BIOLOGY NOTE (SS 1)

FIRST TERM 2024/2025 SESSION

SCHEME OF WORK

Lesson One: DEFINITION OF TERMS
Lesson Two: SCIENTIFIC METHODS OR PROCESS OF SCIENCE
Lesson Three: THE MICROSCOPE

Lesson Four: LIVING AND NON-LIVING THINGS

Lesson Five: MAJOR SOURCES AND FORMS OF ENERGY

Lesson Six: NUTRITION

Lesson Seven: RELIVANCE OF BIOLOGY TO AGRICULTURE

Lesson One
DEFINITION OF TERMS

WHAT IS SCIENCE?
Science is defined as the body of knowledge, a way of thinking, a way of investigating in pursuit of understanding of the way of nature. It is also defined as a systematic process of making enquiry about the living and non- living in our environment

WHAT IS BIOLOGY?
Biology is defined as a branch of science that deals with the study of life i.e. living organisms (plants and animals). It also involves the study of the structure, behaviour and origin of these living organisms and their relationship with their environment. The word biology is derived from two Greek words, 'bio' meaning life and 'logy' meaning to study. There are two main branches of biology;

A. Botany: This is the branch of biology that deals with the study of plants.

B. Zoology: This is the branch of biology that deals with the study of animals.

Other branches of biology include;

1. Ecology: This is the branch of biology that deals with the study of how plants and animals interact with the environment.

2. Embroyology: This is the branch of biology that deals with the early development of plants and animals.

3. Microbiology: This is the branch of biology that deals with the study of microorganisms.

4. Histology: This is the branch of biology that deals with study of living tissues seen under a microscope.

5. Entomology: This is the branch of biology that deals with the study of insects.

6. Anatomy: This is the branch of biology that deals with the internal structure of a living organism.

7. Physiology: This is the branch of biology that deals with the study of how the body of plants and animals functions.

8. Parasitology: This is the branch of biology that deals with the study of parasites

9. Genetics: This is the branch of biology that deals with the study of heredity and variation.

10. Morphology: This is the branch of biology that deals with the study of external features of plants and animals.

11. Cytology: This is the branch of biology that deals with the study of cell biology.

12. Mycology: This is the branch of biology that deals with the study of fungi.

13. Evolution: This is the branch of biology that deals with the study of origin of species of living things.

Lesson Two

SCIENTIFIC METHODS OR PROCESS OF SCIENCE

Scientific methods or processes involve;

1**. Observation**: To observe in science means more than mere looking at something. It means looking carefully with a view of finding answer to a particular question. It can be in varieties of ways like using senses to describe what is seen or felt about a particular problem or problems and also the use of indirect methods.

2**. Classification**: It means sorting things into groups which they belong based on your observation. Classification is the collection of data, comparison and measurement.

3**. Formation of hypothesis**: From what you observed and classified, you can identify the existing problem and use it to form tentative answer(s) (hypothesis).

4. **Testing of hypothesis by experiment**.

5**. Formation of theory**: Theory can be formed when hypothesis is tested repeatedly by experimentation, if found to be true, it now becomes a theory.

6. A theory that have been extensively tested and proven to be true then becomes a **law**.

An experiment is reported on the format given below;

1. **Aim**: This is to state the purpose of the experiment.
2. **Apparatus or material**: This includes materials that will be used for the experiment.
3. **Method or procedures**: This is to describe in details the process that will be used during the experiment.
4. **Observation**: This records what we have seen during and after the experiment has been set up.
5. **Conclusion**: This is to show or tell us what we can say about the observation or outcome of the whole experiment. We can draw our conclusion from the experiment.

Note: In performing an experiment, control experiment and precautions are very important.

Control experiment: This is the experiment designed to eliminate all bias so as to avoid making false conclusions. To do this, all the factors affecting the result of the experiment must be kept constant except the ones that are being tested.

DEFINITION OF SOME TERMS

1. **Hypothesis**: It is a tentative guess or explanation for obtaining behaviour or event which have taken place or will take place.
2. **Theory**: It is a carefully constructed system of logical rhythms with regards to the basic nature of the physical world.

3**. Law or principle**: It is a statement predicting interrelationship among concepts.

USEFULNESS OR IMPORTANCE OF SCIENCE

1. Science and technology has helped man to understand the structure of his body and how it works as well as what he needs to keep him/her healthy.
2. In medicine, science has contributed greatly to the manufacturing of vaccines and drugs that are use today to cure various diseases.

3. In agriculture, scientific knowledge has helped man to increase food production and improve food preservation. Mechanization has helped to put more land under cultivation.

4. Transportation: Today, people travel long distances by cars, jets, trains, ships etc. rather than by foot or horse backs which helps to increase the speed of people travelling today.

5. Science and technology has made it possible for us to communicate by telephone (GSM), electric media such as E- mail, internet etc. At home, it helps in many household works e.g. washing machine.

6. New breeds of animals and varieties of crops have been developed and this has helped to increase food production.

8. Biology is also applied in biotechnology which includes fields like genetic engineering and hybridoma which have helped in the production of antibiotics.

9. Production of Single Cell Protein (SCP) by microorganisms which have saved many from dying of protein deficiency.

Lesson Three

THE MICROSCOPE

The microscope is an instrument used in the laboratory to view tiny organisms which cannot be seen or observed with the naked eyes. It is for magnifying or enlarging organisms which the naked eyes cannot see.

Types of microscope

1. Compound microscope
2. Light microscope
3. Electron microscope
4. Hand lens

Parts of microscope

1. **<u>The mirror</u>**: It helps to reflect light rays unto the specimen, so that the specimen can be seen properly.
2. **<u>The base</u>**: It enables the microscope to rest properly on the table.

3. **The stage**: this is a flat surface or platform where slides or mounted specimen are placed.
4. **Clips**: They help to hold the specimen for proper viewing.
5. **Handle or arm**: Used to carry the microscope.
6. **Condenser**: This is used to focus light rays from the mirror or light source unto the specimen.
7. **Rotatory nasal piece**: This is where the objective lens of varying magnification are fitted. It can be rotated in order to turn on the objective lens with a better magnification.
8. **Eye-piece lens**: This is used for magnifying the specimen and also for viewing the mounted specimen.
9. **Fine adjustment knob**: It helps to focus image sharply and also to focus the lens on the specimen.
10. **Coarse adjustment knob**: This is used to bring the specimen or object into proper focus.
11. **Objective lens**: It is usually placed slightly above the object and it is for magnification.

DIAGRAM OF MICROSCOPE

How to use the Microscope

1. Carry the microscope gently with its handle.
2. Cleanse the microscope gently with soft linen.
3. Adjust the mirror in the direction of light in order to catch and direct the rays of light into the microscope.
4. Where necessary, open the lid of the condenser.
5. Place the slide of the object to be viewed on the stage.
6. Proper adjustment is made on the objective lens so as to rest on the slide carefully to avoid cracking of the slide or shaking of the object. Start with lower power lens, then increase to higher power lens.
7. Adjust the coarse knob to bring the object into focus.
8. Then use the fine adjustment knob to make the object sharper for a clearer view.
9. The object or specimen is then examined carefully and all observations recorded.

Uses or Importance of microscope

1. It is used to view tiny micro-organisms, that our naked eyes cannot see.
2. It is used for cellular and tissue analysis

3. It is used to view and understand the microbial world of bacteria and the virus.
4. It is used for evaluating forensic evidence e.g. DNA, fingerprint, blood stain and pattern analysis.
5. It is used to achieve high magnification of objects.
6. It is used for studying atomic structure

Care of the microscope

7. By cleaning or dusting regularly.
8. By keeping in a dry/safe place
9. By correct and good or proper handling.
10. By covering it.

Lesson Four
LIVING AND NON-LIVING THINGS

Matter

Matter is defined as anything that has weight and occupies space. Based on this, matter is divided into two;

1. Living things
2. Non- living things

The features used to distinguish living things from non- living things are known as characteristics features of living things. They are;

1. Respiration
2. Irritability
3. Growth
4. Movement
5. Excretion
6. Nutrition
7. Reproduction

Others are;

I. Competition
II. Adaptation
iii. Life span/ death

All living things are capable of carrying out the following characteristics and they are;

A. Plants e.g. Spirogyra, moss plant, mango plant, maize plant, etc.
B. Animals e.g. amoeba, tapeworm, earthworm, prawn fish, dog, man etc.

On the other hand, non- living things cannot carry out the above seven characteristics.

THE CHARACTERISTICS FEATURES OF LIVING THINGS

1**. Excretion**: All living organisms are capable of removing waste product of metabolism such as CO_2, urine, bile pigment and other nitrogenous compound.
Excretion is defined as the removal of waste products of metabolism from the cell or body of living organisms.

2**. Movement**: It means change in position which could be total as in animals (moving from one place to another) or limited (as in plants which only move in response to stimuli/ stimulus). Passive movement is movement done by non- living things with the aid of a living thing.

3. **Respiration**: All living things respire. Respiration can therefore be defined as the process that occurs in living organisms whereby oxygen is used to oxidize or breakdown glucose to give us energy for daily (metabolic) activities and at the same time, water vapour and carbon dioxide is given off as a by-product.

4**. Nutrition**: Nutrition simply means the ability to feed. All living organisms need food to survive and also to build up body and provide energy for daily activities. Generally, animals cannot manufacture their own food but depend on plants for their food, so therefore, they are called heterotroph. Plants can manufacture their food through a process called photosynthesis hence autotroph.

5. **Growth**: All living organisms are capable of increasing in size and mass. Growth is defined as the irreversible increase in mass and size as a result of food intake and cell division.

6**. Irritability**: All living things are capable of detecting changes in the environment. Irritability is the ability of an organism to respond to changes in their environment. The change may be internal or external.

7. **Reproduction**: It is the process by which matured living organisms produce new individuals of the same species or kind in order to ensure the continuity of life.

8**. Competition**: This is the ability of living organisms to struggle for all necessity of life in their environment.

9**. Adaptation**: This is the ability to adjust to changes in the environment for survival.

10**. Life span/ death**: All living organisms have definite period of existence i.e. all organisms die.

DIFFERENCES BETWEEN PLANTS AND ANIMALS

PLANTS	**ANIMALS**
1. Plants can manufacture their own food, so they are called autotroph	Animals cannot manufacture their own food, they depend on plants for food, hence heterotroph
2. Plants respond slow to external stimuli	Animals respond very fast to external stimuli
3. Growth in plants is indefinite and apical	Growth in animals is definite and occurs uniformly
4. Plant stores excess glucose/ carbohydrate as starch except in fungi which stores glucose in form of glycogen	Glucose/ carbohydrates are stored as glycogen and fat.
5. Plants have rigid cellulose cell wall	Animals do not have cellulose cell wall
6. Plant cell has large vacuole	Animal cell don't have large vacuole. They have little or no vacuole
7. Chloroplast or chlorophyll present in plant cell	Chloroplast/chlorophyll absent in animal cel

8. They have no sense organs	They have sense organ
9. They have many branches	They don't have many branches
10.Plants are not active and have no organ for movement	Animals are active and have organs for movement

CLASSIFICATION OF LIVING THINGS

Classification of living things is defined as a system of placing living things into groups that have certain features in common which distinguish them from other groups. The system of classification and naming organisms used today is based on the work of a scientist called Carl Linnaeus or Carolus Linnaeus.

Reasons for classification of living things

1. To place every living organism into a systematic order/specific group.
2. For easy identification of similar living things.
3. To show the relationship between different categories of living organism.
4. To show evolutionary trends in different groups of living organisms.
5. For easy research.
6. For easy referencing.

What is taxonomy?

It is the branch of biology which deals with the classification of living things based on resemblance and differences of form and shapes. In other word, taxonomy is the science of classification.

Hierarchy of living things

Kingdom
↓
Phylum (animals)/division (plants)
↓
Class
↓
Order
↓
Family
↓
Genus
↓
Species

Sometimes intermediate levels are added. These are usually identified suffix such as sub, super e.g. sub order, sub phylum, superclass.

What are species?

Species are the smallest, basic unit of classification of living things which contains groups of related organisms with largest number of common features and usually interbreed among themselves to produce fertile offspring. Members from different species cannot interbreed.

HIERACHY OF LIVING THINGS	HUMAN	LION
Kingdom	Animalia	Animalia
Phylum	Chordata or vertebrata	Chordata or vertebrata
Class	Mammalia	Mammalia
Order	Primate	Carnivora
Family	Hominidae	Felida
Genus	Homo	Panthera
Species	Sapiens	leo

BINOMINAL NOMENCLATURE

Linnaeus also introduced a system of naming living things by giving two names of an organism known as Binominal Nomenclature (system of giving two names to an organism). Linnaeus each plant and animal two names. They are;

1. **Generic name**: The name of genus to which the organism belong (very much like our surname). It begins with a capital letter and is written before the specific name.

2**. Specific name**: That is the species to which the organism belongs (very much like our first name). It begins with a small letter.

NAMES OF GENERIC AND SPECIFIC OF SOME ORGANISMS

COMMON NAMES	GENERIC NAME	SPECIFIC NAME
Housefly	Musca	domestica
Amoeba	Amoeba	proteus
Cat	Felix	catus
Tiger	Felix	tigeris
Rat	Rattus	rattus
Plaintain	Musa	sapientum
Banana	Musa	paradisiocal
Maize	Zea	mays
Afrcan elephant	Loxodonta	africana
Man	Homo	sapiens
Dog	Canis	familiaris
Mango	Mangifera	indica
Lion	Panthera	leo

Dichotomous key: Is the grouping of organisms based on the difference in their character, the grouping at each steps is made based on a single character that is presented in one group and the character is absent in another group.

Number of dichotomous key for identifying vertebrates

1. Hair (i). Has hair e.g. man

(ii). Have no hair e.g. fish

2. Fins (i). Have fins e.g. fish

(ii). Have no fins e.g. dogs

3. Feathers (i). Have feathers e.g. birds

(ii). Have no feathers e.g. Lizards

4. Scales (i). Have scales e.g. Lizard, fish, crocodile, birds

(ii). Have no scales e.g. man

Linnaeus placed all living organisms into two Kingdoms:

(i) Plantae (plants)
(ii) Animalia (Animals)

But many one –celled organisms could not fit in properly. The modern classification put all living things into five Kingdoms;
1. Kingdom Monera
2. Kingdom Protista
3. Kingdom Fungi
4. Kingdom Plantae
5. Kingdom Animalia

1. Kingdom Monera

These are single- celled, motile or non- motile organisms. They are prokaryotic cells (i.e. their cells do not have a definite nucleus, no nuclear membrane and no cellular organelles) e.g. Blue- green algae (Nostoc), bacteria and viruses.

2. Kingdom Protista

These are single- celled, motile or non- motile organisms. They are eucaryotes i.e. their cells have definite nucleus, bounded by nuclear membrane and cellular organelles.

Some protists are plant- like and are known as protophyta; they have cellulose cell wall and organelles (chloroplast) e.g. chlamydomonas, chlorella, diatoms e.t.c

While others are animal- like and are called protozoa; they feed on already manufactured food and have no cellulose cell wall e.g. Amoeba, Paramecium, and Euglena e.t.c

3. Kingdom fungi

These are mainly non- motile organisms made up of thread- like structure or hyphae containing many nuclei. The hyphae has a cross wall, rigid and made up of mainly chitin e.g. moulds, mushroom, slime moulds

4. Kingdom Plantae

These are eucaryotes. They are many celled, non-motile organisms which contains green pigments/chlorophyll that enables them to make their own food by photosynthesis e.g. Mosses, Pines, Ferns, Oil palms, Bean plant e.t.c.

5. Kingdom Animalia

These are eucaryotes. They are multicellular, motile organisms that cannot make their own food but feed on already manufactured food made by plant. E.g. worms, insects, Toad, Snake, Rat, man e.t.c.

The above five Kingdoms way of classification of organism still present problem e.g. **Lichen** is made up of a fungus and a protist, so where does it fit in?

For the above reason, we still hold on to Linnaeus classification of living organisms where living organisms were placed in two Kingdoms i.e.

1. Kingdom Plantae which includes all plants both green and non-green plants.
2. Kingdom Animalia which include all vertebrates and invertebrates.

CLASSIFICATION OF LIVING THINGS BY LINNAEUS

All living things are classified into two main Kingdoms which are

1. Kingdom Plantae (plants)
2. Kingdom Animalia (Animals)

The plants and animals are divided into phyla/divisions

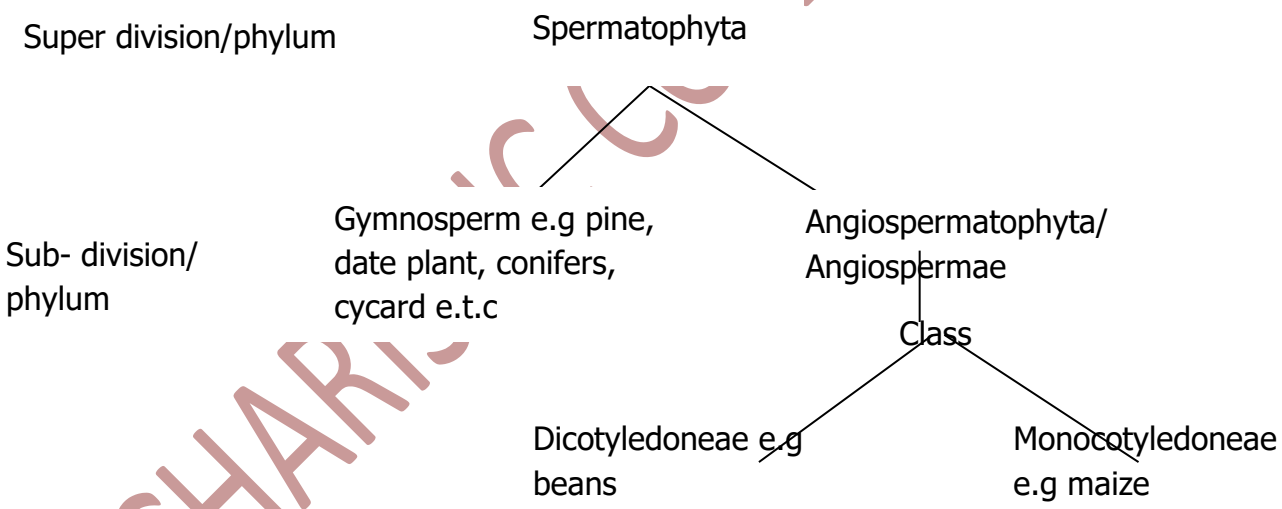
Kingdom Plantae

Non vascular plant

i. Division: Schizophyta e.g. bacteria, nostoc (blue green algae)
II. Division: Thallophyta e.g. spirogyra, rhizopus
III. Division: Bryophyta e.g. Moss plant

Vascular plant

I. Division: Pteridophyta e.g. fern plant
II. Division: Spermatophya



CLASSIFICATION OF ANIMALS

(Invertebrates)

1**. Phylum Protozoa** e.g

a. Amoeba - class sarcodina - Rhizopodia (pseudopodia)
b. Euglena- class mastigophora - flagella
c. Paramecium class ciliata - ciliophora (moves with cilia)
d. Plasmodium - class sporozoa - no organelle for movement
e. Trypanosoma/ Trichomonas - class mastigophora

2**. Phylum Porifera e.g. sponges**

3**. Phylum Coelenterata e.g**

a. Hydra - class Hydrozoa

b. Jelly fish – class Scyphozoa
c. Sea Anemone - class Anthozoa

4. **Phylum Platyhelminthes (flatworm**) e.g
a. Tapeworm (Teania solium) - class cestoda
b. Planaria - class Turbelleria
c. Liver flukes (Fasciola gigantica) - class trematoda
d. Blood flukes (Schitosoma) - class trematoda

5. **Phylum Nematoda (roundworm**) e.g
a. Ascaris
b. Thread worm
c. Filaria worm
d. Hook worm
e. Guinea worm

6. **Phylum Mollusca e.g**
a. Snail- class Gastropoda
b. Aspatharia Sinuata- class Bivalvia
c. Cuttle fish sepia- class cephalopoda
d. Octopus – class Cephalopoda
e. Mussels – Pelecypoda

7. **Phylum Annelida e.g**
a. Earthworm class Oligochaeta
b. Sea worm, Neresis – class Polychaeta
c. Tube worm
d. Leech – class Hirudinean

8. **Phylum Arthropoda**
(i) Class insecta
a. Cockroach- order Dictyoptera
b. Housefly and Mosquito- order Diptera
c. Grasshopper – order Orthoptera
d. Termite – order Isoptera
e. Butterfly – order Lepidoptera
f. Dragon fly – order Odonata
(ii) Class Crustacea
a. Prawn- order Decapoda
b. Crab – order Decapoda
c. Crayfish – order Decapoda
(iii) Class Arachnida
a. Spider
b. Scorpion
c. Mites
d. Ticks
(iv) Class Myriopoda
a. Millipedes – order Diphopoda
b. Centipedes – order Chilopoda

9. **Phylum Echinodermata**

a. Urchines – class Echinaidea
b. Sea cucumber – class Holothuroidea
c. Starfish and bristle star

10. **Phylum Chordata/vertebrata**

a. Class Osteichthytes/ pisces e.g. fishes
b. Class Amphibia e.g. toad, frog, newts
c. Class Reptilia (reptiles) e.g. Lizard, Snake
d. Class Aves (birds) e.g. Pigeons, domestic fowl
e. Class Mammalia (mammals) e.g. dog, man, cat

CHARACTERISTICS FEATURES OF PHYLUM SHIZOPHYTA

1. They are microscopic and consist of one cell only.
2. They are monera, prokaryotic i.e. it has no true definite nucleus and organelles.
3. It has one strand of DNA (Deoxy-ribonucleic Acid) and reproduces by asexual means (binary fission).
4. They are non-green plants e.g. bacteria, virus, blue green algae e.t.c.

DIAGRAM OF VIRUS

FEATURES OF VIRUS AS IVING THINGS

1. It has protoplasm/protein coat.
2. It contains DNA/RNA/ nucleic acid

FEATURES OF VIRUS AS NON-LIVING THINGS

1. It appears as crystals.
2. It lacks organelles.

DIAGRAM OF BACTERIA CELL

DIAGRAM OF YEAST CELL

CHARACTERISTIC FEATURES OF PHYLUM THALLOPHYTA

The thallophyta are non-vascular plants with definite shape. They are eucaryotes. Members of thallophyta are the fungi, algae and lichens.

Note: Lichens are formed from an association between an algae and fungus where both of them benefits. They grow on rocky surfaces and tree trunks.

A**. Fungi characteristics**

1. They are eucaryotes and simple multicellular organisms
2. They have no true roots, stems and leaves
3. They are non- green plant i.e. they lack chlorophyll
4. They are mainly saprophytes while others are parasitic
5. The vegetative part of the body is made up of fine and delicate thread called hyphae
6. They reproduce asexually by means of spores
7. They are found in moist environment. Examples are Rhizopus, mucor, mushroom, penicillium, yeast, Phytophthora and puccinia (parasitic)

Rhizopus - Class Zygomycotina
Mushroom - Class Basicliomycotina
Yeast - Class Ascomycotina

DIAGRAM OF RHIZOPUS

MUSHROOM

The mushroom is an example of fungi. Its habitat is dead wood/ plants, moist tree trunks and decaying leaves. The main characteristic features of the mushroom are;

1. Rhizoid/ false root/hyphae/ mycelium; for anchorage
2. Stipe- a stem like structure which bears the pileus
3. Annulus- It is a ring like structure around the upper end of the stipe.
4. Gills/ Lamallae: Found in the pileus which contains spores for reproduction
5. Pileus/ Cap: Is umbrella- shape cap that bears the gills.

DIAGRAM OF MUSHROOM

B**. Algae characteristics**

1. They are simple microscopic green plants and can synthesize their food.
2. Some are unicellular e.g. (chlamydomonas) while others are multicellular e.g. spirogyra.
3. They have on true roots, stems and leaves.
4. They are mainly found in stagnant waters, pond etc. (aquatic plants)
5. Algae are filamentous and the cells are not differentiated into tissues
6. They reproduce both by sexual and asexual reproduction.
7. They have cellulose-cell walls. Examples are chlamydomonas, volvox, diatom, spirogyra e.t.c.

DIAGRAM OF SPIROGYRA CELL

Functions of the following parts;

A. **CHLOROPLAST:** It helps in the production of chlorophyll which absorbs light for photosynthesis.
B. **PYRENOID**: For storage of starch
C. **NUCLEUS**: It controls the activities of the cell.
D. **MUCILAGE**: It prevents desiccation/drying

DIFFERENCES BETWEEN SPIROGYRA AND RHIZOPUS

Spirogyra	Rhizopus
Filamentous/thread-like cell joined end to end	Cells are branched.
Septate/cellular	Non-septate
Chloroplast present	Chloroplast absent
Sporangia/spores absent	Sporangia/spores present
Sporangiophores absent	Sporangiophores absent

CHLAMYDOMONAS

Chlamydomonas is a primitive plant having animal- like features. It is a unicellular organism.

DIAGRAM OF CHLAMYDOMONAS

Plant- like features of chlamydomonas

1. Cellulose-cell wall for protection and maintaining a definite shape.
2. Cup–shape chloroplast for trapping sunlight for photosynthesis
3. Pyrenoid for the storage of starch

Animal –like features of chlamydomonas

1. Flagellum for movement
2. Contractile vacuole for osmo- regulation
3. Eye spot sensitive to light.

CHARACTERISTIC FEATURES OF PHYLUM BRYOPHYTA

I. They are complex multicellular green plants. Their cells are differentiated into tissues.
ii. They lack true root, stems and leaves but have structure resembling roots, stems and leaves.
iii. They are non- vascular plants; found growing on damp surfaces of drainage, wet walls, damp tree trunks.
iv. Some bryophytes are terrestrial while others are aquatic.
v. They exhibit asexual reproduction by spores found inside capsule in which there is alternation of generation i.e. sporophyte generation and gametophyte generation (dominant moss plant). Examples are mosses and liverwort.
Moss- class musci
Liverwort- class Hepatica

DIAGRAM OF MOSS GAMATOPHYTE BEARING A SPOROPHYTE

CHARACTERISTIC FEATURES OF PHYLUM PTERIDOPHYTA

1. They are multicellular and vascular green plants.
2. They have true roots, stems and leaves.
3. They are non-flowering plants.
4. They are mainly terrestrial pants while a few are aquatic.
5. They do not produce seeds and reproduce asexually by spores found in sori at the back of their leaves.
6. They also exhibits alternation of generation in their life cycle.
7. The stem is called rhizome while the leaves of fern are known as fronds.
8. The mature of a gametophyte is called prothallus. It is the heart- shaped and bears the sex organs in which eggs and sperms are produce.

Examples of ferns and are dryopteris, felimas and water ferns.

DIAGRAM OF MATURED GAMETOPHYTE (FERN PLANT)

CHARACTERISTIC FEATURES OF SPERMATOPHYTA

1. They are multicellular, seed producing flowering plants.
2. They are vascular plants and have well developed vascular tissue.
3. They have true roots, stems and leaves.
4. They reproduce sexually and asexually.
5. They are terrestrial green plants

Spermatophyta can be divided into two main sub-divisions;

i. Gymnosperms.
ii. Angiosperms.

CHARACTERISTIC FEATURES OF GYMNOSPERMS

1. They are plants with naked seeds.
2. They do not bear flowers.
3. Their seeds are borne on special structures called cones
4. They are vascular green plants. Examples are pines, cycads, gingkos, conifers.

CHARACTERISTIC FEATURES OF ANGIOSPERMATOPHYTA

1. They are the most complex green flowering plants.
2. They are vascular plants.
3. They have seeds which are enclosed in the fruits. Seeds develop from the ovules which are enclosed in the ovary.
4. Reproduction is both sexual and asexual.
5. They are mainly terrestrial plants.

DIFFERENCES BETWEEN ANGIOSPERMATOPHYTA AND BRYOPHYTA

Angiospermatophyta	**Bryophyta**
1. True stem present	It lacks true stem
2. They have true leaves	Lack true leaves or leaf- like structure
3. They reproduce by flower or seeds	They reproduce by spores contained in capsules
4. They have true and well developed roots	They have rhizoid or have no true roots

DIFFERENCES BETWEEN GYMOSPERMS AND ANGIOSPERMS

Gymnosperms	**Angiosperms**
1. They do not bear flower	They bear flower
2. Seeds are naked	Seeds are enclosed
3. Seeds are born on cones	Seeds develop from ovules which are enclosed by ovary

Angiosperms can be subdivided into classes according to the number of seed leaf/cotyledons. These are dicotyledonous (two seed leaves) and monocotyledonous plants (one seed-leaf).

DIFFERENCES BETWEEN MONOCOTYLEDONS AND DICOTYLEDONS

Monocotyledonous plants	**Dicotyledonous plants**
1. They have one cotyledon or seed leaf.	They have two cotyledons or seed leaves.
2. They have fibrous root system	They have tap root system
3. The leaf have parallel venation	The leaf has net/ reticulate venation
4. Leaf sheath present	Leaf sheath absent

5. Leaf stalk absent	Leaf stalk present
6. Shallow/ surface root system	Deep root system
7. Long narrow leaves	Rounded broad leaves
8. Anther hangs out of flower	Anther carried by corolla
9. Exhibit hypogeal germination	Exhibit epigeal germination
10. Cambium absent in the vascular bundle of monocotyledon	Cambium present in the vascular bundle of dicotyledon

BODY SYMMETRY

Symmetry in biology is the balanced distribution of duplicate body parts or shape within the body of an organism. Animals can also be classified based on their body symmetry.

Body symmetry means that the body has similar or corresponding parts in shape, size and position on opposite sides of a dividing line or about a centre or axis.

Types of body symmetry

1. Asymmetrical: These are organisms that cannot be divided into equal plane along any axis i.e. no plane of symmetry. E.g. primitive organisms like sponges (porifera).
2. Radial symmetry: In this, the body of the organism can be cut along its axis or vertically from any plane to give two identical halves e.g. coelenterates (hydra).
3. Bilateral symmetry: This is where the body of the organism can be cut along its axis or vertically in only one plane to give two identical halves e.g. Tapeworm, earthworm, ascaris, insects, fish, man e.t.c.
4. Spherical symmetry: This occurs in an organism if it is able to be cut into two identical halves through any cut that runs through the organism's centre e.g. fresh water green alga volvox.

BODY CAVITY

Embryo of an animal when developing, the primary layer of the cells (i.e. the germ layers) differentiates to form various tissues.

The tissues of some animals are derived from two germ layers (i.e. ectoderm and endoderm) while some of most animals are derived from three (i.e. the ectoderm, mesoderm and endoderm).

The organisms with two body layers are called **diploblastic** e.g. hydra and those with three body layers are referred to as **triploblastic** e.g. tapeworm, earthworm, insects, fish, toad, man e.t.c.

The triploblastic organisms can also be classified based on the presence or absence of the body cavity or coelom. They are;
1. Acoelomate: Animals without body cavity (i.e. no space between ectoderm and endoderm, just the solid mesoderm hence no room for increase in size).
2. Pseudocoelomate: Animals with false body cavity (body cavity not entirely bounded by mesoderm).
3. Coelomates: Animals with true body cavity i.e. entirely bounded by mesoderm.

Importance of Coelom/ body cavity in the structural development of organism

1. It allows the animal to grow bigger and provide space for organs inside the body to enlarge.
2. The body wall and gut wall work independently as they are separated by the coelom.
3. The fluid in the Coelom can transport food, oxygen and waste products

Phylum	Coelom	Body symmetry	Germ Layer
1. Porifera	None	Asymmetrical	Diploblastic
2. Coelenterata	None	Radial	Diploblastic
3. Platyhelmithes	None	Bilateral	Triploblastic
4, Nematoda	Pseudocoelom	Bilateral	Triploblastic
5. Annelida	Coelom	Bilateral	Triploblastic
6. Mollusca	Coelom	Bilateral	Triploblastic
7. Arthropoda	Coelom	Bilateral	Triploblastic
8. Echinodermata	Coelom	Bilateral	Triploblastic

CLASSIFICATION OF ANIMALS

Animals can be classified into two main groups, invertebrates (animals without backbones) and vertebrates (animals with back bones) or vertebral column.

Phylum Protozoa characteristics

1. They belong to the group of organisms, Protista.
2. They are eucaryotic, microscopic and unicellular.
3. They reproduce asexually by binary fission.
4. They are aquatic organisms and few are parasitic e.g. Amoeba, paramecium, trypanosome and plasmodium.

DIAGRAM OF AMOEBA PROTIST

DIAGRAM OF PARAMECIUM CELL

Euglena is an animal but have plant-like features.

ANIMAL-LIKE FEATURES OF EUGLENA

1. Eye spot or stigma for sensitivity
2. Gullet for ingestion of solid food
3. Contractile vacuole for osmoregulation
4. Flagellum for movement
5. Pellicle for protection

PLANT-LIKE FEATURES OF EUGLENA

1. Star-shaped chloroplast to trap sunlight for photosynthesis.
2. Paramylon granule for storage of starch

DIAGRAM OF EUGLENA

2. **Phylum Porifera characteristics**

i. They are primitive multicellular organisms with asymmetrically bodies

ii. All are aquatic; they do not move around but live in colonies. The larval stage is usually motile

iii. They reproduce asexually and sexually but most of them are hermaphrodites e.g. sponges.

DIAGRAM OF SPONGES

3. **Phylum Coelenterata characteristics**

i. They are multicellular organisms.

ii. The body is made up of two layers (diploblastic).

iii. They are radial symmetrical

iv. They have tentacle and stinging cells used for capturing food.

v. They reproduce asexually by budding.

vi. They have soft jelly- like bodies and are mainly aquatic organisms.
Examples include Hydra, jellyfish, Sea anemones and coral.

DIAGRAM OF HYDRA

4. **Phylum Platyhelminthes (flatworm) characteristics**

1. They are elongated and flat.
2. They are bilaterally symmetrical.
3. They are triploblastic i.e. they have three body layers; ectoderm, mesoderm and endoderm.
4. They are hermaphrodite and reproduce sexually.
5. They do not have body cavity or lumen.

Examples; tapeworm, planaria and liverflukes.

DIAGRAM OF TAPEWORM

PHYLUM NEMATODA (ROUND WORM)-CHARACTERISTICS

1. The body is round and cylindrical with pointed ends.
2. They are bilaterally symmetrical.
3. Some are parasitic while others are free-living.
4. Some are hermaphrodites while others reproduce sexually.
5. The body is made up of three layers and they lack body cavity.

Examples round worms, hook worms, guinea worms, thread worms, ascaris e.t.c.

DIAGRAM OF ASCARIS

6. Phylum Annelida: characteristics

i. The body is long and cylindrical.
2. They have internal and external segmented bodies.
3. Their excretory organs are called nephridia.
iv. Their organs for movement is called chaetae.

v. They have true body cavity or Coelom.
vi. Some are aquatic while others are terrestrial.
vii. The alimentary canal has two openings, the mouth and anus.
viii. They reproduce and many are hermaphrodites.
xi. Their bodies are made up of three layers.
Examples are earthworm, leeches, tubeworm.

THE EARTHWORM (Lumbricus terretris)

The earthworm is the most familiar of all annelida. It belongs to the class Oligochaeta.

The natural habitat of the earthworm includes moist or wet soil, damp or wet farmland. It is a nocturnal animal and so very active at night in search of food.

Characteristics of earthworm

i. The body is cylindrical, internally and externally segmented.
ii. Presence of chaetae or bristles for movement.
iii. Presence of clitellium which secretes cocoon that contain eggs.
iv. They are bilateral symmetrical.

Economic importance of earthworm

i. They aerate the soil and also loosen the soil particles by their burrowing activities.
ii. Improve soil fertility by dragging humus into their burrows.
iii. Used as bait in fishing and food for some birds.
iv. Worms cast add to soil nutrient.
v. They help in mixing the top soil and sub soil for better quality of soil.

Adaptive features of earthworm

i. Presence of chaetae/seatae for movement
ii. Moist skin for gaseous exchange.
iii. Pointed anterior for burrowing into the soil.
iv. Slimy body reduces friction during movement.
v. Clitellum secretes cocoon.

DIAGRAM OF EARTHWORM

7. Phylum Mollusca: characteristics

i. They have soft unsegmented bodies.
ii. They are bilaterally symmetrical.
iii. Their body is covered by a soft tissue called mantle.
iv. Some have calcereous shells e.g. snails while others have no shell e.g. octopus and slug.
v. They have tentacles bearing eyes. They are used for sensitivity.
Examples are squids, mussels, periwinkles, snails, oysters, octopus, slug e.t.c.

The giant land snail (Achatina achatina)

The land snail is a typical example of mollusca. It is found in damp places under leaves, tree stumps and stones. They are plentiful during the rainy seasons.
Its general characteristics include;

a. A distinct head, foot and body.
b. The body is covered by a shell.
c. It has two pairs of tentacles (each bears the eyes) on the head which is for sensitivity.
d. It has radula(tongue) which is used to rasp food material into tiny bits.
e. The body is covered by mantle which secretes the shell
f. At the boundary of shell and foot is the collar which contain special gland cells which secretes the calcium carbonate of the shell.

The snail feeds mainly on green vegetation. Snails are nocturnal animals that hide in dark damp places during the day and come out to feed at night. It moves by the muscular movement of the foot.

Economic importance

i. They damage crops and garden plants.
ii. Some snails (e.g. water snails) are carriers of diseases like bilharzia and others are hosts to liverflukes.
iii. They are source of protein

DIAGRAM OF SNAIL

8**. Phylum Arthropoda**

This is the largest phylum in the animal kingdom. Members include all insects, spiders, crabs, centipede e.t.c.

The phylum is divided into four class;

i. Class insecta; e.g. butterflies, ants, bees, wasps e.t.c
ii. Class Arachnida; e.g. spiders, scorpions, ticks e.t.c
iii. Class Crustacea; e.g. Prawns, crabs, lobsters e.t.c
iv. Class Myriapoda; e.g.centipedes and millipedes

Characteristics of Arthropoda

i. They have joint appendages.
ii. Presence of chitineous exoskeleton.
iii. Metamerically segmented abdomen.
iv. Their bodies are divided into two or three.
v. They are bilaterally symmetry.

Class insects: characteristics

i. They have three body division i.e. the head thorax and abdomen.
ii. They have three pairs of jointed walking legs.
iii. They have a pair of compound eyes.
iv. They have a pair of jointed antennae on their head.
v. They have two pairs of wings.

vi. Segmented abdomen
vii. Their respiratory organs is the trachea which opens out through the spiracles.

THE GRASSHOPPER

A typical example of an insect. A very common example is valanga nigricornis.
It undergoes incomplete metamorphosis;

Eggs → Nymph → Adult

The nymph resembles adult closely but they are wingless and sexually immature. They moult (ecdysis) several times during the growing period before it becomes an adult. Ecdysis (moulting) is a common feature of all insects. It is the casting off or shedding of their cuticles during their growing period until they attain the adult stage. During the process, the body increases in size.

The habitat of the grasshopper includes; open grasslands, gardens, farms or forest.

Observable adaptive features of grasshopper its habitats

i. Colour blends with vegetation to enable them to escape from predators.
ii. Powerful and muscular long hind limbs for hopping away from dangers.
iii. Wings for flying to avoid predators and also to travel long distances in search of food.
iv. Chewing mouth parts/mandibles for feeding on vegetation.
v. Hardened forewing protect the membranous hind wing used for flying.
vi. Long antenna sensitive to touch.
vii. Spiracles for gaseous exchange.
viii. Compound eyes for wider vision.

Generally, grasshopper feeds on leafy vegetation and attack all cultivated and wild plants. They are active during the day (i.e. diurnal).

Economic importance

i. Pest of plants or they destroy leaves of plants thereby reducing crop yields.
ii. They are source of protein.
iii. They are used as fishing bait.
iv. They transmit plant pathogens and parasites.

DIAGRAM OF A GRASSHOPPER

COCKROACH

There are many species of cockroaches, two common species are Blatia orientalia , (oriental cockroach) and Periplaneta americana (America Cockroach). They also carry out incomplete metamorphosis.

Differences between the nymph and adult cockroach

ADULT	**NYMPH**
1. Wing present	Wing absent
2. Prominent and style	Less prominent and style
3. Prominent egg pouch	Less prominent egg pouch
4. More prominent cerci	Less prominent cerci
5. Long antennae	Short antennae

The adult cockroaches are nocturnal animals found in dark warm place like cracks between planks, underneath drawer, old boxes, always close to a source of food.

They have dorsoventrally flattened bodies which enables them to enter narrow openings and hide. At the side of body there are ten pairs of spiracles for gaseous exchange.

They are omnivorous i.e. they eat dead organic materials, clothes, books e.t.c. The cockroach is brown or dark brown in colour. It has a pair of jointed antennae which are sensitive to touch, smell and vibration. The mouth part is similar to that of the grasshopper which is tearing and chewing food.

The forewings/ elytron covers and protects the membranous hind wings. The membranous hind wings are for flight. The abdomen is segmented and the last segment carries a pair of cerci (cercus) which are sensory in functions. The male cockroaches have anal styles situated near the cerci.

In female, the rear part of the abdomen is modified into boat- shaped bag for carrying egg case or ootheca.

The egg case is chitinuous and looks like a purse. It is found in crevices, cupboards, dark warm corners, toilets.

Observable adaptive features of the egg case (ootheca)

i. Hard case protects eggs from mechanical/chemical injury.
ii' Hard case prevents dessication.
iii. Hard case maintains suitable internal temperature.
iv. Dark brown colour makes it difficult to be seen in the dark i.e. for camouflage
v. Narrow shape enables it to fit into crevices.

Economic importance

i. It is a household pest
ii. It destroys food, clothes, books e.t.c.
iii. It is a vector of germs which it distributes as it runs from one place to another, it carries pathogen that causes the following diseases; plagues, leprosy, dysentery, tuberculosis e.t.c.
iv. It has foul smell and destroys materials as it passes excreta on them as it runs over them.

LEG OF A COCKROACH

DIAGRAM OF A COCKROACH

Note magnitude: is calculated as shown below
Mg= length of diagram
Length of organism
It is written at the right hand lower side of the diagram e.g.x2, x1, x6 e.t.c.

Class Arachnida

The arachnida comprises of organisms like spiders, scorpions, mites, ticks e.t.c

Characteristics

i. They have two body divisions, the cephalothrorax and abdomen.
ii. Absence of wings.
iii. They have eight simple eyes.
iv. They lack antenna.
v. They have four pairs of jointed walking legs.
vi. The respiratory organ is the lungbooks.

The Spider

The spider is the commonest arachnida. It is free living and solitary. Most spider are carnivorous; feeding mainly on insects. They live in various habitat; ceiling of houses, inside the cupboard etc.

It has a part of pedipalp on each side of the mouth for grasping food and they are also sensitive to touch.

The abdomen is large and has tiny openings called spinneret on the ventral surface. The spider has three parts of spinneret (silk spinning organs) for spinning webs.

The sexes are different with the female being much larger. The eggs are bored in silk bay or cocoon. Spiders are useful to man because they eat various household pest.

Reasons a spider is not considered an insect

1. It has four pair of legs while insects have three pairs of legs.
2. It has two body division/cephalothorax and abdomen/opisthosoma while insects have 3 body division, head, thorax and abdomen
3. It has pedipalp while insects have antennae
4. It has no wings while some insects have wings
5. It has eight simple eyes while insects have two compound eyes.
6. It has spinnerets while insects do not have.
7. It chelicerae while insects do not have
8. It respires by means of lung book while insects respire with trachea.

DIAGRAM OF A SPIDER

LEG OF A SPIDER

Class Crustacean

Most crustaceans are aquatic and free living members which includes crabs, prawns, crayfish, lobsters, Barnacles, water plants

Characteristics

i. They have two body divisions, the cephalothorax and abdomen.
ii. Absence of wings.
iii. They have a pair of stalked eyes.
iv. They have two pairs of antennae.
v. They have five pairs of jointed walking legs.
vi. The respiratory organs are gills.

The prawn

It lives in rivers and feeds on dead organic matter and green weeds. The abdomen is segmented with a pair of appendages on each segment. The front of the head contains a sharp beak known as rostrum. They are source of protein to man. It uses swimmerets for swimming and it is attached to the abdominal part of the body.

DIAGRAM OF PRAWN

Class Myriapoda

Myriapoda are the millipedes and centipedes. They are land animals found under rocks, logs and the soil. They breathe by means of trachea.

a. Millipede

It has an elongated and cylindrical segmented body. They have legs and move very slowly. They are found in dark moist places. They feed on decaying plants remains. They have a pair of antennae on their head. The body is divided into three pairs or division.

DIAGRAM OF A MILLIPEDE

b. Centipede

The body is flat, elongated and segmented. It is reddish brown in colour. It also has a pair of antennae and several simple eyes. It has poisonous claws for killing its preys.

DIAGRAM OF A CENTIPEDE

STRUCTURAL DIFFERENCES BETWEEN CRUSTACEANS, INSECTS AND ARACHINDA

Features	**Crustaceans e.g. prawn**	**Insect e.g. cockroach**	**Arachinda e.g. spider**
1. Body division	Two i.e. cephalothorax and abdomen	Three i.e. head, thorax and abdomen	Two i.e. prosoma and opisthosoma
2. Wings	Absent	Present	Absent
3. Eyes	A pair of stalked eyes	A pair of compound eyes	Eight simple eyes
4. Antenna	Two pairs	A pair	None
5. Walking legs	5 pairs of jointed legs	Three pairs of jointed legs	4 pairs of jointed legs
6. Respiratory organs	Gills	Trachea	Lung books

9. Phylum Echinodermata

They are slow moving marine animals found on the sea shore and sea beds. Members include starfish, sea urches, sea cucumbers etc.

Characteristics

i. Have radially symmetrical bodies.
ii. They have neither head nor brain.
iii. They have three layers i.e. triploblastic.
iv. They have tube feet which are used for movement.

DIAGRAM OF A STARFISH

Vertebrates: Vertebrates (i.e. all animals with backbone) belong to phylum Chordata. The phylum Chordata is made up of five classes;

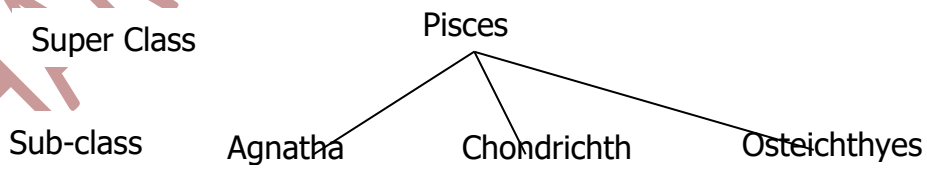
i. Class Pisces/ osteichthyes
ii. Class amphibia
iii. Class reptilia
iv. Class Aves
v. Class Mammalia

Generally, all vertebrates have the following characteristics;

i. A backbone.
ii. They are bilaterally symmetrical.
iii. They have endoskeleton made up of bane or cartilage.
iv. A well- developed central nervous system.
v. They have two pairs of limbs.
vi. They have skin which may be naked or have a covering of scales, feathers or hairs.

CLASS PISCES

This class include all fishes which are all aquatic fishes generally. They are tilapia fish, dog fish, catfish, sharks, whales, dolphins.



1. **Agnatha –** They are jawless fishes with no pectoral or pelvic fins e.g. Lamprey
2. **Chondrichthyes-** They are cartilaginous fishes with the following features;
   a. Fishes with endo-skeleton of cartilage and exo-skeleton of placoid scales (Long overlapping tooth-like scales).
   b. Gills cover/operculum is absent
   c. Gills silts are visible e.g. shark
3. **Osteichthyes**
   a. They are bony fishes i.e their endo-skeleton is made up of bone.
   b. Presence of swim bladder
   c. Overlapping scales covering the entire body
   d. Operculum covers the gills slits e.g. Tilapia

CHARACTERISTICS OF PISCES

i. Cold- blooded animals (body temperature varies with that of the environment)
ii. The body is covered with scales and in some, slimy layers
iii. Their paired limbs have been modified into fins for movement in water
iv. They have gills for gaseous exchange
v. Some are bony fishes while others are cartilagenous
vi. They have a streamlined body for easy movement

The Tilapia fish

The tilapia fish is an example of a bony fish. It has the following features which adapts it to its environment (i.e. water).

Adaptation of tilapia fish to aquatic habitat

i. Streamlined body for rapid movement in water
ii. Body covered with scales for protection
iii. Presence of fins for movement in water
iv. Presence of lateral lines for detection of vibration and pressure charges
v. Gills for gaseous exchange
vi. Swim bladder (for buoyancy or floating in water)
vii. Operculum (gill cover) for protection of the gills.
viii. Muscular tail for swimming.
ix. Position of wide eyes placed at 180^{o} for a wide view
x. Dark grey upper part of the body and slivery under belly for escape from predators

The fins

The fish has paired and unpaired fins. The unpaired fins are the dorsal and caudal fin. The paired fins are the pelvic and pectoral fins.

The unpaired are fins for stabilizing. The paired fins are for balancing and steering in water and also for changing direction.

DIAGRAM OF TILAPIA FISH

Class Amphibia

The members include frogs, toads, newts, salamander etc. They spend their time in water and part of their time on land.

Characteristic

I. They do not have scales on their skin.
II. They are cold- blooded.

III. Gills are used for gaseous exchange at young stage and lungs at the adult stage.

THE TOAD

The toad belongs to the genus Bufo. It is nocturnal and abundant in the rainy season (in ponds), wet or damp places under leaves and in small holes.

Adaptive features

i. It has nictating membrane which cleans, moisten and protect the eye from glare of the sun.
ii. Absence of neck which gives it streamlined shape to swim easily in water.
iii. Presence of eardrum which picks up vibration.
iv. Poison gland present which secretes a foul tasting substance to protect it against predators.
v. Protruding eyes for wide vision.
vi. Webbed digit in the hind feet to swim in water.
vii. Moist warty skin for gaseous exchange and for skin camouflage.
viii. Nostrils for breathing.
ix. Wide mouth for catching flying insects.
x. Short muscular and stout fore limbs to absorb shock on landing.
xi. Long and muscular hind limbs for hopping.
xii. Absence of tail to give it a streamlined body for swimming in water.
xiii. Long sticky tongue attached to the front lip to capture preys and foods.

DIAGRAM OF A TOAD

Class Reptilia

They include members like the lizard, snakes, crocodiles, turtles etc.

Characteristics

I. They have dry horny scales covering their skin for protection.
II. They have a dry skin.
III. Lungs is their organ for gaseous exchange.
IV. They have two pairs of limbs except the snake.
V. No larva stage present, the female lays eggs on land.

VI. Presence of clawed digits.

The Agama Lizard (Agama agama)

They live in colonies. A colony is usually made up of an adult male and several adult females and young matured lizards of the both sexes

The male agama is brightly coloured or orange in colour with nuchal crest on the head, presence of hemi- penis, pre- anal pad around the cloaca and well developed gular fold.

The female has dull colour (greenish brown to brownish), absence of hemi- penis, reduced or absent nuchal crest, absence of gular fold, cloacal opening is not bordered by pre- anal pads and patches on the side of the body.

The lizard has a definite neck and a long tail, pairs of clawed digits. They live on walls, ceilings of building, around homes, concrete slabs, rocks, forests, trees and grasslands. They feed on small insects using its sticky tongue (i.e. Carnivorous).

Observable adaptive features of lizard to its habitat

I. Dry horny overlapping scales on skin to prevent desiccation.
II. Bulging eyes for wide view.
III. Presence of claws on digits for climbing.
IV. Wide mouth for feeding.
V. Long tail for territorial defense.
VI. Presence of tympanum membrane for sensitivity to sound vibration.
VII. Well – developed limbs for movement on land.
VIII. Nostrils for gaseous exchange.

Behavioural adaptation of lizard to its habitat

i. Basking in the early morning sun to reduce the body temperature
ii. Display of colour by male to ward off intruders for courtship
iii. It always blends with its environment to escape predators
iv. It lays its eggs in the soil for protection and warmth

External features of lizard which are of evolutional significance. They are;

i. Dry horny scales on skin.
ii. Limbs ends in five digits with strong curved claws at the tips.
iii. Presence of neck.
iv. Presence of hemi- penis.
v. Eggs covered with shell.
vi. Four chambered heart.

DIAGRAM OF AGAMA LIZARD

Class Aves

The class include all birds on the surface of the earth e.g. those that can fly like dove, crow, sparrow, eagle etc. and those that cannot fly like duck, chicken, ostrich etc.

Characteristics

I. They are warm- blooded animals (i.e. they have a constant body temperature).
II. The entire bodies are covered by feathers except the hind legs covered with scales
III. Their fore limbs are modified into wings for flight.
IV. Their mouth is modified into beaks for feeding.
V. They have rigid and hallow bone which makes them light during flight.
VI. Respiratory organ is the lung.

FEATHER

Feathers are epidermal structure which covers the entire body surface of the birds. We have four types of feather. They are;

i. **Quill feathers (flight feathers)**: They are found on the wings and tails. They are flying and steering feathers.
ii. **Covert feathers**: They cover the general body surface. It keeps the bird's body warm
iii. **Down feather**: They are soft and fluffy. Most of the feather in young birds are down feathers. It is for insulation or warmth.
iv. **Filoplumes**: They are found nearest to the skin. They are small hair- like which are sparsely distributed over the body and grow in clusters.
v. The quill and covert feather establish the contour of the bird's body also known as contour feather.

Functions (uses of feathers)

i. For flight
ii. For insulation and warmth and to keep the body temperature constant.
iii. It is water proof.
iv. For sexual display (courtship).
v. It gives shape to the bird.
vi. For protection.
vii. For incubation.

FILOPLUME

CONTOUR FEATHER

DOWN FEATHER

QUILL FEATHER

Class mammals

This are the most advanced in the animal kingdom. They are warm-blooded. Members include man, donkey, rats etc.

Characteristics

i. Their bodies are covered with hairs or furs.
ii. They have mammalian gland to feed their young ones.
iii. Presence of external ears or pinna.
iv. Respiratory organ is the lungs.
v. Well- developed brain and sense organ.
vi. The viscera or internal cavity is divided into chest and abdomen by the diaphragm.
vii. The skin contains gland.
viii. They have two pairs of limbs.
ix. The rabbits, cats, rats etc. have whiskers or vibrissa which are sensitive to touch.

DEFINITION OF THE FOLLOWING TERMS

i. Ovoviviparity
ii. Oviparity
iii. Viviparity

Ovoviviparity: This is the type of sexual reproduction whereby the fertilized eggs are retained in the female body where the embryo develops using the stored foods in the eggs. When fully developed, the young hatch from the eggs and are released from the female's body e.g. Certain fishes (shark) and reptiles are ovoviviparous.

Oviparity: Is a process of sexual reproduction in animals in which the animal lay eggs into the external environment. The embryo grows and develops within the eggs after which the eggs are hatched to give rise to new offspring. The eggs may be fertilized inside or outside the body of the female animal. The egg also develops outside the body of the animal.

Oviparous: Is the animal that lays e.g. fish, reptile, toad and birds (fish and toad lay unfertilized egg while birds and reptile lay fertilized egg).

Viviparity: Is the process of sexual reproduction in animals in which the animal gives birth to young ones alive. The eggs are fertilized inside the female body and the embryo is also internal, obtaining food directly from the parent through the placenta.

Viviparous: Is the animal that gives birth to young ones alive e.g. mammals like man, goat, dog etc.

DIFFRENCES BETWEEN OVIPARITY AND VIVIPARITY

OVIPARITY	**VIVIPARITY**
Animal lay eggs	Animal do not lay eggs
They do not give to their young ones alive	They give birth to their young ones alive
Embryo development is outside the female body	Embryo development is inside the female body

SUMMARY OF CHARACTERISTICS FEATURES OF VERTEBRATES

Class	**Fishes**	**Amphibians**	**Reptiles**	**Birds**	**Mammals**
Skin	Covered with slimes and scales	Moist, soft warty skin	Covered with horny scales	Covered with feathers(scales on feet)	Covered with hair or furs
Cold/ warm-blooded	Cold blooded	Cold blooded	Cold blooded	Warm blooded	Warm blooded
Limbs	Modified into fins	2 fore limbs, 2 hind limbs	2 fore limbs, 2 hind limbs with toes ending in claws	2 fore limbs modified into feathers, 2 hinds limbs	2 fore limbs and hind limbs ending in nails

Respiratory organ	Gills	Gills in young toad. Mouth, skin and lungs in adult	Lungs	Lungs	Lungs
Fertilization	External eggs are laid in water	External, egg are laid in water	Internal, eggs laid in shells on land	Internal, eggs are laid in shells on lands	Internal, development is usually inside
Physical appearance of young	Look like adult	Different from adult	Look like adult	Look like adult	Look like adult
Parental care	None/ partial	None	None	High	Very high

Note: phylum Chordata is divided into two;

1. Protochordata
2. Vertebrata

Protochordata have some vertebrates and some invertebrates features and this shows that there are possible evolutionary link between the invertebrates and the vertebrates e.g. tunicate and Lancelets.

ORGANIZATION OF LIFE

Living organisms are highly organized. This organization occurs in levels or steps i.e. the simple structures are found at the lowest level and they interact to build up more complex structures at the next level and so on.

Level of organization

There are four levels of organization of live in organism;

i. Cells of organization
ii. Tissues of organization
iii. Organs of organization
iv. Systems of organization

A. First level: cell of organization

The cell is the smallest basic, structural and functional unit of life from which all organisms are built from. All organisms are made up of cells. Some have only one cell (unicellular) while others have many cells (multicellular).

Examples of unicellular organism are amoeba, paramecium, Euglena. Chlamydomonas, trypanosome and plasmodium. These organisms have only one cell each and are capable of carrying out all life processes in living things and they are capable of independent existence. All the organisms above are under the cell level of organization.

Examples of cells in higher plants are phloem cells, xylem vessel etc. while in higher animals, we have the following cells and their functions;

Types of cells	Functions
Rod and cone cells in the eyes	For photoreception
Red blood cells	It transports O_2 round the body
White blood cells	Protect the body against diseases
Nerve cell	To transmit impulses
Sperm and egg cells	For reproduction
Bone cells	Form bones and give support to the body
Epidermal cells	Protect the body against infection, germs and dehydration

B. Second level: Tissues of organization

A tissue is a group of cells which are similar in structure and are specialized to perform a similar function. E.g. of tissues in animals include blood, bone, cartilage, muscle, epidermis and endodermis.

Examples of tissues in plants are epidermis, mesophyll, parenchyma, collenchyma, xylem tissue, phloem tissue. Under tissue level organization, some tissue can be on their own e.g. hydra. Hydra do not have organs. The size of their bodies at the surface area to volume ratio is reduced due to increase in size and hence lower rate of diffusion. This account for the need of specialized action of cells in the course of transportation of materials. The body cell of hydra is differentiated into layers of tissues known as ectoderm and endoderm. The cells of the endoderm carry out the function of digestion of food.

C. The third level: Organ of organization

Organ is defined as a group of different tissues that perform common function in an organism. Some organs carry out a single function e.g. heart while some carry out more than one function e.g. kidney.

Examples of organs in animals include pancreas, liver, tongue, ear, heart, eye, kidney, spleen, skin etc. Examples of organs in plants are vascular bundle, flower, fruits, and leaf etc.

A living thing may be an organ for example, an onion bulb, rhizome, a corn, a tuber are all organs. Such a living thing is at the organ level of organization.

D. The fourth level: System of organization

A system is made up of different organs that perform a particular function. Systems are peculiar to higher organisms or complex organisms. In the animal kingdom, all animals from Platyhelminthes to mammals are organized in this level. Higher plants also have system. Examples of systems are digestive system, reproductive system, excretory system, circulatory system, root system, shoot system and skeletal system.

Complexity of organization in higher organisms

As one moves from unicellular to multicellular organisms, there are gradual complexity in the organization of the mentioned levels. Higher organisms are more complex than lower ones. For instance, in Amoeba or paramecium, gaseous exchange is by diffusion. In insects, there are tracheal system for breathing. In man, there are respiratory system consisting of trachea, bronchi, lungs and alveoli.

Advantages of complexity of organization

1. It leads to cellular differentiation i.e. a group of similar cells are differentiated to form tissues that carry out similar function.
2. It leads to specialization of tissues/ organs.
3. This specialization leads to division of labour among the cells.
4. The division of labour leads to efficiency of tissues/organs/system to carry out life process.
5. One body function does not adversely affect other body functions.
6. It leads to increase in size of organism because there are spaces between cells for growth.
7. Complexity makes higher organisms to become more resistant to adverse conditions within the environment increases adaptation to the environment.
8. Several tasks can be performed simultaneously.

Disadvantages of complexity in higher organisms

1. Inability of individual cells to exist on their own.
2. Ability to regenerate is limited or decreased.
3. Diffusion alone is no longer sufficient for transportation of substance.
4. Damage done to one part of the body affects the other part.

Lesson Five

MAJOR RESOURCES AND FORMS OF ENERGY

Energy is defined as the ability to do work. **Work** is defined as the movement of matter. All living things need energy to enable them to carry out life processes and this energy comes from the food we eat.

Energy requirement of biological activities

Energy is required by living things for the following biological activities;

1. Energy are required for the generation/ supply of heat especially for warming blood of animals.
2. Energy is required for muscular contraction such as walking, talking, running e.t.c.
3. It is required for metabolic process.
4. It is required for growth.
5. It is needed for gaseous exchange.
6. It provides strength for us to do work.

Forms of energy

1. Solar energy (light).
2. Mechanical energy (potential: stored energy and kinetic: in moving objects).
3. Chemical energy (energy stored in chemical substances e.g. fuel and food).
4. Nuclear (Atomic) energy.
5. Electrical energy
6. Sound energy

7. Heat energy

These various forms of energy can be converted from one form to another. For example, chemical energy in food can be converted to kinetic energy and heat energy in our bodies (muscles) when we walk or run.

SUN AS ULTIMATE SOURCE OF ENERGY

The sun is known as solar energy. Light and heat are the main forms of energy that makes up the solar energy. All life on earth depends on the light energy from the sun for survival. Hence, the green plants in the presence of sun manufacture their own food (photosynthesis). In this form, light energy is converted to chemical energy.

The food glucose or starch produced by green plants contains potential energy. Therefore, solar energy gives potential energy in food.

When the food is eaten, it is converted to kinetic energy which is also used for doing work by organisms.

Catabolism as a source of energy

Catabolism is defined as the breaking down of complex organic molecules injected into the body as food. The food broken down (catabolism) provide energy for cells during aerobic and anaerobic conditions. Energy is always produced which shows that food is a source of energy in the body cell. Examples of catabolic processes are respiration and digestion

Anabolisms as an energy consuming process

Anabolism can be defined as the building up of complex organic molecules from simple ones in a biological system. In anabolism, energy is consumed because some forms of energy are required to break the old molecules before building up the complex ones.

Examples of anabolic processes are;

1. The formation of glycogen from glucose
2. Formation of starch from glucose
3. Formation of protein from amino acid
4. Formation of fat and oil from fatty acid and glycerol
5. Photosynthesis in green plants
6. Growth

Note: Both anabolic and catabolic process occurs in the body of living organisms and they are collectively known as metabolic processes.

Metabolism is all the chemical reactions that takes place within each cell of a living organisms which provides energy for vital processes and for synthesizing new organic material.

THE LAW OF THERMODYNAMICS

The first law: It states that energy can neither be created nor destroyed but can only be transformed from one form to another.

For instance, all the forms of energy cannot be created nor destroyed but can change from one form to another e.g. chemical energy in food can be converted to

kinetic energy and heat energy in our body when we walk or run. This is in accordance with the first law of thermodynamics.

The second law: It states that the transformation of energy from one form to another cannot be hundred percent (100%) efficient, heat is lost along the line. OR when one energy is converted from one form to another, a part of the energy is converted to heat, that is to say that during metabolic activities, some chemical energy is constantly lost as heat energy from the body of organisms.

Effects of 2nd law of thermodynamics on energy flow across trophic levels

The 2nd law of thermodynamic can be used to explain energy flow from across trophic levels in this manner. The transfer of energy between trophic levels is not 100% or not completely transferred. Successive levels have lesser useful energy and support fewer organisms. Primary producers or plants have the highest amount of energy. When herbivores feed on plants, the energy level is reduced. When carnivores consume the herbivores, the energy level further reduce. Part of the energy is lost as heat at each trophic level. Not all parts of the proceeding organisms are eaten by the predator or organism at the next trophic level. Energy is lost in the process of respiration, feeding, movement and metabolic activities.

Lesson Six
NUTRITION

One of the main characteristics of living organisms is the ability to feed and this is referred to as nutrition. All living organisms feed and require nutrients for their survival. Some organisms are called autotrophs and can manufacture their own food e.g. plants while other organism s are called heterotrophs and cannot make their own food but depend on ready-made food e.g. animals.

A. PLANT NUTRITION

The plants are autotrophic in nature.

What is photosynthesis?

Photosynthesis is defined as a process whereby green part of plant containing the pigment chlorophyll capture and utilize sunlight energy to convert carbondioxide and water into simple sugar and carbohydrates and oxygen is given off.

$$6CO_2 + 6H_20 \xrightarrow[\text{chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2$$

The raw material for photosynthesis are CO_2 (obtained from the air) and water (from the soil) while the products are starch/ glucose and oxygen. The energy for the reaction comes from the sun. It is the chlorophyll (found inside the chloroplast) that enables the plant to use light energy in this way.

Mechanism of photosynthesis

Photosynthesis is an endothermic reaction and it consist of series of reaction that occur in a stepwise manner. These reactions are divided into two phases or stages.

1. The light stage reaction- photochemical.

2. The dark stage reaction- thermochemical.

The light stage reaction

The light stage reaction occurs during the day or in the presence of sunlight. The chlorophyll molecules in green plants absorb kinetic energy or radiant energy from sunlight and electrons are excited. The energy so trapped is used to split water molecules into hydrogen ion (H^+) and hydroxyl ion (OH^-). This is splitting of water into H^+ and OH^- is called **photolysis of water.**

$$4H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} 4H^+ + 4(OH^-)$$

Water — Hydrogen ion — Hydroxyl ion

The hydroxyl ion (OH^-) which result from ionization of water is converted to water and oxygen.

$$4(OH^-) \longrightarrow 2H_2O + O_2$$

Hydroxyl ion — water — oxygen

During this process, oxygen is given off as the first by- product of photosynthesis and it comes from the water not from the CO_2.

$$NADP + H_2 \longrightarrow NADPH_2 + ATP$$

At the same time, a compound co- enzyme of NADP (Nicotinamide Adenine Dinucleotide Phosphate) is reduced by hydrogen ion to $NADPH_2$ and ATP (Adenosine Triphosphate) is formed.

MAJOR PRODUCTS OF LIGHT- DEPENDENT STAGE OF PHOTOSYNTHESIS

1. ATP (Adenosine Triphosphate) or energy.
2. H^+ (Hydrogen ion).
3. OH^- (Hydroxyl).
4. $NADPH_2$ (Reduced Nicotinamide Adenine Dinucleotide Phosphate or reduced co-enzymes).
5. O_2 - Oxygen gas

Importance of the products

1. ATP - To generate energy for dark stage reaction.
2. Energy – is use to carry out metabolic process.
3. $2H^+ + NADP \rightarrow NADPH_2$.
4. $OH^- \rightarrow H_20 : O_2$ gas
5. $NADPH_2 \rightarrow$ To generate hydrogen ions and to reduce carbon dioxide to form carbohydrate in the dark stage

6. O_2 → is given off into the atmosphere for animals and other organisms to use for respiration.

DARK PHASE OF PHOTOSYNTHESIS

It is an enzyme catalyzed reaction and is temperature dependant.CO_2 from the atmosphere and the hydrogen from the light phase reaction are used to build organic compounds in the stroma of the chloroplast, the carbon dioxide is linked to ribulose biphosphate or five (5) carbon sugar to form an unstable six(6) carbon compound which immediately split into two molecules of a three carbon compound (or glycerate 3 phosphate/glyceraldehyde-3-phosphate(G3P)) which is reduced to a common carbon sugar (or triosephosphate/ phosphoglyceraldehyde) which is then converted to glucose. The process is driven by energy from ATP, produced in the light stage.

$4H_2$ + CO_2 ⟶ CH_2O + H_2O

(Hydrogen ion) (Carbon dioxide) (Sugar) (Water)

Leaf as a photosynthetic organ

The following are adaptation of leaf to photosynthesis;

1. Presence of chloroplast or chlorophyll for absorption of sunlight.
2. Wide or broad or increased leaf surface area for more absorption of light.
3. Presence of air space to enhance diffusion of gases.
4. Presence of stomata/lenticel for gaseous exchange.
5. Presence of xylem to conduct water to the leaf and presence of phloem to transport manufactured food.
6. The leaf stalk holds the leaf blade in the best position to receive maximum amount of sunlight.

Evidence/Fate of photosynthesis in plants

1. The main first suitable product formed during photosynthesis is simple sugar (glucose). The simple sugar (glucose) is partially used by plants and excess of it is converted to starch immediately for storage. The glucose is then transported to their parts of the plants through the phloem tissues.
2. The food can be combined with other elements such as Nitrogen and sulphur to form proteins used for growth and repairs of worn out tissues.
3. Oxygen produced is used in respiration by plants/cells and the excess oxygen is passed through the stomata into the atmosphere.
4. The manufactured food (glucose) is also used for respiration to produce energy. The energy produced is used to carry out metabolic activities.
5. Other products like lipids and cellulose can be manufactured from glucose.
6. They also provide source of food for animals (Primary consumers).

The site of dicotyledonous leaf where photosynthesis occur most is at the **palisade or palisade mesophyll**. This is because of the following reasons:

a. It contains more chloroplast/ chlorophyll than the spongy layers and other parts.
b. Palisade cells are located just beneath the upper epidermis where the chlorophyll could absorb more sunlight.

To know whether photosynthesis have taken place or not in a plant, a test for starch is required:

Experiment 1

1. **Aim** : To test for the presence of starch in a green leaf
2. **Apparatus/ materials required**: Fresh green leaves from outdoor plants, beaker, boiling tubes, water bath, ethanol or alcoholic water, iodine solution
3. **Procedures/ method**:
   i. A leaf from garden plant which has been exposed to sunlight for 3 to 6 hours was plucked
   ii. Boil the leaves in water for 5 minutes. The reasons for this are;
      a. Kill the cell protoplasm of the leaf.
      b. To expose the starch grains in the leaf.

      The leaf is boiled / heated with ethanol or alcohol with the help of water boil for five minutes. The reason is to decolourize the leaf by removing the green colouring matter (chlorophyll) in order to detect the presence of starch. Boil with the help of water bath because alcohol is highly inflammable and may catch fire if heated on a naked flame.
   iii. Remove the leaf from the alcohol and dip it in a warm water. The reason for it is to soften the leaf and remove traces of alcohol.
   iv. Place the leaf in a petri-dish/white tile and add 2-3 drops of iodine solution to it.
   v. Allow the leaf to stand for about 1 to 2 minutes and observe.
4. **Observation**: Within a few seconds, the decolourised leaf turns to blue black colour indicating the presence of starch.
5. **Conclusion**: This confirms that there is presence of starch in a leaf which means that photosynthesis have taken place in the leaf.

Diagram showing presence of starch in a leaf

Factors / materials/ conditions necessary for photosynthesis

There are external and internal factors that are necessary for photosynthesis to occur. The external factors are;

1. Sunlight
2. Carbon dioxide
3. Water
4. Mineral salt
5. Temperature

The internal factors include chlorophyll, hormones, number or state of stomata, enzyme.

Experiments to determine the conditions necessary for photosynthesis

EXPERIMENT 1:

1. **Aim:** Experiment to show that sunlight is necessary for photosynthesis
2. **Materials**: A potted plant, strips of black paper, clips and iodine solution
3. **Methods:**
   i. The potted plant is first destarched by putting it in a dark cupboard for 2 days (48 hours). This is to remove all traces of starch formed in the leaves so that any starch detected at the end of the experiment is formed as the result of the experiment.
   ii. Then the middle of one of the leaves is covered with a strip of black paper both in front and at the back and held in place with clips
   iii. The whole plant is then placed in sunlight for 3 to 6 hours, then the clipped paper is removed.
   iv. The leaf is now tested for starch.

Start of the experiment **End of the experiment**

4. **Observation:** Only the unclipped exposed part of the leaf turned a blue- black while the covered part retained the colour of iodine (i.e. brown). The blue- black colouration shows us that starch is present in that area while the covered part which retained the brown colour of iodine solution shows us that starch is absent in that area.
5. **Conclusion:** Sunlight is necessary for photosynthesis

Experiment 2

1. **Aim**: Experiment to show that carbon (iv) oxide is necessary for photosynthesis.
2. **Materials:** A potted plant, Vaseline, split cork, conical flask, retard stand, caustic soda or soda lime (sodium hydroxide) solution.
3. **Methods:**
   i. The potted plant is first destarched by putting it in a dark cupboard for 48 hours (2 days) before the experiment. One of the leaf in the potted plant is

enclosed in a conical flask containing soda lime. The function of the soda lime/ caustic soda is to absorb carbon (iv) oxide from the air in the flask.

ii. The mouth of the flask is corked within the vase lined split cork to make it air tight.

iii. The whole experimental set-up is then exposed to sunlight for 3 to 5 hours.

iv. After this, one leaf from inside the flask and one leaf from outside the flask are plucked and tested for starch (using the test for starch in leaf method).

4. **Observation:** At the end of the test for starch in the leaves, the leaf inside the flask did not turn to a blue black colouration indicating absence of starch due to lack of carbon (iv) oxide while the leaf outside the flask turned into a blue- black colouration indicating presence of starch.
5. **Conclusion:** It shows that carbon (iv) oxide is necessary for photosynthesis.

Experiment 3

1. **Aim**: To show that chlorophyll is necessary for photosynthesis.

Chlorophyll is green in colour and is contained in the mesophyll cells of the leaf especially the palisade cell and it is being synthesized or produced in the chloroplast.

Some leaves however are not entire green but may have red or yellow patches or sports on them. Red leaves possess a red pigment in addition to the green chlorophyll. This red pigment makes or overshadows the chlorophyll and the leaf appears red in colour. Such leaves are able to carry out photosynthesis with the help of the hidden chlorophyll.

A variegated leaf is a leaf with yellow, white or red patches or spots on the green patches. The leaf has chlorophyll only on the green parts.

An etiolated leaf is a leaf which is completely yellow or white or any other colour apart from green.
The yellowing of leaves due to lack of nutrient is called **chlorosis.**

1. **Materials required**: Plants with variegated leaves, ethanol, iodine solution, petri-dish, thin sheet of paper and pencil.
2. **Methods/ procedures**:
   i. The part of variegated plant is exposed to sunlight for 3 – 6 hours.
   ii. Then only one leaf is plucked freely from the plant during the day time when there is still sunlight.
   iii. A drawing of leaf is made to map out the areas that are green and white.
   iv. The leaf is then tested for starch.
   v. Spread out the leaf and then compare the iodine map with the chlorophyll map (i.e. the leaf tested with iodine solution).

3. **Observation:** The green parts of the variegated leaf turn to a blue- black colouration due to the presence of starch while the white part retained the iodine solution which is brown.
4. **Conclusion:** Chlorophyll is necessary for photosynthesis.

START OF EXPERIMENT **END OF EXPERIMENT**

Note: Variegated leaf is used for this experiment because it retains the main experiment and control experiment.

Experiment four:

1. **Aim**: To show that oxygen is given off as a by-product during photosynthesis.
2. **Materials**: Water plant (Elodea), glass funnel, beaker, water, test tube, glowing splinters, sodium bicarbonate
3. **Methods;**

I. Fill up the beaker with water and add sodium bicarbonate (i.e. to release sufficient carbon dioxide for the water plant (Elodea) to photosynthesis.

II. Place the water plant at the bottom of the beaker and cover with transparent glass funnel (in order to allow sunlight to enter) with the help of plasticine block (the reason for placing funnel with black plasticine is to allow free movement of water).

III. Fill the test tube with Water and then invert it over the stem of glass funnel in order to collect gas (O_2) evolved during photosynthesis.

IV. The whole set-up is then placed in the sunlight for 2 to 3 hours to provide sunlight energy which the plant use to carry out photosynthesis

V. Tiny bubbles of gas start appearing on the surface of the leaves and these breaks off and accumulates at the top of the test tube.

VI. The gas is tested with glowing splinter

4. **Observation:** The gas formed at the top of the test tube rekindles a glowing splinter.
5. **Conclusion:** It shows that oxygen is given off as a by- product during photosynthesis.

START OF EXPERIMENT **END OF EXPERIMENT**

Conditions affecting the rate of photosynthesis

1. **The dark reaction**: It is a limiting factor to the rate of photosynthesis. This means no matter how light we have, the rate of production of carbohydrates is not much affected. It is the speed of the dark reaction that controls or greatly influences the overall rate of photosynthesis.
2. Low relative humidity slows down the photosynthetic rate while high relative humidity speed up photosynthetic rate.
3. **Temperature**: It is one of the factors which affect the rate of photosynthesis. Each enzyme works best at a particular temperature. Extreme temperature will destroy the living cells and enzyme, hence slowing down the photosynthesis process. The favourable temperature range for photosynthesis is below 29^{o}c to 36^{o}c except for desert plants which are suitably adapted to carry out photosynthesis efficiently at temperature as high as 75^{o}c.

Importance of photosynthesis

1. **Production of food**: The process of photosynthesis provides food for both animals and plants
2. **Purification of the atmosphere**: Waste products CO_2 released from respiration by both plants and animals is removed from the atmosphere by plants for use during photosynthesis.
3. **Release of oxygen into the environment**: Oxygen (O_2) is released as a by-product of photosynthesis into the environment which plants and animals uses for respiration.
4. **It serves as building block for other substances**: Photosynthesis provides the building block from which other substances are built e.g. protein and fats and oil.
5. **Conversion of solar energy to chemical energy**: It is only through the process of photosynthesis that solar energy to chemical energy e.g. Food

MINERAL REQUIREMENT OF PLANTS

Mineral salts: They are elements or nutrients needed by plants either in large quantity or small quantity for normal growth.

For optimal growth, plants require certain chemical elements which are taken in by plants in form of mineral salts from the soil in solution form. This terrestrial (land dwelling) plants obtain all the nutrients from the soil through the roots while aquatic plants absorb nutrient from their water habitat and from their mud which the roots of such plants may be in contact with.

The soil is the main source of mineral salts while gaseous elements such as

Elements	Functions	Deficiency/ symptoms
Nitrogen(N)	Synthesis of protein Formation of nucleic acid Formation of chlorophyll Constituents of all enzymes and protoplasm soil	Stunted growth with very small yellow leaves **Sources** Nitrates in the soil, ammonium salt in the soil
Phosphorous (P)	Formation of co-enzymes and nucleoprotein. Acting as a buffer in a cell sap. Help in root development.	Weak slender stem Delayed growth Moulting of leaves Purple colour of leaves **Sources** Phosphate salt in the soil
Potassium (K)	It aids cell formation Regulation of certain cell activities It aids synthesis of CHO	Brown/Orange colour at margin of leaves Weak slender stem. **Sources** Potassium salts in soil
Iron(Fe)	Chlorophyll formation	Yellowing of the leaves (chlorosis) Poor growth **Sources** Iron salts in the soil.
Calcium (Ca)	Formation of cell wall and cell membrane Activates certain enzymes Neutralizes organic acids Normal growth of root/ tips	Weak slender plants Poor root development Stunted growth **Sources** Calcium salts in the soil
Magnesium (Mg)	Formation of chlorophyll	Yellowing of leaves Poor growth **Sources** Magnesium salts in the soil
Sulphur (S)	For protein synthesis	Yellowing of leaves Stem become slender/ weak stem **Sources** Sulphate in the soil
Copper (Cu)	Constituent of respiratory enzymes	Poor growth Pale green colour of the leaves
Manganese (Mn)	Activation of some enzymes for anaerobic respiration	Poor leaf formation
Boron(B)	Transport of calcium and sugar Cell division in meristem	Shoot turns brown
Molybdenum	Aids nitrogen fixation Metabolism of nitrate	Retarded growth Necrosis of leaf tissues

oxygen, hydrogen and carbon are mainly derived from the atmosphere

These elements or plant nutrients are grouped into two classes depending on the quantity that is required by plants. They are as follows;

1. **Major/ essential/macro elements**: They are mineral elements or nutrients required in large quantities for healthy growth and development of plants. Examples are Nitrogen, Phosphorous, Potassium, Magnesium, Calcium, Iron, Sulphur, Oxygen, Hydrogen and Carbon. They are readily made available in form of PO_4^{3-}, SO_4^{2-}, Mg^{2+}, Ca^{2+}, K^+, NO_3^-, and Fe^{3+} (Ferric ion).

2. **Minor/Non-essential/Micro/Trace elements**: They are mineral elements or nutrients required in small quantities for healthy growth of plants. Examples are Manganese, Zinc, Copper, molybdenum, Cobalt, Chloride, and Boron mainly for the formation of pigments and enzymes. When a plants lacks any of these elements, it shows certain signs called deficiency symptoms.

   The functions and deficiency of these elements are stated in the table below;

NOTE: Necrosis means death of cells or tissues. It is not a disease, but rather a symptom of disease or other distress the plant is experiencing. The affected plant tissue usually turns from brown to black in colour.

CULTURE SOLUTION

A culture solution is a solution containing all the major elements required by plants for the normal growth and development. It is also known as water culture solution. Example of culture solution usually prepared in the laboratory are;

1. Knop's culture solution
2. Sach's culture solution

Both culture solutions are called complete culture solution because they contain all the elements necessary for plant growth in their correct proportions

Culture 1: Knop's culture solution

	Salt	**Chemical formulae**	**Quantity (gm/ litre)**
1	Calcium nitrate	**$Ca(NO_3)\ 4H_2O$**	**0.8**
2	Potassium nitrate	KNO_3	**0.2**
3	Potassium dehydrogen phosphate	**KH_2PO_4**	**0.2**
4	Magnesium Sulphate	$MgSO_4$, $7H_20$	O.2
5	Iron (III) phosphate	**$FePO_4$**	**Trace**

Culture solution II: Sach's culture solution

	Salt	Chemical formulae	Quantity (gm/litre)
1	Calcium sulphate	$CaSO_4$	0.5
2	Calcium Phosphate	$Ca_3(PO_4)$	0.5
3	Magnesium Sulphate	$MgSO_4,7H_2O$	0.5
4	Sodium Chloride	NaCl	0.5
5	Potassium nitrate	KNO_3^-	1.0
6	Iron (III) chloride	$FeCl_3$	Trace

Note: If any element is missing from the soil, the plant will not grow well as already mentioned previously and it is said to suffer from mineral deficiency diseases.

Experiment on mineral deficiency

AIM: To show the effect of mineral deficiency on plants.

MATERIALS: Nine wide mouthed jars, nine bean seedlings of the same age and size, Sach's or Knop's complete culture solution, black paper or ink, copper chloride solution, ammonium molydate, manganese chloride, zinc chloride.

METHOD: The nine jars containing culture solution with a healthy seedling each is set up as follows:

Jar 1: Contains complete culture solution which serves as a control.
Jar 2: Contains solution lacking nitrogen.
Jar 3: Lacks potassium.
Jar 4: Lacks sulphur.
Jar 5: Lacks magnesium.
Jar 6: Lacks calcium.
Jar 7: Lacks phosphorus.
Jar 8: Lacks iron.
Jar 9: Contains only distilled water (i.e. it lacks all the necessary element needed for plant growth and development

OBSERVATION: The seedling in jar 1 grew very well because all the needed elements were present. Jar 9 withered within two days. The other jars i.e. 2 to 8 showed deficiency symptoms according to the nutrients lacking in each.

CONCLUSION: Plants will grow well and healthy if all the elements are present but the lack of one of the elements will affect the normal growth and development of plants.

DIAGRAM OF WATER CULTURE EXPERIMENT

Precaution to be taken when performing experiment

1. The apparatus must be kept clean or sterilized to prevent infection of seedling or contamination of nutrient solution.
2. Culture vessels must be painted with black paper to make sure that light is excluded to prevent growth of algae that might damage the roots and also alter the decomposition of the solution.
3. Cotton wool and stoppers must be dry so as to avoid rotting of stems by the growth of microbes and also to hold plant in position.
4. There should be constant aeration to provide air or oxygen for the root to carry out respiration, growth and other metabolic process
5. There should be frequent topping up or replacement of the culture solution every forth night to ensure adequate supply of nutrient
6. The jars must be exposed to the same light and temperature condition
7. Variable seedlings of the same size and age is required
8. Distilled or deionized water must be used in the experiment

NITROGEN CYCLE

Nitrogen cycle is the process by which nitrogen is naturally added and removed from the atmosphere and soil

Nitrogen is used for the synthesis of protein. Living organisms therefore need nitrogen for growth as well as the efficiency of their life processes. Most plants cannot absorb atmospheric nitrogen but can only obtain nitrogen from the soil in form of nitrates. The two major processes by which nitrogen can be removed from the atmosphere are;

1. Electrical discharge through thunderstorm and lightening
2. Nitrogen fixation

Electrical discharge:

During thunderstorm and lightening, atmospheric nitrogen combines with oxygen to form nitric oxides (nitrogen II oxide). The nitrogen II oxide combines with more oxygen to form Nitrogen (iv) oxide

Nitrogen (iv) oxide so formed, combines with rain water to form nitrous and nitric acid (acid rain) and falls as acid rain. The acid rain so formed, combines with mineral salt in the soil to form nitrates which the plant roots absorbs and use to synthesize protein and other nitrogenous compound.

$$N_2 + O_2 \rightarrow 2NO$$

$$2NO + O_2 \rightarrow 2NO_2$$

$$2NO_2 + H_2O \rightarrow \underset{\text{(Nitric acid)}}{HNO_3} + \underset{\text{(Nitrous acid)}}{HNO_2}$$

Nitrogen fixation:

This is the process by which free atmospheric nitrogen is converted to nitrate in the soil or in the roots noodles of legumes which occurs in two ways;

i. Symbiotic nitrogen fixation
ii. Non- symbiotic nitrogen fixation

Symbiotic nitrogen fixation: Some bacteria such as **rhizobium** which lives in the root noodles of leguminous plants can fix atmospheric nitrogen directly into the soil. The plant supplies carbohydrates (food) for use by the bacteria while the bacteria supply the plant with nitrogen (both benefiting from the association).

When these organisms die, their bodies are decomposed and protein they contain are converted to soil nitrate.

Non-symbiotic nitrogen fixation: Some bacteria such as **Azotobacter**, **clostridium** and **blue green algae (Nostoc)** also live freely in the soil and can fix atmospheric nitrogen into the soil by converting it into organic nitrogenous compounds (protein) within their bodies. For these organisms to manufacture proteins, they require energy which they draw from carbohydrates obtained from humus.

Importance of Azotobacter

1. It is a nitrogen fixing bacteria found in the soil that converts nitrogen in the soil to ammonium compounds and protein
2. It also converts nitrites to nitrates in the soil

Other methods by which nitrogen can be converted into nitrates in the soil for plant use are;

a. **Ammonification/ putrefication**: This is the process by which dead decaying plants and animals, waste products of other organisms are being converted into ammonium compound and are added into the soil by putrefying bacteria.

b. **Nitrification**: This is a process by which ammonium compound in the soil is being converted into nitrites by bacteria known as **nitrosomonas** and nitrites is converted into nitrates by another bacteria known as **nitrobacteria**. The two bacteria are called **nitrifying bacteria**. Then nitrates in the soil can be absorbed by plant roots.

c. **Denitrification**: This is the process by which nitrates in the soil is converted into atmospheric or gaseous nitrogen by **denitrifying bacteria** or fungi and sent back to the atmosphere. This process leads to reduction in the soil nitrogen content, hence resulting to decrease in soil fertility.

Differences between nitrogen fixation and denitrification

Nitrogen fixation	Denitrification
Free atmospheric nitrogen is added to the soil	Nitrates in the soil is converted into atmospheric nitrogen
Nitrogen fixing bacteria are involved	Denitrifying bacteria are involved
It involves symbiotic and non-symbiotic bacteria/ organisms	Purely no symbiotic bacteria or organisms
Moderate soil temperature is required	High temperature is required

Generally, nitrogen is made available to the soil in the following ways;

1. Through nitrogen fixation
2. Through thunderstorm or lightening
3. By application of farmyard manure or animal dung
4. By putrefaction or decaying of organic matter
5. By application of artificial fertilizer e.g NPK
6. Through the process of nitrification by nitrifying bacteria

Nitrogen is lost from the soil by;

1. Action of denitrifying bacteria
2. By action of leaching and erosion
3. By absorption by plant roots

HOW NITROGEN FROM URINE GET TO THE ROOTS OF PLANTS

When a person passes urine on the soil, ammonium compound/ urea present in urine is converted into nitrites by nitrifying bacteria or nitrosomonas. The nitrites are oxidized to nitrates by other nitrifying bacteria or nitrobacteria. Then the roots of the plants absorb the nitrates.

DIAGRAM OF NITROGEN CYCLE

ANIMAL NUTRITION

Animals carry out heterotrophic nutrition because they cannot manufacture their own food unlike plants. They depend directly or indirectly on plants for their food. We group the type of feeding found in animals as **holozoic**. We further classify animals based on the type of food they eat;

1. Carnivorous animals; Flesh eaters only e.g. lion, snake, tigers etc.
2. Herbivorous animals: Plants eaters only e.g. goat, sheep, cow, rabbit etc.
3. Omnivorous animals: Both plant and flesh eaters e.g. man, pig etc.

The main processes involved in holozoic nutrition are:

Ingestion → Digestion → Absorption → Assimilation → Egestion

Classes and sources of food

We have six major classes or groups of food substances/nutrients. They are;

1. Carbohydrates
2. Proteins
3. Fats and oil
4. Vitamins

5. Mineral salts
6. Water

Carbohydrates, proteins, fats and oil and water are known as the primary food substances because they are necessary for maintenance of life and also form the basic chemical building blocks of organisms together with the nucleic acids.

Mineral salts and vitamins are known as welfare food substances because they are needed for the well-being of the individual.

CARBOHYDRATES

They are energy giving food. The elements contained in carbohydrates are carbon, hydrogen and oxygen. The ratio of hydrogen to oxygen is 2:1 as in the case of water. They have a general formula $C_x(H_2O)_Y$.

Sources:

The main sources of carbohydrate are potatoes, cassava, rice, bread, yam, maize, garri, e.t.c.

Types of carbohydrates:

There are 3 types of carbohydrates. They are;

A. **Monosaccharides or simple sugar or reducing sugar**: They are the simplest sugar e.g. glucose with chemical formular $C_6H_{12}O_6$. Other examples are

Glucose – grape sugar
Fructose – fruit sugar
Galactose.

B. **Disaccharides**: These are complex non- reducing sugars formed by joining or condensation of two units of simple sugar molecules. When heated with dilute Hydrochloric acid, they are broken down to simple sugar (i.e. hydrolysis). The chemical formular is $C_{12}H_{22}O_{11}$. E.g. sucrose found in sugar cane stems, ripe sweet fruits and storage roots (like sugar beets and carrot), lactose (found in milk of mammals) and maltose (i.e. malted cereals and sprawling grains).

Maltose = glucose + glucose
Lactose = glucose + galactose
Sucrose = glucose + fructose

C. **Polysaccharides**: These include glycogen (animal starch), starch and cellulose. They are made up of condensation of hundreds of simple sugar molecules. Starch are white and insoluble substances.

Functions of carbohydrates

i. It provides energy
ii. It provides or generate heat during its oxidation used in maintenance of body temperature
iii. It is the starting point for the synthesis of proteins and lipids
iv. Excess is stored as glycogen for later use
v. Mucus which are important lubricant in the body is composed of carbohydrate

Note: Excess carbohydrate leads to obesity while lack of carbohydrate causes weakness, fatigue and tiredness.

PROTEIN

These are complex organic compound made up of smaller unit of amino acids**.**

The elements contained in proteins are nitrogen, carbon, hydrogen, oxygen, sulphur and phosphorous. The major element in protein is Nitrogen. Proteins are found in the flesh of vertebrates known as **MYOSIN**, in milk as **RENIN**, in cheese as **CASEIN** and in eggs as **ALBUMEN**.

Deficiency of protein results in **kwashiorko**r and **marasmus**. Kwashiorkor usually occur in children between one to four years, who after late weaning, are put on starchy diet. The children have the following appearance;

1. Poor growth
2. Thin and tiny legs
3. Swollen stomach
4. Oedema, swollen legs and feet
5. Skin becomes scaly, decoloured and may crack
6. Diarrhoea
7. Pale body
8. Anaemia
9. Liver may fail to function properly

Marasmus follows early weaning, occurs in infants under the age of one. The infant shows poor growth and look like a " wizened old man".

Sources

The main sources of protein are beans, meat, egg, fish, groundnut, milk, cheese etc.

Functions of protein

1. For growth/ body building
2. For repair/ formation of worn-out tissues
3. Oxidized to give energy in the absence of carbohydrates
4. For synthesis/ production of enzymes and hormones
5. Formation of blood protein/fibrinogen

FATS AND OIL

They are also called lipids. They are made up of fatty acids and glycerol. Fats are solid at room temperature while oil is liquid at room temperature.

The elements that make up fats and oil are carbon, hydrogen and a little oxygen.

Sources

Butter, groundnut oil, palm oil, margarine, avocado pear, olive oil, melon oil, sesame seeds etc. They are soluble in alcohol but insoluble in water.

Functions of fats and oil

1. Oxidized to give energy.
2. Stored under the skin in adipose tissue to insulate or prevent loss of heat.
3. Formation of cell membrane.
4. Stored as food reserve.
5. It protects vital organs of the body
6. It forms solvent for some fat soluble vitamins like A,D, E and K

MINERAL SALTS

They are in organic salts which regulates the body metabolism of living organisms. Humans needed about 15 different mineral salt in their diet. Lack of these results in nutritional deficiency symptoms. Examples of mineral salts are Calcium, Iodine, Phosphorous, Fluorine, Copper, Iron, Sulphur, Sodium etc.

Sources

Onions, green vegetables, milk, liver, eggs etc.

Generally, mineral salts play specific roles in metabolic processes and maintenance of body.

Mineral salts	**Sources**	**Functions**	**Deficiency symptoms**
Calcium	Eggs, fish, sea food, green vegetables	Bone and teeth formation For blood clotting Proper functioning of the heart, muscles and nervous system	Rickets in children Softened bones in adult (osteomalacia)
Iron	Liver, meat, unripe plantain, eggs, millets etc.	Formation of haemoglobin in red blood cells	Anaemia
Phosphorous	Milk, fish, egg, wheat, liver	For strong bones and teeth Forms part of RNA and DNA For respiration	Rickets
Sulphur	Beans, eggs, table salts, fruits	• Constituent of amino acid	• Kidney failure • Muscle paralysis • Poor growth
Potassium and sodium	Table salts, fruits, vegetables	• Functioning of muscles • Sodium helps to maintain water balance • Transmission of impulses in nerves	• Muscle paralysis • Dehydration • Kidney failure
Iodine	Table salts, sea foods	• Needed for synthesis of thyroxine • For normal reproduction in mammals	• Goitre • Poor growth
Cobalt	Meat etc.	• For haemoglobin formation • Constituent of vitamin B_{12}	• Pernicious anaemia
Fluorine	Drinking water, milk	• Good bone and teeth formation • Prevent dental decay	• Dental caries (weak teeth)
Magnesium	Leafy vegetables, sea food	• For bones and teeth formation • Activates glycotine enzymes in the body	• Depression • Weakness • Disturbed muscle contraction

- **VITAMINS**

They are organic compounds. They are not energy producing. They promote chemical reactions in the body. We have 2 groups, they are;

1. Fat soluble vitamins: vitamin A, vitamin D, vitamin E and vitamin K.
2. Water soluble vitamins: vitamin B and Vitamin C.

Vitamin B is a complex group. Members are;
Vitamin B_1 (Thiamine)
Vitamin B_2 (Riboflavin)
Vitamin B_3 (Niacin)
Vitamin B_5 (Pantothenic acid)
Vitamin B_6(Pyridoxine)
Vitamin B_{12} (Cyanocobalamin)
Folic acid.

Sources

Fruits, vegetables, red palm oil, eggs, milk, animal organs etc.

Generally, vitamins are bi-catalysts. They are also for calcification of bones and formation of red blood cells and they help to maintain the body.

Importance of vitamins

1. For calcification of bones
2. Formation of red blood cells
3. It helps to maintain the body

Types of vitamins and their functions

Vitamins	Sources	Functions	Deficiency symptoms
Vitamin A(Retinol)	Red palm oil, fresh green vegetables, liver, milk, egg yolk and carrot	• Needed for vision in dim light • For normal growth • Normal growth of cells and skin	• Night blindne • Flaky skin
Vitamin B_1	Yeast, beans, unpolished rice, palm wine, liver	• For synthesis of enzymes • Involved in cellular respiration	• Beriberi • Stunted grow
Vitamin B_2	Yeast, beans, unpolished rice, palm wine, liver	• For synthesis of enzymes • Involved in cellular respiration	• Cracking of sl around corne of nose, eyes and mouth
Vitamin B_3 (Niacin)	Yeast, whole grain, milk	• Formation of co-enzymes needed in cellular respiration	• Pellagra • Sore mouth
Vitamin B_{12}	Kidney, liver, milk, fish, green vegetables	• Formation of red blood cells	• Pernicious anaemia
Vitamin C	Fresh citrus	• For healthy bone	• Scurvy

(ascorbic acid)	fruit, paw-paw, guava, fresh vegetables	and dentine • Help to resist infection	
Vitamin D (Calciferol)	Early morning sunlight rays, milk, egg, fish, liver oil	• Formation of strong bones and teeth	• Rickets in children • Softening of bones in adul
Vitamin E (Tocopherol)	Green leafy vegetables, egg, butter, liver	• Promotes fertility in animals • Prevents break down of red blood cells	• Sterility • Reproductive failure
Vitamin K (Phylloquinone)	Tomatoes, egg yolk, green vegetables	• Essential for blood clotting	• Inability/ slov clotting of blo leading to sev bleeding

WATER

It is the basis of all metabolic reaction. We get water from natural sources like rivers, springs, rain, fruits, and vegetables.

When we do not have or take enough water, it can lead to dehydration or even breakdown of metabolic activities. It is made up of the elements hydrogen and oxygen (H_2O).

Importance of water

1. It is an essential part of living protoplasm.
2. It acts as a solvent and transport medium in the body for food substances.
3. It transports waste excretory products.
4. It aids easy digestion of food substances.
5. It aids in the distribution of body heat.
6. It is the main component of the synovial fluid of joints and the amniotic fluid.
7. It allows easy movement of food through the digestive tract.
8. It is needed for Photosynthesis in green plants.
9. It helps in dispersal of seeds/ fruits.
10. It helps in germination of seeds.

ROUGHAGES

Roughages are indigestible cellulose of plant fibres from the cell wall of plant like vegetables and some fruits e.t.c. It provides bulk to the intestinal content and it is also stimulates muscular movement and also bowel movement thereby preventing constipation, prevention of colon (large intestine) cancer.

BALANCED DIET

A balanced diet is a diet containing all six food classes in the right proportion or correct proportion to meet the body's requirement for growth, repair and proper development.

Importance of balanced diet

1. It helps us to resist diseases.
2. For growth and normal development.
3. It provides energy.

4. To prevent malnutrition and other deficiency diseases.

Lesson Seven
NUCLEIC ACIDS

Nucleic acids are found in all living cells. They are composed of strands made up of repeating units called **Nucleotides**.

Nucleotides is defined as a basic block of a nucleic acid consisting of a ribose, deoxyribose, protein, a phosphate group and a nitrogen base. There are two types of nucleic acids;

1. DNA (Deoxyribonucleic acid)
2. RNA (Ribonucleic acid)

The sugar in RNA is a ribose while that of DNA is deoxyribose.

STRUCTURE OF THE DNA

DNA is found in the chromosome located in the nucleus of cells. It stores organism's hereditary characters or traits in coded form. It also directs the metabolic activities of the cells.

DNA molecules consists of two strands twisted about each other as a double helix. Each strand is made up of nucleotides which are repeated many times. Each nucleotide consists of a sugar (deoxyribose), a phosphate and a nitrogenous base. We have four nitrogenous bases which are classified into two;

1. **Purines**: which consists of Adenine and Guanine
2. **Pyrimidines**: which consists of cytosine and thymine.

Adenine on one strand pairs with thymine on the other strand, while Guanine pairs with cytosine. This pairing is held together by a hydrogen band.

A → T
G → C

RNA

The RNA is found in the cytoplasm of a cell and its main function is for the synthesis of protein under the influence of DNA. RNA is similar to DNA except that it occurs as a single strand consisting of ribose sugars instead of deoxyribose sugars.

DIFFERENCES BETWEEN DNA AND RNA

DNA	RNA
Double strands of polynucleotide chain	Single strand of polynucleotide chain
Deoxyribose sugar	Ribose sugar
Possesses thymine nitrogenous base	Possesses uracil nitrogenous base
Present in the nucleus	Present in the cytoplasm
Stores hereditary traits	Does not store hereditary traits
Does not synthesize protein	Synthesizes protein

FOOD TESTS

Food	Test	Observation	Inference
Test for starch e.g. Yam, bread	• Crush a piece of food e.g. yam • Add a little distilled water to the crushed food to form a solution. • Then put few drops of solution of the food substances (yam) in a test-tube. • Then add one or two drops of iodine solution.	The solution of the food turns into a blue- black or black colouration on addition of iodine solution	Starch is present and confirmed
Test for simple sugar or reducing sugar e.g. glucose	• Glucose + H_2O to form solution • To the solution above, add few drops of Benedict's solution and heat	• Soluble and colourless solution • The colourless solution turns to light blue but on heating changes to brick red precipitate	Reducing or non-reducing sugar suspected Glucose is present
	OR • Glucose + H_20 to form a solution. • Then glucose solution plus few drops of Fehling's solution	•An orange/ brick red precipitate is formed	Glucose is present and confirmed

TEST FOR COMPLEX OR NON- REDUCING SUGARS

Food	Test	Observation	Inference
Sucrose or altose or lactose	Sucrose + H_20 to form a solution	Colourless and soluble in water	Simple or complex sugar
	Solution + dilute HCL and then heat (i.e. hydrolysis)	Colourless solution is	Non-reducing

	complex food is being broken down to simple sugar	formed	sugar present
	Solution + dilute HCL + heat + NaOH (i.e. to neutralize the acidic content of the food	Colourless solution is formed	Sucrose present
	Solution + dilute HCL + NaOH + few drops of Benedict's solution and heat	Orange to brick-red precipitate observed	Sucrose present and confirmed

TESTS FOR PROTEIN

The presence of protein in any food substances may be tested for by the following;

1. Biuret test
2. Millions test
3. Xanthoproteic test

BIURET TEST

Food	Test	Observation	Inference
Fresh milk or egg white	To small quantity of milk in a test tube, add Sodium hydroxide and 1% of Coper (II) sulphate solution and shake. No heat is required	Creamy solution turns purple or violet precipitate	Protein present and confirmed

Million's test

Food	Test	Observation	Inference
Egg white or milk	Put few egg white in a test tube, add few drops of Million's reagent and warm/ heat the mixture	White precipitate which quickly turns to brick red precipitate on heating	Protein is present

Xanthoproteic test

Food	Test	Observation	Inference
Milk or egg white	• To milk, add a few drops of concentrated nitric acid and heat • Allow to cool • Then add excess ammonium hydroxide solution	A white precipitate is formed which turns yellow on heating. On cooling and adding ammonium hydroxide, it turns to deep orange precipitate.	Protein is present

TEST FOR FATS AND OILS

The presence of fats and oils or lipids can be tested by

1. Translucent test
2. Sudan test

Test	Observation	Inference
1. Translucent test Drop oil on a filter paper, observe the spot against a source of light.	It shows translucent mark i.e. it allows more light to pass through when held in front of a source of light.	Fats and oil are present.
2. Sudan (III) test To small quantity of oil, add few drops of Sudan(III) solution and heat	Red colouration observed on heating i.e. changes to black precipitate.	Fats and oil is present and confirmed

TEST FOR WATER

Test	Observation	Inference
Water as a solution, few drops of it was added on anhydrous white solid copper II sulphate	The white solid anhydrous copper (II) sulphate change from white to blue colour	H_2O is present and confirmed
Dip a blue dry Cobalt chloride paper in a food item that contains water	OR The colour of the paper changes from blue to pink	Water present and confirmed

ENZYMES

Enzymes are organic substance or protein or catalyst secreted by special groups of cells in living organisms which speeds up the rate of chemical reaction without being altered in the process.

Enzymes are responsible for controlling all the metabolic or chemical reactions which takes place in the body of living organisms.

Types of enzymes

There are two major types of enzymes. They are;

1. **Intracellular enzymes:** These are enzymes that function inside the cells of living organisms**.** They are the enzymes that catalyze cellular respiration inside the mitochondria.
2. **Extracellular enzymes:** These are enzymes that function outside the cells e.g. digestive enzymes.

Characteristics of enzymes

1. They are protein and soluble in nature
2. They are organic catalyst which speeds up the rate of chemical reaction
3. They are usually involved in reversible reactions
4. They are sensitive to PH medium of their environment
5. They work best at optimal temperature, high temperature destroys enzymes while low temperature inhibits their activities.
6. They are affected by intake of poisons

7. They are required in smaller quantities for catalysis
8. Enzymes can function outside the organisms that produce them e.g. housefly and fungi
9. They remain unchanged at the end of the chemical reaction

SUMMARY OF SOME DIGESTIVE ENZYME

Enzymes	Source/ gland	Digestive juice	Site of action	Food acted upon	PH	End product or effect
Ptyalin	Salivary gland	Saliva	Mouth	Cooked starch	Alkaline	Maltose
Pepsin	Gastric gland	Gastric juice	Stomach	Protein	Acidic	Peptone
Renin	Gastric gland	Gastric juice	Stomach	Milk protein	Acidic	Thick curd or casine
Amylase	Pancreatic gland	Pancreatic juice	Duodenum	Left over starchy food	Alkaline	Maltose
Trypsin	Pancreatic gland	Pancreatic juice	Duodenum	Peptone	Alkaline	Polypeptides
Lipase	Pancreatic gland	Pancreatic juice	Duodenum	Fats and oil	Alkaline	Fatty acid / glycerol
Maltose	Succus entricus	Intestinal juice	Small intestine	Maltose	Alkaline	Glucose + glucose
Sucrose	Succus entricus	Intestinal juice	Small intestine	Sucrose	Alkaline	Glucose + fructose
Lactase	Succus entricus	Intestinal juice	Small intestine	Lactose	Alkaline	Glucose + galactose
Erepsin	Succus entricus	Intestinal juice	Small intestine	Polypeptide	Alkaline	Amino acid
Lipase	Succus entricus	Intestinal juice	Small intestine	Fats and oil	Alkaline	Fatty acid and glycerol

Classification of digestive enzymes

These are named according to the food substance on which they act on. They are;

1. **Proteases:** act on proteins
2. **Amylase:** act on carbohydrates
3. **Lipases**: act on fats and oils
4. **Cellulase**: act on cellulose

Functions of digestive enzymes

1. It helps in breaking down protein into amino acid
2. It helps in breaking fats and oils into fatty acid and glycerol
3. It breaks down carbohydrates into glucose, fructose and galactose
4. They help in the absorption of digested food through the addition of water to the food

MODES OF NUTRITION

Mode of nutrition can be broadly grouped into two major classes;

1. Autotrophic nutrition
2. Heterotrophic nutrition

Autotrophic nutrition

This type of nutrition is carried out by organisms that are able to manufacture their food. The organisms are known as autotrophs. Autotrophic nutrition can be further divided into two which are;

I. Chemosynthetic nutrition
II. Photosynthetic or Halophytic nutrition

Chemosynthetic nutrition: It occurs in primitive plants or bacteria. They lack pigment chlorophyll but are able to manufacture their food using simple inorganic compounds like ammonia, carbon (IV) oxide, nitrate, water etc. The energy for the process comes from the oxidation of the inorganic materials (chemical) e.g. nitrosomonas, nitrobacteria, sulphur bacteria, nitrococcus etc.

Photosynthetic / Halophytic nutrition: This is carried out by all green plants with pigment chlorophyll, in which they manufacture their own food making use of CO_2 and water in the presence of sunlight energy captured by chlorophyll. Here, the energy for making food comes from sunlight and it is trapped by chlorophyll e.g. flowering plants, spirogyra, euglena, Chlamydomonas etc.

Heterotrophic nutrition:

This is the type of nutrition in which organisms cannot manufacture their own food but depends directly or indirectly on plants for their own food. We refer to such organisms as heterotrophs. Most animals, protozoa, fungi belong to this group. Heterotrophic nutrition can be subdivided as follow;

1. **Holozoic nutrition**: This involves the digestion of complex food substances by help of enzymes to simple substances which are absorbed and used in the body. We can group holozoic organisms as follow;

a. Herbivores: They feed on plants e.g. cattle, goat, rabbit etc.
b. Carnivores: They feed on flesh e.g. dogs, cats, lion etc.
c. Omnivores: Which eat both plants and animals e.g. man, pigs etc.
d. Scavengers; They are organisms that feed on dead animals e.g. vulture
e. Frugivorous: Animals that feed on fruits e.g. parrots and squirrels

II. Parasitic nutrition: This is the type of nutrition in which certain organisms known as parasites obtain their food or energy from the body of another living organism known as the host thereby causing harm and danger to the host. The two organisms are of different species. The association is called parasitism.

A parasite is an organism which lives in or on the host, obtaining food and shelter from the host and in the process causing harm or even death to the host. Animal parasites are classified into;

1. Ectoparasite
2. Endoparasite

Ectoparasite : are those parasite that lives outside or on the body of the hosts and derive food and shelter e.g. flea, body louse, bed bug, Aphid, tick and cotton strainers.
Aphids and cotton strainers are ectoparasites of plants.
Endoparasites: are those parasites that lives inside the body of their host and derive food and shelter e.g. Tapeworm in intestine of man, ascaris, liver fluke, elephantiasis (wucheraria bancrofti), guinea worm, all are endoparasite of man and other animals.

TAPEWORM

It is a long parasitic flatworm which lives in the gut of small intestine of human. Several species of tapeworm infect human e.g; Taenia solium is found in pig. Taenia saginata is found in beef/ cattle

The adult tapeworm is found in the small intestine of man while the bladder worm is found in the intestine of cattle and pork, therefore man is the primary host while cattle/ pork becomes the secondary host.

Tapeworm can get into man's body when we eat raw vegetables or undercooked part of meat (cattle/pork) containing the bladder worm. Once the bladder worm is eaten, the digestive enzymes of man dissolves the bladder worm and the young tapeworm emerge.

Adaptation of Tapeworm to Parasitic mode of life

1. Possesses hooks on the scolex for attachment to the gut wall/small intestine of the host.
2. Presence of suckers for attachment to gut wall of host.
3. Flat- shape to provide large surface area for absorption of digested food.
4. Thick body cuticle which resist digestive enzymes of the hosts.
5. Has no digestive tract because they can absorb digested food through the body surface.
6. It is hermaphrodite to allow successful sexual reproduction.
7. Mature proglottides loaded with fertilized eggs and are expelled with faeces of the host for dispersal

Economic importance of tapeworm

1. It causes anaemia.
2. It causes weakness and loss of weight.
3. It causes abdominal pain or discomfort.
4. It causes indigestion and vomiting.

Control of tapeworm

1. Examine the meat thoroughly for bladder worm before serving to the public.
2. Cook meat properly before eating.
3. Treat infected person by regular deworming.

General effects of parasites on host

When the parasite absorb nutrients from the body of their host, it causes the following

1. It can lead to low resistance of diseases in the host
2. It leads to loss of blood
3. It leads to stunted growth
4. It leads to loss of weight

5. It leads to anaemia
6. It causes death of the host
7. It can devalue the worth of the animal skin hence reducing the value of the farm animal

Plant parasites

Plant parasites are;

1. Dodder (Cassytha filiformis)
2. Mistletoe

Dodder or Cassytha filliformis: It is a thin thread- like stem which curls around the stem of the root (i.e. another plant). It has no roots, no chlorophyll hence cannot manufacture food. It has suckers which grows through the stem of the host until it reaches the phloem tissue of the host from which it absorbs already manufactured food from the host. Cassytha is usually regarded as a complete parasite because it absorbs already made food from its host.

Mistletoe: It is another parasitic plant commonly found growing on another plant called the host. It has green leaves and so can synthesize its own food. However, it is regarded as a partial parasite because its roots only penetrate into the xylem tissues of the host where it only absorbs water to enable it manufacture its own food through the process of photosynthesis.

Diagram of mistletoe

1. **Mutualistic nutrition**: This is the type of nutrition in which the two organisms of different species live together and derive nutrients or food from each other. It is also known as symbiosis nutrition and the association between the two organisms is said to be symbiosit. The association is known as symbiosis.

Apart from nutritional benefits like protection, shelter and reproduction.

Examples;

I. **Certain bacteria (Rhizobium) in the root noodles of leguminous plants;** The root noodles provide food and protection to the bacteria in return for nitrogen for the plants use.

II. **Sea anemones and hermit crab**: The sea anemones attach itself to the empty shell of a hermit crab to feed on the pieces of food left behind by the crab and the sea anemones provide protection for the crab.

III. **Intestine of herbivores and rabbits**: Herbivores like rabbits are able to digest cellulose contained in their food by the action of cellulose (enzyme) secreted by cellulose bacteria found in their intestine. The herbivores in turn provides food, shelter and protection to the bacteria

IV. Lichens which are symbiotic association of algae and fungus. The green algae manufacture food for both plants and fungus protects the algae and absorb water from its surrounding.

4. **Saprophytic nutrition**: This is the type of nutrition in which certain organisms called saprophytes obtain energy by feeding on dead organic matter hence bringing about their decomposition. The association is called saprophytism. Example moulds found on spoilt bread, mushroom growing on damp wood, Rhizopus on food, penicillium bacteria etc.

RHIZOPUS NUTRITION

Rhizopus grows on organic matter e.g. damp moist food/ bread and decaying substance. Its hyphae penetrate the substance and secretes hydrolysing enzymes which digest the food outside the body (extracellular digestion). The hyphae or rhizoids absorbs the digested food for metabolic activities.

5. **Carnivores / insectivorous plants**: These are plants in addition to being autotrophic and photosynthetic have special devices for trapping and digesting insects and other smaller animals to balance nitrogen defficiency and use it to synthesize protein. This is because these plants grow in nitrogen deficient soil. Examples are pitcher plant, bladdewort, sundew, venus flytrap etc.

For instance, in pitcher plants of the nepenthes and sarracenia, has a lid which when insects fall into it, it responds by closing up. The sac contains liquid coupled with enzymes secreted to hasten digestion and absorption.

In sundew (Drosera), it has long hair leaves that when flies land on it, it curls over the insect, secrete enzymes and digest it.

DIAGRAM OF VENUS FLYSTRAP

DIAGRAM OF PITCHER PLANT

VIRUS

Virus is a microscopic organism which cannot be seen with the naked eyes except by an electron microscope. It does not have a cell structure but is made up of coiled strand of nucleic acid (i.e Ribonucleic acid (RNA) or Deoxyribonucleic acid (DNA)) which is enclosed within a protein coat. It does not have structures used in the synthesis of protein. The study of virus is known as virology.

We can classify virus into living and non-living things based on the following reasons;

As a living thing

1. Virus can reproduce only in another living cell.
2. It possess characteristics which can be transmitted from one generation to another.
3. It possess either DNA or RNA

As a non-living thing

1. When it is removed from a living cell and placed in a non-living medium it assumes a crystalline form, thus becoming a non-living thing.
2. It cannot respire, excrete or respond to stimulus.

Lesson Seven
RELEVANCE OF BIOLOGY TO AGRICILTURE.

Agriculture is the act of growing crops and rearing of animals.
Biology and agriculture are closely related because they both deal with plants and animals.

CLASSIFICATION OF PLANTS

Plants can be classified into three different ways:

1. **Botanical classification**: This is by the use of the binominal system.
2. **Agricultural classification**: Plants can be classified for the products for which they are grown. These includes;
   a. **Cereals**: These are the grain crop which belongs to the grass family. They generally provide carbohydrate. Examples include maize, rice, millet, wheat, oats e.t.c.
   b. **Legumes**: They are important source of protein and also add nitrates into the soil. E.g. Cowpea, beans, groundnut, crotalaria, soya beans, pride of babardos, flamboyant e.t.c.
   c. **Roots and tuber crops**: They are grown mainly for starch. E.g. Yam, cassava, sweet potatoes, carrots e.t.c.
   d. **Vegetables**: They are herbaceous plant which provides vitamins and mineral salts. E.g. pepper, tomatoes, okra, onion, lettuce e.t.c.
   e. **Fruits**: They provide vitamins and mineral salts. Most plants are grown for their fruits. E.g. orange, mango, banana, pawpaw, pineapple e.t.c.
   f. **Beverages and drugs**: They provide food drinks when processed and some are medicinal in function. E.g. coffee, cocoa, tobacco, quinine from the bark of anchona spp.
   g. **Spices**: They are mainly for flavouring food. E.g. ginger, garlic, pepper, nutmeg e.t.c.
   h. **Oil**: The fruits and seeds of some plants are rich in oil. E.g. oil palms, sheabutter, groundnut, cotton flower, melon e.t.c.
   i. **Forage crops**: They are grasses and legumes grown for animal feed e.g. hay.

j. **Fibres**: They are used for making ropes and clothes. E.g. jute, cotton, hemp, kapop e.t.c.
k. **Latex**: Some plants produce a milky fluid called **Latex** when they are cut on the stem. The latex can be used to make rubber in plastic industries. E.g. Rubber plant.

CLASSIFICATION BASED ON LIFE CYCLE

Plants are grouped into three categories:

a. **Annual plants**: These are plants that complete their life cycle in one growing season i.e. one year. They grow, mature and produce seeds within one year. E.g. groundnut, maize, cowpea, rice, cotton, guinea corn e.t.c.
b. **Biennial plants**: Theses plants complete their life cycle within two years. In the first year, they develop vegetative parts, produce seeds and die in the second year. E.g. carrot, cabbage, cocoyam, onion, ginger e.t.c.
c. **Perennial plants**: These are tree, shrubs and herbs that grow, mature and produce seeds for more than two years. They continue to grow from year to year. E.g. hibiscus, banana, oil palm, cocoa, rubber e.t.c.

EFFECTS OF AGRICULTURAL PRACTICES ON ECOLOGICAL SYSTEM

The balance of ecosystem is disrupted by man through various activities; one of the most important is agriculture. The following are some agricultural practices and their effects;

1. **BUSH BURNING**: This is the setting of fire on the bush in order to clear the farm land or vegetation.

EFFECTS OF BUSH BURNING

i. It destroys the organic matter in the soils.
ii. It leads to air pollution.
iii. It destroys some micro-organisms in the soil.
iv. It exposes the soil to erosion and leaching.
v. It releases mineral salts like potassium and phosphorus into the soil in form of ash.
vi. The natural food chain is disrupted.
vii. It reduces the water holding capacity of the soil.
Viii It helps to break dormancy of some seeds.

2. **OVERGRAZING**: It is a continuous feeding of vegetation by farm animals. It is also a way of exceeding the carrying capacity of the soil.

Effects of overgrazing

i. It removes the vegetative covering of the soil.
ii. It destroys the soil structure.
iii. It exposes the soil to heat which makes it dry up quickly.
iv. The faeces dropped by this animal can improve the soil fertility.
v. It exposes the soil to erosion.
vi. It leads to compactness of the soil resulting from continuous trampling by animal hoofs.

3. **FERTILIZER APPLICATION**: This is the application of certain chemicals into the soil to improve the soil fertility.

Effects of fertilizer application

i. Excessive use of fertilizer causes increase in soil acidity.

ii. Continuous use over the year results to loss of soil organic matter or humus, hence decrease in soil porosity.
iii. When applied in excess they are washed by rain water into water bodies (i.e. river, stream, ponds) where they cause **eutrophication**.

4. **PESTICIDES AND HERBICIDES**: Pesticides are synthetic organic compounds (chemicals) used for killing pests WHILE herbicides are also chemical substance in form of solution or gases used in destroying herbaceous plants.

There are different categories of pesticides;

HERBICIDES: For killing weeds.
INSECTICIDES: For killing insects.
FUNGICIDES: for killing fungi.

EFFECTS OF PESTICIDES APPLICATION

i. It can pollute the environment.
ii. It affects or destroys other useful plant and animal.
iii. Excessive use may destroy the crop plants.
iv. When washed into rivers, lakes e.t.c they can cause the death of aquatic plants.

5. **TILLAGE**: This is the breaking or loosening of the soil for planting of crops.

Effects of tillage

i. It encourages leaching
ii. It exposes the soil to erosion. It enhances the proper aeration of the soil.
iii. It can lead to loss of fertility.
iv. Over tillage of lands leads to poor vegetation.
v. It exposes micro-organisms (soil) and may kill them.
vi. It increases soil porosity.

Differences between tillage and bush burning

TILLAGE	BUSH BURNING
IT LOOSES the soil	It compacts the soil
It aerates the soil	It leads to poor aeration of the soil
It mixes organic matter with the soil hence improve the soil nutrient	It destroys soil nutrient
It enhances the activities of soil micro-organisms	Soil organisms are killed
It does not lead to air or soil pollution	It leads to soil or air pollution

6. **DEFORESTATION**: This is the continuous removal of trees by indiscriminate felling down of trees without replacing and also by bush burning.

Effects of deforestation

i. It encourages erosion and leaching.
ii. It leads to desert encroachment.
iii. It reduces the humus content of the soil.
iv. It reduces water percolation due to absence of humus and dead leaves on the soil surface.
v. It reduces wildlife population in the area concerned.

7. **CLEAN OR BUSH CLEARING**: This is a farming practice whereby the whole vegetation is cleared and removed, thus leaving the land clean.

Effects of bush clearing

i. It exposes the soil to direct heat from the sun, hence increases the rate of evaporation of water from the soil.
ii. It exposes the soil to erosion and leaching.
iii. It leads to reduction of soil organisms.
iv. It leads to removal of the rich top soil.
v. It reduces the organic content of the soil.

FARMING METHODS AND THEIR EFFECTS ON ECOLOGICAL SYSTEM

1. **MONOCROPPING AND MONOCULTURE**:
MONOCROPPING: Is the growing of one type of annual crop on a piece of land at a given season and harvesting it before planting another.
MONOCULTURE: Is the growing of only one type of crop on the same piece of land from year to year.

Effects of monocropping

i. It provides abundant food for pest of the cultivated crop.
ii. It increases the population of pests and spread of pathogens.
iii. It depletes the soil nutrients.

2. **SHIFTING CULTIVATION**: This is the cultivation of a piece of land for some years and abandoning it for another with no intention of returning to the previous land.

Effects of shifting cultivation

i. It wastes valuable land.
ii. It helps to increase the mineral nutrient of the soil in the abandoned land.
iii. It decreases the activities of useful micro-organisms.

3. **CROP ROTATION**: This is the cultivation of a piece of land year after year but with different crops in a defined manner in order to maintain soil fertility.

A four year crop rotation plan

Year	Plot 1	Plot 2	Plot 3	Plot 4
1	Yam (shallow root)	Maize (shallow root)	Cassava (deep root)	Cowpea (legume)
2	Maize	Cassava	Cowpea	Yam
3	Cassava	Cowpea	Yam	Maize
4	Cowpea	Yam	Maize	Cassava

Effects of crop rotation

i. It controls erosion.
ii. It controls the growth of weeds.
iii. It maximises the use of available land.
iv. It adds nutrient to the soil through the incorporation of legumes in the rotation.

4. **MIXED FARMING**: This is the production of crops as well as rearing of animals on the same farm.

Effects of mixed farming

i. Waste products from farm animals (i.e. dungs) are used to enrich the soil by using them as manure.
ii. It maximises the use of available land.
iii. Some animals serve as a means of transport and also provide labour for ploughing e.g. donkeys.
iv. Farm crops like straw are used to feed the animals.

5. **PASTORAL FARMING**: This is the method of farming in which animals like cattle, sheeps e.t.c. are kept for the purpose of earning income (nomadic farming).

Effects of pastoral farming

a. It leads too overgrazing which result in erosion.
b. It may lead to quarrel between the nomadic farmers and crop farmers when the animals graze and destroys their farms.
c. It is a source of milk, meat and hides.

6. **LAND ROTATION**: This is also known as bush fallows. It is a modified form of shifting cultivation. A piece of land is cultivated until its fertility decreases, it is then allowed to lie fallow until it regains fertility and then the farmer returns to cultivate it again.

METHODS OF REPLENISHING LOST NUTRIENTS IN THE SOIL.

We have different methods of retaining the fertility of the soil. These methods include;

1. **Crop rotation**
2. **Organic manuring**: This involves the application of organic manure to the soil in order to improve soil fertility. Organic manure is decayed plants and animal products carefully prepared to supply nutrients to plants. It has the following advantages.
   - **i.** It helps to promote the fertility of the soil by promoting the activities of soil micro-organisms like earthworm, termite, e.t.c.
   - **ii.** It helps to improve the structure of the soil by binding the particles of coarse texture soil together.
   - **iii.** It helps to conserve moisture and prevent evaporation from the soil.
   - **iv.** It balances the acid-base condition of the soil or soil P.H.
   - **v.** It increases the rate of water percolation through clay soil.

   There are three types of organic manure. They are;
   - **a. Green manure**: This is formed from leguminous crops and other fresh plants which are ploughed into the soil while they are still growing. E.g. Cowpea e.t.c.
   - **b. Farmyard manure**: This is a combination of animal waste such as animal faeces or dung, urine and animal bedding which collectively undergoes series of decomposition before the manure is applied into the soil.
   - c. **Compost manure**: This is formed as a result of rotting down of animal remains in heaps or pits before the residual is applied to the soil.
3. **Bush fallowing**
4. **Cover cropping**
5. **Inorganic fertilizers**
6. **Liming:** This refers to the process whereby calcium or magnesium containing compounds are added to the soil to reduce soil acidity.

USES OF LIME IN AGRICULTURE

1. It helps to reduce or neutralize soil acidity.
2. It helps to increase the activity of soil living micro-organisms.
3. Liming makes nutrients like calcium and phosphorus more readily available for tissue development.
4. It improves soil structure.
5. It increases the rate of water percolation in clay soil.

PESTS AND DISEASES OF AGRICULTURE

Pests are living organisms which cause damage to other organisms, plants and animals as well as their products.

Plant pests are known as weeds. **Weeds** are unwanted or undesirable plants that compete with crops for space, light, nutrient. Examples of weeds are grasses, tridax, desmodium. e.t.c.

Animal pests includes insects, nematodes, rodents, birds, man, monkeys e.t.c

CLASSIFICATION OF INSECT PESTS

These can be classified into various groups based on their mode of feeding. These are;

1. **Biting and chewing insects**: E.g. termites, grasshopper, leaf worms, armyworms, mantid, locusts, beetles e.t.c. They have strong mandible and maxillae mouth parts which enables them to bite and chew plants parts.
2. **Piercing and sucking insects**: E.g. Aphids, cotton stainers, mealy bugs, scale insects, capsids or mirids, white flies e.t.c. These groups possess strong mouthparts called proboscis which enables them to pierce through plants and suck liquid materials from plant tissues.
3. **Boring insects**: E.g. bean beetle, stem borers, maize weevils and rice weevils. These insects and their larvae bore into plants parts and destroy the tissues of plants.

   A major pest of maize is the maize weevil (Citrophilus species). It has the following effects on maize grain:

   1. It consumes the embryo resulting in loss of planting material/seed.
   2. It consumes the endosperm or reserve food hence, reducing the economic and nutritional value of the grain.
   3. It makes hole in the grain in which it lays eggs, reducing the quality and also changing the taste of the grain.
   4. It destroys the texture of the grain thereby reducing the quality of the grain.
   5. Holes created promote secondary infection.

   We can control maize weevils by;

   a. **Chemical control** i.e. use of insecticides and pesticides
   b. **Traditional control** i.e. use of air tight containers/silos with dry pepper.
   c. Avoid mixing old stock of grains with new ones.
   d. Proper drying of grains and storing in a dry place.

DIAGRAM OF DORSAL VIEW OF MAIZE WEEVIL

No.	Insect Pests	Crops Affected	Nature Of Damage and Economic Importance	Prevention and Control Measures
1.	Stem borer	Cereals e.g. rice, maize, guinea corn.	• Larvae bore holes into stem. • They eat up the tissue. • They weaken the plants • Reduced growth and yield.	• Uproot and burn infected plants. • Spray with insecticides i.e. Gammalian 20. • Early planting. • Crop rotation.
2.	Army worm	Cereals e.g. maize	• Larvae invade and eat up leaves and stem. • Reduced photosynthesis. • Retarded growth. • Reduced yield.	• Hand picking. • Spray with insecticides e.g. DDT.
3.	Yam beetles	Tubers e.g. yam	• Bore holes into yam tubers. • Reduction in yield. • Reduction in quantity and market value.	• Dust yam seeds with Adrin dust before planting. • Crop rotation.
4a.	Cassava mealy bugs.	Tubers e.g. cassava	• Twisting of stem and reduced internodes. • Swelling of shoots. • Reduced yield.	• Early planting. • Use resistance varieties. • Dip stem cutting in suitable insecticides before planting. • Spray with insecticides.
b.	Green spider,mites		• They feed on leaves thereby reducing the rate of photosynthesis	• Spray with insecticides.
5.	Cocoa mirids or capsids	Beverages e.g. cocoa	• They inject toxic saliva into plants. • They transmit fungal diseases. • Reduced yield. • Stunted growth.	• Spray with insecticide e.g. Gammalian 20. • Regular weeding.
6.	Cotton stainers.	Cotton	• They pierce and suck sap from plants.	• Hand picking. • Spray with insecticides.

			• Produce toxic saliva. • Reduces the quality of cotton boll	
7.	Cotton bollworm.	Cotton	• Larvae feeds on the seeds of cotton, • Premature fall of cotton boll.	• Spray with insecticides. • Burn cotton plant debris after harvesting.
8.	Leaf eating and punching beetles.	Vegetables e.g. pepper, okro and groundnut.	• They eat up the leaves and stem	• Spray with appropriate insecticide e.g. Vetox 85.
9.	Aphids	Legumes e.g. cowpea, soyabean	• Stunted growth. • Galls on leaves. • Vector of diseases e.g. rosette, mosaic diseases of cowpea.	• Spray with insecticides to kill vectors. • Uproot and burn infected plants.
10.	Bean beetle, grain weevil	Stored produce e.g. rice, cowpea. Maize	• Bore holes into grains and eat them up. • Reduced quality of stored produce. • Reduces grain to powder.	• Early harvesting. • Proper storage of produce. • Proper cleaning or fumigation.

OTHER PESTS, THE CROPS ATTACKED, NATURE OF DAMAGE AND PREVENTION.

No.	Pests	Crops Attacked	Nature Of Damage And Economic Importance	Prevention And Control Measures
1.	Birds	Rice, maize, millet, sorghum	• Feeds on grains in the fields. • Reduction in quality and yield. • Reduction in income of farmers.	• Children to scare birds. • Use scare crows. • Early harvesting.
2.	Rodent e.g. bush rabbit, rat, squirrel	Rice, yam, cassava, fruits.	• They feed on crops. • They destroy the whole plants. • Reduction in yield. • Increase in cost of production.	• Use of traps. • Wire or net fencing. • Use poisoned baits.
3.	Monkeys	Cocoa, mango, banana, orange	• They eat up fruits. • They reduce quality of fruits.	• Use traps. • Shooting with guns where possible.

ECONOMIC IMPORTANCE OF INSECTS PESTS IN PRODUCTION OF CROPS

1. They destroy crops in the fields by biting, chewing, boring e.t.c.
2. They cause reduction in value/quality of stored products.
3. Site of injuries by insects exposes crops to secondary infection.
4. They increase the cost of production during the course of controlling them.
5. They render vegetables and fruits unattractive and unmarketable i.e. reduce the quality.
6. Profit made by farmers is reduced.

7. Some are carriers and vectors of disease causing organisms.

PEST CONTROL

Pests of crops can be prevented or controlled through the following methods;

1. Physical method.
2. Chemical method.
3. Biological method.
4. Cultural method.
5. Modern trends in pest control.

1. **PHYSICAL CONTROL METHODS**: This involves the physical removal of pests by;
   i. Using traps to catch rodents.
   ii. Burning or flooding to destroy soil pests.
   iii. Hand picking of insects and larvae.
   iv. Fencing round the farm with wire nets.
   v. Shooting rodents with gun.

2. **CULTURAL CONTROL METHODS**: This involves the use of farm practices to control pests especially on the field. Examples are bush fallowing, crop rotation, change in time of planting season, regular weeding, proper timing of planting, use of resistant varieties, bush burning, proper time of harvesting e.t.c.

3. **BIOLOGICAL CONTROL METHODS**: This involves the introduction of natural enemies of pests (like predators, parasites or diseases of pests) to destroy or keep the pests population under control. E.g. wasp feeds on stem borer.

4. **CHEMICAL CONTROL METHODS**: This involves the use of chemicals called pesticides to control pests of crop plants. These chemicals may be in form of powder, liquid, granules and tablets. It can be sprayed or dusted on seeds or plants to check pests
   Examples of such chemicals are;

   Pesticides: Chemicals used to control pests.
   Insecticides: Chemicals used to control insects.
   Rodenticides: Chemicals used to control rodents.
   Avicides: Chemicals used to control birds.
   Nematicides: Chemicals used to control nematodes.
   Fungicides: Chemicals used to control fungi.

5. **Modern trends in pests control**: In the sterile male technique, the male insects are sterilized by chemicals and radiation and then released into the pest population. This reduces the pest population.

DISEASES OF CROPS

A plant disease is the condition where there is a deviation of the plant from the normal functioning or state of health, presenting marked symptoms or outward visible signs.

Symptom of disease is defined as any observable effects of an organism caused by the presence or irritation of disease causing agent or pathogen.

CAUSES OF CROP DISEASES

Diseases of crops are caused by the following;

i. Fungi
ii. Virus

iii. Nematodes
iv. Bacteria
v. Nutrient deficiency.

i. **Fungi diseases**: Most disease causing fungi are microscopic and are very common in plants. They are parasitic. E.g. maize smut, rice blight, leaf spot, maize rust, cocoa black pod, coffee leaf rust, okro dumping off, onion twister diseases, rice smut, blast diseases, black spot diseases e.t.c.

ii. **Viral diseases**: The diseases they cause have varied symptoms. These are;
Rosette diseases, cassava mosaic, maize streak, yam mosaic, leaf curl, swollen shoot diseases, chlorosis, necrosis, tristera, cowpea mosaic diseases e.t.c. Many virus infections are spread by insect vectors.

iii. **Bacterial diseases:** These includes;
a. **Blight**: Cassava blight, cotton blight, coconut blight, web blight of cowpea, potato leaf blight, fire blight of apple.
b. **Bacterial wilt**: Cassava wilt, banana wilt
c. **Soft rot**: soft rot of tomatoes, soft rot of carrot, ring rot of potato, onion rot, yam rot e.t.c.
d. **Bacterial gall**: Crown gall of apple, sliminess of vegetables.

iv. **Nematode diseases**: Root knot, golden nematode diseases of potato

Name of diseases	Causal Organism	Mode of transmission	Symptoms and Economic importance	Prevention and control method
Maize smut	Fungus (Ustilago maydis)	Air borne, Spore deposit on fruits.	• Reduced yield • Galls on ears, leaves and tassels which later turns black	• Destroy diseased plants. • Use resistance varieties. • Seed treatment.
Rice blight	Fungus (Piricularia oryzae)	Air borne, Spores on leaves.	• Small longitudinal red spot on leaves which turn grey/brown. • Reduced yield.	• Use clean seeds • Avoid heavy use of nitrogen fertilizers • Use fertilizer varieties.
Maize rust	Fungus (Puccinia polysora)	Air borne, Spores on leaves.	• Red spot on leaves • Reduced yield • Death of the crop.	• Early planting • Crop rotation • Use resistant varieties.
Rosette disease of groundnut	Virus	By piercing and sucking insects.	• Yellow leaves with mosaic mottling • Stunted plant with curled leaves • Wilting and death of plant.	• Early planting • Crop rotation • Uproot and burn infected plants • Use resistant varieties.
Cocoa black pod diseases	Fungus (Phytophthora palmivora)	Rain splash, Insects	• Brown spots on pod • Rottening of pod • Entire pod turns black • Low yield.	• Remove and destroy infected plants • Regular weeding • Spray with fungicides • Avoid overcrowding.
Swollen shoot disease of cocoa	Virus		• Swollen stems and shoots.	• Destroy infected plants and healthy plants surrounding the infected plant.
Swollen shoot diseases of cocoa	Virus		• Swollen stems and shoots.	• Destroy infected plants and health plants surrounding the infected plant.
Black arm (Bacteria blight of cotton)	Bacterium	Through leaves, Stems near the ground.	• Angular spots on leaves and stem. • Boll rot. • Exudates from affected leaves. • Retarded growth and death of plant.	• Seed dormancy • Uproot and burn the infected plant • Use resistant varieties • Crop rotation.
Cassava mosaic.	Virus	Through piercing and sucking	• Mottling of leaves • Mosaic pattern on leaves	• Uproot and burn infected plants. • Spray with

		insects (white fly), Infected plants cutting.	• Stem/leaf distortion • Stunted growth • Reduced yield.	insecticides to kill vectors • Use disease free stem cuttings • Use resistant varieties.
Root knot of tomato /okro	Nematode	Nematode in soil.	• Knotting or galling of roots. • Early death of plants. • Reduction in yield.	• Soil sterilization • Crop rotation • Use resistant varieties • Uproot and burn infected plants.

EFFECT OF DISEASES ON CROP PRODUCTION.

1. It reduces crop yield or production.
2. It causes the malformation of plants.
3. It reduces the quality of crops.
4. It can kill or cause the death of plants.
5. They increase the cost of production in the course of controlling them.

CONTROL OF PLANT DISEASES

The diseases of plants can be controlled through;

i. Biological method
ii. Chemical method
iii. Cultural method
iv. Physical method

Other methods include;

1. Quarantine of imported seeds and plants before their introduction into the country.
2. Avoid close planting to reduce the rate of spread of diseases.
3. Destruction of crop residues after harvesting to prevent the building up of diseases/pathogens.

Effects of mouldy maize grain on public health

1. Nutrients are removed by fungi.
2. It may be infiltrated with fungal toxin.
3. It gives grain unpleasant odour.
4. It makes food distasteful to humans.
5. Spores may cause respiratory problems to humans or handlers.

Effects of mouldy maize grain on food scarcity

1. It causes wastage of food.
2. Unwholesome animal feed affects animal performance.
3. It poisons animals.
4. Destruction of planting grains.
5. Source of spread of contaminants to other harvested or stored materials.
6. Heat generated during fungal growth destroys embryo of the grain.

FARM ANIMAL PESTS, PARASITES AND DISEASES

Parasite is an organism that lives on or in the body of another organism called a host. It obtains food, shelter and protection from the host, at the expense of the host leading to harm or even death of the host.

Animal parasites can be internal e.g. liverfluke, hookworm and tapeworm or external e.g. ticks, lice, mites e.t.c.

LIVERFLUKE (FASCIOLA HEPATICA)

It is an endoparasite which kills farm animals. Liverfluke is brown in colour, flat and a leaf-like organism. The secondary or intermediate host is the water snail while farm animals like cattle, sheep and goat are the primary host.

THE LIFE CYCLE OF LIVERFLUKE

The adult fluke lives in the bile duct of the primary host and reproduces there. The eggs pass out with the faeces. Under favourable conditions, the egg hatches into larvae called **MIRACIDIA** (plural) or **MIRACIDIUM** (singular) which is able to swim. Each Miracidium swims and finds the snail where it loses it cilia and becomes a sporocyst. The sporocyst undergoes asexual reproduction to form other larvae called **REDIA.**

The redia ruptures from the sporocyst and migrates to the digestive gland where it develops into a small worm called **CERCARIA** (the final larva). The cercaria comes out from the snail and searches for the primary host. It can be taken in through contaminated drinking water or eating vegetables which are encysted during grazing by animals.

LIFE CYCLE OF LIVERFLUKE

DIAGRAM OF LIVERFLUKE

ECONOMIC IMPORTANCE OF LIVERFLUKE

1. It causes a disease called **BILHARZIASIS** or **SCHISTOSOMIASIS.**

Symptoms of the disease

1. Passing of blood during urination which can lead to anaemia.
2. It affects digestion of animals.
3. It can result in liver rot leading to drowsiness and death.

Control of liverfluke

1. Introduction of ducks and geese to eat up the snails in water.
2. Destroy the water weeds which the snails feed on so as to destroy the snails.
3. Drain pastures properly since wet pastures can habour snails.
4. Use lime on pastures because the eggs of liverfluke do not hatch in water containing high level of alkaline.
5. Proper sanitary habits to prevent rivers and ponds from becoming contaminated by infected urine and feaces.

TRYPANOSOME

It is a protozoa transmitted by **Tse-tse flies** to farm animals causing a disease known as **TRYPANOSOMIASIS** (Sleeping sickness). The symptoms are anaemia, loss of weight, fever, headache and eventually death.

CONTROL OF TRYPANOSOME

i. Their habitats like ponds, swamps e.t.c. should be drained.
ii. Physically killing the vectors i.e. tse-tse fly

LIFE CYCLE OF THE TRYPANOSOME

TICKS

The tick is an ectoparasite of cattle, goat, sheep, dog e.t.c. It possesses a toothed **hypostome** for piercing and sucking the blood of the host.

ECONOMIC IMPORTANCE OF TICKS

1. They cause irritation and annoyance to their host.
2. They act as vector of diseases like tick fever.
3. Injuries from tick bites may become ulcerated wounds.
4. It causes loss of blood (anaemia) in the animal.

5. It damages the skin and hides of animals thereby reducing their value.

CONTROL OF TICKS

1. Keep the animals in clean surroundings.
2. Regular dipping of animals to destroy ticks.
3. Isolation of new animals to ensure that they are free from infections.
4. Handpick ticks from the body of host animals.

DIAGRAM OF TICK

ADAPTATION OF TICK AS AN ECTOPARASITE

1. Dark colour to hie in the fure of the animal.
2. Dorsoventrally flattened to avoid falling of host
3. Biting mouth part (hypostome) to attach to the body of host and for feeding.
4. Chitenous exoskeleton to avoid drying off.

Adaptive /Observable features of ticks that adapts it to its mode of feeding

1. Well developed piercing and sucking mouth parts for piercing the skin and for sucking blood, and for attaching itself to the host.
2. Presence of large abdomen for storing blood.
3. Presence of claws on digit to hold well on the furs of the body of the host.

LIFE CYCLE OF TICK

Animal	Diseases	Mode of transmission	Effects or symptoms	Control
Cattle, sheep, goats, pigs	Foot and mouth diseases (virus)	• Through infected material like urine, faeces, milk	• High fever •Lesions on hands and feet. • Blisters on mucus membrane of the mouth, on the skin, between and around the hoof. • Inflammation of testis and udder. • Salivation and loss of weight.	• Regular vaccination • Isolation of infected animal •Burning or burying of contaminated materials.
Poultry birds, cattle, pigs	Aspergilasis (fungi)	• Through contaminated feeds. • Mouldy litter. • Contaminated incubator.	• Difficult breathing. • Loss of appetite • High body temperature. • Irritation of the skin. • Respiratory disorder.	• Regular disinfection of pens and equipment • Good sanitation and hygiene. • Spray with fungicides to prevent growth of fungi.
Domestic fowl, turkey, duck, goose, guinea fowl.	New castle disease (virus)	• Contaminated feeds. • Water breeds • Litter.	• Respiratory symptoms i.e. difficulty in breathing, coughing	• Vaccination • Good sanitation. • Burning and burying of infected birds.
Fowl, duck, rabbits	Coccidiosis (protozoa)	• Contaminated food.	• Dropping wings • Blood stained diarrhoea • Lack of hair in rabbit • Crowding together • Loss of appetite	• Proper sanitation • Avoid wet litters and feed • Use suitable drugs
Dog, cat, horse, cattle	Rabies (virus)	• Contact with infected saliva	• Excitement and restlessness. • Tendency to attack. • Paralysis and finally death	• No cure once contaminated. • Vaccination for prevention • Animals should be destroyed.
Cattle, poultry birds, pigs, sheep	Tuberculosis (mycobacterium tuberculosis) bacteria	• Contaminated feed, water, litters and droppings.	• Difficult breathing • Milk reduction • Constant coughing • Pale combs and wattles • Loss of weight and appetite • Soft and moist	• Regular vaccination • Slaughter infected animals • Proper sanitation • Isolation of infected animals

			coughing	
Cattle, sheep, goat	Rinder pest (virus)	• It is contagious and can be contaminated when in contact with an infected animal through their: • Contaminated food and water. • Contaminated faeces and urine.	• Severe diarrhoea • High fever • Ulcers on mouth and tongues • Eyes and nostrils discharge • Weakness	• Vaccination for prevention. • Isolation of infected animals.

FOOD SUPPLY

To provide food for an ever increasing human population is one of the major concerns today, therefore we have to study the factors that affect our food supply. They are;

1. Food production
2. Food preservation and storage
3. Food wastage.

FOOD PRODUCTION

To improve food production, we must consider the following:

a. **Role of government in agricultural production** so as to have a good and high harvest at the end of the planting seasons. The ways by which government may increase food production includes:
   i. Provision of financial assistance.
   ii. Provision of high quality planting materials like seeds.
   iii. Provision of agro-chemicals like fertilizers, herbicides/fungicides, insecticides and drugs.
   iv. Provision of farm implement like tractors, harvesters, planters e.t.c.
   v. Educating the local farmers on modern family practices or techniques
   vi. Efficient quarantine measures
   vii. Provision of research work.

b. **Environmental factors required for food production** are grouped into;
   i. **Climatic factors** e.g. temperature, rainfall, wind, relative humidity
   ii. **Biotic factors** e.g. soil organisms, parasites, diseases, weeds, pests and predators.
   iii. **Edaphic factors** e.g. soil PH, soil texture, soil structure.

c. **Ways of improving crop production;**
   Food production can be improved in the following ways. They are:
   i. Proper timing of planting.
   ii. Use of manures and fertilizers.

iii. Control of pests and diseases of crops.
iv. Use of resistant varieties.
v. Control of weeds.
vi. Use of good crop varieties.

PRESERVATION AND STORAGE OF FOOD

Food can be preserved or stored using the following methods:

1. Salting.
2. Canning or bottling.
3. Refrigerating/freezing.
4. Pasteurization.
5. Drying or sun-drying.
6. Smoking.
7. Use of chemicals or food preservatives.
8. Irradiation.

1. **SALTING:** This is the dusting of farm products with table salts. It is used on food like meat, fish e.t.c.

PRINCIPLES/ADVANTAGES OF SALTING.

i. It increases the osmotic concentration of the food which makes it unfavourable for the growth of micro-organisms.
ii. It removes water from the food (dehydration) which prevents growth and activities of spoilage micro-organisms.

2. **DRYING OR SUN-DRYING**: This involves using heat from the sun to dry up food product like cereals (maize), groundnut, meat, fish, e.t.c. modern methods use hot air, direct heat or vacuum to dry food like fish, legumes, vegetables e.t.c.

PRINCIPLES/ADVANTAGES OF SUN-DRYING.

i. It dehydrates the food.
ii. It prevents normal microbial activities which require water.
iii. It increases the osmotic concentration of the food thereby killing the spoilage organisms.

3. **SMOKING**: it is the drying of some farm produce using smoke from a naked fire. Chemicals in wood slow down the growth of spoilage micro-organisms hence, preventing the food from decaying. Examples of food that can be preserved using the smoking method includes; meat, fish, groundnut, maize, tobacco, okro e.t.c.

PRINCIPLES/ADVANTAGES OF SMOKING.

i. It creates or develops high temperature or heat which kills spoilage micro-organisms.
ii. The carbon contained in the smoke can kill micro-organisms in the food.
iii. It causes dehydration.
iv. It also increases the osmotic pressure of the food.

4. **USE OF CHEMICALS OR PRESERVATIVES**: This involves the use of some harmless chemicals to preserve some food. Examples of food that can be preserved by the addition of chemicals are cakes, soft drinks, tin tomatoes e.t.c.

PRINCIPLES/ADVANTAGES OF CHEMICALS IN FOOD

i. It alters the pH of the food medium and eventually kills the micro-organisms hence, preventing the food from spoiling.
ii. It also chokes or suffocates the spoilage micro-organisms in the food.
iii. It toxicates spoilage micro-organisms in the food.

5. **CANNING/BOTTLING**: In this process, food items are put into containers and sealed with the exclusion of air to prevent micro-organisms from respiration; this prevents food spoilage. E.g. of food under here are fruits, fish, tin tomatoes, tin beans, meat e.t.c.

PRINCIPLES/ADVANTAGES OF BOTTLING/CANNING.

i. It ensures long storage of food.
ii. It prevents the entry of new micro-organisms.
iii. It kills micro-organisms gradually.

6. **REFRIGERATION/FREEZING**: It involves the use of refrigerators or freezers at a very low temperature (4^{o}C) to preserve food. This prevents the growth of spoilage micro-organisms hence preventing the food from spoiling. Examples of food preserved by this method are meat, fish, vegetables, fruits e.t.c.

PRINCIPLES/ADVANTAGES OF REFRIGERATION/FREEZING.

i. It slows down the biological processes in spoilage micro-organisms.
ii. It provides a lower temperature in the food which kills some micro-organisms.

7. **PASTEURIZATION**: It involves the heating of some food products to about 72^{o}C for about fifteen minutes and then immediately cooled for the purpose of storage. Examples are milk, cheese, beer e.t.c.

PRINCIPLES/ADVANTAGES OF PASTEURIZATION.

i. It generates high temperature which kills spoilage micro-organisms.
ii. Additional method of storage e.g. canning prevents the entrance of new micro organisms.

8. **IRRADIATION**: In this, some food are subjected to a very high energy radiation such as ultra- violet rays. These kill the food spoilage micro-organism and prevent them from entering into the food. Examples of food preserved by irradiation are meat, canned food, seeds, tubers, fruit juice e.t.c.

PRINCIPLES/ADVANTAGES OF IRRADIATION

i. It kills micro-organisms in the food.
ii. Prevents entering of micro-organisms into the food.

FOOD WASTAGE

Most food produced by farmers is at times wasted and this eventually leads to food shortage. The causes of food wastage include;

i. Lack of storage facilities to store food.
ii. Damages caused by pests and diseases.

iii. Inadequate transport facilities may be responsible for food wastage as most food produced in rural areas cannot be moved to urban centres as a result of inadequate means of transportation.
iv. Late harvesting of food in the field.
v. Natural disasters.
vi. Bush burning when not controlled may spread to farmland, destroy cultivated crops which eventually leads to food wastage.

POPULATION GROWTH AND FOOD SUPPLY

In developed countries, the rate of population growth is controlled. This is because a fall in death rate is accompanied by a rise in birth rate while in developing countries, the birth rate is higher than the death rate. This is as a result of women marrying when they are very young.

Population growth therefore needs to be checked and this can be done by family planning method to decrease the birth rate.

FACTORS AFFECTING POPULATION GROWTH

A number of factors affect population growth all over the world. These factors may have positive or negative effects on the growth of population. These factors include;

1. **Availability of food and water**: When there is enough food , it leads to increase in population as human beings feed well and are more likely to give birth to more children. But lack of food on the other hand leads to a decrease in population growth.
2. **Natural disasters:** Natural disasters like earthquake leads to the death of many people hence, leads to low population in that place where it occurred.
3. **Wars** :It leads to massive deaths which tends to reduce the population of people in the area concerned.
4. **Birth rate or natality**: Increase in birth rate leads to increase in population growth rate of all countries.
5. **Death rate or mortality**: It also leads to decrease in population growth rate of all countries.
6. **Drought**: The occurrence of drought in an area leads to low agricultural production and this eventually leads to low population growth.

FACTORS AFFECTING THE AVAILABILITY OF FOODS (Causes of food shortage)

There are many factors which may be responsible for food or non-availability of food. Such factors are;

1. **Overpopulation**: Overpopulation naturally leads to high demands for food consumption which eventually leads to scarcity and famine.
2. Most food produce are wasted as a result of lack of storage facilities and this leads to food spoilage.
3. Pests and diseases
4. Bush burning
5. Flood and drought
6. Poor harvesting or yield
7. Soil infertility (lack of good soil)
8. Lack of financial aids for farmers
9. War.