

CLASSIFICATION OF LIVING THINGS

KINGDOM FUNGI

Is the kingdom which consists of non-photosynthetic organisms that obtain nutrients through the absorption of organic compounds from their surroundings.

◇ The Organisms that belong to kingdom fungi are known as fungi

◇ The study of fungi is called mycology

Example of organisms that belong to kingdom fungi

◇ Mushrooms.

◇ Yeast

◇ Moulds

◇ Rhizopus

◇ Toadstool

◇ Bracket fungi

◇ Puffballs

GENERAL CHARACTERISTICS (FEATURES) OF THE KINGDOM FUNGI

Members of Kingdom Fungi have the following general characteristics:

- (i) They are eukaryotic organisms with true nucleus which is enclosed in a nuclear membrane.
- (ii) They store carbohydrates in the form of glycogen.
- (iii) They feed saprophytically but some of them are parasitic e.g. *Candida albicans*
- (iv) Their bodies are made up of a mycelium consisting of a network of fine, tube-like filaments called hyphae (except yeasts)
- (v) They are either unicellular such as yeast or multicellular such as moulds and mushroom.
- (vi) Some fungi form symbiotic associations with other species as mycorrhiza and lichen.
- (vii) They reproduce both sexually by using spores and asexually by budding.
- (viii) They are found in various places such as air, water, soil, food, and in the body of animals and plants.
- (ix) They produce a chemical substance called pheromone that facilitates sexual reproduction.
- (x) They exhibit alternation generation (gametophyte and saprophyte generation).
Gametophyte is dominant over sporophyte

Mycelium: is a collection of hyphae

- Purpose of hyphae and mycelium is to digest and absorb nutrients by secreting enzymes outside of the cells.

Distinctive characteristics (Features) of Kingdom Fungi

Yeasts, Bread moulds, Mucor, mushrooms and all Fungi) are placed in Kingdom Fungi because they have the following unique characteristics (features):

- (i) They have cell walls made up of chitin. Chitin is a substance containing protein and complex sugars.
- (ii) Their bodies are made up of a mycelium except yeasts
- (iii) They feed saprophytically but some of them are parasitic e.g. *Candida albicans*
- (iv) They secrete digestive enzymes outside their bodies into their food.

PHYLA OF THE KINGDOM FUNGI

Members of Kingdom fungi are classified into three main phyla, based on the structures they use to produce sexual spores, namely

Phylum	Examples of Common member (s)
(i) Ascomycota	Yeast
(ii) Zygomycota	Bread mould (Rhizopus) and Mucor
(iii) Basidiomycota	Mushroom

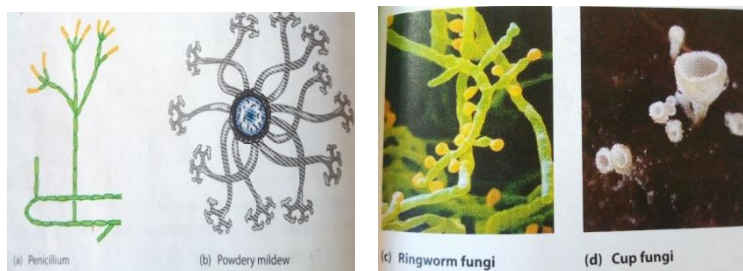
1. PHYLUM ASCOMYCOTA

This phylum consists of unicellular (single celled) organisms such as yeasts

- ◇ Members of this phylum are commonly called **ascomycetes** or **asci fungi**. This is because their spores are enclosed in sac like structures known as asci (singular: ascus).

Other members of phylum Ascomycota includes:

- Cup fungi
- Penicillium
- Powdery mildew
- Ringworm fungi.



General characteristics of phylum Ascomycota (yeast)

Members of phylum Ascomycota have the following characteristics:

- (i) They reproduce sexually by ascospores and asexually by budding
- (ii) Some are unicellular e.g. yeast while others are multicellular e.g. Penicillium
- (iii) They have sac- like cells called asci for ascospores production

- (iv) They can ferment sugars to form alcohol e.g. Saccharomyces (yeasts)
- (v) They have hyphae with cross walls (septa)
- (vi) They grow and feed on decaying materials.

Distinctive features (characteristics) used to place Yeast in the Phylum Ascomycota

Yeasts are placed in phylum Ascomycota because they have the following distinguishing features:

- (i) They reproduce asexually by budding
- (ii) They are unicellular
- (iii) They have hyphae with cross walls
- (iv) They can ferment sugars to form alcohol
- (v) They attach to each other to form short chains

Economic importance of Yeast

- (i) Used in biological studies as specimens.
- (ii) Used in fermentation process.
- (iii) Used in bread making.
- (iv) Used as source of vitamin B
- (v) Yeasts cause spoilage of foods. E.g. tomatoes

Advantages of yeasts in industries

- (i) Used in brewing industries to ferment sugars into alcohol such beers, wines
- (ii) Used in baking industries to manufacture breads.
- (iii) Used in vitamin B synthesis.

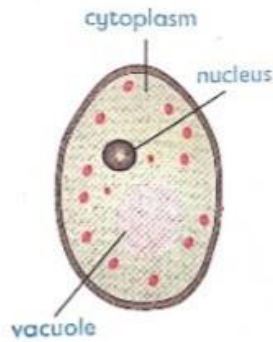
Mode of Nutrition and mode of reproduction and habitat of Yeast

Organism	Mode of nutrition	Mode of reproduction	Habitat
Yeast	Saprophytic nutrition Reason: It feeds on dead and decaying organic matters.	Asexual reproduction through budding	Found on the surface of sugary ripe fruits.

Meaning of budding

Budding is a form of asexual reproduction whereby a new organism develops as an outgrowth of the parent.

Diagram of yeast cell



2. PHYLUM ZYGOMYCOTA

This phylum consists of multicellular organisms such as Mucor and Rhizopus.

- The members of this group are called **zygomycetes**. This is because they produce sexual spores called zygospores in the structures known as zygosporangia.

Examples of zygomycetes (common members of phylum zygomycota)

- ◇ Bread mould or Rhizopus
- ◇ Mucor

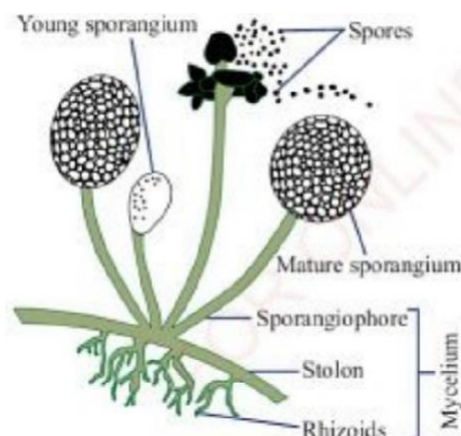
General characteristics of Phylum Zygomycota

- (i) They are multicellular
- (ii) They have hyphae without cross walls
- (iii) They are saprophytic growing on decaying organic materials such as on bread, ripe fruits and vegetables.
- (iv) They reproduce sexually through zygospores or asexually through sporangioophore
- (v) They have rhizoids for anchorage
- (vi) They grow as a mass of white tiny threads on decaying bread, cassava, pawpaw and tomato

Distinctive features used to place bread mould or Mucor to Phylum Zygomycota

- (i) They reproduce sexually through zygospores or asexually through sporangioophore.
- (ii) They grow as a mass of white tiny threads and feed on decaying materials.
- (iii) They have hyphae without cross walls (septate).
- (iv) They are saprophytic, growing on decaying organic materials.

A WELL LABELLED DIAGRAM OF BREAD MOULD



Adaptations of Bread Mould to its mode of life

- (i) It has rhizoids for anchorage and nutrients absorption.
- (ii) It has sporangium to store spores.
- (iii) It produces light spores for easy dispersal by wind.
- (iv) It has spores which are used for asexual reproduction.
- (v) It has stolon for allowing it to spread rapidly on the substrate
- (vi) It has sporangiophore to hold the sporangium in position for easy dispersal.

Economic importance of Bread Mould

- (i) Used in biological studies as specimens.
- (ii) Used to increase soil fertility by decomposing dead organic matters.
- (iii) It causes spoilage of foods.

Mode of Nutrition, mode of reproduction and habitat of bread mould

Organism	Mode of nutrition	Mode of reproduction	Habitat
Bread mould	Saprophytic nutrition	◊ Both sexual and asexual reproduction.	– Grows on dead and decaying organic matters. E.g. bread, cassava, tomato.

SPECIMENS

Bread mould.....**A**

Yeast.....**B**

1. You have been provided with specimen **A**

- (a) (i) Identify specimen **A** by its common name
 - (ii) Classify specimen **A** to the phylum level.
 - (b) How does specimen **A** adapted to its mode of life?
 - (c) Write three economic importance of specimen **A**
 - (d) (i) Name the phylum to which the specimen **A** belongs. Give two reasons for your answers.
 - (ii) What are the observable features of specimen **A**? Give three
 - (iii) Suggest the possible habitats for specimen **A**
 - (e) (i) Identify the mode of reproduction of specimen **A**
 - (ii) What is the mode of nutrition of specimen **A**?
 - (iii) Mention only two distinctive features of the kingdom to which specimen **A** belongs.
 - (iv) In what ways does the specimen **A** useful to farmers? Give two points
 - (f) Draw a well labelled diagram of specimen **A**
2. You have been provided with specimen **B**
- (a) (i) Identify specimen **B** by its common name
 - (iii) Classify specimen **B** to the phylum level.
 - (b) How does specimen **B** adapted to its mode of life?
 - (c) Write three economic importance of specimen **B**
 - (d) (i) Name the phylum to which the specimen **B** belong. Give two reasons for your answers.
 - (ii) Mention two observable features of specimen **B**
 - (iii) Suggest the possible habitat for specimen **B**
 - (e) (i) Identify the mode of reproduction of specimen **B**
 - (ii) What is the mode of nutrition of specimen **B**?
 - (iii) Mention only two distinctive features of the kingdom to which specimen **B** belongs.
 - (f) In what ways does the specimen **B** useful in industries? Give two points

3. **PHYLUM BASIDIOMYCOTA**

This phylum consists of multicellular organisms such as mushrooms.

- The members of this group are called **Basidiomycetes**. This is because they produce sexual spores called basidiospores in the structures known as **Basidia**.

- Basidiomycetes have club-shaped structures called **Basidia**. This is why they are also called **club-fungi**

Examples of Basidiomycetes

- Mushrooms
- Toadstools
- Puffballs
- Bracket fungi

General characteristics of phylum Basidiomycota

The following are general characteristics of phylum Basidiomycota

- (i) They are multicellular organisms
- (ii) They are saprophytic, growing on decaying organic matters
- (iii) They reproduce both sexually and asexually
- (iv) They have hyphae with cross walls (septate)
- (v) They produce sexual spores called basidiospores.
- (vi) They have club-shaped structures called Basidia

Distinctive Features of phylum Basidiomycota

The following are distinctive Features used to place mushrooms in phylum Basidiomycota

- (i) They have club-shaped structures called **Basidia**
- (ii) They have gills containing Basidia
- (iii) They produce sexual spores called **basidiospores**
- (iv) They have cap like structure called pileus

Adaptations of mushroom to its mode of life

- (i) It has stipe to ensure the pileus is well-positioned above the soil for the dispersal of spores.
- (ii) It produces enzymes which help them to break down complex food particles.
- (iii) It has **pileus** to protect gills from physical damage.
- (iv) It has hyphae for anchorage and absorption of nutrients from the soil.

Economic importance of mushroom

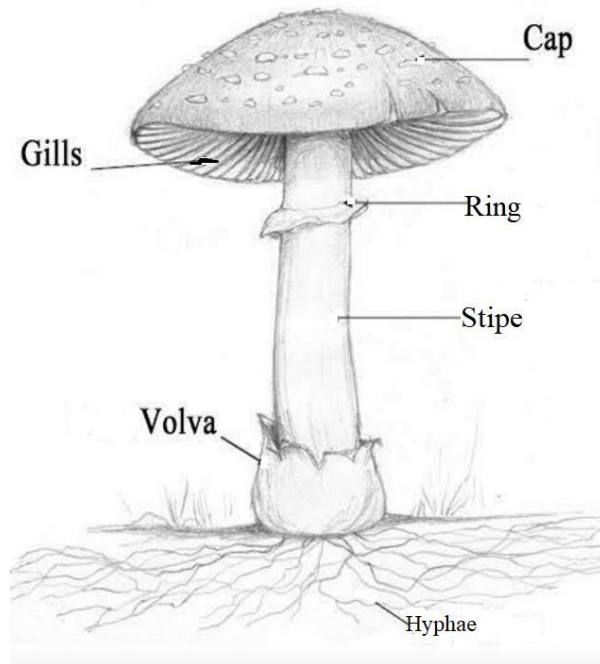
- (i) Used as source of food.
- (ii) Used in biological studies
- (iii) Used as decomposers hence increase soil fertility
- (iv) Used in genetic engineering and research
- (v) Some of them are poisonous when eaten cause death to human eg. Amanita species

STRUCTURE OF MUSHROOM

Mushroom is a multicellular organism made up of the following structures (parts):

- (i) It has **stipe** (a stem-like) to ensure the pileus is well-positioned above the soil for the dispersal of spores.
- (ii) It has **pileus** which is cap shaped to protect gills from physical damage.
- (iii) It has **hyphae** for anchorage and absorption of nutrients from the soil.
- (iv) It has **gills** which contain Basidia for basidiospores production.

A WELL LABELLED DIAGRAM OF MUSHROOM



NB: The part of mushroom that is above the soil is called the **fruiting body**.

Mode of Nutrition, mode of reproduction and habitat of Mushroom

Organism	Mode of nutrition	Mode of reproduction	Habitat
Mushroom	Saprophytic nutrition	◊ Both sexual and asexual reproduction.	– Grows on dead and decaying organic matters.

ECONOMIC IMPORTANCE OF KINGDOM FUNGI

This includes both advantages and disadvantages of fungi

Advantages of Fungi or kingdom Fungi

Most of fungi are **beneficial** or useful to human beings as follows:

(i) They are used as source of food

Some types of fungi such as edible mushrooms are used as food and they have high contents of proteins and vitamins.

(ii) They are used in bread making

Some fungi such as yeasts are commonly used in bakery industries to make bread and cheese

(iii) They are used in fermentation process to produce alcohol

Some fungi such yeasts are used in brewing industries to ferment sugars to produce alcohol such as beer and wines.

(iv) They are used in the production of antibiotics

Some types of fungi are used in the production of antibiotics. For example Penicillium used to produce antibiotics called penicillin which used in treating bacterial infections including bronchitis and laryngitis.

(v) They are used as decomposers hence increase soil fertility

Saprophytic fungi decompose dead organisms and waste materials to release important nutrients into the soil hence increases soil fertility.

(vi) They are used in genetic engineering and biological researches

Some fungi are widely used in studying genetics and research. For example neurospora are used in the study of genetics.

(vii) They are used in production of acids

Several species of fungi are used in making lactic acids, citric acids, cheese, and commercial enzymes.

(viii) They are used as a source of vitamin B and proteins

Some fungi such as yeast is known to be rich source of vitamin B and proteins, hence used as source of vitamin B and proteins.

(ix) Used in enzymes synthesis

Many enzymes such as amylase, invertase and protease are synthesized on a commercial scale from fungi.

DISADVANTAGES OF KINGDOM FUNGI

Some fungi are **harmful** to human beings and to other organisms as follows:

(i) Some fungi cause food spoilage

Some fungi such as moulds and other parasitic fungi cause food spoilage such as rotting of meat, bread, cereals, fruits and vegetables. E.g. tomatoes are spoiled by yeast while onions are spoiled by *Puccinia*.

(ii) They cause diseases in plants and animals

In plants, parasitic fungi cause various fungal diseases such as potato blight, wheat rust and maize rust while in animals they cause fungal diseases such as athlete's foot, ringworm, meningitis, candidiasis and skin infection in human beings.

(iii) They cause death to human being.

Some mushrooms are poisonous and cause death to human beings when eaten, also amanita species are responsible for many death caused by fungi poisoning. Other species are known to paralyse the central nervous system in human beings.

(iv) They produce poisonous substances called mycotoxins

Some fungi such as a certain types of ascomycetes produce poisonous substances called mycotoxins. The most common mycotoxin is known as aflatoxin. Aflatoxin is a carcinogen or cancer-causing agent. Aflatoxin is commonly found in harvested maize, groundnuts and peanuts that have been left in damp places.

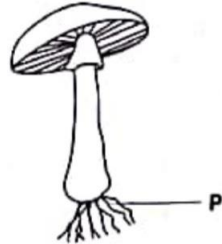
(v) They destroy timber, timber products and other materials.

Some fungi such as dry rot fungi attack and destroy the timber used in building houses and making furniture. This cause destruction of property.

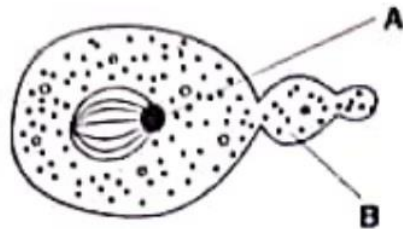
REVISION QUESTIONS

1. Suppose you are in a class and your Biology subject teacher brings you an unknown specimen. Which characteristics will you look for to confirm that it belongs to the Kingdom Fungi? Give four points.
2. Name the phylum in which each of the following organisms belongs:
 - (a) Bread mould
 - (b) Mushroom
 - (c) Yeast
3. Explain the disadvantages of fungi
4. Describe how yeast reproduce
5. Explain the importance of fungi
6. If you put a piece of bread in a wet cupboard after a few days the bread will be covered with organisms called Fungi.
 - (a) Give the common name of these fungi which grow on bread.
 - (b) Outline three phyla of the Kingdom Fungi.
 - (c) Outline five advantages of the Kingdom Fungi
7. A majority of people believe that all fungi are harmful organisms. As a biologist, explain four ways in which fungi are beneficial to human beings.

8. A bread was put in a wet cup board. After a few days black thread-like structures which ended up in club-like shape appeared on the bread.
- Write the common name of the organism that grew on the bread surface.
 - Name the kingdom in which the observed organism belongs.
 - Name the phylum or division in which the observed organism belongs.
 - Outline the advantages of the members of the kingdom you mentioned in (b) above.
9. The diagram below represents a certain organism.



- Name the organism.
 - Giving two reasons, identify the kingdom and phylum or division to which the organism belongs.
 - Name the structure labelled P.
 - State the type of reproduction exhibited this organism
 - Identify the habitat and the mode of nutrition of the above organism.
10. Use the organism shown in the figure below to answer the following questions:



- Identify the common name of the organism in the figure above.
- Identify the kingdom and phylum to which the organism belongs
- Name the part labelled A and B.
- State the type of reproduction shown on the diagram, giving reasons.
- State three economic importance of the above organism.

KINGDOM PLANTAE

Kingdom Plantae: this kingdom is composed of a wide variety of **plants** such as mosses, ferns, cone bearing plants and flowering plants.

- The members of Kingdom Plantae vary greatly in size, forms, habitat, means of reproduction and morphology.
- Plants are found in various habitats such as on land, in oceans, and in fresh water.

Plants: are multi-cellular eukaryotic organisms with ability to manufacture their own food by using energy from the sun through the process of photosynthesis.

Example of common representative members of Kingdom Plantae

- Moss plants
- Fern plants
- Cone bearing plants such as pines
- Flowering plants such as maize, bean, and hibiscus plants

GENERAL CHARACTERISTICS (FEATURES) OF KINGDOM PLANTAE

The members of Kingdom Plantae are characterized by the following general features:

- (i) They are multi-cellular and eukaryotic organisms.
- (ii) They have cell organelles called chloroplasts that contain chlorophyll
- (iii) They are autotrophs. This means they can make their own food using sunlight through photosynthesis process.
- (iv) Some plants reproduce sexually through flowers or cones while others reproduce asexually by means of spores.
- (v) Their cells are organized into tissues, organs and organ systems.
- (vi) They show limited movement, for example opening and closing of flower petals and growth movements towards stimuli like light and water.

Distinctive features of kingdom Plantae

The members of Kingdom plantae are distinguished from members of other Kingdoms by having the following unique features:

- (i) Their cell walls are made up of cellulose.
- (ii) They store food (carbohydrates) in the form of starch.
- (iii) Higher plants have vascular tissues for the conduction of water, mineral salts and manufactured food.

- (iv) They have roots, stems and leaves

DIVISION OF KINGDOM PLANTAE

The Kingdom Plantae is divided into four main divisions. These are:-

Division	Examples of Common member (s)
(i) Bryophyta	Moss plants (mosses)
(ii) Filicinophyta or Pteridophyta	Fern plants
(iii) Coniferophyta	Pines, cypress, Christmas tree
(iv) Angiospermophyta	Maize plants, hibiscus plants, bean plants, grasses, mango plants

(i) DIVISION BRYOPHYTA

This division is composed of all bryophytes.

- Bryophytes are the most primitive plants found in wet and shaded environment such as on floors, rock surfaces, bare soil, cracked or paved surfaces, bricks, on trunks and branches of trees.
- The reproduction process in bryophytes depends on availability of water that is why their distribution is restricted to shady and moist places.

Examples of bryophytes (common members of division Bryophyta)

- ◇ Mosses
- ◇ Liverworts

General features of the division Bryophyta

- (i) They live in moist, damp and shaded areas.
- (ii) They do not produce flowers, fruits or seeds.
- (iii) They have root-like structures called rhizoids
- (iv) They lack vascular tissues (xylem and phloem)
- (v) They reproduce both sexually and asexually by spores.
- (vi) They undergo alternation of generation with gametophytes and sporophytes generation.

Distinctive characteristics of the division Bryophyta

- (i) They are simple plants which lack true roots, stems or leaves.
- (ii) They have thalloid plant body, which is leafy in nature
- (iii) They have thallus (a leaf-like structure) and rhizoids (a root-like structure).
- (iv) They lack vascular tissues. This means that they have no xylem and phloem

- (v) The dominant part of the plant body is gametophyte (the gamete producing plant body)
- (vi) They depend on water for sexual reproduction because the male gametes can only reach the female gametes by swimming.

The general structure of mosses

Mosses are primitive plants believed to be among the first plants to develop the ability to live on land. An example of a moss plant is *Funaria sp.*

Moss plants have the following structures (features):

- (i) They have no true roots instead they have root-like structures called **rhizoids** for water absorption and to hold moss plant to their growing surfaces.
- (ii) They have no true leaves instead they have leaf-like structures called **thallus** for carrying out photosynthesis.
- (iii) They have no true stems instead they have stem-like to hold thallus in position.
- (iv) They lack vascular tissues to transport water and nutrients from one part of the plant to another. This is the reason, why bryophytes do not grow tall but are short and spread out.
- (v) They grow on water collecting surfaces to allow direct water absorption through the body surface. The absorbed water move up by capillary action.
- (vi) The gametophytes is the main moss structure which is a greenish stem-like and leaf-like body.
- (vii) The gametophyte have male and female reproductive structures and also carry out photosynthesis.
- (viii) They have capsule to store spores
- (ix) They have seta to hold capsule in position to facilitate spores dispersal

Reproductive structures (organs) of moss plant

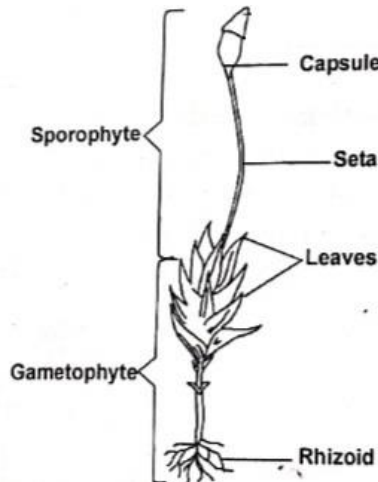
Each Moss plant has three reproductive structures (organs), namely:

- (i) **Archegonium** – Egg producing organ in the gametophyte generation.
- (ii) **Antheridium** – sperm producing organ in the gametophyte generation
- (ii) **Sporangium or Capsule** – spores producing organ in the sporophyte generation

Mode of Nutrition, mode of reproduction and habitat of Moss plant

Organism	Mode of nutrition	Mode of reproduction	Habitat
Moss plant	Autotrophic nutrition	Both sexual and asexual reproduction.	Grows in moist, damp and shaded areas.

A well labelled diagram of moss plant



Adaptation of moss plant to its mode of life

- (i) It has rhizoids for water and nutrients absorption from the soil and for anchorage.
- (ii) It has rigid capsule to store spores
- (iii) It has seta to hold the capsule in position in order to facilitate spores dispersal
- (iv) It has leaves-like structures for carrying out photosynthesis
- (v) It has chlorophyll to trap sunlight needed for photosynthesis.
- (vi) Moss plants are small in size which enable them to germinate even in restricted place.
- (vii) Moss plants produce mobile male gametes which can move toward the female gametes for fertilization purposes.

Question: Why the moss plants do not grow tall?

Answer: This is because:

- (i) They have no true roots, stems or leaves.
- (ii) They lack vascular tissues.

Advantages of Moss Plants

- (i) They provide shelter for insects and small animals. E.g. earthworms
- (ii) They help to keep the soil moist. This is due to their ability to retain water.
- (iii) They help to decompose dead logs and enhance nutrients circulation.
- (iv) They help to prevent soil erosion by holding the soil particles together
- (v) They are primary producers in the environment. Therefore, they provide energy for heterotrophs such as insects, fungi and bacteria.

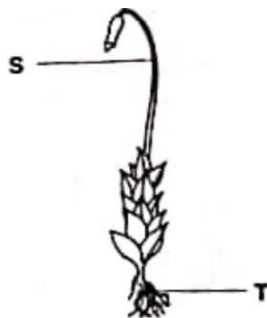
- (vi) They produce oxygen to the atmosphere. Oxygen produced by mosses is used by animals and other organisms.
- (vii) They serve as pioneer plants on bare ground. This helps to create a suitable environment for the growth and development of higher plants.

Disadvantages of Moss plants

- (i) They are weeds in gardens and other places.
- (ii) They are difficult to remove when invade an area.
- (iii) They cause buildings to look old and unattractive. This is when they grow on the surfaces and walls of buildings.
- (iv) They cause the area to become marshy. Since, they cover ponds and some other small water bodies completely.

REVISION QUESTIONS

1. Briefly explain why moss plants do not grow tall as higher plants? Give two reasons
2. (a) List four general characteristics of division in which a moss plant belongs.
(b) Outline three distinctive characteristics of division in which a moss plant belongs.
(c) Briefly explain how moss plant is adapted to its habitat?
3. Draw well labelled diagram of moss plant.
4. (a) What are the two generations that occur in bryophytes? Which generation is said to be dominant?
(b) List three reproductive structures (organs) found in moss plant
(c) Identify the habitat, mode of feeding and mode of reproduction of moss plant
5. Explain the general and distinctive characteristics of members of the Kingdom Plantae.
6. Explain four advantages and three disadvantages of mosses
7. In an ecological survey of an old building, pupils collected the plant shown below:



- (a) (i) Identify the common name of the plant collected by pupils.

- (ii) State the division where this plant belongs and give reasons for your answer
- (iii) Identify the habitat and mode of reproduction of the above plant
- (b) Name the structures marked S and T
- (c) State the function of the structures marked S and T.
- (d) State the type of nutrition exhibited by the above specimen.

DIVISION FILICINOPHYTA (PTERIDOPHYTA)

This division is made up of plants known as filicinophytes or pteridophytes such as ferns.

- Filicinophytes are much more advanced than bryophytes **because** they have true roots, stems and leaves

Examples of filicinophytes or pteridophytes

- Ferns
- Horsetails
- Club mosses

◊ A young fern is called a **fiddlehead**.

General characteristics (features) of division Filicinophyta (pteridophyta)

- (i) They live in moist, damp and shady areas.
- (ii) They have vascular tissues (xylem and phloem).
- (iii) They have true root, stems and leaves
- (iv) They do not produce flowers and seeds.
- (v) They reproduce by means of spores
- (vi) They show alternation of generations. The sporophytes generation is dominant

Distinctive characteristics of division Filicinophyta

Members of division Filicinophyta differ from the members of other divisions by having the following unique features:

- (i) They have simple vascular tissues
- (ii) Their mature leaves bear spore-producing structures called **sori** on the lower side.
- (iii) Their leaves are arranged in a clump and are called fronds.

THE STRUCTURE OF FERN PLANT

A fern plant is made up of the following parts:

- (i) **Frond** – is the leaf of a fern plant used to carry out photosynthesis.
 - The structure of fern fronds ranges from simple (undivided blade) to compound (blade is divided into leaflets known as pinnae)
 - The fronds have spore producing capsule on the underside called **sori**

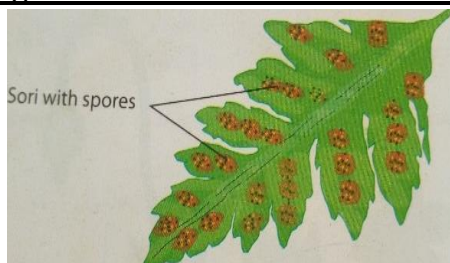
- (ii) **Sori** – are groups of sporangia in a fern plant. They are reproductive structures of fern plant.
- (iii) **Pinnae** –are small leaflets of a fern plant connected to rachis.
- (iv) **Rachis** – is the stalk of the frond connected to the rhizome
- (v) **Rhizome** – is a very short vertical stem at or near the soil surface.
- (vi) **Adventitious roots** attached to the rhizome for anchorage and absorption of water and nutrients from the soil
- (vii) **It has vascular system** for transportation of water and nutrients.

Reproductive structures (organs) of fern plant

Fern plant has the following reproductive structures (organs):

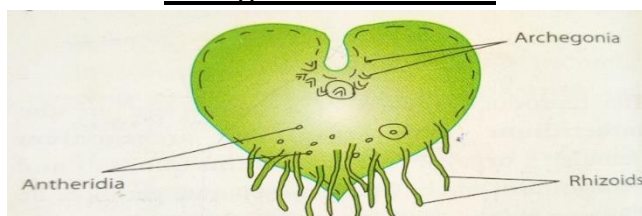
- (i) **Sori (singular: sorus)** –clusters of spore- producing structures called **sporangia**.

A diagram of lower side of a fern leaf (frond) showing sori



- (ii) **Archegonia** (eggs producing organs) and **antheridia** (sperms producing organs) which found on the **Prothallus** (a flattened leaf like structure germinated from mature spore)

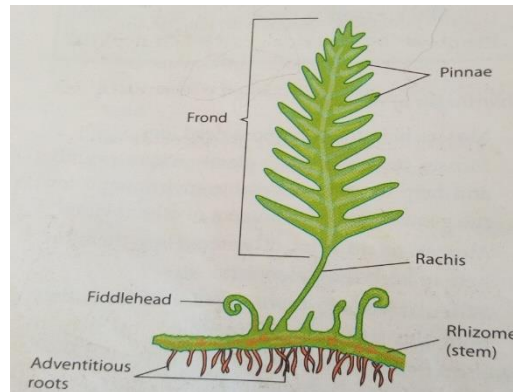
A diagram of Prothallus



Mode of Nutrition, mode of reproduction and habitat of Fern plant

Organism	Mode of nutrition	Mode of reproduction	Habitat
Fern plant	Autotrophic nutrition	◊ Both sexual and asexual reproduction.	– Grows in moist, damp and shaded areas.

A well labelled diagram of fern plant



Advantages of ferns

(i) **They are used for decoration in homes and offices.**

Some types of ferns are grown as ornaments in home and offices, thus, beautify the environment and make it more attractive.

(ii) **They are used as food for animals.**

Ferns are primary producers in the ecosystem, thus produce food for themselves and for animals such as herbivores in the ecosystem.

(iii) **They are used as a biological fertilizer.**

Ferns such as *Azolla sp.* are used as biological organic fertilizer as they are able to fix nitrogen from the air into compounds that can be absorbed by plants.

(iv) **They are source of oxygen to the atmosphere.**

Ferns produce oxygen gases during photosynthesis and release them into the atmosphere. Oxygen given out by ferns is used by other living organisms in respiration process.

(v) **They are used in biological studies and research.**

Ferns are used by biologists in biological studies and research as specimen.

(vi) **They are the major components of coal.**

The remains of primitive plants such as ferns that died a long time ago in muddy swamps decay anaerobically to form a fossil fuel called Coal.

Disadvantages of ferns

(i) **Ferns are regarded as weeds in many places.**

Some species of fern plants are common weeds in water and terrestrial habitats, for example the giant water fern is one of the world's worst aquatic weeds that threaten the life of other aquatic organisms while *Pteridium sp.* are common weeds in terrestrial environment.

- (ii) **They provide habitat to dangerous animals such as snakes.**

Fern plants act as home for dangerous small animals such snakes

Similarities between moss plant and fern plant

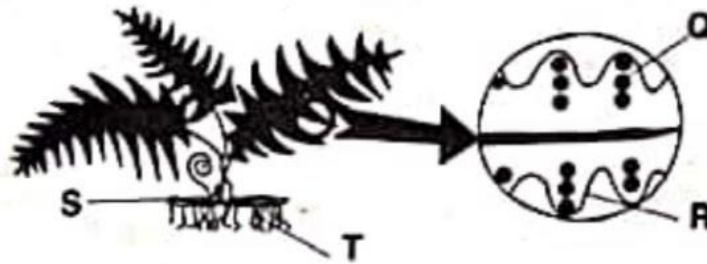
- (i) They have chlorophyll
- (ii) They reproduce asexually and sexually
- (iii) Their cell walls are made up of cellulose
- (iv) They show alternation of generation
- (v) They are autotrophs

Differences between moss plant and fern plant

Moss plant (bryophyte)	Fern plant (Filicinophyte)
(i) Lacks vascular tissues	Has vascular tissues
(ii) It lacks true roots, stems and leaves	It has true roots, stem and leaves
(iii) It has rhizoids	It has roots
(iv) It has capsule	It has sori
(v) Gametophyte is dominant over sporophyte	Sporophyte is dominant over gametophytes
(vi) It has no fiddlehead	It has fiddlehead

REVISION QUESTIONS

- (a) Name the division of the Kingdom Plantae in which the sporophyte is a dominant plant body?
(b) What is meant by the term sporophyte?
- Study the figure below:



- Identify the common name of the above organism.
 - Giving reasons, state the kingdom and division to which the organism belongs.
 - Name the structures labelled Q, R, S and T and state their functions.
- Mention three examples of the members of the division Filicinophyta.
 - What are the advantages and disadvantages of the members of the division Filicinophyta?
 - Draw and label a diagram of one of the members of the division Filicinophyta.
 - Name the importance of a fern to human or living organisms
 - Name the habitat and mode of reproduction for a fern plant.
 - State two similarities and two differences between moss plant and fern plant

NUTRITION

Nutrition

This is the process by which an organism takes in and uses nutrients

Or

Nutrition is the process of feeding and utilisation of food for energy provision, growth and development, repair and maintenance of the overall body health.

Nutrition also refers to the study of the relationship between diet, health and diseases.

- People who study nutrition are called **nutritionists** or **dieticians**

They are professionals who advise people on nutrition affects their health and well-being.

IMPORTANCE OF NUTRITION IN LIVING THINGS

- (i) Nutrition helps the body to synthesize important chemical substances such as enzymes and hormones.
- (ii) Nutrition helps organisms to get energy required for growth and development of cells, tissue and organs.
- (iii) Nutrition helps the body to carry out different life processes such as movement, reproduction, contraction and relaxation of muscles and transmission of nerve impulses.
- (iv) Nutrition helps the body to replace, repair the worn out and damaged cells and tissues.
- (v) Nutrition provides protection to the body against infections and diseases.
- (vi) Nutrition helps organisms to get nutrients necessary for maintaining body temperature.

TYPES OF NUTRITION

There are two major types of nutrition based on how organisms obtain their food. These are:-

- (a) Autotrophic nutrition
- (b) Heterotrophic nutrition

(a) AUTOTROPHIC NUTRITION

Is a type of nutrition whereby organisms manufacture their own food using energy sources available.

- An organism that manufactures its own food is called an **autotroph**.
- The term autotroph comes from two Greek words namely ‘**autos**’ which means ‘**self**’ and ‘**trophy**’ which means ‘**feed**’ hence ‘**autotrophy**’ which means ‘**self-feeding**’
- Autotrophs are very important because are capable of making their own food for their own use and for other organisms and without them, no other organisms could exist or survive.

Examples of autotrophs (autotrophic organisms)

- Green plants
- Algae
- Some bacteria such as cyanobacteria

TYPES OF AUTOTROPHIC NUTRITION

There are two types of autotrophic nutrition based on how organisms obtain their energy. These are:

- (i) Photoautotrophic nutrition
- (ii) Chemoautotrophic nutrition

(i) PHOTOAUTOTROPHIC NUTRITION

Is a type of nutrition in which organisms use light energy to make their own food.

- An organisms that obtain their energy from sunlight in order to make their own food are called photoautotrophs
- They make their own food in the form of carbohydrates using water and carbondioxide in the presence of chlorophyll and sunlight through a process called photosynthesis.

Examples of photoautotrophs

- Green plants
- Algae
- Some bacteria such as cyanobacteria
- Euglena

(ii) Chemoautotrophic nutrition

Is a type of nutrition in which organisms use chemical substances to make their own food.

- Organisms that obtain their energy from chemical substances like hydrogen sulphide, iron, methane and ammonia are called **chemoautotrophs**.
- They use chemicals to make their own food in the form of carbohydrates through a process called **chemosynthesis**.

Examples of chemoautotrophs

- Some bacteria such as archaebacteria that live in harsh environments such as in the deep sea and around the volcanic sites where there is no sunlight and where many other organisms cannot survive.

(b) HETEROTROPHIC NUTRITION

Is the mode of nutrition in which an organism feeds on already manufactured food.

- Heterotrophic nutrition is also known heterotrophism
- Organisms that cannot make their own food instead depends on food already made by other are called **heterotrophs**.
- The term **heterotrophs** comes from two Greek words namely ‘**hetero**’ which means ‘**different**’ and ‘**trophy**’ which means ‘**feeding**’. Therefore the term **heterotroph** means ‘**different feeding**’.

Examples of heterotrophs heterotrophic organisms

- Animals

- Fungi
- Most bacteria
- Protoctists

TYPES OF HETEROTROPHIC NUTRITION

There are three types of heterotrophic nutrition

- (i) Saprophytic nutrition
- (ii) Holozoic nutrition
- (iii) Symbiotic nutrition

(i) SAPROPHYTIC NUTRITION

Is the mode of nutrition in which an organism feeds on dead and decaying organic matters.

- Organisms that obtain their food from dead and decaying organic matters are called **saprophytes**

Example of saprophytes

- Fungi
- Bacteria.

(ii) HOLOZOIC NUTRITION

Is the mode of nutrition that involves taking in complex food substances, digesting, absorbing and assimilating the nutrients into the organism's body.

- The undigested and indigestible food remains are finally egested as faeces.
- Holozoic nutrition is found most animals.

MODE/FORMS OF HOLOZOIC NUTRITION

Holozoic nutrition is divided into three modes of feeding. These are:

- (a) Herbivorous
- (b) Carnivorous
- (c) Omnivorous

(a) HERBIVOROUS

Is the mode of feeding whereby an organism feeds on plants.

- Animals that feed on plants are called **herbivores**.

Examples herbivores

- Cow
- Goat
- Rabbit
- Antelope

(b) CARNIVOROUS

Is the mode of feeding in which an animal feeds on other animals.

- Animals that feed on other animals are called **carnivores**.

Examples of carnivores

- Lion
- Tiger
- Hawk

- Leopards
- Driver ants
- Ground beetles

(c) **OMNIVOROUS**

Is a mode of feeding in which an animal feeds on both plant and animal food sources.

- Animals that feed on both plants and animals are called **Omnivores**
- They also feed on other organisms including fungi and algae.
- Omnivores are regarded as **opportunistic feeders** because they feed on a variety of food sources.

Examples of omnivores

- | | |
|----------|--|
| – Man | – Lizards |
| – Monkey | – Chimpanzees |
| – Bears | – Turtles |
| – Pig | – Insects such as crickets, ants and wasps |
| – Birds | |

(iii) **SYMBIOTIC NUTRITION**

Is a feeding relationship between two species in which one or both benefits from the relationship.

Forms of symbiosis

Symbiosis can be in the form of:

- Mutualism
- Commensalism
- Parasitism.

(a) **MUTUALISM**

Is a feeding relationship between two species in which both species benefit from each other.

Example of mutualism

- Bacteria living in the gut of goat, cow or sheep get their nutrients from the food digested by the animals. The bacteria in turn help the animals to digest cellulose as the animals cannot produce the enzymes used to digest cellulose.

(b) **COMMENSALISM**

Is a feeding relationship between individuals of two different species in which one species benefits while the other is neither harmed nor benefiting.

- In most cases, the host individual is large in size compared to the commensal individual.
- The commensals benefit in various ways such as getting nutrients, shelter, support or transport from the host.

Example commensalism

- The relationship between Epiphytes and big trees (epiphytes are small plants that grow on different trees but do not harm the trees).
- Remora (small fishes) which attach to the body of a large fish such as a shark.

(c) PARASITISM

Is a feeding relationship between two species where one species benefits while the other is harmed.

Example of parasitism

- The relationship between two a tapeworm and a human being

EXERCISE 1

1. Explain the meaning of nutrition
2. Differentiate between autotrophic and heterotrophic modes of nutrition.
3. Briefly explain the following types of heterotrophic nutrition:
 - (a) Holozoic nutrition
 - (b) Saprophytic nutrition
 - (c) Symbiotic nutrition
4. Why are omnivores regarded as opportunistic feeders?
5. What is the role of enzymes in a saprophytic mode of feeding?
6. Why are large trees in the forest not harmed by epiphytes that grow on their bodies

NUTRITION IN MAMMALS

Human nutrition

Refers to the science of food and its relationship to health and well –being of human beings.

- It is also includes how nutrients are harnessed and utilized for various life processes.

FOOD

Is a substance that provides the body with energy, materials for growth, repair and factors for good health.

NUTRIENTS

Are chemical components of food which are essential to life and health.

Or

Are substances which organisms use for the body processes.

- They are very important for promoting growth and development, as well as regulating chemical processes in the body.
- Nutrients are obtained from various food such as cassava, meat and bananas.

MAJOR TYPES OF NUTRIENTS

There are five major types of nutrients. These are:

- (a) Carbohydrates
- (b) Proteins
- (c) Lipids (fats and oil)
- (d) Vitamins
- (e) Minerals

NB: Water and roughage are also important.

CATEGORIES OF FOOD NUTRIENTS

Nutrients are divided into two categories, namely:

- (i) Macronutrients
- (ii) Micronutrients

(I) MACRONUTRIENTS

Are nutrients that are needed by the body in large amounts.

- These nutrients contain calories which can be burned in the body to produce energy needed for various body functions.

A calorie: is a unit of measurement of food energy.

Example of macronutrients

- (a) Proteins
- (b) Carbohydrates
- (c) Lipids

(II) MICRONUTRIENTS

Are nutrients that are needed by the body in small amounts.

- Micronutrients do not contain calories but are very important for carrying out body functions.
- They assist in many aspects of body functions such as digesting food substances and making macromolecules.

Example of micronutrients

- (a) Vitamins
- (b) Minerals

CLASS ACTIVITY 1

You are provided with the following food item (food stuffs): eggs, maize, beans, carrots, sweet potatoes, tomatoes, Irish potatoes, milk, mangoes, fish, groundnuts, mushrooms, vegetables, oranges and chicken.

- (a) From the food items provided above, identify the food items which contain
 - (i) Proteins
 - (ii) Carbohydrates
 - (iii) Lipids
 - (iv) Vitamins and minerals
- (b) Group the food items provided above into different categories based on the type of nutrients they contain.

(a) PROTEINS

Are organic compounds made of amino acids.

AMINO ACIDS

Are small building units of protein

Types of amino acids

There are two types of amino acids, namely:

- (i) Essential amino acids
- (ii) Non-essential amino acids

(i) Essential amino acids

Are amino acids that are obtained from food eaten.

(ii) Non-essential amino acids

Are amino acids that are made by the body.

NATURAL SOURCE OF PROTEINS

The following are food items (food stuffs) which contain proteins:

- | | |
|-----------------|-----------------|
| (i) Meat | (vi) Chicken |
| (ii) Liver | (vii) Fish |
| (iii) Eggs | (viii) Milk |
| (iv) Beans | (ix) Cheese |
| (v) Soya beans | (x) Peas |
| (xi) Groundnuts | (xii) Mushrooms |

FUNCTION OF PROTEINS

The following are the function of proteins:

- (i) Used as a source of energy.
- (ii) Used in body building.
- (iii) Promote growth and repair of worn out body tissues.
- (iv) Used in the formation of plasma membrane
- (v) Some body proteins such as antibodies provide body immunity.
- (vi) Some body proteins such as hormones and enzymes regulate various body processes.
- (vii) Some body proteins such as haemoglobin enables red blood cells to transport oxygen in the body.

PROPERTIES OF PROTEIN

- (i) They are insoluble in water.
- (ii) They are amphoteric. This means, each amino acid in proteins behaves as an acid as well as a base.
- (iii) They are denatured by high temperature
- (iv) They are affected by pH
- (v) Proteins react with sodium hydroxide and copper sulphate to produce a violet or purple colour. This is called the Biuret test.
- (vi) They coagulate on heating. This means small particles of protein clump together to form bigger particles when a mixture of protein and water is heated. This process is called denaturation.

(b) CARBOHYDRATES

Are organic compounds that are mainly made up of carbon, hydrogen and oxygen.

- Carbohydrates are referred to as the **energy- giving food** because they are chief sources of energy in the body.

SOURCES OF CARBOHYDRATES

The following are some of the food that contains nutrients of carbohydrates:

- | | |
|--|------------------|
| (i) Cassava | (v) Wheat |
| (ii) Sweet potatoes and Irish potatoes | (vi) Yams |
| (iii) Maize | (vii) Bananas |
| (iv) Rice | (viii) Sugarcane |

FUNCTIONS OF CARBOHYDRATES

- (i) Used as a source of body energy
- (ii) Some carbohydrates such as cellulose are used in plant cell walls formation.
- (iii) They serve as food reserves in plants and animals e.g. starch and glycogen
- (iv) They form glycoproteins and glycolipids which are important components of cell membranes when combined with proteins and lipids respectively.
- (v) Used in the formation of genetic material such as DNA and RNA in the cell
- (vi) They form parts of the cell like cell walls and cell membrane

(c) LIPIDS

Are compounds of carbon, hydrogen and oxygen.

- They are insoluble in water.
- Lipids are made up of smaller units known as **fatty acids** and **glycerol**.
- Fatty acids can be essential or non-essential.
- Three molecules of fatty acids combine with one molecule of glycerol to form **fats**.

MAIN FORMS OF DIETARY LIPIDS

There are two main forms of dietary lipids, namely:

- (i) **Fats**: are obtained from animals and are solid at room temperature.
- (ii) **Oils**: are obtained from plants and are liquid at room temperature.

NB: Oils are storage materials in some seeds such as maize grain and coconut.

SOURCES OF LIPIDS

The following food items (food stuff) containing lipids:

- | | |
|-----------------|---------------------------|
| (i) Fish | (iv) sunflower |
| (ii) Nuts | (v) coconuts |
| (iii) seed oils | (vi) Avocados and olives. |

FUNCTIONS OF LIPIDS

- (i) They are used as a source of energy
- (ii) They protect delicate organs such as heart and kidneys.
- (iii) They are used as heat insulators. E.g. adipose tissue deposited below the skin.
- (iv) They are used as source of metabolic water.
- (v) They are important components of cell membrane.

(d) VITAMINS

Are complex organic micronutrients that are essential for body growth and survival.

- Animals need vitamins for proper body functioning and metabolism.
- Lack of vitamins in the body leads to deficiency diseases.

CATEGORIES OF VITAMINS

Vitamins can be grouped into two categories, namely:-

- (i) Fat-soluble vitamins
- (ii) Water-soluble vitamins

(i) FAT-SOLUBLE VITAMINS

Are vitamins that can be stored in the body.

- Fat-soluble vitamins are not consumed daily.

Examples of fat-soluble vitamins

- (i) Vitamin A
- (ii) Vitamin D
- (iii) Vitamin E
- (iv) Vitamin K

(ii) WATER-SOLUBLE VITAMINS

Are vitamins that are not stored in the body.

- Water-soluble vitamins should be consumed daily.

Examples of water-soluble vitamins

- (i) Vitamins B
- (ii) Vitamin C

NB: Vitamin B is of various forms, namely:

- Vitamin B₁
- Vitamin B₂
- Vitamin B₃
- Vitamin B₆
- Vitamin B₉
- Vitamin B₁₂

They can be easily destroyed by heat.

- Vitamins are formed by the combination of glucose and some mineral elements
- Most of the vitamins are synthesized by autotrophs particularly green plants
- Animals can synthesize vitamin A and D using plant molecules obtained in their food.

FUNCTIONS OF VITAMINS

- (i) They help in the metabolic activities of both plants and animals.
- (ii) They promote functions of immune and nervous systems.
- (iii) They help in the formation of body tissues and red blood cells

THE TABLE BELOW SHOWS EXAMPLES OF VITAMINS, THEIR SOURCES, FUNCTIONS AND DEFICIENCY SYMPTOMS

Vitamin	Source	Function	Deficiency disorders and symptoms
Vitamin A (Retinol)	Liver, milk, carrots, orange and yellow vegetable	<ul style="list-style-type: none"> – Formation of membranes of the eyes and the respiratory tract – It is important for night vision. – It protects the skin. 	<ul style="list-style-type: none"> (i) Night blindness. (ii) Increased risk of infection.
Vitamin B₁ (Thiamine)	Lean meat, Liver, Eggs, Beans, Yeast, Whole-grain cereals, brown rice and mushroom	<ul style="list-style-type: none"> – Assists in carbohydrate metabolism. – Helps in muscle coordination – Proper growth in children. 	Beriberi , a disease characterized by loss of appetite, muscle cramps, nerve disorder and heart failure.
Vitamin B₂ (Riboflavin)	Liver, meat, unpolished cereals, fresh fruits, vegetables	<ul style="list-style-type: none"> – Metabolism of all foods and the release of energy to cells. 	<ul style="list-style-type: none"> (i) Cracks and sores around the mouth and nose. (ii) Visual problem

Vitamin B₃ (Niacin)	Nuts, fish, meat, mushroom, yeast, brown rice and whole grain cereals.	<ul style="list-style-type: none"> – Needed by enzyme to convert food into energy – It maintains normal skin health. – 	Pellagra (skin disease), a disease characterized by skin lesions, loss of appetite, diarrhoea and muscle weakness
Vitamin B₆ (Pyridoxine)	Meat, vegetables, yeast, brown rice, mushroom and whole grown cereals	<ul style="list-style-type: none"> – Protein metabolism 	(i) Nerve irritability (ii) Sores in the mouth and eyes (iii) Anaemia. (iv) Slow learning (v) Skin diseases (vi) Insomnia
Vitamin B₉ (Folic acid)	Liver, fish, green leafy vegetables, legumes, and folate fortified foods	<ul style="list-style-type: none"> – Synthesis of new cells – Metabolism of carbohydrates 	(i) Birth defects (ii) Anaemia (iii) Frequent infections
Vitamin B₁₂ (Cyanocobalamin)	Fish, meat, eggs, milk, liver	<ul style="list-style-type: none"> – Helps in making genetic material. – Helps to form red blood cells. 	(i) Anaemia (ii) Weight loss (iii) Nerve damage
Vitamin C (Ascorbic acid)	Tomatoes, Fresh green vegetables, Citrus fruits such as orange and lemons	<ul style="list-style-type: none"> – Antioxidant – Improves absorption of iron – Used in synthesis of collagen in the bones and gums. – It provides protection against infections. 	(i) Scurvy (bleeding gums) (ii) Muscle weakness (iii) Easy bruising (iv) joint pains (v) Poor healing of wounds (vi) Frequent infections.
Vitamin D (Calciferol)	Egg yolk, milk, fish, sunlight and liver.	<ul style="list-style-type: none"> – Helps to build and maintain teeth and bones. 	(i) Rickets in children. (ii) Osteoporosis (soft bones) in adult
Vitamin E (Tocopherol)	Corn or sunflower oil, butter, brown rice and peanuts	<ul style="list-style-type: none"> – Antioxidant – Prevents damage of cell membranes 	(i) Nerve abnormalities (ii) Infertility.
Vitamin K (Phylloquinone)	Green vegetables and liver	<ul style="list-style-type: none"> – Needed for normal blood clotting. 	Defective blood coagulation resulting in excessive bleeding in case of injury

(e) **MINERALS**

Are inorganic compounds containing elements which are vital for the proper functioning of the body.

- There are different types minerals needed for different activities in the body. These minerals are called essential minerals.

Examples of essential minerals

- | | |
|-----------------|----------------|
| (i) Sodium | (vii) Sulphur |
| (ii) Chlorine | (viii) Zinc |
| (iii) Potassium | (ix) Iodine |
| (iv) Calcium | (x) Copper |
| (v) Phosphorous | (xi) Manganese |
| (vi) Magnesium | (xii) Fluoride |

Functions of minerals

- (i) They are important for enzyme activities in the body.
- (ii) They are essential for maintaining balance of body fluids
- (iii) They are essential for development of bone tissues.
- (iv) They are essential for synthesis of hormones and activation of enzymes.
- (v) They are essential for transmission of nerve impulses as well as contraction and relaxation of muscles.

THE FOLLOWING ARE EXAMPLE OF MINERALS, THEIR SOURCES, FUNCTIONS DEFICIENCY SYMPTOMS

Mineral	Sources	Functions	Deficiency symptoms
Calcium	Milk, yoghurt, cheese, sardines, eggs, green vegetable	<ul style="list-style-type: none">– Helps build strong bones and teeth.– Promotes nerve transmission– Helps in muscle and nerve functions.– Important in clotting of blood.	<ul style="list-style-type: none">(i) Weak bones and bleeding easily.(ii) Impaired nerve activity
Phosphorus	Meat, milk, fish, eggs and nuts	<ul style="list-style-type: none">– Builds bones and teeth– Helps muscle and nerve activity– Aids formation of genetic materials	Poor bone and teeth formation
Potassium	Peanut, bananas, orange juice, green beans and meat	<ul style="list-style-type: none">– Maintain regular fluid balance needed for nerve and muscle function.	<ul style="list-style-type: none">(i) Poor muscle contraction(ii) Impaired nerve activity
Iron	Liver, meat, beans, green vegetables	<ul style="list-style-type: none">– Essential for making haemoglobin.	Anaemia
Zinc	Oysters, shrimp, crab, meat, chicken, whole grains and vegetables	<ul style="list-style-type: none">– Activates enzymes– Helps in wound healing.– Necessary for a healthy immune system.– Helps in taste detection– Promotes protein synthesis and DNA production– Controls normal growth and sexual maturation	<ul style="list-style-type: none">(i) Impaired taste(ii) Poor immune response.(iii) Skin problems.
Sodium	Table salt, soya sauce, milk, bread, vegetables	<ul style="list-style-type: none">– Necessary for nerve transmission.	<ul style="list-style-type: none">(i) Muscle cramps.(ii) Poor nerve

		<ul style="list-style-type: none"> – Needed for muscle contraction – Necessary for protein making – Needed for proper fluid balance 	transmission
Chlorine	Table salt, eggs, milk, meat, sea foods and whole grain foods	<ul style="list-style-type: none"> – Maintenance of water and ionic balance in the body. – Formation of hydrochloric acid in the stomach. 	Poor digestion of proteins.
Magnesium	Spinach, pumpkin seeds, sesame seeds, beans, nuts, sea food and magnesium.	<ul style="list-style-type: none"> – Maintaining a healthy immune system – Making proteins – Contraction and relaxation of muscle. – Strengthening of bones. 	(i) Muscle weakness (ii) Irregular heartbeat. (iii) Weak bones
Iodine	Iodinated table salt, sea food, dairy products.	<ul style="list-style-type: none"> – Production of thyroid hormone which regulate growth, development and metabolism. 	(i) Goitre (enlarged thyroid gland). (ii) Growth retardation (iii) Mental retardation (iv) Still birth
Fluoride	Fish, fluorinated water, or water naturally containing fluorine and most varieties of tea such as green tea	<ul style="list-style-type: none"> – Development of bones and teeth. – Helps prevent tooth decay 	(i) Poor development of bones and teeth. (ii) Tooth decay
Manganese	Kidneys, liver, tea, coffee nuts, fruits	<ul style="list-style-type: none"> – Helps in formation of bones. – Activation of enzymes (coenzymes). 	(i) Nausea (ii) Dizziness (iii) Loss of hearing (iv) Loss of bone mass
Copper	Whole grains, meat, drinking water, fish, legumes, liver, and other seeds	<ul style="list-style-type: none"> – Synthesis of bones and hemoglobin – Activation of enzymes 	(i) Bleeding under the skin (ii) Easy rupturing of blood vessel. (iii) Bones and joint problems. (iv) Anemia

ROUGHAGE

Is dietary fibre that is obtained from the indigestible part of plants.

- (i) Roughage does not have any nutritional value as it is not digested and absorbed in the body. However, it helps in the passage of food and faeces through the gut by aiding contraction and relation of the gut muscles (peristaltic movement).

SOURCE OF ROUGHAGE

- | | |
|-------------------------|--------------|
| (i) Whole grown cereals | (iv) Cabbage |
| (ii) Fruits | (v) Spinach |
| (iii) Beans | (vi) Cassava |

FUNCTION OF ROUGHAGE

- (i) Helps in the passage of food and faces through the gut by aiding contraction and relaxation of the gut muscles.
- (ii) It helps to control the body weight, thus protects the body from diseases such as heart diseases.
- (iii) Roughage prevents constipation
- (iv) Roughage adds to the bulk of food.

WATER

Is a compound of hydrogen and oxygen

- Water forms about 90% of the cell and acts as a medium for many biochemical reactions in cells.

FUNCTION OF WATER

- (i) It helps in the process of breaking down food during digestion.
- (ii) It is a major constituent of body fluids such as blood, tears and saliva
- (iii) It helps in the regulation of body temperature.
- (iv) It lubricates moving parts of the body and prevents friction. E.g. eyeball
- (v) It forms a large part of the cell cytoplasm
- (vi) It helps to maintain the shape of cells, tissues and organs
- (vii) It helps in excretion of harmful by product of metabolic process e.g. urine, sweat.

DIET

Is the food an animal eats everyday

BALANCE DIET

Is a meal containing food from all food groups in the right proportions

Or

Is a diet that contains all types of nutrients in the correct proportions.

IMPORTANCE OF BALANCE DIET

- (i) It helps an individual to remain healthy.
- (ii) It helps an individual to maintain an ideal body weight
- (iii) It helps the young individual to grow and develop normally.
- (iv) It helps an individual to minimize the risk of contracting long-lasting diseases like cancer, diabetes, obesity, high blood pressure

COMPONENTS OF BALANCE DIET

- (i) Proteins
- (ii) Carbohydrates
- (iii) Vitamins
- (iv) Minerals
- (v) Lipids
- (vi) Roughage
- (vii) Water

- In order to promote a healthy lifestyle, it is important to take in diets containing less fats, sugars, and salts but having moderate amounts of food containing proteins, carbohydrates, vitamins, minerals, and roughage.
- It is also important to drink adequate amounts of water and engage in regular physical exercises.

The following should be done in order to ensure a healthy lifestyle

- (i) Take recommended amounts of proteins, fats or oils, sugars and salts
- (ii) Take recommended amounts of fruits and vegetables in the diet.
- (iii) Eat a variety of foods including whole grains, fruits, vegetables and food with roughage in order to provide the body with required energy and nutrients.
- (iv) Maintain appropriate body weight to height ratio within the limits recommended by the World Health Organisation (WHO)
- (v) Do physical activities daily for 30 to 40 minutes
- (vi) Replace red meat diet with fish, poultry, or lean meat.
- (vii) Take low fat dairy products and low salt foods.
- (viii) Limit the frequency of sugary drinks and all sweets
- (ix) Avoid processed and baked foods of all kinds

NUTRITIONAL REQUIREMENTS FOR DIFFERENT GROUPS OF PEOPLE

The ratio of nutrients needed by the body varies depends on factors such as:

- Body size
- Age
- Sex
- State of health
- Occupation

GROUPS OF PEOPLE	Recommended Nutritional requirements	REASON(S)
EXPECTANT AND LACTATING MOTHERS	Food rich in proteins	<ul style="list-style-type: none"> – In order to promote growth and development of foetus – In order to stimulate production of milk for the baby. – In order to build the muscles, breasts, uterus, blood supply and for proper functioning of tissues and organs of the foetus and baby.
	– Food rich in Folic acid and vitamin B	<ul style="list-style-type: none"> – In order to lower the risk of birth defects such as <i>spina bifida</i>. <p>(Spina bifida is a spinal disorder characterized by a hole in the spine. It results from incomplete formation of the spinal cord and the bones of the spine. Often, the spine protrudes through the hole and sometimes a fluid filled sac may surround the protruding spinal cord.</p>
	They should drink plenty of water.	<ul style="list-style-type: none"> – Because water is a major constituent of breast milk. Some hormones produced during breastfeeding increase thirst.

	They need food rich in calcium	– In order to promote development of the foetus and baby's bones. If the mother's diet does not contain adequate calcium, it will be delivered from her bones for the foetus or the baby. This weakens the mother's bones
	They need food rich in zinc	– In order to promote proper progression of labour during delivery of the baby and for proper growth and development of the baby.
	The pregnant woman requires iron	– For her blood supply needs. The foetus also needs to store iron for use during the first few months after birth
	Requires adequate amounts of dietary fibres such as vegetables and fruits	– In order to avoid constipation that is common complaint during pregnancy
	They should avoid alcohol consumption	Because alcohol can easily pass from their bodies to the foetus and baby during pregnancy and breastfeeding respectively and affect their development.
CHILDREN	They need food rich in vitamins	In order to protect them from diseases.
	They need food rich in proteins.	In order to promote growth and development of the body tissues. Inadequate supply of proteins can lead to stunted growth.
	They need food rich in minerals such as calcium	In order to promote formation of strong bones and teeth
	They need food rich in zinc	In order to promote body growth and for biological processes including cell growth, differentiation and metabolism. Deficiency in zinc limits childhood growth and decreases resistance to infections.
	They need vitamin B₁₂	<ul style="list-style-type: none"> – In order to promote formation of red blood cells because the growing body needs more oxygen and more blood. – Because vitamin B₁₂ is essential for brain development as well as nervous and cognitive functions. – Because inadequate vitamin B₁₂ during pregnancy and early childhood causes improper cognitive development for children.
	They need vitamin C	Because vitamin C helps children to build their immunity and also functions as an antioxidant. Antioxidant is a substance that removes toxins from the body.
	They need enough carbohydrates and lipids	Because they are active than adult.
ADOLESCENT	Food rich in carbohydrates and proteins	Because they have high body metabolism.
	Adolescent girls need food rich in iron	In order to compensate the lost blood during menstruation.

THE ELDERLY	Food rich in vitamins and protein.	In order to make their bodies repair worn out and damaged tissues and maintain a state of good health.
	Food rich in roughage	In order to reduce constipation and bowel problems that comes with age.
	Adequate amounts of food rich in vitamins, minerals and roughage	In order to maintain their health.
	They also need food rich in minerals such as iron, zinc and calcium.	<ul style="list-style-type: none"> – Iron is necessary because it helps to make red blood cells which carry oxygen around the body. – Zinc is required for a healthy immune system and for regulating the healing of wounds.
	Adequate amounts of calcium	In order to strengthen their bones because old age comes with the loss of calcium from bones that can break easily.
	They need vitamin D	In order to improve their mental health and overcome depression
	They can get proteins from eggs or liver instead of meat.	In order to ensure nutritious and easy to chew and swallow. Because they have problems of chewing tough foods due to weakened teeth and decreased production of saliva.
SEDENTARY WORKERS Example, tailors, potters, weavers, clerk, receptionists and doctors.	Less intake of carbohydrates and lipids.	In order to avoid obesity and non- communicable diseases such as diabetes as well as disorders of the muscles and skeleton.
	Encouraged to balance their daily diet with physical exercise.	In order to avoid obesity and diabetes
The sick Example: PLWHA	Proper nutrition with high proteins, minerals and vitamins.	<ul style="list-style-type: none"> – In order to keep the body immune system strong and able to fight against infections and diseases. – In order to help the body to withstand heavy medication. – In order to compensate a rapid weight loss
	They should increase the intake of fruits, vegetables and water	<ul style="list-style-type: none"> – Fruits provide vitamins to fight disease. – Water replaces the amount lost through diarrhea or vomiting.
	– Sick people require plenty of nutrients	To help recover their health.
	– Proper diet and exercise	Helps to combat symptoms such as fatigue, nausea, diarrhea and high blood sugar.
	– They should avoid excess intake of caffeine products, sugary foods, fried foods, spicy foods and alcohol	Because they are harmful to a body whose immune system is already weak.

THE FOOD GUIDE PYRAMID

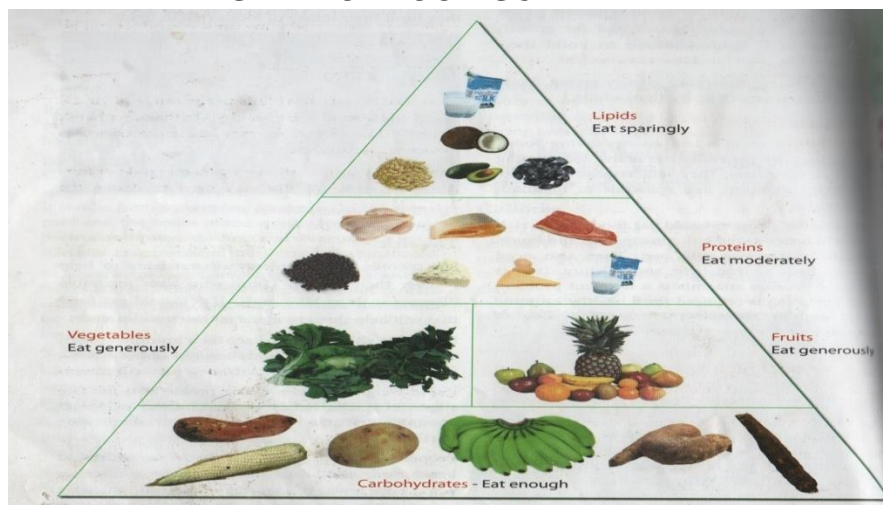
Is a chart showing the recommended amounts of different food types that dieticians consider as healthy eating.

- It is advisable to use food guide pyramid to know what to eat.
- The base constitutes foods that are required in larger amounts while the apex constitutes the food that needs to be taken in lesser amounts. The food guide pyramid is not universal for all groups of people, it depends on the need of health status of a person. For example, a diabetic person should not consume a lot of carbohydrates as indicated in the pyramid. Similarly, the elderly require small amounts of carbohydrates, but more proteins and vitamins.

IMPORTANCE OF FOOD GUIDE PYRAMID

- It helps an individual to eat better every day.
- It helps an individual to choose the right healthy diet.

THE DIAGRAM OF FOOD GUIDE PYRAMID



NUTRITIONAL DEFICIENCIES AND DISORDERS

There are different types of nutritional deficiencies and disorders in human beings, which are generally called **malnutrition**

MALNUTRITION

Refers to lack of proper nutrition caused by imbalance of nutrients in the body.

Or

Is a condition which occurs when the body lacks proper nutrition.

- It is a result of not having enough nutrients or excess consumption of certain food nutrients.

Causes of malnutrition

- Eating too little a certain food nutrients
- Eating too much a certain food nutrients

Symptoms of malnutrition

- Lack of appetite
- Tiredness
- Inability to concentrate

- (iv) Always feeling unhappy
- (v) Longer healing time for wounds
- (vi) Depression
- (vii) Dry skin and mouth.

Effects of malnutrition

- (i) Mental health problem
- (ii) Low intake of food
- (iii) Social and mobility problem
- (iv) Digestive disorders
- (v) Lack of breast feeding.

NUTRITIONAL DEFICIENCIES

These deficiencies arise when the body does not have sufficient supply of a particular food or nutrient.

Types of nutritional deficiencies in human beings

These include:

- (a) Kwashiorkor
- (b) Marasmus
- (c) Rickets

(a) KWASHIORKOR

Is a form of malnutrition in children caused by a deficiency of proteins.

- Kwashiorkor affects children, mostly after stopping to breast- feed or during weaning. A child ranging from 6 months up to 5 years is in danger to suffer from kwashiorkor if food rich in proteins will not be provided.
- Kwashiorkor is an acute malnutrition with oedema.

Symptoms of kwashiorkor

A child suffering from kwashiorkor shows the following symptoms:

- (i) Protruding stomach.
- (ii) Extremely thin arms and legs.
- (iii) Poor growth
- (iv) Swollen abdomen due to enlargement of the liver
- (v) Reddish or yellowish thin and weak hair.
- (vi) Weakened immunity
- (vii) Diarrhoea
- (viii) Anaemia
- (ix) Dry skin that cracks easily
- (x) Oedema. This is due to accumulation of excess fluid in the body
- (xi) Short temper

Effects of kwashiorkor

- (i) Weaken body immunity that makes a child prone to diseases like malaria and diarrhea
- (ii) Poor growth of child

(iii) The child becomes anaemic and weak.

Prevention and control of kwashiorkor

- Kwashiorkor can be prevented by providing a child with a diet that has adequate amounts of proteins and other food nutrients.

(b) MARASMUS

Is a form of malnutrition in children caused by lack of adequate amounts of food nutrients (starvation).

- Marasmus is also an acute malnutrition

Symptoms of marasmus

A child suffering from marasmus shows the following symptoms:

- (i) Weight loss
- (ii) Slowed growth
- (iii) Decreased activity and lack of energy
- (iv) Wrinkled skin
- (v) Extreme hunger and cries often
- (vi) Weak muscles

Prevention of Marasmus

- Marasmus is prevented by giving a child adequate amounts of food that contains all the nutrients in the right proportions.

(c) RICKETS

Is a condition whereby the bones of a child soften, leading to fractures and deformity.

- Rickets is caused by **lack of vitamin D, phosphorous and calcium.**

Symptoms of Rickets

A child suffering from rickets is identified by the following symptoms:

- (i) Skeletal deformities such as bow legs, knock knees, an odd shaped skull and a deformed spine.
- (ii) A child feels bone pain
- (iii) Weak teeth and delayed formation of teeth
- (iv) Develops weak muscles.
- (v) Bones are easily fractured.
- (vi) Slow growth
- (vii) Muscle spasms and muscle cramps.

Prevention of rickets

Rickets can be prevented by the following ways:

- (i) Increasing the amount of vitamin D, phosphorus and calcium in the diet.
- (ii) Ensuring exposure to sufficient amounts of sunlight.
- (iii) Providing the child with enough milk, sardines and green vegetables.

NUTRITIONAL DISORDERS

Are conditions that occur when a person's dietary intake does not contain the right amount of nutrients for healthy functioning of the body.

- Nutritional disorders are caused by the imbalance of nutrients in the body due to not having enough nutrients or excess consumption of food.

TYPES OF NUTRITIONAL DISORDERS IN THE HUMAN BEINGS

The following are the common nutritional disorders in human beings:

- (a) Obesity
- (b) Anorexia nervosa
- (c) Bulimia nervosa

(a) OBESITY

Is a nutritional disorder characterized by excess body fat leading to overweight.

- Obesity mostly results from eating large quantities of carbohydrates and fats and not exercising enough to sufficiently burn the excess calories produced in the body.
- A person's sex, age and level of activity are among other factors that determine his or her ideal body fats. To maintain fertility, women need more fat than men. Women also store more fats in their breasts, hips and thighs.

Causes of obesity

The following are causes of obesity. These include:

- (i) Overeating
- (ii) Inactivity (lack of physical exercise).
- (iii) Eating high amounts of energy foods such as fats and sugars
- (iv) Frequent eating
- (v) Genetic makeup. Some people have genes that affect the way food are processed in the body

Effects of obesity

Obesity is accompanied by several health problems. These include:

- (i) Shortness of breath and snoring
- (ii) High blood pressure
- (iii) Diabetes
- (iv) Certain types of cancer
- (v) Stroke
- (vi) Arthritis
- (vii) Respiratory problems

Control measures of obesity

Obesity can be prevented by:

- (i) Avoid eating too much fatty foods such as butter, fat meat, chips, margarine, sausages and sugary foods such as sweets, cakes and chocolates
- (ii) Engaging in regular exercise.
- (iii) The intake of calories should balance one's physical activity.
- (iv) Avoid also unhealthy dieting.

NB: Body weight and health risks associated with it are expressed by the Body Mass Index (BMI)

Body Mass Index (BMI)

Is a relationship between the estimated body fat and the risk of a certain diseases or conditions.

- Based on height and weight ratio, people can check their Body Mass Index (BMI)
- Body Mass Index (BMI) is the value obtained when the body mass divided by the square of the body height.
- BMI is calculated by using the following formula and expressed in units of kg/m^2

$$\text{BMI} = \frac{\text{Body mass (in kilograms)}}{\text{Person's height (in meters)}^2}$$

- If an individual's BMI range **18.5—25.4**, an individual is considered to be **healthy**.
- If an individual's BMI is **over 30**, an individual may be at risk of diseases associated with obesity.

The following table shows a general guide of how different values of BMI are used to define the condition of the body.

BMI guide for adults with 20 years and above

BMI	Body condition
18.5 and below	Underweight
18.5 to 25.4	Normal weight
25.5 to 29.4	Overweight or pre-obese
29.5 to 34.9	Class 1 obesity
35.0 to 39.9	Class 2 obesity
40 and above	Class 3 obesity (extreme or severe obesity)

Worked Example.

1. (a) If the body height of James is 1.65 meters tall and his body weight is 60 kilograms. What will be his body mass index (BMI)?
- (b) What is the body condition of James?
- (c) What advise will you give James and why?

(a)

Data given

- Body weight = 60kg
- Height = 1.65m = $(1.65\text{m} \times 1.65\text{m}) = 2.723\text{m}^2$
- Body Mass Index (BMI) = ?

From

$$\text{BMI} = \frac{\text{Body mass}}{\text{Height}}$$
$$\text{BMI} = \frac{60\text{kg}}{2.723\text{m}^2} = 22.03\text{kg/m}^2$$

Therefore: The body mass index (BMI) will be **22.03 kg/m^2**

- (b) James is considered to be **having normal health.**
- (c) My advice to James is **to eat well balanced diet in order to avoid obesity and diabetes**

2. (a) If Queen is 80kg and 160cm tall. What is her BMI?
 (b) What dangers are facing Queen?
 (c) What advise will you give Queen and why?

(a)

Data given

- Body height = 80kg
- Body weight = 160cm

Where 1m=100cm

? = 160cm

$$\frac{1m \times 160cm}{100cm} = 1.6m = 1.6m \times 1.6m = 2.56m^2$$

- Body mass index (BMI) = ?

Formula

$$\text{BMI} = \frac{\text{Body mass (in kilograms)}}{\text{Person's height (in meters)}^2}$$

$$\text{BMI} = \frac{80kg}{2.56m^2} = 31.25kg/m^2$$

Therefore: The body mass index of Queen is **31.25kg/m²**

- (b) Queen is likely to suffer **from class 1 obesity and other diseases associated with obesity such as hypertension and diabetes**
- (c) The following are my advise to Queen:
 - (i) To avoid high intake of fatty and sugary foods such butter, fat meat, chips, margarine, cakes and chocolates in order to control obesity.
 - (ii) To engage in physical exercise in order to control obesity.

3. If Dina is 70kg and 150cm tall.

- (a) What is her BMI?
- (b) What dangers are facing Dina?
- (c) What advise will you give Dina and why?

(b) ANOREXIA NERVOSA AND BULIMIA NERVOSA

Anorexia nervosa

Is a nutritional disorder that occurs when a persona when a person intentionally refuses to eat enough food, leading to a severe loss of body mass.

- It is also called **slimmer's disease** or **self-starvation syndrome.**

Sign and symptoms of anorexia nervosa

- (i) Muscle wasting (including weakening of heart muscle)

- (ii) Excessive loss of body mass
- (iii) Extreme fear of being fat.
- (iv) Anxiety over body mass and shape.
- (v) Weak heartbeat

Bulimia nervosa

Is a nutritional disorder, which involves excessive eating followed by efforts to remove food from the body.

- This effort could involve self- induced vomiting, fasting, excessive exercising or taking drugs that stimulate, emptying of the bowels or excessive urination.
- Bulimics usually have a normal body mass and keep their eating behaviour secret, hence, it may be difficult to tell that they have a problem.
- Bulimia and Anorexia mostly affect women.

Causes of Anorexia and Bulimia

Both Bulimia and Anorexia nervosa have underlying psychological causes such as:

- (i) Depression
- (ii) Low self-esteem
- (iii) Bottled-up emotions
- (iv) The need to fit contemporary standard of beauty.

Effects of Anorexia and Bulimia nervosa

- (i) Heart problems. This is due to weak cardiac muscles or an imbalance of mineral salts.
- (ii) Impaired mental function. This is because the brain lacks adequate amount of glucose.
- (iii) Dehydration.
- (iv) Serious damage to the gum and erosion of the teeth. This is when the acidic present in the stomach come into contact with the teeth and gums during vomiting.
- (v) Anaemia
- (vi) Stomach ulcers
- (vii) Abdominal cramping and inflammation of the gut
- (viii) Irregular or absent menstrual periods
- (ix) Dry skin.

Treatment for Anorexia and Bulimia nervosa

Anorexia and Bulimia nervosa can be treated by:

- (i) Resolving the underlying psychological problems.
- (ii) Seeing a medical practitioner who can prescribe a way of getting back one's health.
- (iii) Adhering to the necessary lifestyle and dietary changes.

PROPERTIES OF FOOD SUBSTANCES (NUTRIENTS)

Food substances (nutrients) have various properties that help to distinguish them. Such properties can be determined using various laboratory reagents and chemicals such as iodine solution, Benedict's solution, Sudan III solution, copper sulphate, hydrochloric acid and sodium hydroxide. Experiments conducted to identify properties of food nutrients are known as **food tests**.

FOOD TESTS

Food tests: are tests used to determine which nutrients are present in a given food sample, solution or specimen.

MAJOR FOOD TESTED

The following are the major food tested:

- (i) Starch
- (ii) Reducing sugar
- (iii) Non-reducing sugar
- (iv) Protein
- (v) Lipids

COMMON REAGENTS AND CHEMICALS USED TO DETERMINE FOOD PROPERTIES

The following are common reagents and chemicals used to determine food properties

Food tested	Reagent used	Reagent colour	Confirmatory colour if the food tested is present	Colour observed if the food tested is absent
Starch	Iodine solution	Brown	Blue black colour or dark blue colour	Brown colour is retained
Reducing sugar	Benedict's solution	Blue	Colour changes from blue to green to yellow to orange and finally to brick red	Blue colour is retained
Non-reducing sugar	(i) Dilute hydrochloric acid solution	Colourless	Colour changes from blue to green to yellow to orange and finally to brick red	Blue colour is retained
	(ii) Sodium hydroxide solution	Colourless		
	(iii) Benedict's solution	Blue		
Protein	(i) Sodium hydroxide solution	colourless	Purple colour or violet colour	Blue colour is retained
	(ii) Copper sulphate	Blue		
Lipid	Sudan III solution	Red	Red ring or red droplets colour	Red colour is retained

– When doing the food test, the following are important things to consider:

- (i) Food to be tested
- (ii) Required materials (reagents required)
- (iii) Procedure
- (iv) Observation
- (v) Conclusions

PROCEDURE

This involves the steps to be followed when carrying out the test for a particular food substance.

– Steps differ when testing for one food type from another. Failure to follow these steps often results into a wrong conclusion.

The following are steps (procedure) to be followed when testing for:

- (i) **Starch:** 2ml of solution + 2 or 3 drops of iodine solution + shaking the mixture
- (ii) **Protein:** 2ml of solution + 2ml of NaOH + shaking well the mixture for 1 minute + 2 or 3 drops of copper sulphate solution + shake well the mixture after adding each drop.
- (iii) **Reducing sugar:** 2ml of solution + 2ml of Benedict's solution + boiling the mixture
- (iv) **Non-reducing sugar:** 2ml of solution + 1ml of dilute HCl + warm the mixture for 1 minute + cool the mixture + 1ml of NaOH + 2ml of benedict's solution + boiling the mixture.
- (v) **Lipid:** 2ml of solution + 2 or 3 drops of Sudan III solution + shake well the mixture + leave the mixture for 3 – 5 minutes to settle.

By grease spot test, lipid can be tested as follows:

Rub the peeled food sample on a piece of white paper + dry the rubbed piece of paper + expose the paper to light + compared the rubbed part and the part not rubbed.

OBSERVATION

It refers to the series of changes that occur when carrying out an experiment.

- These changes can be colour, smell, sound or heat changes.
- The changes differ from one experiment to another. During observation, it is important to make sure the colour of the reagent is known so as to be clear with the new changes.

Food tested	Observation if food tested present in the solution	Observation if food tested absent in the solution
Starch	Blue-black colour	Brown colour
Protein	Purple colour or violet colour	Blue colour
Lipid	Red ring (when tested by Sudan III solution)	Red colour
	Translucent mark (when the paper is rubbed)	No translucent mark
Reducing sugar	Colour changes from blue to green to yellow to orange and finally to brick red	Blue colour
Non-reducing sugar	Colour changes from blue to green to yellow to orange and finally to brick red	Blue colour

INFERENCE

It refers to the conclusion that is made following the observation.

- The conclusion tells whether the type of food tested is present or absent

TEST FOR CARBOHYDRATES

There are three types of carbohydrates, which are:

- (a) Monosaccharides
- (b) Disaccharides
- (c) Polysaccharides

(a) MONOSACCHARIDES

These are also known as simple sugars (single sugar).

- The general formula for monosaccharides is **(CH₂O) n** where **n** represents the number of carbon (C) atoms and has a value of between 3 and 6. For example, the formula for glucose is **C₆H₁₂O₆**
- All monosaccharides have ability to reduce copper in Benedict's from **copper II (Cu²⁺)** which is **blue** to **copper I (Cu⁺)** which is **orange or brick red** hence they are named as **reducing sugars**.

Examples of monosaccharides

- (i) Glucose
- (ii) Fructose (fruit sugar)
- (iii) Galactose (milk sugar).

Food sources containing reducing sugars

- Onions
- Carrots
- Oranges
- Honey
- Bananas

PROPERTIES OF REDUCING SUGARS

- (i) They dissolve in water to form sweet solutions.
- (ii) They have sweet taste
- (iii) They are crystalline
- (iv) They small molecules
- (v) They have ability to reduce copper in Benedict's solution from **copper II (blue in colour)** to **copper I (orange or brick red)**.

NB: During the reduction process, the colour of Benedict's solution changes from **blue** to **green** to **yellow** and finally to **oranges** or **brick red** depending on the concentration of the reducing sugar.

- If it is high, the colour change can reach to brick red but if it is low it can end up to the intermediate colours that have been mentioned.

EXPERIMENT 1

Aim: Test for the presence of reducing sugars in an onion bulb

You are provided with the following materials: Benedict's solution, an onion bulb, knife, mortar and pestle, measuring cylinder (10mls), test tubes, test tube holder, heat source, water, filter funnel, dropper and beakers. Use them to carry the following procedure:

Procedure

- (i) Peel an onion and cut it into small pieces using a knife.
- (ii) Grind the pieces onion using mortar and pestle, then add water to make a mixture.
- (iii) Decant and filter the mixture into a beaker to remove solid particles so as to get a solution.
- (iv) Put 2mls of the solution into a test tube.
- (v) Gently heat the mixture for 2-3 minutes.
- (vi) Record the series of colour change occurring.

Questions

- (i) What was the aim of the experiment?
- (ii) What series of colour change was observed?
- (iii) What was the final colour?

(b) DISACCHARIDES

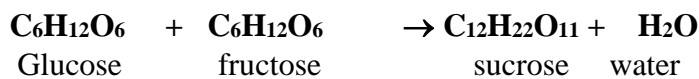
These are also known as double sugars.

- They are formed through condensation process when two monosaccharide molecules combine.
- The general formula for this reaction is:



Example of disaccharides

- (i) **Sucrose** – the sugar found in sugar cane. Sucrose is formed when, a glucose molecule combine with a fructose molecule. As shown in the reaction below:



- (ii) **Maltose** – the sugar found in germinating seeds. Maltose is formed when two glucose molecules combine.
- (iii) **Lactose** – the sugar found in milk. Lactose is formed when a glucose molecule combines with a galactose molecule.

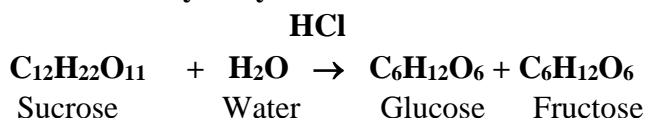
NB: Lactose and maltose have ability to reduce copper II ions into copper I ions hence, they are also called **reducing sugars**

Sucrose do not have the ability to reduce copper II ions to copper I ions hence they are also called **non-reducing sugars**.

PROPERTIES OF NON-REDUCING SUGARS

- (i) They dissolve in water and form sweet solutions.
- (ii) They have sweet taste
- (iii) They are crystalline
- (iv) They have no ability to reduce copper II ions to copper I ions.

- Therefore, non-reducing sugars cannot be tested directly by Benedict's solution. Instead, they are first converted to reducing sugars by using hydrochloric acid (HCl) in the process called **hydrolysis**. As shown in the reaction below:



- The acidic mixture is heated and left to cool. It is then neutralized by using sodium bicarbonate (NaHCO₃) or sodium hydroxide (NaOH) for the Benedict's solution to work properly. Thereafter, steps for testing reducing sugars is carried out.

EXPERIMENT 2

Aim: Test for non-reducing sugars in sugar cane

You are provided with the following materials: Benedict's solution, hydrochloric acid, sodium hydroxide, a piece of sugar cane, a knife, mortar and pestle, measuring cylinder (10mls), test tubes, test tube holder, heat source, water, filter funnel, dropper and beakers.

Procedure

- (i) Peel a piece of sugar cane and cut it into small pieces using a knife.
- (ii) Grind the pieces of sugar cane using mortar and pestle and add water to make a mixture.
- (iii) Decant and filter the mixture to obtain a solution
- (iv) Pour 2mls of a sample solution into the test tube.
- (v) Add 1ml of dilute

(c) POLYSACCHARIDES

These are complex sugars formed by condensation of several monosaccharides.

- They are commonly used as storage form of food.

Examples of polysaccharides

- (i) **Starch** – a plant storage compound
- (ii) **Glycogen** – an animal storage compound
- (iii) **Cellulose** – a structural material in plant cell walls
- (iv) **Chitin** – a component of exoskeleton of arthropods and cell walls of fungi

(i) STARCH

This is a carbohydrate made by condensation of many glucose molecules.

- Starch occurs naturally in plant cells as small particles called granules

NATURAL SOURCES OF STARCH

The following are common starch-containing foods:

- Sweet potato
- Irish potato
- Cassava
- Yam
- Maize
- Rice
- Wheat
- Green banana

PROPERTIES OF STARCH

Starch and other polysaccharides have the following properties:

- (i) They are tasteless. This means they are not sweet
- (ii) They are insoluble in water. When put in water they form a suspension.
- (iii) They coagulate when boiled in water
- (iv) When mixed with iodine solution, starch changes colour to blue black.

Functions of starch

- (i) It provides the body with energy.
- (ii) Used as the storage form of carbohydrates in plants
- (iii) Used as the component of the cell membrane.
- (iv) Used to make cellulose in plants

EXPERIMENT 3

Aim: Test for the presence of starch in an Irish potato

You are provided with the following materials: Iodine solution, Irish potato, a knife, mortar and pestle, measuring cylinder (10mls), test tubes, test tube holder, heat source, water, filter funnel, dropper and beakers.

Procedure

- (i) Peel the Irish potato and cut it into small pieces using a knife.
- (ii) Grind the pieces of Irish potato using mortar and pestle and add water to make a mixture.
- (iii) Decant and filter the mixture to make a solution
- (iv) Put 2mls of a sample solution into the test tube.
- (v) Add 2-3 drops of iodine solution.

Questions

- (i) What is your observation?
- (ii) Give three properties of starch

EXPERIMENT 4

Aim: investigation of the solubility of starch in water.

You are provided with the following materials: maize flour, measuring cylinder (10mls), heat source, water, stirring rod, spatula and beaker.

Procedure

- (i) Take two full spatula of maize flour and put it into 100ml beaker.
- (ii) Add 50ml of water and stir the mixture
- (iii) Leave it to settle for 3-4 minutes.
- (iv) Observe and record the findings
- (v) Take the mixture and boil for 3-4 minutes while stirring
- (vi) Observe and record the findings

Questions

- (i) What happened when the unboiled mixture of flour and water was left to settle?
- (ii) Was there any difference when the unboiled mixture was allowed to settle and when it was boiled?

TEST FOR LIPIDS

Lipids are organic food substances consisting of carbon, hydrogen and oxygen

- A lipid is composed of a glycerol molecule and fatty acids joined through condensation.
- Unlike carbohydrates, lipids have much less oxygen compared to carbon and hydrogen. For example formula of beef fat is $C_{57}H_{110}O_6$.
- Lipids occur naturally in the protoplasm of all living cells and in adipose tissues of animals.

NATURAL SOURCES OF LIPIDS

The following are common lipid-containing foods:

- Groundnuts seeds
- Coconuts
- Sunflowers
- Castor oil seeds
- Margarine
- Butter

PROPERTIES OF LIPIDS

Fats and Oils have the following properties:

- (i) Fats are insoluble in water.
- (ii) In a mixture of water and oil, oil takes up Sudan III dye to form a red ring or red layer on the top, leaving the water clear.
- (iii) When oil is shaken in water, the oil breaks down into droplets which disperse in the water. The water and oil separate into two layers.
- (iv) Fats and oils dissolve in organic solvents such as ether, alcohol, acetone and chloroform.
- (v) When fat is rubbed against paper, the paper becomes translucent.
- (vi) Oils react with osmic acid and stain black
- (vii) When water is added to a fat or oil that has dissolved in an organic solvent, a white milk suspension is formed. This is called an emulsion.
- (viii) Fats melt at high temperature while oils solidify at low temperature

EXPERIMENT 5

Aim: Test for the presence of lipids in groundnuts by the grease spot test.

You are provided with the following materials: groundnuts seeds, and a piece of white paper.

Procedure

- (i) Peel the groundnuts.
- (ii) Rub the peeled seeds on a piece of paper.
- (iii) Expose the piece of paper to light.
- (iv) Compare the part of the paper rubbed with seeds with the part that was not rubbed.
- (v) Record your observation

Questions

- (i) Is the area of piece of paper rubbed with seed similar to the unrubbed section of paper?
- (ii) What did you see after exposing the paper to light?
- (iii) What other seeds can you use to perform the grease spot test?

EXPERIMENT 6

Aim: Test for the presence of lipids in cooking oil by using Sudan III solution.

You are provided with the following materials: Sudan III solution, 5ml of cook oil, test tube, measuring cylinder (10ml) and water.

Procedure

- (i) Pour 3ml of water in the test tube followed by 2mls of cooking oil.
- (ii) Add 2 drops of Sudan III solution in the mixture.
- (iii) Shake well the mixture
- (iv) Leave the mixture for 3-5 minutes to settle.
- (v) Observe and record what happens.

QUESTION

What changes did you observe?

TEST FOR PROTEIN

Protein is a major nutrients that is essential for growth, building body and repair of damaged cells.

It is a major building block of human body responsible for the building and maintenance of the body tissues

Natural sources of protein

The following are protein containing foods

- Beans
- Eggs
- Fish
- Chicken
- Milk
- Soybeans
- Soybean products

PROPERTIES OF PROTEINS

- (i) They are insoluble in water
- (ii) They coagulate on heating. This means small particles of protein clump together to form bigger particles when a mixture of protein and water is heated. This process is called denaturation
- (iii) Proteins react with sodium hydroxide and copper sulphate to produce a violet or purple colour. This is called the Biuret test.
- (iv) The biuret test can be used to identify a protein substance and confirm its presence
- (v) Each amino acid in proteins behaves as an acid as well as a base. This means proteins are amphoteric.

EXPERIMENT 7

Aim: Test for the presence of proteins in egg white using Biuret test

You are provided with the following materials: Egg white, sodium hydroxide, 1% Copper sulphate solution, measuring cylinder (10mls), test tubes, test tube holder, dropper and beakers.

Procedure

- (i) Pour 3ml of water into a test tube followed by 2ml of egg white.
- (ii) Add 2ml of sodium hydroxide solution to a test tube containing the mixture of protein and water.
- (iii) Shake the mixture
- (iv) Add 2 drops of 1% copper sulphate solution to the mixture and shake.
- (v) Record your observation

Question

What was the colour changes

EXPERIMENT NO.1 2A NECTA 2016

You have been provided with solution Z.

- a) Perform experiments using the reagents provided identify the type of food substance(s) present in solution Z. Tabulate your results as shown in table 1

Table 1

Food tested	Procedure	Observations	Inference

- b)
 - i) Name two sources of food from which food substances identified in 1 (a) could have been extracted.
 - ii) For each food substances identified in 1(a), give the name of the end product of digestion in human being.
- c) Why is it important to use iodine solution in this experiment?
- d) What will happen in human body when the end products named in 1(b) (ii) are in excess

EXPERIMENT NO. 2

Materials:

- Specimen A- glucose
- Specimen B- Fruit juice
- Specimen C- egg albumen
- Specimen D- Cooking fat
- Specimen E- starch powder

- (a) Carry out the following food test on each specimen:

- (i) Test for reducing sugar, non-reducing sugar, starch , proteins and lipids
 - (b) Make your observations and conclusions and write them in your notebook
 - (c) Discuss your observations and conclusions with your group members.

REVISION QUESTIONS

1. Write **TRUE** for a correct statement and **FALSE** for incorrect statement.

- (i) All disaccharides are soluble in water.
- (ii) Galactose is a fruit sugar.
- (iii) Proteins are the major sources of energy.
- (iv) The emulsion test is used to test for proteins.
- (v) The Biuret test is used for determining protein properties.
- (vi) Nutrients are chemical components of food.
- (vii) Macronutrients are required by the body in small quantities.
- (viii) The calorie is a unit of measurement of food energy.
- (ix) Nutrients contain calories which can be burned in the body to provide heat.
- (x) Carbohydrates are micronutrients because they are required by the body in large quantities.

2. Match the statement in **column A** against its corresponding item from column B.

Column A	Column B
(i) A chart depicting the recommended amounts from different food groups that nutritionists consider as healthy eating.	A. Malnutrition
(ii) Chemical components of foods.	B. Protein
(iii) A substance that is important in the diet, but which cannot be digested and absorbed by human beings.	C. Carbohydrate
(iv) Poor nutrition resulting from an insufficient or poorly balanced diet or from defective digestion or defective assimilation of foods.	D. Hydrochloric acid
(v) An organic compound composed of carbon, hydrogen and oxygen and is the main source of energy.	E. Roughage
(vi) An organic nutrient that an organism requires in small quantities.	F. Vitamins
(vii) An important nutrient for body growth and repair of worn out cells and tissues.	G. Minerals
(viii) A chemical reagent used to test non-reducing sugar by converting non-reducing sugars into reducing sugars	H. Food guide pyramid
(ix) An inorganic compounds containing elements which are vital for the proper functioning of the body.	I. Sodium hydroxide
(x) A test used to determines which nutrients are present in a given food sample, solution or specimen.	J. Food test
	K. Nutrients
	L. Marasmus
	M. Micronutrient
	N. Kwashiorkor
	O. Rickets
	P. Biuret test

3. Differentiate the following terms:

- (a) Food and nutrient
- (b) Kwashiorkor and marasmus
- (c) Macronutrients and micronutrients
- (d) Monosaccharides and polysaccharides
- (e) Oils and fats

4. A 3 years old child has been brought to a dispensary following these complaints: He is weak, and has persistent diarrhoea. The child also looks skinny with extremely thin arms and legs, a swollen belly, wrinkled skin like an old person and hair looks yellowish and very thin.
 - (a) Which nutritional disorder is the child suffering from?
 - (b) What is the cause of the nutritional disorder mentioned in (a) above
 - (c) What advise will you give to the child's parent?
 - (d) Suggest four natural sources which will you recommend to the child's parents.
5. What are the special nutritional needs of the following people?
 - (a) A 65 years old person
 - (b) A 4 years old child
 - (c) A pregnant woman
 - (d) A breast feeding mother
6. Briefly answer each of the following questions.
 - (a) Vitamins are divided into how many groups? Name the groups of vitamins and give two examples of each.
 - (b) Name the forms in which excess carbohydrates are stored in animals and plants.
 - (c) Name the places in the body where excess carbohydrates can be stored.
7. Answer the following questions:
 - (a) Name the process by which a monosaccharides can be converted into a disaccharide.
 - (b) Give any two characteristics of monosaccharides.
 - (c) How would you test for monosaccharides?
 - (d) When testing for a non- reducing sugar, the sample solution is mixed with hydrochloric acid. What is the use of the acid?
8. (a) What are polysaccharides? Give two examples.
 (b) Give any two characteristics of polysaccharides
9. Answer the following questions.
 - (a) Explain briefly how you would carry out the following:
 - (i) Test for proteins
 - (ii) Test for starch
 - (b) What food substances are tested by the following tests:
 - (i) Biuret test
 - (ii) Grease spot test
 - (iii) Sudan III test
10. Fill the gaps in the following table to show that the test is positive for the type of food being tested.

Test	Observation	Inference
Biuret test		
Emulsion		
Benedict's solution		
Iodine solution		

DIGESTIVE SYSTEM IN HUMAN

Human digestive system: is a body system composed of alimentary canal, associated organs and glands.

Function of human digestive system

The digestive system has two main functions:

- (i) Digestion
- (ii) Absorption
- (iii) Other function of digestive system is the removal of undigested food materials.

ALIMENTARY CANAL

Is a muscular tube running from mouth to the anus

OR

Is a long hollow tube that runs from the mouth to the anus

- Alimentary canal is also known as **digestive tract** or **gut**.

The main parts of alimentary canal

- (i) Mouth
- (ii) Pharynx
- (iii) Oesophagus
- (iv) Stomach
- (v) Small intestine (duodenum and ileum)
- (vi) Large intestine (colon and rectum)
- (vii) Anal canal (anus)

The associated organs and glands

Human digestive system is associated with the following organs and glands:

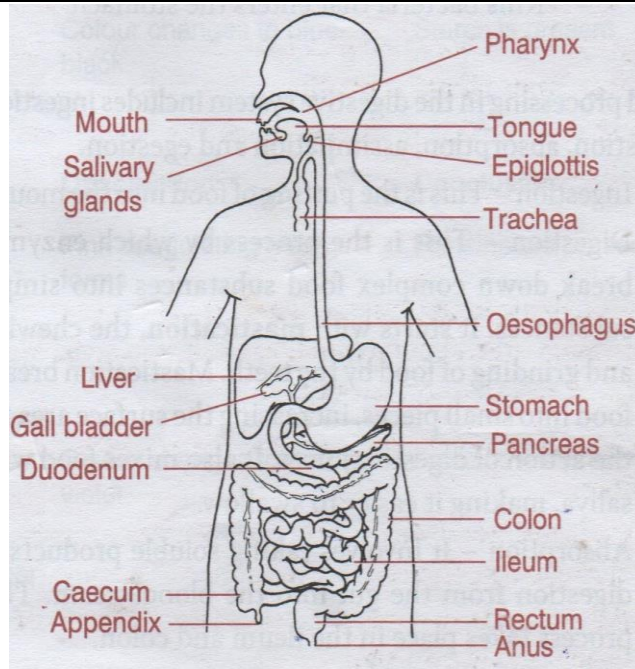
- (i) Tongue
- (ii) Liver
- (iii) Pancreas
- (iv) Gall bladder
- (v) Appendix
- (vi) Salivary glands

Parts of the human digestive system

Generally the following are parts of human digestive system. These include:

- (i) Mouth
- (ii) Oesophagus
- (iii) Stomach
- (iv) Duodenum
- (v) Ileum
- (vi) Colon
- (vii) Rectum
- (viii) Pancreas
- (ix) Liver

THE DIAGRAM OF HUMAN DIGESTIVE SYSTEM



THE PROCESS OF DIGESTION IN HUMAN BEING

Food taken into the body cannot be utilized by the cells unless it is digested (broken down from complex into simpler, soluble and diffusible form).

DIGESTION

Is the breakdown of food into simple, soluble, diffusible, absorbable and usable form in the body.

OR

Is the process by which food is broken down mechanically and chemically to smaller particles which are absorbed and assimilated in the body.

- The process of digestion takes place in the alimentary canal particularly in the mouth, stomach, duodenum and ileum.

TYPES OF DIGESTION

There are two types of digestion, namely:

- (a) Mechanical digestion
- (b) Chemical digestion

(a) MECHANICAL DIGESTION

Is the breakdown of food into smaller pieces without chemical change to the food molecules.

- It takes place in the mouth and stomach. In the mouth is performed by the teeth by the process called **chewing** and in the stomach is done through the process called **churning**.

Role of mechanical digestion (Chewing)

- (i) It enables the breakdown of large particles of food into smaller particles that can be swallowed easily.
- (ii) It mixes the food particles with saliva for easy swallowing.

- (iii) It enables the breakdown of large food pieces into small pieces to increase the surface area of the food for the action of digestive juice called enzymes

(b) CHEMICAL DIGESTION

Is the breakdown of large insoluble molecules into small soluble molecules.

- Chemical digestion is achieved by digestive enzymes. Chemical digestion takes place in the mouth, stomach, duodenum and ileum.

The process of digestion

Digestion involves two sub-processes which are mechanical and chemical breakdown of food nutrients. The mechanical digestion takes place in the mouth where large food particles are chewed by teeth and broken down into small particles. The process continues in the stomach where such small particles are further broken down into tiny particles. The chemical breakdown of food into simple molecules is done by chemical substances called enzymes found in the mouth, stomach, small intestine and pancreas. The breakdown of food into the smallest is necessary to enable nutrients and organic molecules from the food to be absorbed and utilized in the body.

DIGESTION IN THE MOUTH

The process of digestion begins in the mouth and continues through the alimentary canal up to the small intestine.

- The first step before the beginning of digestion process is called **ingestion**, which is the process of taking in food through the mouth.
- When food is in the mouth, digestion begins whereby food is broken down into small particles by the **mechanical process** known as **chewing** or **mastication**.
- The process of chewing is done by the teeth. In mammals, there are various types of teeth which differ in shape and size. This condition is known as **heterodonty**, where different teeth are specialized for various tasks like biting, tearing, grinding and crushing food.

There are four different types of teeth in human being. These include:

- (a) Incisors
- (b) Canines
- (c) Premolars
- (d) Molars

(a) INCISORS

These are found in the front part of the mouth. They have sharp chisel-like shape specialized for biting and cutting food or other substances. An adult has eight incisors, four in the upper jaw and four in the lower jaw.

(b) CANINES

These are located next to the incisors. They have a sharp pointed shape specialized for grasping and tearing food. An adult person has four canines, two in the upper jaw and two in the lower jaw.

(c) **PREMOLARS**

These are located just behind the canines. They have a broad shape and are specialized for grasping and grinding food. An adult person has eight premolars, four in the upper jaw and four in the lower jaw.

(d) **MOLARS**

These are located the back of the mouth. They have a broader shape than premolars. They are specialized for grinding and crushing food into small particles that can be easily swallowed. An adult person has twelve molars, six in the upper jaw and six in the lower jaw.

NB: Teeth facilitate the chewing of food in the mouth. Chewing of food is necessary because it enables the breakdown of large particles of food into smaller particles and mixes the food particles with saliva for easy swallowing.

Functions of saliva

- (i) Saliva contains a digestive enzyme called **salivary amylase (ptyalin)** that catalyses the breakdown of cooked **starch** into **maltose**.
- (ii) Helps to moisten the mouth, tongue and lips to enable easy chewing and mixing of food in the mouth.
- (iii) Saliva lubricates the food for easy swallowing.
- (iv) Salivary amylase converts starch to maltose.
- (v) Provides alkaline condition for the functioning of amylase.

After the food has been chewed, it is rolled by the tongue into small balls called boli (singular: bolus). The teeth, saliva, and tongue play important roles in rolling the food into bolus. In this form, the food is ready to be swallowed via the pharynx and oesophagus. During swallowing, the food bolus is pressed against the roof of the mouth and pushed into the pharynx by the muscular action of the tongue.

The tongue

The following are the roles performed by the tongue in digestion:

- (i) It helps to turn the food during chewing.
- (ii) It helps to rolls the food into a bolus after chewing
- (iii) It helps to push a bolus into the esophagus

The pharynx

Is the cavity behind the mouth, which is connected to the stomach by the oesophagus.

Furthermore, the pharynx is connected to the trachea by the epiglottis. Epiglottis is a flap of cartilage that controls entering of air into the trachea. It opens to allow air to enter the lungs through the trachea. When eating food, the epiglottis closes the trachea to prevent food from entering into the trachea (the air passage). After the bolus has entered the oesophagus, the epiglottis opens again to allow air to pass into the trachea and proceeds down to the lungs. From the pharynx, food goes into the oesophagus.

The oesophagus

Is a muscular tube connecting the pharynx with the upper part of the stomach.

The food passes through the oesophagus into the stomach by the process called **peristalsis**

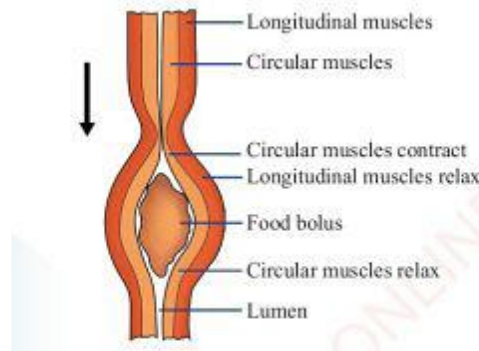
PERISTALSIS

Is the wave like muscular contraction that pushes food along the oesophagus into the stomach.

OR

Is the waves of muscular contractions and relaxations that propel food through the oesophagus into the stomach. The oesophagus walls have two types of muscles that work antagonistically. As the food is swallowed, circular muscles above the food bolus contract and longitudinal muscles relax making the lumen smaller and squeezing food bolus downwards. When the food reaches this point, the muscles automatically relax and allow the food to enter the stomach. Once the food is in the stomach, the cardiac sphincter muscles contract and close the entrance into the stomach. This prevents the food from flowing back into the oesophagus.

Diagram showing peristaltic movement of food



Role of peristalsis

It facilitates the movement of food along the oesophagus

Reasons for why it is possible for a person to swallow food while standing upside down

- (i) Swallowing is facilitated by peristalsis
- (ii) Swallowing is not affected by gravitational force.

DIGESTION IN THE STOMACH

The stomach has elastic muscular walls that can stretch to accommodate about two litres of food and drinks. The food is stored temporarily in the stomach before further digestion. That is why people do not need to eat food constantly. The walls of the stomach have gastric glands that secrete a chemical substance called gastric juice, which contains hydrochloric acid and enzymes. The contraction and relaxation of the muscles of the stomach wall cause the mechanical breakdown of the food into small particles. This process is called **churning**. Churning allows food to mix with the gastric juice. The stomach walls consist of circular and longitudinal muscles. These muscles contract and relax causing movement and thorough mixing of food with the gastric juice, forming a creamy semi-liquid substance called chyme. Thus, food is converted into a digestible form or chyme in the stomach. The gastric juice contains the following substances:

- (a) Hydrochloric acid (HCl)
- (b) Pepsinogen
- (c) Pepsin
- (d) Rennin

(e) Mucus

(f) Water

(a) Hydrochloric acid (HCl)

In the stomach, hydrochloric acid performs the following functions:

- (i) It provides an acidic medium in the stomach for enzymes to work properly.
- (ii) It kills disease-causing germs such as bacteria.
- (iii) It converts pepsinogen into pepsin.

(b) Pepsinogen

This is an inactive form of pepsin enzyme. This form cannot attack the walls the stomach which are protein in nature.

(c) Pepsin

This is an active form of pepsinogen. It is an enzyme responsible for the breakdown of proteins into smaller molecules called peptides.

(d) Rennin

This is an enzyme that coagulates milk. This allows milk proteins to stay in the stomach long enough to be broken down into peptides.

(e) Mucus

This protects the stomach wall against damage by digestive enzymes and hydrochloric acid.

(f) Water

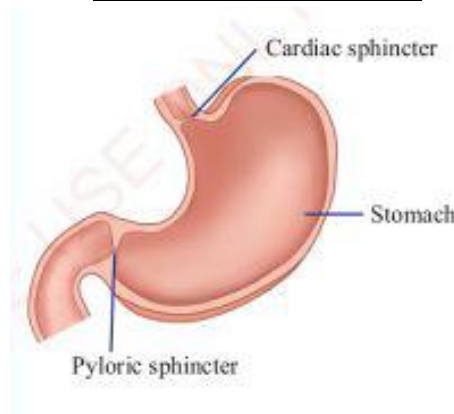
This provides the medium for enzyme activity during digestion.

From the stomach, food in the form of chyme enters the duodenum which is the first part of the small intestine. The pyloric sphincter, which is a ring of muscles at the lower end of the stomach, relaxes to allow small quantities of chyme to enter the duodenum.

ADAPTATIONS OF STOMACH TO ITS MODE OF FUNCTION

- i) Stomach has sphincter muscles to prevent food from flowing back into the oesophagus
- ii) Stomach has gastric glands, which produce gastric juice for the digestive process.
- iii) Also in the stomach of a young baby there is rennin which coagulates milk.
- iv) Stomachs have mucus which protects it from corrosion by digestive enzymes.
- v) There is hydrochloric acid for the emulsification of fats and killing of bacteria

Diagram of the stomach



DIGESTION IN THE DUODENUM

Duodenum is the first part of the small intestine. When chyme reaches the duodenum, it stimulates the pancreas to release pancreatic juice that is transported into the duodenum through the pancreatic duct. The pancreas is located just below the stomach.

Pancreatic juice contains the following components:

- (a) **Sodium bicarbonate** that provides an alkaline medium in the duodenum. This helps to neutralize the acidic condition of the chyme from the stomach.
- (b) **Digestive enzymes** such as trypsin, pancreatic amylase and pancreatic lipase for the breakdown of proteins, carbohydrates and lipids (fats and oils) respectively.

Function of the enzymes produced by pancreas:

ENZYME	FUNCTION
(i) Pancreatic lipase	It catalyses the conversion of fats and oils into fatty acids and glycerol
(ii) Pancreatic amylase	It catalyses the breakdown of starch into maltose
(iii) Trypsin	It catalyses the conversion of proteins into peptides

- Trypsin is produced in inactive form known as **trypsinogen**. This is converted into an active form known as **trypsin** by an enzyme called **enterokinase** that is produced by the duodenal walls.

Also in the duodenum, there is bile which facilitates the emulsification process. The bile is made in the liver and stored in the gall bladder from worn out red blood cells. The gall bladder releases bile through the bile duct that joins the pancreatic duct before opening into the duodenum.

EMULSIFICATION

Is the breakdown of fats and oils into tiny droplets

- This process is performed by bile pigment released into the duodenum

Significance of emulsification

It helps to increase the surface area for digestive enzymes to act on fats and oils.

BILE

Is a greenish-yellow juice containing a large amount of water and small amounts of greenish-yellow pigment, salts, mucin and other substances.

The bile contains the following components:

- (i) **Salts** such **sodium and potassium salts**

These salts help to convert fat-soluble vitamins (vitamin A, D, E, and K) making them water-soluble hence easily absorbed by the body cells.

- (ii) **Sodium bicarbonate**

It provides an alkaline medium favourable for digestive enzymes in the duodenum.

FUNCTION OF THE BILE

In the duodenum, bile perform the following functions:

- (i) It neutralizes the acidic chyme from the stomach.
- (ii) It provides an alkaline medium favourable for digestive enzymes in the duodenum.
- (iii) Breaks down fats and oils into tiny fat droplets to increase the surface area for digestive enzymes to act on.
- (iv) Converts fat-soluble vitamins making them water-soluble hence easily absorbed by the body cells.

DIGESTION IN ILEUM

Ileum is the final part of the small intestine. It is long, about six metres. The process of digestion ends in the ileum. When chyme enters the ileum, it stimulates the intestinal walls to produce an intestinal juice known as succus entericus.

Intestinal juice or succus entericus contains digestive enzymes for finalization of the digestion of proteins, carbohydrates and lipids (fats and oils).

The following are digestive enzymes found in the ileum:

Digestive enzyme	Function
(i) Lipase	It catalyses the conversion of fats and oils into fatty acids and glycerol
(ii) Maltase	It catalyses the conversion of maltose into glucose
(iii) Lactase	It catalyses the conversion of lactose into glucose and galactose
(iv) Sucrase	It catalyses the conversion of sucrose into glucose and fructose
(v) Peptidase (Erepsin)	It catalyses the conversion of peptides into amino acids

FUNCTIONS OF ILEUM

Ileum perform two main functions. These are:

- (i) It is a site where final digestion of carbohydrates, proteins and lipids takes place
- (ii) It is a site for absorption of food (end products of digestion).

ABSORPTION

This is the diffusion of end products of digestion into the blood stream from the small intestine.

ADAPTATION OF THE ILEUM FOR DIGESTION OF FOOD

- (i) It has secretory glands that secrete digestive enzymes to finalize the digestion of food.
- (ii) The ileum has mucus to ensure a constant lubrication of the intestinal walls for effective digestion of foods.
- (iii) It is long to ensure food takes a long time to pass through it for effective digestion.

ADAPTATIONS OF THE ILEUM FOR ABSORPTION OF FOOD

- (i) It has finger-like projections called villi to increase the surface area for absorption of digested food.
- (ii) It is very long and highly coiled to increase the surface area for absorption.
- (iii) The lining of ileum is only one cell thick for easy diffusion of nutrients
- (iv) It has many blood capillaries for easy diffusion of digested materials

ADAPTATION OF ILEUM FOR DIGESTION AND ABSORPTION OF FOOD

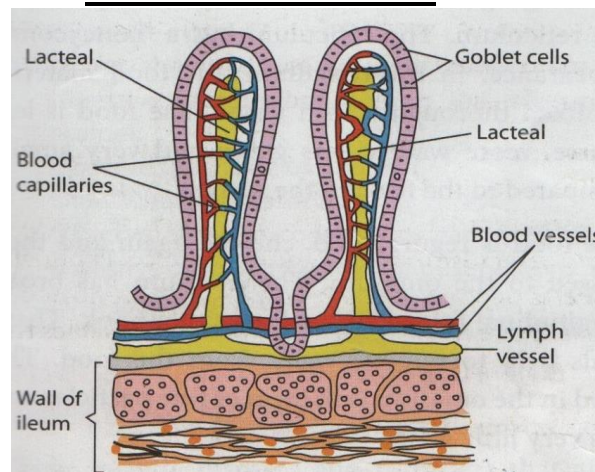
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- (iv) It has finger-like projections called villi to increase the surface area for absorption of digested food.
- (v) It is very long and highly coiled to increase the surface area for absorption.
- (vi) The lining of ileum is only one cell thick for easy diffusion of nutrients
- (vii) It has many blood capillaries for easy diffusion of digested materials.

VILLI (Singular: villus)

These are finger-like projections found in the wall of the ileum that increases the surface area for absorption of digested food.

A DIAGRAM OF VILLI



Adaptations of the villus to its functions

- (i) Villus is only one cell thick for easy diffusion of nutrients.
- (ii) Villus has numerous microvilli to increase the surface area for absorption of food.
- (iii) Villus has many blood capillaries for easy diffusion of digested materials and to transport away the absorbed food.
- (iv) Villus has lymphatic vessels called lacteals for absorption of fatty acids and glycerol.
- (v) Villus has goblet cells for secretion of mucus

THE END PRODUCTS OF DIGESTION OF FOOD SUBSTANCES

Complex food substances digested	Simple, soluble, absorbable end products
Carbohydrates such as starch and sucrose	Glucose, fructose and galactose
Proteins such as beef, milk, beans, chicken and fish	Amino acids
Lipids (fats and oil) such as butter, cheese, cooking oil, groundnuts and coconuts	Fatty acids and glycerol

Vitamins sources such as fruits, milk and vegetables	Vitamin A, B, C, D, E and K
Mineral sources such as vegetables, liver, fish, iodized salt and water	Mineral elements like potassium, sodium, iron, magnesium, iodine, calcium, chloride, fluoride and nitrate

After absorption of the end products of digestion into the blood stream, the end products are used by the body in various functions such as growth, body repair respiration, excretion and reproduction. This process is called **assimilation**

ASSIMILATION

Is the process in which absorbed nutrients are utilized by the body cells and help in various metabolic processes.

The large intestine

This is the part of the alimentary canal that joins with the ileum. It has large width compared to the ileum.

Large intestine has no digestive enzyme hence no digestion process. The undigested and indigestible food materials from the ileum are passed into colon by the process called peristalsis

Function of colon

- (i) It is a site where most of water carried in the digestive system is absorbed.
- (ii) It has bacteria that synthesizes vitamins B₁, B₂, B₁₂ and K.
- (iii) It transports the undigested and indigestible food materials into the rectum

RECTUM

Is the last chamber of the alimentary canal

Function of rectum

Used as a temporary storage of faeces.

EGESTION

Is the process of passing out the undigested food materials through the anus

- When there is enough accumulation of waste materials in the rectum the sphincter muscles at the anus relax and allow faeces to pass out.
- Egestion is also known as **defecation**.

ENZYMES

Are biological catalysts that speed up the rate of chemical reaction but remains unchanged at the end of reaction.

Types of enzymes

- (i) Intercellular enzymes
- (ii) Extracellular enzymes
- (i) **INTECELLULAR ENZYMES**

Are enzymes secreted and used within the cells which produce them.

- Example: Respiratory enzymes.

(ii) **EXTACELLULAR ENZYMES**

Are enzymes secreted within the cells but used outside the cells that produce them.

- Example: Digestive enzymes

PROPERTIES OF ENZYMES

- (i) Enzymes are protein in nature.
- (ii) Enzymes are specific
- (iii) Enzymes remain unchanged at the end of the reaction
- (iv) Enzymes work rapidly
- (v) Enzymes become denatured at high temperature
- (vi) Enzymes are sensitive to change in pH
- (vii) Enzymes can catalyze reactions in both directions

THE RUMINANT DIGESTIVE SYSTEM

Ruminants: are animals that chew food, swallow it, and later return it to the mouth for further chewing.

- Ruminants are herbivorous mammals that obtain food from plant sources.
- The term “**ruminant**” comes from Latin word “**ruminare**” which means “**to chew over again**”

Examples of ruminants

- Cows
- Goats
- Sheep
- Antelopes
- Giraffes

The returning of food to the mouth is called **regurgitation**. The food returned to the mouth is known as **cud**.

Chewing cud: is the process whereby ruminants chew food, swallow it and later return it to the mouth for further chewing

- Chewing cud softens and helps break down plant fibres, making them more access to digestion by the bacteria.
- Chewing cud is also known as **rumination**

NB: The digestive system of a ruminant is different from that of a human being.

Ruminants have a more elaborate system to enable cellulose digestion.

The stomach of a ruminant has four chambers namely

- i) Rumen
- ii) Reticulum
- iii) Omasum
- iv) Abomasums

RUMEN

Is the first chamber of the ruminant stomach

Function of rumen

- i) Act as a site for temporary storage of food when a ruminant first chews and swallows a mouthful of plant matter.
- ii) It contains bacteria that secrete cellulase enzyme which digest cellulose to glucose.

RETICULUM

Is the second chamber of the ruminant stomach

- Reticulum has a honeycomb appearance

Function of reticulum

- i) To mix the food thoroughly with water.

OMASUM

Is the third chamber of the ruminant stomach which receives regurgitated and chewed again food from the reticulum.

- The **omasum** has broad and longitudinal folds like the leaves of a book.

Function of omasum

- Have folds help to remove water from the food.

NB: The food in the omasum is in form of fine particles and has very little water.

ABOMASUM

Is the ruminant's true stomach.

Function of abomasum

- i) Has gastric acid that facilitates the digestion of proteins.
- ii) It kills microorganisms that may have spilled over the rumen.

DIFFERENCES BETWEEN THE RUMINANT DIGESTIVE SYSTEM AND THE HUMAN DIGESTIVE SYSTEM

Ruminants	Humans
Have four stomach chambers	Have one stomach chamber
They chew cud	They do not chew cud
They are able to digest cellulose	They are not able to digest cellulose
They have a relatively long alimentary canal	They have a relatively short
Have no upper incisors and canines	Have upper incisors and canine
Have a gap on the lower jaw called diastema	Have no diastema

COMMON DISEASES AND DISORDERS OF THE HUMAN DIGESTIVE SYSTEM

These include diseases and disorders that affect teeth, the oesophagus, the stomach and the small and large intestines.

Common diseases and disorders associated with the human digestive system include:

- i) Dental caries
- ii) Heartburn
- iii) Stomach ulcers
- iv) Constipation
- v) Flatulence
- vi) Cancer.
- vii) Indigestion- refers to pain or discomfort which occurs after eating too much oily, spicy food

I. HEARTBURN

Is a burning or painful sensation in the oesopgaus caused by regurgitation of the stomach contents.

Causes of heartburn

- Heartburn is caused by excess acid in the stomach.

Signs and symptoms of heartburn

- A sour taste in the mouth
- A burning feeling in the chest or throat
- Excessive belching
- Loss of voice or hoarseness
- Difficulty swallowing.

Effects of heartburn

- An individual with this problem feels uncomfortable all the time
- Prolonged heart burn can lead to esophagus cancer and ulcers

Prevention and treatment of heartburn

- Avoid food that cause heartburn
- Avoid alcohol, caffeine, tobacco and recreational drugs.
- Take measures to reduce stress
- Antacids help to reduce acidity.
- Obese people should lose weight
- Drink water to dilute acid in the stomach.

II. ULCERS

These are sores or broken parts of the digestive system

OR is a wound in the stomach or small intestine which is caused by too much acid in the digestive tract.

Types of ulcers

- i) Peptic ulcers: are ulcers found in the stomach.
- ii) Duodenal ulcers: are ulcers found in the duodenum

A STOMACH ULCER

Is a sore in the stomach lining caused by the erosion of the stomach's mucus coating, exposing the stomach to the action of digestive enzymes and acid.

Cause of ulcers

- Excessive secretion of acid and pepsin in the stomach
- Ulcers can also be caused by stress which stimulates production of acid.
- Keeping the stomach empty for longtime.
- Drugs like aspirin
- **Smoking**
 - Smoking increases production of HCl acid and pepsin which erodes the stomach walls
- **Alcohol**
 - Alcohol cause ulcers, it breaks down stomach's mucus coating and exposing the stomach walls to HCl acids.
- Bacteria called Helicobacter pylori break down the mucus coating and expose the stomach wall to the action of digestive enzymes and acid
- Excessive intake of acidic foods like beans because they irritate stomach ulcers

Sign and symptoms of ulcers

- Burning pain in stomach or the middle of thorax
- Nausea and vomiting
- Tiredness and weakness
- Blood in vomiting or stool (a symptom of bleeding ulcer)

Prevention and treatment of stomach ulcers

Ulcers can be controlled as follows

- Avoid smoking
- Avoid taking alcohol
- Avoid acid producing food
- Avoid emotional stress
- To take fresh milk
- Use antibiotics to kill infectious bacteria that cause ulcers.

III. CONSTIPATION

Is a decrease in the frequency of formation or passage of stool.

- It occurs when the stool become dry and hard due to excessive absorption of water in the colon.

Causes of constipation

- Inadequate amount of fibre in the diet.
- Inadequate intake of water
- Lack of exercise
- Ignoring the urge to go for a long call
- Life style changes such as pregnancy and old age
- Abuse of laxatives

- Excessive absorption of water in the colon

Sign and symptoms of constipation

- Lack of bowel movements for three or more days.
- Hard stools that is difficult or painful to pass.
- The urges to go for a long call even after you have just gone.

Prevention and control of constipation

- Eat enough fibre.
- Drink a plenty of water every day.
- Exercise regularly
- Go for long call when you feel the urge to.
- Seek medical help if constipation is persistent

IV. FLATULENCE

Is a condition caused by excessive gas in the digestive tract.

Causes of flatulence

- Swallowed air or eating food that produce gas such as beans, cabbage, onions
- Eating meals that have too much fat which leads to production of large amount of carbondioxide
- Poor absorption of carbohydrates in the gut

Signs and symptoms of flatulence

- Abdominal pain
- The constant urge to pass wind
- Excessive belching
- Bloating (an accumulating of gas in the stomach)

Prevention and control of flatulence

- Avoid foods that produce gas or eat them in moderation.
- Avoid lying down after eating because it easy for gas to pass from the stomach into the intestines
- Chew food carefully to assist in proper digestion of carbohydrates.
- Limit the amount of lipids in the diet.

V. DENTAL CARIES

This is commonly referred to as **tooth decay**.

- It occurs when bacteria destroy the outer part of the tooth.

NB: Plaque is the sticky substance often found between teeth.

It is formed when bacteria in the mouth combine with acid, saliva and remains of food.

- The bacteria in plaque convert the remains of food (especially sugar and starch) into acids.

- The acid dissolves the enamel in the tooth, forming a **cavity**. If this cavity is left untreated, it reaches the pulp cavity and nerve endings inside the tooth causing an infection.

Sign and symptoms of dental caries

- Toothache, especially after eating sweet, cold or hot foods
- Holes in the teeth

Prevention and control measures of dental caries

- Minimize intake of sugary foods
- Avoid eating very hot or very cold foods
- Brushing teeth and floss frequently in order to remove plaque
- Damaged teeth can be filled or covered with an artificial crown or pulled out
- Visit a dentist regularly for dental check-ups.

NUTRITION IN PLANTS

Plant are autotrophs, means they manufacture their own food.

Although plants can manufacture their own food but they need chemical elements for them to stay health.

MINERAL REQUIREMENTS IN PLANTS

MINERAL ELEMENTS

Are chemical elements that the plants obtain from the soil.

- Mineral elements are found in the soil in form of ions dissolved in water.

TYPES OF MINERAL ELEMENTS REQUIRED BY PLANTS

The mineral elements required by plants are grouped into two types, namely;

- i) Macro elements
- ii) Microelements

I) MACRO ELEMENTS

Are mineral elements that required by the plants in large quantities.

Example of macroelents

- | | |
|--------------|-------------|
| • Carbon | • Sulphur |
| • Magnesium | • Potassium |
| • Calcium | • Nitrogen. |
| • Phosphorus | |

II) MICRO ELEMENTS

Are mineral elements required by the plants in small quantities.

- They are also called **trace elements**

Example of microelements

- | | |
|-------------|--------------|
| • Manganese | • Copper |
| • Zinc | • Cobalt |
| • Sodium | • Silicon |
| • Boron | • Molybdenum |
| • Chlorine | |

THE ROLE OF MINERAL ELEMENTS IN PLANTS

I) MACROELEMENTS

ELEMENTS	SOURCES	ROLES IN PLANTS	DEFICIENCY SYMPTOMS
Nitrogen	<ul style="list-style-type: none"> Commercial fertilizers Obtained from air 	<ul style="list-style-type: none"> For synthesis of protein and chlorophyll Speed up rate of growth 	<ul style="list-style-type: none"> Stunted growth Leaves turn yellow (chlorosis)
Phosphorous	<ul style="list-style-type: none"> Obtained from bone meal phosphate fertilizers 	<ul style="list-style-type: none"> For germination and growth of seed For growth of roots For production of flowers and fruits For ripening of seeds and fruits 	<ul style="list-style-type: none"> Leaves become purple Plants remain short and slender Scorched brown leaf edges
Potassium	<ul style="list-style-type: none"> Obtained from soil minerals Organic material Commercial fertilizers 	<ul style="list-style-type: none"> Promotes resistance to diseases Help in building of protein Steady growth 	<ul style="list-style-type: none"> Leaf margins and tips become yellow Susceptibility to diseases
Calcium	<ul style="list-style-type: none"> Obtained from lime, gypsum Commercial fertilizers 	<ul style="list-style-type: none"> For formation of cell walls 	<ul style="list-style-type: none"> Stems, roots and leaves are poorly developed Internal decay
Magnesium	<ul style="list-style-type: none"> Obtained from soil minerals Organic materials Commercial fertilizers Lime 	<ul style="list-style-type: none"> Synthesis of chlorophyll Activates plant enzymes 	<ul style="list-style-type: none"> Old leaves turn yellow followed by young leaves Leaves fall without withering
Sulphur	<ul style="list-style-type: none"> Obtained from rainwater Gypsum Commercial fertilizers 	<ul style="list-style-type: none"> Components of amino acids Formation of chlorophyll Improved root growth and seed production 	<ul style="list-style-type: none"> Poor growth of terminal buds Young leaves turn yellow Dropping off of leaves In excess result into premature aging of plants

II) MICROELEMENTS

MICROELEMENT	ROLES IN PLANTS	DEFICIENCY IN PLANTS
Iron	<ul style="list-style-type: none"> Formation of chlorophyll Transportation of oxygen 	<ul style="list-style-type: none"> Leaves become yellow Brown spots on leaves

Chlorine	<ul style="list-style-type: none"> • Important in plant metabolism 	<ul style="list-style-type: none"> • Wilting
Zinc	<ul style="list-style-type: none"> • Production of proteins • Regulation of plant growth and maturity 	<ul style="list-style-type: none"> • Purple or dark spots on leaves • Small, deformed leaves • Leaves become yellow
Copper	<ul style="list-style-type: none"> • For reproductive growth • Aids in the production of proteins 	<ul style="list-style-type: none"> • Leaves fail to unfold • Withering of leaves • Distorted growth tips
Molybdenum	<ul style="list-style-type: none"> • Formation of root nodules in legumes 	<ul style="list-style-type: none"> • Yellow spots on leaves • Dead spots on leaves
Boron	<ul style="list-style-type: none"> • Production of sugar and starch • Aids in water intake by cells 	<ul style="list-style-type: none"> • Hollow stems • Deformed fruits • Discoloured leaves • Falling leaves

PHOTOSYNTHESIS

Photosynthesis: Is the process by which green plants make their own food from water and carbondioxide in the presence of sunlight and chlorophyll

REQUIREMENTS AND CONDITIONS NECESSARY FOR PHOTOSYNTHESIS

There are four requirements necessary for photosynthesis process to occur:

- (i) Water
- (ii) Carbon dioxide
- (iii) Chlorophyll
- (iv)Sunlight

Note: Water and Carbondioxide are raw materials while Chlorophyll and sunlight are conditions necessary for photosynthesis

Function (Role) of chlorophyll, sunlight, water and carbondioxide in photosynthesis

REQUIREMENT	FUNCTION (ROLE) IN PHOTOSYNTHESIS
(i) Chlorophyll	used to trap light energy needed for photosynthesis
(ii) Sunlight	Used to break down water molecules into hydrogen ions used in light stage.
(iii) Water	Used to produce hydrogen ions and oxygen when broken down
(iv) Carbondioxide	It combine with hydrogen ions to form glucose

THE PROCESS OF PHOTOSYNTHESIS

Photosynthesis takes place in two stages namely:

- (a) Light stage or light dependent reaction
- (b) Dark stage or light independent reaction

(a) THE LIGHT STAGE OR LIGHT DEPENDENT REACTION

This stage takes place in the grana of the chloroplast. Chlorophyll in the grana absorbs light energy which is used to split up (break down) water molecules into hydrogen ions and oxygen in a process called **photolysis**.

Light stage is represented by the equation below (photolysis reaction)

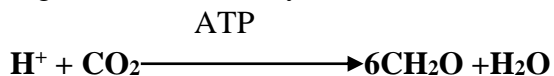


Note: Hydrogen ions produced by light stage enter the dark reactions

(b) THE DARK STAGE OR LIGHT INDEPENDENT REACTION

This stage takes place in the stroma of the chloroplast. Hydrogen ions (H^+ ions) from the light stage combines with carbondioxide from the atmosphere to form glucose in a process called **carbondioxide fixation**.

Dark stage is summarized by the chemical reaction below

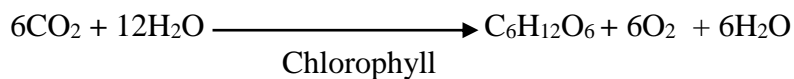


Photolysis is the breaking down of water molecules into hydrogen ions and oxygen in the presence of light energy

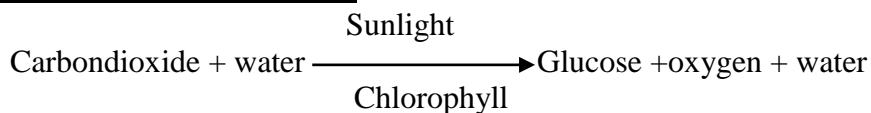
Carbondioxide fixation: is the process whereby hydrogen ions from the light stage combines with carbondioxide to form glucose.

General balanced chemical equation of photosynthesis

Sunlight



Word equation of photosynthesis



END PRODUCTS OF PHOTOSYNTHESIS

- (i) Glucose
- (ii) Oxygen gas
- (iii) Water

Uses of end products of photosynthesis

End product	Uses
(i) Glucose	Used as raw material in respiration to release energy
(ii) Oxygen	Used as raw material of respiration
(iii) Water	Used in photosynthesis process as raw material Used in various chemical reactions within the cells,

IMPORTANCE OF PHOTOSYNTHESIS

- (i) Food production.
Through photosynthesis food such as glucose is manufactured by plants and used by both plants and animals.
- (ii) Energy conversion.
Through photosynthesis light energy is converted into chemical energy
- (iii) Balance atmospheric gases such as carbondioxide and oxygen.
- (iv) Photosynthesis is a source of fuels such as fossil fuels from the remains of dead plants

FACTORS AFFECTING THE RATE OF PHOTOSYNTHESIS PROCESS

Photosynthesis can be affected or influenced by the following factors:

- (i) Light intensity
- (ii) Temperature
- (iii) Carbondioxide concentration
- (iv) Availability of water
- (v) Availability of mineral salts
- (vi) Leaf age
- (vii) Presence of manufactured carbohydrates

1. LIGHT INTENSITY

A good quality of light enhances the rate of photosynthesis. Very bright light damages the plant due to strong sun rays. Plants under shade receive poor quality of light

2. CARBONDIOXIDE CONCENTRATION

An increase in carbon dioxide concentration results to an increase in the rate of photosynthesis up to a certain level.

Any further increase in the carbon dioxide concentration after the maximum point induce the stomata to close and therefore cutoff the supply of carbon dioxide.

3. TEMPERATURE

The rate of photosynthesis increase as the temperature increase up to maximum point i.e. 40⁰c.

4. WATER

Plants require water for the various chemical reactions of the cells.

Water is also a raw material for photosynthesis.

5. MINERAL SALTS

Some minerals such as magnesium and iron are responsible in the formation of chlorophyll.

The availability of these minerals results in the chlorophyll synthesis and the rate of photosynthesis increases.

6. LEAF AGE

As the leaf ages chlorophyll breaks down hence the rate of photosynthesis is reduced.

7. PRESENCE OF MANUFACTURED CARBOHYDRATES

This will reduce the rate of photosynthesis since carbohydrates are product of photosynthesis

THE STRUCTURE OF THE LEAF IN RELATION TO PHOTOSYNTHESIS

LEAF

Is the plant organ which acts as a site where photosynthesis process occurs.

The structure of the leaf contains;

- i) Internal structure
- ii) External structure

NB: The internal and external structures of a leaf make a leaf well adapted for photosynthesis.

I. EXTERNAL STRUCTURE OF A LEAF

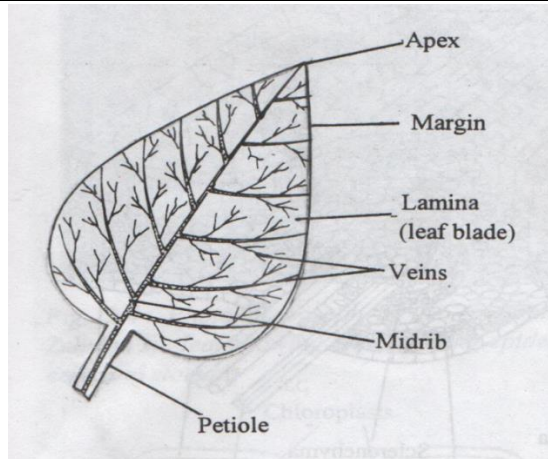
Are the external features of the leaf that can be viewed by using a hand lens or unaided eyes.

These include:

EXTERNAL PART	ITS FUNCTION
Petiole(Leaf stalk)	It attaches the leaf to stem or branch. It holds the leaf in position to trap light for photosynthesis
Veins	They have xylem and phloem for transportation of materials within the leaf.
Midrib	Gives rise to veins. Transports materials to the leaf

Lamina(Blade)	<ul style="list-style-type: none"> • It helps the absorption of light energy and carbondioxide. • It is broad to provide a large surface area for photosynthesis
Margin and apex	<ul style="list-style-type: none"> • Gives the shape of the leaf

DIAGRAM SHOWING THE EXTERNAL STRUCTURE OF A LEAF



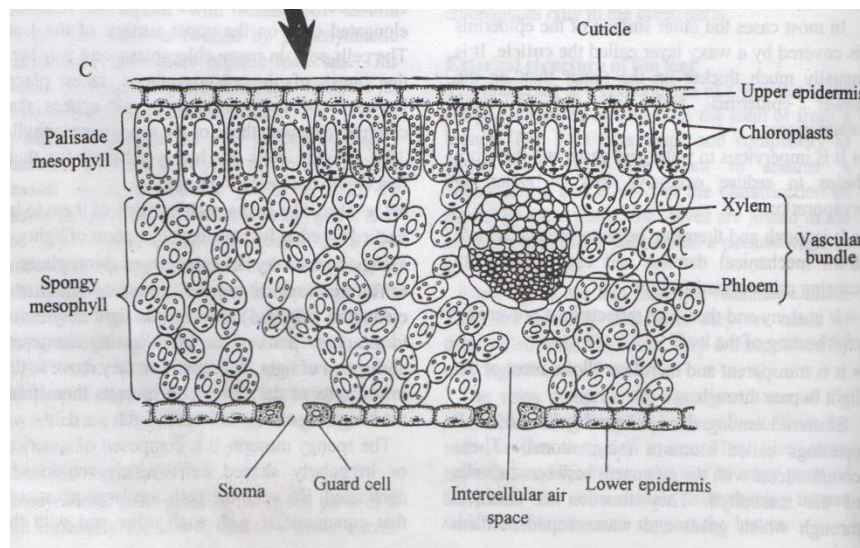
II. INTERNAL STRUCTURE OF THE LEAF

Are the internal features of the leaf that can be viewed by using a microscope

The following are internal parts of the leaf:

- | | |
|--------------------|---------------------------|
| i) Cuticle | v) Spongy mesophyll layer |
| ii) Epidermis | vi) Leaf veins |
| iii) Guard cell | vii) Chloroplast |
| iv) Palisade layer | |

DIAGRAM SHOWING THE INTERNAL PARTS OF A LEAF



FUNCTION OF THE INTERNAL STRUCTURE OF LEAF

1) CUTICLE

Is the outermost transparent layer of the leaf.

- It is thin, waxy, and transparent and water proof.

Functions

- i) Protects the leaf from injury, pests and excessive water loss
- ii) It allows light to penetrate to the photosynthetic cells.

2) EPIDERMIS

It is the outermost layer of cells found both on the lower and upper surfaces of a leaf.

- It is transparent and only one cell thick layer

Functions

- i) It allows sunlight to penetrate the leaf.
- ii) Secretes (makes) the cuticle
- iii) Protects inner tissue from damage

NB: Epidermis has pores called **stomata**

STOMATA (singular: stoma)

Are small pores which allow gaseous exchange into and out of the leaf.

Function

- i) To allow oxygen and carbondioxide to diffuse into and out of the leaf

3) GUARD CELLS

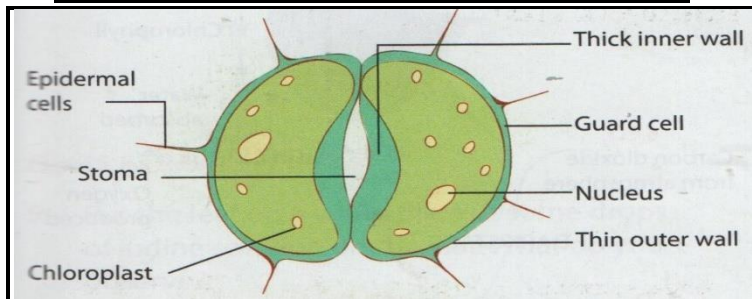
Are bean shaped epidermal cells mostly found on the lower surface.

- Contain chloroplasts with chlorophyll used to trap sunlight for photosynthesis.

Functions

- i) Control opening and closing of stomata
- ii) Control water loss
- iii) Allow gaseous exchange

DIAGRAM OF STOMA AND GUARD CELL



4) MESOPHYLL

Is made up of the palisade and spongy layers

(a) PALISADE MESOPHYLL LAYER

Is the layer found between the upper epidermis and the spongy mesophyll layer

- It is made up of palisade cells which contain **chloroplasts**

- It is a part of a leaf which has abundant chlorophyll to maximize light absorption and photosynthesis.

Functions

- To trap sunlight by using chlorophyll for the process of photosynthesis

(b) SPONGY MESOPHYLL LAYER

Is the layer found between the palisade layer and the lower epidermis

- This layer has very few chloroplasts as compared to palisade layer

Function

- It is a part of a leaf with cells loosely packed to maximize gaseous exchange.
- Photosynthesis takes place in it

5) LEAF VEINS OR VASCULAR BUNDLE

Consist of both xylem tissues in the upper part and phloem tissues on the lower surface

Functions:

- Xylem transport water and mineral salts from the root to the rest parts of the plants.
- Phloem transport manufactured food from the leaves to the rest parts of the plant.

CHLOROPLAST

Is a disc- shaped organelle that contains chlorophyll

- **Chloroplasts** is the main site where photosynthesis takes place which are mostly found in the **leaf**

Functions:

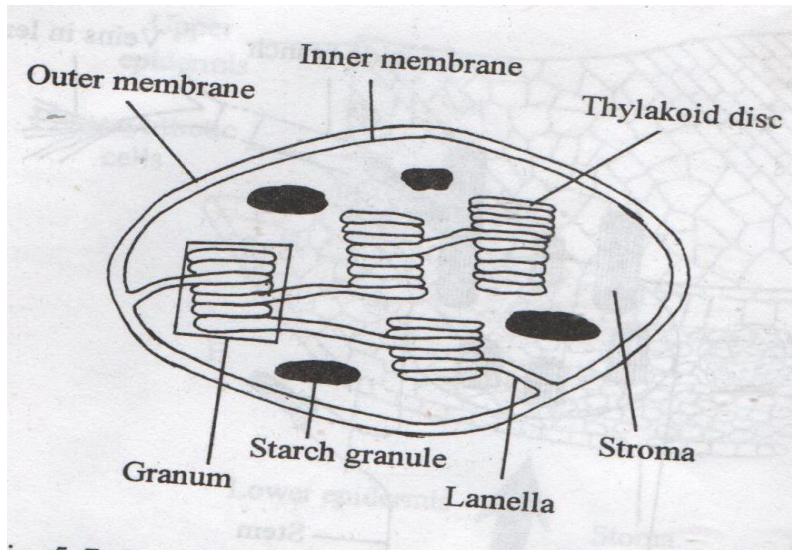
- It contains chlorophyll to trap sunlight for photosynthesis

THE STRUCTURE OF THE CHLOROPLAST

Chloroplast has the following structures:

- Double membrane** i.e. outer membrane and inner membrane
- Chlorophyll** (photosynthetic pigment) - to traps sunlight for the process of photosynthesis.
- Stroma** (aqueous matrix)-is a fluid medium which contains photosynthetic enzymes and it is a site where **dark stage** of photosynthesis takes place.
- The grana**-contain chlorophyll pigments which trap sunlight and it is a site where **light stage** of photosynthesis takes place.

Diagram of a chloroplast



ADAPTATION OF THE LEAF IN THE PROCESS OF PHOTOSYNTHESIS

- i) The leaf has cuticle and epidermis which are transparent to allow easy penetration of light
- ii) Presence of stomata on the leaf allows easy diffusion of carbon dioxide
- iii) The leaf has network of veins which allows movement of materials in and out of the leaf
- iv) The leaf has air spaces in the spongy mesophyll layer allow gases to circulate easily.
- v) Presence of large numbers of chloroplasts in the palisade layer enables maximum sunlight absorption.
- vi) The leaves are well arranged to avoid overlapping and overshadowing
- vii) The leaf has broad and flat lamina to allows maximum absorption of sunlight and carbondioxide

STORAGE ORGANS

Plants store food for future use. Foods in plants can be stored in:

- i) Leaves e.g. Onions, cabbage
- ii) Fruits e.g. Mango, pineapple, pawpaw
- iii) Seeds e.g. Beans, peas, rice, maize
- iv) Stems e.g. Irish potato, ginger, sugar cane
- v) Roots e.g. Sweet potato, cassava, carrots

ADVANTAGE OF FOOD STORAGE ORGANS

- i) Some organs give rise to new plants e.g. Seeds, stem, tubes
- ii) Permits the survival of plants over dry seasons.
- iii) Some are used as source of food by man and other animals e.g. Rice, wheat, potatoes etc.
- iv) The stored food is used during germination before the leaves form.
- v) Some are used for commercial purpose by man e.g. Sugar cane

FOOD PROCESSING, PRESERVING AND STORAGE

FOOD PROCESSING

Are ways in which food is treated in order to make it edible, appetizing and safe to eat or keep it fresh for a long time.

- Some of the activities involved in food processing are:
 - i) Picking, sorting and washing fruits and vegetables
 - ii) Converting raw materials into other products

Example making cheese from milk or sugar from sugar cane

FOOD PROCESSING TECHNIQUES

Common food processing techniques include

- i) Removing unwanted outer layers e.g. peeling potato
- ii) Chopping or slicing e.g. Bananas, mangoes and cassava
- iii) Liquefaction e.g. producing juice by squeezing fruits
- iv) Fermentation e.g. making wine from banana and grapes and beer brewing
- v) Cooking e.g. boiling, frying, steaming or grilling
- vi) Deep freezing
- vii) Baking

FOOD PRESERVING

Are methods that are used to prevent food from getting spoiled or going bad.

OR is the process of adding preservatives such as salts, sugars to the food to prevent deterioration.

PRESERVATIVES

Are chemicals that stop deterioration of food or prevent growth and development of microorganisms.

FOOD STORAGE

Is a method used to keep reserves of food for future use

IMPORTANCE OF FOOD PROCESSING, PRESERVING AND STORAGE

- i) Prevents wastage of food
- ii) Saves money by preventing spoilage of food
- iii) Maintains the quality of food.
- iv) Prevents growth of microorganisms that can cause illness
- v) Helps to improve the flavour of food.
- vi) Removes harmful toxins and microorganisms from food
- vii) Makes food available even when they are not in season
- viii) Enables transportation of delicate and perishable food such as milk and fruits over long distance

METHODS OF FOOD PROCESSING AND PRESERVING

Methods of processing and preserving food are grouped into two main categories, namely:

- a) Traditional methods
- b) Modern methods

A) TRADITIONAL METHODS OF FOOD PROCESSING AND PRESERVING

1) CURING

This involves the addition of substances such as sugar, salt, spices and vinegar to animal foods to remove water making it unsuitable for the growth of microorganism

- It also improves the taste of food.
- This method is used to preserve food such as meat and fish

2) DRYING IN THE SUN

This involves the removal of water from the food by using solar energy to discourage the growth of microorganism.

- This method is used to preserve rice, maize, cloves, bananas, beans, meat, fish, cassava and green vegetables.

3) SMOKING

This involves drying food by using smoke to reduce the moisture content of food to prevent the growth of microorganisms.

- This method is used to preserve cassava, grains, meat and fish

4) SALTING

This involves the addition of salt to remove water from the food and kills microorganisms that might spoil the food.

- This method is used to preserve meat, sardines and fish

5) COOKING

This includes boiling, steaming, baking in hot ash, grilling and roasting.

- These processes help to soften food, improve flavor and preserve food.

Examples: potatoes, banana, and maize can be boiled before being dried. Meat can be grilled or deep fried.

6) FERMENTATION

Is the conversion of carbohydrates such as sugars into acids or alcohol

- Fermentation can occur naturally or can be induced.
- It is used to preserve milk in form of yoghurt

ADVANTAGE OF TRADITIONAL METHODS OF FOOD PROCESSING, PRESERVATION STORAGE

- i) They are simple and can be done by most people
- ii) They use locally available materials and simple technology, the keeping costs low.
- iii) No harmful chemicals are added to the food.
- iv) Curing and smoking add a distinctive flavor to the food
- v) Most methods do not destroy nutrients

DISADVANTAGES OF TRADITIONAL METHODS OF FOOD STORAGE, PROCESSING AND PRESERVATION

- i) Food can be preserved and stored for only limited periods of time
- ii) Traditional method is difficult to do on a large scale. Traditional methods are highly limited in the variety of foods that can be processed, preserved and stored

B) MODERN METHODS OF FOOD PRESERVATION AND PROCESSING

1) PASTEURIZATION

Is a method which involves heating food to very high temperature for a short time to kill enzymes and microorganisms that can cause food spoilage.

- Pasteurizations maintain the nutrients content and flavor of food.
- Example of food which can be pasteurized are milk and fruit juice

2) LIQUEFICATION

This method involves the making of liquids from solid food.

- It is mostly applied to fruits where by juice is made out of them.
- The juice is then pasteurized and post into cans or containers.

3) CANNING AND BOTTLING

In this method, food is preserved by heating it in airtight vacuum – sealed bottles or cans.

- First the container is filled with food then the air is pumped out to form a vacuum.
- The container is sealed and heated to kill micro – organisms and enzymes
- Foods that can be canned and bottled include tomatoes, fruits and fruits juices, beef, fish and baked beans

4) USING ADDITIVES

This involves preservation of food by using chemicals such as sodium benzoate, sodium chloride and vinegar to slow down the growth of microorganisms.

- Examples the food can be preserved by this process are fish and meat.

5) FREEZING

This involves keeping food in freezer at a temperature below -10°C to stop the growth of microorganisms.

- This method preserves the appearance, flavor, texture and nutritive value of food.

6) REFREGIRATION

This involves keeping perishable food in a refrigerator to slow down the growth of microorganisms which cause food spoilage.

- This method is used to preserve food such as milk, meet, chicken, vegetables, fresh fruits, fish etc.

7) IRRADIATION

This involves use of rays of energy to stop growth of microorganisms in stored foodstuffs.

- This method is used to preserve food such as onions, beans or potatoes.

ADVANTAGES OF MODERN METHODS OF FOOD PROCESSING, PRESERVATION AND STORAGE

- i) Food can last for many months or even years
- ii) Modern methods can process, preserve and store a large variety of foods.
- iii) The advanced technology used is fast and can handle large quantities of food

DISADVANTAGES OF MODERN METHOD OF FOOD PROCESSING, PRESERVATION AND STORAGE

- i) The chemicals used can be harmful if eaten in excess.
- ii) These methods can only be used in a certain area. Example – refrigeration and freezing require electricity.
- iii) The process used for example radiation; canning and pasteurizing require special skills.
- iv) Sometimes nutrients are lost thus lowering the nutritional value of food.

DIFFERENCE BETWEEN TRADITIONAL AND MODERN METHODS OF FOOD PRESERVATION

TRADITION METHOD	MODERN METHOD
Less expensive	More expensive
Food cannot be stored for a long period of time.	Food can be stored for a long period of time.
It needs low technology	It needs high technology
It alter the taste, texture and color of the food	Does not alter the taste, texture and color of the food
Can be applied in rural areas where there is no service like electricity.	Can only be applied where service such as electricity is available.

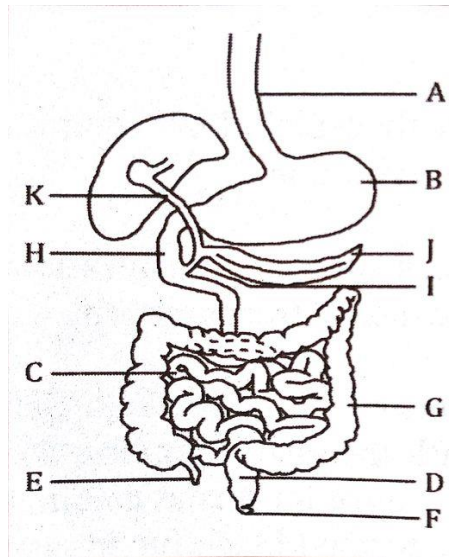
NECTA QUESTIONS

1. Outline the differences between heterotrophic and autotrophic nutrition
2. State conditions necessary for photosynthesis
3. State the roles played by light and water in the process of photosynthesis
4. Write a balanced symbol equation for photosynthesis.
5. Describe the adaptations shown by a leaf for photosynthesis
6. State the consequences for a plant if it lacks:
 - i) Chloroplasts
 - ii) Magnesium
 - iii) Phosphorous
 - iv) Nitrogen
 - v) Calcium
7. Explain the role of the following food substances in the body of a human:
 - i) Proteins
 - ii) Carbohydrates
 - iii) Vitamins
 - iv) Water
8. a) Explain what is meant by the term “malnutrition”
b) List three diseases caused by malnutrition and the main food deficiency associated with each disease
9. A team of researchers went to a village near Ujasi, Dodoma and found a five year old boy with the following symptoms:
 - The stomach was protruding.
 - The hair was reddish and fell off easily

- The skin was dry, flaky and rough.
 - The boy had no appetite.
- a) Name the disease that the boy was suffering from
 - b) What deficiency caused the disease?
 - c) Mention other disorders the boy was likely to be having.
 - d) What advice would you expect the researchers gave to the parents of the boy?
 - e) Suggest the type of diet, which the boy may have been eating?
10. a) What is a balance diet?
 - b) List six components of a balance diet
 - c) List the importance of balance diet in human being
11. Explain what would happen to the body if it lacked

i) iodine	iii) calcium
ii) iron	iv) sodium
12. a) Explain what is meant by the term 'digestion'
 - b) Outline the digestion of the following food substances as meals passes along the alimentary canal of a human.
 - c) Why it is possible for a person to swallow food while standing upside down?
13. Briefly explain what is meant by the term 'enzyme'
 - a) Outline enzymes used to digest protein in the:-
 - i) Stomach
 - ii) Duodenum
 - iii) Ileum
 - b) Outline enzymes used to digest starch in the:
 - i) Mouth
 - ii) Duodenum
 - c) Outline the enzymes used to digest lipid(fats and oils) in the:
 - i) Duodenum
 - ii) Ileum
14. a) Draw a well labeled diagram of a human alimentary canal
 - b) Name four major parts of the alimentary canal
 - c) Describe how the alimentary canal is adapted for its function
 - d) Describe how the ileum is adapted to its function
15. Mention the components of the following digestive juices and state their functions
 - a) Salivary juice or saliva
 - b) Gastric juice
 - c) Intestinal juice or succus entericus
16. a) Explain what is meant by the term 'villus'
 - b) Draw and label the diagram of villus
 - c) State thee adaptation of the villus for the absorption of food in the alimentary canal
17. What are the difference between digestion in humans and digestion in cow?

18. Elaborate any three traditional and three modern methods in food processing, preservation and storage.
19. The diagram in figure 1 is the alimentary canal of a human being. Study the diagram and answer the questions that follow:



- a) Name the part labelled A-K
- b) (i) name the digestive juice which is produced in organ labelled B
- c) Mention the substances contained in the digestive juice named in (b) above.

BALANCE OF NATURE

Balance of nature: is a state of equilibrium in nature resulting from constant interaction among living things and non-living things in the environment.

Or

Is a stable condition in which natural communities of animals, plants, and other organisms are maintained.

- The change of any components in the environment disturbs the entire equilibrium.
- The balance of nature is maintained through interactions among organisms such as cooperation, competition, predation, parasitism and other interactions between organisms and their environment.
- The study of the interactions between organisms and their environment is called **ecology**

THE ENVIRONMENT

Refers to the immediate surroundings of organisms which include living things and non-living things.

- The environment can either be **artificial** or **natural**.
- **Artificial environment** is man-made environment. This includes environment such as dams, parks and zoos.

THE NATURAL ENVIRONMENT

Is all living and non-living things that occur naturally on the earth.

- The non-living things in the natural environment include air, water, rocks, soil, nutrients, cloud cover, and sunlight.
- The living things in the natural environment include organisms such as animals, plants, and microorganisms such as bacteria and fungi.

Importance of the natural environment

- (i) It provides food, shelter and security for organisms.
- (ii) It provides an appropriate setting for organisms to reproduce and increase in number.
- (iii) It provides shelter and security for organisms.
- (iv) It provides space for living and non-living things to interact.
- (v) It provides needs to animals such as water, clean air, minerals, and herbal medicines for treating various diseases.
- (vi) It regulates harmful gases released to the environment by human activities.

TERMINOLOGIES USED IN BALANCE OF NATURE

1. **Population**: is the total number of organisms of the same species living in a certain area.
 - Example the number of frogs in a pond.

2. **Community**: is a group of interdependent organisms living in an environment.

Or

Is the sum of total of all population of different organisms living in a specific called habitat

- Community may contain several populations of plants, animals and decomposers

3. **Habitat**: is the specific area where an organism is found and adopted.

Example habitats

- Aquatic habitats such as an fresh water and salt water
- Terrestrial habitats such as grassland, desert

4. **Ecosystem**: is a natural unit made up of living and non-living things whose interaction lead to a self- sustaining system.

OR is the environment and all its interacting components.

5. **Ecological niche**: Is the role and position an organism has in its habitat.
6. **Carrying capacity**: is the number of living organisms that environment can support.
7. **Biosphere**: is the part of the planet earth, which is inhabited by living organisms. This includes the land, the water and air. It is also known as ecosphere.
8. **Biome**: is a large area of the earth's surface, which has particular climatic factors and characteristics flora (plants) and fauna (animals).

Examples of biome

- Savanna grasslands
- Deserts
- Tropical forests

- Temperate forests and tundra.

COMPONENTS OF THE NATURAL ENVIRONMENT

Natural environment is made up of two main components, namely;

- (i) Biotic component
- (ii) Abiotic component

BIOTIC COMPONENTS

These are living components of an environment

Example of biotic components

- Animals
- Plants
- Fungi
- Microorganisms

Main Groups of biotic components of the ecosystem

In the ecosystem (natural environment) there are three main groups of biotic components. These are:

- (a) Producers
- (b) Consumers
- (c) Decomposers

(a) PRODUCERS

Are organisms that are able to manufacture their own food.

Example of producers

- All green plants
- Photosynthetic bacteria.
- Phytoplankton (green algae)

Roles/advantages of producers in the environment

- (i) They are source of food in the ecosystem. They convert solar energy to food substance that can be used by all organisms.
- (ii) They are primary source of energy flow in an ecosystem.
- (iii) They are source of oxygen in the environment

(b) CONSUMERS

Are organisms in which live by consuming (eating) other organisms

Or are organisms which rely on other organism for food in the ecosystem.

Example of consumers

- Herbivores such as cow, goat, antelope, zebra

- Carnivores such as lions, hyena
- Omnivores such as human beings, pigs

(c) **DECOMPOSERS**

Are organisms that feed on dead organic matters.

- They decompose dead bodies of plants and animals and absorb the nutrients.

Example of decomposers

- Bacteria
- Fungi such as Mushrooms, Bread moulds (Rhizopus) and Mucor

Roles/advantages of decomposers in the ecosystem

- To recycle nutrients in the ecosystem.
- To break down dead organic matters thereby facilitating decomposition.
- To ensure energy circulation in the ecosystem.
- To increase soil fertility by decomposing dead bodies of plants and animals

ABIOTIC COMPONENTS

These are non-living components of an environment.

- They are also known as **abiotic factors or physical factors**.

Example of abiotic components includes

- Temperature
- Wind
- Light
- Soil
- Water
- Atmospheric pressure
- Altitude
- Gases such as oxygen, carbondioxide and nitrogen

INTERACTION AMONG LIVING ORGANISMS

The following are ways in which living organisms interact in the environment:

- Predation
- Competition
- Symbiosis

(i) PREDATION

Is the relationship in which one organism captures, kills and feeds on another in order to get nutrients.

- Predation involves predators and preys

Predator

Is an organism that captures, kills and feeds on prey

Examples of predators

- Lion
- Cats
- Sharks
- Hyena

Prey

Is an organism that is eaten by predators

Examples of preys

- Mice
- Antelope
- Smaller fish
- Zebra
- Wildebeest

Example of predation

- Cats eat mice
- Lions eat antelopes
- Shark eats smaller fish
- A leopard eats zebra

(ii) COMPETITION

Is the relationship whereby two organisms both struggle for the same limited environmental resources for survival.

- Competition involves two or more organisms competing for same resources such as food, space, air, water, light and mate.

TYPES OF COMPETITION

There are two types of competitions

- (a) Intra-specific competition
- (b) Inter-specific competition

(a) Intra-specific competition

Is the competition that involves two organisms of the same species competing for the same limited resources.

Example of intra-specific competition

- (i) Cows competing for grasses.
- (ii) Lions competing for zebra
- (iii) Maize plants competing for nutrients and water
- (iv) Male dogs competing for female dog
- (v) Bacteria competing for space and air

(b) Inter-specific competition

Is the competition that involves two organisms of different species competing for the same limited resources.

Example of inter-specific competition

- (i) Lion and leopards competing for antelope and zebra

- (ii) Potted plants and human being during night competing for oxygen.
- (iii) Maize plants and weeds competing for water and nutrients

(iii) SYMBIOSIS

Is a relationship involving a close association between two organisms of different species.

- In some symbiotic relationships, one of the species can benefit from the other without harming it or causing disease or death to it.
- In other symbiotic relationships both organisms can benefit from the association

Forms of symbiosis

- (a) Mutualism
- (b) Commensalism
- (c) Parasitism

(a) Mutualism

Is a relationship in which two organisms benefit from each other.

Example of mutualism

- (i) A relationship between rhizobium bacteria and leguminous plants.
- (ii) A relationship between human beings and plants

(b) Commensalism

Is a relationship in which only one organism benefits while the other is neither benefits nor harmed.

Example of commensalism

- (i) Association between a big tree and lichen (plants grow on big tree)
- (ii) When a bird builds a nest in a hole in a tree.

(c) Parasitism

Is a relationship in which one organism benefits while the other is harmed.

- Parasitism involves **host** and **parasite**.

HOST

Is an organism from which parasite live and obtain its nutrients

Example of hosts

- Animals
- Plants

PARASITE

Is an organism that obtains its nutrients from the tissues of the host.

Example of parasites

- Plasmodium
- Viruses

- Mosquitoes
- Tick

Types of parasite

Depending on where they live, there are two types of parasite, namely:

- (a) Ectoparasite
- (b) Endoparasite

(a) Ectoparasite (external parasite)

Is the parasite that live permanently or temporarily on the body surface of the host.

Example of ectoparasite

- Ticks
- Mosquitoes
- Lice

(b) Endoparasite (internal parasite)

Is the parasite which lives inside the host.

Example of endoparasites

- Viruses –live in cells
- Plasmodium – live in bloodstream
- Filarial worms – live in tissue fluid

TROPHIC LEVEL

Is the position of an organism occupies in a food chain.

Or is a term which describes organisms with similar nutritional habits.

There are six trophic levels, namely:

- (i) Producers
- (ii) Primary consumers
- (iii) Secondary consumers
- (iv) Tertiary consumers
- (v) Quaternary consumers
- (vi) Decomposers

(i) Producers

Are organisms that are able to make their own food.

- Producers occupy the first trophic level and includes all green plants and photosynthetic bacteria.

(ii) Primary consumers

Are organisms that occupy the second trophic level.

- This level includes all herbivores such as cows, goats, rabbits, zebra, antelope, and wildebeests.
- They feed on producers

(iii) Secondary consumers

Are organisms that occupy the third trophic level

- This level includes all small carnivores such as frogs, fish, birds and snakes.
- They feed on primary consumers

(iv) Tertiary consumers

Are organisms that occupy the fourth trophic level

- This level includes all organisms that feed on tertiary consumers such as owls
- They feed on secondary consumers

(v) Quaternary consumers

Are organisms that occupy the fifth trophic level

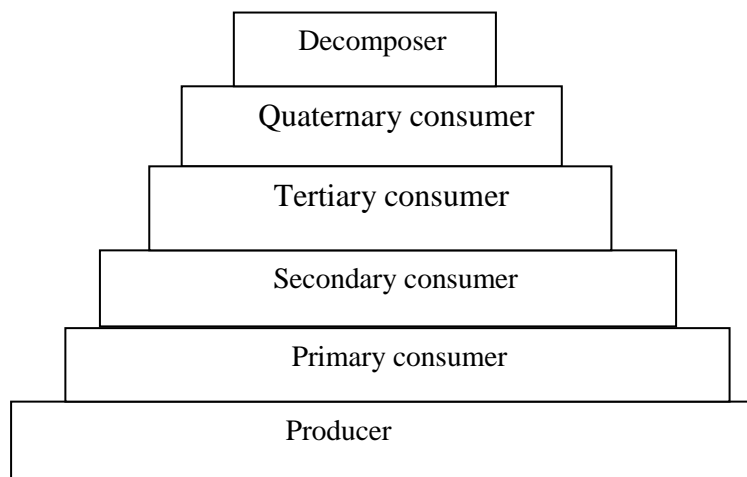
- This trophic level includes all apex predators such as vultures, hawks, eagles, killer whales (orca), lions and tigers.
- **Apex predator** is an animal at the top food chain with no natural predator of its own.
- They feed on tertiary consumers

(vi) Decomposers

Are organisms that occupy the sixth trophic level

- This trophic level includes bacteria and fungi such as bread mould(Rhizopus) Mucor and mushroom
- Decomposers feed on dead bodies of plants and animals by the process called decomposition.

The diagram below represents trophic levels in the ecosystem



Question: Why do the trophic levels form a pyramid shape or taper at the end?

- This is because energy flow decreases as it moves from one trophic level to the next

Reasons for why energy flow decreases as it moves from one trophic level to the next

- (i) Some energy lost as heat through sweating, urination or seavaporation.
- (ii) Some energy lost through respiration process.
- (iii) Not all parts of organism are eaten. Some parts of an organism are not eaten e.g. roots and bones.
- (iv) Some of the parts eaten are not digestible

FOOD CHAIN AND FOOD WEB

FOOD CHAIN

Is the liner flow of energy and nutrient from a producer to a decomposer in the ecosystem

OR

Is a diagrammatic representation, which shows a sequence of organisms through which the energy flows and each organism is the food of the next in the sequence.

OR

Is a sequence which shows who eats whom in a biological community.

Examples of food chains

- (i) Grass → Grasshopper → Bird → Hawk → Bacteria
- (ii) Algae → Zooplankton → Small fish → Large fish → Human being
- (iii) Phytoplankton → Zooplankton → Fish → Bird

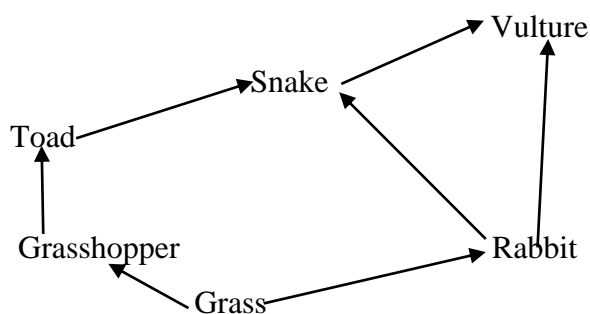
FOOD WEB

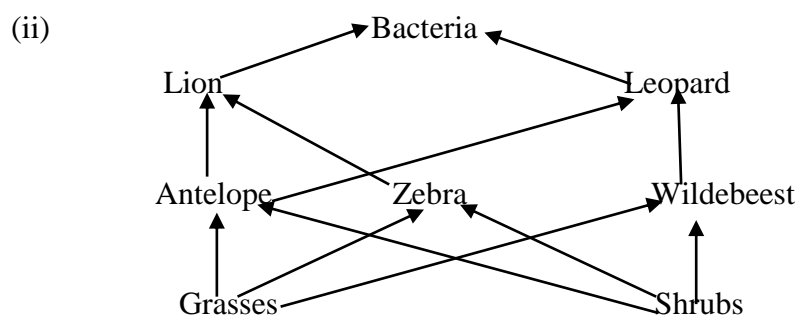
Is a network of several food chains interconnected together.

- Most organisms in food web have more than one source of food and other organisms are eaten by various consumers. This is the reason why, food web is more representative and more stable than food chain.

Examples of food webs

(i)





Components of food chain and food web

There are six components of food chain and food web, namely:-

- (i) Producer
- (ii) Primary consumer
- (iii) Secondary consumers
- (iv) Tertiary consumers
- (v) Quaternary consumers
- (vi) Decomposers

NB: In a food chain, energy flows start with a producer and ends with the top consumer or decomposer.

- A food chain may be short or long, but hardly beyond six links.
- The arrow \longrightarrow means “**eaten by**”.

For example: Grass \rightarrow Cow \rightarrow Lion. This means, Grass is eaten by cow and cow is eaten by human being

The difference between food chain and food web

Food chain	Food web
(i) It consists of only one straight chain.	It consists of two or many interconnected food chains
(ii) Each organism feed on one type of food.	Each organism feed on two or many types of food
(iii) It is less stable	It is more stable
(iv) It is very simple to be constructed	It is very complex to be constructed

The significance of food chain and food web in real life situation

The reasons of why food chain and food web are very important in a real life situation, because:

- (i) They facilitate the flow of energy in the environment.

(ii) They regulate the population of organisms in ecosystem.

(iii) They help in recycling of nutrients in the ecosystem.

REVISION QUESTIONS

1. Study the feeding relationship below and answer the questions that follow:

Grasses → grasshopper → frog → snake

(a) What is the name of the feeding relationship represented above?

(b) Name the organism which is a:-

(i) Primary producer

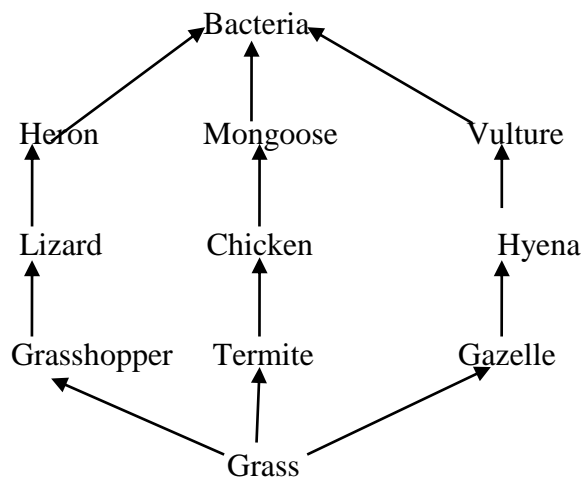
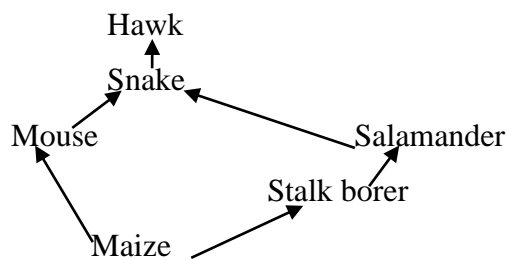
(ii) Primary consumers

(iii) Secondary consumer

(c) What will happen, if there are very few frogs in the feeding relationship represented above?

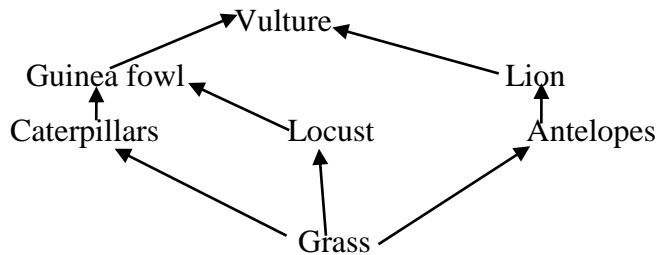
(d) Which group of organisms is not shown on the feeding relationship represented above?

2. The following are examples of food webs.

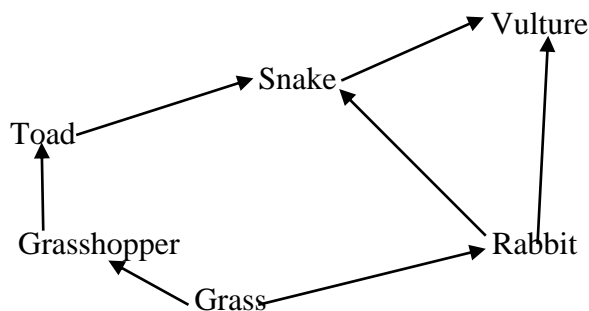


1. Construct a food web by using organisms named in the following list:
Lion, Guinea fowl, Vulture, Locust, Antelopes, Grass, and Caterpillars.

Answer



2. Construct the food relationship by using the following organisms: Snake, Grass, Toad, Grasshopper, Rabbit, and Vulture.



NECTA FORM TWO (2009)

Qn.6 (c) i. What is food web?

- ii) Construct a simple food web involving the following organisms: grasshopper, frog, grass, hawk and snake.
- iii) Which group of organisms is not shown on the food web diagram you have drawn? What is their importance to the food web.

NECTA FORM TWO (2010)

Qn.8 (a) What is a community?

- (b) (i) Distinguish a food chain from a food web
- ii) Explain two significances of food chains and food webs in real life situation.

NECTA FORM TWO (2011)

Qn.7 (a) what is natural environment?

- a) Explain the importance of the natural environment
- b) Explain two significances of food chains and food webs in real life situation.

NECTA FORM TWO (2012)

Qn.7 (a) Define the following terms:

- i) Ecosystem
- ii) Food chain

Explain the role of each of the following organisms in the ecosystem.

- i) Producers
- ii) Decomposers

(b) Explain the significance of food chain.

NECTA FORM TWO (2013)

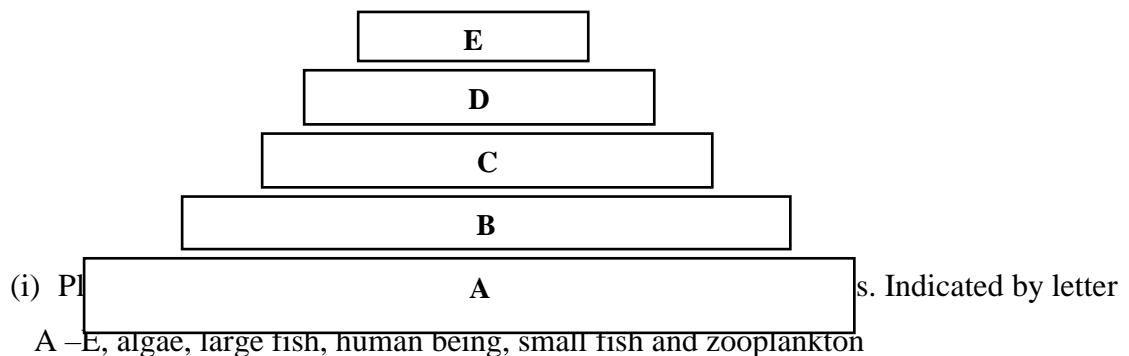
Qn6 (b) Why do the trophic levels form a pyramid shape?

2. (a) Define the following terms.

- (i) Trophic level
- (ii) Population
- (iii) Ecological niche
- (iv) Ecosystem
- (v) Herbivores

(b) Explain why food webs are more representative of feeding relationships than food chains.

3. Figure below represented a pyramid of numbers



- A. _____
- B. _____
- C. _____
- D. _____
- E. _____

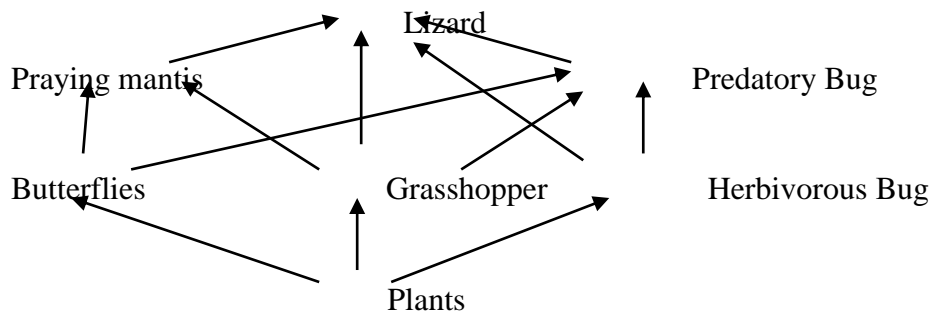
(ii) Give the name of highest trophic levels in this pyramid

(iii) Why do the trophic levels form a pyramid shape?

(c) Using the following organisms construct food chain: spinach, frog, Grasshopper, blank mamba and python.

4. The diagram below represents a feeding relationship in an ecosystem

The arrow \longrightarrow means “eaten by”



(i) What is the name of the feeding relationship represented above?

(ii) What does the sequence: ~~Plant~~ \longrightarrow ~~Grasshopper~~ \longrightarrow Lizard represent?

(iii) Name the organisms which are:-

Primary producers

Primary consumers

Secondary consumer

3. (a) Define the following terms used in the study of Balance of nature

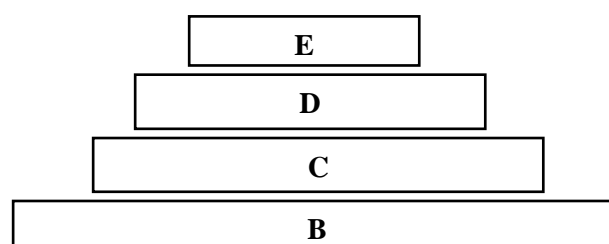
(i) Biotic component

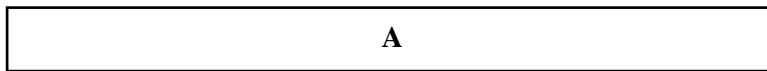
(ii) Abiotic component

(b) Give two examples of each of the following group of organism in trophic levels

S/N	Producers	Primary consumers	Decomposers

4. The diagram below represents the different trophic levels in the ecosystem. Study it and answer the questions that follow.





(a) Mention a trophic level represented by each letter in the diagram.

A. _____

B. _____

C. _____

D. _____

E. _____

(b) Why do the trophic levels form a pyramid shape?

(c) State the role of the organisms in the trophic level represented by the letter E in the diagram.

(d) Construct a feeding relationship which accommodates the following organisms:

Grasses, Goat, Sheep, Shrubs and Man

1. Grass → Zebra → Lion

2. Maize plant → Grasshopper → Frog

3. Phytoplankton → zooplankton → Fish → Bird

What would happen...?

i) If all predators will be removed from an ecosystem

ii) If all bacteria will be removed from an ecosystem

Answers:

i) **If all predators will be removed from an ecosystem,**

- There would be a huge increase in the number of preys and a huge decrease of producers.

ii) **If all bacteria will be removed from an ecosystem**

- There would be no decomposition of dead bodies of plants and animals hence there would be no recycling of nutrient.

4. Why Green plants are known as producers?

Green plants are known as producers because they make food from simple substances

