut.

b. **Flattened body**
   Diagram

e.g Platyhelmither (flat worm)

c. **External gills**
   Diagram

e.g. in young tadpoles

d. **Internal gills (highly visualarised)**
   Diagram

e.g in the body of cartilaginous fish and old tad pole

e. **Lungs (highly visualarised)**
   Diagram

e.g. in mammals, birds reptiles and adult amphibians

f. **Tracheal tubes**
   Diagram

CHARACTERISTICS OF A RESPIRATORY SURFACE

- They have large surface area to enable diffusion of gases.
- They are moist so as to dissolve gases and this enhances (improves) there diffusion normally gases diffuse faster in solution form.
- The respiratory surfaces are permeable to allow gases to go through them.
- They are thin so as to minimise the distance moved by gases during diffusion.
- They are well ventilated i.e. they posses a dense network of capillaries so that oxygen and carbondioxide are carried to and from the surface to maintain the concentration gradient.

- Being delicate, they are highly protected e.g. the gills in fish are protected by the operculum and lungs in man are protected by a rib cage.
- Increase in the volume of the mouth
- Pressure within the mouth decreases and water enters the mouth
- The fish closes its mouth and floor of the water moves to the gills and O2 diffuses into blood while CO2 diffuses out of blood and water is raised covering a reduction in volume and increasing the pressures.

EXPIRATION
At this time the operation is placed closed to the body.
- Tiny operculum muscles increase volume of the opercula cavity.
- Water moves from the buccal cavity to the opercular region bathing the gills.
- Pressure in the buccal cavity increases, mouth closes and water is forced over the gills and out of the body under the free edge of the operculum.

These ramify through the body and penetrate into all tissues e.g. in arthropods. Deoxygenated blood enters the gill capillaries via the afferent bronchia vessels.

FISH
Diagram

Parallel flow of water in gaseous exchange is an inefficient means of obtaining oxygen from water because the diffusion gradient is not maintained. The oxygen concentration in blood leaving the gills can never exceed that of the water within the gills. This results into an equilibrium and hence no net exchange of oxygen at such a time.
In parallel flow, some parts of the gills are unventilated or under ventilated. It can be improved if water flows faster than blood.

GASEOUS EXCHANGE IN BONY FISH
Bony fish have four pairs of bronchial arches supporting gill filaments. These filaments form a double vow arranged in a v-shape bearing gill plates at right angles to there surface. There are no bronchial valves and gill slits are covered by a body flat called the operculum. It offers protection and helps in ventilation.

Structure of a gill filament of a bony fish

Oxygenated blood leaves in the efferent brachial artery to join the dorsal aorta along which it passes to the rest of the body.
Bony fish gills demonstrate extremely well the counter current principals. The blood and water flow over the gill to remain in opposite direction. This allows a diffusion gradient to remain constant and to be maintained between the water across the gill. It ensures that blood which is already partly loaded with oxygen meets water which has very little oxygen removed from it.

Similarly blood with very low oxygen circulation meets water which ahs already had most of its oxygen removed.
This mechanism allows bony fish to achieve 80% absorption of oxygen compared to 50% in the parallel flow system. The over lapping ends of the gill filaments also slow down the passage of water so that there is a greater time for diffusion to occur.

Diagram

VENTILATION MECHANISM IN BODY FISH
Alteration of the buccal pressure pump and an opercular section pump allows water to be drawn over and between the gills more or less continuously.

INSPIRATION
Water is taken by:
The floor of the buccal cavity being lowered.

VENTILATION MECHANISM IN CARTILAGINOUS FISH
Inspiration;
During this process, water is taken into the body through the mouth by;
Hyptobranchial muscles contracting causing the floor of the buccal cavity to be lowered.
The volume of the pharynx increases.
The pressure inside the pharynx and buccal cavity is lowered and this cause the opening of the bronchial valves and water will be the taken in.
Water taken in blows around the gills and gaseous.

Expiration
When the buccal cavity is full of water, the mouth and the spiracles (nostrils) are closed and the floor of the buccal cavity and pharynx are raised. This raises pressure inside the pharynx which forces water to flow over the gill lamellae and later out of the body through the gill slits.

Diagram illustrating ventilation in cartilaginous fish

GASEOUS EXCHANGE IN GILLS OF CARTILAGINOUS FISH
After water has been taken through the mouth. It flows to the gills. Water flows parallel to the flow in the efferent bronchial vessels i.e. water and blood flow side by side in the same direction and at the same speed. This is termed as parallel flow.
There are five pairs of gills which lie either sides of the pharynx; the gills on each side are arranged in a row of five gills slits which open from the pharynx to the extort at right angles.
Each gill is composed of a cartilaginous wall called the bronchial arch which supports a series of sheet-like-structures called lamellae. Each lamella has vertical foils called gill plates which increase the surface area further. The free end of each

gill is a septum which is elongated forming a bronchial valve which is useful during the ventilation activity.

GILL STRUCTURE AND WATER FLOW OVER THEM

De-oxygenated blood from the ventral aorta is carried to the gills by the afferent bronchial artery. The branches repeatedly to form very many fine capillaries. The oxygenated blood is carried away from the gill by the efferent bronchial artery.

VENTILATION MECHANISMS IN INSECTS

a. **Inspiration**

During inspiration, the abdomen of the insect will expand to allow air to enter the tronchial system when the spiracles are opened air diffuses along the trached and finally reaches the tracheoles which are thin walled and fluid filled. Inspired air contains much O2 which then dissolves in the fluid and diffuses out of the cells into the tracheoles.

b. **Expiration**

After exchange of gases in the tracheoles the abdomen contracts and this is due to the contraction of the abdominal muscles that cause the contraction of the insect body. This reduces the volume of the tracheoles system which forces air with much CO2 to move from the tracheoles into the trachea and finally out of the body through the spiracles.

Insects regulate the ventilation rates just like mammals do some insects have nerve centres in the thorax and abdominal ganglia which controls the rhythmical ventilation movement of the body.

In severe muscular activity e.g. during flight lactic acid may accumulate in tissues thus rising the salt drawn out of the tissue fluids. This results in water being air passages to facilitate diffusion of oxygen to tissues.

Therefore;

i. Insects have the most efficient method of supplying oxygen to body tissues.

ii. Insects have respiratory gases delivered directly to body cells and never carried in blood. Blood of insects lack haemoglobin and that's why it appears colourless.

GASEOUS EXCHANGE IN CARTILAGINOUS FISH

Examples of cartilaginous fish are sharts, rays and dog fish

They live in sea water and have no body operculum covering their gills and there skeleton is made up of cartilage.

Diagram

Diagram

Tracheoles are in close contact with body cells valves in spiracles regulate the movement of air in and out of the trachea.

In some insects e.g. locusts air is blown into the trachea through the spiracles on the thorax and out through the spiracle on the abdomen.
Breathing is primarily controlled by the breathing centre in the region of the hind brain called medulla oblongata.
The ventral portion of the centre controls the **inspiratory movement** and its called the inspiratory centre (the ventilation centre) while the remaining portion controls breathing out and is called the expiratory centre. The ventilation centre is connected to the diaphragm and intercostals muscles by an bronchioles are connected to the expiratory by the vagus nerve.
The bronchioles have got stretch receptors that detect the degree of expansion of the lungs. If the lungs greatly expand maximum inspiration stopped by the inspiration centre by sending nervous information to the diaphragm and the intercostals muscles via the afferent nerves.
This inhibition of maximum inspiration initiates expiration which is a passive process. The ventilation centre is also influenced by chemo-receptors which send inspiratory centre. If the partial pressure in blood of Co2 raises the chemo-receptors in the carotid and aortic bodies are stimulated and produces impulses which are taken via the sensory nerve to the ventilation in the brain.
The ventilation centre later responds by sending impulses to the external intercostals muscles and the diaphragm muscles there by bringing about increases in the ventilation rate. It should also be noted that the ventilation centre is also influenced by higher centres in the brain which cause voluntary changes in the breathing.

Gaseous exchange in insects
The respiration system in insects consists of numerous tubules forming a tracheoles system. The tubes open out wards through small holes which are located on the sides of the abdomen and thorax.
The thorax has got two parts of spiracles one pair is found between the prothorax and mesothorax and the second thorax is found between the meso-thorax and metathorax.
Spiracles are guarded by valves or hairs to prevent excessive evaporation of water through them.
The tracheas are lined with cuticles which is impermeable to gases. The trachea verifies to all body parts and the ends are divided into small tube known as tracheoles.
The tracheoles are the main respiratory surfaces in the insects and their walls are thin and permeable to gases and they lack cuticles.

Diagram

Ventilation rate = total volume x number of breath per minute
The ventilation changes with the prevailing circumstances e.g. during muscular exercise. Both the frequency and depths of p breathe increases and these results into high-ventilation rate.

The maximum amount of air taken into the lungs after a deep breath is called the inspiratory reserve volume and thus volume is about 3L of air which is over and above the tidal volume.
Extra amount of air expelled out of the lungs of the end of normal expiration is called the expiratory reserve volume.
The total amount of air that can be expired after a maximum inspiration i.e. (inspiratory reserve volume + tidal volume + expiratory reserve volume.
The vital capacity varies from one person to another and it normally ranges from 4-5ltrs but in a fit athlete, it may be more than that.
There is a certain amount of air which remains in the lungs even after maximum expiration. This volume of air is called the residual volume and it's approximately 1.5ltrs.
Although gaseous exchange takes place across the alveoli, it doesn't occur in other parts of the respiratory system such as the trachea, bronchi and bronchioles.
Such areas or spaces are referred to as dead spaces.

Gaseous exchange across the alveolus:
This occurs across the alveoli which are made up of the squamous epithelium and some elastic collagen fibres. The alveoli is surrounded by numerous blood capillaries which are extremely narrow. Blood flows through this capillary slowly, allowing more time for diffusion to occur and increasing the surface area of the red blood cells attached in the endothelium of the capitaries.
This facilitates the diffusion of oxygen into the red blood cells. The oxygen is inspired air diffuses across the alveolar epithelium and the endothelium of the capillaries and finally into the red blood cells.
Inside the red blood cells, the oxygen combines with the respiratory pigment called haemoglobin to form oxy-haemoglobin. Normally, the carbondioxide diffuses from the alveolus through the alveolar epithelium then leave the lungs in expired air.

CONTROL OF VENTILATION IN MAN
Diagram illustrating the nervous control of ventilation in mammal

- The ribs move down wards or posteriorly and inwards of dorsally.
- The diaphragm muscle relaxes and acquires the normal dome shape.
- The volume of the thoracic cavity decreases and also elastic glands tend to contract and this causes a reduction in their volume. This causes the pressure inside the lungs to increase and the increase in pressure will force the air out of the lungs into the atmosphere.

LUNGS CAPACITY
DIAGRAM SHOWING TYPICAL LUNG VOLUME
The lungs of a living organism at any moment have a certain volume of air inspired and expired and some air retained. The volume of air breathed in and out by a person at rest is called the total volume or the tidal air or volume (is approximately 500cm3 or 1/2/ litres).

The volume of air breath per minute is called the ventilation rate and the ventilation rate = tidal volume.

MECHANISM OF VENTILATION IN MAN

Breathing refers to the muscular movement of some body parts that result in air containing oxygen entering the body and elimination of waste gases from the body. Breathing takes place into two phases namely

- Inspiration (inhalation)
- Expiration / exhalation

INSPIRATION MECHANISM IN MAN

In order for the air to enter into the lungs from the atmosphere, the pressure inside the lungs must be lower than the atmospheric pressure.
The lowering of pressure inside the lungs is brought about as follows.

- External intercostals muscles contract.
- Internal intercostals muscles relax.
- The ribs move up wards interiorly and outwards centrally.
- The diaphragm muscles contract and as a result, the diaphragm flattens.
- The volume of the thoracic cavity increases and the elastic gland expand to fill the space. This results into the lowering of pressure within them. This causes the air to rush from the exterior to the lungs.

EXPIRATION MECHANISM IN MAN

For this process to occur, the pressure inside the lungs must be higher than the atmospheric pressure.
The rising of pressure inside the lungs is brought a bought a follows;

- External in intercostals muscles relax.
- Internal intercostals muscles contract.

DIAGRAM SHOWING A TERMINAL END OF A BRONCHIOLE

Lungs comprise of a tubular system which ends into two sacs like atria which give rise to numerous alveoli to increase the surface area for gaseous exchange.
Being numerous in number, the alveoli provide large surface area which enhances rapid diffusion of gases during gaseous exchange. The membranes of the alveoli are permanently moist in order to make gases to move in a humid environment a factor which contributes to the faster or rapid diffusion of gases.
Further still, the membrane of the alveoli is thin and permeable to air which allow free diffusion of air with minimum resistance.

Each alveolus is highly visualarised with numerous blood capillaries to ensure quick transport of gases.
De oxygenated blood is always carried to the alveolus and this will later become oxygenated blood by simple diffusion. To ensure efficient supply of blood to this

area, the alveolus is highly visualarised and this also helps to ensure that oxygenated blood is efficiently transported away from the alveolus.

TRACHEA
This is a tube running from the pharynx to the lungs and carries air from the pharynx to the lungs. The trachea is made up of a C-shaped cartilage linked wall to prevent it from being blocked or collapsing, every time the neck is bent during leaving movement. The wall of the trachea is also lined with cilia and mucus.
The mucus traps the germs and dust while the cilia remove them from the trachea back to the pharynx by beating rhythmically.

BRONCHUS
The trachea divides into two to give rise to two bronchi each leading into respective lung. The bronchi also have C-shaped ring of cartilage to keep them permanently open without being blocked. The bronchis divide again to form mass of very fine branches of tubes called bronchiole.

BRONCHIOLES
These terminate into numerous branches of tubes called alveolar ducts which are also further sub-divide into smaller tubes known as atria. Atria contain many bubbles like sacs called air sacs which are also referred to as alveoli.
An alveolus is the major structure where gaseous exchange occurs.

RESPIRATORY SYSTEM OF MAN
DIAGRAM

The respiratory system of man is made up of the nose, trachea, bronchioles and bronchi and lungs which are associated with other structures which include the ribs, intercostals muscles and the diaphragm.

NOSE:
This is where air passes through to and from the atmosphere. In the norsal cavity, air is a warmed up and made humid by the moisture which evaporate from the warm norsal membrane which is lying on the walls of the norsal passage.
The wall of the norsal passage a lined with hair like structure known as cilia in between the cilia, there are goblet cells which secret mucus. Mucus traps dust and germs inhaled from the atmosphere. The trapped germs and dust are excitatory or inhibitory influenced on the respiratory centre.
Increase in the pulse rate e.g. during excitant, shock, emotions, this results from impulses generated from the high centres of the cardiac vascular centre through the sympathetic and parasympathetic nervous system.
Adrenal glands secrete adrenaline which prepares the body to copy up with increase in cardiac oxide level.

This is a achieved by increasing cardiac out put and causing general razor contriction of arterioles except those having vital organs like the heart, and skeletal muscles.

EFFECT OF ALTITUDE ON BREATHING

- At a higher altitude there is a lower partial pressure of oxygen than sea level this causes increase in the amount of carbon dioxide in the body increasing the rate of breathing.
- However, organisms that do live permanently at higher altitudes have increased number of red blood cells to increase on the carbon dioxide carrying.
- The organs also have a higher ventilation rate and cardiac out put compared to animals at the sea level.
- Certain animals e.g. those that live in water like the seals, a whale, can survive in along period of oxygen desperation.
- During this state, there is a sudden decrease in the cardiac out put, a condition known as brandy cardiac.

Diagram showing ....

The medulla oblongata has a group of cells that control the ventilation rate and blood flow. These groups of cells form centres i.e. the medulla has a centres that help in the control of carbon dioxide in the body.
These centres are;
- Respiratory centre.
- Caudal vascular centres.

- An increase in carbon dioxide partial pressure stimulates the sensory cells within the aortic and carotid bodies to send impulses through the afferent nerves to the respiratory centres
- They respond by sending impulses to the breathing apparatus (lungs) so as to increase the rate and depth of breathing. It results in more carbon dioxide in blood to be removed the rough breathing out hence raising the blood PH.
- An increase in carbon dioxide level stimulates the carotid body to generate impulses which are carried by the afferent nerves to the cordial vascular centre of the medulla.
- The cardiac vascular centre ....to the arteries causing them to constrict. This results in increased blood pressure and therefore increased cardiac output.
- An increase in blood pressure results in rapid transport of carbon dioxide to the lungs. Accumulation of carbon dioxide in muscles and other organs has a direct effect of causing arterioles to dialled increasing blood flow to these body parts this process is termed as vasodilatation.

Diagram

The carotid sinus which is an enlarged portion of the internal carotid artery plays an important role in controlling of blood pressure. It has stretch as a result of increased blood pressure in arteries.
Once stimulated, they transmit impulses through the afferent nerves to the cardio-vascular centres. Once impulses react, it generates impulses which decrease the cardiac output and cause dilation of the blood vessels.
This helps in lowering pressure.
However, respiratory and cardio vascular centres of the medulla oblongata can be influenced by impulses generate from the celeberum i.e. higher centres of the brain e.g. we can all speed up or slow down our rate of breathing consciously because the higher centres of the brain excerpt either

REGULATION OF CARBON DIOXIDE IN THE BODY

- The human body requires a certain amount of oxygen for normal function depending on the level of activities.
- The body is subjected to if the amount of oxygen in blood is low. Its means the amount of carbon dioxide in high and a deficiency of oxygen in the body is termed as hypoxia.
- In man hypoxia results into impureness of the brain and other special senses particularly vision. This results in sudden unconsciousness and paralysis due to damage of nerve cells followed by death.
- In case of excess oxygen breathed at pressures more than atmospheric pressures e.g. when diving tissues metabolism very rapidly to keep up with pace of oxygen supply. As oxygen accumulates in the body it inhibits certain enzymes controlling the kerb cycle hence interfering with cellular expiration. This is normally followed by dizziness, naeusia, impered hearing and vision, breathing difficulties, confusion, convaltions, death.
- Increase in carbon dioxide in the body may be due to anaerobic respiration, since carbon dioxide is acidic in body. It lowers the PH and these interfere with the Krebs cycle. An increase or decrease in carbon dioxide levels is detected by chemical receptors which are found either in the aorta, carotid arterioles and medulla oblongata.
- Chemo receptors found in the walls of the aorta close to the heart are called the aortic body and those found between the internal and external carotid arteries and its side of the neck are called the carotid bodies.
- Chemo receptors found in the medulla are very sensitive to changes in the level of carbon dioxide and changes in ………………………

Diagram.

8. RESPIRATION.

Tissue respiration *is the process by which organic compounds (mainly glucose) are broken down to release energy.* All living cells carry put respiration since it is required to maintain life.The energy released is carried in an energy rich chemical called Adrenorine triphoshate (ATP).

Structure of ATP

Significance of ATP

ATP is hydrolyzed in presence of water and enzyme ATP are to release enegy, Adenosine diphosphate (ADP) and inorganic phosphate ie

$$ATP + Water \underset{Condensation}{\overset{ATP\ hydrolysis}{\rightleftharpoons}} ADP + P_i + 34KJ$$

NB: ADP and P_i can be converted back to ATP using some energy and this is followed by loss of water molecule. Therefore it is a condensation reaction. Therefore ATP is a useful energy carrier

ATP cannot accumulate in the cells because it is only produced when its demand arises.

Role of energy released during tissue respiration.

Out of 3,000KJ of energy released during oxidation of sugars, only 30 – 34 KJ can be fixed into ATP. ATP contains an energy rich bond and when the bond breaks, the energy is released to do useful activities like

Temperature regulation\transmission of nerve impulses

Synthesis of organic compounds like proteins

Active transport of materials in the body

Contraction of muscles

Building and maintenance of the protoplasm (growth)

Reproduction etc

Types of tissue respiration

These are 2 types of respiration ie aerobic and anaerobic respiration

Aerobic respiration

This is the process by which living cells release energy by metabolic break down of organic compounds mainly CH_2O in the presence of molecular oxygen.

An equation to summarize aerobic respiration

$$C_6H_{12}O_2 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + 2880KJ$$

STAGES OF AEROBIC RESPIRATION

Aerobic respiration involves 3 stages ie glycolysis, Rreb's cycle and election transport system (Respiratory system).

GLYCOLYSIS

This is the process by which a six carbon (glucose) is split into two pyruvate molecules (3 carbon) it occurs in the cytoplasm. It involves 3 stages ie

PHOSPHORYLATION phosphorylation

Splitting of the phospholylated sugar

Dehydrogenation of the sugar (oxidation)

Phosphorylation

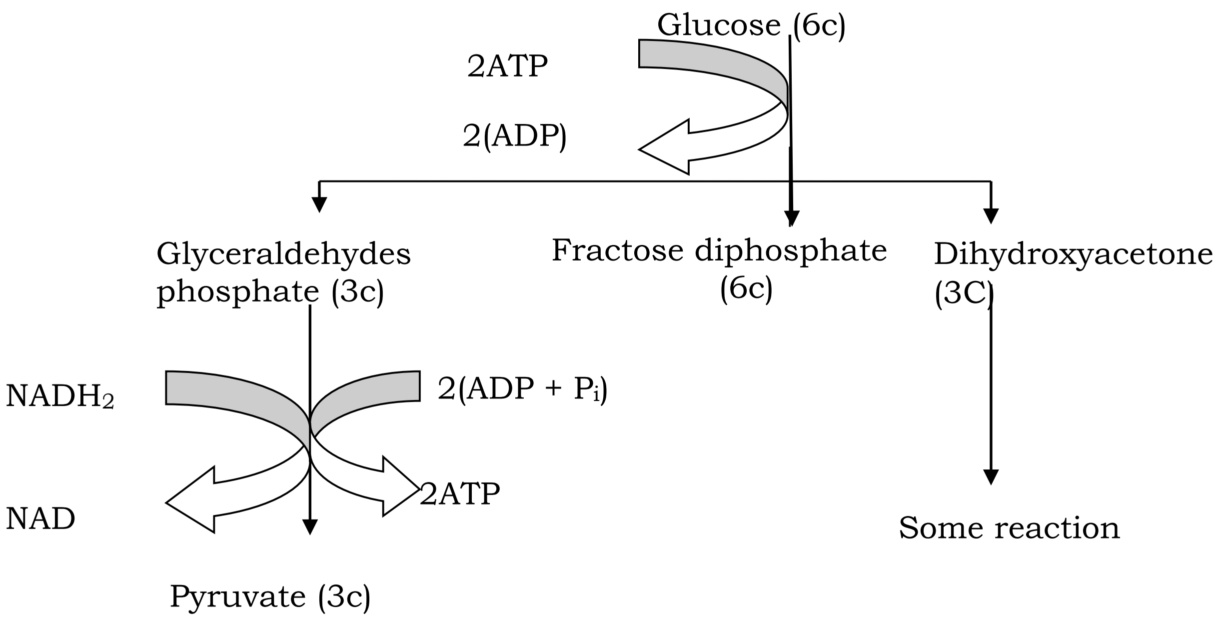
Glucose reacts with 2ATP molecules to produce fructose diphosphate which is more reactive as it has a lower activation energy.

Splitting of fructose diphosphate

Fructose diphosphate splits into two 3-carbon sugars which are inter convertible glycerol hydephosphecte, hydroxyacetone.

Dehydrogenation of the sugar (Oxidation)

Each one of the three carbon sugar is dehydrogenated to form a pyrurate and 2ATP molecules. Two hydrogen atoms are removed and accepted by NAD+ to form $NADH_2$. This is catalysed by hydrogenase.
NB: NAD is nicotinamide Adenine dinucleotide. For every glucose molecule phosphorylated two pyrurate moleles, 2 $NADH_2$ molecules and 4ATP molecules are produce.



BUDGET FOR GLYCOLYSIS

Total input	Total output
1 mole $C_6H_{12}O_6$	2 moles of pyruvate
Hexose (6c) sugar	(2X3C)
2 ATP molecules	4ATP molecules
$2NAD^+$	2 $NADH_2$

Not gain of ATP = 2 ATP molecules
THE IMPORTANCE OF GLYCOLYSIS
It involves phosphorylation of glucose to fructose diphosphate which has lower activation energy and is more reactive.
It involves the splitting of the phosphorylated sugar to 3 carbon sugars
It involves production of 2ATP molecules
it produces two pyruvate molecules perglucose molecule phosphorylated. During glycolysis $2NADH_2$ are produced per glucose molecule which later yield ATP during the election transport system.
KREB'S CYCLE/ THE CITRIC AND CYCLE/TRICARBOXYLIC ACID CYCLE
Each pyruvate molecule from glycolysis enters the mitochonion from the cytoplasm. It is decarboxylated by losing a carbon atom which is oxidized to carbondioxide and

released. This is followed by (dehydrogenation) loss of two hydrogen atoms which are accepted by oxidizing NAD+ to form $NADH_2$ (reduced).
Decarboxylation followed by dehydrogen converts the pyruvate into an xxxx group (2c) which is arrived by co-enzyme A to form a complex called a cetyl co enzyme A.
The above reactions are a transition between glycolysis and Krebs cycle. The Krebs cycle starts when the cetyl group combines with oxaloacetate in the matrix of the mitochondria to form citrate (6c).
The citrate is decarboxylated and it loses 2 hydrogen atoms which are accepted by NAD^+ to form $NADH_2$ while carbondioxide is released to form alpha ketoglutarate ($\propto$ ketoglutarate)
The $\propto$ ketoglutarate undergoes a series of reaction during which it losses a carbon atom, 6 hydrogen atoms, 4 of which are received by $2NAD^+$ to form $2NADH_2$ and the other two are received by FAD^+ to form $FADH_2$ and yields one ATP molecules to get converted back to oxaloacetate.
SUMMARY OF THE PRODUCTS OF THE TRANSITION STAGE BETWEEN GLYCOLYSIS AND KREBS CYCLE FOR EVERY GLUCOSE MOLECULE.
$2NADH_2$
$2CO_2$
SUMMARY TO SHOW THE PRODUCTION OF KREBS CYCLE FOR EVERY GLUCOSE MOLECULE
$4CO_2$
$6NADH_2$
$2FADH_2$
2ATP
THE IMPORTANCE OF KREBS CYCLE
It involves dehydrogen during which reduces NAD [NADH2] and reduced [FADH2] ARE formed which are later fed into the respiratory chain to yield ATP
It reduces 2ATP molecules per glucose molecules.
It involves regeneration of oxaloatate which receives more acety
It links glycolysis to the respiratory chain.
NB; The ten NADH2 molecules and 2FADH2 molecules produced by the end of Krebs cycle enter the respiratory chin where hydrogen in oxidized by oxygen to form water and energy is reduced
THE ELCTRON TRANSPORT SYSTEM/RESPIRATORY CHAIN AND OXISATIVE PHOSPHORYLATION.
This involves series of reactions during which hydrogen carried by NADH2 and FADH2 is oxidized by oxygen to form water and energy is produced..
Some of this energy is used to make ATP, form A &P and inorganic phalphate [p1] and this is called oxidative phosphorylation.
There spiratory chian is a or a system of a series of hydrogen or electron carriers [accepters] with oxygen are the last carrier [accepter].
Hydrogen or electrons are passed from one carrier which is at a higher energy level to another carrier which is at a lower energy level (Down hill).
Each carrier (accept) is repeatedly reduced and oxidized when it receives an electron or hydrogen and hands it over to the next carrier respectively.

NB: At each hydrogen or electron transfer, some energy is released which may be used to make ATP and Pi in the presence of ATP synthetase.
Dehydrogenation occurs in the presence of an enzyme dehydrogenase.

OUTLINE OF THE RESPIRATORY CHAIN

Hydrogen passes from $NADH_2$ to $FAD^{+.}$ Hy.
Hydrogen then splits into hydrogen wns [h#] and electrons
Electrons flow from reduced FADH2] to FE [iron in cytochrone and the to copper [Cu] in cytochrone oxidize and finally to molecular oxygen where they are reunited with hydron to form water.

NB;
Tron is part of the haen group is an electron accepter called cytochrome while copper is part of an electron accepter called cytochroe oxidase.
ii] For each reduced NAD that enter the respiratory chain; three ATP molecular can be made as hydrogen and electrons flow to oxygen. While from each FADH2, only 2 ATP molecular are synthesized because FAD enter the chain at a lower energy level.
Iii] The respiratory chain [oxidative phosphorylation] occurs on the Cristal of the mitochondrion.
BUDGET FOR THE RESPIRATORY CHAIN

Entering output	Output	Used
12 H_2 in the form of $NADH_2$ and	30 ATP + 10 H_20	50_2
$FADH_2$	4ATP + $2H_2O$	O_2
Total	34 ATP + 12 H_2O	$6O_2$

NB; For ever 2 pyrurwte molecules that enter the krebs cycle [ever glucose molecule oxidize], the Krebs cycle uses 6 water molecules as source of oxygen for oxidizing carbon during decarboxylation.
Therefore, though 1 water molecules are made in the respiratory chain; only 6 are released as the net amaint from aerobic respiration. This is called metabolic water.
SUMMARY TO SHOW THE PRODUCTION OF 38 ATP MOLECULES [NET NUMBER].

Glucoses	2ATPs
Krebs cycle	2ATPs
Respiratory	
Chain; 10 NADH2	30ATPs
4FADH2	4ATPs
Total	38 ATPs

QN; Describe how 38 ATPs are produced during aerobic respiration
ANAEROBIC RESPIRATION

This is the process by which energy in leased by metabolic breakdown of organic molecules in absence of molecules oxygen.
It is sometimes called fermentation and it only involves glycolysis. (It takes place in the cytoplasm of the living cell). It yields less energy because it doesnot involve the electron transport system organic molecules are only partially broken down and come energy remains locked up in the products formed ie it is wasteful.
Organisms which obtain energy by anaerobic respiration are termed as anaerobic. Some bacteria can be killed by normal atmospheric levels of oxygen and therefore hey must live in oxygen free environment. These are termed as obligate (complete) anaerobes eg clostridium tetani which causes tetanus.
Other organisms such as yeast and gut parasites eg tape worms, can exist whether oxygen is available or not. They respire aerobically but in absence of oxygen, they can respire anaerobically and survive. They are called facultative (partial anaerobes. The products of anaerobic respiration depend on the organism in question.

Anaerobic respiration in fungi eg yeast and in higher plant cells (alcohol is fermentation)

It involves glycolysis to produce a pyruvate and $NADH_2$. The pyruvate is first converted teethanal and carbondioxide.
Ethanol then receives between from NADH2 to form ethanol. Therefore the end products of alcoholic fementation are carbondioxide and ethanol ie

$C_6H_{12}O_6 \longrightarrow 2CH_3CH_2OH + 2CO_2 + 210Kj$

APPLICATION OF ALCOHOLIC FERMENTATION (ANAEROBIC RESPIRATION) IN DAIRY LIFE

It is used in browing industries to fement sugars and make alcoholic drinks

Yeast is applied in the baking industry since it fements sugar and the CO_2 produced make bread daugh to rise.

Ethanol resulting from alcoholic fementation is energy rich and can be used to make gasohol which is a fuel for cars

It is applied in industries to make milk products like cheese yorghurt, butter etc.

ANAEROBIC RESPIRATION IN ANIMALS eg muscle cell.

It occurs in muscle cells during vigorous exercise when the oxygen available is not enough to cause a high rate of aerobic respiration which matihers the high energy demands during the exercise.
It also involves glycolysis to produce pyruvate and $NADH_2$.
Pyrvate then accepts hydrogen from $NADH_2$ to form lactic acid (lactate) and energy.

Pyruvate + $NADH_2 \longrightarrow$ lactic acid + NAD^+ + 150 kJ

$C_6H_{12}O_6 \longrightarrow C_3H_6O_3$ + 150 KJ
(Lactic acid)

Accumulation of lactic acid in muscle cells can cause muscle fatigue (pain) and may be toxic. It is therefore transported by blood to the liver where it is broken down (oxidized) by oxygen debt to carbondioxide and water with release of energy ie.

$C_3H_6O_3 + 3O_2 \longrightarrow 3CO_2 + 3H_2O$ + energy

Oxygen debt

Oxygen debt is provided by rapid breathing after the exercise

NB: muscle cells contain a compound called creatine phosphate and during high energy demands, the phosphate group is removed from creatine phosphate and this releases enegy which is used to make more energy from ADP and Pi.

Since anaerobic respiration involves glycolysis only, it produces only 2ATP molecules.

Assignment

Compare between aerobic and anaerobic respiration

SIMILARITIES

Anaerobic respiration and aerobic energy

- Both produce energy
- Both take place in living cells
- Both involve break down of arganic spols eg carbohydrates

DIFFERENCES

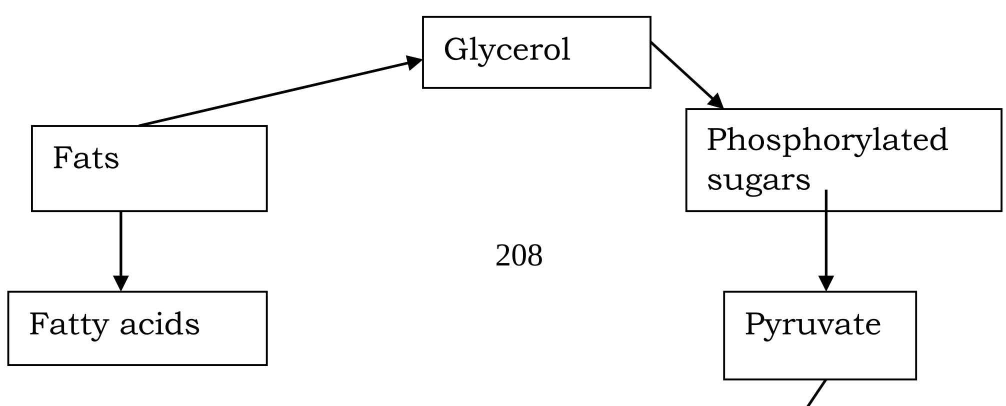
Aerobic respiration	Anaerobic respiration
It uses oxygen during the break down of organic molecules	It does not use oxygen during the break down of organic molecules
It takes place in the mitachondrian and cytoplasm	It takes place only in the cytoplasm
In animals, the end products are CO_2, H_2O and a lot of energy.	In animals the end products are lactic acid and little energy.
In plants, the end products are CO_2, H_2O and a lot of energy	In plants, the end products are ethanol and very little energy
Involves complete breakdown of carbohydrate	Involves partial break down of carbohydrate.

Energy from fats and proteins

When carbohydrates are in shortage, fats may be split into fatty acids and glycerol. Glycerol is then phosphorylated and converted to a 3-l sugar phosphate which is then converted into pyruvate and fed into the Kreb's cycle to produce energy.

Fatty acids through a series of decarboxylation and dehydrogenation reactions is the mitochondrion to form a catyl co enzyme A which enters the Krebs cycle to yield energy.

The hydrogen resulting from dehydrogenation enter the respiratory chain where they are carried from one acceptor to another to release energy in form of ATP.



Proteins

Deeper in metabolic rates

Excess proteins in the diet can be metabolized to release energy.
Proteins are broken down into amino acids and each acid molecule is de aminated (removal of amino group NH_2) to form ammonia which is excreted as urea (when carbondioxide reacts with ammonia is ornithine cycle) or ammonia or uric acid.
The acid group then enters carbohydrate metabolism. The amino acid may be converted into a metyle co enzyme A or pyruvate or a Kreb's cycle intermediate compound. All these ryns are reversible and therefore they are important in synthesizing the $C(H_2O)$ from an amino acid or the revence.
Therefore Kreb's cycle facilitates metabolic inter conversions between C (H_20) fats and proteins.
Scheme showing metabolic conversions between fats, carbohydrates and proteins.

RESPIRATION QUOTIENT (RQ)
This is the ratio of volume of CO_2 produced by volume of O_2 used by an organism or a given period of time.

R.Q	Volume of CO_2 produced
	Volume of O_2 used

The rates of R.Q depends on the metabolic rate hence can vary depending on diet, misulor activity, temperature etc.
Diet
Muscular
The theoretical respiratory for complete oxidation of carbohydrates and proteins are shown below.

Temperature

The theoretical respiratory quotients for complete oxidation of carbohydrates and proteins are shown.

Respiratory substance	R.Q
Carbohydrates	1.0
Fats	0.7
Proteins	0.9

However, the experimental (practical R.Q) of organism may never be the exact value of each of the above because;

A mixture of substance may be oxidized at the same time

A respiratory substate is rasely oxidized fully

FACTORS THAT INFLUENCE THE R.Q VALUE

The extent of oxidation ie whether there is portial or complete oxidation of the respiratory substrate.

The number of respiratory substrates; beng oxidized at any given time ie whether it's a mixture of substrates or only one type of substrate.

Whether respiration is gerobic or anaerobic. A respiratory quotient exceeding 1.0 is not obtained in an organism or tissue which is short of oxygen and respiring anaerobically to produce more carbondioxide using less oxygen.

Whether carbohydrates are being converted into facts or not; convertion of carbohydrates into fats involves release of cabondioxide hence increase the respiratory quotient. This happens in organisms which are laying down extensive fat stores eg mammals preparing to hibernate, fattering livestock etc.

Whether carbohydrates produced by an organism is being used internally or not. A low respiratory quotient may mean that some corbondioxide is used by the organisms eg green plants may use it for photosynthesis while some animals use carbohydrates to make calcerous shells.

Type of respiratory substrate used.

9. EXCRETION AND OSMOREGULATION

Excretion *is the removal of wastes and any excess useful products of metabolism from the body which when allowed accumulating would inter fear with the normal functioning of body systems.* Excretion is different from secretion in that secretion is a discharge of materials what have been formed by specialised cells of an organism for use by the body.

Osmoregulation *is the process which controls quantities of water and dissolved solutes in the tissue fluid / blood so that their osmotic concentration remains at a level that is necessary for body processes to operate normally.*

Metabolic processes normally result in non usable waste and partly metabolised substances which when allowed accumulating will be toxic to body cells.
The excess nutrients taken in by organisms that are in excess of their requirements are removed to avoid interfearing with body physiology.

Importance of Osmoregulation

Non nitrogenous excretory products.
These products don't contain any nitrogen in them and include the following;
CO_2 which is produced from cells respiration and excreted side lungs, gills and over the general body surface in very simple animals.
Water. This produced as a result of cell respiration or excess water intake and is excreted as sweat or urine.
Inorganic ions, result from excess intake and are removed by the kidneys / sweat. They include Na^+, K^+, Mg^{2+} e.t.c.
Detoxification products, results from breakdown of drugs, poisonous products e.t.c. and they are removed by the kidney and via sweat.
Nitrogenous excreting products
They contain nitrogen end include the following:
Product of dominations result from breakdown of proteins / amino acids and includes ammonia, urea, uric acid, trimethyl amine oxide (TMAO). Products mentioned above depend on the animal and its habitat.
Products of metabolism, these include creatine and creatinine. These result from the metabolism of phosphor in muscles. Bile pigments which result from metabolism of Hb in warn out cell (ABC's). the pigments there include Bilirubin and billirudin.
Products of breakdown of parines and pyrimidine (nitrogenous bases of nucleic acids). Examples include; Adenine, thymines, ceanine.

NITROGEN EXCRETION
Excretion in animals normally involves nitrogenous wastes and to a lesser extent of other waste products of metabolism. These 3 main nitrogenous waste products are:
Urea
Ammonia
Uric acid
These waste products are produced by breakdown of proteins and nucloid acid. The immediate nitrogenous waste product of catabolism of proteins is ammonia. It is produced as a result of deamination by the live.

Diagram

After deamination, the ketoacid is utilised in respiration to yield energy and the ammonia given off may be excreted.
Immediately or converted to nitrogenous compounds of urea and uric acid. Different animals excrete different nitrogenous compounds depending on the following;
Animals ability to control water loss/ uptake
Production of enzymes necessary to control NH_3 into urea or uric acid

Availability of water in the habitat necessary for the removal of nitrogenous excretory materials.

Ammonia

Aquatic / fresh water animals excrete mainly NH3 as their chief nitrogenous waste product and are consequently called amineniateric organisms. Ammonia is an extremely soluble gas and dissolves / diffuses rapidly when placed in water. It is a highly toxic substance and organisms can't stand accumulation of it in the body.

Because of its toxicity, it requires large quantities of water for its dilution. Since fresh water animals live in an environment of abundant water, supply to such animals continuously take in water which they use to necessity of such organism becoming dehydrated. E.g. of such organisms include aquatic fresh water inverted rates, fresh water bony fish and large amphibians.

Urea ($CO(NH_2)_2$)

Animals that eliminate nitrogenous wastes as urea are called ureateric organisms. Urea is less soluble in water than ammonia it is less toxic and therefore require s little water for its safe elimination from the body compared to ammonia.

Urea is formed from ammonia resulting from deamination in a process / reaction called the ornithine cycle.

Diagram

$2NH_3 + CO_2 \longrightarrow CO(NH_2)_2 + H_2O$

Under the influence of specific enzymes, the ornithine cycle allows conversion of toxic ammonia into a less toxic urea and the reaction occurs in the liver. The urea formed is released into blood and the eliminated by the kidneys. Excretion of organism that excrete urea include marine bony fish, cartilaginous fish and many mammals.

Uric Acid

Uric Acid is a purine in the same gap of a demine and granine. Its formation from ammonia requires a lot of energy. Its insoluble in water-non-toxic and requires very little water for its elimination.

It is a suitable excretory product for animals living in dry conditions particularly terrestrial condition.

It is the main nitrogenous waste product for reptiles, insects, birds such organisms that produce uric acid are referred to as uricoteric organisms.

NB:

Guanine is less soluble in water than uric acid, it is the major excretory product in spiders and requires no water for its elimination MAD is soluble and non toxic. It is excreted mainly by fish and it gives fish its characteristic order when dead.

Excretion in earth worms.

Members of phylum amelida have a combined excretory and osmoragulatory organ called the nephridia. This consist of a long tube that converse wastes to an excretory pare called nephridia pore useful materials are absorbed along the tube until urine is finally released out.
A long the tube, wastes move by ciliary beating other organisms such as crustaceans and Cray fish use green glands for their excretion and mainly excrete ammonia.
Platyhelmither use flame cells.
Excretion in insects
Insects are adapted to terrestrial environment because of their ability to conserve water.
This is achieved by the process of an exoskeleton and the ability to excrete uric acid that requires less water for its elimination extensions of the gut at the junction between the mid gut and hind gut. Their distal end extends into there haemecael where they are completely surrounded by blood.

Structure of the alimentary canal of an insect
During proteins metabolism, excess amino acids and nucleic acid are converted into uric acid.
Uric acid is then released into blood where it combines with potassium / sodium hydrogen carbonate and water to form potassium / sodium urate.
Potassium urate is actively taken up by the distal and of the Malphigion tubules

Diagram

$H_2O+KHCO_3 \longrightarrow KHCL.$
$KHU+H_2O+CO_2 \longrightarrow KHCO_3+H_2O+H_2Cl$(uric acid).
Upper segment. Lower segment.

Absorption of uric acid makes the Malphigion tubule to content more concentrated. This causes the entry of water into them because of the existing concentration gradient.
As the urate passes down the tube, they combine with water and carbondioxide to form potassium hydrogen carbonate, water and uric acid. At the proximal end, the Malphigion tubule walls have many micro vili and its here where potassium hydrogen carbonate is actively re-absorbed into the tubules hence lowering the osmotic pressure in the tubule.
This leads to the movement of water into the blood by osmosis. The result is that the PH of the contents in the tubule falls and the uric acid starts precipitating out as a crystal. It is in further absorption of water that takes place along the rectal epithelium on the special gland called the rectal hence concentrating the products before elimination.
Adoption.
They are numerous and this increases the surface area for re-absorption of uric acid.

They have microvilli extensions which also increase the surface area for absorption(particularly at the lower section).
Have the ability to stir co2 then blood in the haemecael as they are able to twist and wriph.
This is because of the presence of spirally arranged type of stratified muscles whose concentration is responsible for their movement**.**
Malphigian tubule(structure)

EXCRETION IN MAMMALS.
Basically mammals have three excretory organs namely; liver, lungs and skin. The skin excretes water vapour, salts and urea, lungs excrete carbondioxide and water while the liver excretes bile pigment.
The mammalian kidney.
(Diagram).

Internal structure of a mammalian kidney.
(Diagram).

Externally, each of the two kidneys in the human body is a bean shaped reddish brown organ. Internally three regions can be identified by in the kidney.
An outer dark red cortex which is the largest of the three layers. Its colour is due to the numerous blood vessels it contains.
Medulla; it is the middle layer.
Inner pelvis usually white in colour and a collecting centre for all the urine from all the inside. Running across all the three regions are tinny tubules called nephrones which are the structured and functional acids of the kidney carrying out both functions of excretion and Osmoregulation.
Each kidney contains about a million nephrones to increase the surface area for water conservation.
These are two types of nephrones i.e.
(i)Cortical nephrone.
These are found in the cortex. They have relatively short loops of henle which extend in the medulla. They are used under normal conditions of water availability to control plasma volume**.**
(ii)Juxtamedulla nephrones.
These have their renal capsule(bowmans capsule and glomerulus)of the junction of the cortex and medulla. They are used when the amount of water is so low so that the body retains a lot of water.
Structure of a nephrone.
Each nephrone consists o f a cup shaped structure known as bowmans capsule enclosing a dense network of capillaries known as glomeruli.The dense capillaries receive their blood supply from a narrow branch of the renal artery known as afferent vessel.The blood leaving the glomerulus enters into a smaller vessel which

is a branch of the renal artery known as the efferent vessel which drains into the blood veins.

THE NEPHRONE (Diagram)

The glomerulus sits in the cap shaped structure called the bowmans capsule from the bowmans capsule, the rest of the nephrone forms a renal tubule with four distinct regions namely;

The proximal convoluted tubule.

This is adjacent to the renal capsule and coils over its self.

Loop of henle.

It is a U-shaped structure with a descending and ascending limb.

Distal convoluted tubule.

Forms the second coil after the loop of henle

Collecting duct.

Portion leading from the di stal convoluted tubule and found in the pelvis. It has many nephrones attached to it.

ULTRA FILTRATION OF RENAL CORPUSCLE

The podocytes are special epithial cells that cover the outside surface of the glomerulus.The renal corpuscle is made up of bowmans capsule and the glomerulus. For ultra filtration to occur, two things are necessary;

(i)There must be a barrier containing pores large enough to allow some substances to pass through and small enough to prevent others from going through.

(II)There must be sufficient pressure to force the fluid through the filtrating barrier.

The capillaries of the glomerulus are more permeable than another in the body. This permeability is due to presence of numerous pores called fenestration between the endothehal cells through. These pores are quite large enough to let blood cells through. The endothehal cells rest on a basement membrane on the other side of which the epithelial cells of the capsule (podocytes).

The epithelial cells of the bowmans capsule form a continuous sheet of cells that is arranged in an irregular pattern. Its cells i.e. pedocytes have processes that extend to the basement membrane of the capillary epithelium.

They are spaces between those processes and between the pedocytes them selves.

The glomerului filtrate, having passed between the endothelial cells and the basement membrane can then new pass into the bowmans carpule vile large slit like pores between the process and between pedocytes.

The blood pressure in the glomerutar is high is high and it is highest at this point than in any capillary system of other organs. This is because the efferent vessel is narrower than the efferent vessel that brings blood into the glomerulus on the glomerulus tends to force the fluids consistent of the blood into the capsular spaces loading to the filtration process.

Filtration takes place through 3 layers

The endothelium of the blood capillary which is perforated with than sands of pores. In these pores, plasma proteins pass through.
Basement membrane of the blood capillary which is a thin layer of cells that under lyses and supports the cells of the epithelium. In the membrane, water and small salt molecules pass through, platelets and proteins molecules. However, RBC's, platelets and proteins molecules don't pass through.
Epithelium of the renal capsules made of the renal podocytes. Filtered fluids passed through the slit forces of these cells.
The molecules filtered in the glomerulus include glucose, A.A, Vitamins, same hormones, urea and some ionic like Na+, K+. The constituents retained in blood include plasma proteins e.g. fibrinogen, globulin album e.t.c. WBC's
NB.
A bout 80% of blood plasma that enters the human kidney is not filtered from the glahurulus, however some substances in the blood may be discharged into the nephrones in the blood may be discharge into the nephrones by direct active secretion from blood capillaries surrounding proximal acculturated tubules.
Substances excreted this way include uric acid;
Direct secretion enables great quantities of such wastes to be eliminated than by ultra filtration alone.

SELECTIVE RE-ABSORPTION (PCT)
All substances useful to the body that are lost through glomerulus filtrate are returned to blood by a selective absorption process which mainly occurs in the proximal conuluted tubules.

THE PROXIMAL CONVOLUTION TUBULE
This is the largest and widest section of the nephrone. It is composed of a single layer of which cuboidal epithetial cells with extensive micro vill at the inner and forming brush boarder.
At the other end of these cells are several invergination s (infolding) called basal channels as shown below.

The cells of the PCT also have numerous mitochondria to provide ATP for different activities the coils of the PTC are tightly arranged by function behind which are intercellular spaces.
At the base of the cells is a basement membrane adjustment to which is a capillary network derived from the efferent arteriate.
Active re-absorption of materials occurs in the PCT and a large portion of the filtrate is re-absorbed into the capillary network at this point:
Glucose, A.A and some ions first diffuse into the cells of actively transported into the fluid of the intercellular spaces and basal channels by carrier protein indecorum from here, these metabolises than diffuse into the capillary blood network.
Sodium ions are pumped from the filtrate into the PCT cells and then similarly transported actively into the blood. This movement of dissolved substances from

the filtrate into the blood capillary network bring about osmotic movement of water in the same direction.
In this way, about 70% of the water is re-absorbed back into the blood capillaries. Some urea in the following filtrate diffuses back into the blood because of the concentration. Difference generated by the water re-absorbed between the filtrate and the blood.
At the same time, poisonous substances are actively selected and then excreted from the blood into the filtrate a long with some nitrogenous wastes such as creatine.
Any blood proteins that may have been forced into the glomerului filtrate by the extra high blood pressure in the glomerulus are taken at of the filtrate at this point by pedocytes vesicles.
As a result of all the processes mentioned above a much reduced volume of filtrate that is isotonic with the body fluids processes into the top of henle.

Adaptations of the PTC cells for re-absorption
They have numerous micro villi and basal channels for increasing of S.A for re-absorption.
Have numerous mitochondria which provide the ATP for carrier molecules involved in the active transport of glucose Na+, and A.A.
The blood capillaries are so close to their cells for on ward transport of materials that have been selectively re-absorbed

Loop of henle
The loop of henle is an organ that is concerned with conservation of water. Birds and mammals are the only organisms with the loop of henle thus it is an adaptation to life on land. The drier the natural habitat of an animal, the longer its loop of henle and the longer the loop of henle, the more concentrated the urine that can be produced by such an animal.
The loop of henle therefore has 2 major functions i.e.
To conserve water
To concentrate sodium chloride (NaCl) along its length

STRUCTURE

The loop of henle has 3 regions namely;
The descending limb
This henle allows substances to diffuse easily through its walls i.e. water and some solutes have its walls are not permeable to ions.

The thin ascending limb.
This is at the lower half of the ascending limb. This portion is impermeable to water.

Thick ascending limb

Which is at the upper half of the ascending limb and has got thick walls at the entire ascending limb is impermeable to water but actively re-absorbs Ci-, Na+, K+ and other ions from the tubules.
Mammals are capable of forming urine that is more concentrated than blood plasma thus Munising excess water loses. This function is achieved by the loop of henle.
How the loop of henle achieves the function of conserving water and producing hypertonic urine.
In the ascending limb, there is active transport of Na+ and of the cells of the ascending limb into the tissue fluid of the medulla by a Na-k pump Na+ then diffuse from the fluid in the medulla by aNa-K pump Na+ then diffuse from the fluid in the rumen of the ascending limb into its cells to replace Na+ lost.
As they move, they pass through a carrier protein which also accepts chloride and potassium ions. These co-transported into the cells with the Na+ against their cane gradient and diffuse out of the cells into the medulla. The process is driven by a Na –k pump and results into the accumulation of Na+,k,cl- while their concentration in the medulla increases. Water molecules however, cannot leave the ascending limb to the medulla because its walls are impermeable to water.
On the hand, the descending limb is very permeable to water and not very permeable to ions .Because of this, a difference of about 200 units between the ascending limb and the medulla and maintained because of the Na-K Pump as shown below.

The high concentration of salts built up in the medulla makes water to leave the descending limb by osmosis such that the fluid in the descending limb gets more concentrated.
The concentration increases from top to bottom resulting in the situation shown in the diagram above.
As the water molecules move out of the descending limb into the medulla, they are carried away by the blood vessels of the vasarecta resulting in the glomerulus filtrate becoming concentrated.
The vasarecta follow the loop of henle and the changes in the composition of blood in it are similar to those in the medulla. The loop of henle there fore forms concentrated urine by acting as a counter current multiplier system. Counter current exchange, system is one that involving the exchange of material between fluid moving in opposite direction.
Counter current multiplier system is one that involves the exchange of material between fluid moving in opposite direction and the active secretion of solute from loop of henle the fluids resulting in the formation of a very concentrated fluid.

Counter current flow in the vasarecta
The vasarecta is a blood capillary system supplying the medulla with nutrients and as well draining water and wastes. It is branched into the descending and ascending capillaries running parallel to each other.
The capillary system is very close to the two limbs. Substances pass from the filtrate into this system via the interstitial region of the medulla where the slow movement of materials in the region makes it possible for the exchange of materials.

As the descending capillaries enter the medulla, they encounter an interstitial region with very high solute potential. This therefore makes water molecules to drawn out of the blood plasma by osmosis into the medulla region while NaCl and urea enter by diffusion. As blood flows from the medulla in the ascending enables water molecules to be re-absorbed into the blood while the NaCl and urea move out of the medulla.
In this region, therefore movement of NaCl and urea doesn't require energy because it is completely a positive process (osmosis).
NB:
The calls of the vasarecta are permeable to ions, water and urea &as these vessels run side beside, they create counter current exchange system.
Difference between the Descending and Ascending limbs of the loop of henle

DISTAL CONVOLUTED TUBULE:
This is the second coil after the loop of henle joining to the collecting duct on the other end. The cells of the D.C.T have a brush boarder boundary (ies) and abundant mitochondria. The D.C.T is the centre where the fire control of salts, water and the PH balance of blood takes place.
The PH of blood is maintained at a constant value of approximately 9.4.The value however, tends to be lowered as a result of accumulation of the H+ produced from dissociation of carbonic acid counteracted immediately by Hb i.e. Hb buffered by their combination with hydrogen carbonate ions and phosphate ions to produce the weak acid respectively hence preventing the excess H+ produced by metabolic acid activities from rising.
The role of D.C.T cells and collecting duct cells in the control of blood PH is in two ways i.e.

If the blood PH lowers. The H^+ produced are secreted by active transport across the cells surface membrane of the D.C.T and collecting duct ells from blood into those tubules.(filtrate).The reverse may happen if the PH of the blood rises. The PH of urine therefore can vary from 4.3-8.5 as a result of those changes. If the PH is raising the HCO-3 are also secreted.
A fall in blood PH may also stimulate the kidney cells to produce a base ion (NH^+) which combines with the acid brought to the kidney to form ammonium salts which are then excreted.

COLLECTING DUCT:
Collecting ducts are tubes which pass from the DCT in the comedown through the medulla where they join with duct to form large ducts known as duels of bellin.
As the collecting duct passes in the medulla region the filtrate in it losses water by osmosis forming a very hypertonic urine, more concentrated than blood. The permeability of the walls of the collecting ducts to water and urea is under the control of anti-diuretic hormone which indirectly regulates water re-absorption in this region.

OSMOREGOLATION

This refers to ability of the kidney nephrone to control the volume and cane of urine. The cane urine is controlled by the absorption of water and salts from glomerular filtrate.

Regulation of water by the kidney

The centre for the control of water in the body is the hypothalamus which is located in the brain. The homeostatic control of water in the body is a negative feedback mechanism.

An increase in blood concentration as a result of dehydration or taking a salt meal is defeated by the Osmoreceptors in the hypothalamus. The hypothalamus then fires impulses to the posterior loop of the pituitary glands. As a result, the pituitary glands release the hormone (vasopressin) ADH in the blood.

The hormone has its effect in the kidney nephrones where it increases the permeability of the DCT and the collecting ducts to water.

This causes more water to pass from the DCT and collecting duct the medulla and black into the blood. This leads to formation of hypertonic urine which is small in amount.

ADH also increases the permeability of collecting duct to urea which then passes through the collecting duct to the medulla making the medulla even more concentrated so that a high osmotic gradient is created leading to osmotic movement of water from the collecting ducts and the loops of henle into the medulla and eventually into blood.

A fall in blood concentration resulting from the intake of too much water is again detected by the Osmoreceptors and will result in the inhibition of release of ADH. As result, little or no ADH is produced hence the walls of the DCT and collecting ducts are made impermeable to water and this leads to the production of dilute/hypotonic urine which is large in amount.

NB:

Osmoreceptors in the hypothalamus also stimulate drinking by making one feel thirsty when blood concentration increases. At sometime, they inhibit drinking when blood is dilute. Failure of the pituitary glands to produce enough ADH results in the production of carpious amounts of dilute urine regardless of the water potential of blood.

This leads to a condition known as diabetes inspidus.

REGULATION OF SALTS(Na+)

Plasma sodium level is kept stable by a hormone called aldosterone which also influences water re-absorption.

A decrease in blood volume due to loss of Na+ stimulates a group of secretary cells called the juxtaglomerular complex situated between the DCT and the efficient arterial to release of hormone called **Rennin**. Rennin activates angiostensinogen (a plasma globulin produced in the liver) to the active form called angiotensin.

This stimulates the release of aldosterone from the adrenal cortex. Aldosterone then stimulates active uptake of Na+ from the osmotic potential of blood and results in osmotic absorption of an equal amount of water.

Fresh water organisms

The main problem fresh water organism as far as Osmoregulation is concerned is that they live in an environment with solute concentration that is far less than that of their body tissues. As a result of this, they tend to face two problems namely;

(a)They tend to gain water by osmosis.

(b)They tend to lose salts by diffusion.

Because of their problems, they need to eliminate the excess water as fast as it accumulates in their tissue and they need to actively take in salts from the surrounding water to replenish those lost.

Fresh water protozoa e.g. amoeba

These employ a contractile vacuole to solve their osmoragulatory needs. The vacuole fill up with water expand and then moves through the cytoplasm to the cell membrane where it discharges its contents to the exterior via its pore. The vacuole has the ability to adjust its filling and emptying capacity depending on the rate of entry of water in the body.

The entry of water into the contractile vacuole is an energy requiring process and this explains why contractile vacuoles are surrounded by various mitochondria.

Fresh water bony fish (Teleosts)

E.g. Tilapia, **N**ile perch.

Teleosts posses gills and kidneys as their excretory and osmoragulatory organs. They are covered with scales and mucus all over their body that prevents loss/gain as well as blocking of exchange of salts. Bony fish, however, have the gills, the lining of the mouth and the pharynx as areas that are exposed for exchange of water and mineral salts.

Fresh water bony fish have a higher body fluid concentration than the fresh water in which they live therefore the expose pads mentioned below above act as a point through which too much water enters their bodies through diffusion.

Bony fish employ one or more of the processes mentioned below to remove the excess water that enters and their bodies and conserve salts in their bodies.

Maintenance of high filtration rates in the kidney by having many large glomeruli. Because of this, they therefore eliminate most of the excess water in very large quantities of urine that they produce.

Having kidneys that have high abilities to re-absorb NaCl in their tubule. The result is hypotonic urine is produced through conserving most of the salts and eliminating only a very small proportion. This enables them to maintain the internal osmotic concentration more relatively the same as that of the external environment.

Posses chloride secretary cells in the membrane of their gills which actively absorb salts/ions from the water and this enables them to replace the salts that are normally lost along with urine.
Removal of their nitrogenous wastes in form of ammonia which is highly toxic and there fore require a lot of water for its elimination.
Active absorption of salts taken with food within the gut.

Marine Organisms.
The main problem facing marine organisms as far as their Osmoregulation is concerned lies in the fact they live in an entrapment with a more negative water environment than their body fluids.
As a result, there is a tendency for them to lose water by osmosis and to gain salts by diffusion which may lead to dehydration of their body tissues. There are tree possible solutions to their problems i.e.
Conserving water/replacing it at a rate as fast as it is lost.
Actively removing salts from the tissue to the surrounding water to counteract the possibility of high concentration i.e. the tissues.
Maintaining a similar lisetonic concentration with the sea water in which they live.
Though the third method is extremely rare, it is employed by marine invertebrates e.g. sea anemones starfish spiders crabs e.t.c. The first mechanisms mentioned above so as to avoid dehydration. The following are the specific mechanisms by which they achieve this.
They normally swallow large amounts of sea water from which they absorb water via their intestinal walls. The water is passively absorbed by osmosis in the intestines to replace any water lost.
Maintenance of flow filtration rates in the kidney due to the fact that these fish normally have kidneys with few and small glomeruli resulting to the production of small volumes of urine hence minimising water loss.
Active out ward secretion of excess salt by chloride secretary cells in the epithelium of their gills which is necessary to keep their internal osmotic concentration low.
Elimination of nitrogenous wastes mainly in the form of TMAO which is a soluble non-toxic substance thus requires very little water for its removal.

Marine cartilaginous fish
E.g. sharks, Roy e.t.c
Though their tissues contain a lower salt concentration than that of the sea water in which they are living, they have been able to achieve osmotic concentration that is slighter higher than that of the sea water by retaining the excretory product urea. This eliminates the osmotic out flow of water by but it requires that the tissues of these animals are tolerant to such abdominal high level of urine. The gills of these fish are impermeable to urea and urea cannot be lost via the blood system. The resulting osmotic concentration of such fish therefore eliminates the need for chloride secretary cells and therefore these fish don't have them.
Osmoregulation of migratory fish (fish that migrate from sea water to fresh water).
To be able to complete such a migration, an animal must be capable of maintaining

the osmotic pressure independent of fluctuations in the salinity of the surrounding water. Some animals i.e. shore crab carbcaraus is capable of some degree of Osmoregulation.
In dilute sea water, the osmotic pressure of its body fluids is maintained above that of the surrounding water. This enables it to live in the bearish water or estuaries.
Some other animals like crab encoder are able to penetrate up stream into completely fresh water although Osmoregulation is necessary for permanent migration ford sea to fresh water, it is not the only means by which a marine animal can with stand dilution of its surrounding medium.
If may posses tissues that can forelate wide range of salinities ehy and Rag worms.
It may avoid the effect of dilution by Behavial means i.e. the snail hydrabia which borrows into which mud when the tide is going out.
The problem facing a fresh water animal is that Opi is greater than Ope. The danger here is dilution of the tissues resulting from the osmotic influx of water across the exposed semi permeable surface of a body.
On purely the critical grounds, there are two solutions to those problems;
Water might be eliminated as fact as it caters by means of a kidney or some equivalent structure, salt being re-absorbed from the water before it leaves the body resulting in the production of hypotonic urine.
Salts might be actively taken up from the external medium thereby offsetting the diluting effect of the inflowing water.

Adaptations of Animals to Water Conservation
By having a water proof integument. This may take on several forms e.g. reptile, the body is covered by keratinous seals which minimise water loss through evaporation. Insects have developed a waxy cotide for the same purposes. In mammals they have developed a cornified epithelium which provides for both physical protection and insulation against water loss.
By reducing the glomerular filtrate rates as the case in marine telecasts which reduces their glomeruli. The same applies to charlottes has very few and small glomerulus. Some animals particularly desert animals have got long loop of water. Desert mammals have an extra long loop of henle and produce more concentrated urine which is four times is concentrated as human urine.
Other animals inhibiting dry hot habitats particularly the insects excrete uric acid which is less toxic and thus the mammals and amphibians excrete urea which though toxic in high concentration is less toxic than ammonia and requires less water for its removal.
Other animals reduce water loss from their body by behavioural methods e.g. a kangaroo sat cots down on evaporation of water from its body by remaining in its burrow during heat period of the day, other organisms go into a state of dormancy during the dry season (gestivation). This is the case with Africa and South American lung fish.
By using metabolic water. Some organisms are able to utilise water that is the product of aerobic respiration for their osmoragulatory needs. This is with the desert

kangaroo which utilise its metabolic water so effective by that it never needs to drink.
By having tissues tolerant to water loss. The camel has tissues that are extra or dinarily tolerant to dehydration.

PLANT EXCRETION AND OSMOREGULATION
Differences between plants and animal metabolism make the processed excretion in plants less significant than that of animals. Plants don't have as many problems as regards excretion composed to animals. This is because of their differences in physicalogy and modes of life.
There are 3 major non-nitrogenous water substances produced by plant namely; Oxygen, CO2 and water. Carbon dioxide and water are recycled and are used as the major raw materials for photosynthesis while O2 which is abi-product of photosynthesis and is used as a raw material for respiration.
For this reason, plants don't require special excretory and osmoragulatory organs as compared to animals. Other wastes products of plants e.g. the back of stems or within leaves of flowers which are periodically lost from the plant.

Adaptations of Plants to Water Conservation
Most organic compounds which may prove harmful to plants often combine with excess cat ions and precipitates out as insoluble crystals which can be safely stored in plant cells e.g. Ca^{+} ions and sulphate ions are taken up together but SO_4^{2-} are used directly in amino acid synthesis leaving an excess of $Ca^{2+.}$ These combine freghy with ataxic and paretic acids to form harmless soluble products e.g. CaC_2O_4 and calcium pectate.
Other ions e.g. Fe2+, Mg2+ and organic acid e.g. tans and anthaeyanin e.t.c. pass into the leaves where they accumulate and contribute to characteristic link of leaves prior to their loss during leaf abscission without leaf loss but also through petals, Fruits and seeds.
Aquatic plants lose most of their metabolic wastes by diffusion directly into water surrounding the implying that there is no need for an excretory organ.
Plants generally have a low metabolic rate as they involve in any requiring activity e.g. movement, which require muscular contractions. In this state less waste products are produced by plants which take long to accumulate.
Many excretory products in animals result from proteins metabolism and plants have few proteins metabolic reactions.

WATER CONSERVATION IN PLANTS
Plant structures i.e. arrangement of tissues i.e. essentially to all flowering plants. Some plants have been modified in such structures so as to conserve as much water as possible. Other plants have modifications which may encourage excess water loss from their bodies.

Types of plants
Hydrophytes.

Xerophytes.
Halophytes.
Mesophytes.

HYDROPHYTES
These are plants which live submerged in water either partially or wholly e.g. water weeds because of the high density and visco city of water, these plants are normally supported.

Characteristics
They have little or no lignified supporting tissues and that's why they are mainly supported by water.
Xylem tissues
Their stems and leaves lack a waxy cuticle.
Stems and leaves have large continuous air spaces forming a reservoir for O2 which also provides buoyancy to the plant tissues when submersed.
They have mainly stomata and much more on the upper surface than the lower surface.
NB:
Hydrophytes face no water problems.
HALOPHYTES
These are plants which are found in areas of high salinity such areas are salty marshes.
Characteristics
Their roots grow in mud and their sheet in the air.
Have breathing roots and stilt for breathing and extra support respectively.
Have large intercellular air spaces in the stem and roots giving buoyancy to the plant.
NB:
These plants have a problem of obtaining water being located in areas of high concentration than their cell sap. This causes water to move out of them by osmosis and diffusion of salts in them. In this way, they got to have adaptations that help to conserve water as much as possible.

XEROPHYTES
These are plants which are found in areas where water is scarce (dry land areas) e.g. desert plants that survive successfully under these conditions show features that minimise water loss due to transpiration.
Characteristics
Have a thick waxy cuticle and reduced number of stomata.
Have deeply sunken stomata which increase humidity so that the rate of transpiration is lowered a round that area.
Have lignified cells of dermis, mesophyll cells and guard cells that prevent water loss.
Some have succulent leaves for water storage.

Some plants reserve the normal stomata rhythm i.e. opening the stomata at night and closing them during day e.g. CAM plants.
Some plants have a deep root system so as to absorb water at all layers of the soil.
Have tissues tolerant to desiccation.
Shed their leaves occasionally to reduce water loss.
Have short life cycles to avoid droughts.
MESOPHYTES
These are plants that are found in habitats with high/ adequate water supply.
Characteristics
Have broad leaves but thin leaf blades.
Have a thin cuticle.
Have a well adopted vascular system
Stomata are not sunken.
Adaptations of plants to conserve and avoid excess water loss
Some plants are succulent so that they store a large amount of water e.g. cactus plants.
Some plants have deep root system which can absorb water deep in the soil as well as superficial roots that absorb water from the surface.
Many plants survive dy periods as seeds/spores and in this way they avoid problems of water loss since seeds have a hard protective testa.
Plants in arid areas have reduced number of stomata. They have reduced number of stomata especially on the upper surface of the leaf to reduce the rate of transpiration.
Some plants have sunken stomata so as to trap moisture and in this way the rate of transpiration is reduced.
Some plants have green small leaves so as to reduce the surface area for transpiration.
They have blood leaves as seen in certain grasses so as to trap moisture that reduce the transpiration gradient.
Some plants have reversed their stomata gryphon and open up only at night.
They have a thick waxy cuticle to reduce cuticle transpiration.
Some plants shed off their leaves during dry conditions completely within off stomata transpiration.

10.HOMEOSTASIS

It means maintaining a constant internal environment. The internal environment means the immediate surrounding of the body cell.The maintenance of stability of the internal environment requires control system capable of detecting any deviation from the normal and making the necessary adjustment to return it to the normal condition.

COMPONENTS OF HOMIOSTATIC PROCESS.

A reference or set point

This is the set point at which the system operates. Sometimes, it is usually given in form of a range.

Detectors

These are signals which indicate the extent of the deviation from the set point e.g. the kidney for water.

Controller

This coordinates the information from the various detectors and sends out instructions to correct the deviation.

Sensors

These consist of receptor mechanism that measure a condition of the internal environment and constantly monitor of Extracellular environment hence relay the information to an integrating central control centre sensors are therefore receptor organs that defect any changes in stimuli occurring in the internal environment.

integrating /control centre

This is where information is sent arm then receptors of information. It normally contains of set (proper value at that condition). When it receives information from the sensors, it weighs the relatives strength of each sensor input and therefore determines whether the value of the condition in deviceting from the set pf. When deviation in a condition occurs, this centre initiates an appropriate correct measure. This centre is usually the brain lesser spinal cord.

Effectors.

They are usually the muscles and glands and they carry out the effective measures. They defend the set pf of the body against deviation. It is because the activity of the effectors is influenced by the effect it produces and because this regulation is in a negative / reverse direction that we all a negative feed back mechanism.

Negative feed back mechanism

Diagram

Feed back

This is the use of the output of a system to control its performance.

Negative feed back

It is when the output of a system is used to decrease / reduce the input so as to restore a steady state.

Positive feed back

Here the output is used to increase input.

Qualities of an efficient homeostatic mechanism

It should respond quality to any deviation/change in the normal condition of system.

It should result into small fluations from the set point.

Importance of feed back mechanism

They play an important role in maintenance of the state of equilibrium in an organism.

Tissue fluid formation and composition

A tissue fluid is formed from blood by filtration at the capillaries. It has the same composition as blood plasma minuet blood and plasma proteins. The process involved in tissue fluid formation is ultra filtration where filtering bacteria is abasement membrane of which of cells of capillary wall rest. The blood cells and plasma proteins are too large to go through the tiny pores of the basement membrane and are often retained while water and other components of blood plasma are allowed to go through.

Tissue fluid formation is controlled by two forces mainly hydrostatic and osmotic pressure.

Hydrostatic pressure

This is caused by the contraction of the ventricles of the heart due to the pumping action of the heart and the resistance to blood flow offered by the capillaries.

Osmotic pressure

This is created by the presence of plasma proteins in blood. The hydrostatic tends to forced water; ions and small molecules out of the capillaries while the osmotic pressure tends to pull water banks into the capillaries.

At an arteriole end

The hydrostatic pressure at the arteriole end is greater than the osmotic pressure therefore ions small molecules into the tissue spaces. As a result, the hydrostatic pressure along the capillary falls.

At the venule end

The hydrostatic pressure along the capillary falls such that the osmotic pressure causes water to diffuse from the tissue fluid back into the capillary.The osmotic pressure is high because of the loss of water from the blood concentration in the plasma creating a high osmotic gradient and therefore the amount of fluid flowing out of the capillary at the arterible end is greater than that being taken to the venule end.This is because the osmotic pressure at the venue end still remains far smaller than the reduced hydrolytic pressure. As a result of this, a large amount of fluid remains a round the cells circulating around and this is actually what forms the tissue fluids.This fluid is later drainage by the lymph vessels thus becomes lymph. Lymph then move through the lymphatic system and finally gets drainage back into blood for the left sub clavier vein.

Homeostatic control of blood glucose levels

Glucose is a vital ingredient of the tissue fluid. It is normal value is approximately 90mg/100cm^3 of blood. For most tissues, glucose is the most ideal respiratory substance which is used to generat ATP required.

Glucose is the prepared fuel molecule for both cardice and skeleton muscle. It is the only metabolic fuel molecular absorbed by the brain because neurone in the brain are unable to respire lipids. Most cells are easily managed by low glucose levels in blood have to maintain constant and this in maintained by two homeostatic organs i.e. the liver and pancreas.Regulation of glucose is co-ordinated via to specific hormones i.e. insulin and glucogen.

The pancreas

In addition to its rate in digestion, the pancreas also plays an important role as an endocrine gland i.e. its involved in the production of hormone.Throughout the pancreas are group of diff cells called the inlets of larger one which produce hormones important in the regulation of glucose levels in blood. The alphas which are the larger ones secrete glucogen while the cells secret insulin. Once produced, these hormones are discharged in blood where they are taken to the lives.This is because the liver can not perform the role of glucose regulation unaided. It has to receive information instructing it to dose and this information comes as insulin or glucogen.

When the blood glucose level rises above normal, this conditions stimulates the beta cells of the islets of turgerhane in the pancreas to secrete into blood the hormones called insulin on reaching the liver, the insulin exerts its effect as follows;

It increases the oxidative breakdown of glucose.

It facilitates the conversion of glucose to glycogen. This process is called **glycogenesis**.

It facilitates the conversion of glucose into fats in the adipose cells.

It inhibits the formation of glucose as it is removed from the blood thereby resulting into the reduction of its level.

Failure of one's pancreas to release the correct level of insulin leads to blood sugar levels exceeding the normal level. This result into a condition called hyper-glycaemia. Should it reach a critical level, glucose

starts to appear in urine and such as condition is called glycosulia. This leads to diabetes mellitus.This condition can be regulated by injecting the victim with correct amount of insulin.

The secretion of glucogen is stimulated by a fall in the blood of glucose level. A condition called hypoglycaemia. When glucogen reaches the liver via blood circulation, it stimulates the following;

Increases the rate of breakdown of glycogen to glucose. This process is called glycogenolysis.

It increases the rate of conversion of amino acids and glycerol into glucose and this process called gluconeogenesis.

In some situations, glucogen is assisted by two other hormones called glucocorticoids and adrenaline both produced by the adrenal glands. In this case the hypothalamus defects the low glucose level in blood and instructs the pituitary gland to produce adrenal corticotrophic hormones (A.C.T.H) which cause adrenal glands to produce the two hormones above.

The two hormones above cause rapid conversion of amino acids and glycerol to glucose.

NB: Adrenaline is produced mainly in emergency situations where the glucose level has to be increased quickly like during running, fighting or stress.

homeostatic summary of glucose regulation.

Diagram

LIVER

Structure

It is the largest organ and the main metabolic centre of the body and thus one of the most important homeostatic organs. The cells of the liver are called hepatarytes and they show no functional or structural differentiation.They have a prominent nucleus, Golgi apparatus (transportation of lipids) many mitochondria (path of ATP), lysosomes and a rich store of glycogen granules stores. They also have a lot of geroxisomes which secrete catalyse enzyme. Hepatcytes are simple cells forming single rows along the epithelium of small blood capillaries called sinusoids are ting bile canals known as canallculi.

Diagram

The Hepatocytes are arranged in row called liver coids radiating from the liver tubules between which are wider Sino solids and narrow canallculi. Blood reaches each lobule via branches of the hepatic artery and hepatic portal vain. It then flows through the sinusoids towards the central branch of the hepatic vein and as it does so, the Hepatocytes remove nutrients from it and also release their wastes into it.The bile that is released by the Hepatocytes is secreted into a canallculi where it is taken into the gallbladder for storage. Bile and blood therefore for opposite directions. Associated with the Hepatocytes are phagocytic macroghogen know and as chuffer cells which destroy won out Red blood cells, bacteria or any foreign bodies.A part from carbohydrates regulation in blood the liver plays several other homeostatic functions in the body size.

i. Regulation of amino acids and proteins.

Liver is responsible for the synthesis of non-essential amino acids in the process called traneamination e.g. gultanic acids is formed from an amino acid called alamine combing with an organic acid (ketoacid) from or-oxoglutanic acid.

The liver also gets rid of excess proteins since these are not stored in the body. These proteins are 1st dominated i.e. an amino group is removed from them to form ammonia. The ammonia is then converted to a less toxic urea for excretion. This occurs through a cycle known as the urethane cycle.

The liver also synthesis plasma proteins e.g. albuma and globulin from amino acids.

ii. Detoxification.

It renders harmless and drugs that enters the blood by changing them chemically e.g. hydrogen peroxide which is by-product of many metabolic process i.e. broken down to oxygen and water by catalyse enzymes in the Hepatocytes.

Toxic ammonia is also converted to the less toxic urea. Alcohol is also delt within the same way.

lipid metabolism

Converts excess carbohydrates to fats. Breaks down fats into fatty acids and glycerol for respiration Hepatocytes remove excess molecules from blood and therefore prevent it from accumulating. Cholesterol has the effects of being deposited in the walls of the arteries leading to their obstruction. If it occurs in the arteries, supplying of heart, total condition known as coronary thrombosis occurs which may lead to heart attack.

Inactivation of enzymes

This is done after the hormones have achieved their effect. This is homeostatically very important because such hormones would continue with their effect and therefore affect the balance.
They would have helped to create.
Production of Bile
Haemoglobin is broken down by the chuffer cells into haemo and globin. Globin is further broken down to its individual amino acids. Iron is removed from haem and the remaining part of the molecule from a green pigment called biliverbin. It is then converted to Bilirubin (yellow) which is a component of bile.
In this way, the chuffer cells break down won out red blood cells to produce bile pigments i.e. bilivedin and bilivubin. The iron that was removed is stored in liver or used in formation of new cells. In the factious, R.B.Cs are made in the liver while in adults, they manufactured in red born marrow. After their life span of 120days, the chuffer cells destroy them as presented above.
Temperature regulation.
Owing to the consistent height metabolic rate and large size and excellent blood supply.
The liver serves as an organ in which heart is generated and transferred by blood to other parts of the body.
The livers together with skeletal muscle activity are used in thermal regulation of most endotherms.
Storage of blood and vitamins.
Veins in the liver get powers of expansion and contraction of an extent that the total volume of blood in the liver varies between 300 – 1500cm3. this enables the liver to serve as a blood reserve in the event of haemorrhage, constriction of these vessels forces the blood into the general circulation to replace blood lost and hence maintain blood pressure. The liver also stores fat-soluble vitamins i.e. A, D, E, K as well as water soluble vitamins B and C.

TEMPERATURE REGULATION
Most organisms live in a narrow range of temperature. To survive, most animals need to exert some control over their body temperature. Temperature regulation of the body is called thermo-regulation.
The necessity to regulate body temperature stands for the fact that organisms can remain active only if they maintain high enough body temperature to enable enzymatic reactions to proceed at rates fast enough to satisfy needs and that the same for the temperatures not to be too high to deactivate enzyme.
Low temperatures on the other hand result in reduced metabolic rates that are due to inactivity of enzyme since body temperatures keep on changing all the time there is need to gain /lose temperature as conditions may necessitate

METHODS OF HEATGAIN BY THE BODY
Metabolism of food (cellular respiration)
Muscle contraction
Radiation conduction or convection to or from an external source.

Methods of heat loss by the body
Evaporation from the body
conduction from the body
convection from the body

NB: Heat gain/loss depends on factors which may include;
Temperature variation in the environment here on warm days, heat gain is higher than loss.
Other prevailing weather conditions such as air movements which lead to heat loss than heat gain.
Size of the organism: small organisms lose heat much faster than large organisms.
Body metabolic rat: small organisms have a high metabolic rate than the large ones so as to compensate for the much heat that is lost to the surrounding.

Fluctuation in an ectotherm with that environment
Diagram

Size and metabolic rate relationship of endotherms
Diagram

As shown in the graph above, the larger the endotherm, the lower the O2 depend (the lower the metabolic rate) and hence the lower its energy demands. Endotherms release heat in their bodies mainly by respiration. The amount of heat lost from the body through the volume the body and on the surface area. However, the amount of heat lost from the body through the skin depends on the surface area of the skin. As animals grow larger, relative to their volume, their surface area increases at a low rate.
In terms of heat exchange a bulky animals like an elephant has a larger volume of tissues in which heat is released but relative to this is a smaller surface which heat which is to the environment.
Smaller mammals on the other hand like rates have a small volume of tissues and relatively large surface area through which heat in lost from their body. Thus their O2 consumption is very high so as to keep high metabolic rate that satisfy their energy demand.
The rate of metabolism thus contracts heat production and from the above, it is clear that smaller mammals with a large surface area through which heat is lost shows the highest metabolic rate
Respond fast to variation stimuli organisms have accelerated development.
Oates hence begins reproduction earlier.
Advantages of endotherms
Can live in a wide range of environment irrespective of prevailing temperature.
Enzymes controlled activities within their bodies proceed efficiently most of the time since an optimum body temperature is always maintained making them more active, speedy and fast response to stimuli.

Disadvantages
- Since most of the heat used to maintain body temperature is generated through metabolic means endotherms requires high food intake and this can be a problem if an endotherm is in a food stressed area.

Temperature regulation in mammals
Mammal lose heat through any surface that came into contact with the bodies in relation to other areas or heat exchange only heat exchange through the skin that can be controlled. Thus the skin is an important thermal regulatory organ because of its position and structure.

MAMMALIAN SKIN
The epidemic of the skin is made up to layers i.e.
Cornfield layer (stratum conium)
It is made up of the dead cells impregnated with keratin. Its rough and preterm the body against water loss and entry of germs.
Granular layer (stratum granulosum)
It is made up of the living cells
Malphigion layer (germinative layer)
This contains melanin which is a pigment that determines skin colour. Melarine absorbs ultraviolet light thus protects the tissues beneath from damage.

Diagram

The dermis contains the following structures which are very important for temperatures regulation.
The sweat glands:
They are of two (2) types
They are coiled tubular gland surrounded by a network of blood capillaries.
They absorb tissue fluid from which blood and secrete it into the sweat duct form where it is cancelled to the skin Evaporation sweat

Hair:
All animals have hair far all over their body surfaces.
This hair is made of dead cells impregnated with melamine contraction causes the hair to erect.
When the hair is erect, it traps a layer of air and because air is a poor conductor of heat, it insulates the body in comparison that their tropical relative.
Subcutaneous fat:
Fat is a poor conductor of heat and therefore the adipose tissue is an important thermal insulator.
Temperate animals have a thick adipose tissue then their counterparts from tropics / deserts.
Blood vessels

Heat is taken into the dermis by blood in arterioles and capillaries where volume of blood flowing through which dermis is high, much heat from body. It occurs when the arterials in the skin are astute of roselilation. Blood flowing through the human skin can be reduced by vasoconstriction hence reducing heat loss to the environment.

Nerve endings

These include sensory receptor of touch, heat, gain and cold. These endings are associated with detecting changes in the environment. They include

Kranses and bulbs which are sensitive to cold

Ruffind endings which are sensitive to heat.

Other receptor includes:

- Sensitive to touch pacinian carpassels (pres) and free nerve endings (pain and air movement)

Response to heat by endotherms

It moves anatomical behavioural and physiological mechanism which comes into play to reduce heat from the body.

Vasodilatation

The superficial blood vessels are dilate such that more blood is brought up near the surface of the skin from where it can easily lose heat by radiation.

sweating

It involves the secretion of a watery fluid from the sweat glands of the skin. Evaporation of sweat carries along with it a great amount of heat hence cooling the body.

Painting

Mammals with a few or no sweat glands like dogs cool by painting; this greatly speeds up the evaporation of water from the Meath and lungs.

Painting is thought to be more effective at cooling the body than sweating.

A fall in metabolic rate ensures that less heat generated by the body. It explains why endotherms are generally less active in hot weather.

The body hair lies more or less flat on the skin. This prevents air from being trapped thus enables heat to escape from the surface hence cooling the body.

Behavioural mechanism. They include;

Burrowing into the soil

Passing water ever the body

Moving to a shed.

Other adaptations to hot environment.

Insulating.

Animals is a hot environment has less hair on their bodies and less adipose tissue below their skin.

This ensures that heat is not prevented from radiating to the environment

Variation in body temperature

Some desert animals allow their body temperature to falcate within a specific range. In cannels this range is between 34 – 42^0c. By allowing their body temperature to rise during hot conditions, they reduce the temperature gradient between their body and that of the environment hence reducing the animal conserves as much water as possible.

Surface area

Endotherms is warm climates frequently have large extreme ties such as the ears tongues than their counter parts in cold climate. This can be seen in the African fox compared with the Actins fox. These extreme ties normally have relatively short hair and are well supplied with blood capillaries hence making them good radiators of heat to ensure that a lot of heat is lost from the body.

Behavial mechanism.

Some desert endotherms have resorted to aestivation so as to avoid excessive heat gain.

Other endotherms avoid over heating during the day by becoming nocturnal e.g. the desert kangaroos.

Response to cold by endotherms

The superficial blood vessels in the skin constrict (under go vasoconstriction) which reduces the amount of blood reaching the skin since most of it is diverted to a deeper blood vessel through the short vessel. This reduces heat loss to the surrounding

In the extreme ties heat is likely to be lost but there are short that take blood to and from the superior ficial capillaries of the skin. There short vessels therefore divert blood going to the skin surface and take it deeper into the skin.

Shivering

This is an involuntary rhythmical contraction of the skeletal muscles of the body which result in the body generating metabolic heat. This also causes the contraction of the smooth muscles in the skin forming gaseous pimples

The body hair is raised as a result of the contraction of the erector pilli muscles

There is an increase in the metabolic rate especially by the liver induced by hormones like adrenaline and thyroxin. It leads to the generation of heat that maintains the body temperature constant. This however, requires high food intake and therefore explains why actin mammals consume more food per kg of body weight than those in the tropes.

Adaptation of endotherms to cold

The extremis of endotherms in cold regions are maintained at a lower temperature than the core body temperature.

The core body temperature is the temperature of the tissues below the level of 2.5 underneath the skin surface; it's measured by taking that of the rectum. This reduces the temperature gradients into the body and the environment.

It helps reduce heat loss from feed which are in contact with the cold ground. This is achieved by a counter current heat exchange system in the limbs of certain birds and mammals. In the flippers of the whales and in blood supply to the testis in the mammals. In the counter current, heat exchange system, arterial blood flowing towards the end of the limb gets gradually as it moves toward the body.

It is because the arterial blood temperature is constantly being transferred to the venous blood so that by the time the blood gets to the feet, it has the same temperature as the cold environment and hence there is little / no heat loss that occurs.

Structure
Diagram

Animals in the cold climates have a tending to be more compact and large with smaller extremities than their relatives in warmer areas. Compact bodies present a very small surface area to volume ratio thus they lose less heat.
These animals have a thick layer of subaitaneous fat insulates the body against heat loss. In addition, they have got thick fur.
They engage in Behavial mechanisms which include being active only during the day (diurnal)
Small animals like shrews and rats survive the cold months by hibernating to survive the adverse heat loses they would encounter. They store food in form of fat and glycogen i.e. using during hibernation
Some others (small mammals) coddles in gps to reduce heat loss.

THE BRAIN AND REGULATION OF HEAT IN THE BODY

The hypothalamus in the brain serves as the monitor and regulators of body temperature. The part of the hypothalamus concerned with this process is the thermo regulatory centre and is composed of a heat gain and heat loss contras

Skin thermo receptors (cruises and bulbs and Ruffins ending) monitor temperature changes at the skin (envital temperature change) and report them to the hypothalamus via parental sen sory nerves in forms of impulse.

The hypothalamus itself can detect temperature changes within the body from the blood that flows through it.

After detecting these temperature fluctuations from the skin and body, the hypothalamus responds from the impulses through the motor nerves to the appropriate effectors i.e. these bring about temperature control e.g.;

Skin arterioles which may constrict / dilate
Sweat gland which may secrete sweat or not
Adrenal medulla which may produce adrenalin
Skeletal muscles (shivering) contraction of skeletal muscles
Thyroid glands which may produce thyroxin

Effects of Lowering and Raising Environmental Temperature on Body Temperature Regulation

The ability of organisms to adopt to extreme temperatures from one organism to another body temperature regulation combines physical (in latory) and chemical (metabolic) means as graphs below, there is a relative extent to which there mechanisms can be stretched if environmental temperature is lowered / raised.

Diagram

A – Lower that temperature – lowest environmental temperature at which due to hyperthermia in metabolic means can no longer regulate temperature
B – Lower critical temperature
C – Upper critical temperature – Highest environmental temperature at which metabolic means alone can no longer regulate body temperature.
The graph above shows of aspects of environmental temperature as explained below; When environmental temperature lowers, the subject will first rely on physical means to maintain a constant body temperature. In this period, the metabolic rate remains unchanged as shown by part BC. However, at a certain environmental temperature, the physical means alone cannot keep the body temperature constant, At this point; the metabolic rate will raise in order to maintain a constant body temperature. The lower critical temperature (B) is therefore the lowest environmental temperature at which physical mechanism alone can no longer regulate the body temperature. As the temperature is further lowered, the metabolic rate increases until eventually the metabolic mechanism can no longer generate enough heat to maintain the body temperature constant. This end temperature is called the lower lethal temperature (A). at this point, the organisms dies due to hypothermic especially if the body temperature falls below 25^0c.
When environmental temperature increases the animals will reach its upper critical temperature when the temperature raises environmental exceeds the normal body temperature. The upper critical mechanism fail to maintain the body temperature constant (C). At the point which metabolic rate and body temperature start raising with environmental temperature until the upper lethal temperature (D) is reached where the organism dies. Desert animals have a higher upper critical temperature compared to these living in cold conditions and this chow that desert animals have efficient oeling mechanisms when the environmental temperature rises exceeds the upper critical point, the metabolic rate increases even more hence quickly contributing further to body temperature rise. The body temperature continues to increase indefinitely causing permanent tissue damage and enzymes denaturing leading to death. This is an example of a positive feedback which doesn't contribute to homeostatic. The highest environmental temperature at which the organism dies of heat strake is the upper lethal temperature and in humans it varies between 42 – 45^0c. The temperature between the lower critical point and the upper critical point is normally referred to as the efficient range of thermal neutrality. This is the environmental temperature at which the body's physical mechanism alone can regulate body temperature. In human it is between 27 – 31^0c.

11. COORDINATION IN ANIMALS:

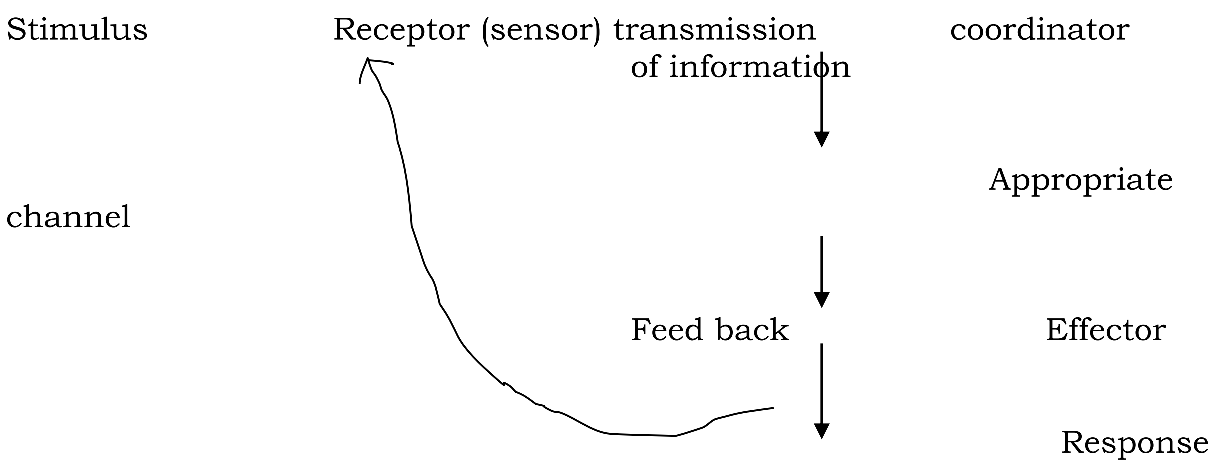
Coordination refers to the body's mechanisms carried out by an organism in causing a response to a stimulus. The ability of an organism to respond appropriately to a stimulus is termed as irritability. Bodies of organisms have a self regulating mechanism which is coordinated differently in different organisms.

A stimulus refers to a change in either the internal or external environment e.g. pain, change in temperature and water content, light intensity and its direction, food and nutrients.

A response refers to a reaction of an organism towards stimuli.

Responses vary amongst different organisms and according to the magnitude and the nature of stimulus. Each organism has its own specific type of sensitivity that improves its chances of survival e.g. an amoeba can move away from very bright light but it can move towards food.Plants grew with there shoots bending towards light from given direction and therefore growing away from darkness.Unicellular organisms lack specialised systems of coordination.Large organisms (multicellular) such as mammals, birds and repta posses a coordinating system for causing an appropriate response to a stimuli.

COMPONENTS OF COORDINATING SYSTEM:



Animals are multicellular organisms (eukaryotes) some lower animals like cordarians (coelenterates) such as a hydra, sea anemone, jelly fish have a coordinating system made up of only the nervous system and there level of organisation it tissue level. The nervous system comprises of a mesh of nerve cells for linking up and sensing stimulus perisieved by the tentacles with other cells.

DIAGRAM SHOWING THE BODY WALL OF A HYDRA:

These animals are diploblastic meliorated. The nervous system of these animals is formed within the mesoglea to coordinate the cells of the endoderm higher animals e.g. birds, reptiles, mammal's amphibians; fish have two coordinative systems namely nervous system, and the hormonal system. The two systems maintain a relatively constant eternal environment by coordinating the functions of the body's other systems. The nervous system acts quickly and provides a short lived regulatory mechanism.
Whereas the hormonal system acts relatively show but provides a large and more sustainable regulation.
The hormonal system in these higher organisms is termed as endocrine and the two systems are interlinked via a central nervous system.

Body (diagram)

DIFFERENCES BETWEEN HORMONAL AND NERVOUS SYSTEM

Hormonal	Nervous
The information / message is chemical	The message transmitted is electrical and chemical in nature.
The message is carried within the blood	The message is carried a long nerve cells.
The message is transmitted slowly.	The message is transmitted rapidly.
Slow and long lived responses.	Responses are rapid and short lived.
Responses are widely spread	Responses are localised.
Coordination is mainly under control of the pituitary gland.	Coordination is controlled by the brain and spinal cord.

ENDOCRINE SYSTEM:
This system is composed of different ductless glands.
These glands secrete chemical substances known as hormones.
Hormones are produced from part of the body (ductless glands) and exert there effects in target cells which posses specific protein receptors that interact with the hormones.

CHARACTERISTICS OF HORMONES:

- They function in low connections and most of them are short lived.
- Most of them are made by their parent cells as inactive precursors and consist of several polypeptides. These are termed as pro hormones e.g. proinsulin.
- Some hormones act immediately while others act slowly e.g. ceanine act immediately after being released in the blood stream while thyroxin and oestrogen yield maximum responses after days or several hours.
- They work by binding to specific receptors and this can be on the surface of the cell or inside the cell.

MECHANISM OF HORMONAL RELEASE:

- By metabolites at a given concentration e.g. insuline and glucogen.
- In presences of another hormone e.g. thyroxin.
- Stimulation from autonomic nervous system.

THE PRINCIPLES ENDOCRINE GLANDS OR MAMMALS TOGETHER WITH THEIR HORMONES AND THE MAIN FUNCTIONS:

Gland	**Hormone**	**Chemical structure**	**Function**
Thyroid	Thyroxine	Amino acid	Raises basal metabolic rate
Parathyroid	Parathermone	Polypeptide	Controls concentration of calcium and phosphate ions in blood.
Pancreas (islets of largerhane)	Insulin Glucagon	Protein polypeptide	Lowers blood sugar concentration. Rises blood concentration.
Adrenal cortex	aldosterone	steroid	Control concentration of …..
	Cortiol Androgens	Steroid steroids	Prevents excessive immune response. Promotes development of testes and secondary sexual

			characteristics in males.
Adrenal medulla	Adrenative	Forms ring compounds with short side chains	Prepares the body for emergence by metabolic rate increase and blood diverted to virtual organs.
Pineal body	melatonin	Hydroxyl - indel	Causes concentration of melatonin especially in frogs, human skin and promotes sexual development.
Testes	Androgens	steroids	Promotes development of testes and secondary sexual characteristics of males.
Ovaries	Progesterone Oestrogen	Steroids steroids	Controls menstrual cycle and pregnancy. Promotes development of ovaries and secondary sexual characteristics of females.
Pituitary Centerior tube	Thyroid stimulating hormone Adrenal cortical trophic	Polypeptide protein	Causes thyroid gland to secrete thyroxine Causes the adrenal cortex to secrete adrenal cortical hormones.
	Growth	Protein	Stimulates growths

	Prolactine Follicle stimulating (FSH)	Protein Glycoprotein	Causes mammary glands to secrete milk. Controls testes and ovaries.
Gonadotrophic	Lutenising (L.H)	Glycoprotein	Controls testes and Ovaries.
Pituitary posterior tube	Antiduretic (ADH) / vasopresire oxytocun	Polypeptide Polypeptide.	Causes reabsoption of water in the kidney. Contraction of the uterus muscles at birth.
Thymus	thymosin	polypeptide	Helps in maturation of lymphocytes.

MECHANISM OF HORMONAL ACTION:

1. The hormonal molecules bind them selves to the receptor side of the cell membrane and after the permeability of the membrane to a specific metabolite e.g. insulin is secreted when excess glucose is available in the body. This insulin decreases the uptakes of glucose into the cell due to the presence of proteins.
2. The hormone acting as the first massager combines with the protein receptor on the cell membrane of the target cell to form a hormone called complex. This complex causes the release of an enzyme called adenylcydase which is found the in the cell membrane. This results in the convertion of AMP (Adenyleycline Môn phosphate) inside the cell…………………………….. hormone with the actual response given by the hormone. This contains with specific enzymes to close down either the existing pathway or open up new ones to enable the hormone to exert its effect e.g. action of adrenaline.

Diagram

This is an illustration of a two massager mechanism. This mechanism is more advantageous in that a small amount of hormone leads to the formation of comparatively large amount of cyclic AMP which in turn produces (evokes) a corresponding large response.

3. However not all hormones involve the two massage type of mechanism. Steroid hormones and the insect moulting hormones (ecdysone) pass through the cell membrane and binds to the receptor within the cytoplasm. The hormone receptor complex formed enters the nucleus where it exerts a direct effect on the chromosomes by activating genes and stimulating transcripts massager RNA is produced and the target cells make specific proteins and an appropriate response to particular hormones produced.
4. Some hormones exert one of there effects on enzymes on the electron carrier system e.g. thyroxin so that the rate of production of ATP is also altered.

PITUITARY GLAND:
It is located at the flow of the brain below the hypothalamus. It is described as the master gland in most cases because many of its secretions in turn control the activities of the most of the other endocrine glands. It has three distinct parts;
i. Anterior lobe.
ii. Posterior lobe.
iii. Intermediate lobe.

BLOOD SUPPLY TO THE PITUITARY GLAND:
This gland receives blood from the branches of the internal carotid artery. The anterior tube of the pituitary is supplied internally with blood that has already passed through the capillaries of the hypothalamus. The posterior lobe of the pituitary is supplied directly with blood from the internal carotid artery.
The pituitary gland together with the hypothalamus act as a unit to regulate the activities of most other endocrine glands.
The hypothalamus coordinates the activities of the pituitary gland by releasing stimulating and inhibiting hormones.
The hormones from the hypothalamus include;-

Hormones	Function
Growth hormone releasing hormone (GHRH) Growth hormone releasing inhibiting hormone (GHRIH). ………………………… Corticotrophin releasing hormone	Stimulates the pituitary to releasing the growth hormone. Inhibits the pituitary gland from releasing the growth hormone as it stimulates the release of thyroid gland. ……………………. The stimulus for its release includes exercise, stress. It stimulates the pituitary gland to release the ACTH

Lactin hormone/PRH (protective releasing hormone)	Stimulates the pituitary gland to produce the Prolactine.
Gonadotrophic releasing hormone (GTRH)	Stimulates this pituitary gland to secrete legitimising hormone

THYROIDE GLAND:
It stimulates a hormone collectively called thyroxins.
It secretes T_4 (tetra iodothyroxine) and T_3 (Tri-iodothyroxine) which affects the body tissues and have two primary functions.
They regulate the growth and development of the body tissues by controlling cell division and differentiation.
They control the basal metabolic rate (BMR) which is the minimum energy required at a state of rest.

CONTROL OF THE THYROID GLAND:
The activity of the thyroid gland is controlled by other organs from the hypothalamus has detectors which detect the level of T_3 and T_4 in blood and sending an appropriate response to the pituitary gland.
The thyroid is released by a hormone secreted by the hypothalamus in response to low levels of the thyroxin (T_3 and T_4).
The thyroid releasing hormones triggers the anterior tube of the pituitary to secrete thyroid hormone which is carried in blood from the pituitary gland to the thyroid gland where it stimulates the secretion of thyroxin as summarised below.

Hypothalamus
(Detector)
↓
Anterior lobe of the
Pituitary TSH
Inhibits ↓ stimulate.
Thyroxin (increase into its level)
↓
Use of thyroxin by cells
↓
Decrease in thyroxin level

MALFUNCTIONING OF THE THYROID GLAND
Over activity of the thyroid gland is called hyperthyroidism while under activity is called hypothyroidism.

Hyperthyroidism (excess secretion of thyroxin) arises from the failure of the thyroid stimulating hormone to control metabolism causing an increase in the thyroid level and this may be due to uncontrolled secretion of T_3 and T_4 by the thyroid tissue.

- Hyperthyroidism results in increased basal metabolism.
- Increased heart beat.
- Loss of body mass.
- Protrusion of the eyes.

In adults:

- Reduced metabolic rate.
- Increase in body mass.
- Slowed mental activity.

In infants:

Causes cretinism: A cretin is characterised by the following:

- Retarded physical growth with disportionately short limbs.
- A coarse dry skin.
- Peer abdominal muscle tone.
- A large protruding tongue.

The cause of hypothyroidism is due to a deficiency of iodine
Note:
The thyroid gland secretes another hormone known as calcium which lowers the concentration of calcium ions in blood by deposing it the bone.

PANCREAS

It has a cluster of cells distributed throughout if forming the islets of Lang nun. These have specialised cell that secrete different hormones. The two hormones are the alpha cells which secrete glucogen and beta cells which secrete insulin. There are also delta cells which secrete the hormone which inhibits the production of glucogen and insulin.

Insulin
The secretion of insulin is stimulated by the increase in glucose level. Insulin is concerned with reducing the glucose level of blood to normal level.
Insulin removes excess glucose …………………
Speeding up entry of glucose to release cells.
Slows down glucogeneogenesis (formation of glucose).
Promotes synthesis of fats and there storage in a dispose tissues a process known as biogenesis.
Secretion of insulin is decreased by any of the following factors:

- Glucogen.
- Adrenaline.

- Growth hormone releasing inhibiting hormone (GHRIH) process known as glycogenesis.
- Accelerating up take of amino acids by cells and synthesising or making up proteins.

Reducing insulin secretion causes an increase in blood sugar a condition known as hyperglycaemia when this happens the glucose level exceeds maximum level which can be reabsorbed and glucose starts to be exposed in the urine a condition known as the respiratory substrates.
Severe cases of diabetes mellitus include body weakness: due to low blood pressure and high plasma ionic pressure and in males it brings about importance.
An over dose of insulin results into the following;

- Confusion.
- Drowns ness
- Trembling.

These are two types of diabetes

- Diabetes mellitus
- Diabetes inspidus.

Diabetes mellitus is categories into two i.e. type one and type two. Type one is genetically and type two is insulin depended and normally occurs during the old age.

AUTONOMIC NERVOUS SYSTEM
Diagram

SUMMARY OF THE REPONSES MADE BY PARTS OF THE AUTONOMIC NERVOUS SYSTEM

Parasympathetic N.S.	sympathetic N.S.
Slows the heart beat.	Accelerates heart beat.
Dilates arterioles.	Constricts arterioles.
Constricts bronchioles.	Dilates bronchioles.
Constricts the iris.	Dilates the iris
Stimulates tear glands.	Inhibits the stimulation of tear glands.
Causes flow of saliva and other gut secretion.	Stops the secretion.
Speeds up gut movement. Relaxes the bladder and the animal sphincter.	Slows gut movement.

	Contracts bladder and annual sphincter

General organisation of the autonomic nervous system

ANS

PS S

Effector CNS effector
(Parasympathetic (sympathetic
Ganglion) ganglion)
Controls body activities associated controls body activities associated
with the relaxed state with emergency e.g. fear, fight and
flight

This part of the nervous system is concerned with controlling the body's involuntary activities such as beating of the heart, movement of the gut, secretion of sweat e.t.c. the main function difference between the two systems concerns the transmitter substance produced.

Noradrenalin is the transmitter substance produced by the sympathetic nervous system and acetylcholine is the transmitter substance produced by the parasympathetic N.S. The effects produced by the sympathetic oppose all those produced by the parasympathetic.

The autonomic nervous system is composed of the sympathetic and parasympathetic nervous system. Parasympathetic opposes controls body activities relating to a relaxed state produced by the sympathetic.

The autonomic nervous system is composed of the sympathetic and parasympathetic nervous system parasympathetic opposes controls body activities relating to a relaxed state while sympathetic control body activities relating to emergency state also slows down peristarisis and gut movement and also increases mental alertness.

Structurally, the sympathetic nervous system has short preganghionic fibres and long post ganglionic fibres. The end of these fibres secretes a transmitter substance known as noradrenalin.

In the parasympathetic nervous system, the preganghionic fibres are long and post ganglionic fibres are shorter. The transmitter substance at the end of the fibres is acetylcholine.

Summary of nervous system

Nervous system

CNS ANS

Brain spinal cord grana nerves ANS spinal nerves

Fore Brain mist brain hind brain parasymthetic sympathetic

NERVES

All animals except sponges posses nerves. Nerves contain neurones which are specialised cells for transmitting impulses.

An impulse is an electrical message that propagates along a nerve fibre and they are measured in mill volts. Each neurone has three basic parts namely;-

- Cell body.
- Dendrites.
- Axon.

Cell bodies for the grey matter of the nervous system. The cell bodied are more localised at the periphery and at the centre of the spinal cord. The cell bodies outside the system are termed as the ganglia. Cell bodies contain a nucleus and it controls the activities of a neurone.

Dendrites are numerous projections and carry it to the cell bodies. These are shorter than the axon and are branched.

An Axon is a single and long extension from the cell body and it carries impulses from the cell body to the C.N.S.

Axons transmitter information over long distances. Neurones are supported by a tissue called neuralgia. The cells of these tissues provide nutrients to the neurone. Neurones synthesis ATP from glucose only. The transmission of impulses is an active process that requires ATP.

The structure of the axon

The axon has a cytoplasm called axoplasm that extents from the cell body. This is enclosed by membranes called an axolemma.

SECTION OF AN AXON

Diagram

Large axons and those of the peripheral nervous system are surrounded by a sheath called myelin sheath which insulates heat and facilitates rapid transmission of impulses. It prevents the transport of ions across the axolemma beneath it.

The myelin sheath is made up of a fat substance known as myelin. This may cover the whole length of the axon or may leave some parts uncovered leaving sections of the axolemma exposed. A neurone with an axon not covered with myelin is termed as a non myelinated neurone.

Non-myelinated neurone:
Diagram

Myelinated neurone:
Diagram

A myelinated neurone transmittees impulse faster than a non-myelinated neurone. Examples of myelinated neurones are those of the post ganglionic fibres and these are small nerve fibres. The nodes of ranvier facilitate rapid transmission of impulses. Neurones are actively involved in conducting impulses and the strength of an impulse is maintained throughout the length of the neurone. Some neurones initiate impulses while others just pass them over.

TYPES OF NEURONES:
Neurones are normally classified into the sensory neurone (afferent neurone) motor (efferent) and intermediate neurones.
These are two types of efferent which are the somatic nerves involved in voluntary and reflex skeletal muscle contraction. Then the autonomic nerves which are involved in the cardiac smooth muscle contraction and glandular secretion.

THE MOTOR NEURONE (efferent or multipolar neurone)
Diagram

The figure above illustrates the structure of a vertebrate motor neurone because it transmittees impulses from the CNs to a muscle. Although specialised in shape, it posses the same basic structures found in other cells i.e. nucleus, mitochondria, cell membrane e.t.c. the cytoplasm contains prominate granules which are groups of ribosomes concerned with protein synthesis (theses are caked Niss/s' granules). The nucleated of the cell, the cell body is located in the CNs and is connected with neighbouring neurones by dendrites one end of the axon enters the peripheral nerve and terminated in a muscle.

THE SENSORY NEURONE, AFFERENT AND UNIPOLAR NEURONE
Many other types of nerve cells are found in the vertebrate nervous system. These include, sensory neurones which transmittees impulses from receptors to the CNs. The same bodies are located in the dorsal route ganglia of the animal nerves.

Diagram

INTERMEDIATE NEURONE / BIPOLAR
Diagram

They are found in the CNs where they connect sensory and motor neurones with each other.

FUNCTIONS OF THE MAIN PARTS OF THE BRAIN IN MAMMALS
The general function of the brain is to coordinate the body activities. The following are the main parts and their functions.

Medulla Oblongata
It contains centres controlling not only breathing and circulating but also swallowing, salivation and vomiting. So the role of the respiratory and cardiac-vascular centre in the medulla oblongata is to control rhythmical breathing and circulation.

Cerebellum
It's situated just in front of the medulla, greatly folded and found as part of the hind brain.
It's responsible for maintaince of posture and equilibrium and the fine adjustment of movement.

Corpora quadrigemina
It's situated in the mid brain which contains a centre of the red nucleus which prevents the state of tonic contraction in organisms like cats so that the limbs are not held out rigidly from the body.

Thalamus
It's a lateral part of the brain that receives sensory impulses for the cerebral hemisphere.

Hypothalamus
It contains centres controlling functions such as sleep, feeding, drinking, speech, body temperature and Osmoregulation.

Cerebral hemispheres
It receives impulses from the factory organisms and relays them to the deeper and more primitive parts of the brain.

STRUCTURE OF THE BRAIN
Diagram

TRANSMISSION OF NERVE IMPULSES
A neurone which is not transmitting an impulse (action potential) is described as a resting neurone and its potential difference across the axolemma is called a resting potential. A neurone which is transmitting an action potential is described as depolarised neurone and the potential difference created between the inside and the outside an axon is termed as action potential.

The transmission of impulses involves two principle ions namely:

- Sodium ions, the main Extracellular ions.
- Potassium ions, the intracellular ions.

Other ions that are involved in propagating action potential are CI^-, Ca^{2+} and organic ions.
When a neurone is polarised (resting stage) the inside is very charged and the outside is positively charged.

NEURONE SHOWING THE RESTING POTENTIAL
Diagram

The inside of the axon at resting stage has a high concentration of K+ and organic ions. The Extracellular fluids (outside of the axon) have a higher concentration of Na+ than the inside.

NEURONE SHOWING THE DISTRIBUTION OF IONS AT RESTING STAGE DIAGRAM

The membrane of the axon channels through which Na^+ and K^+ do pass. During the resting potential, the Na+ the outside as potassium ions diffuse freely to plasma.
However the Na^+ diffuses very slowly into the axoplasm across the membrane. This creates a negative electrical charge inside the axon with respect to the outside.
Note:
For every 3 Na+ pumped out actively, 2 K^+ diffuse back into the axoplasm. The net effect is more Na^+ outside the axon membrane and more K^+ inside the axon. This allows the maintaince of the potential difference. Therefore the resting potential of the resting neuron is created and its about -70MLvolts.

ACTION POTENTIAL
For any impulse to be transmitted, it must have a sufficient magnitude above the threshold value. A stimulus above the threshold value produces an action potential by stimulating the sensory nerve endings. When this happens, the permeability of the axon membrane changes and the axon become depolarised. During depolarisation, the inside of the axon is positively charged while the outside is negatively charged.

NEURONE SHOWING ACTION POTENTIAL DURING DEPOLARISATION DIAGRAM

When stimulated, the permeability of the nerve cell membrane to Na+ and K+ changes i.e. the Na+ diffuse into the membrane and the K+ are actively pumped out.

Diagram

The inward movement of Na+ is due to the ion ………………….. Proteins permeable to Na+
Allowing a large amount of Na+ to flow in. the axoplasm becomes progressively more positive with respect to the outside of the membrane due to this influx. The permeability of the membrane almost instantly stops as the action potential is fired. The process of depolarisation occurs very rapidly and lasts for a few rhilliseconds.

A GRAPH ILLUSTRATING THE PROPAGATION OF AN ACTION POTENTIAL WITH TIME
Diagram

When the action potential reaches its peak * about positive 40 mill volts) the Na+ channels close slowly as the K+ channels open up. Na+ stop flowing into the axoplasm as the K+ diffuse rapidly into it. These changes cause the potential difference to drop. These changes are responsible to return the p.d to about -70 mill volts a condition known as depolarisation. The closing of the K+ channels ensures that the action potential is transmitted in only one direction.

SUMMARY OF THE CHANGES THAT OCCUR WHILE GENERATING AN IMPULSE
Diagram

All action potential is a short leaved and localised response to a stimulus which propagates as waves of depolarisation. The action on potential at one point of the axon stimulates the next region to become depolarised. The size or the magnitude of an action potential does not decrease during the propagation but remains the same as it travels and during this process, local currents are generated progressively to the axoplasm and the surrounding fluid.

Transmission of action potential in a myelinated neurone
In myelinated neurone, the axons are insulated with a myelin sheath that prevents the outward movement of the ions. The nodes of ranvier where local currents are set up as a result of k – Na ion exchange. At these points, the action potential is set up and when the action potential reaches the nodes of ranvier, the K^+ are actively pumped out. At this pint, local circuits are produced which act as stimulus for the next region.
At this point, the action potential jumps from one made to another and this is called the salutatory conduction.
Diagram

FACTORS THAT AFFECT THE SPEED OF IMPULSES TRANSMISSION ALONG AN AXON
There are two factors
- The diameter of the axon
- The presence for the myelin sheath

The large the diameter of the axon, the faster the rate of impulse transmission. Therefore neurones with giant axons transmit impulse faster than neurones with neurones with small axons due to less resistance.
Myelinated neurones conduct impulses faster than the non myelinated neurones because the action potential occurs at the nodes of ranvier and it jumps from one node to another.

SUMMARY OF EVENTS THAT OCCUR DURING THE PROPAGATION OF AN ACTION POTENTIAL IN THE AXON OF A NON-MYELINATED NEURONE.

State	Resting	Active	Recovering
1. Type of potential	Resting potential	Action potential	Resting potential
2. membrane	Polarised	Depolarised	Depolarised
3. Internal potential	Negative	Positive	Negative
4. External potential	Positive	Negative	Positive
5. Lower movement	Stable, differential lower concentrations maintained	Increased permeability to Na^+ and k^+ ions	Most stable differential ionic concentration restored.

PROPERTIES OF NERVE AND NERVE IMPULSES
Nerves are able to generate impulses only after getting excited by different stimuli within the receptor cell. In nervous experiments, the different stimuli can be either osmotic mechanical or electrical but electrical stimuli are normally used because the strength, duration and frequency of the stimuli can be controlled and therefore causing no damage to the axon.
They obey the ALL or NOTHING LAW. This law states that the response of an excitable unit of an axon is independent on the intensity of the stimulus. That is if the strength of the stimulus is below the threshold intensity then no action potential is evoked if the stimulus is above the threshold then full action potential is evoked. However further increase in the intensity of the stimuli does not result in an increase in the size of the action potential. This can be illustrated by the graph below

GRAPH (diagram)

Axons of neurones have a refractory period. A refractory period is that period of an excitability that accompany the recovery phase of an axon after it has transmitted an impulse. After an axon has transmitted an impulse its impossible for it to transmit another in a short period.
This is because its supposed to recover. This period is about 3 micro seconds. The refractory period is divided into two namely:-

1. Absolute refractory period

2. Relative refractory period

The absolute refractory period there is complete inability of the axon to transmitte an action potential even if the intensity of the stimulus if stronger.
In the relative refractory period an axon can transmitte an impulse provide the intensity of the stimulus is stronger than usual.
The absolute refractory period together with the speed of transmission is important in the determining the maximum frequency at which an axon can transmitte an impulse.

SYNAPSES

A synapse is a junction where two nerves meet. This point is important in ensuring that impulses travel in only one direction.
Neurones have ends called synaptic knobs. Each synaptic knob has numinous synaptic vesicles which contain a transmitor substance.
Acetyl chorine
Nor adrenaline
The synaptic knobs posses numerous mitochondria for producing energy needed in the passage of an impulse to the next nerve cell.

Structure of the synapse.
Diagram

The synaptic cleft is about 20 nanometres and embedded in a matrix of calcium ions. When an impulse arrives at the synaptic knobs, it causes calcium ions to enter into the synaptic knob from the synaptic deft. Calcium ions cause the synaptic vesicles to move towards the presynaptic membrane. The mitochondria provide ATP which enables the synaptic vesicles with transmitter substances to move from the post synaptic membrane to the presynaptic membrane.
When the synaptic vesicles reach the pre-synaptic membrane, they discharge their transmitter substance onto specific protein sites on the synaptic membrane causing local depolarisation.This local depolarisation of the post synaptic membrane cause an influx as Na^+ in the most synaptic nerve cell so that a positive develops in this nerve cell is called excitatory post synaptic potential (EPSP).If the EPSP becomes sufficiently extensive i.e. if the positive charge inside the nerve cell reaches the threshold, then an action potential is generated in the next neurone.

<u>Note:</u>

At the synapse, an impulse can be transmitted in both directions but this does not occur fro several reasons.
These include;

- The transmitor substance is located on one side (synaptic knob).
- There is an enzyme called cholinesterase at the synapse which hydrolyses acetic chorine into products that can not transmitte impulses back. These products are pushed back into the synaptic knobs and resettled back into the synaptic resides by ATP. Therefore the transmission of an impulse across a synapse is by chemical means.

A neuromuscular junction.
This is a point where the terminal dendrite of a motor neurone gets into contact with the muscle fibre. At this point, the membrane of the muscle fibre is modified into an end plate (motor endplate) to which the dendrite is attached. When this is excited, it causes the muscle fibre to contract.

Structure of the neuromuscular junction

Diagram

Summation and synapses.
The depolarisation of the postsynaptic membrane of an excitatory synapse occurs when sufficient neurotransmitter substance accumulates at the post synaptic membrane. This phenomenon is termed as summation and it occurs in two ways; i.e. spatial summation and temporal summation

Spatial summation.
This occurs when served synaptic knobs are stimulated simultaneously occurring depolarisation of the post synaptic membrane where each synaptic can not depolarise this membrane.

Inhibitory synapses.
At inhibitory synapses, the discharge of the nerve transmitor substance results in the change of the configuration of the protein receptors to open up allowing the entry of chloride ions and k+ instead of the Na+. These ions move across the post synaptic membrane from the synaptic deft. This makes the post synaptic membrane polarised instead of being depolarised. This resulting potential of polarisation of post synaptic membrane is termed as IPSP (inhibitory post synaptic potential) and this does not allow further propagation of the action potential.

How the transmission of the impulse across the synapse is controlled

- Presence of the synaptic resided on one side of the pre-synaptic membrane
- Destruction of acetylcholine after transmission ensures at depolarisation of the post synaptic membrane
- The rate of receptor e.g. sites on the post synaptic membrane only.
- The rate of formation of acetyl chorine.

The mammalian eye.
Diagram

This is an organ for sight and its equip with photo-receptor cells which are stimulated by light. The eyes specifically are responsible for allowing the organism to distinguish variations in shape, colour, brightness and distance of objects. Therefore the eye receives light energy and then generates an action potential which is then carried to the brain where the actual process seeing is done.
The eyes of mammals are able to utilise the visible frequency of the electromagnetic radiation. The eyes of mammals are found in the orbit of the skull and normally each mammal has two eyes.

External structure of mammalian eye.
Diagram

Eye brow.
- It protects the eye from strong light rays and dust particles.
- It prevents sweat from the head getting into the eye.
- It contributes to the facial expression.

Eye lid
- It covers and protects the eye from dust particles.

Eye lashes.
- They clean the front surface of the eye making it free from dust and dirt.

Norsal lachrymal
- It drains excess tears into the nose.

The eye brow is lined with tear glands and these produce a solution termed as tears. Tears contain water, mineral, anti bodies and lysozymes which are bactericidal enzymes.

Functions of the tears
- They wash away irritating martial such as dust and dirt.
- They nourish the cornea.
- Being eely, they delay evaporation and drying of the conjunctiva
- The lysozymes prevent microbial infections.

Movement of the eyeball.
The eyeball is held in position and moved in the orbit by the extrinsic muscles. These muscles attach to the sclera at one end and onto the walls of the orbital cavity at the other end.

Muscles that move the eye.
diagram

Functions of the parts of the eye.

<u>Sclera</u>
This is a white tough outer coat of the eye with the eye muscle attached to it. It becomes thinner and transparent forming a demeshaped front part called the cornea.
- It helps in retaining the spherical shape of the eyeball.
- It provides surfaces for attachment of the eye muscles.
- It offers protection to inner parts of the eyeball.

<u>Choroids</u>
This is the middle layer of the eyeball containing many tiny blood vessels which supply the eye with food and oxygen. Its deeply pigmented black to prevent internal reflection of light in the eye and absorbs stray light rays.

Retina
This is a very delicate inner most layer of the eye ball. This layer has light sensitive cells of two types i.e.

a. Rods
These are sensitive to low light intensity and have a chemical known as rhodopsin which increases in concentration during low light intensity around the edges of retina. They perceive black, white or grey images only.

Conjunctiva
This is a thin transparent covering of the eyeball. Its kept moist and clean by slow continuous stream of solution from tear glands.
It prevents germs from entering the eye.

Cornea
It allows light into the eye

Iris
It adjusts the pupil size helping in regulation of the amount of light entering the eye.

Pupil
It allows light to enter the eye onto the lens.

Suspensory ligaments
These hold the lens in position and always adjust to increase or decrease the size of the lens.

Ciliary muscles
They are attached to the choroids area of the eyeball.
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Lens
This is a crystalline convex lens which is transparent. Its function is to focus light rays of objects onto the retina.

Aqueous humour and vitreous humour
- The aqueous humour is a watery fluid found in the space between the cornea and the lens while the vitreous humour is a jelly like transparent substance found between the lens and retina.
- The humour helps to refract light so that an image if formed on the retina.
- They also help to maintain the shape of the eye.
- They equalise pressure on both side of the lens.

Yellow spot (forea)
This is a point on the retina containing a lot of cones and lacks rods and it's a point of most acute vision (visual acuity).
Visual acuity is the ability of the cones to distinguish between two closely related and near objects.

Blind spot
This is a part where the optic nerves leave the lens.

- It contains on rods and cones
- Its insensive to light.

……………………………
The eye transdue light rays into impulses. For one to see light rays, move from one object travel until they reach the retina stimulating the photoreceptors to generate an action potential.
Objects reflect light rays some of which reach the eyes. When they reach the eye, they are refracted at various point of the eye.
Refraction occurs at 3 surfaces before reaching the retina namely.

- The front surface of the cornea.
- The aqueous humour and the front surface of the eye lens.
- The surface of the eye lens and vitreous humour.

The path taken by the light rays to reach the retina is as follows:
Air → conjunctive → cornea → aqueous humour → pupil lens vitreous humour → retina.
The image of the object must be focused onto the retina in order to generate (transude) light rays into an action potential.

<u>How the eye controls the amount of light entering into it.</u>

The eye has a mechanism of regulating the amount of light entering into them because of the variations in the level of light in the environment.
Too much light causes over stimulation of the photoreceptors and can even damage them. When there is very little light, the photoreceptor cells may not be stimulated to generate an action potential therefore the control of the amount of light entering the eye is essential. There are few types of photoreceptors in the retina;

<u>The rods:</u>

These are photoreceptors which are sensitive to dim light and are stimulated by light of low intensity into action potential and bring about seeing objects in black and white.

<u>The cones:</u>

These photoreceptors are only stimulated by light of high intensity and are responsible for bringing about coloured objects.
The control of the amount of light is brought by the antagonistic muscles in the iris. These muscles are the circular and radial muscles and there contractions are controlled by the autonomic nerves system.

Seeing in dim light:

The eye adjusts in dim light to allow more light to enter them. To allow more light to enter the eyes, the radial muscles contract as the circular muscles of the eye relax. This makes the pupil to dilate.

Diagram

In dim light, it's the CNS that controls the contraction of this muscle i.e. the radial muscle.

Seeing in bright light.

In bright light, the eyes adjust in order to avoid too much light entering the eye. Excess light is prevented from entering the eye by the constriction of the pupil brought about when the radial muscles relax and the circular muscles contract. This is controlled by the parasympathetic Nervous system.

Diagram

Accommodation

This is a relax mechanism by which light rays from the object are brought to focus on the retina. The eyes are always and constantly focusing objects at varying distances. Some objects are near the eyes while others are far away from the eyes.
A person with normal sight will be able to see objects what are both near and far away. The mechanism of focusing this involves two processes namely:
- Refraction of light rays in the retina.
- Reflex adjustment of the pupil size.

Focusing a distant object.

In focusing a distant object, the parallel light rays from the object reach the cornea through the conjunctiva. The lens is then adjusted to focus these parallel light rays to the retina and at the same time the pupil widens. This adjustment is caused by the following changes.
The circular ciliary muscles relax as the radial ciliary muscles contract. These causes a Suspensory ligament tighten. This makes the eye lens convex. In this state the eye lens is able to focus the light rays onto the retina.

An eye focusing a distant object

Diagram

2. Radial ciliary muscles contract
3. Len less convex.
4. Pupil widens.
5. Suspensory ligament tightens.
6. circular ciliary muscles relax
7.

Diagram

1. Circular ciliary muscles contract
2. Radial ciliary muscles relax.
3. Iris contracts.
4. Pupil contracts.
5. Suspensory ligaments loosen
6. Image formed on the retina.

<u>Retina</u>

This is a photo sensitive part in the eye located at the back.
It has light sensitive cells (photoreceptor cells) namely; the rods and the cones.
The rods lay out the peripheral of this layer and the cones are concentrated at the fovea of the retina. This part lays at the optic axis of the eye. The retina is separated

from the choroids by a single celled layer called the pigmented epithelia. These epithelia contain melanin.
The pigment can move up and down between the gaps of the rods and cones to enable the light of varying intensities. The retina receives nutrients, oxygen from blood in the blood vessels of the choroids.

SIMPLIFIED STRUCTURE OF THE PART OF THE RETINA
Diagram

The retina therefore has two major layers'
- The photoreceptor layer.
- Intermeshed layer.

THE PHOTORECEPTOR LAYER
This layer consists of rods and cones.
The rods are responsible for black and white vision. They are complied of these major parts namely: outer segment, inner segment, nucleus and the synaptic connections.

STRUCTURE OF THE RODS

THE OUTER SEGMENT
This has got several lamellae where the visual pigments are packed. The visual pigment in the rods called rhodopsin. The lamellae are flattened discs stalked on top of each other. The outer presence of light. The outer side of this segment has more Na+ than the inside and therefore these ions flow inside. The outer segment builds up sodium ions which then pass across a connecting cilium.

INNER SEGMENT:
The inner segment has a rich supply of mitochondria and connected to the outer segment via the connecting cilium. It has very active sodium pump which pumps Na+ out to maintain a negative charge inside the rod cell.
The nucleus controls all the activities while the foot moves synaptic connections with the dendrites of the bipolar neurone.

RHODOPSIN
This is a photosensitive pigment in the rods. It is made up of a protein called opsin and a derivative of Vitamin A called Retinine (Retinal). Retinine can exist 2 different isomeric forms namely the 'cis' and 'Trans'.
The pigments readily break up when exposed to light. It breaks down stimulating the generation of an action potential.

Rhodopsin $\overset{\text{Light}}{\rightleftharpoons}$ 'Trans' $\overset{\text{light}}{\rightleftharpoons}$ opsin + Retinine (retinal)

('Cis') dark dark

The enzyme is retinal isomerise.

Transduction of light into impulses

When light strikes the rod, it initiates the splitting of rhodopsin into opsin and free Retinine. This triggers the closeted of the Na channels in the outer segments of the rods and yet the sodium pump of the inner segment continuously continues to actively transport out the Na+. This results in the inside of the rod to become more negatively charged than before. This condition is termed as hyper polarisation.

Hyper polarisation causes the action potential to be generated in the bipolar neurone. The action potential is then connected to the ganglion cells to reach the optic nerves which carry impulses to the brain for interpretation.

Diagram illustrating the changes in the permeability of na$^+$ in the segments of the rods

When rhodopsin after exposure to bright light, it rapidly breaks down and reserves of this pigment are lowered. In this state, the eyes are light adapted. So when a person moves into from a neat roam into darkness, she softens (spend some time without seeing) a moment of poor vision and this means that the rhodopsin in being reynthesised. This moment of period corresponds to the time taken for enough rhodopsin to be reynthesised.

The period required for the eyes to get used to the dark is called the dark adaptations. The resynthesis of rhodopsin requires energy and the rods are equipt with numerous mitochondria to produce enough ATP for this to occur.

The sodium channels open and there is a rapid influx of Na+ and this makes the cell hyper polarised. Rods are very sensitive to lights of low intensity. They have retinol convergence. They have a pigment which can easily be broken down when exposed to light.

If light falls on a few rods and excites them simultaneously, it may be sufficient to cause the generation of an action potential to the bipolar neurones attached to a quantum of light striking a single rod and this is sufficient to generate an action potential.

Retinol convergence therefore makes eyes more sensitive to low light at the expense of visual circuitry. Therefore visual acuity is the ability of the eye to resolve two or more stimuli separated partly.

The separate generator potential produced by the rods summates and produces a propagated action potential which can be registered by the brain for interpretation.

Diagram of the rods showing retinal convergence

They are structurally similar to the rods. They contain photosensitive pigment known as **rhodopsin**. The cones are tightly packed at the fovea and lie within the optic axis of the eye.

The cones are shorter than the rods. They are stimulated by light of high intensity because rhodopsin is less sensitive to low light.

Each cone cell forms a single connection with its own bipolar neurones i.e. cones are not characterised by retinal convergence.

Diagram

The cones are able to distinguish colour. There are three different kinds of cones and each has a maximum light absorption of certain wave length. The 3 cone types are;

Cone type	**wave length**
Blue cones	405
Green cones	530
Red cones	625

Each of the colours obtained is as a result of mixing the 3 primary colours. This can be demonstrated by the absorption spectrum below.

ABSORPTION SPECTRUM OF THE CIS RETINAL (light sensitive pigments of the cone cells)
Diagram

There are some overlaps for the absorption spectrum for the different pigments of the three kinds of cones. The mixing of the primary colours gives the different other colours which are interpreted by the brain according to the extent to which the different types of cone are stimulated.
This theory is called **Trichramatic theory of colour vision**.
Some individuals lack the red green cones and this is caused by genetic disorders resulting in the red green colour blindness.

COMPOUND EYES
They are found on the head of an insect and they are two in number. Each eye is made up of small tiny eyes known as **Ommatadia**.
These are aggregated together into a component structure. Each ommatidium works separately as a functional unit and consists of the following parts;
A convex crystalline lens
A transparent crystalline cone

Structure of the Ommatadia
Diagram

THE HUMAN EAR
Diagram

The human ear is a sensory organ that converts sound waves into an action potential that is interpreted by the brain in what is termed as hearing.
It's composed of 3 major body divisions;-
- External ear
- Middle ear
- Inner ear

The outer ear consists of the pinna and auditory canal. The pinna is made up of cartilage which is covered with a skin. This cartilage gives it rigidity so that it com with stand force of air and prevent covering of auditory canal. The function of the pinna is to receive sound waves from the source and direct them to the auditory canal.

External auditory canal

The canal connects the pinna to the ear drum (tympanic membrane). Its lined with wax secreting glands and its function is to conduct sound waves to the tympanic membrane. Wax traps dust particles that enters the ear.

Tympanic membrane.

This is a part of the middle ear. It's a thin and delicate membrane. It vibrates when sound waves strike it and passes the vibration to the ear ossides. The ear ossides are 3 in number in each ear and there order of arrangement from the ear drum is as follows;

- Malleus (hammer)
- Incus (anvil)
- Stapes (stirrup)

The ear ossides are held in position by muscles and vibrate.

Functions of the ear ossicles.

They transmitte sound vibrations or the ear drum to the oral window and lastly to the middle ear; they amplify the sound waves. The middle ear is filled with air which protects from the damaging effects into the ear drum by very strong atmospheric pressure. For the ear to vibrate properly, the pressure exerted by air must be balanced pressure is equalised in the ear by the Eustachian tube.

The inner ear

This is composed of two important organisms namely;

1. The cochlea which contains the hearing apparatus called the organ of corti.
2. The semicircular canal (Vestibular apparatus) which are the organs for body balance.

Mechanism of hearing.

Sound which is perceived by the ear travels as waves.Sound waves are corrected by the pinna from the source and directed into the external auditory canal where they travel until they reach the ear drum or these vibrations are passed through the oval window by the ear ossides i.e. from Malleus to Incus and to stapes.

As the oval window vibrates, it causes displacement and compression of the perilymph in the vestibular apparatus.

Diagram showing the uncoiled cochlea

The displacement of perilymph by the oval window in the vestibular canal causes similar displacement of the round window.The displacement of the oval window

inwards results in the round window to move outwards. This is achieved because the middle canal is filled with air.As the perilymph of the vestibular canal gets into contact with the waves, it causes the meissner's membrane to vibrate which in turn displaces the endolymph of the middle canal. The displacement of the perilymph of the tympanic membrane causes the displacement of the basilar membrane.Between the basilar membrane and tectorial membrane are sensory hair cells but the tectorial membrane is more rigid and relatively fixed. As the basilar membrane is displaced relative to the tectorial membrane. It stimulates the hair cells to generate an action potential which is carried to the brain in form of impulse through the auditory nerves which bring about the secession of hearing.
Therefore hearing is the resultant effect of stimulating the structures of the organ of corti.The organ of corti is therefore composed of tectorial membrane, basilar membrane and the sensory hair cells.

The control of pitch.
Pitch refers to the sound waves whereas the loudness of sound refers to its intensity.
Sound is characterised by frequency and wave lengths. The longer the wave length, the lower the frequency. Human ear can detect wave length ranging from 40 – 16000HZ. But they are most sensitive between 800 – 8500HZ.Pitch (frequency) and amplitude (loudness) are responsible for causing variation in sound. It's proposed that the ear can discriminate the different sound waves because of their responsively sensory hour cells along the entire length of the cochlea.At the base of the cochlea, the basilar membrane is narrow, thick and ridged it's sensory hair cells respond more readily to high frequencies which are interpreted by the brain as high pitched sound towards the apex of the cochlea, the basilar membrane is wider and less ridged. It contains sensory hair cells which are more sensitive to low frequency and once stimulated.
They cause the brain to interpret the sound as low pitched.
Diagram

AMPLITUDE
This refers to the loudness of sound. Amplitude is measured in decibels (dB). The perception is thought to depend on the number of neurones that are activated and the frequency of transmitting impulses to the brain. The ear is more sensitive to different levels of amplitude at some frequencies and the maximum sensitivity of loudness is at a frequency between 1000 and 3000HZ. Which corresponds to the frequency range of normal human speech.
Above the frequency of 2000HZ, the ears are insensitive.

BODY BALANCE
This refers to the ability of the body when subjected to different forces of distabilisation. It orientates and become stable.
The sense of the body balance is controlled by the vestibular apparatus of the inner ear. It consists of 3 semicircular canals namely;Ampular, Utricle,Saccade

Each consisting of an organ called the p.v crista sac.

Saccade organ (diagram)

Ampular organ (crista) diagram

Utricle organ (maculte) in section diagram

The semicircular canals are three in number and lie at different ends at right angles. This arrangement enables to detect changes in movement in all directions i.e. acceleration and decelerate.Each canal is filled with a fluid called endolymph. The ampular (the swelling at each end) contains a sense organ called a crista. This crista has sensory hair cells embedded in jellatinous body called the copula. The copula moves in response to the movement of endolymph in the semicircular canals causing the bending of the cilia that projects the sensory hair cells.
When the cilia bends, they generate a potential and it its above the threshold, it evokes an action potential in the auditory canal which is transmitted to the brain for interpretation.The saccacle and the organ called the macula which apparatus contains sense organs called the macula which are lined with both the sensory hair, cells surrounded by jellylike fluid,. This contains 5 granules of calcium carbonate called the autolymph.If the cilia bend in one direction, the frequency of the impulses decreases while bending in the other direction increases the frequency of impulses. The information of the vestibular apparatus is transmitted to the several parts of the CNS mainly the spinal cord where the body position can be adjusted by reflex action or to the cerebrum which processes information to produce smooth and coordinated movements. In order to maintain the body balance.

12.BEHAVIOUR AND RESPONSE.

In order to survive, organisms must respond to changes in their environment. Behaviour is the respond to changes and involves both endocrine and nervous systems.The study of behaviour is generally known as ethnology.
Behaviour is outwardly expressed cause of action produced by an organism in response to change in its environment orSimply the way an animal responds to stimuli in its environment. It's the way organisms respond to their environment and to other members of the species i.e. voured activities of an organism.The study of animal behaviour are called **ethology**. The study of behaviour in human is called **anthropology**. Behaviour is based upon feed backs and up on the machinery for response and effector organism.The activities of behaviour of animals enable them to survive and seek out a favourable environment.These include activities like.movements, animals reaction, protective activities,sex related activities. Behaviour is divided into two categories namely; innate instinctive behaviour and Learned behaviour.
An instinct is a complex in born store typed pattern of behaviour appearing universally in members of the same spaces. An instinct is a complex in born

stereotyped pattern of behaviour that is formed universally among members of the same spears and it is produced in response to a sudden change in the environment Instincts are inherited and include a wide variety of examples ranging from simple reflexes to complex behaviours such as next budding, mating behaviour, courtship, parental care, migration and social behaviour.

Innate behaviour;

This is an inherited pattern behaviour that appears in a similar form in all organisms of the same species. Innate behaviour therefore is species characteristic behaviour.Innate behaviour is the result of pre-programmed nervous system path ways under genetic control. Innate behaviour is triggered by a sign stimulus lie a signal in the environment that triggers the behaviour which sets off an innate releasing mechanism that sensory mechanism that detects the signals that produce the nerves instincties for the fixed action pattern.Stereotyped action is an act appearing in the same type in different individuals of same species.

Characteristics of innate behaviour.

- Are inherited and not acquired.
- Are similar among members of a species and there are no individual differences other than those between male female species
- Are automatic and quickly accomplished with little of the organisms control.
- Comprises of a chain of reflexes. Completion of each link of the chain provides the stimulus for the commencement of the next links.

Techniques of Studying animal behaviour

Studying animal behaviour involves observing animals in there natural environments however, the trouble with this is that the animal may be in accessible and its behaviour may not be monitored.

On the other hand, if it's bought into the lab its normal behaviour pattern may be interfered with captivity or by subjecting it to cuticle experimental situation.

Etholoyy therefore compromise between the continuance studying animals and artificially of subjecting it to a natural condition hence both approaches are normally used. First observing the animal in its natural environment, then in its artificial environment.The techniques normally involved include: video recording this involves the use of audio video recorders such as video coverage to absorb an animal in its natural environment.

Kymograph

This involves the use of physiograph to make a graphic record of the muscular response of animals e.g. wasp, sea anemones e.t.c.

Slow motion filming: this is used to record the activities of slow moving animals such as birds.

Multiple flash photography

Rader tracking

Time tape photography. This is used in tracking slow moving animals.

Activities of animals help in explaining the under lining neutral sensory mechanisms coupled with imitation in the physiological techniques.

Types of behaviour.

Behaviour is divided into two namely:

Species characteristic behaviour
The individual characteristic behaviour

Species characteristic behaviour.

These are behaviour patterns which are shown all members of species e.g. courtship, Copulation, species. Characteristic behaviour in born innate in species character.

Individual characteristic behaviour

These are behaviour patterns which vary on individual to another. This involves behaviour learned by an animal during its life span e.g. tricks among students.

Behaviour is a result of an interaction between an individual genetic makeup and its environment.

In organisms behaviour involves some fundamental mechanism e.g.
Reflex action
Conditioning and learning.

LEARNING

It is an adaptive change in behaviour that results from first experience an impression of a certain experience is retained and is used to the very behaviour on a future occasion.

A learned behaviour is acquired by experience and modified in the light of further experience hence a learned behaviour tends to reflect an individuals experience.

A learned behaviour cannot be inherited but the ability to learn can be inherited.

IMPORTANCES OF LEARNING

It permits an animal to adapt quickly to the changing circumstances

It primates, learning is the basis of memory (ability to retain mental image of experiences in a useful way)

TYPES OF LEARNING

Learning is classified into 5 groups
Habituation
associative learning
imprinting
exploratory learning
insight

HABITUATION

This is a form of learning in which a repeated application of a stimulus results in the decreased responsiveness in case it's not harmful.

Habituation is the simplest form of learning behaviour and animals learn not to respond to a repeated stimulus which proves to be less harmful.

Importence

it helps an animal from preventing an escapive response too frequently.

It prevents an animal from responding to releasers that do not leave any more releases are wings the invoke one to respond to a stimulus.
NB:
Habituation is either due to the synaptic block that occurs in the reflex between the afferent nerves in the chord or accommodation

ASSOCIATED LEARNING
This is the type of learning in which an animal associate learning with a reward or punishment.
Here a reward refers to flinching food, mate a likes and punishments involve being attacked by another animal.
In this type of learning the animal remembers its past experience and modifies its behaviour accordingly.
There are two types namely
Conditioned reflex
Trial and error.

CONDITIONED REFLEX (CLASSICAL CONDITIONING)
These were first observed by Ivan Pavlou when experimenting on dogs. A conditioned reflex is a learned response an animal develops after practice when infective stimulus is introduced with another e.g. what Ivan did was to teach his doctors to associate with arrival of 1000l with some other stimulus which was the sound of the bell. In this experiment, he rang a bell immediately before presenting food. He repeated this many times and eventually the dog started salivating as soon as they had the bell
The dogs therefore learned to associate the sound of the bell with the food. The sound of the bell which was the new stimulus called a conditional stimulus evokes a responds called a conditional reflex
Conditioning allows animals to modify their behaviour in away that maximum reward is obtained and punishment is avoided.
Examples
Students associating a bell at lunch time for a meal, several insects with yellow and black colouration either sting or animals may have the same effect on the animal however some other insects consequently all insects with such a colour may be avoided by the predator and hence the predators are conditioned to avoid them.

TRIAL AND ERROR (OPERATE LEARNING)
Ti was developed by professor B.F skinner and it's observed in various animals ranging from black worms to humans.
Skinner carried out an experiment on animals by observing the choices with mates. Each animal was rewarded with the choice and punished for the wrong choice.
A hungry chimp was locked in a room with boxes and food which was tied up on the roof.
The clump tried to reach for the top of the roof to obtain food. It 1st jumped out failed to reach the food it then arranged the boxes and stepped on them and

eventually reached to the top where the food was located. Food in this particulars experiment was a reward.

The graph below illustrates the results of trial and error learning
Diagram

Trial and error learning is confined to animals with well developed brains. It is also shown by the lower animals such as earth worms. The ability of an animal to learn by trial and error is seen in three ways.
The speed with which it sizes to make errors
The length of time it can remember without repeated trials
Complexity of the situation to which it will respond.

EXPLORATORY LEARNING (LATENT LEARNING)
This is the type of learning where by an animal stores information while exploring its environment and uses it at some later initiatives to explore.
Exploratory learning is important in many lives of animals because it enables them to find there way about the environment provided success is expected. Exploratory learning is also known as latent learning e.g. a rat placed in maize is set free to find its way out. When a reward is present it completes the maze move rapidly than when a reward is absent.

IMPRINTING
This is the type of learning which occurs during a very early stage especially the receptive age in the life of birds and animals.
In this period, the young animals form more or less permanent bones with a large moving object which it first observes. The attachment quickly grows especially when reforced by rewards such as food, warm by body contacts.

ADVANTAGES OF IMPRINTING
Young animals gain parental protection
It helps animals to determine individual behaviours through acquiring skills such as fetching.

INSIGHT LEARNING
This is the immediate comprehension and response to a new situation with out trial error. It's the highest form of learning. This type of learning is associated with intelligence and is more applicable in human.
An animal intelligence may be assessed by the speed with which it solves a problem it has never encountered before.
Insight learning involves use of experience gained by an individual is one situation to solve a problem in another.

MEMORY

This is the ability of an animal to perform some previously learned pieces of experience in a useful way.
Memory involves numerous memory units made up of inter connected nerve cells. It also contains a classified cell which has connection with two memory cells. One memory cell is connecting with a nervous path way responsible for attack and another with.
There are two types of memory
Short term memory which lasts for seconds
Long term memory which last for 24hours and move.
Memory is sensual in learning Vourlis from one species to another but the environment plays a very important par in the development of behaviour

Question
Write short notes about the following
Habituation
Imprinting
Comparent behaviour
Conditioned reflex
Latent learning
Intelligent behaviour

REFLEX ACTION.
Reflexes are innate or inborn
This is a simple act of behaviour in which some kind of stimulus evokes a specific, short leaved response. Responses are rapid short leaved. The rapidity of response is cause partly by the speed at which muscles contact, but also by high speed at which impulse are transmitted through the nervous system.
The high transmission velocity shortens the delay between stimulation and the onset of the muscular response, and it results in a synchronous contraction. They are protective responses to danger, or important to survival of an animal.
Examples of reflex action
Knee jerk
Blinking of eyes
Billation of pupil
With draw of hand on touching a hot object
Escape response of the squid

REFLEX ACTION IN EARTH WORMS
In earth worm locomotary movements controlled by reflexes between segments involving stretch receptors in the longitudinal muscles and sensory and motor nerves running between the sensory organs and muscles from the neighbouring segments.
The segmental ganglia and the relay neurones permit communication between segments.

TRANSVERSE SECTION OF THE VENTRAL NERVE CODE AND THE PERIPHERAL NERVES

Diagram

Diagram

Giant nerve fibres innervate (penetrate) the longitudinal muscles of the body wall. Situation of giant nerve fibres result in the speedy transmission of impulses through the full length of the earthworm.

These impulses cause almost simultaneous contraction of the longitudinal muscles in each segment with the posterior end firmly anchored the earth contracts suddenly and may well escape danger by withdrawing rapidly into its barrow.

ORIENTATION

Orientations are inborn or innate.

Here an organism takes up a particular position in relation to a stimulus. Orientation involves movement of motile organisms and gametes in response to external stimulus.

Orientation behaviour is important in the natural environment because it enables organisms to move towards desirable stimuli and away from harmful ones e.g.

Green flagellates are guided toward light (flamalentous algae)

Animals move towards food

Parasites getting towards their hosts.

Spermatozoa swimming towards the female eggs

TYPES OF ORIENTATION

There are two types of orientation process

Taxi

Kinesis

TAXI

This is the movement of a freely motile organism or motile cell in response to a directional stimulus. The direction of movement is relate to the direction of stimulus; either towards it (positive taxi) or way from it (negative taxi).

Tactic responses are classified according to the naïve of the stimulus.

Examples of tactic responses

Name of tactic response	Stimulus	Response of motile cell
Photo taxis	Light	Flagellate euglena moves towards light. Earth worms and wood lice move away from light i.e.

Thermo taxis	Temperature	Chlamidemonas and motile bacteria Bacteria move towards the region of optimum temperature. Blowfly move all from extremities of temperature
Chemo taxis	Chemical	Sperms of mosses and liverworts and ferns are attracted to chemicals produced by archegenium.
Hydro taxis	Humidity	Wood lice move towards the region of high humidity

KINESIS

This is a random movement of an organism in which the rate of movement is related to the intensity of the stimulus but not its direction.

The organism (animal) moves faster and changes direction (kinokinesis) move frequently when subjected to unpleasant stimulus. The greater the intensity of stimulus, The faster it moves and the more often it changes direction e.g. wood lice move about quickly in dry conditions but slow down and stop if there random movements bring them into an of greater humidity.

INNATE OR INSTINCTIVE BEHAVIOUR UNLEARNED SSP SPECIFIC MOTOR PATTERNS

This is an initiated (R) which is increasingly specific.

It involves some complex reflex actions that are decrease genetic control and develop independently of the environment.

Much instinctive behaviour is highly complex and consists of a chain of action, the completion of each stage in the chain acting as the stimulus for the commencement of the next stage.

Instinctive is predominant in the lines of non-vertebrate animals with short life cycle which prevents modification in behaviour occurring as a result of trial and error learning.

Examples of instinctive behaviour

In sand or digger wasps, including species of haemophilia, in these organisms, the parents die along before each wasp hatches and there is no chance for the offsprings to learn from their parents and therefore rely on inherited patterns of behaviour.

When the time comes to lay eggs, a female digger wasp digs a nest and in its contracts small cells which it provides o paralysed caterpillar to act as a food source for its offsprings.
Having done so, it lays a single egg on the root of each cell and seals it upon the roof of the ceiling where its seems the young wasp
The female wasp opens the cell, adds another caterpillar, lays another egg.
The egg hatches into larvae while feeding on the immobilised caterpillar. The young adults emerge from the nests and repeat the process without having met their parents.
However some sand wasps remember the location of each and remember this information which is learned.
SONGS IN SOME BIRDS
In yellow hammers and on hunting's, the song of isolated birds is exactly like that of birds raised normally in the wild.

Characteristics of instinctive behaviour
Its similar among members of the same species
It is intelligent and normally accompanied lay no reward
It is inherited and not acquired
It involves a chain of reflexes and each stage that is completed lead to the development of the next stage.

Revision the figure below shows the relationship between errors made during positive learning image and the extent of damage made in the cerebral hemisphere of the rat **Rattus rattus**

Diagram

Describe a simple relationship between the number of errors and brain damage.
It is argued that learned behaviour can not be inherited but the ability to learn is inherited. Give two examples of how Behavial patterns are learned by mammals.
Hormones affect behaviour, give an example where an animal may fail to exhibit a certain behaviour as a result of

Releasers
A releaser is produced by a member of the same species.The herring gulls chick are feed on food regurgitated by there parents. To make the regurgitate, the chicks peck at its parents beak, the beak is yellow with a red spot towards the tip of its mandible. The red spot acts as a releaser to which the younger one responds so as to get food.This was discovered by tin Berger after carrying out the following experiments. He made cupboard having an exact shape and colour of the head and the beak. He then varietals the colour of the mandibular spot. Each model was presented to the chicks in as a natural a manner as possible. There response was measured in terms of the number of pecks made in a given time. The results obtained are shown below.

Spot colour in yellow back ground	No spot	White	Blue	Black	Red
% No of pecks	30	71	85	86	100

The results showed that the shape of the head and the beck showed no part releasing a response.
The most important feature to elicit a response was the red colour of the mandibulous spot to release a response.To respond to a specific release, there must be a mechanism in the receptor or the brain which filters out relevant features of a stimulant object from the irrelevant ones. The neuron sensory process which does this selecting is called a stimulus filtering process.

Significances of releasers
They act as signals that initiate an appropriate behaviour.
They coordinate interaction between individuals of the same species since the environment is composed of other animals.
They help in avoiding open conflict among members i.e. aggressive behaviour. In sexual reproduction, releases may change an animal normally aggressive to sexual behaviour.

Motivational stimuli
This is the type of stimulus that provides a drive or a good in the organism for a releaser.
A motivational stimulus may be internal e.g. depletion of food reserses in the body during libanation or it may be external e.g. increasing day length which reduces some territorial behaviour and courtship in birds.

TERMINATING STIMULUS
This completes the Behavial response and can either be internal or external e.g. a full stomach with terminate ingesion. In some animals (mammal) internal satisfaction compassing ejaculation in males will terminate corporation.Seeing complete nests in birds will terminate nest building.

MOTIVATION STIMULI
This is the type of stimulus that provides a drive or a goal in the organism for a releaser.
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TERMINATING STIMULUS
This completes the behavioural response and can either be internal or external e.g. a full stomach with terminate ingestion. In some animals (mammals) internal satisfaction accompanying ejaculation in males will terminate corpuration. Seeing a complete nest in birds will terminate building.
MOTIVATION

This refers to a variety of factors that modify the extent and the nature of a behavial response. It results from an animal internal physiological state particularly the level of different hormones in the body. Motivation builds from; The hormones may alter the sensitivity of the peripheral receptors e.g. in rats the male hormones enhance sexual behaviour by raising the sensitivity of the penis. During the development and possibly in adults where the hormone affects the growth of the nervous connection. Motivation can also be elisted by pheromones.
A pheromone is a chemical substance produced by one animal which influences the behaviour of another of the same species mostly.
Pheromones are usually highly volatile with low relative molecular mass.
Most pheromones can act as releasers e.g. civetone which is secreted by a civet cut, muscone which is produced by a musc deer, mucus secretion released by a cow over the vulva.
IMPORTANCE OF PHEROMONES IN ANIMALS
They are used by some animals especially mammals to mark out their territories e.g. an impala.
Act as sexual attachments naturally e.g. secretion over the vulva of the cow. They include mating or sexual intercourse e.g. the queen butterfly (Danaus gilipplus).The male release a pheromone for inducing mating with a female.In social animals e.g. bees pheromone acts as a means of communication. Worker bees detect the absence of the queen by absence of particularly pheromones. The artificial pheromone glyplune is used by man to capture and kill the male month since there are attracted by it. In some animals pheromones help in detection towards a source of food e.g. workers ants lay down scent trails which can be followed by the other workers. However, honey bees communicate to others by the means of dance which is performed on a vertical surface inside the hive or on the flow of the hive entrance.
Two common types of dance performed by bees are;
1. Round dance
2. Tail waggling dance.
Round dance
This is performed by the worker bees to give information about the source of food. This dance indicates that the food source is very close to the hive in the diameter of less than 90m. A round dance gives no direction of the food source.
Illustration.

Diagram illustrating a round dance

Tail waggling dance
This is performed by a worker bee when the food source is in a diameter greater than 90m. It also gives information about the direction of food source. This involves a worker bee walking in a figure of 8 will waggling her abdomen which according Karl ven.
Diagram illustrating the waggle dance

SOCIAL BEHAVIOUR

SOCIAL BEHAVIOUR

This interaction involves two or more member of the same. This occurs clearly in animal which organise themselves into highly social groups called society insoluble groups or life individuals assume specialisation which increase the overall efficiency of a group. These roles include;

Food gathering

Defence

Raring young ones and Reproduction

Specialisation of roles between members of a society depends on stereo typed pattern of behaviour and effective means of communication. Members of insect society play definite roles unlike primate society. This is because they differ in body structure and reproductive potential which affects their role in the society. This illustrates polymorphism.

Bees, termites, ants, are social insects living in columns and have an organisation based of caste system. In a honey bee column, there is a single fertile called queen and a few hundred fertile males called drone plus a hundred of sterile female called the worker.

Each type of honey bee has a specific series of rows determined by whether it hatched from a fertilised or unfertilised eggs.

Fertilised eggs are diploid and developed into females while unfertilised are haploid and developed into males.

The type of food provided for the female larvae determines whether they will become the queens or the works.

Those fed on royal jelly develop into queens and those which feed on diluted nectar and pollen develop into workers.

Advantages of social behaviour

Increased feeding efficiency.

Increased reproduction efficiency.

Energy is saved by endothermic animals as a result of being close to one another.

There is better use of defence and limited resources.

Members have better protection against predators e.g. through improved detection and defence systems.

Increased survival of the offsprings through communal feeding and protection

Disadvantages

Increased competition for water, food, mates e.t.c.

Increased social stability to decrease and parasite

Higher rise of predator especially

There is increased risk of bet being harvested by man e.g. in bees.

Grooming

This refers to the actions of an animal of re-apprearing either fur or feather and clearing the body surface by either biting. Scratching or leaking. This is important in removing parasites and spreading oils over the body. In many mammals especially primates grooming between individuals is important in promoting and mainly social cohesion.

Altruism

This is a form of behaviour displayed by an animal which is beneficial to other animals of the same species. Its found in many animal species being displayed by parents to the offsprings inform of feeding, caring and defending the rest of the animals.

(a) Giving examples in each case, name three types of involuntary responses in animals.

(b)What is ecological value of an animal to the following?

(i)Territorial behaviour.

(II)Insight learning.

(iii) Associative behaviour.

(a)Using example, explain the meaning of displacement activity.

(b) What is the importance of each of the following forms of behaviour to the survival of organisms in the community?

(i) Territorial behaviour.

(ii) Courtship behaviour.

13. SUPPORT AND LOCOMOTION

Locomotion refers to the movement of the whole organism from one place to another and as such plants are unable to locomote.

Locomotion should not be confused with movement which involves displacement of part or the whole organism.

Movement can occur at cellular level e.g. movement of white blood cells, at organ level e.g. beating of the heat or at the level of the whole organism.

Necessity for locomotion:

Animals carry out locomotion for a number of reasons.

To escape predation.

Search for food.

Avoid competition.

To colonise new areas.

Look for mate.

Avoid unfavourable environmental conditions such as extremes of temperature.

THE SKELETON
Properties of skeleton muscle tissue:
The properties of the muscle tissues can be investigated by stimulating the muscle fibre directly or stimulating it via its nerve supply like at the nerve muscle function with a brief electric sheen.

The properties include:
SINGLE TWITCH;
This is a quick sharp contraction of a muscle fibre which occurs when a single electric shock of sufficient energy is sent into the muscle fibre.
Normally, there is very short period called the latent period before the muscle responds.
This latent period is due to;
Time taken for the electrical energy in the stimulus to be transformed into mechanical energy for contraction.
The inertia of the apparatus i.e. general reluctance of the apparatus to respond after switching it on.

Diagram:

At the peak of contraction, maximum tension is obtained and contains or takes a relatively small compound to amide of relaxation.

summation:
This occurs when two shocks are delivered in quick succession. If the second shock is delayed, the twitches are given. However if the line interval is very short between the two shocks such that the second shock is given before the muscle begin to relax, the two twitches summate to give a smooth contraction.
Diagram:

Note: that the summated response of higher response and long duration then single twitch.
tetanus:
This occurs when a train of shocks is used to stimulate the muscle fibre. If the shocks are of sufficient energy, they send a muscle fibre into a maintained contraction called **Tetanus.** There is a general decline in the tension produced due to continuous stimulation and as a result of the amount of the transmitter substance used.

FATIGUE:
A titanic contraction can not go on indefinitely and if stimulation……………
Threshold – A point where contraction can't occur due to little energy.
Is continued, the muscular responses gradually decline and eventually disappear due to fatigue which is brought up by several factors.
These include;

Exhaustion of the transmitter substance.
Exhaustion of ATP supply.

Electrical activity in muscles:
The all or nothing law;
Muscles like nerve fibres obey the all or nothing law which states that the size of an action potential and the resultant contraction are independent of the intensity of the stimulus.
If the intensity is below the threshold no action potential and no convections are given.
But if the stimulus attain the threshold level on action potential is given and the muscle fibre contracts.
Further increase in intensity of the stimulus beyond the threshold wouldn't.
The oil or nothing law applies to isolate muscle fibres but if the whole muscle is stimulating with shocks of increasing intensity more and more muscle fibres are activated and the contraction gets steadily larger causing gradations in muscular response.

Refracting period;
Muscle fibres have a refracty.
Resting and action potential.
Muscle fibres have arresting potential when not stimulated and an action potential when stimulated.
Both of these are similar to those in nerves and have the same ionic basis.

Refracting period:
Muscle fibres have a refractory period during which non-contractions are possible following the previous one. It may be absolute or relative.
Absolute refracting period is the time when the next contraction is impossible even if the stimulus is very weak.
A relative refracting period is the time when the second contraction can occur if the stimulus is very strong.

Structure of the skeleton muscle tissue:
The skeleton muscle fibre consists of elongated cylindrical malt-nuclei cell called muscle fibre cells.
Each muscle is filled with specializes cytoplasm called the sarcrolemma are numerous mitochondria and the sarcroplasm reticulum which is in the shape letter T.
A study was carried out to determine the relationship between population growth and population growth rate in paramecium over a period of about 2 weeks.

Time/Day	No of cells	Rate of cell division

0	16	0
3	30	20
6	80	40
9	160	50
12	180	50
15	200	20
18	210	10
21	220	0
24	220	0

(a) Distinguish between growth and population growth rate:
(b)Plot a suitable graph to represent the results of the investigation.
(c) Describe the graphs.
(d)Explain the nature of the graph.

The muscle fibre cells are in turn made of many slender fibrils called **myofibrils** Each myofibril is composed of two types of microfilament which are the thin octin end thick myosin filament. They are protein in nature and they form the contractile proteins. Muscle fibre (longitudinal section)

Diagram:

The actin and myosin filaments are arranged in alternating light and dark bonds known as isotopic (I- bond and un isotopic/ a bond respectively).The A – bond is made of a thick filament of uniform length joined by a lighter line called the m – line.The I – bond is made up of the thin filament and running through them is the dark **z** line.From the z – line the actin filament extent in both directions between the thick myosin filaments of the A – bond causing some overlap of the two filaments.The region of over lap is charactitically dark as it contains both the thick and thin filament.In between the dark region of the A – bond is the H- zone which is a region of no overlap and is relatively light since it is made up of only the myosin filament. The section between the two z – lines of the my filaments is called the sacromere which is described as the functional unit of the skeletal muscle tissue.

Mechanism of skeletal muscle contraction. (Sliding filament theory)
When the contracted sarcomere is composed with the relaxed sarcomere, the length of the A – bond remains in altered but in the contracted state, the I –bond becomes shorter, the z – lines get closer together shorting the sarcomere length and the H- zone shortens or disappears all together.
Diagram:

It is upon this observation that the conclusion can be made that the actin and myosin filaments most in some way slide passed one another hence the sliding filament theory.In the theory, the actin in filaments and z – line to which they are attached are pulled towards each other sliding passed the myosin filament which remains stationary.No shorting of either type of filament occurs but entire muscle fibre shortens causing a contraction.The exact way in which the actin and myosin filaments slide passed on another can be explained in relation to cross bridges between the two types of filaments.The myosin filament has cross bridges with globular heads and the actin filament had specific attachment sites.In cresting condition, when muscle fibre is not stimulated or when undergoing refraction period, the tropomyosin block blocks the attachment / binding sites on the actin filament preventing the attachment of globular heads.When the muscle fibre is stimulate by an electric shock of sufficient intensity either directly or indirectly or via its nerve muscle supply like at the nerve muscle junction, calcium ions are released from the sacoplasmic reticulum. The calcium ion then combine with another regulatory protein called (Troponin) forming calcium ion troponin complex.This complex dislodges the tropo myosin block from the attachment site of the actin filament, making them free for attachment by the globular heads.The globular heads get attached, pull to some length, change shape to detach and then attach at other sites and pull again.

The effect of one globular head may not be significant but there are so many globular heads and their combined effect brings muscle contraction twitch.After the muscle contraction, the globular heads release the binding site; the sites are blocked by the tropomyosin blocks and the muscle contracts again.

Energetic of skeletal muscle contraction

The energy for muscle contraction is provided by A.T.P which is formed by oxidative phospharylation during the respiratory of glucose.

The supply of glucose is provided from the store of glycogen found in muscles though fatty acids can also be repaired.

Muscles have their own oxygen store because they contain myoglobin with a high affinity for oxygen and therefore can only release it when its supply from haemoglobin is inadequate that is to say during heavy exercise.

Once formed, the A.T.P is hydrolysed to release energy for muscle contraction.

Muscles have a chemical substance phosphor – create which combines with ADP forming ATP. I.e. this occurs when A.T.P supply becomes in adequate due to insufficient amount of oxygen and a decline in glycogen stores. ADP + Cr + Pr

At some stage, phosphor – creatin has to be restored and this occurs after exercise when oxygen supply becomes inadequate again to form A.T.P.

The A.T.P combines with creatin forming phosphor – creatin and ADP

ATP + Pcr $\longrightarrow$ ADP + P_{Cr}. S

Phosphor creating formed is stored in the muscle ready to be used later.

When the muscle become very active, their own oxygen supply becomes insufficient for complete aerobic respiration.

Instead pyruvate is converted into lactate and the individual is said to have an oxygen debt. Lactic acid is toxic and contributes to muscle pains so it needs to be removed when oxygen supply becomes sufficient again.

And under these situations the individual is said to have paid back the oxygen debt.

On the ground to which the body weight is lifted and the centre of gravity is adjusted.
Begin with the right leg off ground, the weight shifts onto the left leg and the centre shifts to the left of the vertebral column.
The same steps are involved in support when the left leg is lifted.
Like in quadrupeds, locomotion is achieved by the activity of both legs that are moved forwards, forwards and backwards by the alternate, relation and contraction of the flexor and exlasor muscles.
When the extensor muscle contracts, the leg acting as a lever extends and exerts a backward force against the ground giving a forward push.
When the flexor muscle contract, the limb is lifted giving a lift force. Both the lift and forward forces are transmitted all over the body which bring about forward movement.

Adaptation for locomotion in man;
A number of animals have evolved in numerous ways.
In order to carry out locomotion in their terrestrial environment some of their adaptations include;
Development of strong antagonistic skeleton muscles that move the locomotary structures such as wings, legs e.t.c.
Aspiring very fast but short distances and maximum long distances and slow

Effects of exercise on a muscle.
Fit individuals have increased number and size of mitochondria Carry out faster respiration. Releasing energy informs of ATP.Thus one can say that number of mitochondria and their ability to generate ATP almost doubles on fit individuals. Muscles of fit individuals have high levels of phosphor- creatin, myosin and glycogen. Training increase muscle tolerance to lactic acid and often increases blood flow to the muscles.

Muscular performance:
A working muscle gives the maximum tension when there is a maximum over lap of the myosin and actin filaments.
At maximum tension, there is maximum number of cross bridges between actin and myosin filaments.

Diagram:

Types of muscles fibres
There are two types of muscle fibres each with it's own special physiological properties i.e.
Slow / tonic fibre.
Fast / twitch fibres.

Twitch fibres enable fist muscle contraction e.g. predators posses many twitch fibre for faster reaction to capture the prey.
Similarly the prey has many twitch fibres for faster reaction to escape predation. This is an aspect of co – evolution where the evolution of one organism is influenced by the evolution of the other.

Tonic fibres are slow at contraction but their contractions can be curtained. These fibres have high glycogen content, many mitochondria and more myuglobin compared to the twitch fibres because their contractions are slow but curtained for along period of time.
Tonic fibres show long muscle contractions along period of time but to which fibres contract very rapidly and are easily fatigue.
Twitch fibres usually occur on oxygen debt due to low levels of myoglobin but tonic fibres may continue to function even during inadequate oxygen supply because other oxygen store in myoglobin.

MOVEMENT WITH OUT MUSCLE
Ciliary movement.
This is seen in paramecium and in the oviduct where the beating of cilia propels the fertilized egg towards the woes and also in the trachea where the beating of cilia removes dust particles from airAnd prevent from reacting the alveoli.In paramecium, the beating of cilia involves an effective powerful backward stroke where cilia first project from the surface of the animal, then beat backwards completing an arc of 180^0c. This gives the animal a forward thrust.After the arc is completed the cilia return to their normal position in a recovery stroke.
The beating of one cilia may not be significant in locomotion but the effect of many propels the animal forward in highly coordinated fashion called metachronal rhyme involving back forth - back sequence.
The power back ward stroke is energy intensive therefore at the base of cilia are numerous mitochondria providing the necessary energy for the process.

Flagella.
This occurs for instances in Euglena, Trypanosome and in sperm cells. As they swim towards the egg, the flagellum makes undulation beginning from the tip of the flagellum moving backwards, giving the animal a forward thrust.At the same time, the cell of euglena rotates along its horizontal reacts so that the animal describes / males a spiral path in water and acts as a screw propeller.

Amoeboid movement.
This is seen in amoeba, white blood cells e.t.c. movement is achieved by change of cytoplasm from on colloidal form to another achieved by changes from a fluid like endoplasm called the sole to a geol. like ectoplasms called a geol.At the fore end, there are points of galations (where the sole is turning into a geal) ant at the rear end there are points of solation i.e.(where the geal is turning a sole).Therefore the cytoplasm flows forward using. At the rear end, protein molecules fold when they

turn from the gael into the sole but they open up at the fore end leading to the formation of a bulb called the pseudopodia. The folding up and is similar to the way, toothpaste is squeezed out the tube.
Diagram:

Movement using muscles
Locomotion in annelids e.g. earthworm
The earth worm uses the hydrostatic skeleton which is a fluid filled cavity surrounded by longitudinal and curricular muscles. Locomotion is achieved by antagonistic action of these muscles are relaxed, lengthens the segment while contraction of longitudinal muscles (white circular muscles are relaxed) shorten the segment making that portion bulks. Locomotion if facilitated by leg like structure called chaetae which prevent backsliding by supporting the stationary part of the earth worm. When the earthworm begins to move forward, contraction of circular muscles begins from the anterior and of the body and continues segment by segment as a wave along the body working backwards. This gives the animals forward thrust. The contractions of circular muscles makes the segments long and thin at the posterior end of the animals the longitudinal muscles contract forming a bulge pulling out the chaetae support.

Locomotion in insects.
In winged insects, there are two forms of locomotion i.e. flight and walking but in wingless insects, locomotion is achieved by walking only.
Flight in insects.
In insects, there are two sets of flight muscles i.e.
Dorso-ventral muscles which run from the dorsal tergum to the ventral tergum and the longitudinal muscles which attach to the posterior and anterior parts of the thorax.
During flight, there are two strokes i.e. the up ward stroke and the down ward stroke.
The up ward stroke involve the wings moving up wards and this is brought about by contraction of the dorso – ventral muscles which pull the dorsal tergum down wards with the result that the wings are raised.
The down ward stroke involves the wing moving down wards and this is brought about by relaxation of the dorsal muscles while the longitudinal muscles are contracted.
This pushes the dorsal tergum upwards with the result that the wing moves downwards.
These dorsal ventral and longitudinal muscles are called indirect flight muscles because they do not attach to the wings directly but rather to the thorax.
However they are some insects with direct flight muscles such as butterflies, dragonflies' e.t.c.
These muscles directly attach to the wings and therefore can adjust wing muscles at rest or during flight. These muscles are elevator and depressor muscles.

Diagram:

Those on one side contract those on the opposite side relax and vice-versa.Forward movement is achieved by the body thrown into waves of contraction beginning from the anterior end moving towards the posterior end. This pushes water backwards and the animal is given a forward thrust. At the posterior end, the tail fin sweeps side to side several times pushing backwards large volumes of water giving the animal a forward push.Two important processes are set up as the tail moves side to side, the forward force propels the animal forwards and the lateral drag due to viscosity of water resists side t side rushing of the tail but because of the stream lined nature, the resistance is low.

Diagram:

Locomotion in fish.
Adaptation of fish to a efficient swimming.
Possession of the swim bladder that can enable fish stay buoyant.
The body is highly streamlined reducing water resistance during movement.
Possession of various fins which maintain suitability during swimming.
Fish has large protruding eyes, to provide a wider field of view during swimming.
Possession of a lateral line, that detacts vibration from an obstacle in its path during swimming.
The gills can extract oxygen from water required during respiration to provide energy for muscle contraction when swimming is taking place.
The caudal fin has a large surface area.

Mechanism of locomotion in fish.
In some fish, only the anterior part moves from side to side and this is called **carangiform** locomotion e.g. in Tilapia.
In some fish, the entire body is thrown into oscillations e.g. in the end. This is called **anguiliform** locomotion.
In other fishes, it is only the small tail that rushes from side to side e.g. trunk fish. This is called ostrae form locomotion.
During swimming, fish is reliable to three kinds of instabilities yawning, pitching rolling.
Yawing.
This is the lateral deflection of the anterior part of the body due to intensive side to side rushing of the tail.This is contracted by general massiveness of the head and the lateral flattening of the body.
Pitching.
This is tendency of the nose to plunge vertically down wards.It is contracted by the dorsa ventral flattening of the body and the horizontal fins.
Rolling.

The tendency of the body to rotate about its horizontal axis.It is counteracted by the dorsa – ventral flattening of the body and all the fins.
Note:
Fins in fish are not for forward moving except for the caudal fin but for maintaining stability during swimming.During swimming, the fish may stay buoyant. This is achieved by the swim bladder.
The swim bladder is of two types. Open and closed swim bladder.
The open swim bladder is connected to the pharynx by a duct when the fish wants to lower its density.
It swims to the surface of the water. Swallows the air and so that it can stay buoyant. The
The closed swim bladder has lost the duct but is surrounded by gas glands that secrete air mainly oxygen inside the swim bladder for the animal to lower its density and stay buoyant without swimming to the surface of water.

Locomotion in birds.
Adaptation for locomotion in birds.
Birds have developed feathers through evolution there by acquiring aerial life thus birds carry out locomotion by way of flight.
Air has less density then water and offers less support.
Therefore birds have undergone modifications to adapt to aerial life.
The pectoral griddle is well developed for firm attachment of wings.
The breast bone is elongate (keeled sternum) to provide a large surface area for attachment of light muscles.
Fore limbs have been modified into wings for flight.
Food storage is in form of fats with low weight.
The body is highly streamlined to reduce air resistance.
Bones are hollow to reduce on over weight of the body.
Birds have a high body temperature and a good isolation mechanism to counteract the cooling effect of air during flight.
The heart is large and four chambered to maintain a high blood pressure and ensure sufficient oxygen supply to the respiratory centre to provide energy during flight.
Have numerous myoblobin molecules in their muscles to store enough oxygen which prevents anaerobic respiration.
Sex organs of birds are very small and only develop fully during the breeding to reduce the weight of the body.
Birds have an excellent visual acquit to easily judge distance and avoid accidents during flight.
Have long hind limbs to prevent the feathers from rubbing against the ground at take off.
They excrete uric acid which requires little water for remove so they store less water in their which reduces on the weight of the crime.
The brain is well developed for efficient muscular co-ordination during flight.

Flight muscles in birds:
Flight in birds achieved by the pectoralias major and pectoralias minor muscles which work antagonistically causing repeated raising and lowering of the wings.

Diagram.

Types of flight.
Birds show two types of flight i.e. passive flight and active flight.
Passive flight.
Is a form of flight which does not need expenditure of energy.
The birds spread their wings at an angle of about 90^0 to the body and float in air without flapping the wings.
Active flight.
Is an active process involving expenditure of energy obtained from A.T.P hydrolysis.It involves repeated flapping of the wings due to the action of strong pectoralias major (Depressor muscles) and pectoralias minor (elevator muscles)The antagonistic action of these muscles results into two strokes i.e. the upward stroke (when the wing is raised) and the down ward stroke (when the wing is lowered).
During the downward stroke, the depressor muscles (pectoralias major contract while the elevator muscles pectoralias minor relaxes.This pulls the wing down wards giving the animal forward and upward push.
During up stroke, the elevator muscle (pectoralias minor) contract while the depressor muscles (pectoralias major) relax which raises the wind.Active flight may involve hovering which is the flapping of wings while the bird remains in one position.
During hovering, the bird's wings move forward and backwards at the same speed making the resultant speed zero and the animal stages in one position.

Forms of passive flight.
It takes two forms i.e. gliding and Soaring.
Gliding flight:
The wings are held at right angles to the body and the bird gradually losses height. In gliding, the bird's wing acts as aerofoil i.e. a smooth surface which moves through the air at an angle relative to air stream.

Diagram:

The air flows faster over the upper surface of the wing then the lower surface. This creates reduced pressure above the wing but increased pressure below it, there by providing the bird with a lift.
The lift force can be increased by holding the wing at a greater angle to the air stream i.e. by increasing the angle of attack.
However, too great on angle of attack may cause turbulence above the wing i.e. air flow causes to be smooth and this interferences with flight.

Diagram:

Turbulence can be prevented by development of the bastarted wings and end feathers which act as smoothers to allow smooth flow of air over the wing.Summary of the forces operating in a bird during gliding in still areas.

Diagram:

The gravitational forces will tend to pull the bird downwards while the aerodynamic forces will maintain the bird in air.
Lift force is provided by an increased pressure below the wing and a greater angle of attack.
The driving force drives the bird forwards but it is observed by the air resistance due to the smoothness of the features on the wing, the influence of air resistance is reduced.

Note:
Even the best gliders can not maintain an absolutely horizontal pathway in still air but if the air is raising, the bird can maintain its level or even climb.
To maintain a horizontal level, the speed at which the air raises relative to the ground must be equal to the speed at which the bird drops relative to the air.
And if the air speed is greater the bird will be given so much lift that it gains height as well as moving forward.

Soaring.
Is a form of passive flight where the bird makes use of either thermal air currents on obstarctional air current. When air is heated up, it losses density and tends to rise up as thermal air current. Birds locate these points where is rising up to gain height without flapping the wings at all. Alternating, when air encounters an obstacle such as a maintain range, it rises up and the bird follows the uprising air without flapping the wings.

Support and locomotion in tetrapods.
The four limbs e.g. in a dog give the animal a tetra pod support in the resting portion.
To maintain balance, one leg is lifted at a time and the remaining three legs on the ground maintain a tripled support.
The centre of gravity of the animal is kept in the triangle of the triploid providing support such that the animal does not fall over.
If the left hind leg is to move fast, the animal leans its weight forwards bring the centre of gravity within the triangle of the left fore, right fore and right hind leg.
The left hind limb is then lifted and brought behind the left fore.
The right fore hind is then lifted and steps forwards and the animal moves its weight and brings the centre of gravity between the triangle of the left fore right hind.
The pattern is related and the animal progresses forwards.

Therefore the sequences of movement of the leg starting with the left fore is left fore, right fore and left hind.
Generally, locomotion is achieved by bending and straightening of the limb. The limbs join at the knee joint.
Bending and straightening of the limbs is achieved by the antagonistic action of the flexor and extensor muscles.
Contraction of the flexor muscles when the extensor muscles are relaxed bends the limb while the contraction of the extensor muscles while the flexor muscle are relaxed straight the limb.
When the extensor muscles contract, the limb extends back wards against the ground pushing the animal forwards. This provides a lift force and a forward force through the limb and the entire body so the limbs are moved forwards.
Continuous movement of the legs one by one brings the animal to anew position.

Note:
When the animal begins to run, it loses its tripod support and all the limbs can be off ground when the speed support increases. At the start of running, the fore limbs are off ground before the hind limbs and usually one limb is off ground before the other.
Therefore, during running there must be quick repeated adjustment in centre of gravity if the animal is to attain support.
Support and locomotion in bi - pods
In a standing position, support is achieved by both legs which carry the weight of the body and the centre of gravity remaining along the vertical column.When the bi – pod begins to walk, one limb is lifted off the ground and support is only achieved by the one reaming.

14. REPRODUCTION

Is the producing of new generation of individuals of the same species during which there is transmission of genetic material from the parents to their off springs to ensure continued survival of the species over a long period of time.
Types of reproduction
There are two main types of reproduction ie sexual and a sexual reproduction
A SEXUAL REPRODUCTION
This is a type of reproduction which involves only a single parent and does not involve production and fussion of gametes. The off springs produced during this form of reproduction are identical to each other and to the parent.
There is no genetic variation except when mutation occurs, very many off springs are always produced during this time, it's considered to be a primitive of reproduction and it is limited to lower animals eg protozoa, Bacteria and some plants.
Forms of a sexual reproduction
Binary fission
This is a type of a sexual reproduction in which the parent divides into two equal parts which later develops into new daughter cells eg in amoeba, paramecium,

bacteria etc for example when an amoeba is ready for binary fusion, it stops moving and rounds up by withdrawing its psuepodia, its nucleus divides first by mitosis and the cytoplasm, constricts so that two daughter cells are eventually produced, this feed and grow to mature.

Multiple fission

This is a type of fission in which a parent organism into more than one identical part and each develops into new individual, during multiple fission, the nucleus repeatedly and each daughter cell divides together with a small portion of the cytoplasm, each nucleus feeds and grow into new individuals, this process is also called <u>schizogany</u> eg in plasmodium.

Speculation

This is a form of a sexual reproduction which involves formation of smaller incellular called spores by cell division with in the parent organism. Spores are small and light and can easily be blown by wind when detouched from parent plant and land on suitable ground they develop into new individuals, spores formation occurs in moses fungi eg rhizopus, mushroom etc ferns, liver wants, Algea, amoeba.

Fragmentation

This involves breaking up of an organisms into two a more genetically identical pieces and each develops into a new individual by mitosis. It occurs in sponges, sygnogella.

Budding

This is a form of a sexual reproduction in which an individual develops an out growth called a bud which a new individual, this occurs in flat worms eg tape worms, yeast, hydra, Obelia, Bnophylum etc.

Vegetative reproduction

This is a form of a sexual reproduction in which part of flowering plant other than the seed detouches its self from the parent plant and develops into a new individual, the parts which the plant such as roots, stem, leaves are specialized to give rise to new individual called propagua which may act as parenting organ in parent plant. Parenting organs are part of flowering plants specialized for vegetative reproduction and food, storage to enable the……….role played by preventing organ.

During unfavourable conditions the plants remains dormant when the conditions normalize stored food like starch is hydralised to sugar and transported to young buds to enable early growth, spanting and photosynthesis. When there is little components for nutrients with other.

Differences between vegetative organ and parenting organism.

Organs of vegetative propagation are part of flowering plants other than a flower eg stem, root or leaf specialized for developing into two individuals when detouched eg the rhizomes like ginger, couch glass, cananile, corms, stem tubes eg Irish potato, root tubers eg sweat potatos, bulbs eh onions, garric etc stolones eg black berry rumen eg straw berries.

Preventing organs these are plant parts specialized for food storage that is sued to develop new individual conditions like drought for example are; Rhizomes, combs, stem and root tubers, bulbs, swollen tape roots.

NB: some organs of perennation also serve as vegetative organs of vegetative propagation but not all vegetative organ act as perennating organs. The specialized organs of vegetative propagation must have buds along their stems except a few eg root tubers like in sweet potatoes and swollen tap root of carrot, this is because root tubers of carrot have small parts of old stem which act as organs of vegetative propagation.

Artificial propagation in plants

Cuttings

This involves chopping a piece of root or stem eg lemon on sugar cane or cassava or a complete leaf deeped in a mixture of hormones and are allowed to grow xxxxx any of these paints is placed in an area where condition are preventing to develop into new individuals.

Layeing

This involves pegiang down a stem of a number or branch of a stem of a tree into the sort to induce develop of adventitious roots after which the new daughter plants are detouched from parent plants by cutting.

Grafting and budding

This is insertion of a stem or a bud of one plant called Scio on to another of closely related plant called a stock to ensure that vassular tissues are in contact. It is applied in propagation in citrius fruits like lemonds, apple, roses, hibiscus, oranges etc.

Advantages and disadvantages of natural vegetative propagation over asexual

Advantages of natural vegetative

It is a rapid mean of production and spread of a given species of plants. Till off springs are genetically identical hence preserving good stems.

Perennating organs enable plants survive advance conditions

The dispersal and spread of plants is independent of external agent

Plants are less affected by environmental factors

Parents pass off their gamers to the off springs.

Only one parent is required

Disadvantages

It leads to over crowding and competition unless separated antificially

New varieties can't be produced except by mutation resulting in reduced vigour and strength

Many individuals can be destroyed by a disaster such as floods etc

Lack of colonization of new area is unlikely since the off springs are produced. Those of the parents

SEXUAL REPRODUCTION

Is the type of reproduction that involves fision of haploid gametes during fertilization to from a diploid zygote that develops into a mature individual. It involves two parents ie the male and female which produces the respective gametes ie the male and female gametes since there is fission of gametes there is genetic mixing up and the genetic composition for the off spring is different from those for the parent organisms. A few individuals are produced at a given time however some species are able to produce both male and female gametes at the same time and this products are described as hermaphrodites or bi-sexual organisms. Examples, tape warms, earth warms, molasses etc.

COMPARISON BETWEEN SEXUAL AND A SEXUAL

Similarities

Both involve mitosis

Both lead to production of off spring

In both there is transmission of genetic males from parents to off springs

In both there is a parent involved.

Sexual	A sexual
Involves fertilization on fusion of gametes	Does not
A diploid zygote is formed	It is not formed
Off springs show genetic variability	Off springs are usually identical to each other and to parent
A few off springs are produced at a given time	Many off spring one produced due to high production
Involves two parents	Involves one parent
It is a slow process	Occurs rapidly under favourable conditions
The off spring take long time to mature	Off spring mature faster
Occurs among almost all organisms	Occurs mainly among plants and lower animals

Advantages of sexual reproduction

It brings about genetic variability in a population to enable the species adopt to changes in the environment.

During a life cycle of an organism resistant stages develop enabling survival of advance conditions

The formation of spores. Seeds or larvae may be used to discuss off spring to reduce intra specific competition

It leads to increase number in a population

It also increased higher changes of colonizing new areas

The mass destruction of off spring by disasters is unlikely due to dispersal.

Disadvantages

May lead to lethal genes

In some animals it is difficult to bring together the male and female gametes at a right time for successful fertilization.

It relies much on external agents hence reducing changes of occurancy

It is a slow method of reproduction

There is a wastage in production of male gametes

The females only pass half of their genes to the off springs because the genome is halved at meiosis.

It is an energy consuming process especially when animals move to look for males

It requires special mechanism like pollination, copulation to bring the gametes together so as to affect fertilization

It may result in production of individuals with undesireable qualities due to mixing of the same species, isolated individuals may never get a chance to reproduce.

SEXUAL REPRODUCTION IN FLOWERING PLANTS

Sexual reproduction in flowering plants or orgiospen takes place in the flower as the reproductive organ of the plant.

Structure of a flower

A typical flower contains chloro arranged in ……….of wholes, the whores arranged as follow, from outside to inwards, the coryx, sepal, corolla or petals, anderecium or stamen and gynoecium or carpels. The carpel consists of stigma. The sepal like structures outside the carpel are called epicaryx.

Terms used to describe a flower

Complete flower. Is the one which bares androecium, gynocium, and corolla and caryx. The androecium and gynoecium are the essential parts while the caryx and corolla are accepting parts.

Androecium is a collection of stamens and each stamen consist of the other attached on to the filament.

The gynocium is a collection of campels and each carpel consist of stigma, style and ovary.

Incomplete flower: Is a flower which lacks one or more of either gynoecium or androcium caryx or corolla.

Perfect flower: is the one which has got both male and female reproductive parts

Dioecius (unisexual flower). Is a flower that is with only one reproductive put ie either pistilate or staminate.

Actinomorphies flowers (ozoregular). These are flowers with radialicementry eg sweet potato flower.

Zygomophyic flowers (irregular). These are flowers which are bi-laterally semetrical eg peas, beans, acacia etc.

Bisexual flower (hermaphrodites). These are flowers with both sexual parts.

Petaloid. Is a condition in which a caryx ressembles petals.

Polysepolows. Are flowers baring unjoined sepals eg hibiscus

Gano sepalous flower. Are flowers with joined sepals eg allamenders

Perianth. Is when the sepals and corollar cant differentiated / distinguished.

Monocarpus. Is the one with one carpel

Apocarpus pistil. Is a flower with many three pistils.

Syncarpus: is one with many pistils fused together.

Superior ovary. Is the one that lies above the origin of other floro whorls eg cacia, hibiscus, crotolar

Inferior ovary. Is the one that lies below the origin of the floro whorls eg in guavas

Epigynous flower. Is the one whose ovary lies at the base and other floro parts are attached on to the epical portion

Hypogynus flower. Is the one whose carpel lies in the center of flowl xxxx and other parts are inserted below the carpel ie the carpels are superior in positions.

Perigynous flower. In a flower whose gynoecium (carpels) lies centrally located at the epical regions of the receptacle and other parts are born at the margin of the receptacle eg in rose.
Pedicel. Is the a stalk of an individual flower
Receptacle . is the apex of the stalk where the flora whorls are attached.
Staminodes. Are the reduced stamens
Epipetuns. Is when the stamens are attached on to the petals or corolla.
Anemorphilous flowers. A flowers pollinated by wind
Anemorphilous flowers. A flowers pollinated by wind
Entomorphirlous flowers. Are flowers pollinated by insects
Synandrous. Is when the stamens are joined completely by both stamen and filaments.
Syngeneceous. Is when all filaments are free but all the anthers are fused
Adelphous. Is when all filaments are united and all anthers are free.
Monoidelphoug. Is when anthers are free, filaments are joined but just in one bundle eg hibiscus.
Diadelphorus. Is when anthers are free, filaments and joined to form three bundles eg sweet peas, beans.
DEVELOPMENT OF A POLLEN GRAIN
Pollen grains develop with the answers, anthers contain pollen sacs in which the pollen grains particularly develop.
Each pollen sac contains large pollen mother cells which are diploid and swollen, mother cell undergoes meiosis to produce for haploids, pollen grains (atetraid) with in which pollen grain is a haploid nucleus which divides mitotically to from two haploid nuclei one called anerative nucleus and another a pollen tubule nucleus. When the pollen grain matures the wall between and pair of pollen sacs breaks down and the antharats rapture longitudinary a long the line of weakness to release the pollen grains.
A transverse section of another head before and after dehiscence
Development of the embryo sac
Embryo sac develops with in the carpel which is the female reproductive part of the flower made up of the stigma, style and the ovary. Each ovary contains one or more ovules which in turn contain a mass of cells called nucleus. The nucleus is completely surrounded by two integuments accept at a small pore called micropores one of the nucellus develops into embryo sac mother cell. The embryo sac mother cell divides meiotatically to filament give four haploid megaspore cells of which only one develops to form embryo sac while the remaining three degenerate. The embryo sac nucleus divides mitotically to form two nuclei of migrate to the opposite poles from where each divides mitotically to form four haploid nuclei at each pole.
One nucleus from either end of the sac moves to the center and difuse to form a diploid endosperm nucleus. The remaining six nucleus each gets enclosed with a thin cell wall and one of the three near the micropile becomes the female gamete ie the egg nucleus. The remaining two nuclei are synergids which later distintegration.

The three nuclei at the other opposite and become the anti-podal nuclei therefore a nature embryo sac contain seven nuclei ie two synergids, three antipoda cells and primary endosperm nucleus.
Diagrams illustrating development of embryo sac
POLLINATION
Is the transfer of pollen grains from anthers to stigma of a flower.
Types of pollination
There two types of pollination ie self pollination, cross pollination
Self pollination: Is the transfer of pollen grains from anthers to stigma on the same flower of the same point.
Cross pollination. Is the transfer of pollen grains from anthers of one flower to the stigma of another flower on the same plant or of the different plant but of the same species.
Flowers basing on agents, flowers are categorized as follows
Anermorphilous flowers. These are flowers that are pollinated by wind.
Entomorphilous flowers. These are flowers that are pollinated by insects
Hydrophilous flowers. These are flowers that are pollinated by H20
Omithophillous flowers. These are flowers pollinated by birds
Chiropterophilous flowers. These are flowers pollinated by bats
Adaptation of flowers to self pollination (in breeding)
Stamens and carpels mature at the same time
They are bi-sexual flowers ie which contain male and female.
Some times they remain close with in underground and only open after fertilization this condition is called cleistogamy.
Pollen is released on to the stigma by mature anthers before petals open
Pollen grains are compatible with the tissues of the style to allow their germinate.
The flowers have reduced size and cant easily be seen by pollinating agent.
Their stamen is above the stigma
The anthers are usually close to the stigma.
The stigma is often coiled to tap the ripe anthers.
The style and filaments coil on one another.
Adaptations of flowers to cross pollination/out break
Stamens may ripe before the carpel, a condition called protandy eg in salvia, denderion, deadnettle.
The carpel may ripen faster than the stamen a condition called protogyny
Self incompatibility, is a condition in which pollen grain of a particular flower cannt germinate on the stigma of same flower (self stemility) eg in pears.
Dioecious, is a condition in which flowers only have male parts of female parts ie staminate flowers have only male parts while pistillate flowers have female parts.
Production of nector to attract pollinating agents
Hanging of stamens downs and outside so that the pollen grain drop away.
FERTILIZATION IN FLOWERING PLANTS
When ripe pollen grains lands on a mature stigma they germinate after absorption of water by developing pollen tubes. The pollen tubes nucleus is at the tip of growing pollen tube controlling its growth while the two male nuclei formed by the mitosis

of the generative nucleus follow chosen behind. The pollen tube tip pierces the stigmatic surface and penetrates the style tissue and embryo sac enable the directional rapid growth of pollen tube towards the ovary on reaching the ovary the pollen tube grows towards the ovule and enters through the micropyle, chalaza, integuments. The pollen tube then penetrates the……………distinretes. the first fertilization occurs when one male nucleus fuses with the ovum to form a diploid zygote.

The 2nd fertilization occurs when another female nucleus fuses with a diploid second nucleus to form a triploid, primary endosperm nucleus. This is therefore called double fertilization that occurs in flowering plants.

Double fertilization is a unique process occurring only in flowering plants in which one male nucleus, fuses with a functional egg nucleus to form a diploid zygote while another male nucleus to form a diploid zygote while another male nucleus fuses with a second nucleus to form a diploid primary endosperm nucleus simultaneously.

Results of fertilization in flowering plants

The ovule becomes the seed

The zygote divides mitotically to form the embryo

The ovary becomes the fruit

The outer intergument becomes testa or seed coat

The inner integument becomes the regume

The ovary wall becomes the fruit wall or pericarp

The triphoid primary endosperm nucleus becomes the endosperm

The microphyle remains unchanged

The nucellus disappears

Caryx wither off/or may persist

Petals, stigma, style and stamen dry and fall off.

Advantages of propagation by seeds

It enables the plant to be better adapted to different environment since water is less required for sexual reproduction.

The embryo is protected with in the seed

There is food reserve for embryo growth in the cotyledon or endosperm

Seeds can easily be dispersed to other areas from the parent to reduce competition

Seeds can easily be stored

It allows mixing of genes which increases hybrid vigour

There is an increase resistance to diseases

There is tolerare to unfavourable conditions especially during dormancy

Disadvantages of propagation by seeds

The seeds produced can easily be destroyed by pests

Seeds have limited food reserves

It requires selection of suitable seeds

Initial in put is expensive

Dispersal may not be easy especially longer sized seeds

Two individuals may be required in the formation of seeds

Seeds depends on external agent for dispersal

PARTHENOGENESIS

Is the development of an embryo from un fertilized egg, or is a process in which the male and female nuclei fail to unit following fertilization.

Types of parthenogenesis

Diploid parthenogenesis. This is the development of embryos from unfertilized diploid eggs that are formed by mitosis instead of meiosis resulting into a diploid off spring which are clones of the parents, it occurs in Aphids, during which a number of wingless females are formed without the presence of the males in flat worms. It is also there in notiferus, clasticians

Haploid parthenogenesis. This is the formation of an embryo from un fertilized haploid egg that is formed by meiosis and may develop directly into haploid off spring. It occurs in honey bees, wasps ants, wip tail lizards etc

In honey bees, the queen bee can either fertilized eggs as they are being layed or allow them out in fertilized. The fertilized eggs become the diploid females ie fertile queens or styles workers. The unfertilized eggs develop into fertile haploid males called drones.

In wip tail lizards of America eg south west meiosis is severely modernized to yield a clone of only females.

Apomixi. It is the formation of plant embryo from unfertilized egg cell or from a diploid embryo sac mother cell or from the a diploid cell in the ovum with out fertilization, it occurs in potatoes and acitic.

Pathenocapy. It is the formation of fruits with out fertilization. Its usually induced by plant hormones eg awains. It occurs in apples.

Advantages of pathenogenisis

It avoids the challenge of bringing two parents together to allow successive fertilization

It leads to production of large number of organisms in shorter time

It eliminates in all generation lethal genes that they have in hormozygous state

Disadvantages

During sudden environment change pathenogenic speedxxx have limited capacity to shift gene combination to adopt to a new condition.

Sexual reproduction in mammals/animals.

Terms used in sexual reproduction in mammals.

Oripanity. It is used to mean animals which lay eggs eg all birds some reptiles.

Ovoviviparity. Is when animals retain eggs in the mothers body to complete development and when embryos are still obtain their nutrients from the egg yolk. The young ones are always expelled from the mothers body when fully developed eg in some fish, reptiles etc.

Viviparty. Is a condition in which the eggs develop to advanced stage in the mother's body and the embryo obtains its nourishment directly from the mothers blood stream eg mammals.

External fertilization. Is where the fusion of male and female gametes take place outside the body.

Internal fertilization. Is where the fusion of gametes occurs inside the body of the female.
Isolecithal eggs. Are eggs with very little yolk that is evenly distributed inside eg human egg.
Mesoleathal eggs. These are eggs with moderate unit of yolk connected in the vegetal pole eg in amphibians
Telolecithal eggs. Are eggs that contain abundance of yolk or large mount that is densely contracted at the vegetal pole of the yolk eg in birds, reptiles and moist fishes.
Gametogenesis. Is a process leading to formation of mature gametes.
Spermatogenesis. Is a process leading to formation of mature male gametes called spermatozoes
Oogenesis. Is the process leading to formation of mature female gametes called ova
Menopose. Is a period when ovulation and menstruation sees in human females
SEXUAL REPRODUCTION IN MAN
Mechanisms considered to be of evolutionary advantage to the success in mammals eg man.
Fertilization and development are internal to limit wastage of gametes and to provide production to the younger ones respectively.
The breading seasons concides with the breeding cycles so that birth occurs at the right time when environment condition are most favourable for growth of younger ones.
Feeding young ones on nutritious milk enables them to prepare for adult food
Secondary sexual characteristics enable easy identification of mating partners during courtship behavior
Parental care provides protection to the younger ones against predators and advance conditions
Development of the placenta in mammals enable exchange of materials between the younger ones and the mother.
Females are often more receptive to male during ovulation or act of copulation stimulating ovulation
MAIN FEATURES OF SEXUAL REPRODUCTION IN MAMMALS
Fertilization is internal
The female experience a sexual cycle called menstrual cycle
The sexual cycle is restricted to breeding season except in human and other primates which are sexually reptative through out the year.
Younger ones are born at an advanced stage
There is a display of courtship behavior leading to mating
The development of the embryo is internal and completely dependent to mother for food and protection
The young are fed on milk
Parental care to the younger ones is prolonged.
HUMAN REPRODUCTIVE SYSTEM
Reproductive system comprise of sex organs which are divided into two categories namely

Primary sex organs. These are organs which produce gametes and secrete sex hormones, they are referred to as gonoid. The include the testes in males and ovaries in females.
Secondary sex organs(accelerouly organs). These are organs that are associated with primary organs and they play some role sin reproduction other than gamete production and hormonal secretion eg penis, prostate gland, seminal vesicles, sperm duct in male, fallopian tube in females, vagina.
Differences between primary sex organs and secondary sex organs

Primary sex organs	Secondary sex organs
Produce gamete	They don't
Produce sex hormones	Do not
Development is under control of follicle stimulating hormone and lecternising hormone	Development is under coxx of oestrogen in females and testaterane in male

THE MALE REPRODUCTIVE SYSTEM
It consists of the following parts
Penis. This contains an erectile tissue. When the male is sexually excited, this feeling cause the penis erect.
Function.
It delivers sperm into the female reproductive system
Scrotum. This is a sac like structure that covers the testes. It is an flexible structure important in temperature regulation.
Function
It regulates the temperature of the testes to favour or suitable for maxium sperm production.
Testes. These are two testes at the lower part of the abdomen in males
Function
They contain somniferous tubules that produce sperm
They produce male sex hormones called testosterone
Prostate gland. This is a gland which is found at the junction where the sperm duct joins the urethra.
Function
It secretes and alkaline fluid that neutralizes acidity in the vagina that would hinder the movement of sperm.
Semino-vesicles. These are vesicles that are situated along the sperm duct just before they join urethra.
Functions
They secrete mucus and watery alkaline fluids that contain nutrients like sugar, fructose, a respiratory for sperm maturity.
Cowper's gland. It is a gland that is situated the prostate gland along the urethra.
Function
It produces mucus secretion into the urethra whose function is to lubricate the penis during the intercourse and neutralizing according to remaining urine.
Epidermis. Is a very long coiled tube about 6 m long pressed against the testes.

Function.
It is also a site where sperm mature from.
Vasdeferens. This is a straight tube of about 20cm long, joins epidemis to the urethra.
Function
It stores spermatozoa for even many months
It conveys sperm from the epidemis to urethra during ejaculation
Urethra. This is a tube which leads to the outside of the style.
Function
It carries/conveys urine from the bladder to outside the system
It also conveys sperms from the vasdefereus to the outside of the system through the penis
Semineferos tubule. Are long coiled tubules coiled in the testes, each is about 5 cm long and 200mm in diameter
Function
They form a site where sperm are produced during spermatogenesis
They also produce the male sex hormone called testosterone hormone.

STRUCTURE OF SPERM
The sperm is a extremely small cell about 2.5Nm in diameter and 50Nm long, the sperm consists of 5 parts ie the head, neck, middle piece, tail and end piece, its head carry's genetic material in the nucleus. The amount of DNA in sperm is constant and it is half the amilf in somatic cell ie the sperm has ahaploid number of chromosomes.
The nucleus is covered with a membrane bound structure called a crosome which contains a hydrohitic enxyme that breaks uo the egg membrane during fertilization, its neck contains a pair of centroites which acts as micro tubules organizing centers from where micro tubules arise and enlongate to land entire length of sperm. The microtubule they form axile filaments of the flagellum. The middle pierce is metabolically active and it is……….. energy required for the movement of sperm. The tail piece and end piece consist of axile filament with a 9+2 arrangement of micro tubules as in lilia and flagella therefore the sperm tail, is a modified flagella. The flagellum propels the sperm cell in the liquid medium as it swims towards the egg for fertilization.
Spermatogenis development of sperms
The cell of semiferous is tube forming a germicell epithelium, called primordial germ tissue under go series of mitotic division. This forms numerous diploid cells called spermatogamia.
This phase is called multiplication phase and each it increases in size. The cell formed out after growth during when it increases in size. The cell formed out after growth are called primary spermatocyte which undergo 1st mirotic division to form secondary spermatocytes. The secondary spermatocytes then undergo secondary miertic division to form spermatic which later mature to form spermatocyte.
Functions of sertolic cells
Provide nourishment hiring maturation of sperm cells

It contains blood vessles through which nutrients and oxygen are supplied to the sperm cell as well as removal of waste products of metabolism from the sperm cells.
Provides mechanical support and protection to the sperm cells
They provide enzymes required for appropriate increase in size of sperm
They produce phagocytes that destroy pathogens that may enter the lumen of somniferous tubules
They secrete a fluid that carries speratids they the tubules.
Diagram showing a group of semineterous tubules seen in TV section
Hormonal control of spermatogenesis
Sperm production requires production of two male sex hormones that are produced by interetual cells next to the seminerous tubules, the whole process is controlled by hypothalamus and pituitary gland. The hypothulumus secretes gonadotrophin releasing gland. It then stimulates the part of the pituitary gland to secrete gonadotrophin. A gonodotrophine is a hormone that secrete gonadotrophin. These gonadotrophin are follicle stimulating horxxx and lueternising hormone.
The follicle stimulating hormone stimulates permutogen by causing sentolity cells to complete the development of protozoa from spermatids. The follicle stimulating hormone also releases a peptide hormone called inhibit that inhibits the FSH secretion.
The LH stimulates the intesitial cells of the testes to secrete testosterone hormone. The testosterone hormone when stimulates the growth and development of germinal epithelia cells to form spermatozoa however the increased testosterone level inhibits the secretion of ganodotrophin releasing and LH.
NB: The general name for male sex hormone are called androgens
Diagram showing hormonal control of sperm
THE FEMALE REPRODUCTIVE SYSTEM
The female reproductive system consist of the following parts,
Ovaries. They are two in females and the female gonads that produce the female gametes, the Ova.
Function
They are sites where eggs are produced
They secrete oestrogen and progesterone hormones
Oviducts/fallopian tubes. These are tubules structures that connect the ovaries to the uterus; they have a funnel cliaped ending called the funnel of oviduct with figure like projects called stxxxxx.
Function
They convey the ovum from the ovary towards the uterus
They form a site where fertilization takes place
Adaptations of the fallopian tube to suit their function
Have fimbriaes at one end to capture the egg soon after ovulation
In the inner linning of their wall is ciliated to beat the ovum rhythmically towards **the uterus**
Their walls contain smooth muscles which contract and relax resulting in peristaltic wave that move the egg towards the uterus.

Uterus. This is a pear cliaped structure made up of two layers of muscles ie the outer myometrium that contracts strongly during labour and the inner endometotium with numerous glands and blood vessels.

Functions

It is a site where implantation of a fertilized egg takes place

It is a site where the development of foetus occurs during pregnancy

It is also an area of origin of contraction that bring about birth or parturition

Adaptation of the uterus to suit its function

It has a thick wall comprising of muscles that can easily extend to accommodate a given size of feotus during pregnancy.

Its muscles can also undergo contraction and relaxation during labour to allow delivery of the baby.

Cervix. This is a narrow enterence to the uterus just below it and it connects the uterus to the vagina.

Function of the cervix

During pregnancy its blocked by a plug of mucus to maintain the foetus temperature pregnancy.

Vagina. This is a muscular tube about 8-10 cm long whose walls contain elastic tissue, its inner lining folded.

Function

It acts as a channel through which a baby passes during child birth

It is also a site where male reproductive cells are deposited after ejaculation

Allows passage of menstrual flow

Adaptations

It has elastic tissues that can stretch during child birth to allow passage of the baby.

Its wall contains secretary cells that secret vaginal fluid to lubricate it during copulation or intercourse.

Clitoris. This is a small structure which could be similar to penis in males

It contains a reptile tissue and can erect when female is sexually excited.

Functions

When stimulate, it excites the females sexually.

Labia major and minor. These form the valve which is the outer part of the female reproductive system.

The structure of the ovum/egg

An egg or ovum is a lenon mortile structure which is simple and big in size compared to sperm, it contains a haploid nucleus ie which contains 23chromosomes which is surrounded by a dense cytoplasm. Part of the cytoplasm is clear towards one pole while the other yolky towards the vegetal pole. The yolk provides some nourishment to the embryo during early stages of development since it contains fats and proteins. The cytoplasm is then surrounded by an envelope made up of two membranes ie plasma membrane and vitellin membrane. These membranes are in turn covered with eyelly like coating made up of glycol proteins called zonapellucida.

Diagram showing structure of mature ovum

Oogenesis

This is a process by which eggs are formed in the ovary. Egg cells develop from a germinal epithelial cell or primodial germ cells of the ovary.
It begins during the development of the fetus utilized spermatogenesis and begins at puberty stage, and perimodial germ all undergoes rapid meiotitic division to form oogonia in the phase of multiphietxx during the phase of growth, the oogonia grows into a primary oocyte. The primary oocytes undergoes 1st meiotic division to form secondary oocyte and the 1st polar body.
The secondary oocyte is then surrounded by two layers of protective cells ie thicker external and thicker internal to form a structure called graafiam follicle during ovolution. The secondary oocyte is released from the ovary and second meotic division occurs after ovulation to form a large cell called ovum. The polar bodies are small cells and have no role they eventually degenerate after ovulation, the role of follicle cell in protecting and nourishing the egg comes to the end.
Diagram showing oogenesis

Comparison between spermatogenesis and oagenesis

Similarities

Both are controlled by hormones
Both occur in the gonads
In both gamets a rise from germinal epitherial cells
Both involve meiosis leading to production of haploid gametes
Both involve three stages ie multiplication, growth and maturation
In both the final maturity occurs in the puberty.
Differences

Oogenis	Spermatogenesis
Follicular cell provide nourishment	Seitoli cells provide nourishment
Starts during development of foetus	It starts during puberty
Stops at menopose	Continues through out life
Polar bodies are formed	Polar bodies are not produced
Occurs in ovaries	It occurs in somniferous tubes of testis
it is a slow process and takes several weeks to be completed	It is a rapid process and occur in a few boans
When it has come to the end, the egg the matures	The sperm cell undergoes a stage involving compete maturation
The process occurs at room temperature	It occurs at low temperature
The egg in large	The sperm in comparatively small

HORMONAL CONTROL OF OOGENESIS AND MENSTRUAL CYCLE
The hypothalamus secretes gonodotuphin releasing hormone which stimulates the release of follicle stimulation and it from petitutary gland
The FSH and LH are called gonado trophic hormones because they stimulates the gonads ie ovaries in female hormones are not secreted constantly in the cycle.
The FSH travels in blood to the ovaries. It stimulates the development of follicles in the ovary.

The granialasa cells of the developing follicle start t produce the female hormone called oostrogen, oestrogen has two targets ie the nucleus and anterior petitutary gland.
In the nucleus it stimulates the repair and development and lining of uterus called endomentrium, in preparation for pregnancy if the embryo is implanted in it. In the anterior petitutary gland, oestrogen stimulate the secretion FSH and this prevents the possibility for further follicles being stimulated so that only one egg is produced at a time. At the mid way of the cycle oestrogen level will have raised to tringer the secretion of LH.LH therefore causes ovulation, is the release of the secondary oacyte of graafian follicle.

REPRODUCTION:
This is the process by which existing organisms give rise to a new generation of individuals of the same species.
It involves transmission of genetic material from one generation to the next to ensure survival of the species over along period of time. There are two types of reproduction i.e Asexual and sexual reproduction.
Asexual reproduction:
Reproduction of offspring from a single parent without production of gametes.
The off springs are identical to the parent. It is considered to be primitive and limited to lower animals e.g protozoa bacteria and some lower plants.
Types of asexual reproduction;
Fission:
(a)binary fission
This is the process by which unicellular organics divide into two and each part growth into a new individual e.g In Amoeba, paramecium, Bacteria, Spirogyra e.t.c.Amoeba for example, if reading for B.F, it stops moving and becomes round by withdrawing the stropodes The nucleus first divides into two by mitosis and the cytoplasm constricts such that each nucleus males on either sides.Identical daughter amoeba are formed, each feeds and grows into a mature amoeba before dividing again.
(b) Multiple fission:
Here a unicellular organism divides into more than two identical parts each capable of an independent existence.During M.F, the nucleus divides repeatedly and each daughter nucleus breaks away together with a small portion of the cytoplasm.Each nucleus going to the cytoplasm feeds and grows into a new organism.The dividing process is called suchizogong and cells that divide are called schizont.
Budding:
Here an organism develops an out growth or blow and i.e. relieved self supporting individual. Budding is found in yeast cells, and hydra.
sporulation (spore formation)
This occurs for example in fungi
Diagram:

At the end of the springhare is the sporangium with spores. The spores have a nucleus are produced asexually in large numbers. They are very light and can easily be dispersed by wind. Spore formation occurs in mucus, rhizopus, penicllium, some bacteria, algae and many plants.

Fragmentation:

This is when an organism is broken into one or more pieces and each of them grows into a new organism. It occurs in fat worms, sponges and green algae, spirogyra.

5. Vegetative Propagation:

This is when a bud grows and develops site on a new plant that becomes self supporting individual.This is the most common form of asexual reproduction in plants.Some plants used for vegetative propagation are swollen with food preserves and can survive conditions of the environment like coldness and draught waiting for favourable conditions to resume growth.Plant organs used for vegetative propagation have buds which are characteristics of stems such as rhizomes, bulbs, runners, tubers, stalons and corms.

Bulbs e.g. Onions and Garlic.

This is a short stem with fleshy leaves surrounded by brown scanty leaves originating from the stem and adventitious roots.

Longitudinal section through a bulb:

Diagram

Corms

This is a swollen underground stem surrounded by protected scaty leaves and has adventitious root.

Diagram:

Rhizome:

This is a horizontally growing underground stem with adventitious roots and scaly leaves it includes spear grass ginger, couch grass.

Diagram;

Root tubers:

These are swollen adventitious roots e.g. cassava. They are for food storage but not vegetative propagation.

STEM TUBERS:

These are underground storages organs swollen with food but with arillary buds for vegetative propagation e.g. in Irish potatoes.NB: Bulbs, corms, rhizomes and stem tubers are called perennating organs.A perennating organ is one that can survive during adverse conditions and develop into new plants when the growing season resumes.

Stolon e.g. the black berry:

This is a creeping horizontally growing stem that grows along the surface.Adventitious roots grow from the mode and new plants develop from the nade.
Diagram:

Arunner (straw berry)
This is a type of stolon that does not creep but run along the ground and new plants develop at the nodes.
Diagram:

Artificial propagation:
(i)Using cutting
Apart of the parent e.g. stem of cassava, sugarcane is placed in soil. Adventitious roots develop from the cut plant and aerial shoots develop from the buds.
(ii)Grafting:
This is the transfer of part of one plant called the scram to and lower part of another plant called the stalk.It is based on the principle that cambium tissues of different plants are capable of writing.In some plants a bud is used as a scram and this is called bugg.Grafting is done to improve the quality of the crop plant.
(ii)Layering:
A branch of a plant is bent in the soil and adventitious roots develop at the nodes buried in the soil e.g. in passion fruit later the bent show is cut off from the main plant.
Advantages of sexual reproduction:
Only one plant is required so no energy is wasted in finding a mat.
A gain there is no need for special mechanism such as copulation gametes formation and fusion e.t.c.
It results into maintenance of derived characteristics since the off springs are identical to the parent.
The resulting off springs mature faster than those produced by sexual means. This is because they have large food reserves.
Large numbers of off springs are produces than in sexual reproduction.
This facilitates faster propagation.
Disadvantages of asexual reproduction:
No new varieties are produced since there is no mixing of genet materials.
Off springs compete for materials such as light and nutrient since many individuals may occupy a limited area.
Many individuals may be destroyed by disasters such as fire and floods since they tend to occupy the same area.
It gradually reduces the strength and vigour of the off springs over generations.
Lack of variety results into reduced resistance to diseases and deserve conditions.
Colonization of new areas is unlikely since off springs are always produced close to the parent plant.

Sexual reproduction.

This is a type of reproduction which involves the fusion of the nuclei of male and female gametes to form a zygote.It are a characteristic of higher animals and plants.The gametes are produced by the process of meiosis therefore there increased venation, increasing adaptation to the changing environment.

Advantages of sexual reproduction:

New varieties are produced since there is mixing of genes from both parents.

There is little or no competition between parents and off springs and among off springs themselves because there is no over crowding.

There are higher chances of colonising areas e.g. in plant dispersal agents disperse the seeds and fruits over long distance.

Mass destruction of off springs by disasters is unlikely due to dispersal.

In plants, seed cans survive adverse conditions and germinates only when condition become favourable.

Disadvantages of sexual reproduction:

it is energy demanding e.g. looking for mates.

It requires special mechanism like pollinating, copulatory organs.

It may produce individuals of undesired qualities due to moving of genes from parents.

Since it requires two individuals of the same species,isolate individuals may never get chance to reproduce.

Differences between sexual and asexual reproduction.

sexual reproduction	Asexual reproduction
Two parents are required unless the parent is hermaphroditic.	**One** parent is required.
Variation occurs.	No variation.
Formation of gametes	No gametes are required.
Depends on meiosis taking place.	Depends on mitosis.
Pat one stage in the life cycle preventing doubling of chromosomes	
Less rapid increase in numbers.	Rapid increase in numbers of off springs.
Occurs in almost all plants and animal species.	Absent in higher animals but common in plants and simple animals.
Some degree of parental care.	No parental care

Sexual reproduction in man:

(a)A male reproductive system

The male gamete production structures are called the testis which performs two main functions.Formation of gametes or sperms and section of the hormone testosterone which controls secondary sexual characteristics.The testis are surrounded outside the body in a serotun to lower the temperature of the testis required for sperm development and maturation.Each testis contains hundreds of tiny tubules called vasdeference from where sperms are made in the spermategesis. The seminiferous tubes begin to coil to form fully mature and develop epididyrmis where sperms are stored so they fully mature and develop ability to scion but this worming is inhibited until after ejaculation.The epididymis is linked to the sperm duct by the vasdeferens which leads to the urethra.The urethra is covered by erectile tissue which during copulation becomes filled with blood making the pens exert.The male reproductive system has three accessing glands namely;

Seminal vesicles:

These secrete mucus and a fluid containing nutrients such as glucose, fructose, amino acids, salts which are energy sources for sperms.

Cowper's gland:

This secretes mucus and an alkaline fluid into the urethra and this neutralises the acidity of any remaining urine in the urethra.It also cleans the urethra to prevent sperm contamination.The scrotal sac has a spermatic cord with an artery and vein which has a counter current heat exchange. This is important in coiling the temperature of a scrotum.The spermatic and moves the testis towards and away from the body depending on the outside and body temperature.When it is hot, the testis is suspended downwards away from the body to the body to gain heat.The scrotal sac of hairy animals has no hair or has scanty hair to give off excess heat which could lead to low sperm count.

Structure of the testis:

The structure of the sperm cell:

NB: Sperms are made by the somniferous and they travel via the vasefferens to the epididymis.The sperm is the male reproductive gametes.

Diagram:

The sperm cell is divided into 5 main regions i.e. head, neck, middle piece, tail and end piece.The head carries genetic materials in the nucleus containing the DNA. The ant of DNA in the sperm nuclei is constant and half the amount in somatic cells i.e. the sperm has a haploid number of chromosomes.The nucleus is covered by a membrane bound structure called acrosome that contains hydrolytic enzymes used in penetration of the egg.The neck contains a pair of cent rides which act as micro – tubules organising centres (MOCS) from where micro-tubules arise and elongate to run the entire length of the sperm. The micro-tubules from the axilefilament of the flagellum.The middle piece is metabolically active and is enlarged with numerous mitochondria required to release energy for the movement of the sperm cell.The tail and end piece consist of axile filaments as in cilia and flagella. Therefore the sperm tail is a modified flagellum. The flagellum propels through sperm cell in the liquid medium as it swims towards the egg cell for fertilization.

Spermatogenesis:

Spermatogenesis is the process by which sperm cells develop and occurs in the testes. It occurs particularly in the somniferous tubules. Cells of the somniferous tubules forming the germinal epithelium undergo a series of mitotic division. This phase is called numerous diploid cells called spermatogornia.This phase is called multiplication and each of the cells undergoes a stage of growth during when it increases in size.The cell formed out of growth is called a 1^{st} spermatacyte which undergoes 1^{st} meiotic division to form 2^{0} spermaacyter. Each 2^{0} spermatacyte undergoes 2^{nd} meiotic division to form the spermatids which undergo Des to form the sperm cell.
Diagram:

Histology of the testis:
The somniferous tubules are long coils of tubes several metres length where spermatogenesis takes place.Sperms develop from the germinal epithelium of the somniferous tubules.As cell division proceeds, the daughter cells move towards the human of the tubule.The spermatids become embedded I the giant sertoli cells where they complete their development forming sperm cells. The sertoli cells are called the nurse cells since they are responsible for the maturation of the spermatids forming sperm cells.
Diagram.

Functions of sertoli cells:
They provide nourishment during maturation of the sperm cells.
They contain blood vessels through which nutrients and O_2 are supplied to the sperm cells as well as removal of wastes of metabolism from the sperm cells. In this way, they are both nutritive and excretory.
They provide mechanical support and protection to the sperm cells.
They produce phagocytes that destroy pathogens that may enter the lumen of the somniferous tubule.
They provide enzymes required for appropriate Des in the sperm cell.
Hormonal control of spermatogenesis:
Sperm production requires the presence of the male sex hormones which are reproduced by the laying cells / interstitial cells next to the somniferous tubules. The whole process is under the control of the hypothalamus and the pituitary.
The hypothalamus secretes genardatraphic releasing hormone (GTR.H).These hormones move to the anterior pituitary gland and stimulate to secrete follicle stimulating hormone and putenising hormone of S.H stimulates sertoli cells to complete the development of the spermatids into sperm cells.L.H stimulates the leydi cells (interstitial cells) making them to secrete the hormone testosterone (the male hormone). Therefore L.H is also called interstitial cell stimulating hormone.Testosterone stimulates growth and development of germinal epithelial form sperm cells. Together with F.S.H testosterone also stimulates the sertoli cells to complete the maturation of the sperm cells.

The human female reproductive system:

Structure of the system;

The human female reproductive system consists of the ovaries, oviducts, (fallopian tubes), uterus, cervix, vagina and the clitoris.

(i)Ovaries are the 2 female gonads located in the abdominal cavity where they are supported by ligaments. They are the sites of agenesis and they also secrete the female sex hormones.

(ii)Oviducts are tubular structures that carry the eggs from the ovary to the uterus. They have a funnel shaped ending called the funnel of the oviduct to the function of carrying eggs in the following ways:

The febrile at the ends capture the eggs following ovulation.

Their walls are lined with ciliates epithelium whose beating propels the egg towards the uterus.

The walls of the oviduct contain smooth muscles which contract and relax resulting into peristaltic waves that move the egg towards the uterus.

(iii)The uterus is a pear – shaped structure made up of 2 layers of muscles i.e. the outer myometriun that contract strongly during labour and the inner endometrium with numerous glands and blood vessels.Following successful fertilization, the embryo implants in the uterus.

(iv)The cervix is a narrow entrance to the uterus normally blocked by mucus forming the cervical plug.

(v) The vagina is a muscular of about 8 – 10cm long. It opens to the outside through outer skin folds called the labia i.e. labia major and minor which collectively form the vulva. Its lining is folded and the walls contain.Elastic tissue and this allows stretching during labour to allow the baby to pass out.

(vi)The clitoris is a small structure called a vestigial penis. It is equivalent to the functional penis in males and has erectile tissue and can become erect.

The egg cell:

Diagram:

The egg cell is non-motile. Its structure is simple and it's large in size compared to the sperm cell. It has a haploid nucleus since it's formed by meiosis and the nucleus is surrounded by a dense cytoplasm. Part of the cytoplasm is clear towards the animal pole while the other is yolky towards the vegetal pole.Yolk provides a source of nourishment to the embryo during early stages of development since it contains fats and proteins.The cytoplasm is surrounded by an envelope made up of 2 unit membranes i.e. the plasma membrane and the vitelline membrane.A jelly coat made up of glycoprotein surrounds the vitelline membrane.Two non-functional eggs i.e. polar bodies formed during meiosis are also present.

Oogenesis:
The egg cell develops from the germinal epithelial cells or the primordial germ cells of the ovary. It starts during the development of the foetus unlike spermatogenesis which starts at adolescence.Each primordial germ cell undergoes rapid mitotic divisions forming Oogania in the phase of multiplication.During the phase of growth the Oogania grows into a 1^0oocyte which becomes surrounded by layers of follicular cells.The 1^0oocyte undergoes the 1^{st} meiotic division to form the 2^0oocyte and the 1^0 polar body.The 2^0oocyte is surrounded by two layers of protective cells i.e. the theca external and theca interna surrounding a fluid called follienlai fluid.The whole structure is known as a grafian follicle.At ovulation, the 2^0oocyte is released from the ovary and 2^0 meiotic divisions occur just after ovulation to produce a large cell called the avian and the 2^0 polar body.Polar bodies are small cells and have no role. So they eventually degenerate.After ovulation, the role of the follicle cells in protecting and nourishing the egg comes to an end.

Diagram;

Differences between o0genesis and spermatogenesis.

Oegenesis	Spermatogenesis
-Follicular cells provide nourishing	-Sertoli cells provide nourishment.
-Starts during the development of the feetus.	-Spermatogenesis starts at puberty.
-Stops at menopause	-It is continuous throughout life.
-Polar bodies are formed which eventually degenerate	-No polar bodies are formed
-Occurs in the ovaries	-Occurs somniferous tubules of the testis.
-Slow taking several weeks to be completed ad one egg is made per month.	-Very rapid and takes a few hours to be completed for the sperm cells to mature.
-Once Oegenesis is over, the egg is mature.	-Sperm cells undergo a stage involving complete maturation called sperm Eogenes during when the aero some develops
-The process occurs at the temperature of the body.	-The process requires low temperature compared the body temperature.

Similarities:
Both processes are controlled by hormones.

Both are made from the germinal epithelial cells.
Both are made by the process of meiosis hence they are haploid.
Both involve 3 phase multiplication which is by mitosis, growth and maturation.
For both processes final maturity accurate puberty.
Both occur in the gonads.

The human female sexual cycle.(Menstrual cycle)
This cycle only takes place in human beings and not in any other animals.They cycle is controlled by hormones coming from the hypothalamus, pituitary and the ovaries.The initial stimulus is body Des for an adolescent which stimulate the hypothalamus to release **gonadotrophs releasing hormone**. This hormone stimulates the anterior pituitary to secrete **follicle stimulating hormone**(FSH).This hormone travels through the blood stream to the ovaries where it causes follicular growth and maturation.The mature follicle cells secret the **hormone oestrogen** which has two target areas;
It stimulates repair and development of the endometrim in preparation for implantation if fertilization occurs.
It inhibits further secretion of F.S.H ifrom the anterior of the pituitary gland, which would lead to development of another follicle. This is an example of negative feedback.
High levels of Oestrogen build up in the blood stream as the cycle proceeds and they stimulate the anterior pituitary to secrete the hormone **luteinising hormone** (L.H) which travels in the blood stream to the ovary where it performs two functions;
it causes ovulation at around the 14th day of the cycle.Ovulation is the release of the 20oocyte from the ovary. only one 20oocyte is released every month so ovulation alternates between the two ovaries.
L.H also stimulates the follicular cells to develop into yellow body called the corpus luteum.
The corpus luteum secretes the hormone progesterone and some little ant of oestrogen.Progesterone has two target areas;
Uterus where it maintains the thickness of the endomentrium.
Anterior pituitary gland where it inhibits secretion of L.H and F.S.H by negative feedback.
If fertilization does not occur, the corpus starts to degenerate and this has 2 effects i.e.
Decline in the level of oestrogen and progesterone hence the endomentrium can not be maintained any more. This causes blood containing the tissues of the endomentrium to flow from the uterus through the vagina in the process called **menstruation.** Menstrual flow lasts for about 5 days in the next cycle.
Decline in the levels of progesterone and oestrogen causes no more inhibition of the pituitary gland and therefore F.S.H is secreted to repeat a new cycle.
Copulation (sexual intercourse)
Since fertilization in man is internal, there must be a mean of placing sperms in the female reproductive system. This is achieved through copulation.Copulation is

when the penis. As a result of increased blood vessel and blood pressure in the erectile tissue of the penis, it enlarges and becomes erect.

Ejaculation:

This refers to the release of sperms into the vagina after inverting an erect penis.

When inserted, the penis is stimulated particularly at the tiny where there are nerve endings and by reflex action, the sperms are released from the epididymis via the urethra and are deposited into the vagina from where they swim up to the oviduct where fertilization takes place.Ejaculation is accompanied by a pleasurable feeling called organism which comes at the climax of coitus.During ejaculation, by reflex action the urinal blades sphincters are closed preventing urine from contaminating the sperm.During sexual intercourse, the female reproductive tract secretes fluids that are used as lubricants.During intercourse, the clitoris of the female also becomes erect and female organism involves contraction of the vagina and uterus without necessarily discharge of fluids.

Passage of the sperm to the egg

Fertilization occurs in the oviduct and yet the sperms are deposited at the top of the vagina.Travel of the sperm from the vagina to the oviduct is achieved through;

Contraction of the oviduct caused by hormones contained within semi.

Swimming of the sperm cell using its flagellum.

The beating of the cilia that lines the oviduct propels the sperm cell towards the egg.

Capacitation:

This refers to the process undergone by the sperm cells in which the female genital tract is making the following the;

Removal of a layer of glycoproteins' from the outer surface of the sperm cell which may interfere with fertilization.

Increase in permeability of the sperm cell membrane to calcium ions which increases the beating activity of the sperm.

Fusion of the crosome membrane with the cell surface membrane to ease rapture and release the crosome enzyme.

Fertilization

This is the fusion of the sperm nucleus with the egg nucleus to form a diploid cell called zygote and it occurs in the oviduct.The sperm cells come into contact with the egg by random movement though it is possible that the egg secretes chemical which attract the sperm cell. This is an example of chemo taxis.When the head of the sperm cell hits the vitelline membrane, its crosome raptures releasing enzymes such as proteases and hyaluronidase. These reactions are called acrosome reactions. The enzymes hydrolyse the proteins in the vitelline membrane and soften the membrane allowing the sperm cell to enter the egg cell. Immediately after the entry of the sperm, cortical cells surrounding the egg release enzymes that harden and thicken the corona radiate or zona pellucida. This is a layer of cells divided from the follicular cells surrounding the 2^0oocyte at the point of ovulation. Hardening of the corona radiate prevents entry of other sperms hence preventing fertilization of the egg nucleus by more than one sperm cell, a condition called poly sperm. The harden membrane is called the fertilization membrane. It's only the sperm nucleus that enters the cytoplasm of the 2^0oocyte and the remaining parts are discarded.

Entry of the sperm nucleus stimulates the 2^0 polar undergo the 2^0 meiotic division to produce the ovum proper and the 2^0 polar body.The polar body degenerates while the nuclei of the sperm and the ovum swell forming the pronuclei. These two fuses to form a diploid cell called a zygote in the process called fertilization.

Implantation:

After fertilization, the zygote divides mitotically to form a mass of cells called the blastocyst. At about 9 days after fertilization, the blastocyst becomes embedded in the walls of the uterus and this is called implantation and the female is aid to be pregnant. The outer layer of cells surrounding the blastocyst is called trophoblast and it develops fungi like projections known as trophablastic villi which penetrate into the endometrium to absorb nutrients. The embryo is now called the foetus and it is enveloped by the foetal membrane which consists of 4 membranes called extra embryonic membranes i.e.

Chorion

This is the outermost membrane and forms chorionic vili which later contribute to the formation of the placenta used for removal of wastes and supply of nutrients to the foot as/embryo.

Amnion:

This covers the foetus directly it secretes afloid called amniotic fluid which supports and protects the embryo from mechanical shock.

Yolk sac.

This has no function in humans but useful in birds and reptile where it helps in the absorption of food from the yolk.

Allantois:

This joins with the chorion and participates in the formation of the placenta.

Extra embryonic membranes.

Diagram

Hormonal control pregnancy;

During pregnancy, the trophoblastic cells begin to secrete hormone, human chorionic genadatrophin (H.C.G) which prevents the breakdown of the euripus luteum and therefore continues to secrete progesterone and oestrogen.Presence of H.C.G either in urine or the blood stream is the basis of pregnancy test.Progesterone and oestrogen continue to maintain and develop the endametrium hence preventing menstruation. They also inhibit the secretion of F.S.H hence preventing development of more follicles.After 3 months of pregnancy. The corpus luteum degenerates and by this time, the placenta is fully developed so it takes over the role of secreting progesterone and oestrogen.Before birth, progesterone and oestrogen inhibit the secretion of the hormone prolactin which is responsible for milk ejection. At the end of pregnancy, the placenta is lost causing a drop in the levels of oestrogen and progesterone and this permits secretion of the hormone prolactin. Oestrogen and progesterone are also responsible for the growth of the mammary glands during pregnancy.

The placenta:

This is an organ composed of cells derived from the mother and the foetus.The placenta consists of cells of the cherion which produce projections called chroreonic villi. The chrononic villi increase the surface for exchange of materials between the mother and the foetus.There is no direct contact between the mother blood and the foetal circulation at the placenta instead exchange of materials by diffusion.Material blood and foetal never mix because;

The mother's blood is at a relatively higher pressure compared to that of the foetus.

The mother and the foetus may be having different blood groups and blood mixing would cause egg lutination.

It prevents diseases of the mother and toxins from being transmitted to the child. However some pathogens like this causing syphilis can penetrate the placenta.

Exchange of substances across the placenta is by diffusion, active transport or facilitated diffusion: The chorionic villi have numerous micro villi which increase the S.A for exchange of materials. Its cells also have numerous mitochdria to provide energy for active transport.The umbilical artery and vein maintain a sleep diffusion gradient by the arteries transporting away wastes and veins supplying nutrients.

Functions of the placenta:

Exchange of nutrients, glucose, amino acids and glycoid from the mother to the feetus across the placenta by facilitated diffusion mineral salts are exchanged from the mother to the feetus by active transport.

Exchange of respiratory gases; O_2 diffuses from the mother's blood into the blood of the feetus while CO_2 diffuses from the blood of the foetus into the mother's blood across the placenta.

Removal of nitrogen wastes from the foetus; Urea diffuses from the feetus blood into the mother's blood across the placenta then transported away to the mother's kidney for removal.

Antibodies move from the mother to the feetus across the placenta providing passive immunity.

It acts as an endocrine organ by secreting the hormones oestrogens are progesterone following degeneration of the corpus luteum after 3 months of pregnancy.

Drawing of association placenta and uterine wall.

Structure of the placenta related to function.

The umbilical vein that carries nutrients and oxygen from the mother from maternal blood to the feetus.

The umbilical artery that carries carbon dioxide and nitrogenous wastes from the feetus to the maternal blood.

The chorionic villi which are highly folded increasing surface area for exchange of materials between foetal and maternal blood.

The chorion encloses of fluid called chorionic fluid that acts as a cushion or shack absorber preventing mechanical damage to the foetus.

Harmful substances that may cross the placenta
Tobacco smoke rich in nicotine can across the placenta and can cause premature birth and mental retardation of the child.
Alcohol and drugs also across the placenta and excessive use of alcohol drugs can be harmful to the foetus.
Some bacteria are too large to cross the placenta but some viruses are small enough and they cross the placenta.
Rhesus anti-bodies also cross the placenta. A rhesus factors was first discovered in rhesus monkeys. Individuals having the factor are rhesus positive while those without the factor are Rh. Rh individuals produce anti Rh. Antibodies and can not receive blood from rhesus positive individuals.
If a Rh^- mother bears a Rh^+ foetus, the Rh^+ cells cross from the feetus to the mother and the mother acquires a Rh^+ status. The mother therefore begins producing anti-Rh anti-bodies which may not have serious effect on the 1st child but subsequent Rh^+ foetus would be rejected because the anti Rh antibodies are crossing from the mother to the foetus.

CHANGES THAT OCCUR IN FOETAL CIRCULATION AFTER BIRTH
During pregnancy, the foetus uses the placenta as an organ of nutrition, excretion and gaseous exchange. Therefore blood flow to the kidney is low, the gut is almost useless and the lungs are not used.
During pregnancy, the lungs of the feetus are non-functional and blood is presented from going to the lungs. The foetal heart has a hole called foramen ovale guarded by valves. This holes connects to the auricles such that blood from the R.A instead of containing to the ventricle, it is shunted to the L.A then to the L.V and finally to the general circulation which the aorta until when it reaches the placenta for oxygenation.

Failure to shunt blood to the L.A, it would be pumped to the lung by the right ventricle yet the lungs are non-functional.

Organisation of the foetal heart.
Diagram

Any blood the leaks to the R.V passes via the ductus arteriosus following pumping of the heart to the aorta. In this way, the lungs are totally avoided.
At birth, cutting the umbilical artery increases the blood pressure I the left auricle and back flow of blood via the hole in the heart to the R.A is likely to occur. But this is prevented by closure of the hole using the valve. The hole closes permanently and new tissue develops in the hole to close it. Failure to close the hole, the child is bone with a condition "hole in the heart" and the condition is corrected through surgery. At the same time, the ductus arteriosus constructs and degenerates. The lungs become inflated following the 1st breath by the child. The ventricle now pumps blood to the lungs which becomes functional.

There is increased blood flow to the gut for absorption of digested food and an increased blood flow to the kidneys to the wastes.

Birth / partrition.
During the last month of the pregnancy, the foetus sets in motion a sequency of hormonal controlled mechanisms that lead its expulsion from the body.The foetal pituitary gland secretes the adrenal tropic hormone which stimulates foetal cortex to release cortiol steroids. These cross the placenta into the mother's blood causing a decrease in the levels of progesterone and influencing the uterus to secrete prostaglandins. The hormones prostaglandins are very effective in uterine contraction and causes powerful uterine contraction. Another hormone oxytocun is releases from the posterior pituitary of the mother and travels to the uterus where it causes uterine contractions enhancing labour. These contractions are accompanied by dilution of the cervix, rapture of the amnion and the chorion and then releasing the amniotic fluid which is followed by expulsion of the body.
Lactation
Milk is produced by the mammary glands which are stimulated by the hormone prelactin. At birth, the level of progesterone falls since the placenta has been lost so there is no inhibition of prolactin release. Therefore prolactin stimulates lactation of birth.
Evolution and reproductive methods:
The simplest form of reproduction is when the gametes are released and meet outside the body. This is called external fertilization. This method is unreliable since the gametes are unlikely to meet, they be eaten or they may dry out.To overcome these problems, the gametes are produced in large numbers. In terrestrial animals sperms are introduced into a female and fertilization occurs inside the body. And this is called internal fertilization. It is a sure method of sperms meeting the egg. The fertilised egg may be enclosed within the protective covering before it leaves the female's body as in birds and reptiles where the egg is protected by a shell. This is called Oviparity. In most insects, the fertilized egg is retained within the body and is container protected there during development before it is laid. This is called Ovoviparity. In mammals, the embryo is protected and nourished within the uterus until a stage when it can support itself then it is produced. This is called viriparity.Mammals use internal fertilization and have evolved mechanisms that increase chances of fertilization and survival of the off springs.
These mechanisms include;
Development of Secondary Sexual characteristics:
These characteristics allow sexually mature individuals to recognise each other and mate.
Seasonal breeding cycles:
These cycles restrict copulation to only the times when the female is ovulating increasing dances of fertilization.
In some mammals, the female is receptive to the male when ovulation is taking place increasing chances of fertilization.

Internal development of the embryo in a stable and protected environment increases chances of survival.
Mammals have developed a placenta which acts as a barrier to harmful substances and a link between the mother and the foetus for useful substances.
It's only in mammals where suckling takes place. This is a mean of providing the young one in a protected environment. During Pregnancy, the young one learns skills of survival e.g. hunting skills and escaping predation.
Mammals carry out courtship which ensures that the male or female mates with a member of desired quality and avoiding wasting gametes.

BIRTH CONTROL METHODS AND CONTRACEPTION
Contraception involves preventing conception i.e. it involves prevention of fusion of gametes.Birth control involves prevention of birth and therefore it includes contraception.Both contraception and birth control aim at controlling population growth.
Barrier methods:
Use of condom.
This is a rubber sheath placed over the erect penis to prevent sperms from entering into the vagina. The method is reliable, cheap, and easy to use and offers protection against S.T.D's.
Use of femidom.
It's an equivalent of the condom but used in females. It's a thin rubber sheath tubular with a closed end that fits in the vagina.
Diaphragm:
It's a flexible cap which fits over the cervix and prevents entry of sperms into the oviduct. The disadvantage; it does not offer protection against S.T.D's
Spermicides:
These are chemicals that kill sperms and they are placed in the virginal tract shortly before intercourse.
(b)HORMONAL METHOD:
Morning pills:
These contain the sex hormones progesterone and oestrogen which inhibit secretion of F.S.H hence no egg development and o ovulation.The disadvantage is they cause nausea, fluid retention and weight gain.
Noplant:
This is a material containing oestrogen and progesterone that is surgically placed within the around the shoulder region.It also prevents ovulation from taking place.
(c)Methods that prevent implantation:
This involves use of the intiquterine device (IUD). The device is made up of copper or stainless steel. It is placed in the uterus by a Gynaecdogist.Fertilization occurs but implantation of the zygote does not occur.
(d)Natural method:
Abstinence:
It is the most reliable method. It can also be used by married couples.
Ryhthm method:

This is avoiding sexual increase around the time of ovulation. The problem with this method, the cycle may be irregular and also requires proper reaping of records.

Coitus interrupts:

Here the penis is withdrawn from the vagina before ejaculation. It is the most unreliable method because it depends on one's self discipline and the pre-ejaculatory fluid may contain some sperms.

(e) Sterilization.

Vasectomy:

This occurs in females and involves either tying the oviducts or tying them and cutting them. Tying alone is reversible and normally recommend.

Female inferitlity

Failure to ovulate results in fertility. This is a result of the hypothalation no secreting hormones that influence the pituitary t release F.S.H and L.H.

This Can Be Solved by taking fertility drugs which contain hormones that stimulate.

Failure to release the hormone may be as a result of emotional factors such as stress, fear or anxiety.

Infertility may be caused by damage of the uterus due to growth to tumors in the uterus called fibroid

Fertilisation is taking place but the zygote can be implanted. The tumoris can be removed surgically

Infertility can also be caused by damage to the ovary which can not release the egg.

Somaga to the oveolet also causes infertility. It maybe partially or completely blocked such that both the egg can not meet.

Male infertility

Absence of sperm in the semen as a result of blockage of tubes like vasdeferens .This is caused by an infection such as gonorrhea and TB.

Failure to produce enough sperms at puberty resulting to low sperm count.

Abnormal sperm e.g. having no tail, no head etc.

Retro grade sperms where the sperms move up the urethra instead of down the urethra.

Premature ejaculation i.e. ejection occurs before the penis erects or it can not enter the vagina.

Impotence, Inability of the penis to erect. It is psychological and may be solved by counseling.

Parthenogenesis

This is the development of new individuals from unfertilised eggs. There are two types of pathogenesis i.e. haploid pathogenesis and diploid pathogenesis.

During haploid pathogenesis, the eggs are produced by mitosis.

Diagram:

and they develop into a new individual without being fertilised e.g. in bees, the drone develops from unfertilised eggs laid by the queen.

Diploid pathogenesis is when the eggs are formed by mitosis hence diploid and these eggs develop into a new individual e.g. In aphids.
Pathogenesis also occurs in plants and involves formation of an embryo without formation of gametes. In plants, it is called apomixes.

SEXUAL REPRODUCTION IN FLOWERING PLANT
Parthenogenesis.
This is the development of new individuals from unfertilised eggs.
There are twp types of pathogenesis i.e. haploid pathogenesis and diploid parthenogenesis.
During **haploid pathogenesis**; eggs are produced by meiosis hence haploid and they develop into a new individual without being fertilized. E.g. in Bees, the drones develop form unfertilized eggs loid by the queen.
Diploid pathogenesis; is when the eggs are formed meiosis hence diploid and these eggs develop into anew into anew individual. E.g. in Aphids.
Parthenogenesis; also occurs in plants and it involves formation of an embryo formation of gametes in plants it is called Apomixes.

Sexual reproduction in flowering plants.
Development of the pollen grain:
Pollen grains develop from the anther contains pollen sacs in which the pollen grains develop. Each pollen sac contains large pollen mother cells which are diploid. Each mother cell undergoes meiosis to produce four haploid pollen grains (leotard).
Within each pollen grain, the haploid nucleus divided mitotically into two haploid nuclei, one called the generative nucleus and the other tube nucleus.
The wall of the pollen grain then thickens and is said to be mature.
Pollen grains themselves are not the mole gametes but they contain the pollen mother cell (2n).

Diagram:

Development of the embryo sac:
The embryo sac develops from the carpel which is the female reproduction past of a flower made up of the stigma, style and the ovary.
The ovary starts as a protrusion from the inner ovary wall into the ovary cavity. It is attached to the ovary wall by the start.
Stalk (funcle) through which food and water pass and has a tissue called a placenta at its base.
Each ovule consists of a mass of cells called the nacelles which becomes surrounded by protective inner and outer integuments.

Structure of the carpel showing the ovule

The integuments do not completely enclose the nacelles but a small opening at one end near the stalk called the microphyle and another near the style called the chalazas.It is from the nacelles – that the embryo sac mother cell is found. This embryo sac mother cell develops into a female gamete which is haploid.
Diagrams;

The embryo sac develops from a single diploid cell called the embryo sac mother cell.The embryo mother cell undergoes meiosis to form haploid cells (tetrad) three of which degenerate and only one remains and enlarges rapidly.Each nucleus undergoes mitotic division to form 8 daughters' haploid nucleus.
For nucleus migrate and each end of the embryo sac. One nucleus from each group moves to the centre and becomes the polar nucleus.The remaining 6 becomes separated by cell walls each becoming a separate cell within the embryo sac.This gives a mature embryo sac each containing 3 haploid cells at one end. Two free haploid nucleus in the centre and 3 haploid cells at the other end.One of the cells at the microphyll end comes the functional and the rest are called synergids.The 3 cells at chalazae end are called the antipodal cells.
Diagram:

Fertilization:
A mature pollen grain lands on a mature stigma of the same species and it germinate. Sucrose secreted by the stigma stimulates germination of the pollen grain since it supplies nutrients.A Pollen tube grows down the style tissue to the ovary and its growth is controlled by the tube nucleus formed at the growing tip.
The pollen tube towards the mature embryo sac by chemicals secreted over other. This is an example of chemotropism.Shortly before the pollen tube enters the embryo sac the generative nucleus divides by mitosis to produce two male nucleuses that are haploid.The pollen tube enters the embryo sac through the microphle but rarely through the chalazae.The tube nucleus of generates and the tip of the pollen tube bursts realising the male gametes which enter the embryo sac.One of the nucleus fuses with the egg cell to form a diploid zygote.This is called **double fertilization** and occurs in the flowering plants. This forms the 2 structures found in the seed i.e. the embryo and the endosperm.

Results of fertilization:
Ovules become the seed; the ovary becomes the fruit wall.
The zygote divides mitotically to give an embryo with aplumule, radical and cotyledons.
The integuments become the seed coat.
The microphyle persists and is present in the seed to allow water and oxygen into the seed during germination.
The floral parts wither and fall off giving two sacs i.e the remain of the style and the other remain of the stalk.
Advantages of reproduction by seeds:
The seed protects the embryo.

The seed contains food for the embryo.
The seed can remain dormant and survive during unfavourable conditions of the environment.
Seed are usually adapted for dispersal either by wind, water and animals.
The plant is independent of water if it reproduces by seeds. Therefore adapted to land environment.
The seed is a product of sexual reproduction, therefore allows the variation and adoption to the changing environment.
Disadvantages of reproduction by seeds
Seeds are large structures so dispersal is more difficult by spores.
Seeds store food and are likely to be eaten by animals unlike spore which can not b eaten.
Seeds depend on external agents for dispersal.
Food supply in the seed is limited and can not sustain plant growth for along time unlike in vegetative reproduction.
Two individuals are required in seed formation making this reproduction expensive compared to vegetative propagation where one is required.

Pollination:
This is transfer of mature pollen grains from the anther of the flower to the stigma of the same flower or different but belonging to the same spices.

Types of pollination:
Cross pollination and self pollination

Cross pollination:
.is the transfer of pollen grains from the anther of a flower to the stigma of a different flower born on another plant but of the same species.
Self pollination:
Is the transfer of pollen grains from the anthers of the flower to the stigma of the same flower or different flower but born of the same plant.
Characteristics of flower that promote cross pollination.
Some plants are dioecious i.e. one plant is male and another female.
The male plant produces only male flowers (staminate flowers) while female plants produces only female flowers (pistillate flowers) e.g. in paw-paws.
Dioeciuos conditions are rare because they need agents of pollination to transfer the pollen grains from one plant to another. However this condition is common in animals because animals can move and look for mates.
Different maturation times of the carpel and anthers (Dichogamy):
When the female parts mature first the condition is protogymy soil receives pollen grain from a different flower and when the male parts mature fast the condition is protandry so the pollen can be dispersal to already mature stigma of different flowers.
Floral structures:

If the stigma is above the anthers i.e. the style is longer than the filament, there are increased chances of cross pollination.
Self incompatibility:
Here the pollen grains fall to germinate on the stigma of flowers of the same plant but can germinate on the stigma of flowers of a different plant.
Some plants are monoecious but having separate male and female flowers e.g. in maize. This encourages cross pollination.
In maize, the flowers mature at different times with the male maturing faster than the female.
Adaptation to self pollination:
Monoecious condition i.e. flower has both male and female fruits.
Maturation of both anthers and stigma at the same time.
Anthers located above the stigma i.e. the filaments are longer than the style.
Anthers and stigma being enclosed in the corolla.

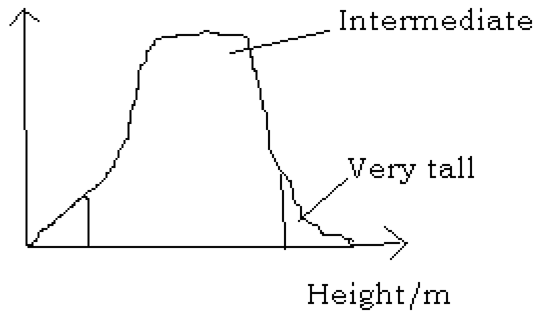
Note:
The advantages associated with cross pollination are creating genetic variation as a result of out breeding.
The advantages associated with self pollination are maintaining the desirable characteristics since there is no mixing of genes of the different individuals to plants.

15. GENETICS

Genetics and heredity
The study of similarities between organisms is called genetics and the transfer of characteristics from parent off spring is called inheritance/heredity. The inheridity characteristics are acquired in sexual reproduction where new individuals result from the fusion of gametes containing information from both parents. However parents and off springs are not exactly identical and the differences between them is due to variations. There are 2 types of variations of variations

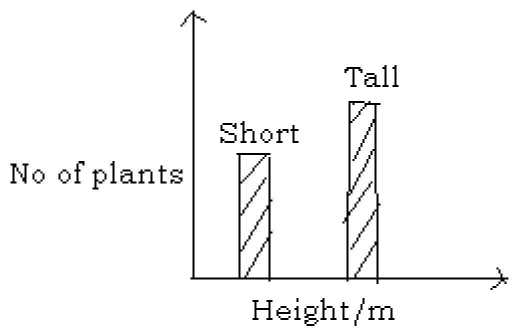
Continuous variation

This shows a clear greadatian from one extreme to another through intermediate individuals. It is under the control of many games and very important in evolution. Examples include weight, height, skin colour in humans, beef yield, egg yield etc
If a sample of 100 men is taken randomly it difficult of them to have the same height but their heights vary from short ones through intermediates to very tall ones. If a graph showing their heights is to be plotted, it gives a normal distribution curve.



(b)Discontinuous variation

This occurs when there is a clear out difference in the phonotype of the individuals with 2 clear groups with out over lap. Variables like blood group tongue rolling, sex and heights in plants are discontious variables. Individuals with such characteristics can be put into 2 groups with out intermediates eg heights in plants.



Discontinuous variables are under a control of a few genes and are not important in evolution.

Menel's experiments on inheritance

From his experiments mendel collected one of a varieties of graden peas with clear contrasting characteristics such as height. Initially he studied only one pair of contrasting characteristics which he called monohybrid inheritance.

In one of his experiments he used tall plans with a pure line. He crossed a pure line of tall plants with pure line of short plants. He did this by transferring the pollen grains of the short plants to the stigma of the tall plants.

He planted resistant seeds and examined the off springs. All off springs were tall and non shortest. He called this the first filid generation (F1)

When mendel selfed the plants in F1 in generation to obtain the F2 generation, $\frac{3}{4}$ were tall and ¼ short. When he self pollinated the planes from the plant grew into short plants only while those of the tall plants gave the following results, 1/3 of them gave tall plants only and $\frac{2}{3}$ of them gave tall and short plants in the ratio 3:1.

Mendel called the character which became parent in the F1 generation. Dominant and the one which did not appear in the F1 generation. Recessive eg tallness is dominant, shortness is recessive. He found out that whether the tall parent is a male or female.

Let T represent allele for tallness

T represent allele for shortness

Parents	phenotype	tall	x	Short
	Genotype (2n)	TT	x	tt
	Meiosis			
	Gametes (n)	T		t

F1 Genotype (2n) Tt
F1 Phenotype: all tall
Mendel made the following conclusions, he said that

- Gametes like pollen grains contain character determinity factors eg height.
- A character like height is controlled by a pair of factors which segregate during dormination of gametes the process of meiosis
- Because of the above, only half of the factors is represented in a single gamete giving a hap laid condition.
- The diploid condition as restored during fertilization

Mendel did not know genes and alleles. He talked of a pair of factors which is a gene today and each of the pair is called allele.
From his conclusion model put up 2 laws law 1 ie the low of segregation
Law 1 ie the law of segregation
This occurs during meiosis and it states that of / in a pair of factors controlling a particular characteristic only one of them is represented in a single gamete?
Law 2 ie this is the law of independent assort went.
The law states each of the pair of factors controlling a particular characteristic may combine with another factor from another pair. This occurs during random fertilization.
Mendel preferred the garden pea for his experiment because

- They show clear contrasting characteristics eg heights, blour, texture of the seeds.
- They are easy to self pollinate. Mandel did this by wrapping the flowers in a polythen beg.
- They are easy to grow and have a short generation time eg if a pure strain of mice with brown coloured fir is allowed to breed with a prestrain of house with grey coloured its they produce off spring having brown coloured for. If the F1 mice allowed to inter breed, F2 generation had mice with for in the ratio 3 brown: 1 grey.
- Explain the results

Let B rep allele for Brown
B rep allele for grey

Parents	phenotype	Brown	x	Grey
	Genotype (2n)	BB	x	bb

Meiosis
Gametes (n)

t

F1 Genotype (2n) Bb T
F1 Phenotype: all tall
F1 x F1
Parent phenotype Brown x Brown
Genotype (2n)Bb x Bb
Meiosis
Gemetes (n)
Random fertilization B b B b

F2 genotypes (2n) BB Bb Bb
F2 phenotype 3 brown : 1 grey

GLOSSARY OF GENETIC TERMS
Allele
This is an alternative form of the same gene controlling a particular characteristics.
Bivalent
This is a pair of homologous chromosomes lying side by side during meiosis.
Chromatid
This is half of the chromosome that is produced when it divides longitudinally during cell division.
Chromosome
Is a thread like structure carrying the gene matril DNA is located with in the incler
Diploid
Description of a cell having 2 sets of homologous
Chromosomes
Haploid
Description of a cell having one set of landxx chromosomes.
Dominant
This is an allele that appears phenotypically in the leterozygaces state.
Recessive
An allele where effect is not seen in the heterozygous state due to presence of a dominant allele of the same gene.
Gene
This is a unit of heredity located on the chromosome.
Genotype
Description of an organism interms of the genetic constitution.
Phenotype
Description of an organism interms of what can be seen from the outside
Homozygote
Description of an organism having 2 identical alleles of the same gene
Heteropzygote
An organism having 2 different alleles of the same gene

Loci
Position of a gene along the chromosome
Hybrid
An off spring produced when 2 varieties of the same species or different species interbreed.
Incomplete dorminance
Is a condition where neither of the alleles is dominant than the other and each has half contribution to the phenotype of the off spring.
Test cross
Is the cross aimed at finding out the genotype of an organism by crossing it with homozygous recessive individuals.
Back cross
Is a cross between off springs and one of its parents.
Recipirical cross
Is the exchange of the sex of the parent as regards the phenotype eg if in one cross the male is the tall and female is short, then the second cross, the male short and female tall.
This is possible in plants and does not affect the phenotype and genotype of the off spring
Monohybrid test
It involves studying a pair of contrasting characteristics such as tallness. The genotype of organisms produced by breed homozygous dominant and homozygous recessive present is heterozygous.
Is heterozygous but phenotypically it shows the dominant characteristic. To evidence whether the genotype is homozygous dominant heterozygous, a test cross is carried out.
If the unknown genotype is homozygous dominant and cross with homozygous, recessive in the test cross, all offsprings will show the development characteristics but if it was heterozygous, the recessive phenotype appears in the off springs eg
In the drosophilafly long wings are dominant to vestigial wings. The genotype of the long wings drosophila may be WW or Ww. Inorder to test the exact genotype, the fly is test crossed with a double recessive ww.

Parents	Phenotype	Long winged	x	Vestigial wings
	Genotype	WW		ww
	Meiosis			
	Gametes (n)			
	Random	W		w
Fertilization				
Offspring genotype (2n)		Ww		

Offspring phenotype: all long winged

Parents	Phenotype	Long winged	x	Vestigial wings
	Genotype	WW		ww
	Meiosis			
	Gametes (n)			
	Random	W w		w

Fertilization
Offspring genotype (2n)   Ww   ww
Offspring phenotype: 1long   1 vestigial
Winged   wings
Dihybrid inheritance

Mendel also investigated the simultaneous inheritance of 2 pairs of contrastic characteristics in garden pea. He called this dihybrid inheritance eg he crossed a pure breeding cotyledon with a pure breeding plant growing from round seeds with yellow cotyledons.
Wrinkled seeds
Let   R rep. allele for round seeds
r rep. allele for wrinkled seeds
Y rep allele for yellow cotyledons
y rep allele for green cotyledons
All the F1 off springs had round and yellow cotyledon

Parents — Phenotype   yellow Round   x   Green wrinkled
Genotype(2n)   YYRR   yyrr
Meiosis
Gametes (n)   YR   yr
Random fertilization
F1 Genotype (2n)   RrYy
F1 Phenotype: all round yellow

When plants from the F1 generation were sulfed, the resultated F2 plants gave 4 phenotypes
F1 x F1
Parents — Phenotype   yellow Round   x   Green wrinkled
Genotype (2n)   RrYy   RrYy
Meiosis
Gametes (n)   RY Ry rYry   RYRy rYry
Gametes

Gametes

♀/♂	RY	Ry	rY	Ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rryy	rryy

R-Y- Round yellow = 9
R-yy round green = 3
rry- wrinkled yellow = 3
rryy wrinkled green = 1

Four possible phenotype ie bound yellow, round green wrinkled yellow, wrinkled green representing ratio 9:3:3:1. Medes also noted 2 new phenotypes round green and wrinkled yellow.

Example

Tall coloured plants were crossed with short white plants. All the F1 off springs were tall coloured on selfing the F1 the F2 generation gave a ratio of 9:3:3:1 discuss these results.

Let T represent allele for tallness
t rep allele for coloured
B rep allele for coloured
b rep allele for white

Parents — Phenotype tall coloured x Short white
Genotype (2n) TTBB ttbb
Meiosis
Gametes TB tb
Random fertilization
F1 genotype (2n) TtBb
F1 phenotype : All tall coloured

F1xF1

Parents Phenotype tall coloured x Short white
Genotype(2n) TtBb TtBb
Meiosis

Gametes(n) TB Tb tB tb
Gametes

Gamete

	TB	Tb	tB	Tb
TB	TTBB	TTBb	TtBB	TtBb
Tb	TTBb	TTbb	TtbB	Ttbb
tB	TtBB	TtBb	ttBB	ttBb
tb	TtbB	Ttbb	ttBb	Ttbb

In guinea pig there are 2 alleles for hair colour, black and white and 2 alleles for hair length, short and long. In the breeding experiment all the phenotype produced from a cross between all the phenotype produced from a cross between pure breeding and black parent were all long haired with white for

Explain which alleles are dominant

What is the expected proportion of the F2 phenotype

A pure breeding drosophila fly with broad abdomen and long wings was crossed with a pure breeding drosophilafly with narrow abdomen and vestigial wing. If the allele for broad abdomen is dominant over the narrow abdomen while long wings being dominant over vestigial wings, determine the genotype and phenotype of the F2 generation.

b) Why is drosophila preferred in genetic experiments?

Let the allele for long hair be T
Short hair be t
White fur be W
Black parent be W

Parents — phenotype long haired x short haired
White fur black fur
Genotype(2n) TTWW ttww
Meiosis
Gametes (n) TW tw
Random fertilization
Off spring genotype(2n) TtWw
Off spring phenotype: All long haired with white fur
F1x F1
Parents — phenotype long haired x short haired
White fur black fur
Genotype(2n) TTWW ttww
Meiosis
Genotype (n) TWTw tWtw
Gametes

Gamete

♀/♂	TW	Tw	tW	Tw
TW	TTWW	TTWw	TtWW	TtWw
Tw	TTWw	TTww	TtWw	Ttww
tW	TtWW	TtWw	ttWW	ttWw
tw	TtWw	Ttww	ttWw	ttww

Long haired white fur (T-W-) = 9
Long haired black fur (T-ww) = 3
Short haired white fur (ttw-) = 3
Short haired black fur (ttww)= 1
Let B rep allele for broad abdomen
b rep allele for narrow abdomen
R rep allele for long wings
r rep allele for vestigial wings

Parents — phenotype Broad abdomen x narrow abdomen
Long winged vestigial wings
Genotype(2n) BBRR bbrr
Meiosis
Gametes (n) BR br
Random fertilization
Off spring genotype(2n) BbRr
Off spring phenotype: All broad abdomen long winged
F1x F1
Parents — phenotype Broad abdomen x broad abdomen
Long winged long winged
Genotype(2n) BbRr BbRr
Meiosis
Genotype (n) BRBr bRbr
Gametes

Gamete

♀/ ♂	BR	Br	bR	Br
BR	BBRR	BBRr	BbRR	BbRr
Br	BBRr	BBrr	BbRr	Bbrr
bR	BbRR	BbRr	bbRR	bbRr
br	BbRr	Bbrr	BBRr	bbrr

Broad abdomen long wings (B-R-) = 9
Broad abdomen vestigial wings (B-rr) = 3
Narrow abdomen long wings (bbR-) = 3
Narrow abdomen vestigial wings (bbrr)=1
DIHYBRID TEST CROSS
Like with monohybrid inheritance, phenotypes of the heterozygote individuals would be identical to those of homozygote individuals for the dominant characteristics. To prove whether an organism is heterozygous or homozygous, a trial test cross is carried out during when the homozygous recessive individual. If the organism is heterozygous, all the four possible phenotypes will come out in theratic 1:1:1:1

Eg Parents Phenotype Tall coloured x Short white
Genotype(2n) TtBb ttbb
Meiosis
Gametes(n) TB Tb tB tb tb
Random fertilization
Test cross genotype (2n) TtBb Ttbb ttBb ttbb
Test cross phenotype Tall colour... ...hite
Phenotype ratio
If the unknown is TTBB
Parents Phenotype Tall coloured x Short white
Genotype(2n) TTBB ttbb
Meiosis
Gametes (n) TB tb
Random fertilization
Test cross genotype(2n) TtBb
Test cross phenotype All tail coloured

SEX DETERMINATION
In humans there are 23 pairs of chromosomes 22 being somatic chromosomes while 1 pair is called the sex chromosome. Females have identical sex chromosomes denoted as xx where as males have an x and y chromosome (xy). In the formation of gametes the sex chromosomes segregate during meiosis such that all the egg cells will have x chromosomes where as 50% of the sperm cells will carry x and 50% will carry y chromosome. Females are therefore homogametic while males are heterogametic.

On fertilization the egg may be fertilized by a sperm carry an X chromosome producing a zygote that has xx chromosome resulting into a baby girl. The same egg can be fertilized by a sperm cell carrying a y chromosome giving a zygote with XY chromosomes which results into a baby body.
In humans sex is genetically determined by which sperm fertilizes the egg therefore the father determines the sex.

Parents Phenotype father x Mother
Genotype XY XX
Meiosis
Gametes (n)
Random X Y
Fertilization
Offspring genotype (2n) XX XY
Offspring phenotype: Girl boy
50% 50%

In birds the female is heterogametic with XY and the male is homogametic xx so sex is genetically determined by the female.
In some insects like the butterfly the females is xx and the male is Xo ie Y is missing and sex is genetically determined by the male. In the diosophilic fly the female is xx and the male is xy in the same ways as in humans.
SEX LIMITED, SEX LINKED, SEX INFLUENCED AND HAURANDRIC CHARACTERS.
Sex limited characteristics are those restricted to only a particular sex phenotype eg boudness restricted to the male phenotype.
Sex linked characteristics are those that are carried on the sex chromosomes.
Sex influenced characteristics are those that are under the control of sex hormones and they include the secondary sexual characteristics.
Haurandric characters are those that are carried on the Y chromosome such as presence of hair in the ears. Originally the y chromosome was thought to be empty but recently it has been found to carry characteristics, hair in the ears and size of the testis.
SEX LINKED CHARACTERS.
These are characterized carried on the sex chromosomes particularly the x chromosome. Two most common set linked characters include colour blindness and haemophilia.
Haemophilia is caused by recessive allele carried on the x chromosome. The presence of the recessive allele for gaemophilia can be masked by the dominant allele. In the male, the presence of an allele for haemophilia on the single x chromosome is enough to produce the disease because the y chromosome can not carry an allele for normal blood cloating which can mask the affect of recessive allele. Therefore heomophilia and many other sex linked characteristics affect mainly males though transmitted by females who are always carriers but do not suffer from the disease.

People who are hemophiliac lack the blood clotting factor VIII which makes the process of blood clotting a failure. The individual will continue bleeding to death even after a minor injury.

Let allele H rep normal bleed clotting
h rep haemophiliac condition

parents phenotype carrier female x Normal male

Genotype (2n) X^hX^H X^HY
Meiosis
Gametes (n) X^h X^H X^H Y
Random fertilization
Off spring gew type (2n)
Off spring phenotype: carr X^hX^H X^hY X^HX^H ıal
Daughter Son dau X^HY

Chances of producing a haemophiliac are very low about 0.004% in males and 0.00004% in females. This indicates that female haemophiliacs are less common because the male haemophiacs rarely survive up to their reproductive age inorder to breed and pass on the recessive allele to their daughters. Similarly haemophiliac daughter do not survive up to their reproductive age as they bleed to death on their first menstruation.

The pattern of inheritance of sex linked characteristics follows a crisis cross inheritance ie the sex linked gene is transferred from the father to the grand son through the daughter.

In the daughter the character is not expressed and daughter remains a carrier. The characteristic reappears in the grand son. Eg a colour blind man marries a normal female show by using well defined genetic symbols how colour blindness is transmitted to the grand son.

Let R rep allele for normal colour vision
r rep allele for colour blindness

A colour blind man marries a woman whose fatxx was colour blind. Determine the proportion of their who are likely to be colour blind

Linkage on other chromosomes

Genes situated on the same chromosome are said to be linked and they make up a linkage is important eg in humans where there are so many characteristics eg blood group, eye colour, ability to roll the tongue, skin colour, amount of fur, ability to secrete insulin, height weight can be carried on the same chromosome. If there was no linkage humans would be having only 46 c-tics since there are 46 chromosomes assuring each carries one x-tics.

Linkage groups do not show in dependent assxxx and the whole linkage groups goes into a single gamete.

Therefore linkage does not conform to mendees saw of independent assortment and they fail to produce the expected 9:3:3:1 ratio for hybrid inheritance in the F2 generation instead they produce a ratio of 3:1.

Consider for example the drosophilafly, the gene for body colour and wing length are linked. A grey bodies and long winged fly was crossed in a black body and vestigial winged fly. All the F1 off springs has grey bodies and long wings. Using well defined genetic symbols and show the genotypical ratio you would obtain in the F1 generation if linkage was complete.

F1 generation if linkage was complete

Let G rep allele for grey body

g allele for black body

L allele for long wings

l allele for vestigial wings

CROSSING OVER AND RECOMBINATION

Crossing over is the exchange of potions between homologous chromosomes during prophase 1 of meiosis. Crossing over results into changes in the pattern of genes a long the chromosome where genes are linked. This gives recombinants. Recombinants are off springs that have a combination of characteristics from both parents but different from either parent eg

In sweet pea the gene for flower colour and pollen grain nature are linked. If a purple flowered plants with long pollen grains, all the F1 plants were purple flowered with long pollen grains. If the F1 generation were selfed, a variety of combination were obtained giving the following number of off springs, purple flowered with long pollen grains = 44.

Red flowers with short pollen grains = 48

Purple flowered with short pollen grains = 13

Red flowered with long pollen grains = 12

Let P rep allele for purple flowers

P rep allele for red

L rep allele for long

l rep allele for short

TEST CROSS WITH RECOMBINATION AND LINKAGE

When flies with ebony body and curled wings were crossed with normal flies having grey body with straight wings all the F1 off springs were heterozygous for grey body and straight wings. When these were crossed with homozygous recessive fly for both characteristics, 20% of the off springs were recombinants and the vest parental types. If the gene are linked, work out to show the phenotypes resulting from the test cross.

Let G rep allele for grey body

g rep allele for ebony body

A rep allele for straight wings

a rep allele for curled wings

In practice a ratio of 1:1:1:1 is not obtained since the recombinants are always very few with many parental an a ratio of 4:1:1:4 is obtained.

Chanced of producing a recombination are limited and they depend on the distance of separation of the locus of linked genes on homologous chromosomes. The further a part the locus of linked genes are the higher the chances of producing recombinants because the chasmata is going to be formed between the locus of the linked genes.

If the locus of linked genes are very close to each other, chances are high that the chasmatic will be formed behind the locus of the linked gene and no recombinants will be produced.

CROSS OVER VALUES (COVs)

COVs represent the %age of linked genes that are exchanges during the process of crossing over at prophase I of meiosis. COVs can be calculated as the %ge off springs showing recombination to the total number of off springs COVs are used to locate positions of linked genes on the chromosomes.

COV = $\frac{recombination}{total\ no\ of\ off\ springs}$ x 100

Eg if purple flowered plants with long pollen grains are crossed with red flowered plants having short pollen grains and the F1 off springs selfed to obtain the F2 generation, the following results were obtained.

Purple flowers long pollen grains = 56
Purple flowers short pollen grains = 13
Red flowers long pollen grains = 11
Red flowers short pollen grains = 48

Solution

Total recombinants = (13+11) = 24
Total off springs = (56+13+11+48) = 128

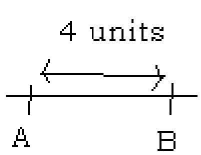
COV = $\frac{recombination}{total\ no\ of\ off\ springs}$ x 100

COV = $\frac{24}{128}$ x 100 = 18.75% = 19%

A small COV for a pair of linked genes shows that the genes are together. Plant breeders use COV values to determine the relative positions of linked genes on the chromosome and a certain the likelihood of recombinants if they have desired X-tics eg early maturity, high yielding, increasing etc.

Chromosome maps

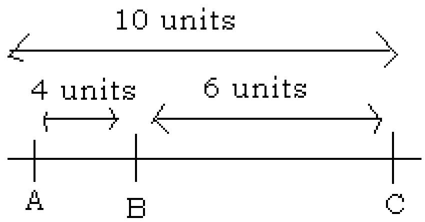
This shows relative positions of linked genes along the whole length of chromosome. Consider 2 genes A and B linked on the same chromosome the further apart they are on the chromosome, the higher the chances of crossing over. Chromosome maps are obtained from cross over values and conqinient of COV of 1% represents 1 unit on a chromosome. If the COV of A and B is 4% it means that A and B are units apart on the chromosome and the chromosome map appears like.



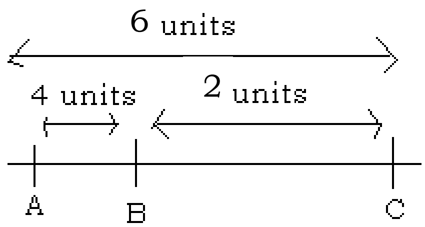
If on the same chromosome there is another linked gene C and the COV of C and A is 10%, determine the locate the positions of linked genes.

COV of A and C = 10%
COV of A and B = 4%

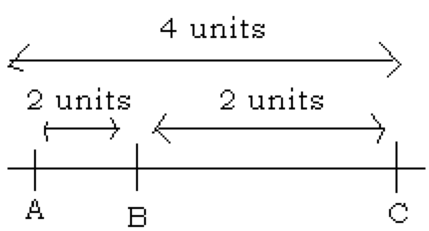
COV of B and C = 6%



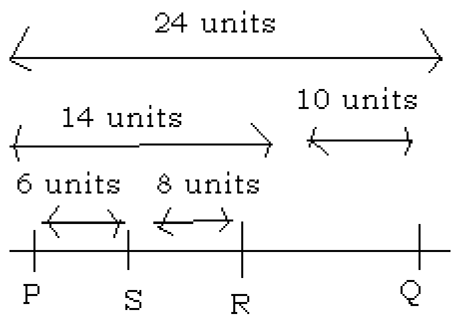
Assuming A and C give COV of 2%, band C 6% construct a chromosome map to locate the positions of the genes on the chromosomes
COV of A and C = 2%
COV of B and C = 6%
COV of A and B = 4%



Another possibility is having A and C and B and both having COV of 2%.
COV of A and C =2%
COV of B and C = 2%
COV of A and B = 4%



Example
Consider the following COV values
P-Q = 24%
R-P = 14%
R -S = 8%
S-P = 6%
R-Q=10%
Use the information to construct a chromosome map



GENE INTERACTION

In some cases genes interact bringing about abnormal phenotype and genotype. The phenotype no longer agree with the mendelian fashion of inheritance.

Incomplete dominance

This is a condition where 2 alleles do not show complete recessiveness or dominance due to the failure of any allele tomask the other in the heterozxygous state. Eg when homozygous red and homozygous white flowered plant were crossed, the f1 off springs did not produce the expected results of either white or red is recessive or dominant but both have the same powers of expression such that they contribute equally to the final colour resulting into an immediate colour which is pink.

Let the allele for red be f

Allele for white colour be W

Parents Phenotype : Red coloured x White coloured

Genotype (2n) C^RC^R C^wC^w

Meiosis

Gametes (n) C^R C^w

Random fertilization

F1 genotype (2n) C^RC^w

F1 Phenotype : All pink coloured

F1 x F1

Parents Phenotype : Red coloured x White coloured

Genotype (2n) C^RC^R C^wC^w

Meiosis

Gametes (n) C^R C^W C^R C^W

Random fertilization

F2 genotype (2n)

F2 phenotype Red C^RC^R C^RC^W C^RC^w

1 2 1

This modifies the medelian f2 phenotype ratio which is expected to be 3:1 only appearing as 1:2:1.

2. Lethal genes

In certain cases genes may be lethal in the homozygous dominant condition producing abdominal phenotypic ratios deviant from medelian fashion of inheritance eg the coat between two 2 yellow rats gives rise to a ratio of 2 yellow to one 1 agautis since the homozygous dominant for yellow colour dies before birth.

Let y rep allele for yellow

Y rep allele for agouti colour.

Parents phenotype yellow coloured x yellow coloured
Genotype(2n) Yy Yy
Meiosis
Gametes (n) Y y Y y
F1 genotype (2n) YY Yy Yy yy
F1Phenotype rat 2 yellow 1 agout
With homozygous
Yellow dies

Complementary genes

These are 2 or more genes that are inter dependent that the dominant allele from the gene can only produce an effect on the phenotype of an organism. If the dominant form of the other gene is also present it's a common form of gene interaction and was first discovered in sweet pea. When 2 white flowered varieties were crossed, all the f1 of springs were found to have purple f1 flowered and white flowered plants in the ratio 9:7 thus shows that the characteristic is controlled by the genes located different loci of the chromosome. One gene controls the production of the colourless pigment precussor while the other gene p is responsible for converting the ovules pigment processor into the colour is not going to be produced suggesting that either pigment precussor is not used or if produced is not either converted into the active purple form.

Parents phenotype white flowered x white flowered
Genotype (2n) CCpp PPcc
Gametes (n) Cp Pc

Random fertilization
F1 Genotype (2n) CcPp
F1 phenotype: All purpled flowered
F1 x F1
Parents phenotype white flowered x white flowered
Genotype (2n) CCpp PPcc

CPCp cP cp CPCp
cP cp

Using the pinnate square

Gametes

♂/♀	CP	Cp	Cp	Cp
CP	CCPP	CCPp	CcPP	CcPp
Cp	CCPp	CCpp	CcPp	Ccpp
cP	CcPP	CcPp	ccPP	ccPp
cp	CcPp	Ccpp	ccPp	ccpp

Gamete

Coloured purples
C-P- = 9
Coloured white
ccP-
C-pp = 7
CCPP

Therefore F2 phenotype ratio is 9 purple: 7 white

SUPPLEMENTARY GENE

Supplementary genes have been seen in determining coat colour in mice. The common mice has 3 main colours, Agauti, black, and albino. Dominant gene A when present along which B produces agauti pattern. Gene B is for black colour, there for absence of gene A has no effect on its own but its called a supplementary gene since it supplements B in producing the agouti pattern.

When black mice which a genotype aaBB are crossed with another albino of AAbb all the f1 off springs are agauti colour. When the f1 agauti one selfed the phenotype ratio in F2 is 9 agauti.

Therefore 3 black : 4 albino. A modification of the 9:3:3:1 ratio.

Parents	Phenotype	Black	x	Albino
	Genotype (2n)	aaBB		AAbb
	Meiosis			
	Gamates (n)	aB		Ab
	Random fertilization			
	F1 Genotype (2n) :		AaBb	
	F1 phenotype		All agauti	

F1 x F1

Parents	Phenotype	Black	x	Albino
	Genotype (2n)	aaBB		AAbb
	Meiosis			
	Gamates (n)	AB Ab aBab		ABAb

Gametes

Gamete

♀/♂	AB	Ab	aB	Ab
AB	AABB	AAbb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	AaBb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	aabb

Agauti coat colour

A-B- = 9

Black coat colour

aaB- = 3

Albino coat colour

A-bb

= 4

Aabb

The F2 phenotypic ratio is 9. Agouti : 3 black : 4 Albino

Epistasis

A gene is said to be Epistatic when its presence suppresses the expression of another gene located at a different locus. Some time such genes are refered to as inhibiting genes because their effects inhibit expression of other genes. The gene whose effect is masked is called a hypostatic gene egthe recessive gene for albinism inhibits the activity of several other genes which determine age and hair pigment in humans.

In poultry feather colour is controlled by two sets of allele, w (white) which is dominant over w (coloured) and B (black) which is dominant over b (brown). A form which is heterozygous for both alleleWwBb is whxxx.

This shows that the gene for white colour is epistatic and the gene for white colour is hypostatic since its effects are not expressed in the heterozygous state.Eg a white foul with genotype WWbb is crossed with a cock with a genotype wwBB all the f1 off springs were white. If the F1 are selfed the f2 phenotypic ratio gives 12 white: 3 black and 1 brown coloured.

Parents
Phenotype White x Black
Genotype (2n) WWbb wwBB
Meiosis
Gamates (n) Wb wB
Random fertilization
F1 Genotype (2n) : WwBb
F1 phenotype All white

F1 x F1
Parents
Phenotype White x White
Genotype (2n) WwBb WwBb
Meiosis
Gamates (n) WB Wb wB wb

Gametes

Gamete

	WB	Wb	wB	Wb
WB	WWBB	WWBb	WwBB	WwBb
Wb	WWBb	WWbb	WwBb	Wwbb
wB	WWBB	WwBb	wwBB	wwBb
wb	WwBb	Wwbb	wwBb	wwbb

White
W-bb
= 4
W-B-
Black
B-ww = 3
Coloured/Brown
wwbb = 1
The F2 phenotypic ratio is
12 white: 3 black: 1 coloured
Which is a modification of medel's 9:3:3. F2 phenotypic ratio for dihybrid inheritance

Question
What would be then phenotypic ratio of the cross between white fawl which genotype WwBb with a brown cock.

Parents phenotype White x Black
Genotype(2n) WwBb wwbb
Meiosis
Gametes (n)
WB Wb wB wb
F1 genotype (2n)
F1Phenotype 2 WwBb Wwbb wwBb rown
Therefore the F1 phenotype ratio is 2 white: 1 black: 1 brown.

GENE INTERACTION IN DOMESTIC FOWL
Genes sometimes interact to give rise to unusual phenotypes eg in domestic fowl there are 4 types of combs determined by p and the rose comb R. if both are present together a different comb called wu/nut appears. If both are absent, he comb is single the genes are inherited in the normal medelian.
If a foul with a rose comb having the genotype RRpp is crossed with one having pea comb with genotype PPrr all the F1 off springs had wulnut type of combs selfing the f1, off springs gives f2 with the phenotypic ratio of 9:3:3:1 showing all the 4 types of combs inherited in the medelian fashion.

Parents Phenotype: Rose x pea
Genotype (2n) RRpp PPrr
Meiosis
Gametes (2n) Rp Pr
Random fertilization
F1 genotype (2n) RrPp
F1 phenotype: All wu/nut
F1xF1
Parent Phenotype wulnut x wulnut
Genotype(2n) RrPp RrPp
Meiosis
RP Rp rP rp RP Rp rP
rp

Gametes

Gamete

♀/♂	RP	Rp	rP	Rp
RP	RRPP	RRPp	RrPP	RrPp
Rp	RRPp	RRpp	RrPp	Rrpp
rP	RrPP	RrPp	rrPP	rrPp
rp	RrPp	Rrpp	rrPp	rrpp

Wulnut
R-P- =9
Rose

R-pp = 3
Pea
rrP- =3
single
rrpp = 1

CO-DOMINANCE

This is a condition where by the effect of 2 allele is expressed in the phenotype of the off spring. The phenotype is not an intermediate but each allele contribute independent of the other. Both allele are dominant to each other hence the edition co-dominance. Eg the blood group AB, if the male parent is blood group A and female parent B, the offspring will have blood group AB.

MULTIPLE ALLELE INHERITANCE

Under normal cases, each characteristic is controlled by a single gene carrying 2 alleles ie dominance recessive alleles. In the blood group inheritance, the gene carries 3 alleles. Inheritance of blood group is controlled by a gene called Isohaemologous gene represented by I which may carry alleles A, B and O hence the name multiple allele inheritance.

If the gene carries allele A, the person has blood group A. if it carries B the person has blood group B if it carries both A and B, the person has blood group AB. When it carries allele O the person has blood group O.

There are 6 possible genotypes and 4 phenotypes in blood group inheritance.

Genotypes	Phenotypes
I^AI^A	Blood group A
I^AI^0	Blood group A
I^BI^B	Blood group B
I^BI^0	
I^AI^B	Blood group AB
I^0I^0	Blood group O

Blood group inheritance can be used to solve social problems like finding out percentage of the child. Eg If the mother's blood group is B and that of her child is AB, What could be the blood group of the father.

Parents	Phenotype	Father	x	Mother
	Genotype(n)	I^AI^A		I^BI^B
	Meiosis			
	Gametes (n)	I^A		I^B
	Fertilization			

Child's genotype (2n) I^AI^B
Child's phenotype: Blood group AB

The blood grouped of the father is A with genotype I^AI^A

Mary a student with blood group A and a baby with blood group O. Peter a fellow student who she name responsible for the pregnancy denied responsibility. The case was taken to court the following facts we established.

Peter's mother was of blood group A and father blood group B. state whether the court will find peter guilty or innocent.

Peter's parents
Phenotype Group A x Group B
Genotype (2n) I^AI^A I^BI^B
Meiosis
Gametes(n) I^A I^B
Fertilization
Peter's Genotype(2n) I^AI^B
Peter's phenotype : Blood group AB

Child's Parents
Phenotype Group AB x Group A
Genotype (2n) I^AI^B I^AI^O
Meiosis
Gametes (n)
Fertilization I^A I^B I^A I^o

I^AI^A I^AI^o I^AI^B I^BI^o

Peter was innocent

POLYGENIC INHERITANCE (MU [illegible]E)

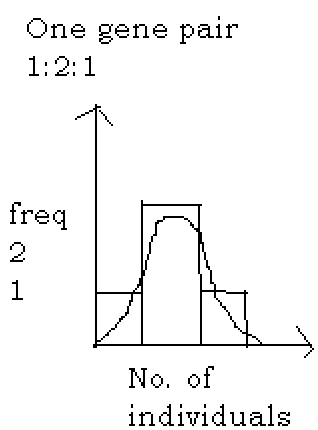
Polygenic inheritance involves quantitative inheritance. Unlike qualitative inheritance, where there are no intermedeates, in qualitative inheritance there is continuous variation. Polygenic inheritance shows the following features.20

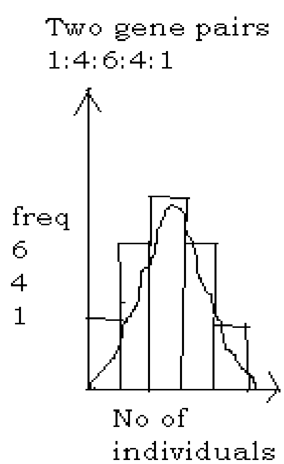
i. Each characteristic is determined by more than 1 gene ie polygenic and all such genes are non allelic.

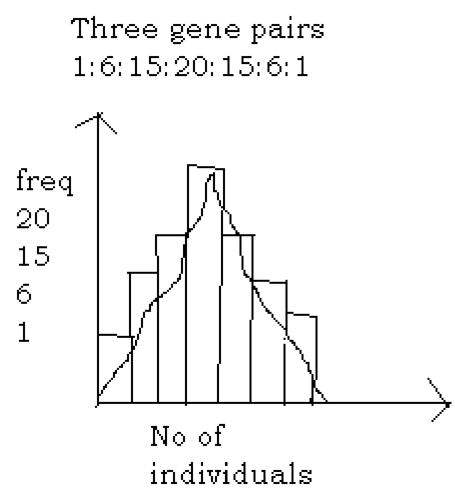
ii. Individually each gene has little effect on the phenotype but their combined effect is very significant.

iii. Each gene has a certainxxxxx of effect and the is the x-tic.

iv.Polygenic inheritance does not follow the mondelian ratio. If 1 gene pair is studied, the f2 ratio is 1:2:1, if 2 gene pair the ratio is 1:6:15:20:15:6:1 in each case a normal distribution curve showing continuous variation is obtained.







The skin colour in man is an example of polygenic inheritance and shows a wide continuous variaties. At least 3 gene pair (may be 6) determine the skin colour in man. Skin colour is due to the pigment melanin. The more the pigment, the dark the skin. The amount of melanin is determined by the number of dominant genes present. Each dominant gene is responsible for the synthesis of a fixe amount of melanin. Since the effect is addictive, the amount of melanin produced is always proportional to the number of dominant genes.

In a cross between an albino (no melanin at all) and a negro (maximum melanin), the f1 off spring would show an intermediate colour of skin and the f2 generation would show a complete gradation of colour from one extreme to another. Plotting the frequency distribution against the number of individuals showing gradation in skin colour once gets a normal distribution curve.

In all case of polygenic inheritance extreme phenotypes are rare and the intermediates are more frequent as shown in the graphs.

Example

A red nickel maize was crossed with a white keneld maize. The f1 off springs were intermediate red. When these were selfed, the f2 off springs gave a phenotype ratio of 1:4:6:4:1. Explain your results.

Let the gene for red be represented as R

The gene for white be represented as r

Parents Phenotype Red x White

phenotype (2n) RRRR rrrr

meiosis

gametes(n) RR rr

fertilization

F1 Genotype(2n) RrRr

F1 phenotype: All intermediate red

F1 x F1

Parents Phenotype Intermediate Red x Intermediate White

Phenotype (2n) RrRr RrRr

Meiosis

Gametes (n) RR Rr rR rr RR

Gametes

♂/♀	RR	Rr	rR	Rr
RR	RRRR	RRRr	RRRr	RrRr
Rr	RRRr	RrRr	RrRr	Rrrr
rR	RRRr	RrRr	RrRr	Rrrr
rr	RrRr	Rrrr	Rrrr	Rrrr

Gamete

Genotype	Phenotype	Freq	No of dominant genes
RRRR	Dark red	1	4
RRRr	Red	4	3
RrRr	Red intermediate	6	2
Rrrr	Light red	4	1
rrrr	White	1	0

There are very few extreams with only 1/16 show dark red or white phenotype and 6/16 showing the intermediate phenotype characteristic of the continuous variation. Polygenic inheritance is also under the control of the environment and very important in formation of new species.

Differences between monogenic and polygenic inheritance.

Monogenic inheritance	Polygenic inheritance
Governed by 2 or more allele of the same gene	Governed by many no. allelic gen
Gives discontinuous variation	Gives a continuous variation
Also known as qualitative variation	Also known as quantitative inheritance
No intermediates	No. of intermediate give a smooth gradation
Phenotype only genetically determined	Phenotype influenced by both the genotype and xxxx
Eg several traits studied by mendel	Eg skin colour in man

PLEIOTROPY

Is a condition where by a single gene exerts more than 1 phenotypic effect eg the gene for sickle cell anaemia. Sickle cell anaemia is heritary disease caused by a pleiotropic gene with isthal effects in the homozygous recessive condition. The gene has the following effects; production of abnormal haemoglobin, Distorting the shape of red blood cells leaving sickle shaped.

The physiological effect is lowered by amount of oxygen carried by the RBCs causing insufficient oxygen supply.

Similarly the sickle shaped RBCs normally break as they pass through the tiny capillaries causing anaemia. This inturn may lead to heart and kidney failure.

The homozygous recessive individuals normally die early in life due tosevereanaemia caused by premature detruction of the sickle shaped RRCs. However the heterozygotes suvive but show mild anaemia. They have both normal and abnormal haemoglobin and hence some o the RBCs are sickle shaped.

Heterozygous are highly resistant to malaria since the malaria parasite (plasmodium species) survive in normal RBCs and therefore affect the normal homozygous individuals who usually suffer from severe malaria.

Both the homozygous recessive and homozygous dominant are not favoured but the heterozygotes are favoured since they don't suffer from malaria and only got mild anaemia. This gives them a selective advantage. This condition is called heterozygous superiority and it explains why the gene for sickle cell can't disappear from the population from generation to generation.

In several malaria affected areas of Africa 40% of the population are carrier of the sickle cell gene.

Illustration of sickle cell inheritance

Let Hbs rep normal allele for sickle cell

Hbs rep allele for sickle cell diseases.

Parents	Phenotype	carrier but Normal	x	carrier but Normal
	Genotype(2n)	HbSHbs		HbSHbs

Meiosis

Gametes(n) HbS Hbs HbS

Random fertilization

Offspring genotype(2n) HbS HbS HbSHbs HbSHbs

Offspring phenotype: Nc HbSHbs er

(Suffer from malaria) suffer from wild anaemia from severe anaemia

Pedigree analysis

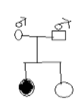
It is possible to make genetical experiments in man the way are made in peas, flies or other organisms because; humans have a long generation time, humans produce a much smaller no. of off springs such that the gene of interest may not express itself.

Here a pedigree analysis is done where information about the family is collected and assembled like a family tree.

Pedigree analysis is a system of analysis by following the movement and distribution of a certain gene in the family. In this analysis, females are symbolized by circles O and by shaded symbols represent the trait or characteristic being student ie for diffected females and for affected open symbols represent normal conditions ie O normal female, normal male. Parents are joined by the horizontal line ……off springs are connected to the horizontal line below the parent ie

Uses of pedigree analysis

Pedigree analysis helps in many ways ie



It helps to fill up the possible genotypes by knowing the phenotypes only

It helps to study he pattern of inheritance of the dominant or recessive x-tic.

It helps genetic counseling to advise couples about the possibilities of having a genetically defective child.

It helps to identify whether a particular genetic disease is due to a recessive gene or a dominant gene.

In certain cases it may help to identify the genotypes of off springs not yet born.

It helps to identify the possible origin of the effective gene in the family

- **16. ECOLOGY.**
- **Introduction to ecology**
- *Ecology is the study of the structure of the nature*. Structure includes the distribution and abundance of organisms as influenced biotic and abiotic elements of the environment. Functions include all the aspects of the growth and interaction of population e.g competition, predation, parasitism in addition to the transfer of nutrients and energy among others. In brief; *ecology is the study of the relationship between organisms and their surroundings.*

- **Scope of ecology.**
- The study of ecology is wide ranging but those of the higher levels of organization. Ecology is broadly divided into two;
- Autocology: Study of relationship between individual species (population).
- Synecology: Study of interrelationship between different species (community).
- At the lowest level, ecologist study has individual organisms are adapted to their environment and they are affected or affect their environment. Most organisms however don't live in isolation. Their part of population through which they interact of the environment. A population is defined as all the organisms with in an area belonging to the same species. At population level, ecologist are concerned with;
- Presence
- Abundance of species.
- Distribution of species.
- Population distribution also lives in isolation. They live by interacting with other population to form communities.
- A community is defined as all different species (populations) occupying the same environment. At the community level, ecologists are interested in knowing low interaction such as predation and competition, parasitism affect the organization of the environment. Beyond the community level is the ecosystem which consists of the communities in the environment interacting with the abiotic environment. At ecosystem level, ecologists are interested in the function and this is in terms of energy flow and chemical cycling. The biosphere consists of that part of the earth soil water and air where living organisms are found.
- Importance of the study of ecology.
- Future quality of human life in all aspects and the sustainability of the earth depend upon our ability to recognize and apply ecological principles to its management.
- The environment and its factors.
- Environment is the immediate surrounding of an organism. Where the organism lives, every other element other than that organism forms its environment. The environment consists of many functions which are also known as ecological factors with which the organisms interact. Some of these factors originate from physical components of the environment and are known as physical environment and also abiotic factors. Others result from the interaction between the organism and other organism of its species and also other species and are known as biotic factors.
- Environmental factors.
-
-

Biotic Abiotic

-

Climatic factors.

-

Edaptic (soil) factors

Intra specific interaction. Intraspecific interaction. –

Topographical (height,

-Predation. Aspect, shape

-Reproductive behaviour. –Completion. Inclination of land

-Cooperation. –Association e.g mutualism. scape)
-Social behaviour. –Back
ground.
-Competition.
-Territorialism.

Climatic factors.

- Precipitation (rain fall)
- Humidity.
- Air current.
- Light.
- Temperation.
- Precipitation.
- This is a special important variable of climate which affects life of organism directly and indirectly depending on the season and environment. It directly off influence the distribution of vegetation, the morphology of organisms and all their physiological process is a habitat for many organisms which also has many roles as the most abundant chemical of life. Because of the different in precipitation, organisms are adapted differently to live in deserts, water logged areas.
- Humidity.
- This is the measure if moisture content of the atmosphere. It influences rates of water loss through evaporation and transpiration and indirectly influences temperature as it is also influenced by temperature.
- Abiotic factors of the environment.
- Light:
- Light influences the distribution of vegetation. It is also important for the following processes i.e germination, phototropism tuber formation, stem and root formation etc. In animals, it influences visibility which is important for the location of food, mates and avoidance of predations. It also influences ability of animals such that some are active during day light and others are active at night (Nocturnal).
- Crepuscular – Animals are active in the morning.
- Twilight active – Active in the evening.
- Light affects the aspect of life in 3 ways: – Light intensity.
- \- Wave length.
- \- Duration.
- Temperature.
- Respiration.
- Photosynthesis.
- Fruiting in plants.
- In animals, temperature influence more the distribution of ectothermic animals than endothermic animals. Behaviors such as lubrication, migration.
- Hibernation – Dormancy due to called weather.
- Aestivation – dormancy due to hot weather.
- Generally low temperature affect the enzymatic act and therefore slow growth and longer growing seasons.
- Low temperature also affects the rate of decay.

- Low temperature is likely to set up the behaviour of dormancy especially hibernation.
- Extreme low temperature can affect water supply because of the freezing of water body.
- High temperature increases the rate of evaporation which also affect water supply.
- High temperature increases the rate of decay.
- High temperature increases deciduousness in plants.
- Plants and animals have adaptations to light and temperature.
- Air current / wind.
- Dispersal of seeds, spores and fruits affecting the rates of transpiration in different plant areas. Distribution of moisture and hence distribution of rain fall. Creation of water currents in water bodies that is important in rainfall formation.
- Soil factors. (Edaptic factors).
- Soil organism;
- With in the soil, a number of organisms live.
- Soil organism………
- Micro organism – Decomposition of organic matter.
- - Affect seed germination by breaking hard seed cots.
- - Nitrogen fixation.
- Macro organisms – Create tunnels to improve percolation of water.
- - Improve aeration.
- - Destroy seeds of plants in soil.
- - Contribute to humus content in the soil.
- - They are part of food chain where they are part of food.
- Soil moisture – Water content of the soil.
- - Its important in seed germination.
- - Supply of water and dissolved minerals in plants.
- When in excess (water logging), this affects aeration of the soil thus resulting to reduced decay and absorption.
- Soil texture.
- Soil texture is the size of soil particles in the soil. Soil structure is the arrangement of soil layer.
- Soil texture affects the water retention of the soil, how much air can be kept in the soil, drainage of the soil (leaching). Temperature of the soil also affected by the texture.
- **Leaching.** Nutrients moving from upper soil layers to lower soil layer where plant roots cannot reach. Structure in the arrangement of soil particles.
- Structure of the soil affects; - Drainage.
- - Percolation.
- - Erosion.
- - Aeration of the soil.
- Soil temperature affects the following processes,
- Decay.
- Nitrogen fixation.
- Physical factors like soil formation.
- Respiration of plant roots and soil organisms.
- Weathering of rocks.
- Water content of the soil.

- Seed germination.
- Growth of roots and tubers.
- Temperatures of the soil are also affected by other factors of the soil.
- Water content.
- Vegetation cover.
- Colour of the soils.
- Texture.
- Structure.
- Soil PH:
- This affects: - Decomposition.
- Nitrogen fixation.
- Solubility of different minerals and their distribution. Because of these, soil PH directly affects the distribution of vegetation.
- **Soil air.** This depends on the pore spaces of the soil especially their number and size. Soil air affects
- the following processes:
- Decomposition.
- Nitrogen fixation.
- Root growth.
- Root hair formation.
- Water absorption.
- Respiration of plant roots and soil micro organism.
- The amount of air in the soil itself depends on;
- Water content.
- Humus content.
- Texture of the soil.
- Topography.
- This is the height of land above sea level, this affects temperature, atmospheric pressure, relative humidity and partial pressure.
- Abiotic factors in water bodies.
- Chemical changes in oxygen content which in turn affect nutrient content.
- Have work in affecting light penetration.
- Affect river / stream current.
- Biotic factors:
- Examples; Feeding relationships / associations – mutualism.
- Pollination - commensalisms.
- Predation - competition.
- Parasitism - cooperation.
- The concept of ecosystem.
- An ecosystem is a situation where there is interaction between organisms and their abiotic environment in a self sustaining way. Ecosystem is functional system of ecology. It consists of all the population in the area together with the physical environment in which they interact………of an ecosystem (physical / abiotic) include: the soil, water, light, inorganic nutrients and weather variables. The living components (biotic) are categorized into 3 categories i.e producers, consumers and

decomposers. The consumers are heterotrophic that depend on organic food, producers are autotrophs (chemo and photosynthetic). An ecosystem is an energy processing system that is sustained by continuous supply of energy from the sun and recycling of matter within it. The smallest ecosystem is one which can allow the interaction between biotic

- And abiotic components sustainably and can be as small as a single drop of cold water as the largest ecosystem is known as biosphere. A biosphere is *defined as that part of the earth and its atmosphere which is inhibited by living things.* The boundaries of the system are however determines what kind of life can be sustained by the environmental conditions in particular region. The plants and animals in a system represent the structural components through which the system functions. The driving force of the ecosystem being the energy of the sun which causes materials to circulate within. In most ecosystems, the components have evolved together over long period and their interactions are the ones that are responsible for their continued existence.
- Broad classification.
- Natural Artificial (man made)
- Crop field.

Terrestrial Aquatic Settlement.

Rivers.
Lakes.
Oceans
Swamps

Energy comes from the sun in form of solar radiations and only a small fraction of this energy =1% is usuable after being fixed plants in photosynthesis process. Plants are producers and pass on energy through the series of organisms that depend on each other for food and are categorized into primary consumers, secondary and tertiary consumers. However at each of these transfers, energy is lost through the following processes;

- Heat due to respiration.
- In excretory materials like feaces.
- On death of organisms.
- For this reason, the total energy being transferred decreases from one organism to another and infact the total energy lost is =90% leaving 10% to be transferred and then the most efficient ecosystem don't exceed 20%, this explains why the level of transfer of energy donot normally exceed five. Each level of energy transfer is referred to as trophic level.
- Primary producers.
- These are autotrophic organisms that contain photo and chemo synthetic organisms i.e the algae, plants as the chemosynthetic are mainly bacteria. These are important of in nature because;
- They offer oxygen.
- Carbondioxide elimination reducing the green house effect.
- Primary consumers.
- These are organisms that feed directly from primary consumers and generally referred to as herbivores, in terrestrial ecosystem most of the consumers are insects, birds and mammals as in the aquatic ecosystem, there is fish and small organisms known as zoo plantation, small crustaceans, molluse, filter feeders and many larvae. Some are parasitic which include amphids, dodders.
- Secondary consumers.

- These are organisms that feed on primary consumers and are generally known as carnivores, among these are predators which harm, capture and kill their live prey. Scavengers which feed on dead corpse i.e hyena, vultures and marabastocks also have parasites.
- Decomposers.
- These are organisms which break down organic matter to simpler components like carbondioxide, water and inorganic nutrients. They release energy that is locked up in the organic matter and they also release nutrients that can be recycled. They carry out the process of decomposition which means breaking up matter into simpler components. These include bacteria and fungi (all are saprophytic).generally bacteria are the major decomposers of animal matter while fungi are the major decomposers of plants. Both secrete enzymes that break down the complex organic matter into simpler………… Often they work in succession such that once one group has exploited, the material to its ability, another remaining material more resistant to the decomposition moves in finely produced to organic nutrients. Animal matter takes a shorter time to decompose than plant matter because animal matter is made of proteins and many organisms can secrete the necessary enzymes while plants contain cellulose which are organisms which many organisms cannot digest. Decomposition is aided by detrivores which are organisms which feed on fragments of decomposing matter known as detritus. Detrivores include maggots, termites, dung beetles, earthworms, millipedes, blowfly, nematodes etc.
- Factors affecting the rate of decomposition.
- Nature of organic material i.e hard / soft has cellulose or not.
- Presence or absence of detrivores.
- Temperature of the environment, decomposition is high at warm temperatures.
- Level of moisture.
- Food chain, food web and ecological pyramids.
- Food chain is a nutritional relationship that is linear showing transfer of energy from the producers to the final consumers.
- Producers $\longrightarrow$ primary consumers $\longrightarrow$ secondary $\longrightarrow$ tertiary.
- The arrows indicate the direction of flow of energy and points to the organism eating.
- There are two types of food chains namely:
- Grazing food chain.
- Detritus food chain.
- **Grazing food chain:** This is one that begins with the plant to other consumers through the linear series.
- **Detritus food chain:** This is the one that begins with the feeders in form of organic matter to other detrivores organism. The number of links on a food chain does not normally exceed five because of the following reasons:
- Not all the food available in a trophic level is transferred to the next.
- Energy is lost as heat, un edible parts.
- Food web:
- In an ecosystem, feeding relation ship is complex because each animal may feed on more than one organism in the same food chain or in different food chains and because of this, there is a lot of inter linkage between the several food chains, every organism is involved in. the best presentation of the feeding relationship between different organism in an ecosystem is there fore in form of a food web. This is shows all the organisms alternative food sources.
- Diagram;
-

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•
•
• Ecological pyramids.

• These are a diagrammatic way of indicating the flow of energy between organisms of a food chain in terms of numbers, biomas and energy. They are a type of bar graphs that are arranged one above the others occurring to the trophic levels with the first trophic level being the base.

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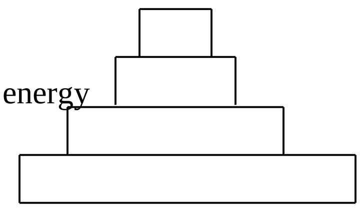
• Pyramid of energy



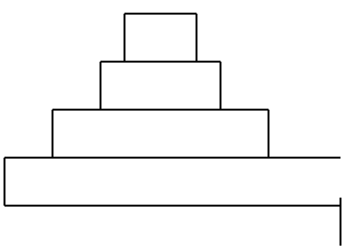
Units of productivity KJ /m^2/ yr

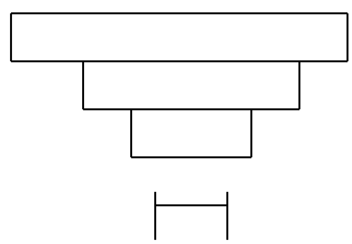
The biggest energy loss is between producers and consumers. Generally, energy level goes on decreasing from the 1st to the last trophic level. Each bar re[resents the total amount of energy at each trophic level.

Pyramid of biomass.

Biomass represent the total living weight but usually in determining the biomass of organism at each level, dry mass is used where a few individuals are sampled and their mass determined after……….

Upright pyramid. Inverted pyramid.

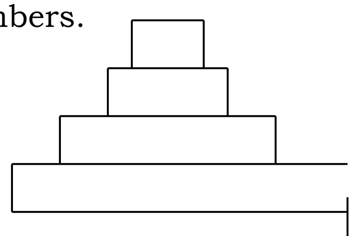




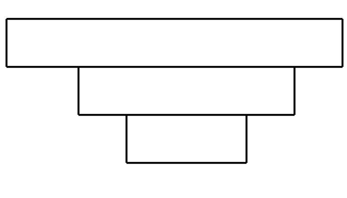
E.g single cabbage plant can support many aphids which in turn support very many lady birds beetles which support many birds.

Pyramid of numbers.

Upright pyramid of numbers.



Inverted pyramid of numbers.



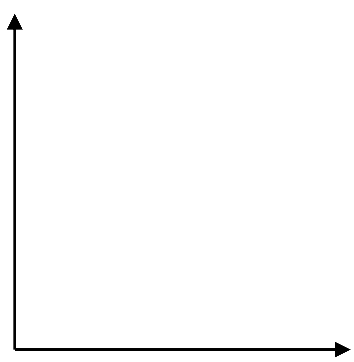
BIOGEOCHEMICAL CYCLES.

To learn ecosystem, in addition to energy from the sun, several materials are recycled between the living organism, the earth and its atmosphere which are important in maintaining the balance of nature. This includes;

- Nitrogen – Nitrogen cycle.
- Carbondioxide – Carbondioxide cycle.
- Water – hydrological cycle.
- Other Minerals e.g phosphorus – phosphorus cycle, Sulphur – sulphur cycle.
- Nitrogen cycle.
- This is the circulation of nitrogen in nature. Plants need nitrogen to manufacture proteins yet they can not utilize atmospheric nitrogen directly, so they depend on several processes to obtain.
- This include;
- **Decomposition (decay of organic matter).** This is done by saprophytic bacteria (nitrifying bacteria). This breaks down nitrogen compounds to ammonia compounds together with carbondioxide. The resulting carbondioxide combine with ammonium compounds to form ammonium salts like ammonium carbonate.
- **Nitrification.** When there is plenty of air, ammonium salts are converted to nitrites with the help of nitrosomo bacteria. Some plants are able to use nitrogen in the nitrite form. The nitrites are further converted to nitrates with the help of bacteria called Nitrobacter. Nitrate is the major source of nitrogen in plants.
- **Nitrogen fixation.** Some bacteria are able to directly combine atmospheric nitrogen with oxygen to form nitrates with in the soil. Some of these are free living bacteria like Azotobacter, others are living in mutualistic association in root nodules of plants e.g Rhizobium bacteria. The majority form the association with legumes like beans, soyabeans, but root nodules are formed in leguminous plants. Azotobacter and Rhizobium are known as nitrogen fixing bacteria. Nitrogen fixation can also occur directly in the atmosphere by the combination of nitrogen and oxygen with the help of lightening energy forming nitrates which fall in rain. Areas where thunderstorms are common, nitrates are common. Finally, one type of bacteria returns nitrogen to the atmosphere through breaking up nitrates and converting them to nitrogen gas are called Denitrifying bacteria e.g Thiobacillus.
- Human interface with nitrogen cycle.
- Manufacture of fertilizers in large scale.
- Pollution of environment affecting decomposition of organic matter and bacteria.
- Diagram;

-
-
- THE CARBON CYCLE:
- The carbon cycle is a situation of carbon in nature. Carbon is normally circulated in form carbondioxide gas in terrestrial systems and carbonate ions in aquatic systems and under the earth in several places they are reserves of carbon in form of fossil fuels that have been preserved as decay of dead plants and animals e.g oil, coal, carbondioxide is removed from the atmosphere mainly by photosynthesis and returned by the process of respiration. These two processes have balanced the carbon cycle in nature because the amount of carbondioxide used in photosynthesis per molecule of glucose formed is the same as the amount of carbondioxide formed when the same glucose is respired as shown in the equation below.
- Photosynthetic equations.
- $6CO_2 + 6H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6O_2$
- Respiratory equation.
- $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$ + energy.
- At the same time, seas, oceans and atmospheres are large reserves of carbondioxide. Recently, human activities have tended to produce and add more carbondioxide to the atmosphere then is removed. Such activities include:
- Burning of wood fuel.
- Increased rate of deforestation resulting to less carbon being locked up in forests.
- ECOLOGY OF POPULATIONS.
- Population *is the group of organisms of the same species living in the same environment.* It is not just a group of individuals but a group of potentially interbreeding organism of the same species occupying a particular space at the same time. The population is both a genetic and evolutionary unit. It's a genetic unit because it has one gene pool. Its an evolutionary unit because evolution results from changes in the gene frequencies of population.
- The definition of the boundary of population is not usually easy because most populations extend beyond the boundaries of ecosystem. So when ecologist uses the term population, they conveniently limit it to the boundaries of specific ecosystem. Determining the number of individuals in a population is also a difficult process where numbers are large or where its difficult to determine a single individual e.g in plants produced vegetatively.
- Properties of population:
- Because populations are aggregations, they have properties that are different from individuals comprising of environment. They include:
- Density.
- Mortality rate (death rate).
- Fatality rate (birth rate).
- Dispersion.
- Age distribution.
- Growth form.
- Biotic potential.
- Density

- This is the number of organisms occupying a definite unit of space. The density of population can be distinguished into 2 types namely;
- Crude density.
- Ecological density.
- Crude density is the measure of the number of individuals per unit area.
- Ecological density however takes into consideration the actual space occupied by organisms in the habitat by the organism being in mind those they doesn't occupy all the space. The density of organism in an area is not constant but varies with environment condition which affects resources.
- Size of organisms.
- Trophic levels.
- Level of resources.
- However, it also depends on;
- Dispersal of mechanism.
- Resource availability.
- Level of physiological stress.
- **Carrying capacity** of environment is the maximum number of individuals of a given species the environment in support using the available resources. Since the availability resource varies in nature, it follows that the carrying capacity is also variable and is always influenced by the most limiting resource at a time. Resources are biotic and abiotic components of environment that support living organism e.g light, water, food, space and mates. Limiting are those environmental aspects at specifically determine the growth rate and size of a population and an organism lives. The closer the population nears the carrying capacity from the environment, the more likely resources becomes scarce and at this point, biotic factors that are density depended e.g competition and predation becomes more severe at this point, the population is said to be facing an environment resistance whose effect is to lower the birth rates and raise the death rates until the 2 balance and the population will remain stable.



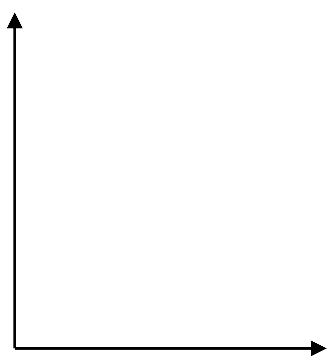
MOTALITY RATE

This is the number of individuals which die from the population in a specified period of time. In human population the mortality rate is normally expressed as number of deaths per 1000 individuals per year and expressed as percentage e.g

If the population size and those alive at the end of the time period is 400, the average size of population is determined as $\frac{1000 + 400}{2} = 700$

$$\text{Death rate} = \frac{1000 - 600}{700}$$

Ecologist sometimes determines mortality differences using the following methods.
Probability of dying = number of death during the given period
Number alive at the beginning.
Probability of surviving = number of survivors in a given period.
Number of people alive at the beginning of the period.
Life expectancy = average number of years to be lived in future by members of a given age in a
population.
Survivorship.
This is the probability of new born individuals of the same generation surviving through a particular ages. This is a number of individuals in a population alive at the beginning of each age. Survivorship is normally shown by a survivorship curve which shows the number of survivors with time.
number of
survivors.



Curve I: This is where most individuals live up to the end of their life span and die at their old age. This type of survivorship is rare and can only occur where environment is fully favourable through out but it's also observed in large mammals, humans in developed countries and annual plants.
Curve II: this occurs when organism die at a constant rate through out their life time meaning that death is not related to birth. This is typical with birds, rodents and perennial plants.
Curve III: This is when most organisms die at an earlier age in life but the few survivors live up to maximum age. This is typical of invertebrates, most perennial plants and humans in developing countries.
BIRTH RATE:
This is the number of individuals which are born with in a population in a specified period of time. In human population, it is also expressed as the number of new burns per 1000 of total population. Birth rate is very important because it influences population increase. Fertility rate is the average number of children born at each woman of child bearing age. Fecundity is the number of off springs per individual.
Population growth rate:
A population growth pattern refers to the ………….

Types of growth curves.
The logistic growth curve/S/sigmoid growth curve.
Logarithmic growth / Exponential/J – shaped growth curve.
Boom and burst cycle.
The predator prey birth growth.
Four factors interact to bring about population change.

- The birth rate (BR).
- The death rate (DR).
- Immigrant rate (I).
- Emigration rate (E).

Population are in equilibrium if BR + I = DR + E.
Population increases when BR + I > DR + E.
Population decreases when DR +E > BR + I.

ECOLOGY
Ecology refers to the study of the interactions between organisms and there environment.
Environment; Refers to the immediate surroundings of an organism. It may be aquatic, marine or terrestrial environment.
There are two main branches of ecology;
(a) Auticology.
(b) Synecology.
Auticology; Is the ecology study of a single species or population in relation to other species and the environment.
Synecology; Is the study of different species, communities and their environment.
Common terms used in ecology
Habit: Is a place where an organism lives. It is characterised by its physical features or by the dominant plant species.
Population: A group of organisms belonging to the same species that occupy a give area and is capable of interbreeding.
Community; A group of organisms of different species living in a given area.
Ecosystem; A unit of the environment consisting of both living things (biotic) and non living things (abiotic) whose interaction result into a stable self perpetually system. It can also mean, a unit of environment composed of living and nonliving things interacting together in their environment so that a flow of energy leads to clearly defined tropic structures, material cycle and biotic diversity.
Biome; Is the terrestrial part (land) of the biosphere characterised by sesunique conditions as it supports a particular flora and fauna. Within the biomes are numerous habitats which are specific localities, each with a particular set of conditions and an appropriately adapted community of organism.
Ecological niche; Refers to the role played by an organism in its community e.g. its behaviour, feeding relationship, e.t.c. It therefore means the physical position of the species in the habitat, its behaviour and interaction with the biotic factors.

THE ENVIRONMENT AND ITS FACTORS.

Environment is the immediate surrounding of an organism.
Several factors that affect the lives of organisms include;
(i) Physical factors (abiotic)
(ii) Living factors (biotic)
(iii) Adalic factors (soil)

Abiotic factors include;
1. WATER.
Economic importance of water;
It is a habit for plants and animals.
It is a raw material for photosynthesis.
Due to it's thermal capacity and high heat capacity, large water bodies absorb most of the sun's radiation, thereby maintaining water temperature low.
It is an agent of dispersal of fruits and seeds.
It is a medium for reproduction in aquatic animals.
It is a medium for the recycling of materials in nature.
It is a raw material for germination.

2. LIGHT.
In ecology, light is considered in three aspects namely;
(i) Its intensity.
(ii) Its quality.
(iii) Its duration. (Day length)
Light influences the process of photosynthesis on which life depends directly or indirectly.
It improves visibility in the ecosystem.
It influences stem or root elongation.
It influences flowering.
It influences stematal movements.
It influences phototropism.

In animals the direction of light is the most recommenced aspect of life because it affects production in some species in terms of availability of food.
TEMPERATURE.
This influences physical processes like growth, transpiration, fruits, etc.
Environment temperature also affects the distribution of ectothermic organisms e.g. reptiles, amphibians, fish, etc.
Temperature also influences the behaviour of some animals leading to hibernation during extreme cold o aestivation during too high temperatures like summer/winter.
Some may be nocturnals to avoid day temperatures.

HUMIDITY.
Affects the rate at which water evaporates which from the surface of the organisms which influences its ability to with stand drought.

5. AIR /WIND.
It's an agent of seed dispersal. Agent of pollination. Affects stomatal movements (open & close). It also varies transpiration rate.
Disperses atmospheric pollutants. Agent of soil erosion.

ADAFIC FACTORS
There affect the soil and hence plant and animal life
They include:
Soil micro organisms (bacteria and fungi)
They affect recycling of water by influencing decomposition of organic matter
They assist in seed germination by breaking seed dormancy
They also provide nitrogen cycling.

Soil water / moisture
Affects the supply of water and dissolves salts in plants
Provides conducive environment in seed formation

Soil texture
Affects attraction, water content and soil productivity

soil structure
May affect the drainage, erosion e.t.c.

soil temperature
Assists in seed germination.
Provides suitable environment in soil micro organisms.
May influence root growth and underground crops like root tubers.
May affect the rate of water absorption which decreases with decreasing temperature.

soil PH
Can affect the activity of nitrating bacteria.
Affect the solubility of some salts like calcium, magnesium e.t.c. which may influence air distribution in the soil.
It influences vegetation distribution.

FIRE
Is an important ecological factor because it has both negative and positive effects.
Fire is used to clear the old unpalatable plant in tropical area to give way to new
Aspects of fire as ecological factors
Source of fire
Wild fires
Fires enclose source is not unknown
1. Prescribe fire

Set up and regulated in ecological purposes like removing unpalatable vegetation, destroying pests e.t.c.
2. Season of burns
3. Fire intensity
Refers to the heat content and usually depends on the type of fuel present and environmental factors e.g. the grassland normally burns much faster on woodland and the fire dies out faster.
4. Fire severity
An attribute of fires intensity measured in terms of the destruction of the vegetation
Fire spread and duration
How much has been covered by the fire i.e. called fire spread and the duration of burning is fire duration and at duration and proportional to fire severity.
Fire frequency: Refers to the number of times in a year an area is burnt.
Note:Areas that receive law intensity or less fire the bush increases in the grassland while constant annual burning eliminates the parental grasses
Burning during a demand dry season at suitable frequency can be covered to remake top vegetation which prevents……………………………………………………………
Adaptations of plants to fires
By possetion of thick barks in trees with high H2O content e.g. acacia species.
Growth of grasses, tussocks to protect the inner bards e.g. cymbopoge imperata.
Development of a high sprating ability e.g. spear grass inryteams, cores and bulbs
Effects of fire on vegetation
Advantages (positive effects)
Destroys pests and parasites or chase them away
Encourages regeneration of some grasses like cymbopogens imperata which are fresh.
Breaks seed dormancy is some species like accasia.
Helps in recycling of some materials e.g. nitrates and phosphates in ash and carbondioxide are …………….
It improves visibility in the bush land with animals which is important in predation and mating.
Encourages the development of a sub climax community.

Disadvantages (negative effects)
Causes pollution as it increases soil erosion as it moves reorganise
Destroys humus which affects structure
May lead to extraction of some species
Pasture destroys show moving organisms and soil micro organisms.
……………… Growth of fire resultant species which are unpalatable and make poor
Destroy habitats which contains
Can lead to the change in the characteristics e.g. encroachment of shrubs into grass land.
Fire is a necessary ecological "evil" discuss with specific examples; describe how some plant species are adapted to fire

…………………………
,……………………………
………………………………

Biotic factors
A living component of an ecosystemAn organism biotic entire is made up of all other organisms which it comes into regular contact or which it interacts with.Biotic factors include;Feeding relationships include predation, parasite, commissialian, mituatisms a grazing.

Predation
Is where an organisms feeds and is fed on by another organism
The one feeding is the predator and the fed on is the prey
………………………………………………………………………………………………………
………………………………………

Interspecific association occurs between members of different species which interspecific association occurs between members of the same species.If he prey population increase, it will support more predators and when the predator population increases, it results in the reduction of the number of the prey population.Normally the number of predators tends to lag behind at the prey because the predator behind large was a low rate of population increase though it lives longer.

A graph for the predator – prey relationship

A population of the prey increases at 1st exponentially because of the law number of the predators.
In increase in the number of predators is due to the increase in the number of prey which is used as food in the predatorsThis results in a decrease in the prey population as more predators feed on them with a decrease in the number of prey which predators experience a greater competition against them selves due to lack of food which is struggle for existence increases as some die due to starvation and their population reduces (survival for the fittest)Reduction in the predator population results in fewer prey being eaten and so their number increases again and so provides plenty of food for the remain few predators which later increase the cycle repeats
Note: in the absence of predators, the prey population will gain attain sigmoid curve

Significant of the predator prey relationship.
The fluctuation of the population plays an important role in the evolution.
In that the periodic population clusters creates a selection pleasure where by only the individuals that escape predation would be selected to reproduce while those which can't are selected against. (Survival for the fittest)This is the theory behind natural selection

Adaptations of predators to predation.
High speed of locomotion thus e.g. have strong limbs to take on the 1st moving preys (fast)
Possession of long pointed canaries for piercing and tearing the flesh of the prey.
They also have carnassials for scraping off flees from the bones.
Strong claws for holding the prey.
Strong sense of small for chasing the prey to their hiding places.
Intelligence in their ability to follow the foot marks and the droppings of the prey.
Ability to ambush the prey.

Adaptations of preys against predators
Prey population usually wore in herds threaten the predators
Some prey produces a bad smell which scares off the predators.
Mimicry, an organism resembles a poisonous organ or on palatable species which the predator ignores on its 1st sight.
Preys also have a strong sense of smell to detect the presence of predators.
Preys also have fast speed to enable them run faster on presence of predators.
Camouflage, is when an organism stays near a back ground that resembles it so that it's not easily noticed by the predators.

CAMOUFLAGE
Importance of predation
It's a major mechanism by which excess animal productivity and redistributed by conservation into other animal tissues.
It helps to maintain the population within the carrying capacity of the environment.
It helps in maintaining the health of the ………………. of the prey population by isolation and elimination of the sick preys.
Its one of the most vital means of natural selection where the less fit individuals of the prey population are removed from the prey population so that their inferior genes are removed from the prey population

DIFFERENT BETWEEN AND PARASITE
A predator is bigger that its prey while a parasite is smaller than its host.
A predator feeds on the whole of the prey while the parasite feeds on part of the host.
The predator kills the prey fast while parasitism is a slow process.
A predator has to look for its prey while the parasite possesses the host through out its larva stage.
The predator does not get shelter from its prey while the parasites get shelter from the host.

PARASITISM
It's a feeding relationship between two organisms, the parasite and the host.

The parasite lives temporally or permanently in / at side the organism receiving metabolic benefits thus harming it.
The metabolic benefit does not involve nutritional benefits only but other aspects of life such as developmental stimulus, digestive enzymes and maturation.
Parasitism may be between one organism and another e.g. warm and tape worm, one plant and another e.g. striga and sorghum or a parasitic plant and animal e.g parasitic fungi and man, nematodes and plants, bacteria and plant and various plant e.g. cassava mozaicia

TYPES OF PARASITES
There many ways in which parasites are classified
position occupied on the host,
These include ecto parasites which leave on the external of the host
Endo parasites leave in the hosts body e.g. tape worms
Ectolendo parasites which are partly in the hosts body e.g. jiggers
Feeding harbits:
True parasites (obligate parasites); these depend entirely on the host for survival and can leave
freely outside the host e.g the hook worms (ancylostma duodenal). Partial parasites are plants
that can carry out photosynthesis but obtain nutrients from the host e.g. casscusa (dodder)
Parathoids; utilise more than one host e.g. insects like mosquitoes and tsetse flies.

TYPES OF HOSTS
Reservoir hosts; is where a parasite lives without any dangerous effects not because the host can't be affected but because the host attains immunity against a parasite after a long time of exposure.
Definitive host; the final host were a parasite gets sexual maturity e.g. the blood flukes in man.
Intermediate host; the host in which the immature stages of a parasite like cycle takes place e.g. the larva stages of schistose (bilharzias worms) and snails which is their intermediate host.

General effects of parasites on hosts
They utilize the depositive food causing H2O and nutritional stress.
Distraction of the hosts tissues during entry
They also utilise the hosts tissue e.g. blood
They way cause abnormal growth of parts of their host e.g. fascicle hepatica (liver flute). It attacks a sheep's liver and may cause inflammation of the liver.
Mechanical intemperance e.g. elephantiasis is as a result of blockage of the lymphatic vessels.
Atores cause discount and physical irritation of the host.
Indirect effect resulting in enunciation e.g. weakening of an individual making him susceptible to diseases.

Adaptations of parasites to their mode of life
Structural / morphological adaptations;
Variety of structural adaptations of parasites can be regarded as adaptations to parasitic mode of life.
The features endeavour the parasite to leave in a new environment. These include; organs of adhesion that enable the parasite to firmly attached on the host e.g. hooks of the tape worm
Devices for sucking blood and cutting host tissues e.g. haustrial structures developed by some parasitic plants for absorbing the hosts fluids and stylets for sucking as in mosquitoes.
Lose of sense organs, most endo parasites have lost sense organs e.g. loss of the eyes replaced by some organs which help in recognitions of the host and loss of gut to other organs.
Replacement of the soft epithelia / covering with the tough resistant skin to protect their cuticles against digestive enzymes of the host.
In some parasites their body colours change so as to camouphlage on or in the body of the host e.g. they like on man and ticks on cattle.

Physiological modifications
These are any changes in energy physiology of the environment changing environment; they include:
Ability to leave in places of high temperatures law oxygen intention (being aerobic), PH fluctuations and complete darkness as provided by the alimentary cannel in the gut parasites.
Ability to resist digestive enzymes e.g. askaris lowbrows are able to procue anti – enzymatic substances.
Pronounced chemo sensitivity in order to reach the right places in the hosts body e.g. the plasmodia.
Ability to modify red recycles and the electro transplersystem such that provision of energy is a very quick system
Adaptations to more chances of reproduction
Production of numerous eggs e.g. the astarias produces 20.000eggs per day
Ability to get suitable hosts exposed to it's final host e.g. schiztosoma in snails that are easily exposed to man's aquatic environment
Hawmphrodaite condition which makes it possible for self fertilization in many parasites e.g. tape worm
Prolonged association of the sexes were the female may carry the male e.g. the liver flukes (faolex hepatica).
High degree of resistance of the reproductive bodies e.g. cysts.
Employment of specialised reproductive life stages of the life cycle.

PLANT PARASITES
Potato Blight (phytopitora infestains)

Diagram

Potato Blight (phytopitora intestines
This is a parasitic plant belonging to photomycetes.
It causes potato blight and rot
It causes brown particles on potato leaves and tubers.
It has a well developed mycelium which grows into the tissues of the potatoes.
The fungus attacks the leaves, stems and tubers
From the mycelium, several hyphae of the phongus penetrate the cells of the host (potato).
They digest the cell content and absorb nutrients from the soil
Hyphae are also called aesto
The hyphae secret cellulose and pectinase enzymes for digestion of plant tissues
The growth of the hyphae is very rapid the fungus may infects a whole field of potato plant which a few days under favourable wind conditions e.g. wet and windy conditions

Adaptations of phytopthora infestains to it's mode of nutrition
Proliferous reproduction with both sexual and asexual phase
Possession of a persistent stage of xygosphore which survive adverse environment clouds
Development of specialised cholastrial which a attain epithelia layer for absorption for absorption of soluble product in digestion
Propagation of spores for propagation
Secretion of excessive cellular enzymes used in injection in the host cell.
They have a fast rate of growth hence can colonise their host rapidly
Specifity of the host i.e. the position where it attacks the leaves and stems.

Effects of potato blight to the host
It congests intercellular air spaces of the host depriving it of the necessary oxygen.
It digests cells of the host forcing death of the hosts tissues and produces brown spots that spread further
Heavy infestation causes blacked smelly tissues.
It causes drying smelly tissues
Reduces the synthetic ability of the plant
Control of potato blight
Spray the infected plants with a fungicide like Bordeaux mixture.
planting of disease resistant variety
Destroy the infected crop by burning all of it
Practice crop rotation.

Witch weed (striga asiatica)
Common in places with sorghum, millet, rice, simsim
Adaptations to its mode of life
They are mainly parasites of serials like rice, simsim e.t.c.
They produce large number of seeds.

Seeds can remain dormant for a long time.
Germination occurs in the vicinity of the host stimulated by exudes from the host.
Siblings quickly get attacked to the host plant
Establishes a vesicular connection with the host plant so as to absorb nutrients.
It has the ability to carry out photosynthesis

Effects of striga species
It causes H_2O stress
Stained growth
Causes plant to show symptoms of immunal deficiency.
A host plant may not reach maccurity.

Dodder (vascular)
Adaptations
It is a stem parasite
Its none specific grow it survives on a wide range of hosts.
It reproduces both sexually and asexually producing a large number of seeds by fragmentation.
It has the ability to grow faster after establishing leaves by quick flowering and fruiting.
Loss of unwanted organs like roots since it absorbs its food directly from the host plant.
Possession of sacking haustoria and production of enzymes which dissolves the hosts wall linking up with the phloem and the xylem

Animal parasites
Round worms (phylum nematode)
It's a large cyliudrial worm found in the intestines of the host.
It also affects pig and squirrels
It is an endo parasite

Nutrition
Adult askaris feed on blood and tissue juices like lymphatic
Adaptations to parasitic life
Ability to respire aeroblatly in conditions of law oxygen tensions in the alimentary canal.
Ability to copulate with in the intestines followed by laying of large quantities of eggs by the female.
Possession of a muscular pharynx the sacking the host digested food.
Possession of a resistant cuticle to prevent destruction by the host's digestive enzymes.
Ability to position its self in a habitat in the body where it gets maximum benefit of haurishment, warrantee and protection.
Have a large body surface area with absorption of the host's food.
They have a reduced alimentary canal.

Lack of unwanted organs like locomotary organs and several sense organs.
They lay eggs which are protected by a resistant shell
Production of large number of eggs 200.000 eggs per day.

Effects of round worm: (askaris lumbriccides)
It deprives the host of digested food nutrients leading to emaciation.
It sacks the host's blood leading to anaemia.
It may block the intestines
Damage and irritation of the lungs by the young worms moving through blood.

Control of Ascaris infection
Proper use of latrines and toilets
Boiling drinking water, cooking food properly and washing fruits properly before eating.
Education of people on programs related on hygiene.
Taking drugs e.g. perazine, wabendazol.

Cycle of teania solium
……………………………………………………………………………………………………
………………………………………………………………………

Life cycle of a tape worm
A tape worm lives in the gut of the hosts. solium are pork tape worms

TAENIA SOLIUM
Are pork tape worms
Behind the head of the tape worm are a number of proglottids.
As the proglottid mature, they wove further away from the scolex and develop reproductive organs.
The eggs are fertilised by the sperms from the same proglottid.
Each egg develops into a small six looked embryo. (Hevacanth) which is encased into a resistant ecosphere.
Ripe proglottids containing ecospheres become detached and pass out in the host's faeces.
If ecospheres are eaten by a suitable secondary host, (a pig) further development takes place.
The embryo is released from its case in the host's stomach and bores its way into blood vessels.
If eaten, pork without thorough cooking to kill them.
The worm attaches cell in the gut wall and develops into an adult tape worm.

Diagram

Ancylostoma duodenal (hook worm)
Adaptations

Reduced alimentary canal.
High rate of reproduction
Strong teeth for grasping the walls of the small intestines

Schiztosoma mansoni (Bilharzia fluke)
Most snails have developed resistance against the present medicine.
They live in blood associated with the intestines and the urinary systems where they reproduce sexually.
Large number of eggs are released into intestines of bladder by rapture of blood vessels i.e. the high rate reproduction.
Formation of the sprocyetsm which form numerous cercarea (larva worms). This means high rate of reproduction

THE CERCAREA (LARVA WORMS)
Have glands for piecing the skin
They are always found in pairs.
Have vertical suckers for sucking food.
They have miracidia which bore into the tissue of the snail which is the intermediate host.

The tick
Adaptations
Is mainly a parasite of mammals.
Possession of piecing month parts called the hypatomes.
The hypatomes have several roles of carved hook like teeth which enable the tick to penetrate the host's skin and cling firmly.
The legs also have claws for holding onto the host.
Extensive pharynx and abdomen to accommodate large quantities of blood.
They are very sensitive and can easily recognise the presence of which host can survive for several days without feeding.
Produce large number of eggs.
They have a hard cutical resistant to mechanical injury and dehydration.
Have a dull colour for camouphlage.
Ability to inhabit of types of the host were its able

Life cycle of a tick
Stages
Eggs are layed on the ground.
Eggs hatches into 8-legged larvae which climb and feed on blood of host.
Larvae filled with blood moult into six-legged nymph.
Nymph feeds on the host's blood and gets full.
It then moults into eight legged adult.
Adult male and female feed on host's blood and mate.
Engorged female drops to the ground to lay eggs.

0ne - host tick
- Stages 1 and 7 are on the ground but the rest are on the host

Two – host tick
- Two hosts are needed to complete the cycle

Stages
Stages 1, 3 and 7 are on the ground but the rest are on the host.

Diagram

Three – host tick
Three hosts are needed to complete the cycle
Stages 1, 3 and 7 are on the ground and the rest on a host.

Diagram

Effects of ticks
Causes physical discomfort and irritation.
Transmits diseases to the host like the east cost fever and red water.
It damages the host's skin by biting.
Causes loss of blood from the host.
They leave open wounds which become sites for secondary infection.

Symbiosis
It refers to the association between two or more organism that benefit atleast one.
If the association is obligatory the experiment:
The wood eating termites live in association with the trichonympha species.
The hyper flagellates live in the gut of the termites and digest cellulose e.g. obtain shelter from the termites.
Association between nitrogen fixing bacteria and legumes the bacteria fixes nitrogen into the soil for plants while the bacteria obtain shelter and nutrients for the plant.
Ruminants have protozoa in their intestines the secret celluloses and cello blazes which digest cellulose and utilise their products they provide the host animal with protection.

Mutualism
Is the not obligatory in that either organism in the association is capable of living an independent life by the association in mainly symbiotic i.e. both participants gate from the relationship e.g.:
The white egrets and grazing mammals the birds pick off ticks from the grazing animals releaving them of parasites. They also warm grazing mammals of approaching animals
Hydro and algae (200 chorea) the algae lives in the endoderm cells of the hydro from where they produce oxygen by photosynthesis nitrogenous wastes for the algae and also provides shelter.

Commercialism

Its a loose association between two organisms in which one benefits (commercial) benefit while the host e.g. the hermit crab inhabits the mollasean shell in association which the sea anemone provides protection to the crab.

Other examples include:

An orchid / lichen grazing on the tree, epiphytes growing on trees.

Phoresis

It's a loose form which commercialism where the commercial only depends on the other for shelter or transport.

Saprophyltism

Is where an organism gets its food derived from the break down of dead organic materials

The saprophy lives on dead organic materials.

It renders the materials soluble and then absorbed.

It reduces Extracellular enzymes which break down food materials.

The conversion process from organic to a more diffusible form is known as purification.

Comparison between a saprophyte and a parasite

Similarities

Both are hyperopic

Both absorb soluble food.

Both have simple digestive systems.

Both exhibit sexual and a sexual reproduction.

Both produce large number of offsprings.

Differences

PARASITES	SAPROPHYTES
Derive energy from living organism	Derive energy from dead and decayed organism
Has many stages in its life cycle	Has single adult stage
Very specific on their host. Are nutritionally highly adapted.	Use a verity of food rescues simple methods of nutrition.
Most plants and animals groups have reproductive mainly aerobic	Most are bacteria and fungi mostly arerobic

Importance of saprophytes to man

Recycling of nutrients e.g. carbon, nitrogen, decomposes are mainly saprophytes.

Fungi are used in brewing and backing.

Are a source of food e.g. mushrooms.

Pencilline from penicillium notation

Used in sewage treatment.

Fungi can be used as biological control agents for many insect pests.

Importance of soil organisms
These include the flora, i.e. the algae, fungi and bacteria and the fauna which include the protozoa, nematodes, mites, insets like auts and bitts and barrowing invertebrates.

Decay and nutrient cycles
Soil organs destroy wastes like dead animals and plants remains hence to return nutrients for plants in the soil.
Soil organs improve soil erosion by digging tunnels in the soil.
Production of carbondioxide needed for photosynthesis by plants in soil mixing.
Improvement of great soil structure by breaking down soil lumps into smaller particles to increase H_2O infiltration.
Nitrogen fixation by the nitrogen fixing bacteria.
Production of toxin subs to plants.
In the absence of O_2 these organisms respire aerobically producing baldheads an organic acid which are toxin to plants.
Injury on higher plants by some organs e.g. the ticks and rat way feed on the roots.
Competition which nutrients with higher plants.
Since the soil organs are living, they obtain nutrients for growth from the surrounding environment.
Alternation of soil PH e.g. the carbondioxide; by-product of respiration lower the Ph of the soil.

Factors that influence distribution of soil organs
Rainfall, moisture and humid cand favour decomposition thus animals distribution in the soil if high.
Soil temperature, moderate temperature which wide physiological ranges favour multiplication of enzymes.
Soil erosion, oxygen concentration is needed for growth and carbondioxide concentration increase soil acidity.
Increased soil acidity may not favour increase in the population of some organs.
Soil PH, ranging towards nutrielarity is the best for life.
Presence of toxic subs in the soil may not favour the increase in population of the organs.
In polluted habitats, soil population may be high or law depending on the type of pollutant.
Availability of nutrients/food, the continued existence of micro organs depend on food and energy. The sources of food include: plant root remains, dead animals and secretion from roots.

THE BIOLOGEOCHEMICAL CYCLES.
THE CARBON CYCLE

Carbon is the most important element in the protoplasm.
Major constituents of carbohydrates proteins, lipids and nucleic acids of all the cells of organs
In the non-living environment, its present in the form:
As carbondioxide in air and in the dissolved form in H_2O (oceans)
As carbonates in the rocks in the earth's crust.
As carbon in fossils fuels like coal, petroleum.

Fixation of carbon
The carbon present in coal and petroleum and in the form of carbonates in the rocks is not available until its burnt or chemically changed.
The carbon present as carbondioxide is the basic source which enters the organs to photosynthesis by plants and various soil organs through the food chain.

The release of carbon bark to the environment
Release as carbon dioxide during respiration of organisms.
By decomposition of dead bodies and body wastes.
By burning of wood and fossil fuels.
By disillusion of carbonate rocks.
By volcanic activity of rocks.
Effects of access carbon dioxide in the atmosphere
An excessive use of fossil fuels can change with cell regulated cycle of carbon.
Its believed that the content of CO_2 has improved tremendously from 240 – 320 parts / million.
This traps the infrared radiations (long wave) which normally are radiated back to the space from the earth's surface.
This has resulted into the global temperature increase, aphenominate know as global warming and melting of the polar cups.

The carbon cycle
Diagram

OXYGEN CYCLE.
Oxygen is one of the most essential elements for existence
It occurs in the atmosphere as molecular oxygen (O_2) or in compounds like H_2O & CO_2

Utilisation of oxygen
Animals take O2 from air in the atmosphere or from H_2O (aquatic) for respiration.
Plants take O2 as an element through carbon dioxide and water during photosynthesis.
Oxygen is sued during combustion and oxidative weathering of rocks.

Release of oxygen
Oxygen is released as bi-product during photo

Its released as carbon dioxide during decay of dead organisms.

The balance of O_2 and CO_2
This is an interaction between plants and animals.
Plants release during photo and animals consume it during respiration thus maintaining a balance in nature.
Oxygen and carbon cycles are completely dependent on one another.
Increased burning of fossil fuels not only releases carbon dioxide which also release O2 tough it has been found that the carbon dioxide constant fairly remains constant.
Its believe that the increased CO2 has led to increased photo and hence increased O2 production that replaces the one burnt in fuels.
Its believed that the increased CO2 has led to increased photosynthesis and hence increased O2 production that replaces the one burnt by fossil fuels.

Diagram
THE NITROGEN CYCLE
Nitrogen is essential in life since it's a major constituent of proteins, nucleic acids and chlorophyll molecules of the all for the content given as………………………………….

NITROGEN FIXATION
The atmosphere is the largest receivers and contain 79% of nitrogen but it can not be taken up by the organism directly when its fixed some nitrogen living bacteria can combine nitrogen into nitrates (NO_2).
Biological fixation: it amounts to 140 – 700mg/m^2 per year.
Nitrogen fixation bacteria – Rhizobium, azobacter and clostridium
Blue green algae or Cynon bacteria. Anabina, aulosiha and tolypothrix
Electro chemical and photochemical fixation: By the action of lightening on oxygen and nitrogen 35mg/m^2 per year.
Industrial fixation: fixed by chemical fertilizers pactomer (during haber process)

Nitrogen used by plants and animals
Plants take the nitrates from the soil are from proteins; when animals eat plants. The proteins are converted into animal proteins.
The breakdown is excreted in the form of urea or urine acid or Ammonium compounds. In the soil, or in H_2O, decomposition of the waste products takes place and N_2 is converted back to free nitrogen involving a number of steps.

Decomposition by micro – organisms: like actmoneyctes and fungi by magnifying bacteria which converts waste and decayed head bodies to Ammonia or NH4 compounds.
Nitrifying bacteria like: converts NH4 salts to nitrites to nitrates by metronomes and nitrobacters nitrates may be used by plants.
Denitrifying bacteria – convert nitrates to molecular nitrogen like ……………..

Nitrogen cycle
Diagram

THE WATER CYCLE
Water is a magic content of lung cells. It is found on the living matter on earth. Water is cycled constinous through nature. Water may exist as gaseous include of solid state, which are matter cycles. There are two over tapping cycles of water which occur in nature.

Large H_2O Cycle: it doesn't involve life and in this, the H_2O evaporates from H_2O bodies, hydrosphere (oceans, Rivers and Lakes) and form clouds. The H_2O vapour in clouds subsequently cools and condenses to form snow. The H_2O may fall directly to oceans or may flow to oceans through rivers or underground H_2O

Smaller Cycle: It involves the living world. It consists of environmental H2O into the living organisms and back to the environment. It is a complicated cycle.
The aquatic animals take the H2O directly from the surrounding medium and return it back to the surrounding by excretion, death or decay.
The land animals may take the water directly from the fresh water sucrose or may take it as food from plants and aquatic animals.
From the plants, apart of it may go directly back by transpiration. The remainder and the one presenting the animals take a complicated cycle through the soil.

THE PHOSPHORUS CYCLE
The main reservoir of phosphorous is crystalline rocks and natural phosphate deposits.
In the living organisms, it occurs as an important constituent of DNA, bones, teeth and plasma membranes.

Phosphorus in the sediments: phosphorus gets released from roots and deposits by weathering or leaching some parts may be added to 3 soil by man in the form of natural fertiliser.

Phosphorus in living organisms
The soluble phosphate makes its way to plants through absorption by the roots. It is assimilated into the plants.
It goes back to the environment by excretion or by decomposition of the dead and decayed.

LOSS OF PHOSPHORUS
The phosphate present in the bones and teeth in resistant to decay and hence…………………………………………………….

THE SULPHUR CYCLE
The main reservoir of sulphur is the earth's crust.
Its absorbed as sulphates from the soil. Sulphur is a structural component of nearly all proteins.
Animals depend on plants for their sulphur requirement.
They get it through food.
The sulphur is released back to the soil by decomposition. The bacterial and fungi under aerobic conditions convert sulphur in proteins to sulphates. Under Anaerobic condition as in mortises, it may be converted to sulphates by bacteria. There harm sulphates are for oxidised to sulphates under, anaerobic conditions.
The sulphur is also being added to atmosphere as oxides like sulphur dioxide (SO_2). It is to a result of burning of fossil fuels, volcanic activities and smelting of sulphates in factories.

Diagram

Competition
This is a situation where organisms strive to get the necessary resource from the environment that is in a short supply. The competition may be for food, mates, shelter/space, and light in case of plants, water and nutrients.
There are two types of competition.
Intraspecific competition
Interspecific competition

Interspecific competition:
Occurs between members of different species while intraspecific competition occurs between members of the same species. The closer the ecological niches of the competing organises the mate fierce the competition. This factor is a very critical biotic factor because it's a constituent of environmental and natural section that if affects the organism growth rate, reproductive potential and consequently the size of the population.

Competition exclusion
Only are species (population) in a given community can occupy a given ecological niche at a given time or no two species in the same ecosystem can occupy the same ecological niche indefinitely i.e. co-existence is impossible between two species which compete with each other in every aspect e.g. likely at the specie of the organisms which compete more efficiently and the weak ones will die.This can be illustrated using two species of paramecium namely; Paramecium Auraha and paramecium candatum

Description of the graphs in separate culture
The population of p.aurelia grow a much faster of p.aurelia increases slowly. It increases exponentially between 2 and 3. Between 3 and 5, it decelerates and reaches a constant for caudation, between 0 and 1 ½, the population grows slowly

then between 1 ½ and 4 ½, it grows exponentially.Between 4 ½, it decelerates and reacts a constant.

Description of the graph in mixed culture
The population of p.aurh a grows slowly between 0 and 2 then it grows exponentially between 2 and 4.Between 4 and 5, the population decelerate to constant.The population of p.caudation slowly between 0 and 1 and then exponentially to a maximum between 1 and 3 ½, it then reduces to 0 at 7

Explanation for separate culture
The population of p.caudation and p.aurelia initially grows slowly because;-
Individuals have not yet adapted to the environment.
Individuals would be widely disappeared into the environment.
Few individuals have reacted epiredectics, stage

The population increases exponentially because
food rescues are adsuite
There is competition among organisms thus the rituality rate if higher than the mortality rate.
Many organisms have reacted reproduction age

The population reduces because;
Individuals are competing for the available resources and environmental resistance has set in
Production of toxic substances in the environmental limits population increases.

The population attains a constant because
The rotality rate is equal to the mortality rate and survival for the fittest has set in thus the population is regulated at the carrying capacity of the environment.

Explanation for mixed culture
Population of p.caudation increases faster than that of p.aurelia because;
It adapts much faster to the environment.
Its relatively much bigger than p.aurellia.
It reproduces at a faster rate.

The population of p.caudation decreases while that of p.aurellia increases because;
P.aurellia being smaller in size uses less food, but at a faster rate. This favours its reproductive potential and hence increased in the population.
P.aurelia has it higher efficiency of obtaining food than p.caudation

The population of p.aurelia reaches a maximum when p.caudation is almost becoming extinct because it's a poor competitor thus at maximum of mortality of p.caudation balance the natality for p.aurellia which salts the carrying capacity of the environment

Man as a biotic factor
Is the most important ecological biotic factor because;
He influences the distribution of other organisms more than any other single species.
He's very destructive of both habitant and life of other organisms and in the process; he threatens his own existence e.g. the distraction of the ozone layer.
Clarity vegetation for settlement/industrialisation
Pollution of the environment by addition of toxic materials
Man is predator, kills other organisms for his survival and so threatens their existence.

MIMICRY
Tendency of some organisms/animals to dosely resemble other species which are unpalatable to the predator.
The unpalatable species posses destruct martings (usually warming cokes). So the predator wants to recognise these colours and avoid attacking them and by doing so, the mimic survives e.g. the chameleon.

Antibiotics
Here plants and animals produce chemical substances in their surrounding which repel other organisms. This may be directed to members of their species (Intraspecific antibiosis) or to members of other species (Interspecific antibiosis). In Intraspecific antibiosis, pheromones (external pheromones/ the stint are produced by vertebrates to guar their temtory e.g male rabbits which often rub the others on the ground.
This releases the pheromones from the sub manddoularssahany glands to warm that the temtory. Interspecific antibiosis is shown by the saprophyte fungi e.g. peniciline produces antibiotics to prevent bacterial growth in their varsity.

Territorial behaviour
This is where a group and organisms in a habitat own an area and defend it against other members of the some species by being aggressive. By acting like this, the animal ensures that;
Food supply is enough.
The young ones are protected.
Uniform distribution of members in the habitat.
Reduces competition.
It ensures high chances of obtaining mates.
Limits diseases spread.

Relationships between ecological factors (concept of the ecological niche)
The eco-system is a natural system of living and non-living components whose interactions result into a stable perpecuating system. It's stable in a sense that it

can continue on its own withought a necessity of human or other external influences.
A community is made up of organisms which interact with one another and the non-living constituents of the environment thus it includes all the organisms in a given area interacting with the physical environment of the area so that the flow of energy leads to clearly defined tropic structure, material cycles and biotic diversity within the system irrespective of the size or duration.
An ecosystem is therefore a structure and function all unit of ecology.

Its divides into:
Inorganic components e.g. hydrogen carbon, oxygen, nitrogen e.t.c.
Organic components e.g. carbohydrates, proteins.
Physical factors e.g. wind, humidity e.t.c.
Producers e.g. autotrophy which are capable of synthesising their own food from simple inorganic compounds.
Consumers which include both macro – consumers (heterotrophy like animals) and micro consumers i.e. decomposers like bacteria and fungi.

All these mates of structural components of the ecosystem
Functionally, the ecosystem is divided into energy levels
Food chains and webs – diversity patterns on the space.
Nutrient cycles (e.g. nitrogen, carbon cycles, e.t.c.)
Development and evolution.
Control (cybernetics)

Principle and concept of energy flow in an ecosystem.
Energy from the sun enters the living system through photosynthesis in autotrophic (producers which are mainly green plants).
From here, it enters other organisms which are consumers and are mainly animals.
The transfer of energy from one organism to another inform of food following feeding relationships amongst organism forms the blood chains and food webs. At each feeding level (trophic level) there is considerable amount of energy lost in various ways like respiration, body metabolism, heat in excretory, death and decay such that the amount of fixed energy goes on decreasing at successive trophic levels.
For this reason, there is a limit to this level in a food chain e.g. don't exceed five.

Terms used
Food chain
This is a linear food relationship or sequence in which one organism eats another and also its transfer of food energy from the source in green plants following a number of organisms (consumers and decomposers) which repeated eating and being eaten.

Food chains fall into two;
The grazing food chain where food energy this is transferred directly from plants.

Grass $\longrightarrow$ herbivores $\longrightarrow$ camivores $\longrightarrow$ omnivores $\longrightarrow$ decomposers

The detritus food chain where energy is always obtained from decomposition of organic materials. Detritus means organic matter obtained from decomposition of dead organisms.

Note:

Food chains are very susceptible to environmental changes.

Food web:

This is a complex nutritional inter-relationship in which organisms have alternate food sources in cyctic and unidirectional manner due to discomplexity. This makes food webs resistant to environmental changes.

Aquatic food web

Diagram

Trophic level:

This is an energy level or feeding level which in a nutritional relationship.

Terms used in energy production and transfer in an eco-system.

Primary productivity

This refers to the amount of energy which producers (green plants) fix in form of organic matter or it refers to the synthesis of organic matter by green plants. It's expressed in terms of mass/area/time/kilograms per square/kilometre per year.

Gross primary production (GPP)

This is the total amount of energy fixed by producers during photosynthesis per unit area of the photosynthetic products are formed.

Net primary production (NPP)

This is the rate at which photosynthetic products accumulate or is the assimilation of the photosynthetic products.

Note:

NPP excludes the portion of app used by plants for their own assimilation thus it represents the amount of energy available to the heterophs

Trophic efficiency

This is the amount of energy that trophic levels can convert into organic tissues (usually 10% of what is received from the previous trophic level)

Standing crop

Is the amount of living materials in the different trophic levels. It can also mean the dry weight (energy content of organisms in an area at a particular time)

Standing states

Is the amount of inorganic / biotic materials like carbon, potassium that are present in an ecosystem.

Biomass
The mass of the organism per unit area of the ground (or H_2O)
Secondary productivity
Is the rate of the production of biomass by heterophs.
Ecological pyramids
Are histograms used to show various ecological factors diminishing with trophic levels. They include;
Pyramid of numbers
This shows the population of numbers of organisms at various trophic levels in a food chain.

Diagram

shows the normal pyramid of numbers with no dropping from producers to consumers B, C, D are usual pyramid of numbers
shows that large numbers of producers are eaten by a single primary consumer which is later ingested by parasites as the 2^0 consumers.
Shows producers as a single plant which is infected with parasites (1^0 consumers) and are also parasited on further by other parasites (2^0 and 3^0).
Shows the producers as a single plant which supports a number of herbivores which in turn supports a number of parasites like birds.
NB: The length of each bar is ɑ2 the number of each organism. However the abnormality associated with pyramids is that they fail to distinguish between the sizes of the organs e.g:
A mature bee in a forest ecosystem is counted the same as the diatonic e.g. green algae, phytoplankton thus pyramid of numbers are bulged in number as in the middle when the producers are larger in numbers as in the rest ecosystem.
They are inverted when the consumers are parasites (B, C, D)

Pyramid of Biomass
This shows the proportions biomass of organs at various trophic levels in a food chain or
It shows the dry mass of organs in trophic levels at a particular point.
The length of each bar ɑ2 the biomass at each trophic level.

Diagram

NB: The standing biomass or crop biomass is the biomass at which time of sampling.
Pyramid of Energy
This shows how much energy passes a long the food chain. It can also show the energy available at each trophic level.

Diagram

NB: Because only a ɷ0 energy in the level is transferred to the next, energy pyramids are never inverted nor do they have a control bulge.
Population and communities
Population is a group of interbreeding organisms of the same species living together in the same habitant.

Characteristics of a population
Population y(Density)
Is the number of individuals per unit of a living space.
Mortality rate (Death rate)
Refers to the number of individuals in which population who die at a given time and is exposed as a% of in human as number per 1000mk^2
Notality rate
Refers to the number of individuals burn in a population at a given time.
Its expressed as notaliy 18 number per 1000km2.
Age distribution land on structure
This refers to the proportional distribution of individuals of various ages about future trends or population growth e.g. a population which mostly youthful ages is likely to grow faster than one full of elders.
Population dispersion
This is the structural and partial distribution of individuals within a given arm.
Biotic potential.
This is the maximum rate at which members of specie can reproduce given unlimited resources and ideal environment conditions.
Growth (growth forms)
Refers to variation of population size with time. The normal population growth takes an S-shaped signed curve.
NB: characteristics of population as grouped may differ from the individuals under it.
Diagram

Population
Principles of population growth
Populations are changing (e.g. are dynamic entities)
The population grows when the notality exceeds the notality rate and when there is immigration of other individuals into it.
The population decreases when mortality rate exceeds the notality and when there is emigration of individuals from it.
The population remains stable when the notality and notality are stable.
Growing population normally follows a pattern or an exponential.
All this occur when no food shortage, predation and other forms of competition limiting.
The absences of predators and competition for food, space, e.t.c. is termed as having no environmental resistance.

Under circumstances of resistance, the struggle for existence is high, survival is low and the reproduction potential of species is also low.
Note: in case of no environmental resistance, the struggle for existence s low, survival is high and the species realise full reproductive potential.
However, population growth becomes limited within when environmental resistance sets in and the exponential growth flattens out as the environment becomes saturated with a particular species and is said to have reached its full carrying capacity and can't support any more as mortality rate balances the notality rate.

The carrying capacity is the maximum number of individuals on environment can support given the limited resources.

Forms of environmental resources
Shortage of water / food
Lack of light important for food production.
Predators
Lack of shelter/space
Diseases
Accumulation of toxic substance in the environment.
Physiological factors like over crouding which may hinder the individuals from breading e.g. birds offset terristorial behaviour.

GROWTH CURVE
There are two basic forms of growth curves namely:
The S – shaped (sygnoid curve and the J – shaped growth curve.

The sygnoid growth curve.
Diagram

Log phase
The S-shaped curve describe the situation in which an organism in a new environment. The population density of an organ increases slowly initially because;
The numbers are very small
There are few reproducing individuals
Organs are widely dispersed.
Organs are not adapted to the environment.

It increases rapidly in its exponential phase. This is because
There are many reproducing individuals
Organs are well adapted to the environment
There is excess supply of resources
There is little or no competition.
There is no predation.
Waste products have not accumulated.
No diseases and the birth rates become greater than the death rates.

Deceleration phase, where the population decreases saturated a carry capacity of the environment.
Population grows until the growth rate becomes constant after reaching the carrying capacity of a given environment.
This slow rate is due to the'
Increases in competition foe essential resources like food, nesting materials.
Accumulation of waste products which are toxic.
Diseases caused by high population e.g. cholera.
Competition foe mates.
Over crowding and high predation, e.t.c.
This type of population growth is said to be density dependant for a given set f resources, growth rate depends on the number present in a Population many more organs will have sygnoid curves.

The J-shaped curve. (Boom and Burst)
This describes the situation in which the initial establishment phase, population growth continues in an exponential form until stopped abruptly as environmental resistance becomes suddenly it shows water, file growth in culture.

Factors regulating growth rate are not tied to the population density
A GRAPH TO SHOW H_2O FLEAS GROWING IN A CULTURE ME MA

Growth is said to be density independent and since regulation of growth rate is not tied to the population density.
It may be associated with a particular stage in life cycle e.g. number of caterpillars.
It may be induced by human intervention such as use of pesticide in pest control.
It may be included by natural calamities like bush fires, flood, earth quake following the clash. Some populations show a fractuating recovery partner giving the boom and burst. It's a characteristic of most insect species and algae blooms.

Factors affecting population growth
Notality rate and mortality rate
Population may increase as a result of immigration from nearing population. Population size may decrease as a result of emigration or death (mortality)
Survivorship curves
A percentage of individuals that die before reaching the reproductive age is one of the factors affecting the population since when a number of new born individuals and number of survivors is plotted against time, a survivorship curve is obtained

Number of survivors x 100
Different species have different survivorship
Diagram

There are three types of survivorship curves

Curve a
This shows an almost ideal curve of a population in which senescence is a major factor affecting mortality. This curve can also be obtained from an annual crop plant such as wheat, when all the plants in a given field survive well early in life and senescence simultaneously.
Curve b
This is for a population with a high mortality rate early in life such as the one which may occur for mountain sleep or for humans in a country in which starvation and diseases are prevalent.
Curve c
This shows the kind of smooth curve that would have been obtained if chance is the major factor influencing mortality and the organs die out before senescence because evident.
Some animal population show survivorship curves which approximate closely to this model curve e.g. the hydra where there is no special risk attained to being young. Most non-vertebrates and plants show a curve similar to this but with high juvenile mortality super imposed such that the initial part of the curve descends even more steeply.

Disease.
These increase the death rate and hence lower the population size and also inhibit the rate of which organisms mate.
Migration.
Organs often move into and a way from a habitat. When organs move into ahabitat, the population increases the movement of an organ into an area is called immigration.
When organs move a way from an area the population decreases and this is called emigration.
Availability of food.
Increase in food supply favours an increase in population. Birth rates increase and the immigration when the food supply increases.
Availability of H_2O.
Predation
Temperature
Territorial behaviour
Over population
This is when space is the limiting factor in population growth.
The animals fail to capture, there is increased infertility and eating the young ones by parents. It has been shown at the number of eggs laid by drosophila decreases as the population density of flies increases.

COMMUNITIES
A community is a group of organs within a community interacting in various ways within a habitat and usually adopt to survive in a community.

Methods of determining population
Determination of population density of plants
The belt transects method.
This method is suitable for determination of parts and slow moving animals population density.

Requirements.
Quadrant, square strings and pegs
Procedures.
Using pegs, strings, construct two parallel lines across the study area chosen. The parallel lines should be in a part making a belt.
Chose the organisms whose population and distribution you would like to find.
Fix the quadrant frares between the lines at regular intervals e.g. skip 5m before placing the next quadrant.
Make 5-10 quadrants depending on the size of the study area.
Count the number of species that occur in each quadrant and record this table
Find the population of organisms in the whole study area.

Quadrant	A	B	C	D	E
No of organisms					

$$\text{Average} = \frac{A + B + C + D + E}{5}$$

Determination of population density of small organisms like earth worms
Requirements:
Quadrant, beakers, potassium permanganate solution
Procedures:
Spray KnMno4 around the study area to make sure all the earth worms come out of the soil.
Randomly throw the quadrant in the area of study.
Collect the earth worms which come to the surface in the beaker.
Repeat the collection for each quadrant.
make a table for the results and calculate the mean, density (eaten worm per square metre)

Determination of population density in arthropods
Use a quadrant.
A quadrant is a metal of wooden frare with no dimensions used to demarcate off the study are u
It can be squared, triangular, e.t.c.
Procedures
Throw the quadrant randomly in the area of study.
Count the number of species found in the quadrant and record.
Repeat this for other trials within the study area.
Calculate the average number of species in the quadrant.
Calculate the estimated population of organs.

Estimated population: $\dfrac{\text{Total area}}{\text{Area of quadrant}}$ x average per quadrant

Examples

A quadrant or area 1cm2 was thrown in areas 250cm2 in a view to determine the population of a certain species of snails. The number counted per throw was 8, 6, 20, 4, 2, 3, 8, 7 respectively. Calculate the estimated population size of snails in as area and hence population density.

Average quadrant = $\dfrac{8 + 6 + 20 + 4 + 2 + 3 + 7}{7}$

$= \dfrac{50}{7}$ snails

Estimated population = $\dfrac{\text{Total are}}{\text{Area of quadrant}}$ x average quadrant

$= 250 \times \dfrac{50}{7}$

= 1786 snails.

Population density $= \dfrac{\text{estimated population}}{\text{Total area}}$

$= \dfrac{1786}{250}$

= 7 snails per square metres

Advantages of quadrants

Its relatively ant tedious

It doesn't need to be completed since it depends on estimations.

It reduces chances of counting some organisms more than once or missing others completely.

It doesn't kill organisms.

Disadvantages of quadrants

The species may not be randomly distributed in nature Hence random plot may give inconsistent results.

The method is not applicable to large animals and pants.

The method may not apply to aquatic organisms

It is difficult to apply to fast moving animals.
Note:
A quadrant provides 3 aspects of species distribution.
Species density:
This is the number of a given species in a given area. It's obtained by counting a number of organisms in randomly small square quadrants. This method has the advantages of being accurate enabling different areas of the species to be compared and also provides an absolute measure of abandancy.
The disadvantage is being time consumely and requires individuals to be different e.g. a grass tossect counted as one plat or does each part as the tossect need to be counted.
Species frequency.
This is the measure of the probability of finding a given species in any one quadrant in a given area e.g. if a species occurs once in every 10quadrants, then its frequency is 10%. This measure is obtained by recording the presences or absence of that particular species in randomly thrown quadrants.

In this method the size of the quadrant must be stated and also when the frequency. The species is only recorded as percent if its foliage over laps into the quadrant from outside to rooted frequency. The species is only recorded as present if its actually in the quadrant.

Advantages
It's a quick and easy method
Its useful for large scale ecosystems e.g. wood lands

Disadvantages
Size of the quadrant plant size and spatial distribution in nature which may be random clamp or uniform all those affect species frequency.

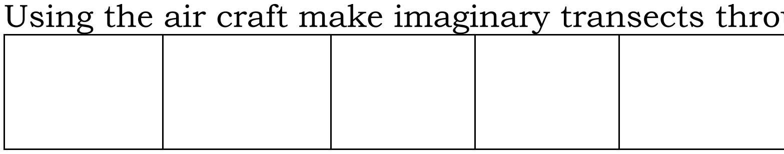
Species cover
This is the measure of the population of the ground occupied by the species. It gives an estimate of an area covered by the species as percentage of the total area. This method is useful for estimating species especially grasses where individuals have to be counted.

Estimation of population of micro organisms (bacteria, protozoa)
Requirements:
Sample, sampling bottle, centrifuge, haims, cytometer or concentrate microscope and water
Procedure:
A known value of H_2O is collected using a sampling bottle.
It's centrifuged to concentrate using iodine (or filtration) measure the value of the concentrated solution.

Remove a known value (sample) from the concentrate solution e.g. $1m^3$ and place on a haemocytometer.
This is a special microscope slide with 1mm3 grid used to count blood cells of organisms within 1mm3 counted.
The total number of organisms in the original value of H_2O is obtained by multiplying the number of organisms in 1mm3 of H_2O and the total sample.

Examples
1 litre of water was collected and concentrated to some 1mc was obtained from concentrated solution placed on a haemocytometer and the cells were counted under a microscope as 30cells. Calculate the number of planktons in the value of water collected.
1mc contains 30cells
50mc will contain (30 x 50) plankton
1500 planktons

Determination of population of large animals
Method 1 Direct counting
Requirements
Low flying air crafts, survey map of the area, atleast 2 – 4 people to count the animals
Using the air craft make imaginary transects through the study area.



A B C

The plane if flown on a transect section of the area of know dimensions and animals in each transect counted.
The sample procedure is repeated for other transect until the whole area is counted.
The average value of the animals calculated, if the total area of study is $4km^2$ and that of each transect is $9km^2$.
The average number of organisms / animals in each transect in "n" where,

$$N = \frac{A + B + C}{3}$$

Then the population of animals N = (A/a x n) organisms per km^2

Procedures:
The air craft should be flown at the same altitude in order to maintain the same cross section of the transect.
The altitude of the aircraft should be such that the animals on the ground are easily reorganised and hence counted.
Mandates of the study area must be recognised.

Advantages
It gives a rough estimation of the population of animals in an area.
Reduces the risk of attack by aggressive animals.
Reduces the risk of counting the same organisms more than once.
Can be done concurrently with other studies of population and of other aspects of feeding habits, breeding habits e.t.c.

Disadvantages
Requires sufficient and expensive technology.
The air craft may secure a way some animals into concealment hence not be accounted.
It can be used or applied like forest.
It's affected by climate i.e. works on only clear and non cloudy or moist days.
NB:
Direct counting can also be done on vehicle along prescribe paths.

Method 2: Estimation of population by aerial photography.
It's good for large animals which graze in herds

Requirements
Aircraft and camera, counter, survey map
Take photographs of herds all over the study area of known size and then count the animals from the photographs.
The population density is given as animals per unit area.

Method 3: Drive and count method
This can be done in two ways

Procedure A:
Fence an area and leave only a gate
2 – 4 people stand near the gate.
Drive the animals towards the open gate.
Each of the people counts the animals inform of tally as they pass the gate.
Get the average of the two or four counts.
Then estimate the population density of the animals in the enclosed area.

Procedure B:
Organise people in a rectangular form.
Let the people on one side move and drive animals towards the opposite side where e.g. are counted.
Make a total count and calculate the population density.

Advantages
It reduces counting of same animals more than once.
Its quick and easy method of determining the population density of animals

Disadvantages
Disturbs animals and makes them aggregate.
May not be used for aggressive animals.
Difficult to apply on fast moving animals.
Can't be used on animals that aren't living in herds.

4. Strip census

These animals are counted along the paths which are walking in a vehicle.
Estimate the population of the area in number per unit area of strips.

Advantages
Comparatively cheaper than aerial photography.
Gives quick estimate of the population.

Disadvantages:
Some animals avoid such paths and may not be able to be counted.
Moving vehicle or humans may scare animals.
Very many counts have to be done in order to get a reliable average population density.
Some animals are two motile and are likely to be counted twice

5. The capture release and recapture method (Lincoln index method)

This is suitable for small fast moving animals and those in concealed habitats e.g. fish, grass hoppers, rodents e.t.c.

Apparatus:
Suitable trap, marking points.

Procedures:
Set up a trap randomly to the environment.
Count all captured animals.
Mark all the animals which a permanent easily recognised marks.
Release the marked animals thoroughly into the environment.
Set up traps a gain at random in the area.
After sometimes for the marked animals thoroughly mix with the rest of the animals that bear all the second capture.
Count all the animals that bear the mark from those captured.

$$\text{The total} = \frac{\text{Total number of } 1^{st} \text{ captured x Total number of } 2^{nd} \text{ capture}}{\text{Numbers of organisms recapture.}}$$

$$\text{The total} = \frac{\text{Number of } 1^{st} \text{ capture x Number of } 2^{nd} \text{ capture}}{\text{Number of organisms recaptured}}$$

Assumptions:
The marked animals are not affected and that the marks are permanent.
The marked animals become completely mixed with others.
The population is sampled randomly with respect to its status.

The sampling is done at discrete time interval and the time involved in taking samples is small compared to the total study time.
The population is closed or notality, mortality and the rate of immigration and emigration can be calculated.
Being captured once or twice dose not affect the chances of animals being captured.
Every marked animal has the same probability of serving the sampling periods.

Examples:
In the determination of the population of wild rabbits in an area. 247 rabbits were captured in the 1st sample, marked and released. After 2 weeks 259 of animals were captured out of 16 were marked. Calculate the estimated population of the area.

$$\text{Population} = \frac{247 \times 259}{16}$$
$$= 3998 \text{ rabbits}$$

To determine the population of grass hoppers in the football pitch 100grass hoppers were captured, marked and released. After a given time, 80 were captured out of which 40 had been marked. Calculate the estimated population.

$$\text{Population} = \frac{100 \times 80}{40}$$
$$= 200 \text{ grass hoppers}$$

Determination of population of fish in the river
Requirements:
Wire mesh
Procedure:
Demarcate part of the river with a wire mesh

Diagram

The wire mesh prevents migration into or out of the part of the river.
Catch the fish into this part enclosed using a net.
Mark off the catch and release all into the river.
After a short interval, repeat the fishing, count the number caught and among them, note the number with the mark estimate the population using Lincoln index as above.

Precautions:
The markings used shouldn't scare off the animals.
The marking should be seen easily and should not disappear.
Intervals between the sampling should not be too wide.
Thos may decrease or increase due to emigration, predation and immigrations.
The time taken during marking should not be low, long to suffocate the organism.

Population Dispersion:

This refers to the spatial distribution of individuals in an area i.e. it refers to the way individuals in a population are distributed on a horizontal space within an area they are living in.

Factors affecting population dispersion:

Adaphic factors

Climatic (a biotic factor)

Intrinsic behaviour.

Human activities like agriculture, industrialisation.

Competition.

Types of population Dispersion

Random / even dispersion:

This occurs where the environment is uniform and therefore there is no tendency of aggregation.

It is usually a common feature to all population

Uniform / regular dispersion:

This occurs where competition is so severe and hence there is a positive antagonistic that new individuals are less forced to shift about. This feature is rare in a natural population and activities influencing the distribution.

Clamped / irregular / aggregate dispersion:

This is the most common type of population dispersion where organisms tend to be concentrated in certain parts of the area as a result of the following;

Resources being clamped or source in a distribution e.g. self dispersal of seeds, development of tillers by pants, e.t.c.

Dependency of some species so that they co-exist.

It also occurs when organism show aggregate e.g. in herds species interrelationships e.g. a specie might be depending on another specie such that the presence of the farmer ensures presence of the later.

Uniformly clamped

Randomly clamped

Importance of population dispersion

It increases gene exchange in populations through mating hence variation.

It may result into competition thus reduce in population.

Percentage cover

This is an area of the ground covered by a particular species

Calculation of percentage cover
Procedures:
Mark out the area of study and demarcate it into small square units about 1cm2.
Get the total area of study.
Find out how many of these squares are inhabited by the species under study.
Sum them up and hence note their area.

$$\%\text{age cover} = \frac{\text{Area covered by species} \times 100}{\text{Total area investigated}}$$

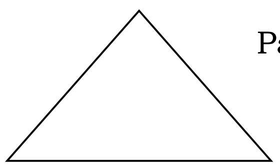
Importance
It isolates the most common / dominant species and the target species in an area.

Causes of imbalance in nature:
(Factors that affect distribution of an organism in an ecosystem)
Climate:
Draught makes the soil bare and cause emigration of animals.
This is because without rainfall, no food can be synthesised.
It also the presence of rainfall determines the moisture and temperature in an area. Therefore irregular changes in rainfall partner may produce a permanent effect on the floral and fauna. A change in climate may lead to death on other species and this leads to an imbalance in nature.
Over grazing:
This makes the sol bare. It involves herding of cattle in a area more than what the pasture can support. Overgrazing removes the grass cover resulting;
Increase in abandancy of certain unpalatable species like the sporobulusspecies.
Increase in sheet, Gully and Rill erosion which may result into desertification.
Erosion of pasture by shrubs followed by succession form a forest as the climatic vegetation.
Reduction in abandancy of palatable grasses dominant in lightly grazed areas which may result into low productivity.
Floods:
Where a large volume of H_2O covers a large place thus taking all the lives present and since life there is an adopted to terrestrial condition.
Volcanic eruptions:
When a volcanic eruption occurs, all life forms in the surrounding area are destroyed.
Invasion:
Introduction of new species in an area may change a balanced ecosystem because when the species become more competitive, it becomes the dominant species e.g. introduction of certain plans which become serious weeds e.g. lantana camara, introduction of later milotilus in Ugandan lakes have threatened other fish species, like tilapia and others which are extinct.
Diseases:
This kills organisms which may be less resistant leading to an imbalance in nature.
Man's activities:

These include agriculture, road construction, industrialisation e.t.c. of might climate certain species due to habitat loss or being killed.
Natural fires:
These destroy large places of forests and change the soils physical conditions.

Causes of the world human population explosion
The major cause is the decline in the mortality rate due to;
Improved medical services.
Improved agriculture and living standards.
Other factors such as wars, epidemics like cholera have been reduced to great extent.
The most convenient way to visualise population growth is to arrange the data inform of a polygon or age pyramid.
The number of individuals or percentage of each age gross being shown by the relative width of succession horizontal bars.

There are 3 types of pyramids:
The broad – based pyramid:
This indicates a high percentage of individuals. (Pre – reproductive age).



Past reproductive age
Reproductive age
Pre – reproductive age.

2. The bell – shaped pyramid:
This show a moderate population of young and old individuals.
3. Pentagonal figure:
This shows a low percentage of young individuals. This is a characteristic of senile (declining) population.

A broad base pyramid depicts:
A rapidly growing population because of greater proportion of young individuals in animals other than man, a ratio of juveniles to adults indicates a highly breeding season. It also shows the likely hoof of a large population the coming year provided the juvenile mortality is not exceeded.

Age Distribution of population:
This refers to the internal diversity of a population due to a mixture of individuals of different ages.
The ratio of various age groups in a population may give an indication of what is expected in the future.
A static population contains a balanced distribution of age classes while a declining population contains a balanced distribution of old individuals. A rapidly growing distribution contains a large distribution of young individuals.

In a population, there are 3 biological ages;
The pre productive age (young)
The reproductive age (mature)
The post reproductive age (old individuals)

Factors causing high fertility in humans
In many tropical countries, it's a custom to many at an early age and this increases the number of children e.g. in India.
The male in African society gains pride when he is able to keep more than one wife.
A good number of people in tropics have rejected family planning methods as a method of reducing fertility.
Some churches like Catholic Church oppose family planning.
Most Africans enjoy the idea of having a large family since most children and die at an early age.

Problems of high population
Declining soil fertility due to short farrows periods and over stocking of animals due to over grazing.
Use of excessively steep slopes.
Land disputes.
Decline in crop yields.
Land fragmentation.
Diversification may result due to over grazing and burning of land cover.
Unemployment and under employment.
Swamp reclamation.
Emigration.
Provision of social facilities becomes a problem leading to air and H2O pollution.

Factors that may affect population Distribution:
Social factors
Intertribal wars which may lead to migration.
Modem economic activities e.g. industries which lead to migration and development of urban centres.
Cultural factors e.g. pastrolism where a family may have a large piece of land and control a large population.
Physical factors:
These are attracting large populations which include;
Favourable temperature.
Rainfall.
Fertile soils
Those limiting large populations include;
Aridity.
Fertile soils.
Biological factors. E.g.
Presence of tsetse flies and other factors.

Areas occupied by game parks are less populated because there are wild animals also in forested and swampy areas.

Sex ratio in humans:
Sex ratio is the number of males per 100 females of the population of males to females in the population.
At birth, sex ratio of males to female is 105:100.
It's observed that mortality occurs more in males yearly of life thus reducing the population of males to females.

The possible explanations are:
It could be genetically caused where large population of the male gametes succumb to x – linked genes.
It could be because in the later stage, men go for very dangerous activities like hunting, war face e.t.c

Development of an ecosystem:
Ecosystems are not static but dynamic entities.
As an ecosystem lives, its structure and functions tends to wards the equilibrium and so stability.
The gradual change of the community and the a biotic environment to ultimately attain a stable ecosystem is called ecological succession
The sequence of communities that appear during succession is referred to as a serie / sense of successive ecological system established in one area.
Each community is referred to as the pioneer and the final stage called the climax.
The process involves establishment of a sequence of different communities in a particular area over a period of time as one community replaces another.

There are three types of series:
Hydro sere – kind of serie resulting from colonisation of any fresh water area e.g. a pond.
Halo sere – kind that develop on salting water e.g. ocean and seas.
Xero sere – develops on dry conditions e.g. letho sere – develops on rocks.
Psamoser – develops on heaps of dry sand
E.g. lichen → mosses → herbs → shrubs forests

Pioneer 2nd serial stage climax

The initial organisms (pioneers) are dominated by small numbers of population like lichens (algae and fungi) which are usually autotrophs.
The original special interacts in a biotic environment around them and causes the change. These change are created as a result of changes in the community find them selves unable to live any longer

Types of ecological succession

Primary succession:
This occurs in primary as a result of colonisation of an inhibited area where there was no source of life or an area which has never been occupied before e.g. colonisation of a base rock.
The conditions supporting life are very harsh.
Examples include; an exposed bare rock, larva flow of volcanic activities and uplifted pieces of land form from water.
NB:
For primary succession to occur, it takes a very long-time.
There are normally six stages of different succession vegetation until a relatively stable vegetation is reached realised.
These are:
Crustose: lichen stage (algae):
This is the 1st stage involving colonisation of a rock or heap of sand by crustose lichens. Other plants are unable to grow because of extreare conditions of weaker e.g. lack of nutrients, great exposure to sunshine which may not favour growth of some plants.
Crustose lichens have the ability to absorb rain H2O and retain it
They harbour parasitic fungi which weather the rock and modify it for other parasitic organisms to occupy it.

Foliage lichen stage:
These plants follow the crustose lichen type. They get attached to the substratum at a single point or along a single margin.
They are larger than the crustose type.
They may grow and over shadow the crustose type which die and decay thus producing the fertility.
Decay process acids which cause further weathering or later, Crustose forms to give way to various foliage forms and new types of invaders come by dispersal mechanism.
Mosses stage:
Sufficient soils being in xerophytic species, the mosses by wind. These have rhizoids which help them to out compete foliage forms for nutrients and water.

Herbaceous stage
It involves invasion of the area by herbs which are simple and don't require much and may be stunted later, as soil activity increases, other herbs may come into displace mosses completely.
When the soil is prepared for pioneer, mosses and herbs, woody plants, the shrub finds conditions suitable for growth. Shrubs may be invaded by seed germination or by rhizomes, strawberry foe example, the over growth of shrubs displaces the herbs and conditions can be suitable for growth of trees.

CLIMAX

The 1st trees are xerophytic in nature i.e. they are adopted to dry conditions. The pioneer species are widely spaced and are stunted. There is an increase in tree species number and hence microclimate modifications. The reduced in sheds makes the light demanding shrub fail.
Invasion of tolerant species to produce distinct layers of forest i.e. herbaceous plants, shrubs and canopy layers with time the atmosphere becomes more humid and the soil richer. There is increased displacement of less tolerant species by more tolerant ones of trees which lastly form the climax vegetation of forests.
The periods taken to reach the climax may be over 50 years.

Primary succession on a bare rock:
During weathering, rocks may breakdown physically or chemically or by both processes. The cracks formed in rocks expand due to water expanding and freezing in them during nights. This results in crumbling of rocks.
The carbon dioxide dissolved in the rocks resulting into further rock disintegration area lichens (algae and fungi).
The 1st species to occupy the rock surface are lichens (algae and fungi). The fungal hyphae penetrate the tiny rocks and cracks in the rocks and absorb H_2O and organic nutrients from the rock.
The algae on the other hand use solar energy to make food by photosynthesis which is provided to the fungus the action of lichens breaks down the rock fungi. The remains of the dead decompose to provide nutrients to support growth of small plant community like the mosses which are also drought resistant.
This result into a thicker layer of soil being formed thus mosses fore go a dense may trapping more rock particles and H2O.
Also their death and decomposition adds nutrient in the mat and eventually flowering or seeded plants may begin colonising soon herbs wood plants (shrubs) begin to grow in the newly formed soil while the mosses and lichens becomes sledded/covered by decaying leaves of other regration and begin to disappear from the community.
Later, big trees emerge and after along time, a forest community (dominant species) grows and the community is said to be at its climax. The dominant species is normally very prominent and has a biomass.
NB:
At its serial stage, a similar animal community is also established. These raise from ground dwellers or arthropods in mosses, lichens to flying insects in the ferns. In primary succession, the colonising species (pioneers) create an environment where e.g. them selves become unflavoured and there after become extinct.

Observation during primary succession:
There is a progressing development of soil with increasing depths organic content and differentiation into layers towards the mature soils of the final community.
There is high massiveness and differentiation into strata of plant community which increases the succession.

Productivity increases with increasing soil development of the community structure from pioneer to climax.
Species diversity increases form simple community of early succession to complex communities of the climax.
There is a relative stability of the community which increase succession up to climax.

1. Primary succession in Aquatic Environment.
This type of succession is called hydro sere e.g. a lake. A new lake may be formed by rivers which bring in sediments that settle at the bottom of the lake. This results in accumulation of nutrients in the lakes and becomes shallow at the bottom hence making it more fertile.

Diagram

Sediments deposit at the lake bottom to make it shallow and also nutrients accumulate in the lake. A floating mat of sphagnum mass forms a crust on the sunrise trapping more sediments and also increasing the thickness.As it grows, also more plant communities become attached at edges.Seed grasses, small trees even papyrus begin colonising the sphagnum mass and the lakes falls with compressed plant material (pills) with the centre of the lake forming an aquatic bug.

Diagram

The floating mass of sphagnum forms a crust on the surface trapping more sediments. Plant communities attach at edges later. Sedges, grasses and trees colonise the mat centre of the lake forming aquatic bug.
Later and shrubs and finally a forest community.
NB: The whole process relatively lakes along time.

Diagram

The climax community:
This is the final community developed in a particular habitat after the succession under stable environmental conditions and the ecosystem is said to be balanced.
The climax community persist for a long time because it doesn't create conditions which are unfavourable to itself or which favour invasion of better adopted forms of going unless disturbed by man's activities.
The climax vegetation is thus one that makes the most efficient use of all resources in the community.
Examples of forest community, grassland community e.t.c

Secondary succession:
This normally begins on an abandoned field where the biotic factors are already conducive for biotic existence. The early plants colonisers are called the open

pioneers community which may have been vegetative remains or seeds of original plant.They are normally 1st growing species e.g. Widens galisoga e.t.c.Development hence is more rapid than in primary succession since conditions are already conducive thus its those plants that have plenty of their reproductive structure that will spring up.Different types will spring up at ago, the less competing ones will be out competed and the resistant one will continue such succession normally just replicates what was there.The a ultimate end of succession is when there is no further change hence at climax. The kind of climax community established under natural conditions is mainly determined by climatic and adaptic factors, in this regard, the climax may be referred to as;

Adaptic climax; where sal is a limiting factor.

Climatic climax' where climate is the limity factor

In case, where due to human interference, a climax is not attained but a a particular kind of community is maintained such a community is referred to as a disclimax and it may also be referred to as biotic climax.

Examples of secondary succession

An abandoned piece of land.

On the abandoned piece of land, a species of a plant community grows up replacing one another i.e. weeds, parental grass, shrub trees e.t.c. till the forest ends the development.

Succession of an abandoned piece of land

Time / Months	Floral	Tauna.
1 – 4	- Short grass appears	- Soil bacteria, grass hoppers and black ants
5 – 8	- Tall grass and few herbs	-Grass hoppers and black ants increase in number.
9 – 12	- Few grass, small thickets tall thickets and small shrubs	- Birds (seed and fruit eaters) pollinating insects (beetle thicks) and shakos
13 – 15	- Tall shrubs, woody shrubs, thick thickets and climbers with tendrils	- Has above and roads and paths
15 – 20	Big shrubs and small trees	Squirrels, big snakes, more wild cats, field mice, few monkeys and geckoes.
21 – 124	Has above and few forest	Has above and many monkeys

Note:

A pelagic climax is a community where human intervention has led to the long term establishment of a community. Very different from the original climax.

Succession here is said to deflected.
It pleasures such as grazing and burning which caused the succession to be defected or removed the inevitably renewed succession is said to occur.

Productivity biomass and diversity during succession.
Diagram

A
Net productivity increases to a steady and stable level in the herbal stage 2 – 6 years then increases as woody plants enter the community 14 – 50 days and finally a stable level that may persist in the climax.
B
Biomass is low throughout the herbal stage and then increases steeply which accumulation of woody shrubs and trees.
C
Species diversity (number of species) increases into the herb stage reduces into the shrub stage i.e. 14 – 20 years and increases again into a young forest i.e. around 50years and from this it decreases into the climax.
D
The number of exotic species: These are present only in the herbal stage and shrub stage.

Changes that occur during ecological succession:
Succession is initiated by alternation of physical environmental organisms such that those initially there make the environment better off for a new lot that replaces the previous one. Apart from the physical environment, the following occurs.

Species diversity:
This increases from simple communities of early succession to relatively mature ones. This enables maximum and orderly interactions leading to reduced competition.
Productivity:
The rate of productivity (formation of organism's matter per unit area) in the community increases with development of the soil ad community structures as there is increasing use of environmental resources of a community.
Clear out foot chains merge into food webs which becomes more and more complex with time thus resulting in energy due to the various resources.
A pool of inorganic stock of nutrients held in the vegetation and soil increases and increasing fraction of this stick is held in the tissue of the plants. This is because various nutrients cycles become established and more stable in time.
Standing biomass increases with time.
The relative stability of the communities consequently increase time early stages are in some rises of evident in stability with population rapidly replacing one another. The final community is usually stable and dominated by long lived plants

that maintain their population within the community composition no longer changing directionally.
The height, massiveness and differentiation into strata of a plant community increases as succession progresses.
Populations rise and fall and replace one another along the time gradient in a manner which is much like in the stable communities along environmental gradients.
This is usually progressive development of the soil with increasing depth organic content and differentiation of layers or horizons towards the mature soils of the final community.

Factors affecting the rate of ecological succession:
A biotic factors e.g. Temperature, rainfall e.t.c.
In dry conditions, grasses tend to be the dominant species while in wet conditions; forets tend to be dominant species. Any type of vegetation that occurs in a given area is greatly affected and determined by these biotic factors.
Biotic factors
Plants:
Plants them selves influence each other
The initial plants in a sere of development are referred to as pioneers.
The lichens appear fast on the dry rock because they are adopted to harsh conditions and don't need a lot of soil.
The lichens modify the site, the roots crack the rock and when they die and decompose, they buffer the rock for tinny grasses and in that process you find that where there was no life, there is vegetation through survival for the fittest.
The weak ones die and the adopted ones survive. There is competition between species and through the death, there comes in what will improve the soil hence acceleration the rate at which succession occurs.
Animals:
These are a predominant factor affecting the rate at which ecological succession occurs e.g. the grazers kill the vegetation if they over graze.
They therefore hold the succession in the grass land serial stage at their survival.
Micro organisms:
This break down organic matter of dead organisms making the soil more fertile hence increasing the rat of ecological succession.
Time factor:
As time goes on, different serial stages come in.
Change in plant numbers goes in different serial stages.

Change in plant numbers goes in different serial stages
Diagram

Changes in biomass in different serial stages as time go on.
Diagram

Productivity biomass:
Succession involves an increase in productivity until a climax community is reached in which maximum efficiency in energy conversion occurs. The amount of energy flowing through an ecosystem is a major limiting factor in determining the numbers and biomass of the organisms it can support.
In later stages of succession up to a young forest, there is an increase in productivity, but this gross productivity declines as one reaches the climax. The order of productivity in older forests is lower than in young forests.

Decrease in productivity may be due to;
Older forests become less productive than the young ones because the accumulation of nutrients in the standing crop biomass may lead to accumulation in the nutrient cycle.
The reduction in vigour as the average age of the individual in the community increases to constant and this causes a reduction in productivity.
Succession leads to a maximum accumulation of biomass e.g. in forest community plants become larger during succession and this is accumulated as biomass in the climax communities is normally greater than other succession stages.
The upper limit in biomass is reached when the total respiratory losses form the ecosystem equals to the gross productivity i.e. $\frac{P}{R} = 1$

NB:
The grass productivity to community respiration is higher / larger than when its at early forest and approaches at maturity or older forest.

Graph

Net community production is higher in young forest.
The food chains are linear mainly of grazing type in young succession stages become web like mainly in the detritus at climax.
The total organic matter of biomass is small at early stages of succession and large at climax.
Species diversity is normally at early stage ad high before climax
The nature of community is normally at early simple in the lower seres and becomes complex (strata sitraction) with many micro habitats at the climax.
During succession, more and more of the available nutrients become locked up in the biomass of the community with subsequent decrease in nutrients in the biotic components of the ecosystem.
The amount of detritus produced also increases detritus feeders take over from grazers as the main primary.

Significance of ecological succession:
Production.
Diversity.

Reliance (for an ecosystem to come where ti used to be).
Competition.
Predation.
Parasitism.

Grasses and Grass lands:
Grasses are groups of plants that belong to the family called graminae and they are monocots.
Characteristics:
They have narrow leaf laminae and each leaf is divided into a leaf sheaf called (ligule) and lamina.
They have stems called abole and this has two types of growing regions which have laminae and a leaf sheath.
A ligule is the part between the lamina and the leaf sheath or culms.

Diagram

Grasses have tossect (but out growth) which germinates when atleast is eaten by grazers or burnt down by fire.Tossects are always present in gasses with nature leaves.Grasses are grazed upon by two types namely

The specialist and generalists.
Specialists are selected grazers which pick on specific grass species and mainly on the palatability and proximity of the various grass species.
Specialists are then limited by the available food abandancy
NB:
Specialists have one major disadvantage of cleaning a particular grass species to almost extinct especially when they are hinging in the numbers.

Adaptations of grasses
They have hollow stem (bole) which is non woody but kept upright with its high tugor pressure.
The stems are flexible hence can't be eroded off the ground easily.
Most grass pieces have short stems to minimise erosive action of the wind.
They have small leaves which narrow lamina which provides a small surface area for low transpiration rates.
Grasses have parallel venation which helps to reduce specialists.
Some grass species like pasparum notatum have superficial roots which run horizontal onto the ground to absorb H_2O whenever it runs. The superficial roots form a dense network on the grand which prevents other plant specie form colonising their area and hence makes pasparum a good competitor.
Most grasses (include pasparum) reduce vegetatively hence have reproductive potential and high maturities. This enables them to colonise a particular area in a short time and makes good competition.
These organs serve a purpose of vegetative propagation.

Grasses have tussects which are protected by the leaf sheath and can germinate and form a new leaf when the original leaf has been grazed upon or burnt down.

Natural resources.
These are components which are found in the atmosphere; hydrosphere and they are a source of energy and support life.Natural resources are therefore needed for survival and prosperity.

Classification of natural resources
Natural resources can be broadly classified into;
Exhaustible resources:
These are resources that are likely to be exhausted by man's activity
Inexhaustible resources:
These are resources that aren't likely to be exhausted by man's activity e.g. wind, sunlight, soil e.t.c.
Renewable resources:
These can replenish themselves by quick recycling and replacement within a reasonable period of time e.g. H_2O, forest, soil. However, if renewable resources aren't managed properly, they can become non renewable resources.
Non-renewable resources:
This exists in fixed amounts and lacks the ability to replenish or recycle themselves e.g. minerals, fuels like petrol and coal.

Forests
A forest is a large chunk of land with its predominant vegetation as trees.
Conservation of forests
For conservation purpose, forests are divided into
Natural reserves
Buffer zones
In the natural reserves, exploitation of forest resources is prohibited whereas in the buffer zones sustainable exploitation is allowed. Activities such as fire wood picking, spot hunting e.t.c. are allowed. Conservation of forests is for two broad reasons.
Protective:
To ensure a permanent cover which protects the catchment and set up slopes so that;
Prevent soil erosion.
Preserves climatic and soil conditions for agriculture.
Has a moderate influence on climatic, rainfall and thus sustains H_2O supply.
Productive:
Government wants to ensure future supply of forest products to people e.g. timber, charcoal.
Problems faced by forest
Pests and diseases which attack the trees.
Wild fires what destroy trees.
Unsustainable exploitation.

Political instability.
Political interference.
Settlement and industrialisation.
Law of forest conservation personnel.

Wild life:
Several areas have been demarcated for wild life conservation and these include game reserves, national parks, wild life sanctuaries and community wild life area.
A game park is an area gazetted for several purposes mainly conservation, scientific research and recreation.
In such an area activities such as hunting are prohibited.

Importance of wild life conservation
Employment: Wild life provides employment opportunities to citizens as game wardens working in the tourist industry.
Animals are protected form extinction since activities such as over exploitation of economically valuable species aren't allowed.
Food for animals is adequate.
Education and research
Earn of country's foreign exchange through tourists.
For scenery

Problems facing the tourism industry
Pouching.
Diseases
Air pollution.
Agriculture.
Discovery of mineral and mining.
Political instability.
Poor transport.
Shortage of funds for management.
Lack of advertisement.

POLLUTION
The presence in the environment of significant amounts of a natural toxic substance or abnormally high concentration of natural constituents at a level that causes undesirable effects.
Pollution can be categorised in many ways depending on the type of pollutant or type of habitat polluted. Certain products are created for useful purposes to man but when used; they have highly serious side effects e.g. synthetic detergents, pests, medical drugs e.t.c.

Some of these can not be degraded or processed by nature within a reasonal period of time, so e.g. accumulate and pollute the environment pollution so reaction to the type of habitat can be categorised as:
Air/atmospheric pollution
Water/acquatic pollution.
Terrestrial pollution.

Acquatic pollution:
This is sub – divided into fresh water (lakes, rivers, ponds) and marine (oceans and seas) pollution.
Fresh water pollution:
Most ecological studies on acquatic pollution have been done on lakes classification of lakes depends on the level of circulation of inorganic nutrients in the lake.
This type of classification is known as trophic and it includes:- eutrophic and aligatrophic lakes.
Eutrophic lake: there are lakes with waters relatively enriched in plant nutrients.
Eutrophic lakes have the following features
Hugh surface area to value ratio and hence easy circulation of nutrients.
They are relatively shallow with gentle sloping banks which can support bits of marginal vegetation.
They have a relatively high concentration of nitrates and phosphates and are therefore very productive.
The upper layers have a small concentration of oxygen.
Aligatrophic lakes: These are lakes with low plant nutrients and e.g. have low surface area to volume ratio and usually small with steep rock sides. They have low vegetation and low productivity e.g. Lake Tanganyika.
Dytrophic lakes: are lakes with brown water. They have high concentration of acids which inhibit material decomposition and saturation of nutrients.
Diagram

Littoral zone:
Is a shallow water zone. It's a region where light penetrates to the bottom of the lake and it has rooted plants.
Limnetic zone:
Is the zone of open water. Plant life is apparently phytoplanktons floating on water depending on the time of the day. When temperatures are high, those phytoplanktons are few cm below the surface and when temperatures are low, they are on the water surface. The phytoplanktons include: algae (blue green) zooplanktons are also present in this zone as well as fish

Protundal zone:
There is no light in this zone. All its inhabitants depend on the littoral and limnetic zones for basic food materials.
It has the least amount of life including bacteria and fungi in the mud.

Another group of animals are annelids and other worms. Most of these organs are anaerobes and are adapted to with stand low O_2 concentration

Dissolved gases in lakes
Many gases are found dissolved in lakes and those are nitrogen, methane, O_2 e.t.c. the most wide spread gases are O_2 and CO_2.
Oxygen
This is the most important of all chemical substances present in water.
It regulates metabolic processes for the organism and its presence indicates lake conditions like productivity pollution e.t.c.
The volume of O_2 dissolved in the H_2O at any one time depends on:
Temperature of the atmosphere in contact with the H_2O.
Concentration of dissolved salts in H_2O.
Biological activities taking place in H_2O.
Low temperatures increase solubility of O_2 in H_2O. Increased concentration of salts also increases solubility of O_2 in H_2O.

Sources of O_2 in water
Atmospheric O_2 dissolving into the water.
Photosynthetic activity of water plants.
Atmospheric CO_2 diffusing into the water.
Sources of water pollution
Domestic wastes and sewage. Discharge of untreated sewage into the water bodies causes pollution.
Industrial wastes and effluents. Discharge of treated and untreated effluents from breweries, dying industries e.t.c. can cause pollution.
Resistant objects e.g. jeerycans, tyres or plastics.
Biocides and pesticides are chemicals used for pest control sometimes however; their spectrums of activity extents beyond the pests hence called biocides, pesticides may retain their biocides activity in the water for along time. They are persistent and their concentration builds up at successive levels of the food chain, aphenone known as biological magnification. These pesticides may be released into water by running water from agricultural fields.
Asbestos: used for roofing and insulating materials. It's resistant to full disinter ration and causes hazards such as cancer of the lungs and digestive system.
Silt includes dust particles carried from land to water. Silt causes sledding, reduces depth e.t.c.
Fertilisers bring beneficial effects such as improvement of so for food production but they produce some adverse effects such as:
Deteloration of water bodies.
Disturbance in ionic balance in water and soil bringing about high acidity and also simulate weed growth in thicks.
Thermopolution:
Industrial processes may discharge heat in form of hot water, air effluents in water. Hot water may kill the acquatic flora and fauna.

The rise in temperature may result into easy multiplication of bacterial diseases of fish and other acquatic organs of water.
Increased temperature results into increased metabolic processes on water and hence increased demand for O2.
Incrassated temperature may also cause O2 to diffuse out of the water.
Oily spillage from tankers covers the surface of water hindering diffusion of O2 from air into the water for the acquatic organisms.
Water is said to be polluted if its quality or composition is changed so that its less suitable of drinking, agriculture, recreation, fishing and other purposes for which it was suitable.
Polluted water may cause diseases such as cholera, bilharzia and many others. It may also be toxic to living organisms due to various toxic substances like biocides.

Eutrophication:
This refers to the determination of water quality for domestic recreational and other uses following the discharge of wastes containing nutrients, salts such as nitrates and phosphates in the water. Eutophication results into growth of algae bloom – blue green algae (ciadophora spp).
Increase in the density of these blooms inhibits penetration of light to lower or deeper regions of the water. The flora in these regions hence can not carry out photosynthesis hence die and decomposes. They decomposed by bacteria which use up O2 causing a biochemical O2 demand (B.O.D). This results in the death of aerobic organisms in the lake.

Results of discharge of sewage in the water:
Deption of O2 content caused by biological oxidation of organic matter, presence of organic matter stimulates bacteria to breakdown organic materials in the sewage which results in a great increase in the number of bacteria.
During the decomposition process, bacteria uses up O2 reducing its amount in water. This creates a biochemical O2 demand.
Incase of large amounts of sewage on a small water both the B.O.D may be so great to remove entirely all the O2 which causes death of aerobic species.
Organic matter s broken down into soluble compounds like PO42- and NH3. Ammonia is then converted into nitrates.

Diagram

Features of the graph
The amount of O_2 falls because it's being used by bacteria in the breakdown of organic matter.
The increase in amount of O_3 may be due to:
Decrease in demand for O_2.
More O_2 dissolving from the atmosphere
Increase of a river, the B.O.D falls because of the decomposers being by flowing water suspended.

Chemical changes
Graph
Describe and explain the changes in the graph
Part of the sewage is combined nitrogen. Each human produces this daily mostly in the form of urea and uric acid. This combined nitrogen is converted to ammonia by bacteria while the ammonia may be toxic, its effects are temporary as nitrifying bacteria rapidly oxidise it to nitrates.

Results of discharge of sewage in water.
Changes in flora and fauna.
Saprophytic bacteria increase in population as they feed on the sewage. These include: filanentus bacteria such as sewage fungi. The algae levels first fall, but later increase when sewage has been converted to nutrients
Graph

Initially algae levels fall due to reducing the amount of light penetrating the water. Algae levels then rise greatly due to availability of nutrients released from sewage e.g. nitrates by material breakdown of organic matter. The algae use up these nutrients and grow rapidly. Algae levels then fall to normal as the mineral nutrients are used up as a result of dilution of the minerals down streams by tributaries. The fauna also vary in numbers of according to the amount of O2 in water. Some fauna are tolerant to sewage (tolerant to lower O2 conditions) e.g. amelida such as tubitex.
Diagram

Estimation of Eutrophication
The O_2 content of the water is an important index for its purity. Presence of pollutants in commonly measured by the Biochemical O2 demand. (B.O.D)

Procedure to slow down Eutophication of water.
Limit the amount of nutrients entering the water.
Flashing and removal of algae blooms and mechanical removal of higher plants. This can reduce the amount of nutrients recycling in the water body.
By encouraging the set up of micro food webs e.g. having fish that can eat the algae and the fish is subsequently harvested.
Removal of dissolved nutrients from the water either physically of chemically.
By controlling the growth and multiplication of algae and higher and higher plants by applying appropriate doses of copper (II) sulphate, arsenide.

Minerals in water:
Sources of minerals in water.
Minerals core in to seas by rives water containing dissolved minerals.
Dissolution of minerals from the underlying rock.
Decomposition of organic matter in water
Dust particles from the atmosphere dissolve into the water.
By rainy water washing them from the neighbouring land.

Primary production in water

The amount of increase in organic matter per unity area gives the primary production. Primary productivity is the rate of activity of organic matter averaged over a definite period of time. Primary production is given by the quantity of new organic matter manufactured by plants.

Factors limiting primary production

Light and Temperature:

In temperature lakes, during winter, there is reduced light intensity and this reduces the growth rate of phyloplanections.There's a general decline in physiological processes resulting in a general decline of the population of zooplanktons and phytoplanktons. In spring, solar radiation increases to algae blooms and the algal blooms use erreilatinf nutrients and increased light penetration to increase primary productivity.

However, when e.g. increase so much, they cause sledding resulting into decreased light penetration which gain reduces productivity.

Depth of the water body:

This affects production and rate of nutrients turn over; shallow water bodies have a high productivity than deep water since there are easy nutrients mixing in the water.

16. EVOLUTION.

Evolution *is a gradual process by which new, more complex species of organisms arise as a result of changes in pre-existing, simpler species.*

THE ORIGIN OF LIFE

Several theories have been advanced by scholars explaining the form and manner in which life might have originated including the following.

- The theory of special creation by God
- The theory of spontaneous generation of organism
- The theory of organic evolution
- The steady state theory.

The theory of special creation by God.

This theory is represented by Moses, in the book of Genesis, it suggests that life started under the influence of supernatural being power which is attributed to God the creator. According to this theory and general excessive stages, millions of years ago God simply commanded several species of organisms in existence ie let there be species "X" and it happened. The theory further suggests that species God created did not undergo evolutionary changes/modifications and that species of organisms are not in any way related to descent and that there was no pe-precursor to life. The theory insists that while there may be resemblances between organisms of different species those on their own alone do not automatically justify relationship between them.

Short comings or weakness of the special creation theory.

The theory falls short of scientific support since the manner in the claims life started can not be observed, repeated or subjected to experimental studies.
The theory falls outside the sphere of science

The theory of spontaneous generation

According to the theory, life begin by repeated appearances of living organisms from non-living material eg earth worms store from mad, suggests from decomposing organic matter, houseflies from gabbage.

Shortcomings

- The theory does not clearly explain how non-living material can gie rise to living organism.
- All experiments to prove the claim have been fertile

The steady state theory

It states that the earth has no origin, life has no origin. The earth has always been able to support life and has not changed remarkably.
According to the theory, species of organisms have no origin and have always existed. A species may only change in numbers or become extinct but can not become modified to give rise to new species.

The theory of organic or biochemical evolution

This is the most modern and widely accepted theory to explain the origin of life. It is divided into four parts namely

Formation of organic molecule
Formation of the 1st organism
Formation of autotrophs
Further evolution of autotrophs and heterotrophs

Formation of organic Molecules

This was the 1st stage of life formation and it occurred millionn's of years ago. The earth at that time was at very high temperature and the atmosphere was anaerobic/reducing and consisted of 4 major gases namely methane, ammonia, hydrogen and water vapor. The four gases (CH_4) (NH_3) (H_2) combined under the influence of gamma radiation and the ultra violet rays to form simple organic molecules. When eventually the earth's temps. Cooled the water vapour liquefied the raints which washed down the simple organic molecules that had been formed into the oceans and the seas to form some form of "**Organic soup".**

Formation of the first organism.

The simple organic molecules in the organic soup combined further to form a stable integrated chemical system capable of releasing energy and replicating itself with time, this integrated chemical system developed a membrane a round itself to give rise to the first organism.

Characteristics of the First Organism

Simple, primitives, prokaryotic, anaerobic, unicellular, heterotrophic that feed on the "organic soup" where it lived on acquatic kriol of life.
Reproduced a sexually probably by binary fission

The Evolution Of Autotrophs.

A large number of heterotrophs in the "organic soup" reduced the supply of organic molecule that initially acted as their food resulting in stiff competition. The stiff competition provided a catalytic environment of the emergency of the 1st autotrophs as a result of evolutionary modifications in the structure and function of some of the 1st organisms.
The formation of autotrophs later led to the evolution of oxygen gas mainly due to photosynthesis and this later led to the formation of the Ozone layer. Evolution of oxygen later provided an aerobic environment hence the emergence of aerobically respiring simple organisms that the plant kingdom while the heterotrophs with which they co-existed gave rise to the animal and fungi kingdoms.
Eventually the prokaryotes developed further to give rise to different kinds of Eukaryotes mainly through the endorymbion theory mechanism in which it is thought that one prokaryote ingested one or more other prokaryotes the ingested prokaryote(s) instead of being digested persisted and developed into a functional organelle such as a nucleus, mitochondrion, golgi apparatus etc.
Later univellular organisms gave rise to a wide range of mult cellular ones. It is though that this was achieved by mitotic cell divisions of uncellulor organisms that resulted into daughter cells that did not separate completely but remained in close association metabolically.

Further evolution of autotrophs and heterotrophs

Under the influence of environmental Des and mutations over long periods time, different organisms developed different adaptations to occupy different habitats under different circumstances, resulting in the evolution different species of organisms along several species lines of evolution leading to evolution of millions of several species that we see today (and those that already became extinct).

The theory of panspermia/ the cosmozoan theory

According to his theory, life has an extra terrestrial origin life contouring materials in comets and meteorites from the universe fell on the earth and acted as seed of life.

The mechanism of evolution.

Te following theories have been advanced to explain how the process of evolution could have taken place;

- The theory of catatrophion (By George curier)
- The theory of inheritance of acquired characters (By Lamarck)
- The theory of evolution by natural selection (By charles Darwin)
- Neo-Darioinism

The theory of catastrophism (by George curier)

According to this theory, life was brought about through special creation by a supernatural power attributed to God, but at certain times in the earth's history, a series of catastrophies occurred and destroyed most of the life forms. The same supernatural power carried out an organisms/species. This explains why 2 day's life forms are not exactly smiles to their fossilized counterparts.

The theory of inheritance of acquired characteristics by lamark.

The principle of use and disuse acquired characters from one generation to the next. According to Lamarck, an acquired character one develops in the course of the life of an individual usually through a change in the external environment of the organism reacting continued/persistent use/disuse of part of the organisms body.According to this theory changes in the condition of an organism create new needs leading to new methods of behavior, involving fresh levels of use or disease of existing body organs. This leads to D in their structure function. The resulting Des in body structure and behavior are inherited by member of subsequent generation. According to this theory increased levels of use of a given organ leads to increased sized and efficiency of the body organ while disuse of heads to degeneracy/atrophy.

Lamarkan account for the evolution of the giraffe

According to Lamarck, the ancestors of the giraffe had short legs and necks. In the cause of feeding, these giraffes tied on grass in the grass lands. With time, there was a decrease in the amount of pasture, resulting in the need to also feed on leave of shrubs and short trees.

Continued browsing resulting in stretching of furaffer necks and legs resulting in slightly longer necks and legs and this character was handed over to subsequent generation which also stretched and the necks and legs further.

Each generation of giraffe therefore inherited the gains of the previous one and also added on to the net by leg length at reating. And this explains why today greffers have long necks and long legs.

Short comings

The theory does not precisely explain how an acquired character can be hentable, modern science proves this to be impossible.

The Theory Of Evolution By Natural Selection (By Charles Darwin, 1859)

Darwin is built on 3 observations and 3 deductions as follows.

Observation 1: experimental fecundity of organisms

Organizations generally have a high reproductive potential ie they are very highly fecund and if they were to exploit their reproductive potential to maximum, they would become extremely numerous in a few generations.

Obervaion II: Constary of populations

Despite the high reproductive potential of organism, numbers of organisms do not change very significantly save for a few fluctuation.

Deduction I: (struggle for existence)

There is a cute competition between organisms for essential resources such as food, space, mates, shelter etc so that the struggle for existence take place in this struggle, many individuals may die or fail to reproduce.

Deduction II: variation among individuals

A closer examination of a large number of species that there is a considerable variation between individuals ie no two individuals appears or behaves exactly a like.

Deduction III (a survival of the fittest)

In the struggle for existence only the fittest survive it ie those whose character confer adv. To organisms. The less fit on the other handle those whose characters confer disadvantages are out competed.

Deduction IV: Like producers like and the origin of species

All those qualities that flow the fittest individuals to survive are passed from one generation to another through reproduction. On the other hand, the unfavourable character would not and instead will generally tend to disappear from the population which subsequent hence natural selection.

The Darwinian account on evolution of a giraffe

Darwin suggested that actually said that the ancestor of the giraffe had short legs and necks, a mutation occurred this giraffe form co-xistes site. The long legged/necked gessaffes would obtain more food than their short and legged/necked counterparts since the famer would browse and freely yet the later would only graze ie the former were be adapted and therefore more fit than the latter.In times of seaveity of food, low necked/legged griffes out competed their short legged/necks counterparts and this explains why today giraffes have long legs and long necks.

Evidence for evolution.

The following are evidences supporting evolution has taken place/takes place.

- Evidence derived from palaeontology
- Evidence derived from comporative anatomy of veterbrates
- Evidence derived from comparative embryology of veterbrates
- Evidence derived from comparative brochemistry
- Evidence from coparative cell biology
- Evidence from breeding and domestication of plants and animals
- Evidence from geographical distribution of plants and animals
- Evidence from classification studies.

Evidence derived from palaeontology

Palaeontology is the study of fossils. Fossils are preserved remains of living organisms that live in the past geological ages.

Examples for fossils

Fossils	Fossilization	Examples
Entire organism	Died, frozen, during glaciations. Dead, encased in nordened resin of corniferous trees. Died, trapped in acidic bags where there is lack of bacterial and fungi/decay. (total decomposition is prevented)	Wolly mammals/woolly mammals. Insects "Mummies" in acidic bags scendinavia.
Herd skeletal parts	Died trapped and buried in sedimentary sand and clay in sedimentary rocks eg limestone.	Bones, teeth and shells of organism.

Petrifaction (petrifact)	Gradual replacement by water carried mineral deposits eg silica. Slow in filling by silica as organisms decomposes. Produce fine detail of organisms shape.	Silica replacement of the achinoderm. micraster
Impressions	An impressive illustration of remains of organisms of rocks or fine sand after the organisms has died and decomposed.	Feathers of Archeopteryx impressions of jelly fish and leaves of trees.
Imprint	These may be front prints, trails, tracks of various organisms made in mud, which became rapidly booked.	Foot prints of the Dinose.
Coprolites	Faecai pellets prevented from decomposing	Mammalian faecal – pellets.

How palaeontology supports evolutions; The fossils record shows that:-

- Fossils have been laid down in layers, the oldest fossils are at the bottom the youngest fossils are at the tap.
- Older rocks contains pure species of fossilized organisms while younger rocks contain more species of fossilized organisms.
- Older rocks contain less variety of fossilized species of organisms compared to the youth rocks.
- Many species, if fossilized organisms appear in lower strata but are absent in higher strata ie such fossils appear in all the rocks but are absent in the younger rocks indicating that some species of organism may have been formed and later become extinct.
- Old fossils mainly represent aquatic organisms while young fossils mainly represent terrestrial organisms. Indicating that life evolved from aquatic to terrestrial forms.

Short comings of the fossil record.
It is incomplete and therefore can not be used to accurately represent what takes place in nature.
Why the fossil record is incomplete?

Dead organisms tend to decompose rapidly
Many dead organisms are eaten by scavengers
Soft bodied organisms do not easily fossilize
Many animals die in conditions which do not favour fossilization
Only small fractions of fossils have been discovered.

Evidence from comparative anatomy of veterbrates

The following similarities about vertebrates, comparative anatomy suggests a common ancestor. All vertebrates have two pairs of limbs. Distribution and positioning of internal organs such as brain, heart, liver, blood vessels, and nerves follow a similler partern in all vertebrates.In all vetevrates, the respiratory system develops to the enterior part of the alimentary of homologous, analogous and vestigial organs.

Homologous organs; are *organs with the same basic structure plan but perform different function.* In adult organisms where they are found eg pentadactyl limbs in letrapod vertebrates (except fish) beaks of birds, perteare in fruit.Homologous organs suggest that during the course of evolution of organism that share a common ancestry, such organisms developed different adaptations to different environments thus enabling them occupy several different habitats and arches ie adaptive radiation and divergent evolution.

Analogous organs; are organs with different basic structural plan but that serve the same function in adult organisms where they are found eg Eyes of Arthropods and eyes of humans,Wings of birds and using of insects,Thorns of plants and spines of certain animals. Analogous organs confirm **convergent evolution**; Where by different organisms that have evolved along different lines of ancestry come to occupy similar habitats/niches.

Vestigial organs; *These are organs that have become significantly reduced in size during the course of evolution to the extent that they have lost their original apparent.* Examples

- The wings of the kiwi, Ostrich and other flightless birds
- The limb buds of the Python and the boa constrictor
- The appendix in man.

Vestigial organs confirm a common ancestry of organs. They show that during the course of evolution, changes in the organism's environment may result in new needs which demand certain structural modification.

Evidence derived from comparative embryology of vertebrates;

In other words, the developmental stages through which an embryo possess, reflects a repeat of its evolutionary history ie "**ontogeny recapitulates phylogeny**" (Ernest Haeckel).

Evidence derived from comparative biochemistry;

Similarity in the following chemical components of living organisms suggests a common ancestry.

- In all organisms, living matter is made up of carbon, Nitrogen oxygen and hydrogen. These together constitute up to 90% of living matter.
- All organisms are composed of 70-90% water by weight and wider is the most plentiful compound in their protoplasm.
- Chemicals such as nuclei acids, ATP, cytochromes are of universal occurance in all organisms.

- Cytochrome C has a section of amino acids that is the same in all organisms. Chromosomes of all organisms contain. Distribution of blood pigments such as haemoglobin, haemoerythrin, chlorocruorn, haemocyenin for vertebrates.All vertebrates show similarity in enzyme and hormones distribution

Studies from serological (pecipition) tests suggest a common ancestry. The serological test is a biochemical test used to compare blood proteins of animals of different species. According to this test. It is accured that the close species are phylogenetically; the more alike their proteins are likely to be.To trace how close, blood proteins of man area. To those of the blood of another animal X, use the following procedure.

- Obtain a small volume of human serum and inject it into animal X.
- Animal X would then response by producing antibodies against the antigen in the human serum.
- Obtain some of the antibodies from animal X and mix then with a human serum in a test tube.
- An immunological reaction occurs resulting in the formation of a perceptible.
- The procedure may be repeated using human serum and blood from several other animals and in case each role the amount of precipitate formed.

The greater the amount of protein, the closer the animals blood proteins are to those of men.Serelogical tests have confirmed that human blood proteins are those closer to the great Apes such as chimpanzees, Baboons, Gorillas, compared to those of lower vertebrates such as dogs, cats, fish etc

Evidence from comparative cell biology.
All most all cells function in the same way and share many biochemicals and organelles such endoplasmic reticulum, Golgi apparatus, Ribosomes mitochondria occur in all Eukoryotic cells.Chloroplasts occur in all plant cell. This suggests a common ancestry.

Evidence from taxonomy (classification).
Structural similarity and differences between organisms are used as the basis for classification, organisms with used as the basis for classification; organisms with similar characters are grouped in the same taxonomic rank…….suggests a common ancestry.

Evidence derived from domestication and cultivation of plants and animals respectively (selective breading)
Evidence derived from domestication and cultivation of plants and animals respectively (selective breeding).Man has deliberately selected (domesticated and cultivated) avariety of animals and plants. Man acts as a selective agent faouring/ promoting individuals with desirable traits to bread lie artificial selection.
Through selective breeding, many varieties of animals and plants have evolved and many wide animals have been tamed. Dosmetication of plants and animals (Artificial selection indicates how natural selection actually occurs during evolution)

Evidence from a mutation
Mutations are sudden (spontaneous) changes in the arrangement structure or amount of genetic material of an organism.
Heritable mutation bring about heritable changes in the organisms there by creating desirable or undesirable characters thus proving a basis for natural selection.
The a fact that mutation continue to take place evidences that evolution is in process under driving force provided by differences created by these mutations.
Evidence from genetic distance
A close study and comparison of DNA of organisms indicate a close degree of resemblance and similarity thus suggesting that such organisms have similar phylogency and a common ancestry.
Evidence from chromosomes.
Many organisms share many chromosomes in common similarity in chromosome suggests a common ancestry eg a horse and a sonkey can mate to produce a male which is infertile due to miss matched chromosomes but the fact that the two can inter breed suggest similarity in chromosome structure and common ancestry.
Evidence derived from geographical distribution of species (biogeography)
The distribution of different organs and fossils is related to their ancestry.
Geographical areas with similar geographical conditions tend to have similar flora and fauna.Continental drift, migration of organisms from their places of origin and subsequent geographical inslation led to evolution of new species of organisms as ancestral forms adapted to new environmental conditions in the different geographical area/land mass.
Evidence from Comparative Embryology.
Embryology is the study of the early development stages of an organism**.**
the following facts from comparative embryological studies of organisms suggests common anienstry of vertebrates.

- Most start their life history as single cells eg single fertilized ovum.
- Go through developmental stages
- Embryos of some higher vertebrates tend to posses structures of adults of lower animals through some of these structures may later be lost during development of the organisms.

In other wards the development stages through which organisms pass reflect a repeat of its evolutionary history i.e **"Ontogeny recapitulates phylogeny" (Enerst Haeckel**).

Evidence from comparative biochemistry.
Similarity in the following chemical components of organism a common ancestry.
In all organisms living matter is made of C, hand N and these together constitute to 90% of living matter.All living organisms are compared of (70-90%) water by weight and water is the most plentiful compound in their protoplasm.Chemicals such as nuclei acids, cytochromes, ATP are of universal occurale. Cytochromic has a section of a minoacids that is the same in all organisms. Chromosomes of all organisms

contain DNA. Distribution of blood pigments, haemoglobin, haemorythrin, chlorocmom, haemocynin (vertebrate).All organisms (vertebrates) show similarity in enzyme and hormonal distribution.

Studied from serological test (precipition tests).***Serological test*** *is biochemical test and used to compare blood proteins of animals of different species.* According to this tests, the closer the species are evolutionary, the more alike their proteins are likely to be.

To trace how close blood proteins of man are to those of blood of another animal X use the following procedure.

- Obtain a small volume of human serum and inject into animal X. animal X would then respond by producing antibodies against antrogens in the human serum in a test tube.
- An immunological reaction occurs resulting into the formation of a precipitate.
- Procedure may be repeated using human semi and blood from several other animals and in each case not amount of precipitate formed.

The greater the amount of ppt, the closer the animals blood proteins to those of man. Serological tests have confirmed that human blood proteins are much closer to the great apes compared to their lower veterbrates such as dogs.

Evidence for Evolution from Cell Biology

All cells function in the same way and share may biochemicals and organelles eg Endoplasmic reticulum, Golgi apparatus, ribosomes, mitochoadria occur in all eukamotic cells, cgloroplasts occur in all plant, these suggest a common ancenstry.

Evidence derived from taxonomy (classification)

Structure similarities and difference are used as the bases of classification.
Organisms with similar character are grouped in the same taxanomic rank.
Structural similarities among organisms suggest a common ancenstry.

Evidence derived from domestication and cultivation of animals and plants respectively (selective breeding).

Man has deliberately selected domesticated and cultivated a variety of animals and plants man acts as a selective agent favouring /promoting individuals with desired trait/character to breed ie artificial selection.

Through selective breeding, many varieties of animals and plants have evolved and many wild animals have now been tarned.

Domestication of plants and animals (artificial selection) indicators how natural selection naturally occurs in evolution.

Evidence (derived) from mutation

Mutations are sudden/spontaneous Des in the arrangement, structure or genetic material of an organism.

Heritable mutation brings about britable changes in the organisms thereby creating desirable and/or undesirable characters, the providing a basis for natural selection to take place..

The fact that mutations continue to take place today is evidence that evolution is still in place under the driving force provided by different created by these mutation

Evidence from genetic distance

A close study and comparison of DNA, of crome, organisms indicate a close degree of resemblances and similarity thus suggesting that such organism have similar and common ancestry.

Evidence derived from domestication and cultivation of animals and plants respectively (selective breeding).

Evidence From X-Some Structure

Many organisms share many x-somes in common similarity in x-somes suggests a common ancestry eg a horse and a donkey can mate to produce a male which is infertile the due to mismatched x-some structure and common ancestry.

Evidence From Geographical Distribution Of Species (Biogeography)

The distribution of different organisms and fossils is related to their ancestry.

Geographical areas with similar environmental conditions tend to have similar composition of flora and fauna.

Continental drift, migration of organisms from their places of origin and subsequent geographical location lead to evolution of new species of organisms as ancestral forms adapted to new environmental conditions in the different geographical areas/land masses.

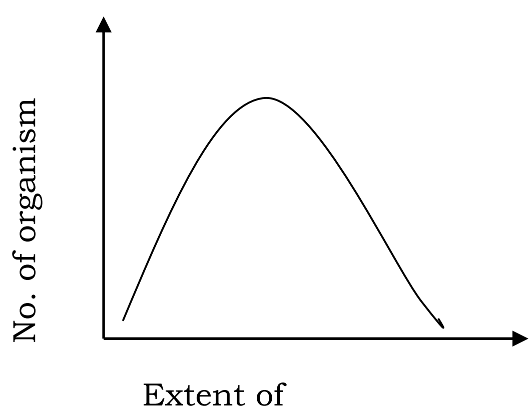
The process of natural selection

Natural selection. Is the process by which organisms that are physically, physiologically and behaviorally better adapted to their environment survive, reproduction and become more numerous over generations while the less adapted ones fail to do so.

The organisms environment exerts a selection pressure ie disease, selection of a male, predation, harsh environment condition. The intensity of this selection pressure varies in both time and space.

Types of natural selection

The characteristics of organisms such as height, weight, skin colour vary continuously giving a normal distribution curve as shown below.



Natural selection may affect such a variation in 3 different ways.
There are 3 main forms of natural selection.

Stabilizing/normalizing natural selection. This is natural selection which follows the survival of individuals close to the mean in the distribution of the population and select against individuals at either extremes of the distribution.

NB: Stabilizing natural selection brings about uniformity in the population and therefore does not favour evolution.

Examples of inheritance of sickle cell anaemia where the horozygotes namely, the normals and sickers are selected against the heterozygous halls are selected for.

Weight of children at birth where the very light and very heavy new borns are selected against while the average new borns are selected for.

Direction/progressive natural selection

This is natural selection which favurs the survical of organisms at an extrems and at the mean.

In this case, the mean of the population shifts towards the selection or extreme of the composition of the population changes accordingly.

Eg industrial melarism as observed in the paper de moth (Biston Behilazia. During the industrial revolution in the great Britain where black/carbonated. melanic form was selected fro while. The while form was selected organism.

Resistance to antibiotics by bacteria

Destabilizing/disruptive natural selection

This is natural selection which favours the survival or organisms of either extremes in the distribution and selects against those close to the men.

Selective pressure

Refers to all factors that may exert/cause differential survival of groups of individuals of the same species.

Examples of selective pressure include;

Increased levels of predation

Increased levels of competition eg food, water, males, breading space

Increased incidences of disease out break

Change in environmental/climatic conditions

Examples of present day evolution

Industrial melatism and the paper de moth Biston betularia

Resistance to antibiotics

Resistance to antimalerial drugs

Resistance to pesticides and insecticides

Note

In case of 2,3 and 4, in response to the chemicals applied, A few resistant straits may emerge from the original population through mutations. When selection pressure is exerted the resistant traits have selective advantage over the original strains. The latter become more numerous and the former less numerous.

POPULATION GENETICS

Population genetics deals with frequency of genes and alleles in a population.
Genes are transmitted from parents to off springs and since parents are rarely made up of the same genes the populations of subsequent generation are likely to have different genotype and genotype frequency.

Basic terms;

Gene pool

Is the sum total of all alleles for all genes in a reproducing population at a given time.

Species

A group of similar organisms capable of interbreeding to produce fertile organisms.

Speciation

Is the evolution of two or more new species from pre existing species.

Deme

*Is a small interbreeding population with its own gene pool which is genetically isolated from other similar population.*A given population may have several demes.
Genes flow between members of different demes of the same species is still possible but members of a single deme reproduce more often amongst themselves with members of other demes of the same species.A deme can therefore re-defined as a breeding sub unit of a population with its own gene pool. Which is genetically isolated from other breeding sub units?

Allele frequency. *Is the proportion of any allele in given population relative to other alleles at the same locus.*

Gene flow. Is the continous movement of genes in a population, usually as a result of reproduction and migration.

Genetic equilibrium. Is the situation where the over all allele frequency in a breeding population remain constant from generation to generation.

Genetic drift. Is a change in allele frequencies of a given population, occurring not as a result of a natural selection but rather due to chance.

Genetic death. Is the elimination from a population of recessive alleles that confer disadvantages on the phenotype due to death of the organism before breeding/reproduction eg haemophilia.

Genetic load. Refers to the continued existence with in a population of disadvantageous recessive allele mainly in a meterozygous.
Usually as a result of recessive allele confirming selective advantage to the neterozygous and selective disadvantage to the homozygous.

The hardy-weinberg's principle/ equilibrium.

States that in large a large breeding population, allele and genotype frequencies remain constant from generation to generation in absence of mutations, migration and natural selection.
Pre-conditions for hardy-weinberg principle/ equilibrium to apply (Factors that may maintain genetic equilibrium of a poluation).

- Large population
- Random mating/breeding
- No mutations should occur
- No natural selection should occur
- No migration should occur
- There should be no over lap of generation.

Factors that may distablise / upset the equilibrium of a population.

- Non random mating / selecting
- Occurance of mutations
- Occurance of migrations
- Occurance of natural selection.

If P and Q represent the respective frequencies of the dominant and recessive alleles in the population. The frequency of the dominant and recessive alleles with in the population sum up to a unit ie

$p + q = 1$ or $1 - p = q$

by random mating ie

$(p+q) \times (p + q) = (p + q)^2$

$= p^2 + 2pq + q^2$ where p^2 = genotype frequency of the dominant allele

$2pq$ = genotype frequency of the heterozygotes

Q^2 = genotype frequency of the recessive allele

Application of hardy Weinberg principle

1. Consider a genetically controlled failure to produce the pigment melanin (albinism) in a large population only 1 person is abnormal per 1000 individuals.

Normal; $0.987 \times 25 \times 10^3 = 24675$

Carriers; $0.0126 \times 25 \times 10^3 = 315$

2. A particular species of insects may occur in either light or dark form. The dark trait is dominant over the light trait. In a certain population of 500 such insect there are 50 which are dark. Using Hardy Weinberg expression, calculate and show your working

(i)The frequency of the light allele

(ii) Frequency of the dark allele

(iii)The no of population of insects which are heterozygous

Dark = 950

$$\frac{p^2 + 2pq + q^2}{950}$$

Number of light in insects = 5000 – 950 = 4050

Using $p^2 + 2pq + q^2$

Allele frequency of light allele = $q^2 = \frac{4050}{5000}$

$$\sqrt{q^2} = \sqrt{\frac{4050}{5000}}$$

$$q = 0.9$$

3. Consider a case of albinism; Let A represent the allele for normal pigmentation (dormant); Let a represent the allele for albinism (recessive)
Consider a normal man and albino wife.

Parents phonotype normal Mn x Albino women
Parental genotype AA aa
Meiosis
Gaametes (n) all A a
Randon fertilization
F2 genotypes (2) Aa
F2 phenotype all norma ozygous

4.Consider marriage between heterozygous above
F1 genotype (2n) Aa x Aa
Meiosis
Gemetes (p) A a A a
Random fertilization
F2 genotypes (2n)
F2 phenotype

Let p represent the allele frequency of allele A
Q represent the allele frequency at allele a.
P+q = 1.0 or 100%
$P^2 + 2qp + q^2 = 1.0$ or 100%
The above $p^2 + 2qp+q^2 =1$ is refered to as Hardy Weinber's equation where
p- refers to the frequency of dominant allele in the population
q – refers to the frequency of recessive allele in a population
p^2 – refers to the frequency of homozygous genotype
2pq – refers to the frequency of heterozygous genotype
q2 – refers to the frequency of heterozygous recessive genotype.

4. In a population of 100 individuals, 30 can roll their tongues. Calculate
(a) The propotion of non rollers.
(b) Calculate the population of the roller allele.
(c)Calculate the populations that are homozygous rollers and rollers.

Solution.
a) No of non rollers = 100-3= 70
$q^2 = \frac{70}{100}$
$q^2 = 0.1$
b) proportion of roller allele p.
from Hardy Weinbergs low p+q = 100
$q^2 = 0.7$
$q = \sqrt{0.7} = 0.837$
p = 1-q
= 1-0.837
P=0.163

Proportion of homozygous rollers (p^2)
P= 0.163
P^2 = 0.0267
Number of heterozygous rollers 2pq
2pq = 2(pxq)
= 2(0.163 x 0.857)
=0.273
No of heterozygous rollers = 0.273 x 100
= 27

5. In a group of 22 individuals, 12 can roll their tongues. Given that ability to roll the tongue is called by a dormant allele. Calculate

(i)The percentage of non rollers
(ii) Frequency of the non roller allele
(iii) Frequency of the roller allele
(iv) Percentage of homozygous dorminant rollers
(v)percentage of heterozygous rollers.

Solution

(i)No. of non rollers 32-12 = 20
$Q^2 = \frac{20}{32}$ x100
Q^2= 62.5%
(ii) frequency of non rollers alleles(q)
$\frac{no.\ of\ non\ roller}{total\ proportion} = \frac{20}{30}$ = 0.625
q^2= 0.625
q=$\sqrt{0.625}$
q=0.79
iii. Frequency of roller allele = p
p+q = 1
p= 1-q
= 1-0.79
P=0.21
(iv) Percentage of homozygous dormant rollers
no of homozygous dormant rollers = p^2= x total population
or p^2x 100 = 0.21^2x100 = 4.4
$(0.21)^2$ x 32 = 1.4
$(\frac{1.4}{32})$ x 100= 4.375= 4.4%
(v) percentage of the heterozygous roller
number 2pq = 2 x 0.21 x 0.79 x 32
number of heterozygous = 10.617
%ge =$(\frac{10.617}{32})$ x 100= 33.18%

6. The genotype of rhesus positive individuals may be represented by RR and Rr. Rhesus negative individuals are rr. Consider a population frequency in which 16% of individuals are rhesus negative

(a) What is the frequency of;

(i)the small r allele
(ii) the RR allele
(iii) the Rhesus positive individuals carrying a recessive allele
(b) in a population where the frequency remains constant. What assumptions can be made about that population.

Solution.

(i) $q^2 = \frac{16}{100}$
$q^2 = 0.16$
$q = \sqrt{0.16}$
$q = 0.4$

(ii) $p+q = 1$
$p = 1-0.4$
$p = 0.6$

(iii) $2pq = 2 \times 0.6 \times 0.4$(frequency represented as 2pq)= 0.48

(b)
- No. mutation
- The population is large
- Random mating
- No natural selection
- No overlap of generation
- No migration

7.Given that in population of 5000 people. 1800 of them are non rollers.calculate
(a) Percentage of homozygous recessive individuals
(b) Frequency of a recessive allele in a population
(c) Frequency of dormant allele in a population.
(d) percentage of people, who are
(i) Homozygous
(ii) heterozygous dormant

Solution;

(a)($\frac{1800}{5000} \times 100$) = 36%
(b) Frequency of recessive allele (q)
$q^2 = \frac{36}{100} = 0.36$, $q = \sqrt{0.36}$, $q = 0.6$
(c) Dormant allele (p), $P+q = 1$, $P = 1-0.6$, $P=0.4$
(d) (i) percentage of homozygous dominant
No. of homozygous dominant (p)
$P^2 \times 5000 = 0.4^2 \times 5000 = 800$, %ge =($\frac{800}{5000} \times 100$)= 16%
(ii) No. of heterozygous dominant = $2pq \times 500 = 2 \times 0.4 \times 0.6 \times 5000$
2400
%ge =($\frac{2400}{5000} \times 1000$) = 48%

SPECIATION

Is a process by which new species are forced from pre-existing species.
Speciation arises when two similar groups of responding individuals are reproductively isolated. Ie when gene flow between such groups are referred to as isolating mechanism.
Isolating mechanisms; *are a means of producing and maintaining reproductive isolation with in a population.*Or a means of producing and maintaining prevention gene flow with a population.

Types Of Speciation

Intraspecific agaist interspecific speciation
Intraspeciation;*Occurs when a single species gives rise to new species.*
Interspecific speciation / interspecific hybridization;*Occurs when two different species give rise to a new species.*
Intraspecific speciation may further be classified as sympatic speciation and allopatric speciation.

Allopatric speciation.

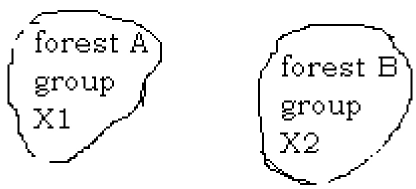
This occurs as a result of orgasms of the same species becoming geographically isolated by physical barriers eg mountain ranges, deserts, rivers etc.
This leads to either groups on either side of a physical barrier adapting to suit. Its own environment ie adaptive radiation. Image that climatically changes result into areas becoming isolated from one another by an area of rid grassland.

A possible sequence of events which could lead to a new species being formedunder these conditions is illustrated below.

(a)

Species X occupies a forest area. Individuals of the species with in the forest form a single gene pool.

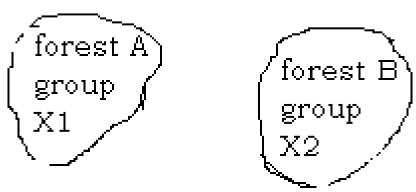
(b)



Arid grassland

Climatic changes to drier conditions reduce the size of the forest to two smaller isolated forests. The distance between the two smaller forests is large for the two deme members to meet or breed.

(c)



Further climatic changes result in one region (Forest A) becoming adoptive radiation to adapt these new environment. On the other hand, climate changes in forest B market warmer and dry; group X2 also undergoes adaptive radiation to adopt these new conditions.

(d)

Continued adaption lead to evolution of a new form thus group Y in forest A.

(e)

A return to the original climatic conditions results in the re-growth of a forest. Forest A and B are merged and groups X and Y are (re) united.
The two groups are no longer capable of inter breeding to produce fertile off springs.
a) sympatric speciation
it occurs when organisms. Inhabiting the same area become reproductively isolated into two groups for reasons other than physical or geographical barriers. Such organisms are prevented from breeding by form of effective reproduction isolating mechanisms which may act pre- or post zygotically.
Pre-zygotic isolating mechanisms
Seasonal isolation. Occurs when members of two demes of given species, mate or flower at different times of the year.
Ecological isolation. Occurs when members of two different dem of a given species inhabit the same area but have the different preferences ie one dreme preferring acidic soils, the other alkalne soils.
Behavioral isolation. Occurs in numbers that exhibit courtship patterns, mating only occurs if the courtship display by one sex results in acceptance by the other sex. In members of two different done have different courtship pattern, the mating may not be possible.
Mechanical isolation occurs in animals where physical non- correspondence of the genitals prevents successive copulation between members of two different genes of a species. In plants it occurs where members of two different demes of a plant species are pollinated by different animals.
Gamete incompatibility: occurs where the gametes from members of two different demes of a species are so different that the male and female cannot fuze for successful fertilization.
Post zygotic isolating mechanisms. (barriers affecting)
These are barriers that affect hybrids /zygotes; a hybrid is formed between members of two separate demes of a species or between two separate species but the hybrid faces serious challenges which include the following.
1. Hybrid inviability: Hybrids are forced but fail to develop to maturally.
Hybride sterility: The hybrid fail to produce functions gametes eg the horse (equus equus) and the ass (Equus hemonins) the resulting hybrid the male is infertile.

Horse (2n = 60) x Ass (2n = 66)
N=30 n= 33

Mute (infertile)
(2n = 63)

Hybrid breakdown
F1 hybrids are fertile but the F2 generation and back crosses between F1 hybrides and parental stocks are infertile or fail to develop eg as observed in cotton.
Interspecific hybridization

It occurs when to different species give rise to a new species. It is a form of sympatric speciation that occurs when a new species is produced by the crossing of individuals from two unrelated species.

Such only happens, in cases where the interspecific hybridization is as a result of special of chromosome mutation known as allopolyploidy.

Cabbage X Radish
Parents (2n) Brassica-deraceae Raphanus Sakivus
2n =18 2n=18
Meiosis
Gametes n=9 n=9
Fertilization
F1 Hybrid 2n = 18

2n = 18 During meiosis in F1 hybrids, chromosomes from each parent cannot bear together to form homologous pairs. The F1 hybrids are therefore sterile occassionaly, non-disjunction of chromosomes occurs during gamete formation in F1 hybrids resulting into formation of gametes with a diploid set of chromosomes (2n = 18).

Gametes 2n =18 x 2n = 18
Fertilization
F2 Hybrids 4n = 36
Raphonobrassica (tetraploid).

QUESTIONS;

1(a) What is a gene pool?

(b) What may cause a gene pool of a population to be static?

(c)(i)State three factors that may contribute to the change in the frequency of the dominant and recessive allele in a population.

(d) Explain how each factor stated in (c)(i) above may cause changes in the frequency of the dominant and recessive alleles in a population.

Solution

(a) A gene pool is the total variety of genes and alleles present in a sexually reproducing population.

(b) -When the genetic variation in a population is independent to bring about evolutionary change.

- Lack of distructive influences like mutation or environmental change.

(c)(i) -Mutations

-Environmental change

-Small population

-Natural selection

-Blased selection mating or non random mating

-Total loss of an allele from a population as a result of inter breeding between neighbouring population

(ii) – Mutation alters genes or chromosomes. This changes the frequency of the allele.

Environmental change can cause alteration in selection pressure which may favour certain alleles at the expense of the others.
In a small population size, individuals may fail to produce successfully and leads to alternation of frequency of alleles.
Natural selection, promotes alleles for favourable characteristics with in a population which therefore reduces/eliminates alleles of unfavourable characters.
Biased/selective mating promotes certain alleles against others, changing the frequency of the alleles.
Total loss of an allele in a small population, individuals carryng a particular allele may fail to reproduce successfully. Their alleles are then totally lost from the population.
2(a) What is meant by the following phenomenon?

Natural selection

Reproductive isolation

Polyphidy

(b) Explain the role played by each of the phenomenon in (a) above in evolution of a new species.
(c)How may species become extinct.
Solution
(a)(i) Natural selection is a phenomenon where organisms with favourable characters have larger and reproduce in an environment of contrasting characteristics which those unfavourable traits die and weeded out.
(ii) Reproduction isolation in cessation/prevention of free interbreeding among individuals of the population
(iii) Polyphoidy is a condition in which an organism acquires an extra complete set of chromosomes.
(b) (i) Role of natural selection organisms with new formulable characteristics live longer and reproduce. They pass on their traits to the next generation. If this confirms for a long time it leads to accumulation of the new favourable alleles with the subsequent evolution of new species.
Early death of organisms with unfavourable characteristics eliminates them from the population.
(ii) Role of reproductive isolation.

It leads to differential reproduction among some individuals of the population new traits accumulate in the population and over several generations, new species may arise.

Role of polyploidy

It is often associated with advantageous characteristics (hybrid vigour) due to gene mixing.

Associated traits include greater hardness a resistance to diseases/ adaptation to environment

Selection for these characteristics in nature leads to production of new species.

(c) Extinction of species
- Species may become extinct because of failure to adopt to the environment resulting in selective disadvantage.
- Selection pressure that may cause extinction include predation, lack of basic nutrients or elimination of a time in a food chain.
- An organism may also extinct as a result of interse competition from new development closely related species.
- As its population decreased gene flow with in the population in intemepted leading to extinction.

3. Describe how a new species of organisms may arise.

Solution

The process by which a new species a rises is called specialization splits into two or more separate demers each with its own gene pool.

These demes should be isolated from one another to avoid exchange of genes in a single large population, this encourages gene differentiation.

Mutations and selection also take place independently in the isolated populations and each can develop into distinct species.

The mechanisms of isolation that may lead to formation of new species.

Geographical / ecological isolation.

This is when physical barriers such as mountains or rivers separate a population into two or more populations subjected to different physical conditions. It enables each of the population to evolve into a new species so that when these are brought together, each population will have charged its genetic constitution, making interbreed impossible.

Reproductive isolation

Two or more population may not be ecologically separated but may effectively be isolated by the fact that they cannot in breed. This may be caused by lack of attraction between males and females or by physical non correspondence of genetalia. This makes the two or more isolated population to inbreed and produce new species.

Behavioural isolation

This usually occurs in animal is so that courtship behavioral of one group of animals fails to stimulate the other to sexual activity. This leads to failure of interbreeding between such animals but occurs only among those in which sexual activity is stimulated. This produces new species of differentally interbreeding population.

Genetic isolation

Even though mating may be possible, fundamental different in genetic constitution may prevent reproduction being successful. Thus the gametes may be prevented from fusing. Forex ample by the pollen grain of a population of plants to germination the stigmas of the other.Even after fertilization if it occurs, the zygote may be inferior in same way and fail to develop properly. Some times off spring are produced but the hybrids may be adaptively inferior, having for a short time arthey may be sterile as in the mule, formed by inter breeding between donkeys and horses.

4(a) Outline the five major theories of origin of life (5 marks)
(b) Which are three stages that have been proposed for biochemical evolution theory of the origin of life (4 marks)
(c) What do you understand by the following terms as used in evolution.
i). Adaptive radiation (2marks)
ii). Convergent evolution (2marks)
iii). Divergent evolution (2 marks)
Solution

Theories of origin of life these area:

Special creation

According to this theory, life was created by super natural being (God) at a particular time in the past. It is supported by most of the world's major religions and civilizations since the process of creation occurred once, it can not be investigated to prove or disprove it.
(ii) Spontaneous generation.
According to this theory, life arose from man living matter on numerous occasions in a process called a biogenesic eg field mice from mud of water bodies, flies from dirt like decaying meat etc.
The theory was believed to be a process of origin of life because complex life cycles of many plants and dominants were not understood at that time.
However Franscisco Redi demonstrated that maggots of files could arise spontaneously from decaying meat but from living eggs laid by flies. He showed that can only arise from living matter a process called biogenesis as it was later demonstrated by Louis Pasteur that life arises from pre-existing life.
(iii) The steady state theory
The theory states that the earth and species on it have no origin and have always existed. It contends that the species on the earth have only changed remarkably through the process of evolution hence life has no origin.

Cosmozoan theory

This theory states that life arose from else where in the unverse and arrived on earth by some means life could have existed outside the solar system and when it reached the earth, organisms gained it.

The theory of bio chemical evolution

This is the most widely accepted theory by the scientists up to present day. It states that life a rose from combination of simple molecule to form complex ones which gave rise to the first primitive organisms. I oparin and J.B.S Haldane put forward this theory and suggested that it occupied in three steps.

Formation of small organic molecules

At the beginning molecules like CO_2, NH_3, CH_4, H_2, H_2O, He were present in the atmosphere. These molecules had been formed from condensed solar material during cooling.

Due to electrical discharge such as lightning in the earth atmosphere, there molecules combined to form other organic simple molecules such as amino acids, organic bases and sugars like glucose, fructose, ribose etc. the concentration of these molecules increased on surface of oceans and seas especially in the estuanine mud due to accumulation of organic molecules, oceans and seas become a thick organic soup with a variety of such organic molecules.

Formation of polymers

The concentration of the organic molecules in step I became so great and became polymerized by condensation reactions.
Amino acids combined to form protein molecules called proteinoids. The organic bases, in presence of phosphates also combined with ribose to form nucleic acids or poly nucleotides (RNA). The polymers then formed special droplets called ceacervates which broke up and increased in size. When they became large enough, they again broke up and in the process, they replicated them selves.

The formation of the first cells (protocells)

Before the first true cell arose there would have been a proto cell, a structure that has a lipid – protein membrane and carries an energy metabolism.
The coatervates were surrounded by a lipid- protein membrane to firm the first cells called proto cells. These contained nucleic and which replicated they fed by absorption and respired anaerobically.
The early cells or anaerobic prokaryotic cells later developed ability to synthesis complex organic molecules (polymers) from simple in organic molecules using earth's radiation hence became photosyntic. These produced oxygen that later enabled aerobic forms/cells to evolve.
In this way, the prokaryotic cells gene rise to enlearyotic cells which resulted in colonial/synatial forms that later gave rise to multicellular organisms. As a result of adaptive radiation and natural selection, different species arose including those found on land.
Assumptions on to which the theory of bio chemical evolution was based

- The primitive earth's atmosphere was quite different from that of today.
- There was an abundance of chemical ingredients than enabled the molecules to interact.
- The source of energy was also available to bring about interactions of molecules that resulted in form of complex molecules of life.

Theories of Evolution.
Two main theories were put forward based on the evolution of new species by gradual adaptation of the existing ones.
These are: Lamark's theory and Darwin's theory.
Lamark's theory; (1744-1829)
Lamark was a French biologists who first putforward a hypothesis to account for the mechanism of evolution. He based his theory on two conditions.

- The use and disuse of paits of the organisms. According to Lamark, when extensive use of a part of the organism leads to its increase in size and efficiency. The disuse of a part of the organism leads to its degeneracy and atrophy.
- The inheritance of acquired characteristics.Lamark contended that the traits acquired during lifetime of an organism are inherited and transmitted to the off spring.

Lamarks theory is illustrated using examples like:

- The long neck and legs of the modern giraffe were the result of generations of short necked and short logged ancestors feeding on leaves at higher levels of trees.
- The webbed feet of aquatic birds arose as a result of their ancestors speading their toes and the skin between them for swimming.
- The shape of flat fish came about as a result of the fish lying on their sides in shallow water.

Advantage of theory.
He emphasized the role of the environment to produce phenotypic changes in the individual eg body building exercise increase the size of the muscles.
Disadvantage/limitation
The acquired characteristics have no influence on the genotype and cannot be intritedxxx as demonstrated by weisman when cut off tails of mice did not produce a progency with smaller tails hence smatic (body) acquired traits don't affect gametes through which traits are passed on to a new generation.
Discuss the essential features of the theory of natural selction as put forward by Darwin.
Darwins theory of evolution by natural selection
According to Darwins and Wallace natural selection the mechanism by which new species arise from pre-existing species. This theory was based in three observations and two deductions
Observation 1
Individuals with in a population have a high / great reproductive potential ie they a recapable of giving rise to large number of off spring and if survived would lead to a geometric increase in the size of any population.
Observation 2
The numbers of individuals in a population remain approximately constant ie the majority of the off spring must die before they are able to reproduce.
Deduction 1
Darwin deduced basing on observation 1 and 2 that members of a pseices were constantly competing with each other for existence ie struggle for existence. In the struggle for existence only a few could live longer and mate/breed or reproduce.
Observation 3

The sexually produced in individuals / off springs show variations so that no two individuals are identical.

Deduction 2

Some individuals had between and favourable characteristics that enabled them survive in a given environment. They were more adapted (fitter) to survive long enough in the struggle for existence and be able breed.Since like produces like those which survive to breed are likely to produce off spring similar to them. Their advantageous characteristics are then passed into the subsequent generation.The individuals with unfavourable characteristics are less likely to survive long enough and over many generations their numbers decline.The development of a number of variations in a particular direction over many generations will gradually lead to evolution of new species by natural/selection.

Facts about 3 observations based on natural selection

Observation 1

Reproductive capacity is a basis to all living organisms and ensures the continuity of a species.

Observation 2

The number of individuals in a population remains approximately constant because all population sizes are limited by various environment factors such as food availability, space, light etc. the population tends to increase up to the maximum level (at equilibrium) that can be supported by the environment.

Observation 3

Darwins study of beetles, pigeons and Finches gave him a due that individuals had different characteristics that either enable them survive or not in a given environment by becoming better adapted or less. However Darwin could not account for the sources of these variations.

Conclusions / deductions

Deduction 1

The continous competition between individuals for environmental resources creates a struggle for existence. Whether the competition is with the species or between members of different species may be irrelevant in affecting the size of the individuals population, but will still indicate that certain organism will fail to survive or reproduce.

Deduction 2

Since all individuals with in a population show variation and a struggle for existence has been clearly established. It follows that some individuals having particular variations (physical physiological or behavioural) that give an organism an advantage over another organism acts as a selective advantage in the struggle for existence. The favourable variations are inherited by the next generation while the unfavourable variations are selected out/against and their presence conferring a selective disadvantage on the organism. In this way natural seletion leads to increased vigour with in the species and ensures the survival of that species.

Misconceptions of Darwin's theory

Darwin made on attempt to describe how life originated on earth. His new ways about how new species might a rise from pre existing species.

Natural selection is not simply a negative destrive force, but can be a positive mechanism of change with in a population. The struggle for existence explained by darwins had unfortunate terms like survival for the fittest or elimination of unfit according Herbet spencer.

That humans were discended from the apes by the process of linear progression as offended by the religious and secular communities.

The apparent contradiction between the genesis 6th day creation account and that of the aprogressive origin for species.

Modern views on evolution

The theory of evolution as proposed by Darwin and Wallace has been modified in terms of modern genetics and other branches of biology and this is called **Neo-Darwinism.**

Neo-Darwinism is a theory of organic evolution by natural selection of inherited characteristics in order to accept neo Darwiniar evolutionary theory it is necessary to;

Established the fact that evolution (charge) has taken place in the past (past evolution)Demonstrate a mechanism which results in evolution (natural selection of genes).Observe evolution happening today (evolution in action).

Genes serve to work together with the environmental factors and determine the phenotypes of the organisms and are responsible for variations with in populations. The theory of natural selection suggests the phenotyps adapted to the environmental conditions are selected for while those that are not well adapted, are selected against and then eliminated when natural selection operates on individual organisms of a species, it is the collective genetic response of the whole population that determine both the survival and formation of a new species of natural selection are at the level of the gene and the population rather than the individuals because members of the population can interbreed, exchange their genes and pass them to the next generation. Hence there is flow of genes between members of a population. Natural of the fittest genes occurs.

Evolution occurs when the gene frequencies change distance the Hardy Weinberg equilibrium.

Other factors that bring about in gene frequencies are:

Mutation

Genetic drift

Selection or differential reproduction

Migration

The greater the number of variable loci and the more allele are each locus, the greater is the possibility for change in allele frequencies.Natural populations show a great extent of variation with respect to many characteristics. Not all variations that organisms exhibit in nature are heritable as some are mere adaptations for a particular mode of life in a particular environment.The only variations that cause a change in gene frequencies are heritable genetic variations and when passed on to the subsequent generations, they are like to cause evolutionary changes.

Agents of evolution (causes of genetic variation)

An agent of evolution is a factor that brings about a change in allele frequencies in natural population. These are

- Genetic recombination
- Mutation
- Natural selection
- Isolation mechanisms

Genetic recombination

In a population of organisms which reproduce a sexually, every new individual in identical with its parents since they are product mitotically (unless mutations occur).However most of the individuals produced by sexual means differ from their parents in many aspects. This is due to genetic recombination.In sexually reproducing organisms during gameto genesis, the homologous chromosomes pair up and exchange genetic material by the process of crossing over. This produces new combinations of genes in chromosomes in a process called **genetic recombination**.

Fertilization brings together genetic material from two different cells (sperm and ovum) which differ in their genetic constitution. The off spring has all the genes of the parents with their different ambitions hence the difference in the phenotypic characteristics.The process of recombination add variability to individuals of the population and hence a change in gene frequencies.An evolutionary change is possible only when some of these variations are selected due to their adaptive advantage.

Mutations

A mutation is the sudden, spontaneous appearance of a new allele for a particular gene or group of genes most mutations that occur are harful to organisms (Lethal mutations) and have no evolutionary significance because the organisms possessing them are not able to survive.However a fraction of mutations help to increase variations in populations.Natural selection acts on fvourable mutations to bring about evolutionary changes hence act as raw for the process of evolution.

Genetic drift

Genetic drift is the variation/ change in the allele frequencies in a natured population by pure chance (ie due to death of individuals by accident or natural calamities or due to migration) rather than natural selection. This change decreases as the size of the population increases and has great effect on changing the allele frequencies of small populations hence bringing about evolution.

Gene reshuffling

Gene reshuffling occurs as a result of meiosis. During metaphase I of the first meiotic division homologous chromosome come together in pairs and subsequently segregate into daughter cells, independtly of each other. The result of the production of a wide variety of different gametes depending on which particular chromosomes are combined in the daughter cells.This in turn depends on the way the different chromosomes line up on the spindle prior to separating. The total number of possible combinations depends in how many pairs of chromosomes there are in the parent cell.This promotes genetic variability as it mixes up the alleles of genes carried on different chromosomes and this provides a basis of continuous variation in a population although they play little role as the new combination of genes in one generation can be reversed. This plays only little parts in effecting long term evolution any change.

Natural selection (differential reproduction)

This is a process in which individual with favourable characteristics are better adapted to their environment, survive breed and pass their favourable characteristics to the off spring while those with unfavourable fail to do so and are weeded out.It is an evolutionary agent that determines which of the heritable variations are to be retained in natural population.Organisms in a population show a great deal of difference in terms of rates of survival and reproduction. Due to this differential reproduction and survival among individuals of a population, certain alleles increase in frequency in a deme at the expense of others.When the frequency of some alleles increase, that of others decreases. The increase or decrease in allele frequencies in the population due to natural selection depends on the phenotype characteristics produced and the uses of these characteristics to the organism in their survival and reproduction in a particular.

Adaptation

Adaptations is the fitting of an organism to its environment so that it can survive and reproduce successfully. It can also be defined as a character of an organism that can enable it survive in its environment.Natural selection preserves the best adapted individuals and the best adapted individuals are the best adapted individuals are the ones which possess heritable variations of an advantage in nature. Natural selection thus maintain a continuous pressure called selection pressure on the population pressure on the population to retain only better adapted individuals of a population.Selection pressure is exerted by the environment. The intensity and direction of pressure vary in both time and space when the population increases in size certain environmental factors become hunting and the individuals begin to compete for resources.Limiting factors and population size operate together to produce selection pressure. The selection pressure then determines which alleles are passed on to the next generation due to differential advanatage they will have shown when they express.

Types of selection process

Describe the major types of selection which operate in a population.

There are three types of selection process that operate in a population of a given species. These are

- Stabilizing selection
- Directional selection
- Disruptive selection

Stabilizing selection

When many different factors both genetic and environmental, contribute to a particular phenoty, petrait among individuals of a population, natural selection has stabilizing effect on that particular trait. The distribution of the particular phenotypes in this way is normal. It occurs in all populations and tends to eliminate the extremes with in a group thus reducing the variability in a population and hence a chance for evolutionary change.If the phenotypes in the middle of the distribution are favoured by natural selection, selection reduces variability around the mean (central part of the curve but does not change it).
For example in a population of a particular mammal, fur length shows continous variation. When the average environmental temperature is 10^{0}c, the optimum for length in 15cm and this represents the mean for length of the population.Individuals with in the population have a range of coal length from 0.5 cm to 3.0 cm but the average temperature varies from year to year.When the environmental temperature rises to 15^{o}c, the individuals wurt shurter for may be at an advantage. They lose heat at a high rate and their members increase at the experise of those with longer fur.However, when the environmental temperature falls, the reverse is fur and individuals with longer fur increase in numbers at the expense of those with shorter fur.
Periodic fluctuation in environmental temperature help to maintain individuals with long and short fur. If the average environmental temperature is 10^{o}c and remains constant no fluctuations occur. The mean fur length remains at 1.5 cm but the distribution curve would show a much narrower range of fur length.
Directional selection
This form of selection operates in response to gradual changes in the environmental conditions to enable a species adapt to these new conditions.
In a population there will be a range of individuals in respect of individuals in respect of any one character. The continous variation among individuals firms a normal distribution curve with a mean which represents the optimum for existing conditions.
When the conditions charge, the optimum also change by moving the mean phenotype to one phenotypic extreme needs any fur survival. A few individuals will possess the new optimum and by selection, these in time will predominate. The mean of this particular character will have shifted.
For example if the average environmental temperature is 10^{o}c the optimum fur length is 1.5 cm and this represent the men fur length in a population. A few individuals in the population a fur length of 2.0 cm or greater of the average environmental temperature falls to 5% these individuals are better insulated and so are likely to survive to breed. There is a selection pressure in favour of individuals with longer fur.
Selection pressure causes a shift in the mean fur length towards longer fur length towards longer fur length towards, longer fur length over a number of generations and then continues over further generations the shift in the mean fur length continues until it reaches 2.0 cm (The optimum length) for the prevailing average environmental temperature of 5^{o}c and then selection ceases as shown below.
………………………………………………………

Disruptive selection

This is a form of selection in which the changes in the environmental conditions favour the presence of more than one phenotype with in a population. This is a rare form of selection but very important in bringing about evolutionary change.The selection pressure act form with in the population as a result of mercased ampetition to push the phenotypes a way from the mean for a particular characteristic in a population towards the extremes of the population.This splits the population into two sub populations is prevented, each population gives rise to new species.For example, if the environmental temperature fluctuates between 5^0c and 15^oc with no intermed late temp occuring. Thus would favour the development of two distinct phenotypes with in a population one with fur length of 2.0 cm^2 the optimum length at environmental temperature of 5^oc) and the other with fur length of 1.0cm (optimum length at 15^oc).It is possible the group with 2.0 an fur would aestivate or migrate when it is not to prevent over heating and the other group of 1.0cm fur xxxxx imbernate or migrate during cold conditions to avoid much heat loss.In this way, reproduction between the two groups is interrupted and gene flow between the two groups is prevented.Each population may become a separate species but where interbreeding continues and the number of distinct phenotypic forms remains it is called **polymorphism.**

POLYMORPHISM.

This is the existence of two or more forms species with in the same population. There are two forms of polymorphism i.e transient polymorphism and balanced stable polymorphism.

Balanced polymorphism

This occurs when different forms co-exist in the same population in a stable environment. The genotypic frequencies of the various forms exhibit equilibrium since each form has a selective advantage of equal intensity.

Examples of balanced/stable polymorphism

The existence of A, B, AB and O blood groups. The genotype frequencies with in different populations may vary but they remain constant for generations with in a population. This is because none of them have a selective advantage over the other. For example white men with blood group O have greater life expectancy than those of the blood groups but have increasing risks of developing duodenal ucers that lead to death.

- Red-greed colour blindness in humans.
- The existence of workers, done and queens in social insects.
- Pin eyed and thrum-eyed in miose.
- Colour and banding pattern in land small.
- Colour and banding pattern in land snall (cepaea memoralise). The shells of land snails cepaca ne moralis have avariety of distinct colours such yellow, pink and brown.

The shells may also be marked with dark bands, ranging in number from 1 to 5. The proportions of the handed shells differ depending on the habitat around eg

where the surrounding in relatively uniform eg a grass land, the proportion of banded shells captured by predator is greater than that of un bended, while a less uniform area the proportion of unbanded shell is greater than that of banded.
In the uniform back grounds band shells are more conspicuous band shells are more easily seen by predators and form a large number of them in this habitat while the bands on the shells tend to break up the shape of the animal hence providing a form of disruptive carnouflage.Being more conspicuous, they are more frequently captured by the predator and as a result of this selection, the variety of snail shell commonly sound around any anvil is rare in the surrounding habitat.The balance in number of each form may not be determined purely by colour and band pattern. The physiological effect may help to maintain the polymorphic equilibrium.Polymorphism is cepaea is said to rely in the existence of a special form of gene linkage. The genes for colour and banding are linkages together to form super gene which acts as a single unit. The genes that determine characteristics have a selective advantage to be maintained in a population. It is a variety of allelic forms of these genes maintained by heterozyotes which form the basis of the polymorphism.The existence of a number of distinct inherited varieties co existing in the same population at frequencies too great to be explained by recurrent mutation.Transient polymorphism.This a rises when different farms or morphus exist in a population under go a shrug selection pressure. The frequency of the phenotypic appearance of each form is determined by the intensity of the selection pressure such as the melanic and non melenic forms of preppered moth. This type of polymorphism occurs in situations where one form/merph is gradually being replaced by another.
Polymorphism in the peppered moth (Biston betularia) (industrial melanism.
Industrial melanism refers to the development of darker colours by certain moths in response to large deposition of soot/carbas on the tree trunks in the industrialized area in Britain. Before industrial revolution the forms of peppered month Biston betulana appeared creamy white with black dots and darkly shaded areas. During industrial revolution pollution caused death of linchens and accumulation of carbon / sat on barks of trees. Around this time the melanic (black) variety a rose as a result of mutation.These mutants has occurred before the revolution but were highly consupions against the hight back ground of the lichens that covered the trees and rocks on which they normally rest. As a result the black mutants were subject to predator from insect coting birds than were better camonflaged, normal light forms.
The melanic (black) form of moth later became better adapted in the darker backgrounds with in the industrial areas as they could be more inconspicuous to predators. This form of natural selection is called selective predation andit acts as a selection pressure on distribution of the melanic and non melanic forms.
The melanic form of the moth' Biston betularia carbonana has a selective advantage in industrial areas over lighter form Biston betulana where as the lighter form has the selective advantage in non polluted areas.

The colouration of the dark form is due to presence of a dominant melanic allele. The presence of melanic forms in a non-industrial areas was as a result of their distribution by winds.

Artificial selection

This is a process in which man has influenced the process of evolution by exerting selection pressure inform of domestication of animals and plants man has bred plants and animals selectively were a period of time. This has been done in ways.

Inbreeding

This is a process by which a specific of plants or animals with desirable characteristics are made to breed with closely related individuals in order to retain such desirable characteristics in the subsequent generation eh in dogs and cats, cattle, pigs, poultry, sheep etc.

Disadvantage

It may lead to the increase in the frequency of harmful necessive genes whose expression in homozygous condition leads to reduction of variability and un desirable characteristics.

Out breeding

This is a process by which individuals that are genetically distinct are crossed to form new improved individuals with better qualities. The formed individuals are called hybrids and have the following advantages in plants.

Increased size in fruits

Increased resistence to diseases, drought etc

Early maturity

High yielding eg

In animals, out breeding is not so common and where it has occurred, the individuals produced are usually sterive.

Out breeding frequently produces tougher individuals with a better chance of survival especially where many generation of inbreeding have taken place. This is known as hybrid vigour.Outbreeding results in individuals in heterozygous condition such that the recessive alleles are masked by the dominant alleles.

Note: selective hybridization can induce charges in chromosome number (chromosomal – mutation and this condition is called polyploidy that leas to the formation for a new species.

Founder's principle

It refers to the fact that when a small population splits off from the parent population it may not be fully representive in terms of alleles of the parent population. Some alleles may be absent and other disproportionally represent antimuos breeding with in the pioneer population will produce a gene pool with allele frequencies different from that of the original parent population.Genetic drift tends to reduce amount of genetic variation with in the population, mainly as a result of loss of those alleles which have low frequency. Antimial-mating with in a small population decreases the proportion of heterozygous and increases the number of homozygous while genetic drift may lead to a reduction in variation with in a population it can increase variation with in the species as a whole.Small populations may develop characteristics typical of the main population which may have a selective advantage of the environment changes. In this way genetic drift can contribute to the process of speciatic or formation of a new species.

Non random breeding (sexual selection)

Mating in most natural populations is non random. Sexual selection occurs when ever the presence of one or more inherited characteristics increase the likehood of bringing about successful fertilization of gametes.There are many structural and behavioral mechanism in both plants and animals in both plants and animals which prevent mating from being random eg

- Flowers have increased size of petals and amount of nectar to effect pollination.
- Colour patterns insects, fishers and birds effects selective breeding.
- Behavioral patterns such as rest building territory possesium and courtship increase the selective nature of breeding.

Sexual selection as a mechanism of non random mating, ensures that certain individuals with in the population have an increased reproductive potential and their alleles are likely to be passed on to the next generation.Organisms with less favourable characteristics have a decreased reproductive potential and the frequency of their alleles being passed into the next generations reduces.

Migration

A small fraction individuals in a given population may move a way from the original stock. The migrated organisms may under go mutation which in turn increase variations in the population hence their genes frequence will have changed with time and tend to differ from the original population leading to the formation of a new species.

Drug and pest resistance.

- Resistance to drugs.

It has been found out that certain bacterial cells developed resistance to some drugs ie the antibiotics failed to kill them in the normal way.Experiments have shown that this is not accumulative tolerance to the drug, but the result of chance mutation. The mutation allowed the bacteria to survive in presence of drugs like penicillin eg by producing an enxyme to break it down.In the presence of penicillin non resistant forms are destroyed.There is a selection pressure favouring the resistant types and the quantity and frequency of penicillin used increases the selection pressure also does. The resistance can be transmitted to the subsequent generations hence bring about an evolutionary change.

- Resistance to pesticides/ insecides.

When a pesticide eg DDT issued to spray for sometime, many insects develop resistance to it. The presence of the insecticide stimulates the gene present in mutatant varieties. This gene mitiates the synthesis of enzyme which break down the insecticide. Examples are mosquitoes in all the three genera. The insects which are exposed to insecticides exists in large numbers and have high reproductive potential to give a vast. In this populations there is a variety of different genes with different combinations. The individuals with such combinations of genes are less susceptible to insecticide. Pesticides than others. These survive and their offspring may be more resistant than the parent forms.Continued application of DDT selects for more adapted and resistant individuals which gives rise to new species.

Heavy metal tolerance in plants.

Natural selection also occurs on spoil heaps that contain the waste material from mining activities. These heaps contain high contain high concentration of certain heavy metals such as tin, lead, copper and nickel. In the high concentration, these metals are toxic to most plants.However some plants eg varieties of grasses have become genetically adapted to **survive high levels of metals. These plants are less competitive where** concentration of the metals is low and do not always survive. The well adapted plants to tolerate high concentration of metals survive and pass their characteristics to the next generation hence a new species a rise.

POPULATION GENETICS.

Concepts of species

A species *is a group of closely related of organism capable of interbreeding produce viable offspring organisms belong to a given species rarely exist naturally as a single large population but it is usually for species to exist a small inter breeding population called demes.*

Speciation

This is a process by which one or more species a rise from pre existing species.

Types of speciation

Intraspecific

This is a type in which a single species give rise to new species when intraspecific speciation occurs and the two populations are separated, it is called **allopathic speciation.**

Interspecific hybridization

This is when two different species give rise to one species. When the two populations occupy the same graphical area it is called **sympatric speciation**.

Intraspecific speciation

Several factors involved in intraspecific speciation but in all cases gene flow with in populations must be interrupted. As a result of this each sub population becomes genetically isolated.Changes in alleles and genotypes frequencies with in populations brough about by the effect of the natural selection on the range of phenotypes produced by mutation and sexual recombination leads to the formation of races and subspecies.If genetic isolation persists for over a prolonged period of time and the sub species come together to occupy same area, may or may not inter breed.If the breeding is successful they may still be considered to belong to the same species.If the breeding is in successful, then speciation has occurred and the subspecies may now be considered to be a separate species. In this way an evolutionary change is brought about.The initial in the process of speciation may be the reduction in intensity of selection pressure with in the population. This leads to increase mitraspecific variability. This leads to increased intraspecific variability.The new phenotypes may enable the population to increase its geographical range if the phenotypes show adaptation to the environmental conditions founded the extremes of the range provided there is no reduction in gene flow through out the population, the species while exhibiting localized phenotypic variation, will share same gene pool and continue to exist as a single species.Speciation will only occur as a result of the formation of barrier which lead to reproductive isolation between members of the population.

Allopatric speciation

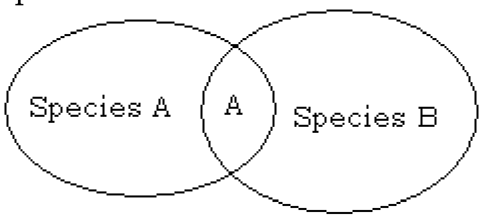
This is a mode of speciation in which there is separation of the two population by a natural barrier such as a mountain, sees, ocean or a river or lake to prevent gene flow.The mobility of organisms or their gametes to meet leads to reproductive isolation. Adaptation to new conditions or random genetic drift in small populations leads to changes in allele and genotype frequencies. Prolonged separation of populations may result in them becoming genetically isolated been brought together. In this way new species may rise.For example the variety and distribution of the dinche species belonging to the family geospizidac on the islands of Galapagos arehipelago and thought to be as a result of allopatric speciation.**Davis lack** suggested that original stock of finches reached the Galapos islands from the main land of south America, in the absence of competition from endemic species (relaxed selection pressure) adaptive radiation occurred to produce avariety of species adapt to particular ecological inches. The various species are believed to have evolved in geographical isolation to the point that when dispersal brought them together on certain islands they were able to co exist as separate species.

Sympatric speciation

This is a mode of speciation in which two different population occupy the same geographical area.Genetic differences may accumulate allopatrically in populations which have been geographically isolated for much shorter period of time. If these population, hybrids may form where these over lap.For example both carrian crow and hooded grow are formed in British isles. The carrion grow is black common in England and Scotland. The noocked grow is black with a grey back and belly founded in northern Scotland.Hybrids from mating of carrian and hooded crows occupying a narrow region extending across central Scotland. These hybrids have reduced fertility and serve as an efficient reproductive barrier to gene flow between populations of the carrian and hooded grows.Selection against cross breed may occur, leading to specialization since much speciation occurs financially in the same geographical area, this is called sympatic speciation.Sympatric speciation doesnot include geographical separation of population at the time at which genertic isolation occur.It requires some form of reproductive isolating mechanism which arises by selection with in a geographically confirmed area.Sympatic speciation provides an explanation or how closely related species probably arose from a common ancestor by temporary isolation, can coexist as separate species with in the same geographical area for example in the Galapagos archipelago, the finch (C. pauper) is found only an Charles islands where it co exists with a related form C-Psittacula which is widely distributed through out the centered islands. These species have different beakshape feed in different food, do not attract each during breeding season and therefore remain distinct and are able to co exist.

Ring species

This is a special form of sympatric speciation which occurs at a point where two populations at extremes of a dine meet up and inhabit the same area.



Sympatic speciation with out geographical isolation in sexually reproducing species in unlikely. However in a sexually reproducing species including vegetatively propagated angiosperms, a struggle mutant so different from its parent population as to be genetically isolated called give rise to a new species sympatrically eg polyploidy in spantiria.

Inter specific hybridization

This is a form of sympatric speciation which occurs when a new species is produced by crossing individuals from two un related species.Fertile hybrids usually appear only in cases of inter specific hybridization as a result of a form of chromosome mutation called allopolyploidy. An example is the case of hybrids formed between he cabbage and the radish.

Mechanism of speciation

Allele, genotype frequencies and Hardy Weinberg's principle

Gene Frequency

The appearance of ant physical characteristics for example coat colour in mice if determined by one or more genes. Genes exist in several forms called alleles. The number of organisms in a population carrying a particular allele determines the allele frequency.For example in humans the frequency of the dominants allele for production of pigment the skin/ law and eyes is 99%. The recessive allele responsible for lack of pigment (albinism) has frequency of 1%.The means that of the total number of alleles controlling production of the pigment, 1% results in lack of pigment and 99% result in its present ie the dominant allele frequencies 150,99 and the recessive allele frequency is 0.01.

Since the total population is 100% = 1.0

Dominant allele + recessive = 1

Frequency allele frequency

0.99 + 0.01 = 1

In mendelian geneties

Dominant allele is represented by N

Recessive allele by n

Therefore N= 0.99
N=0.01
In mathematical terms
Dorminant allele is represented by P.
Recessive allele by Q
P + q = 1
Since p = 0.99
Q = 0.01
If the frequency of either allele is known, the frequency of the pter may be determined.
Example
If the frequency of the recessive allele is 25% what is the frequency of the dominant allele.
Solution
P + q = 1
Q= 25% = $\frac{25}{100}$
= 0.25
P + 0.25 = 1
P = 1-0.25
= 0.75 or 75%
Genotype frequencies
The frequencies of particular alleles in the gene pool are of great importance in calculating genetic charges in a population and is determining the frequency of the genotypes since the genotype of an organism is the majo frequency are used in predicting possible out comes of the particular matings or crosses.
The mathematical relationship between the genotype and allele frequencies in a population was developed by English mathematician GH Hardy and a German physician W. Weinberg. The relationship is called Hardy weinberg equilibrium (principle).
It states that:
"The frequency of dominant and recessive alleles in a population will remain constant from generation to generation provided certain conditions exist".
These conditions are;

- The population must be large
- Mating must be random
- No mutation must occur
- All genotypes are equally fertile so that no natural selection occurs
- Generations should not over lap.

There should not be emigration and immigration from or into the population so that to prevent gene flow between the population.
Any changes in the allele or genotype frequencies must result from the introduction of one or more of the conditions above. These factors are important in producing

evolutionary change and when the changes occur, the hardy-weinberg equation can be used to study the change and measure its rate.

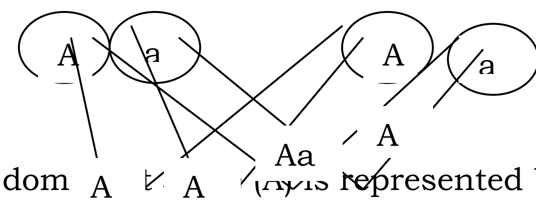
The Hardy – Weinberg equation

This equation provides/show how genetic equibrium can be maintained in a genepool. It’s main application is to calculate the frequencies of alleles and genotype.

Example

If there are two homozygous organisms, are dominant for allele (A) and the other for recessive allele (a). The off springs are all heterozygous (Aa).

Parental homozygous x Homozygous
Phenotypes dominant recessive
Genotypes Aa x Aa
Meiosis
Gemetes

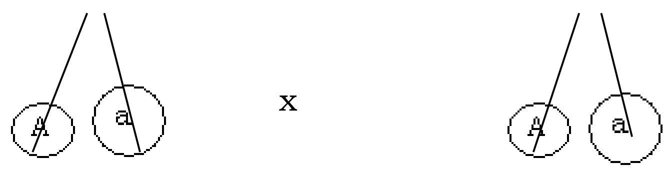


Fertilization
F1 genotypes

If its presence of a dom (A) is represented by P and recessive allele (a) by q, the nature and frequency of the genotypes produced by crossing the F1 genotypes are as follows:

Phenotypes Heterozygous Heterozygous
genotype Aa x Aa

Meiosis
Gametes x



Using a pumet square

Q/A	A(P)	a(q)
(p) A	A A (p^2)	Aq (pq)
a (q)	Aa (pq)	aq (q)

F_2 genetypes: AA (P^2) 2Aa (2pq) aa (q^2)

Phenotypes: Homozygous dominant heterozygous Homozygous recessive

since A is a dominant allele the ratio of dominant: recessive genotypes is 3:1, the mendalian monohybrid ratio. The distribution of possible genotypes is based in probability and can be represented in the following frequencies.

AA 2Aa aa

¼ ½ ¼

In terms of genotype frequency the sum of the three genotypes presented in the population is equal to one. When expressed in terms of P and Q, it is as follows

$P^2 + 2pq + q^2 = 1$

But mathematical expression of probability is p + q = 1 and $P^2 + 2pq + q^2 = 1$ is abinomial expression of that equation ie $(P\ t\ q)^2$.

From $P^2 + 2pq + q^2 = 1$ Hardy Weinsberg equation

P = dominant allele frequency

q = recessive allele frequency

P^2 = homozygous dominant genotype

2pq = heterozygous genotype

q^2 = homozygous recessive genotype

It is possible to calculate the allele and genotype frequencies using the expressions

P+q = 1 (for allele)

$P^2 + 2pq + q^2 = 1$ (for genotypes)

Example

One person in 10,000 is an albino ie the albino genotype frequency is 1 in 10000. Since the albino condition is recessive, the person must possess the homozygous recessive genotype and in terms a probability it is;

$q^2 = \frac{1}{10,000}$

$\sqrt{q^2} = \sqrt{0.0001}$

q=0.01

The frequency of the albino allele in the population is 0.01 or 1

Implications of Hardy Weinberg equation

Hardy-weinberg shows that a large proportion of the recessive alleles in a population exist in carrier heterozygotes. The heterozygotes maintain a potential source variability. Due to this, a few of the recessive alleles can be eliminated from the population in each generation.

Only the allele present in homozygous recessive organism will be expressed in phenotype and so be exposed to environmental selection and possible elimination.Many recessive alleles are eliminated because they confer disadvantages on the phenotype. This may result from death of the organism prior to breeding or failure to reproduce a condition called genetic death.However not all recessive alleles are disadvantageous to the population. For example in Human blood groups the commonest phenotypic characteristics in the population is blood group O, the homozygous recessive condition. Another agenetc defect of blood common in certain population. The homozygous recessive individuals usually die before reaching adulthood die before reaching adulthood to eliminate the two recessive allele from the populations. However the heterogotes do not suffer the same fate and sickle cell frequency remains relatively stable in the population. The individual with sickle cell allele have increased resistance to malaria. This gives a selective advantage to the heterozygous genotype to maintain sickle cell in the population at frequencies between 10 and 20%. As a result of the recessive allele is slowly being eliminated from the population, it gives an example of evolutionary change in action. The influence of the environmental selection mechanism in charges in allele frequency, a mechanism in that disrupts the genetic equilibrium predicted by Hardy-Weinberg principle. This mechanism brings about changes in population leading to evolutionary change.

Conditions in which Hardy Weinbergs principle does not apply

- There is non random breeding
- The population is small and leads to genetic drift
- Genotypes are not equally fertile so there is genetic load.
- Gene flow occurs between population.

More about genetic drift

Hardy-Weinberg principle is only applicable to large populations. In small populations, a condition called genetic drift arises. Consider an allele which occurs in 1% of the members of a species in a population of one million 10,000 individuals may be expected to possess that allele. Even if some of these fail to pass it into their off spring, the vast majority are likely to dose.

The proportion of individuals with the allele will not be significantly altered in next generation.

However if the population in much smaller e.g 100 individuals on by 10 will carry the allele. The effect of some of these failing to pass it on will have a marked effect on its frequency in the next generation. This drift in the frequency of an allele is greater the smaller the population eg a population of just 100 individuals, only me individual will possess the allele and if the individual fails to breed the allele will be lost from the population altogether.

Extinction of a species

This is an irreverble process by which a species of organisms gets lost after the death of the last surving individuals and their alleles do not exist any more.

Causes of extinction of aspecies.

- Destruction of habitats
- Over exploitation of species eg hunting
- Stiff competition in a new area.
- Intensive predation
- Oil pollution some rare species of birds
- Destruction by man as being a health risk eg badger

Isolation mechanisms

There are four main forms of isolation. These are

- Geographical/ecological isolation

This is when a physical barrier such as a mountain, a river separates a population into two or more populations and each is subjected to different environmental/physical conditions. This leads to the group/ population on each side to adapt suitably to its own environment ie under goes adaptive radiation.This enables a population to evolve into a new aspecies so that when they are brought together, each population will have charged its genetic constitution and inter breeding is impossible.

Physiological/ reproductive isolation

Two or more populations may be in the same econological area but can fail to breed fertile off spring successfully due to non correspondence of the generation.

Lack of attraction between the males and females

The gametes may be prevented from meeting eg in animals, the sperm may not survive in the female reproductive tract or in plants the pollen tube may fail to grow/geminate. This makes the two or more isolated populations to inbreed and produce new species.

3) Genetic isolation

Even though mating may be possible fundamental differences in genetic constitution may prevent reproduction being successful. Thus the gametes may be prevented from fussing eg the pollen tube may reach the embryo sac or the sperm may reach the ovum and fail to fuse due to being genetically incompatible.Even after fertilization, if it occurs the zygote may be inferior in some way or fail to develop properly (hybrid inevitability).Sometimes the off spring may be sterile eg in mile produced by a donkey and a horse.

4. Behavioral isolation

This usually occurs in animals so that courtiship of one group of animals fails to stimulate the other to sexual activity/mate.Timing of courtship behavior and gamete production is also important that if the season groups does not coincide, they can not breed. Different flowering times in plants may mean that cross pollination is impossible. This produces new species of differentially inter breeding populations.

Evidence of evolution

There are many sources of evidence for evolution. The main ones are:

Paleontology – Artificial

Classification - Selection

Comparative embryology

Comparative anatomy

Comparative biochemistry

Geographical distribution

Paleontology is the study of fossils.Fossils are forms of reserved remains that are believed to have come from living organisms eg a whole organism hard skeletal structures, moulds and casts, impressions, imprints, petrifications, coprolites. Most fossils occur in a rock which is formed from slow deposition of mud and silt to form a sedimentary rock laid down in layers called strata. The oldest layer at the bottom and newest at the top. The fossils in lower layers were formed earlier than those in the newer layers. The fossils reveal a gradual change from one form to the next as you move up the strata.

However the sequence of fossils is not continuous due to:

Dead organisms decompose rapidly
Dead organisms are eaten by slavenger
Soft bodied do not fossilize easily
Only a small fraction of the organisms will have died in condition favourable for fossilization.
Only a fraction of fossils have been discovered.

Fossil evidence a lone is not sufficient to prove that evolution has occurred but it supports the theory of gradual and progressive change from simple to complex forms.

Classification

In modern classification, organisms are grouped together basing on characters that have similar evolutionary origin. The characters that have similar position and evolutionary origin regardless of their functions in adult organisms, are called homologous characters eg the wing of a bird and the aim of human are homologous characters.The structural similarity in the characters suggests the existence of evolutionary change. However the differences in functions of the characters areas a result of adaptive radiation to the environment over a period of time.

Comparative embryology;

Is the study of embryonic development of groups of organisms to establish a phylogenetic relation. The structural similarities that occur at particular stages in the development of different groups of organisms suggests that such organisms originated from the same ancestor.The development stages through which an organism passes repeat the evolutionary trend of the group to which it belongs ie "antogeny recapilculates phyzogeny" for example when the embryonic stages of vertebrates are examined it is formed that they show some similarities ie have a tail, external branchial groves (visceral defts), muscle blocks and a single circulation with a two chambered heart. These show that these organisms have the same ancestral origin but have only developed differently to suit different environmental conditions.

Comparative anatomy

Is the study of the anatomy/body structure of un related organisms. It gives evidence for evolutionary relation on the basis of structural similarities and differences among organisms.

The similarities in many structures of different unrelated organisms show common ancestry eg All flowers have corolla, calyx statements and pistils but differ in size and number in individual species implying that all higher plants have some ancestry.In higher animals, the pentadactyl limb is common to all. It has become modified to a number of functions in different environments despite of diverse in uses the structure are all homologous.A homologous structure is a structure found

in different groups/species of organisms having the same basic plan but modified to perform different functions in different organisms.
Examples; Pentadactyle limb of all vertebrates,Ovary wall of flowering plants,Ear ossicles in mammals and branchial arches in fishes.
Note: adaptive radiation is when a homologous structure shared by a group of organisms becomes modified in different organisms to serve different functions in such organisms to enable them survive in different environments.
Divergent evolution is when organisms of the same ancenstral origin under go structural modifications to bring about differences in the basic structure to enable them survive in different environments.
Vestigial structures. These are structures that have become reduced in size/been lost all together because they have no function e.g Lost tail in man,Digits in bird's wing,Pelvic girdle of a whale,Hand bud of a python