# FORM ONE BIOLOGY UPDATED NOTES

## (SET 1)


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## INTRODUCTION TO BIOLOGY

- It's the science that involves the study of living organisms
- The word Biology comes from the Greek words: **bios-** which means life and **logos-** which means knowledge hence Biology means the knowledge of life. The term Biology was first carried a scientist called Lamarck in 1805.

### Branches of biology

- There are two main branches i.e.
  **(a) Zoology –** it's the study of animals. A scientist who studies animals is called **zoologist.**
  **(b) Botany-** it's the study of animals. A scientist who studies plants is called botanist.

**Othe branches**

| Branch of Biology | Name of the scientist that has specialized in the area | Nature of study |
|---|---|---|
| Taxonomy | Taxonomist | The study of classification of organisms |
| Cytology | Cytologist | The study of cells |
| Ecology | Ecologist | Study of relationship between organisms and their environment |
| Microbiology | Microbiologist | Study of microscopic organisms |
| Biochemistry | Biochemist | Study of chemical changes inside living organisms |
| Entomology | Entomologist | Study of insect |
| Genetics | Geneticist | Study of inherited characteristics and variations among organisms |
| Parasitology | parasitology | Study of parasites |

**Importance of Biology**

- In studying biology one acquires very useful knowledge that can be used in many ways e.g.
- In solving environmental problems such as shortage of food, poor health services, pollution, misuse of environmental resources e.g. forests, wildlife, water and soil.
- Entry into careers such as medicine, agriculture, public health, veterinary practice, dentistry.
- The scientific skills that one develops while studying Biology such as observing, identifying, recording, classifying, measuring, analyzing and evaluating are all useful in everyday life.

➢ Promoting international cooperation in solving pertinent and emerging problems e.g.

-Joint development of HIV/AIDS vaccine by Kenyan and British scientists.

- The co-ordinated fight against severe Acute Respiratory Syndrome (SARS) Involving scientists all over the World.
- The fight to save the ozone layer from depletion through various international agreements such as Kyoto protocol

-Management of resources through international treaties such as the CITES (Convention Against International Trade in Endangered species)

**Characteristics of living things**

➢ Characteristics which can be observed in all organisms are also called life processes because they are the things that keep organism's alive e.g.

**Nutrition**

- It is the process by which living things acquire and utilise nutrients.
- Green plants manufacture food materials like glucose in a process called photosynthesis.
- Animals cannot manufacture their own food and they obtain from plants and other animals.

**Respiration**

- This is the process in which food substances are broken down in the body to release energy. The energy produced enables the organism to carry out the life processes.

E**xcretion**

- It's the removal of waste substances produced from the breakdown of certain substances in the body. Waste substances may be harmful if left to accumulate in an organism.

**Growth and Development**

**Growth-** it's the process by which organisms permanently increase in size and mass.

**Development**- refers to irreversible change in the complexity of the structure of living things.

**Reproduction**

- This is the process by which living organisms give rise to young ones of their kind.
- When living things reach maturity, they produce young ones by asexual or sexual reproduction. Asexual reproduction is where a single parent produces offspring's that are identical to itself.
- In asexual reproduction two parents are involved and the offspring are not identical with either parent.
- The production of offspring ensures that a species lives on or does not become extinct.
- **Sensitivity (irritability)**
- This is the ability of organisms to sense changes of the environment and to respond to them e.g. living things react to changes in temperature, humidity light, pressure etc.

**Movement**

- It's a change in position by either a part of or the whole living thing. When a whole organism moves from one place to another, it is known as locomotion e.g. in animals.
- Animals carry out locomotion in various ways e.g.
  - -Flying
  - -Walking
  - -Swimming
  - -Running
- Locomotion enables animals to search for food or mates and escape from danger.
- In plants movement is limited to certain parts such as

-Closing of leaves

-Growing of shoot towards the light

**NB-** since most of the plants make their own food they do not need to carry out locomotion.

**Collection of specimens**

- Some apparatus used in collection and observation of specimens.

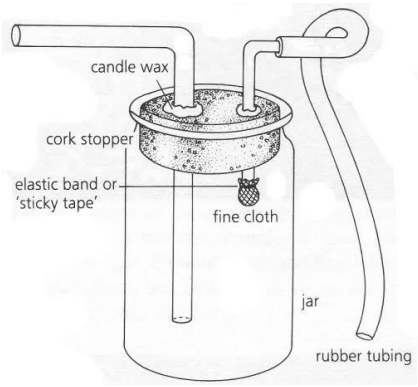
**Sweep net**

Its used for catching flying insects.

- **Fish net**

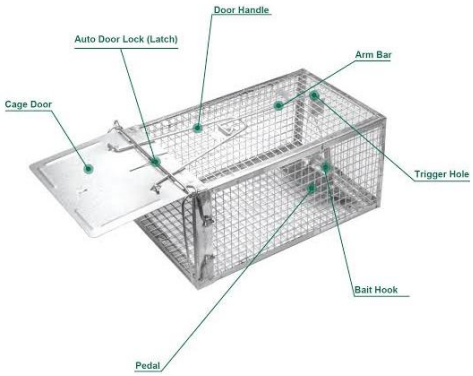
- used for trapping small fish and other small water animals.

**Pooter**



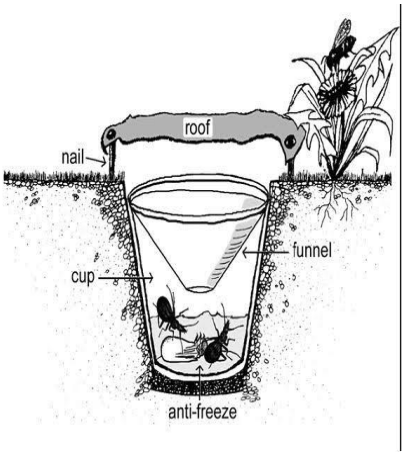

- -used for sucking small animals from rock surfaces or barks of trees

**Bait trap**



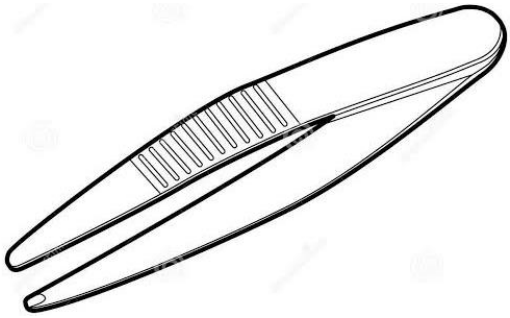

- For attracting small animals including rats.

**Pitfall trap**




- -for catching crawling animals.

**Pair of forceps**



- Used for picking up small crawling animals e.g. stinging insects.

**Specimen bottles**

- For keeping collected specimen. Larger specimens require large bottles.

**Magnifying lens**

- It's used to enlarge objects.

**Activity 1: collection of specimens**

**Procedure:**

- Collect a wide variety of plant and animal specimens e.g. grasshopper, earthworm, grass, pinus leaves.
- Place them in appropriate containers and carry them into the laboratory
- Observe the specimens collected and record common features observed in plants and animals.
- Preserve your collection

**Precautions during collection and observation**

- Collect only the number of specimens you need.
- Do not harm specimens during the capture(collection)
- Do not destroy the natural habitat of the specimen .After use return any live specimens back to their habitat whenever possible.
- Dangerous/ injurious specimens should be handled with a lot of care such include stinging plants or insects make use of forceps and hand gloves in such cases.
- For highly mobile animals they should be immobilized.

**Comparison between plants and animals**

| Plants | Animals |
|---|---|
| Most plants have chlorophyll | They don't have chlorophyll hence can't make their own food |
| They store excess as starch | They store excess as glucose |
| They respond slowly to changes in their environment as it involves growth | They respond quickly to the stimuli as they have receptors |
| They don't move about since they are anchored to the ground | Most animals move about in such of food and shelter |
| They lack specialized excretory organs | Have complex excretory organs |
| Growth occurs throughout the life of a plant | Growth occurs during the early life and stops at maturity |
| Growth occurs at specific regions of the plant | Growth occurs over the whole organism |
| Plant body parts are spread out | Animal bodies are compact |

**Activity 2: external features of plants and animals**

- Identify a mature small plant and dig it out.
- Using a sweep net provided, collect a grasshopper and put it in a specimen bottle
- Observe the external features of the two specimens. Record your observations for each specimen.
- Gently disturb the animal specimen and the potted plant with a blunt piece of stick or ruler. Record your observation.
- From the observation record the major differences between plants and animals in the table below.

# CLASSIFICATION 1

**Magnifying lens**

- Magnifying Lens is a special instrument made from glass. It is biconvex i.e. it is thickest in the middle.
- When this lens is fixed on a frame that can be held by the hand when being used, it is called a hand lens.

**Activity: How to use a hand lens**

- Hold the lens with one hand
- Place the specimen or object on a bench
- Bring the lens over and near the object
- Look down through the lens
- Move the lens up and down slightly until the image is sharp focus. This means that it can be seen clearly. What you see is a magnified image of the object.

**Magnification = Size of drawing**
**Size of specimen**

- A biologist collected a bone measuring 25cm in length. He then illustrated the bone in a paper. On measuring the length of the drawing, he found that it was 10cm. calculate the magnification of his drawing. Give the formula you use and then show your working.
- It's the process of grouping organisms according to similar characteristics. The groups are called **taxa** (singular taxon)
- A taxon is a group of organisms with similar characteristics
- The branch of biology that deals with naming and classification of living things is called **taxonomy.**

**Significance of classification**

- To help in identifying living organisms into their correct groups for reference.
- Groupings bring together living organisms with similar characteristics but separate those with different features.
- To help us arrange the information about living organisms in an orderly manner to avoid chaos and confusion that would arise if this were to be done arbitrarily
- To help us understand the evolutionary relationship

**Major units of classifications**

- There are 7 major classification groups or taxa i.e.

-Kingdom
-Phylum (division in plants)
-Class
-Order
-Family
-Genus
-Species

- The largest taxonomist unit is the kingdom which is divided into smaller groups called phyla (sing. Phylum) in plants division is used instead of the phylum.

- Each phylum (division is divided into classes, within each class are orders which are divided into families
- A family consists of many genera (singular genus) which is divided into species. Species is the smallest taxonomist unit.

**Comparing classification groups and address information**

| **Address information** | **Classification group** |
|---|---|
| Country | kingdom |
| Province | phylum (division |
| District | class |
| Division | order |
| Location | family |
| Sub- location | genus |
| Village | species |

- The modern system of classification puts living organisms in 5 kingdoms i.e.
  (i) Kingdom **Monera** e.g. Bacteria and Blue green algae
  (ii) Kingdom **Protoctista** e.g. Amoeba, plasmodium e.t.c.
  (iii) Kingdom **Fungi** e.g. mushroom, rhizopus (bread mould)
  (iv) Kingdom **Plantae**- flowering plants e.g. maize
  (v) Kingdom **Animalia** – e.g. animals e.g. lizards, dogs
- The kingdom Plantae and Animalia are very large. Members of these groups are therefore classified further.

**Binomial nomenclature**

- Binomial means two names while nomenclature means system of naming hence binomial nomenclature refers to a system of giving two names to an organism.
- The first is the name of the genus (generic name) to which the organism belongs while the second is the specific name of the species of which the organism is a member.
- The names are in Latin language or are Latinized.

**Rules for Binomial system of nomenclature**

- When written both genus and species names should be underlined separately or printed in italics e.g. *Homo sapiens (*man).
- The genus name should start with a capital letter while the species name should start with small letter

**Examples**

- *Canis familiaris (*domestic dog)
- Canis – refers to the genus to which dogs belong while familiaris is the species.

**Examples of scientific names**

**Animals**

| Common name | Scientific name |
|---|---|
| humans | *Homo sapiens* |
| House fly | *Musca domestica* |
| Common frog | *Rana temporaria* |
| Dog | *Canis familiaris* |
| Lion | *Panthera leo* |
| Leopard | *Panthera pardus* |
| Mountain gorilla | *Gorilla gorilla* |
| Fruit fly | *Drosophila melanogaster* |
| Domestic chicken | *Gallus domestica* |

**Plants**

| | |
|---|---|
| Mango | *Mangifera indica* |
| Maize | *Zea mays* |
| Black jack | *Bidens pilosa* |
| Bean | *Phaseolus vulgaris* |
| Onion | *Allium cepa* |
| Tomatoes | *Lycopersicon esculentum* |
| Sweet potatoes | *Ipomea batatas* |

**Why scientific names are used**

- There is no confusion about which living thing is being referred to. This is because no two organisms have the same scientific name.
- Scientific names rarely change
- Scientific names are written in the same language around world. Latin is used because it is a language that does not change.

# CELL PHYSIOLOGY

**The Cell**

- The word cell is derived from the Latin word cella which means a store room.
- Some organisms have body structures that are made up of a singley cell hence called unicellular or single-celled organisms
- Other organisms have body structures that are made up of many cells hence called multicellular organisms.
- Definition: cell is the structural and functional unit of any living organism.

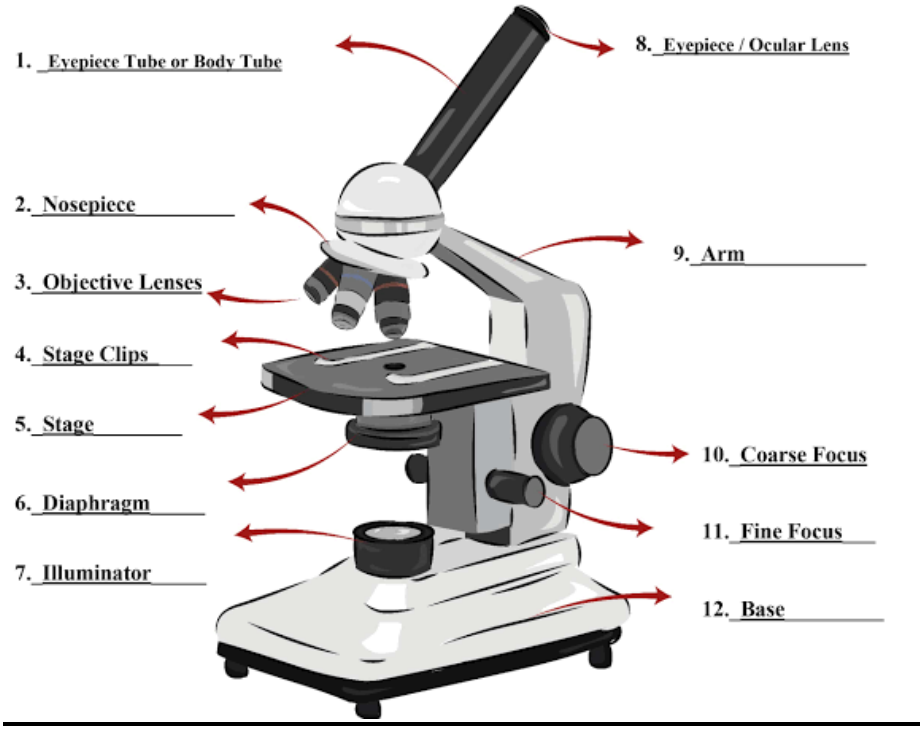
**Light microscope**

- A microscope is an instrument that is used to observe cells which are too small to be seen by an unaided eye.
- The most commonly used instrument for observing cells is the light microscope. Cells are thus described as microscopic in size because they can only be seen with the help of a microscope.

**Functions of microscope**

- To make very small organisms appear bigger so that they can be seen. This is called **magnification.**
- To make it possible to see two objects which are very close together as separate objects. This is called **resolution.**
- It is called the light microscope because light has to pass through the object to be viewed.

**Parts of a light microscope**




- **Arm (limb)** – it supports the body tube. It is the part that you hold when carrying the microscope.
  **NB**- always carry the microscope in an upright position.
- **Base** –this is the lower heavy part of the microscope.

-It rests on the bench and gives the microscope firm support.

**Eye piece (ocular lens)-** it magnifies objects. It is often unattached and may fall out unless the microscope is kept upright.

-It can be removed and replaced with an eyepiece lens of lower or higher power. Microscopes have several interchangeable lenses of different magnifications e.g. X10, X15

-Eye piece lenses are usually fitted into an opening at the top of the microscope.

**Objective lens-** brings image into focus and magnifies it. There are usually 3 types i.e.

- Lower power objective lens
- Has a magnification of X4
- Its shows the largest area of the specimen but least detail.
- Medium power objective lens- has a magnifying power of X10. It is used after the low power lens has been clearly focused.
- It shows a smaller area of specimen but with more detail than the lower lens
- High power objective lens- has a magnifying power of X40
- It shows a smaller area but with most detail.

**Turret (revolving nose piece)** – it's the revolving base on which the 3 lenses are mounted. It allows you to choose the most appropriate lens when magnifying a specimen.

- It must be firmly clicked into position when the objective lens is changed

**Stage and clips**

- The stage is the flat surface onto which the microscope slide is placed. The stage has a hole so that light can shine through it to the specimen.
- The clips hold the slide in place

**Barrel / body tube**

- It joins the nose piece to the eye piece. Its moved up and down by the coarse and fine adjustment knobs when focusing the image.

**Coarse adjustment knob**

- It moves the body tube (or stage in some microscopes) up and down to bring the specimen into focus.
- This knob is used with lower objective. It is easy to see the tube moving when the knob is turned.

**Fine adjustment knob**

- It moves the body tube (or stage) up and down to the right position so that the specimen is in sharp focus.
- It is used to achieve sharp focus with the low power objective as well as high power objective.
- It difficult to see the tube moving when this knob is turned.

**Mirror**

- Used to reflect light from another source such as sunlight into the microscope. Light coming into the microscope lights up the specimen so that it can be seen.

**Iris diaphragm**

- Regulates the amount of light that is allowed to pass through the specimen. It has a central circular opening whose size can be varied.

**Condenser (light director)**

- It's a lens located above the diaphragm. It concentrates light before it passes through the specimen.

**Use and care of microscope**

- Hold the arm of the microscope with one hand, place your other hand at its base then transfer the microscope fron one place to another.

**Using a microscope**

- Place the microscope on a bench in front of you. The handle should be towards you. Make sure the microscope is not at the edge of the bench.
- Look into the eye piece. Adjust the mirror below the stage so that it catches light from a window and reflect it into the microscope.
- Cut out a newspaper print and place it on the stage. Hold it down with clips.
- Rotate the revolving nose piece until the low power objective lens clicks into position.
- Lower the low power objective lens using the coarse adjustment knob. View all this from the side of the microscope.
- Look into the eyepiece and keep on adjusting the coarse adjustment knob until the print is visible. Very slowly use the fine adjustable knob to bring the print into sharp focus.

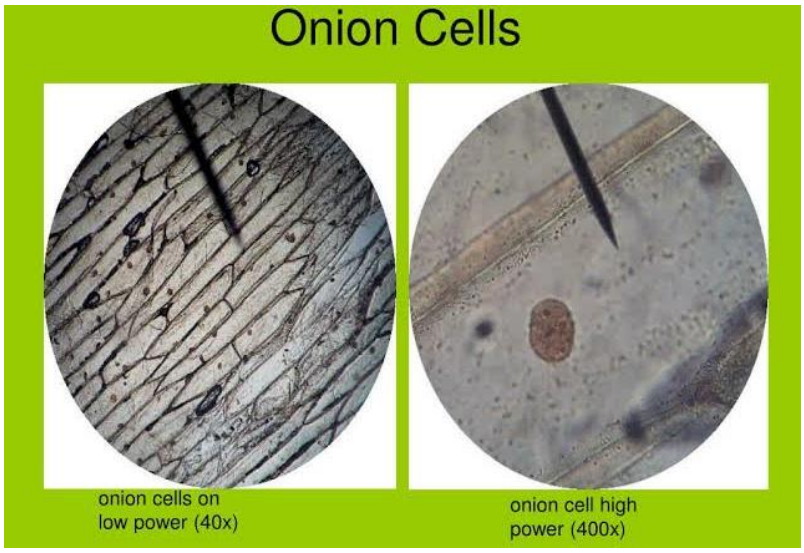
**Additional points to note when using a microscope**

- Place the microscope on a bench always in an upright position with its arm towards you. Do not place it in bright sunlight to avoid too much light getting to the eye.
- Use the iris diaphragm to increase or decrease the amount of light getting into the microscope from the light source.
- Carefully mount the specimen on the microscope slide and cover it with a cover slip.
- Arrange the microscope slide on the stage so that the specimen is in the middle of the hole on the stage. Gently lower the stage clips to hold the slide in place.
- Watch the slide from the side and use the coarse adjustment knob to lower the body tube until the end of the objective
- Look through the eye piece.
- Turn the coarse adjustment knob slowly upwards to raise the body tube or to increase the distance between the slide and objective lens could crush the slide and both may be damaged.

- To examine the specimen under high power objective clicks into position.
- Never use the coarse adjustment knob to focus specimens under high power objective. This is because the high power objective is too near the slide. It could damage the slide and objective lens.

**Field view as seen with light microscope**

- Te field of view is the circular space in the microscope in which the image of the specimen is observed.
- It varies according to the magnification at which the specimen is viewed.
- Under the low magnification power the field of view is wider than high magnification power.
- If 25 plant cells are to be viewed under a microscope all may be seen under low power magnification, but only 10 of these may be seen at high power magnification. This is because at lower magnification the field of view is larger and all the cells are observed.
- Cells as seen under low power vs Cells as seen under high power




**Points to observe when using the microscope**

- Keep the lenses clean by carefully wiping them with special lens tissue. Do not use water or tissue paper. Do not touch the lenses with your fingers or allow them to get wet.
- Always cover the specimen with a cover slip and make sure the slides and cover slips are clean.

**Storing the microscope**

- **Procedure for storing**
- Rotate the nose piece to have the microscope power objective. Never sore the microscope under high power objective lens.
- Raise the body tube with the coarse adjustment knob so that the lenses with lens paper.
- Cover the microscope with its cover to prevent accumulation of dust.
- Pick up the microscope by its arm with one hand and support it under the base with the other hand and return it to its storage box or cabinet.

- **Magnification of a microscope**
- Total magnification = eye piece magnification x objective lens magnification

- **Estimating the cell size**
- Cells sizes are measured in vey small units called micrometers (um) or microns (u)
  - 1mm = 1000um

**Procedure**

- Place the transparent ruler on the microscope stage so that it extends across the diameter of the cell.
- Count the number of millimeter marks that you can see under the microscope. This is the diameter of the field of view
- Place a temporary slide with onion tissue on the stage and focus under low power magnification.
  - X

- Count the total number of cells that occupy the diameter of the field of view – 3 cells
- Divide the diameter of the field of view by the total number of cells counted i.e.
  - 3mm/4 cells = 0.75 mm
- This gives the length of one cell image in mm but 1mm- 1000um the size of image
  - = 0.75x 1000
  - = 750um
  - Real length of cell = cell size (um) / total magnification.



# NUTRITION IN PLANTS AND ANIMALS

**Nutrition-** it's the process by which organisms in food materials.

- **Importance of nutrition**

- It provides a living organism with raw material for:
- Respiration to produce energy in the cells
- Growth of cells and tissues
- Repair of worn out or damaged tissues such as healing of wounds

**Types of nutrition**

- There are two types of nutrition

**Autotrophic nutrition –** This is where the plants contain chlorophyll make their own food. Such organisms are called autotrophs.

**Heterotrophic nutrition-** This is where the organism takes in or ingests food from plants or animals. The organisms are called heterotrophs.

**Nutrition in plants**

- Plants and certain types of bacteria are autotrophs. There are type of autotrophic nutrition i.e.

**Phototropism**

- The organisms use carbon dioxide water and energy from soil to make their own food in a process called photosynthesis.
- Phototrophic nutrition is also called holophytic nutrition.

**Chemotropism**

- The organisms called chemotrophs make their own food using energy from special types of chemical reactions.
- They do not use sunlight, chemotrops include certain bacteria.

- **PHOTOSYNTHESIS**

- This is the manufacture of food materials using light energy from the sun. It takes place in green plants.

**Importance of green plants**

- **As source of food and energy**
- Plants make their own food and animals depend directly or indirectly on plants for their food. Food contains energy from the sun stored as chemical energy.

**Provides oxygen**

- It replaces oxygen in air which is continuously used up by all living things for respiration.

**Makes carbon IV oxide available to plants and animals**

- Photosynthesis uses carbon IV oxide from the air and incorporates it into carbon found in food substances.

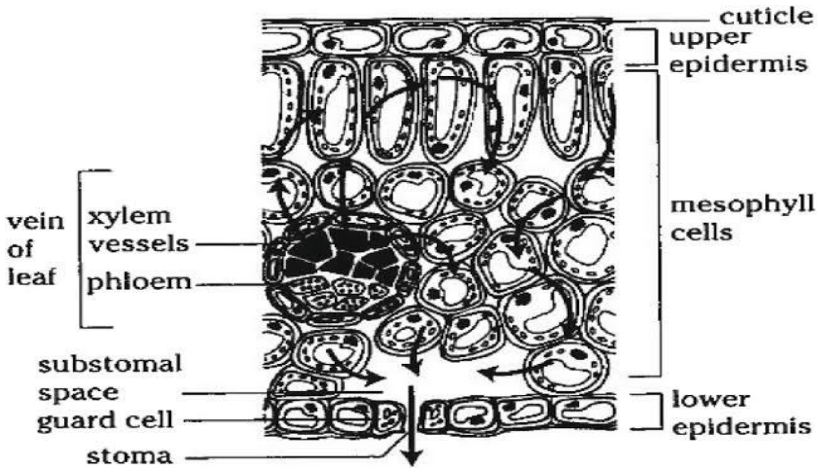
**It is responsible for the energy stored in coal and petroleum**

- Plants and animals that existed on earth millions of years ago were converted into fossils. The energy they contained is stored as fossil fuels such as petroleum and coal.

**External structure of a leaf**

- It consist of ;
- Leaf blade/lamina-it's the flattened surface.
- Its green in colour and contains the photosynthetic tissue
- In dicotyledonous plants, simple leaves have a thick mid-rib which runs in the middle.
- From the mid-rib arises small veins that run into the lamina forming an extensive network of veins
- In monocotyledonous plants, the mid-rib is absent small veins run parallel to each other
- In some plants the leaf is attached to to the stem or a branch by a petiole while in others the leaf is attached directly
- In monocotyledonous plants, some leaves are attached to the stem by the leaf sheath

**Internal structure of a leaf**




**Cuticle**

- It covers the upper surface of most leaves and makes them appear shiny.
- It's very thin waxy transparent coating found on the upper and lower leaf surfaces of some plants.
- Its waxy nature makes it waterproof.

**Functions of cuticle**

- To reduce the amount of water lost from the plant by transpiration.
- To protect the inner tissues from:
- Infection by micro- organisms that may cause disease
- Mechanical damage by animals or falling objects.

**Epidermis**

- This is the layer of cells below the cuticle. It's usually one cell thick to allow light to pass though the cells easily.
- The epidermis forms a protective layer over the cells that carry out photosynthesis

**Palisade mesophyll**

- Maximum photosynthesis takes place in the palisade mesophyll. This is a layer of cells located below the upper epidermis.

- Palisade cells are closely packed with a few air spaces between them
- The cells are elongated and lie at right angle to the leaf epidermis. They contain many chloroplasts. Their shapes allow them to absorb most of the light falling on the leaf.
- They are close to the upper epidermis so as to absorb maximum light. The chloroplast can move within the palisade cells to the side receiving the optimum amount of light.

**Spongy mesophyll**

- It's composed of cells located between the palisade mesophyll and the lower epidermis.
- The cells are irregular in shape and are loosely arranged. They have large air spaces between them which allows for air circulation and gaseous exchange between the cells and the air surrounding them.
- Spongy mesophyll cells are also lined with moisture to facilitate uptake of oxygen and release of Carbon iv Oxide. They have fewer chloroplasts than the palisade mesophyll cells.

**Vascular tissues**

- The network of veins in the leaves is made up of vascular tissues. This tissue has xylem vessels which supply water and mineral salts to the leaf. It also has phloem which takes away manufactured food substances from the leaf to other parts of the plant.
- Vascular tissues also provide support for the cells in the leaf

**Stomata**

- They are found on the upper or lower epidermis or both.
- They allow entry of Carbon iv Oxide into the leaf for photosynthesis

**Adaptations of a leaf for photosynthesis**

- The leaf blade (lamina) is broad and flat to provide a large surface area for absorption of sunlight and Carbon iv Oxide
- Most leaves are thin to reduce the distance across which Carbon iv Oxide has to diffuse from the stomata to reach the photosynthesizing cells.
- The leaves are arranged on the stems of some plants in such a way that each leaf is able to absorb the maximum light. This regular arrangement of leaves on the stem minimizes overlapping and overshadowing. This is called **leaf mosaic**
- The presence of air spaces in the spongy mesophyll allows for faster movement of gases.
- The leaf veins conduct water and mineral salts to the photosynthetic cells. They also transport manufactured food to other parts of the plant enabling more to be made.
- The cuticle and epidermis are transparent, ensuring penetration of light to the palisade cells.
- Each palisade cell contains a large number of chloroplasts and their arrangement and location next to the epidermis enables them to receive maximum sunlight
- Presence of stomata for efficient diffusion of oxygen, water vapour and Carbon iv Oxide
- Palisade cells are closely packed and vertically elongated to allow many to be packed beneath the epidermis where they can receive maximum light

**Structure and function of the chloroplast**

- The chloroplast is the organelle in a plant cell where photosynthesis takes place.
- Chloroplasts are found in the cytoplasm of palisade mesophyll, spongy mesophyll and guard cells.
- Cells that have chloroplasts are called **photosynthetic cells**
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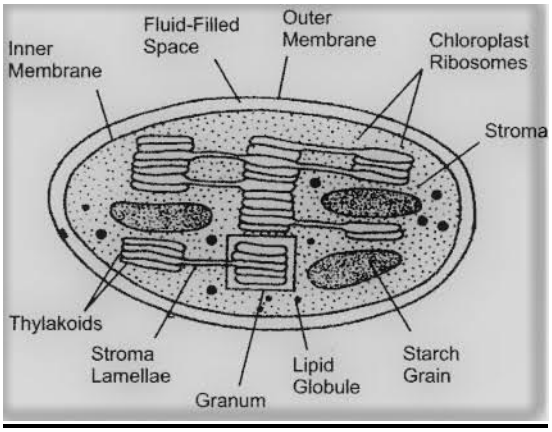



- Each chloroplast is surrounded by two membranes ie the outer and inner membranes.
- Inside each chloroplast, are small units called **grana** (singular granum)
- A granum consists of a number of disks placed on each other like a pile of coins. One granum is connected to another by **inter-granular/lamellae**
- Granum contains chlorophyll molecules, and other photosynthetic pigments for the light reactions of photosynthesis
- Granum provides a large surface area to accommodate a large number of chlorophyll molecules
- **Stroma** contains enzymes that speed up the rate of photosynthesis.

**Activity 1: testing for starch in a leaf**

- **Materials**
- Water bath
- Bunsen burner
- Forceps
- Droppers
- Iodine
- Water
- Ethanol(methylated spirit)
- 2 test tubes
- White tile
- stop watch

**Procedure**

- Take a leaf from a green plant that has been in the sun for several hours and dip it in a boiling water bath for 2-3minutes. This treatment:
- Kills all the living tissues in the leaf thus preventing further chemical reactions.

- Ruptures any starch granules present
- Put a boiling tube half filled with methylated spirit into the boiling water (water bath). Do not expose the methylated spirit to a naked flame because;
- Alcohol boils at a lower temperature than water (78ºC) so it will boil in hot water.
- Take the leaf and dip it into the boiling methylated spirit. Leave the leaf in the hot methylated spirit until all the chlorophyll is removed – the hot methylated spirit is a good solvent which dissolves and extracts (removes) chlorophyll from the leaf leaving it white.
- **NB:** Alcohol also makes the leaf stiff and brittle.
- Remove the leaf from the test tube and dip it in a beaker of cold water. This softens the leaf by returning water that was removed by ethanol.
- Take the leaf using a pair of forceps and spread it out carefully onto a white tile.
- Using a dropper, place a few drops of iodine solution onto the leaf and note the colour.

**Results**

- The parts of the leaf containing starch are stained blue- black while those without starch are stained brown.
- Methylated spirit turns from purple colour to green colour indicating presence of chlorophyll from the leaf.



## NUTRITION IN ANIMALS

**HETEROTROPHISM**

- It's a mode of nutrition that involves taking in complex food materials like carbohydrates, proteins and fats obtained from bodies of other plants and animals.

- The organisms that feed on these already synthesized foods are called heterotrophs.

**Modes of heterotrophic feeding**

**Holozoic nutrition**

- It involves ingestion, digestion and assimilation of complex food materials. Examples of heterotrophs are carnivores, omnivores and herbivores.

**Saprophytism**

- This is a type of nutrition where organisms obtain nutrients from dead organic matter causing decomposition. Examples; Fungi and bacteria.

**Parasitism**

- This is an association where one organism, the parasite, feeds on or obtains nutrients from the tissues of another living organism, the host. Examples tapeworms.

**Symbiosis**

- This is an association where two organisms live together and mutually benefit from each other.

**Dentition**

- This is the description of types, number and arrangement of the teeth of an animal. The type of dentition in an animal is related to the type of food that it eats.
- When all the teeth are similar in structure and size, the dentition is known as homodont e.g. Fish, frogs and crocodiles.
- When the teeth are of different type and size the dentition is known as heterodont
- Teeth are arranged in groups to occupy specific positions in the jaws i.e.
- Incisors are flat, chisel-shaped with sharp ridged edges for cutting and biting food.
- -They have one root.
- Canines are conical with sharp pointed tips especially modified in carnivores for seizing the prey and tearing flesh.
- -They have one root.
- Premolars–They have 2 roots.
- -They have 2 cusps.
- Molars – They have 2 roots (lower molars) or 3 roots (upper molars).

- Have 4-5 cusps.

- -Both have broad surfaces and maybe ridged with cusps on their crown for crushing and grinding food.

**Dental formula**

- This describes the types, number and position of the teeth in the jaws of animals. In the formula, letters represent the types of teeth as follows;
- I-incisors
- C-canines
- PM-premolars
- M-molars

- The types and number of the teeth in the upper half of the jaw are written on top of similar ones in the lower half of the jaw. The type of teeth are given in the order; incisors, canines, premolars and molars eg
- I $\frac{2}{1}$ C $\frac{1}{1}$ PM $\frac{2}{2}$ M $\frac{3}{3}$
- In order to work out the total number of teeth in man, the above dental formula is multiplied by two;
- 2 ( i $\frac{2}{2}$ c $\frac{1}{1.}$ pm $\frac{2}{2}$ m $\frac{3}{3}$= 32

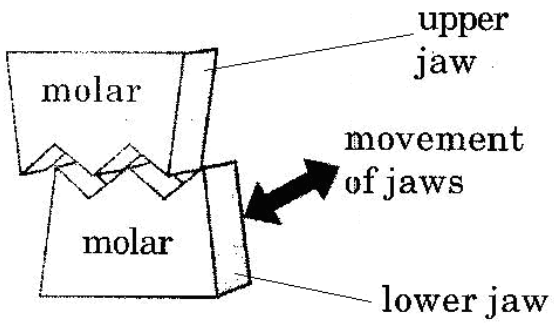
- **Examples of Holozoic heterotrophs**

**Herbivorous mode of feeding**

- In this mode of feeding, animals feed on plant material only. These animals are called herbivores. They are grouped as;
- -Grazers- they feed on grasses only e.g. cows, sheep etc
- -Browsers- they feed on herbs and shrubs e.g. giraffes, goats and antelopes.

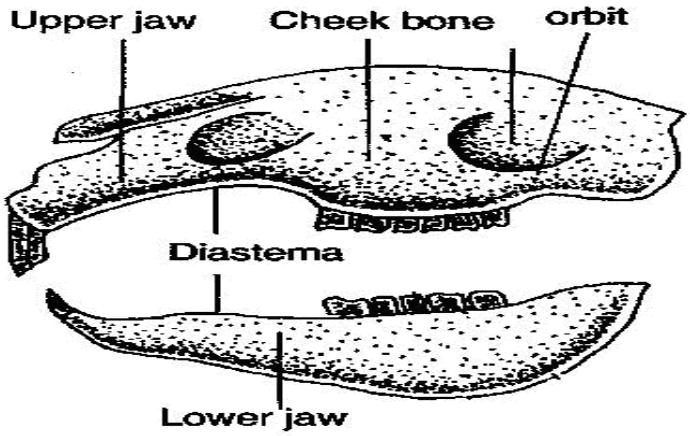
**Adaptations of herbivores**

- Most herbivores do not have upper incisors but instead have a **horny pad** against which grass is pressed and cut by the lower incisors.
- They have a long tongue which assists in ;
- - Cutting and turning of grasses.
- - Moving the food during grinding
- Have **diastema**- This is a gap in the lower jaw between the front teeth and the molars. It creates space for the tongue to move in and out thus assisting in pulling in grass.
- The joint in the jaw is movable. This makes it possible to the lower jaw to be moved easily. When chewing the lower jaw is moved from side to side hence enable the premolars and molars to grind the food.
- The molar teeth have broad upper surfaces which provide a large surface area for grinding grass.
- The surface area of molars is further increased by cusps in the upper teeth which forms a **W** – shape and the lower teeth that form an **M**- shape eg



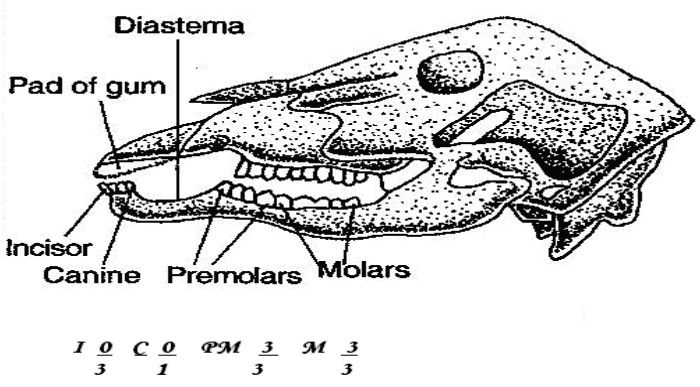

- The teeth of molars herbivores have large pulp cavity and an open enamel in the crown, a condition which allows continuous growth to replace worn-out surfaces due to grinding.
- The lower jaw has incisors and canines which are chisel shaped. The canine teeth are either absent, very small or form tusks like in elephants.

**Dention of a rabbit**




$$i\ \frac{2}{1}\ c\ \frac{0}{0}\ pm\ \frac{3}{2}\ m\ \frac{3}{3} = 28$$

- **Dentition of a sheep**




$$I\ \frac{0}{3}\ C\ \frac{0}{1}\ PM\ \frac{3}{3}\ M\ \frac{3}{3}$$

**Carnivorous mode of feeding**

- Carnivores are animals which feed exclusively on flesh. Most carnivores are hunters.
- Most are adapted to fast running and have well developed leg muscles that facilitate this movement eg cheetah.
- They also have strong jaws and sharp teeth to grasp their prey.
- They have 4 different types of teeth ie

**Incisors**

- -They are chisel-shaped.
- -Small and pointed
- Used for gripping and stripping flesh from the bone.

**Canines**

- They are conical, long, sharp and curved.
- Used for stabbing and killing prey.
- They pierce and penetrate the flesh to hold firmly onto its prey to prevent it from escaping.

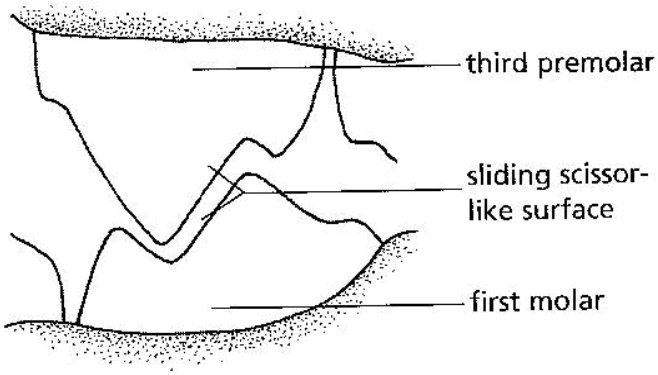
**Premolars and molars**

- They have a broad surface with pointed cusps.

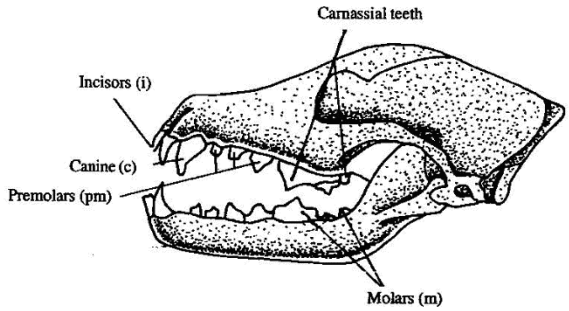
- They meet each other to crush and crack bones.

**Carnassial teeth**

- These are the last premolars in the upper jaw and first molar on the lower jaw.
- They have sharp cutting edges. The upper and lower jaws carnassial teeth pass against each other during the up and down jaw movement and act as shears /scissors. They slice off meat and crack bones.




- The jaw muscles are strong and the hinge joint between the two jaws allows only up and down movement of the lower jaw.
- Dental formula of a dog
- 2 ( I $\frac{3}{3}$ C $\frac{1}{1}$ PM $\frac{4}{4}$ M $\frac{2}{3}$ ) 42




$i\frac{3}{3}c\frac{1}{1}pm\frac{4}{4}m\frac{2}{3} = 42$

**Omnivorous mode of feeding**

- Omnivores are animals which feed on both vegetation and flesh. They have the following types of teeth;

**Incisors**

- They are located at the front of the jaws.
- They are chisel- shaped and this creates a flat surface with a sharp edge that makes incisor tooth suited for cutting and biting.

**Canines**

- They are located on the left and right of the incisors. They are pointed.
- They pierce and hold the food.
- In man, canines are poorly developed and are rarely used.

**Premolars**

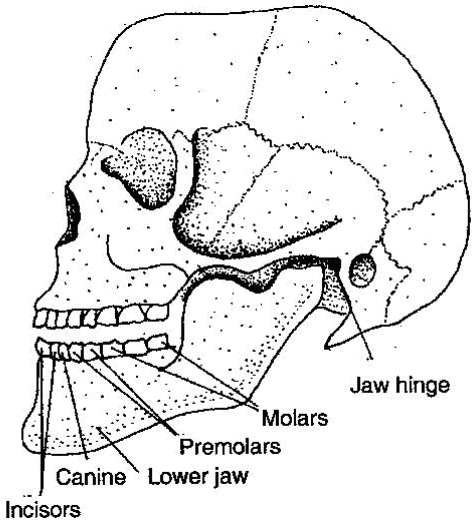
- They arelocated after the canine towards the back of the jaw.
- They have broad top surfaces usually with two projections called cusps that give them a ridged appearance.
- They are used to crush and grind food.

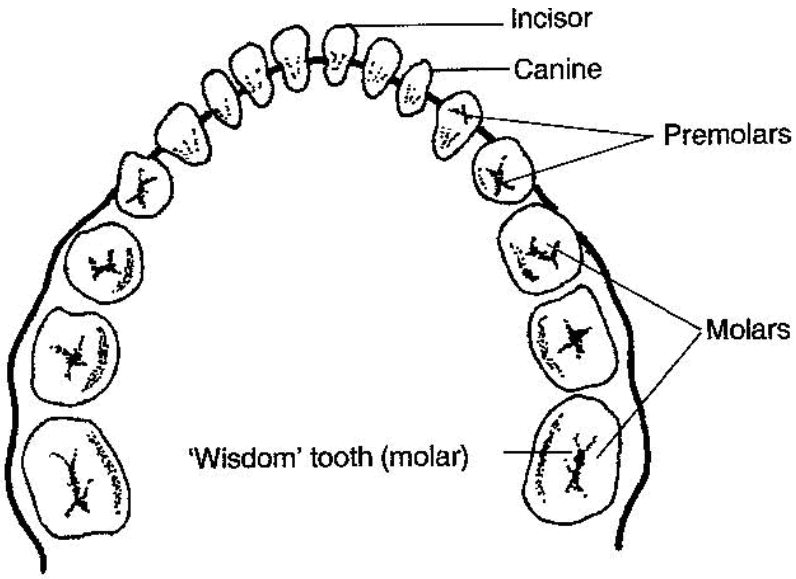
**Molars**

- They occupy the back of the jaw, in the cheek.
- They have broad top surfaces with 4 or 5 cusps that give them a ridged appearance.
- They are used to crush and grind food.

**Dental formula**

- 2 ( I $\underline{2}$ C $\underline{1}$ PM $\underline{2}$ M $\underline{3=}$ ) 32
- 2 1 2 3



- Humans have 2 sets of successive teeth. The first set is known as the milk teeth or deciduous teeth.
- They form in the jaw before birth. In a new born baby the teeth are not visible above the gum. They erupt out of the gum at about 5 months.
- At 2 years the baby has all the teeth in the mik set (20 teeth ) and they are lost between the age of 6-12 years.
- Milk teeth are replaced by a second set of teeth which are larger and more permanent. An adult has 32 permanent teeth. The last molar to appear are called wisdom teethand they erupt between 17-25 years.
- Premolars and molars are also called cheek teeth.

**Structure of a tooth**

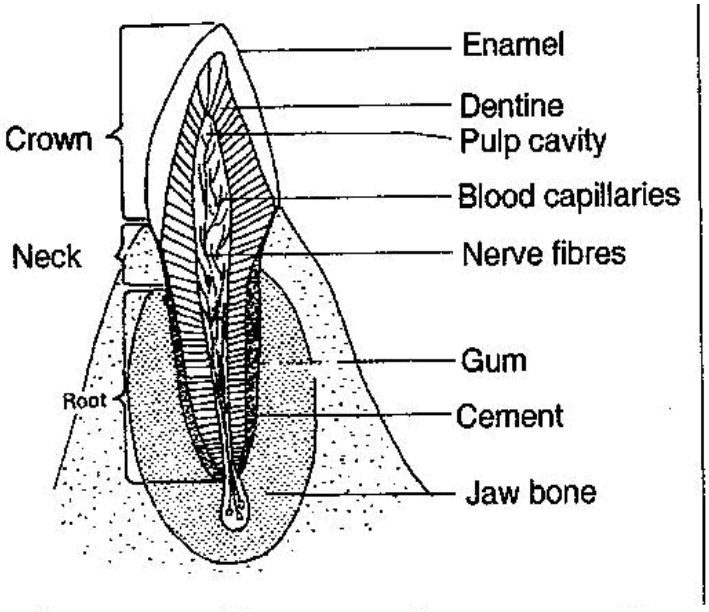
- Externally the tooth is made up of 3 regions ie
- **Crown**- Projects above the gum.
- **Neck**- Region between the crown and root.
- **Root** – Part embedded in the jaw.
- The crown is covered with a hard non-living layer called enamel that is made of calcium phosphate and carbonate.

**Enamel**

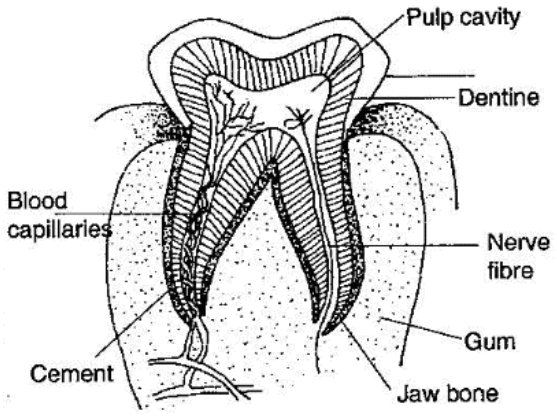
- It's the outer part of the tooth and it's the hardest substance in the human body.
- Its made up of non-living tissue.

**Functions**

- Protects the inner parts of the tooth from infection by bacteria and other micro-organisms.
- Protects the inside of the tooth from mechanical damage by hard food material such as bones,
- It provides a hard biting surface.




· *Vertical section through an incisor tooth*




*Vertical section through a molar tooth*

**Dentine**

- This is the part found immediately beneath the enamel. Its not as hard as enamel.
- Its made up of living tissues.

**Functions**

- Provides most of the bulk of the tooth.
- **Pulp cavity**

Its found at the centre of the tooth.

- It contains numerous blood capillaries and sensory nerves. These enter the Pulp cavity through a small opening at the bottom part of the root.

**Functions**

- Blood capillaries supply nutrients and oxygen to the celle of the Pulp cavity. They also transport waste materials and $CO_2$ from the tooth.
- The sensory nerve fibres have nerve endings that make the tooth sensitive to temperature, pain etc
- Special cells in the Pulp cavity produce dentine which contributes to the bulk of the tooth.

**Cement**

- Its similar to the bone in structure and it lines the root and holds the root in its socket in the jaw.

**Periodontal membrane**

- This membrane is found between the cement and the jaw bone in the socket of the tooth.

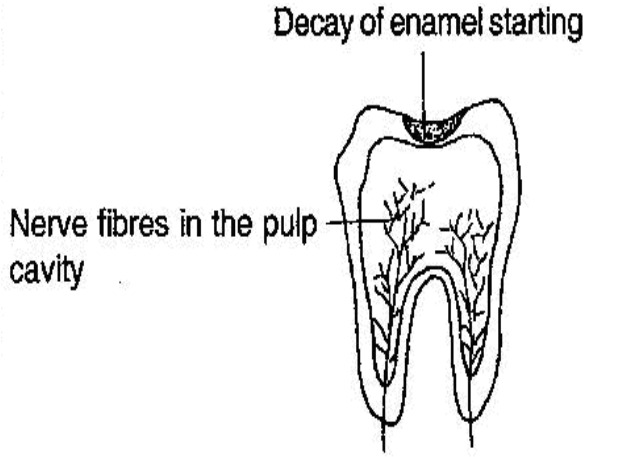
**Function**

- It contains cells that secrete cement.
- It also allows the tooth to move slightly to avoid breaking during chewing.
- Dental diseases

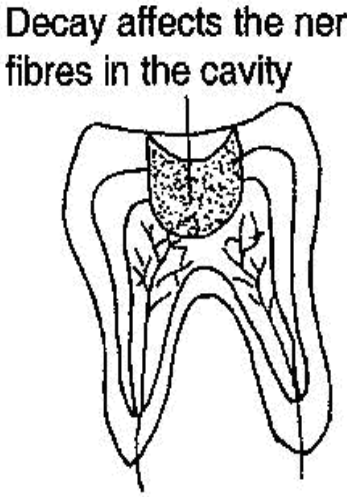
- The sugars and starch that we eat become lodged between the teeth and the teeth cavities where they are broken down by micro-organisms. The micro-organisms use up the sugars for their own food and produce acids as waste products.
- The acids react with enamel and dentine of the teeth causing them to dissolve. A hollow area of those decayed parts is formed. When the decaying process continues into the pulp cavity, the nerves are affected and a lot of pain is felt. (Tooth ache).
- In very serious cases, the pulp cavity may be destroyed and the infection spreads to the gums.
- There are 2 main dental diseases i.e

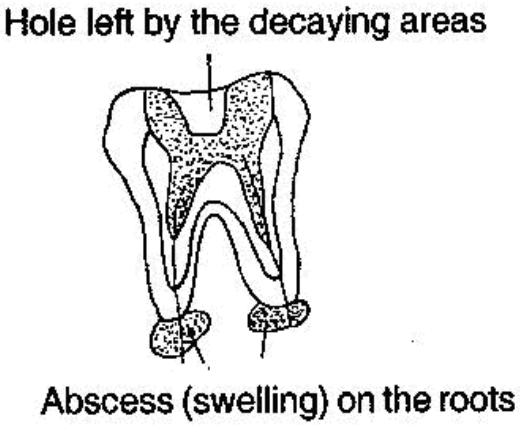
**Dental caries /cavities**

- This is caused by;
- -Plaque (bacteria + saliva) found on the surface of the teeth and between the teeth. Plaque is soft and easy to remove by thorough brushing but if left to accumulate, it hardens to produce a substance called tartar which a dentist has to remove.
- -Lack of hard food.
- -Too much sweet / sugary foods.
- -Lack of calcium in the diet.
- -Lack of vitamin D.
- -Lack of cleaning of teeth.
- These have the effect of causing gradual tooth decay e.g




**Decay of enamel continues and affects the dentine**




**Treatment**

- In case of small cavities (not reached pulp cavity) they can be cleaned and filled with special material to form a filling that seals and protects the tooth from further damage.
- Incase of deep cavities that have exposed the pulp cavity, the cavity is thoroughly cleaned to remove the bacteria and decaying food material. The resulting space is then filled with a special material which solidifies to seal the tooth. This procedure is known as root canal treatment.
- In very severe tooth decay, the whole tooth is removed.

**Periodontal diseases**

- It is caused by;
- Lack of vitamins A and C.
- Lack of massage of gums.
- Lack of proper cleaning of gums.
- This disease causes the gums to become soft and flabby so that they don't support the teeth.

- There are 2 types of periodontal diseases ie

- **Pyorrhoea**

- It's a condition where the teeth become loose due to the infection of fibres holding the teeth in the sockets.

**Gingivitis**

- Its characterised by;
- -Reddening of gums
- -Bleeding of gums
- -Presence of pus in the gums

**Dental hygiene**

- Requires the following;
- Regular cleaning or brushing of teeth after every meal. The food particles stuck between the teeth can be removed by inserting a strong nylon thread into the gaps between the teeth and pulling the thread upwards.the thread used this way is called dental floss.
- Avoid eating too much sugary foods.
- Eat hard foods eg raw carrots, cassava, yams and sugar-cane. This helps to remove the soft materials from the gums and teeth. It also helps to exercise the teeth.
- Eating diet rich in calcium, phosphate and vitamins A, C and D.
- Teeth should not be used to open beverage bottles or crack hard nuts.
- A regular visit to the dentist.
- Taking water with minute quantities of fluoride and using toothpaste with small amounts of fluoride. Fluoride helps in the formation of hard, strong teeth.

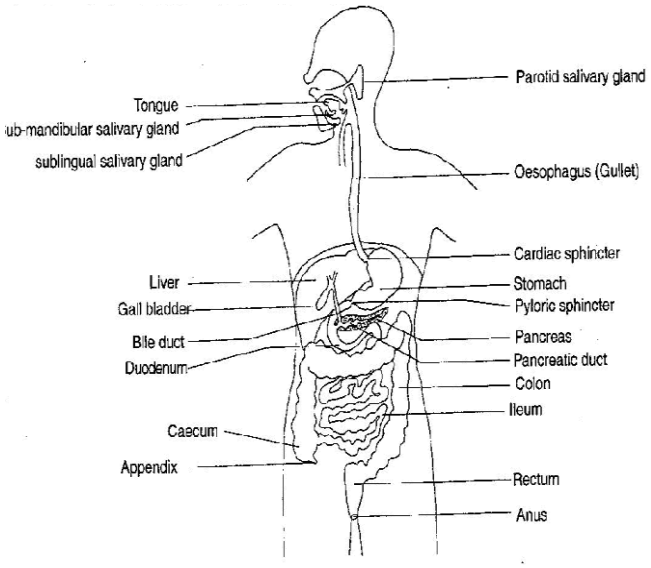
- **Digestive systems in animals**
- **Digestion** –It's the process of breakdown of complex food to simple compounds in the digestive system.

**Digestive system**

- Digestive tracts of mammals show basic fundamental plan with slight variations which co-relate to the kind of diet each animal eats eg
- Carnivores have a relatively short digestive tracts with very much reduced and functionless caecum and appendix. This is because, the proteins which form the bulk of their diet is rapidly digested in the gut.
- Some herbivores have a very long Digestive tract with a single stomach and a large caecum and appendix especially in non-ruminants e.g rats.
- In ruminants herbivores eg cow, the stomach is 4- chambered inorder to increase the surface area for the digestion of cellulose which takes a long time.

**Alimentary canal**

- It's also known as gut. It's a muscular tube that runs from the mouth to the anus. The walls of the alimentary canal are lined with glands and blood vessels. As food passes through this tube, it undergoes the process of digestion then the digested food material is then absorbed into the blood stream.



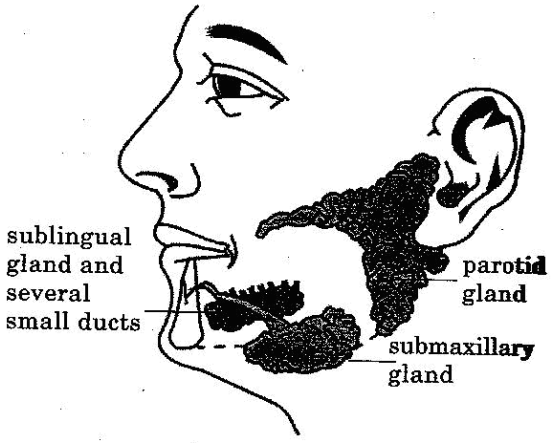
- **Digestion in the mouth**

- The introduction of food into the mouth is called ingestion. The mouth opens into a large space or cavity called the buccal cavity.
- In the mouth, the food is mechanically broken down by the teeth in the process of chewing and grinding (mastication). Mastication reduces food to small particles and increases the surface area for enzymatic action.
- The tongue is a long muscular organ on the floor of the mouth.

- **Functions of tongue**

- Contains taste buds for tasting food.
- Moves food around inside the mouth. This allows the food to mix with the saliva which is secreted from the salivary glands.

- **Saliva**
- It contains;
- Water- Acts as solvent.
- Mucus- Lubricates the food and lining of the mouth.
- Enzyme (salivary amylase / ptyalin) – Digests starch to maltose.
- The substance called mucin (water + mucus) in the saliva moistens, softens and lubricates the food.
- This makes the food easy to swallow and also the food particles are able to stick together to form balls called boluses.
- Mixing of food also allows enzymes to be in contact with most of the food.
- Three pairs of salivary glands inside the mouth cavity secrete saliva into the mouth through short tubes called ducts. The salivary glands in the mouth are;
- Two parotid glands located on each side of the mouth infront and below the ear.
- A pair of submaxillary glands located below the jaws.
- Sublingual glands located below the tongue.

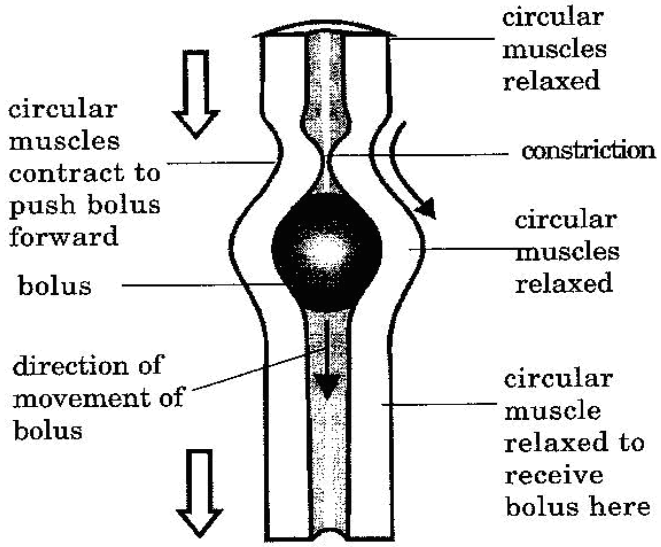



- Saliva produced by these glands contains the enyme salivary amylase/ ptyalin. This enzyme converts starch to maltose. Ptyalin works best at a medium which is slightly alkaline.
- When the food has been chewed enough, the tongue rolls the food into boluses (singuar bolus) then pushes the bolus into the pharynx (back of the mouth). This is the beginning of swallowing.

- The soft palate (uvula) is raised to open the gullet and close the nasal cavity while the epiglottis relaxes to close the wind pipe or trachea.These 2 actions temporarily stop the breathing process.
- Swallowing is a deliberate action but once the process begins, it can not be stopped. Once the swallowing process is complete epiglottis and uvula open the air passages and breathing continues.
- **NB** If you eat and talk at the same time, some food might get into the entrance of the trachea. This causes violent coughing to remove the food.
- The food then passes down into the gullet/oesophagus which contains circular and longitudinal muscles. Circular muscles are arranged in a circular manner inside the wall of the alimentary canal while longitudinal muscles are arranged along the length of the alimentary canal.
- When a food bolus is in oesophagus, muscles in the oesophagus walls contract and relax in a wave like manner to squeeze it along. This process is known as peristalsis.

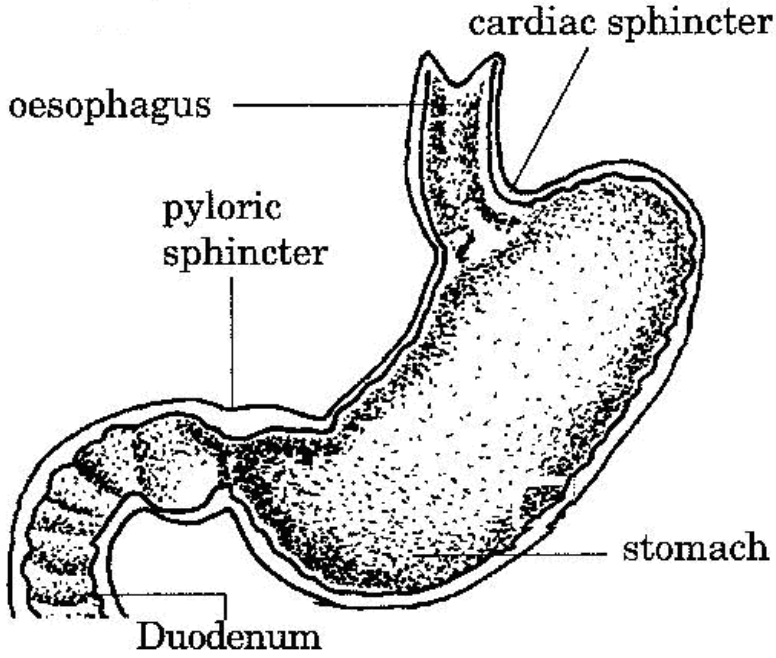
**Peristalsis**

- During peristalsis, the circular muscles behind the food bolus contract causing narrowing of the oesophagus in this area. This creates pressure that squeezes the bolus into the oesophagus, then the circular muscles relax allowing the oesophagus to receive the bolus.
- The alternate contraction, constriction and relaxation of the circular muscles in the oesophagus enables the food to be propelled into the stomach.




**Digestion in the stomach**

- Stomach is the thick walled muscular bag that stretches as it fills with food. Its located on the left side of the abdomen just below the diaphragm.
- A ring of muscle called cardiac sphincter is found at the point where the oesophagus opens into the stomach. There is another ring of muscle at the lower end of the stomach. This is known as pyloric sphincter.
- The two sphincter muscles control the movement of food into and out of the stomach. They help to retain the food for long periods in the stomach which can store food for 2-6 hours.




- The stomach wall is made up of thick muscular muscles and longitudinal muscle layers. These muscles contract and relax producing movements that mix the contents of the stomach. The mixing is known as churning and results in the formation of a fluid called chyme.
- When the stomach is empty, the muscle contractions sometimes produce a rumbling noise. This also makes one feel hunger pangs.
- The presence of the food in the stomach, smell or taste of food stimulates thesecretion of the hormone gastrin juice from the gastric glands embedded in the glandular layer of the stomach wall.
- The walls of the stomach have special epithelial cells which release mucus that forms a shield between the stomach and the gastric juice hence preventing digestion of the stomach lining by the enzymes in gastric juice.
- If the protective mucus layer breaks down, a part of the stomach lining wall may be digested causing a painful ulcer to develop (stomach ulcers).
- Some ulcers are caused by excess secretion of gastric juice due to nervousness or stress. Ulcers are treated by;
- -Proper diet
- -Medication
- -Surgery in severe cases

**Functions of the components of gastric juice**

**Dilute hydrochloric acid**

- The acid kills some bacteria that may be present in the food.
- It provides an acidic medium for optimum activities of pepsin enzyme.
- It changes the inactive pepsinogen to the active enzyme pepsin.
- **NB** Occassionally after a heavy meal, the high pressure in the stomach causes some Hcl acid to leak in the oesophagus. Since it does not have a mucus lining, the Hcl causes a burning effect producing the pain called **heartburn**.

**Pepsin**

- Its secreted as an inactive form called pepsinogen by special cells in the gastric gland. This protects the enzyme producing cells from being digested.
- Once in the stomach, pepsinogen is converted to active pepsin due to the presence of hydrochloric acid. Pepsin breaks down proteins to peptides.

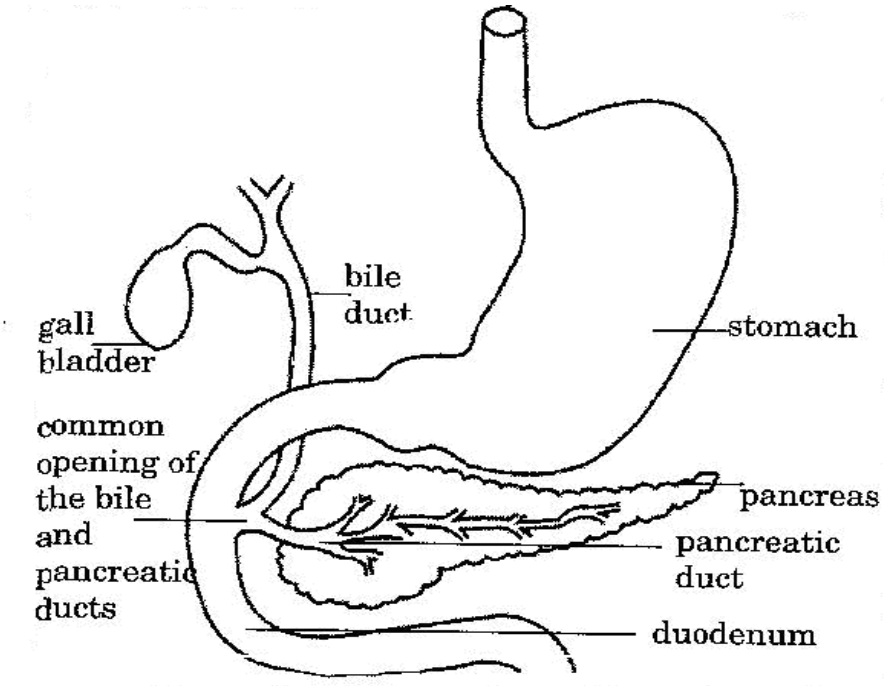
**Rennin**

- Its function is to make liquid milk to curdle – this is callled coagulation of milk. It does this by converting a soluble milk protein caseinogen into an insoluble form called casein. Pepsin can only act on milk protein when it is converted to casein.
- Coagulation of milk is important because the solid milk stays in the stomach longer for digestion to occur.
- Rennin is found mainly in young mammals becase the diet of young mammals mainly consists of milk.
- After 2-6 hours of churning and digestion, the chyme is gradually released in small amounts into the duodenum through the pyloric sphincter muscles which relax at intervals.
- **NB** Some substances like alcohol, water are absorbed directly into the blood system from the stomach.

**Digestion in the small intestines**

- The small intestines is about 6-7 metres long in an adult human. Its made up of duodenum and ileum

- **Digestion in duodenum**
- It's the 1st part of the small intstine. Its about 20-30 cm long and shaped like the letter C. the pancreatic duct and bile duct open into the duodenum eg



- ✓ The pancreatic duct carries pancreatic juice from the pancreas. The bile duct carries bile from the gall bladder. The two ducts join and form a common duct that empties its contents into the duodenum.
- ✓ The duodenum receives secretions from the following organs;
- ✓ The liver has specific cells which secrete bile into the gall bladder, to be stored. The gall bladder releases the bile into the duodenum through the bile duct.
- ✓ The pancreas lies just below the stomach. It's a thin, flat and cream coloured gland. It plays two major roles i.e.

- -Secretion of hormones
- -Secretion of digestive juices
- The arrival of food into duodenum stimulates the secretion of the hormone secretin from the pancreas and cholecystokinin from the duodenal wall.
- Cholecystokinin stimulates the secretion of bile from the gall bladder and secretin stimulates the secretion of pancreatic juice.
- Pancreatic juice is alkaline and contains 3 digestive enzymes i.e.

**Pancreatic amylase**

- It breaks down any undigested starch into maltose.
- **NB** Starch digestion started in the mouth.

**Trypsin**

- It digests proteins into peptides. This enzyme is secreted in its inactive form called trypsinogen. Trypsinogen is activated by an enzyme called enterokinase.

**Pancreatic lipase**

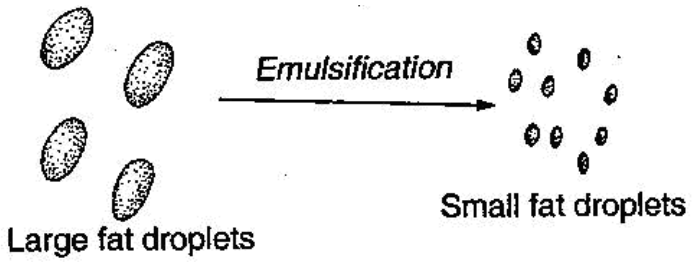
- It digests lipids into fatty acids and glycerol.
- Pancreatic juice also contains sodium bicarbonate (Sodium hydrogen carbonate). It has 2 roles i.e.
- -It neutralises the acidic chyme from the stomach.
- -Creates a suitable alkaline medium for pancreatic enzymes.

**Bile**

- It's a green liquid and contains bile salts eg sodium glycocholate and sodium taurocholate.

**Functions of the salts are;**

- Aid in break down of fats into tiny droplets to increase surface area for digestion by pancreatic lipase. This breakdown is known as **emulsification** eg




- The salts also provide an alkaline medium in which the enzymes in pancreatic juice work best.

- They neutralise the acidic chyme from the stomach.
- NB In the absence of bile there is very little digestion of fats and most of them are voided in faeces. This may occur due to blockage of the bile duct.

**Activity; To demonstrate emulsification of fats**

- **Materials**
  - Cooking oil
  - Test tubes
  - Measuring cylinders
  - NaHCO3 solution
  - Water

**Procedure**

- Pour $2cm^3$ of cooking oil into two test tubes labelled A and B.
- Add $2cm^3$ of $NaHCO_3$ solution into test tube A.Rinse the measuring cylinder.
- Add $2cm^3$ of water into test tube B.
- Shake the contents in both test tubes.

**Observation**

- X

**Digestion in ileum**

- It's the lower part of the small intestines and the longest section of the alimentary canal.
- Its coiled to fit in the limited abdominal space. The inner walls of the ileum contain secretory cells some of which secrete mucus and some of them secrete an alkaline fluid known as **intestinal juice** or **succus entericus.**
- The arrival of the chyme in the ileum stimulates the secretion of intestinal juice which contains 4 enzymes i.e.

**Maltase**

- It speeds up the break down of maltose to glucose.

**Sucrase**

- It speeds up the break down of sucrose to glucose and fructose.
- Maltase and sucrase complete the carbohydrate digestion.
- **Peptidase**
- It breaks down peptides into amino acids.

**Lipase**

- It breaks down lipids into fatty acid and glycerol.
- The process of digestion is thus completed in the ileum. The resulting watery emulsion of food is called **chyle** and contains soluble products of digestion ready to be absorbed.
- The entire canal is lined with an epithelial membrane that contains goblet cells which secrete mucus.

**Functions of mucus**

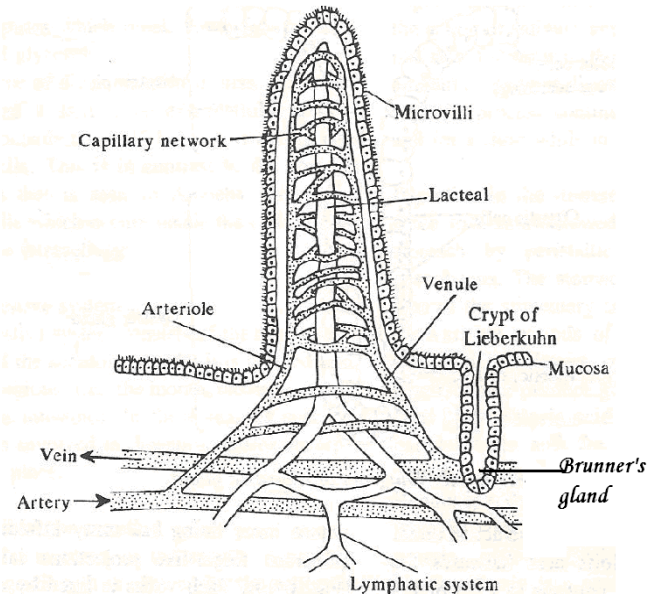
- Allows smooth movement of food materials/lubricates the alimentary canal.
- Coats the wall of the alimentary canal thus protecting it from being digested by the enzymes.
- It makes the food particles to adhere to one another during swallowing and during egestion.

**Absorption**

- This is the process by which the soluble products of digestion diffuse into the cellular lining of the villi. Absorption of alcohol, some water, water soluble vitamins (B &C) takes place in the stomach.
- Most of absorption of final products of digestion occurs in the small intestines (Ileum).

**Adaptations of ileum**

- Its long and therefore provides a large surface area for absorption.
- Narrow so as to bring digested food into close contact with the walls of the ileum for easier absorption.
- Highly coiled inorder to slow down movement of food and thus allowing more time for digestion and absorption to take place. It also increases the surface area for digestion and absorption.
- The inner surface of the ileum has large numbers of villi and microvilli (fingerlike projections) which increase the surface area for digestion and absorption.
- Thin layer of cells through which digested food diffuse.
- Presence of a dense network of blood capillaries in the villi into which amino acids, sugars, vitamins are absorbed. This helps to maintain a steep diffusion gradient.
- Presence of lacteals in the villi for absorption / transport of fatty acids and glycerol.
- Crypt of lieberkuhn has cells which secrete intestinal enzymes.




**The large intestines**

- ✓ Its also called colon. Its about 1.5m in length and is composed of the caecum, appendix, colon and rectum. The walls of the large intestines have no villi. They have mucus secreting glands.

**Functions**

- ✓ Absorbs water and this makes the contents of the large intestine to become more solid. At this point, the material is known as faeces.
- ✓ Synthesis of vitamin K.
- ✓ The mucus secreting cells produce mucus to lubricate the passage for easy movement of faeces.
- ✓ Faeces is composed of undigested roughage material, dead cells from the lining of the alimentary canal, unwanted mineral salts and bile pigments.
- ✓ The rectum stores these faeces until powerful peristaltic waves cause the sphincter muscles in the rectum to relax and the faeces are released in a process called defaecation.
- ✓ Faeces may take 12-24 hours and even upto 3 days or more to pass to the rectum.
- ✓ A sphincter muscle at the entrance to the rectum prevents faeces from entering the rectum until its ready for elimination.
- ✓ X

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