

BIOLOGY FORM ONE NOTES

FOR FORM 2, 3, 4 NOTES, SMS OR WHATSAPP: 0723981225

INTRODUCTION TO BIOLOGY

What is Biology?

Biology is the branch of science that deals with the study of living things. In Greek, Bios means life while Logos means knowledge.

Branches of biology

There are two main branches:

1. **Botany:** Study of plants
2. **Zoology:** Study of animals

The others include:

1. **Ecology:** Study of living things in their surroundings.
2. **Genetics:** The study of inheritance and variation.
3. **Entomology:** Study of insects
4. **Parasitology:** Study of parasites
5. **Taxonomy:** Study of classification of organisms
6. **Microbiology:** Study of microscopic organisms
7. **Anatomy:** Study of structure of cells
8. **Cytology:** Study of cells
9. **Biochemistry:** Study of chemical changes inside living organisms

Name at least six other smaller branches of biology (6 marks).

Importance of Biology

1. **Solving environmental problems** e.g. Food shortage, poor health services, pollution, misuse of environmental resources etc.
2. **Choice of careers** e.g. Medicine, Agriculture, public health, Veterinary, Animal husbandry, Horticulture, Dentistry etc.
3. **Acquiring scientific skills** e.g. observing, identifying, recording, classification, measuring, analyzing, evaluating etc.
4. **International co-operation** e.g. Development of HIV/AIDS vaccine, fight against severe Acute respiratory Syndrome (SARS),

fight to save ozone layer from depletion, management of resources through international depletion.

Others

- Help on study of other subjects
- Learn what living things are made up of and their bodies work
- Acquire knowledge about plant and animal diseases and their treatment.
- Know the effects of our bodies on drug and substance abuse and can kill.
- Learn about HIV\AIDS diseases and other viral diseases e.g. its treatment—balanced diets, proper hygiene, spreading, sexual behavior, cultural practices etc.

List five professional occupations that require the study of biology. (5 marks)

Characteristics of living things;

- 1. Nutrition:** Process by which living things acquire and utilize nutrients: plants photosynthesize; animals feed on already manufactured foods.
- 2. Respiration:** energy-producing process occurring in all the cells of living things.
- 3. Gaseous Exchange:** where living things take in air (oxygen) and give out air(carbon iv oxide) across respiratory surfaces.
- 4. Excretion:** Process by which waste or harmful materials resulting from chemical reactions within cells of living things are eliminated. Excess of such materials poison living things.
- 5. Growth and Development:** **Growth** –is the irreversible increase in size and Mass.—Essential for body function. **Development** –Irreversible change in complexity of the structure of living things.
- 6. Reproduction:** Process by which living things give rise to new individuals of the same kind.
- 7. Irritability:** Is the ability of living things to perceive changes in their surroundings and respond to them appropriately. E.g. reaction

to changes in temperature, humidity, light, pressure and to the presence of certain chemicals.

8. **Movement:** Change in position by either a part or the whole living thing. Locomotion – Progressive change in position by the whole living thing. In animals, movement include; swimming, walking, running, flying. In plants, closing of leaves, folding of leaves, closing of flowers, growing of shoots towards light etc.

Question

1. List four uses of energy obtained from the process of respiration. (4 marks).
2. List six characteristics of living things (6 marks).

Collection of specimens

Apparatus used

1. **Sweep net:** for catching flying insects.
2. **Fish net:** For trapping small fish and other small water animals.
3. **Pooter:**For sucking small animals from rock surfaces and tree barks.
4. **Bait trap:** For attracting and trapping small animals e.g. rats.
5. **Pit fall trap:** For catching crawling animals.
6. **Pair of forceps:** picking up small crawling animals e.g. stinging insects.
7. **Specimen bottles:** keeping collected specimen. Larger specimens require large bottles.
8. **The magnifying lens:** Instrument used to enlarge objects. Lenses are found in microscope and the hand lens (magnifier). Its frame is marked e.g. x8 or x10—indicating how much larger will be the image compared to object.

Precautions during Collection and Observation of specimens

- Collect only the number of specimen you need.
- Do not harm the specimens during the capture or collection exercise.
- Handle dangerous or injurious specimens with care e.g. stinging plants or insects i.e. use forceps or hand gloves.

- The teacher will immobilize highly mobile animals. (diethyl ether, formalin, chloroform)
- Do not destroy the natural habitat of the specimens.

Practical activity 2

Practical activity 3

Comparison between plants and animals

Plants	Animals
1. Green in colour(have chlorophyll)	1. Lack chlorophyll thus feed on readymade food.
2. Their cells have cellulose cell walls.	2. Cells lack cellulose cell walls.
3. Respond slowly to changes in the environment.	3. Respond quickly.
4. Lack specialized excretory organs.	4. Have complex excretory organs.
5. Do not move about.	5. Move about in search of food and water.
6. Growth occurs in shoot and root tips.(apical growth)	6.Growth occurs in all body parts9intercalary growth).

Revision questions

CLASSIFICATION I

INTRODUCTION

Living things are also known as living organisms.

Organisms (forms of life) have distinguishing characteristics and therefore are grouped.

The Magnifying lens

-Is used for enlarging small objects.

(Diagram)

Procedure of its use

- Place the object on the bench.
- Move the hand lens from the object to the eye.
- An enlarged image is seen.

Drawing magnification = $\frac{\text{Length of the drawing}}{\text{Length of the object}}$ / $\frac{\text{drawing Length}}{\text{Actual Length}}$

(Diagram)

External features of plants and animals

External features of plants

- Rhizoids as in moss plant.
- Fronds in ferns.
- Roots, stems, leave, flowers, seeds, fruits, and cones in higher plants.

External features of animals

- Tentacles in hydra
- Feathers in birds
- Shells in snails
- Wings in birds
- Fur and hair in mammals
- Scales and fins in fish
- Proglotids in tapeworms
- Mammary glands in mammals
- Locomotory Structures e.g. limbs in insects
- Body pigmentation

Practical activity 1

To collect and observe animal specimens

To collect and observe plant specimens

What is classification?

-Is an area of biology that deals with the grouping of living organisms according to their structure. Organisms with similar structures are put under one group referred to as **a taxon—taxa** (plural).

The groupings also consider evolutionary relationships (phylogeny)—since all living organisms had a common origin at one time.

Taxonomy—Science of classification.

Taxonomist—Biologist who studies taxonomy.

Need for classification.

Reasons

1. To identify living organisms into their correct groups for reference and study
2. To bring together living organisms with similar characteristics but separate those with different features.
3. To arrange information of living organisms in an orderly manner. This avoids chaos and confusion.
4. To understand the evolutionary relationship between different organisms

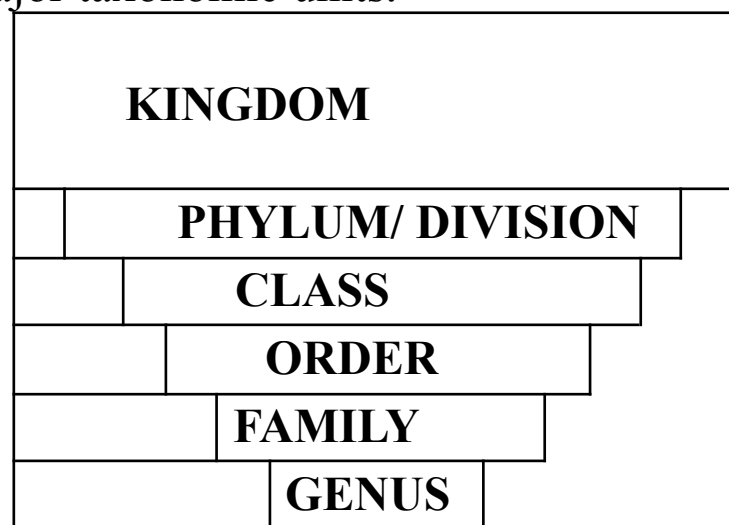
Taxonomic Units

Are groups (taxa) into which organisms are placed as a matter of convenience.

Groups are based on observable characteristics common in the group.

In a classification scheme (taxonomic units or groups, a hierarchy of groups are recognized starting with the first largest and highest group; the **Kingdom** to the smallest and lowest unit; the **species**.

There are 7 major taxonomic units.



The Kingdom

There are five Kingdoms of living organisms, namely:

1. **Kingdom Monera**: bacteria
2. **Kingdom protocista**: algae, protozoa, amoeba, paramecium
3. **Kingdom Fungi**: Moulds, Yeast, Mushrooms
4. **Kingdom Plantae**: Moss plants, ferns, maize, garden pea, pine, meru oak, bean etc.
5. **Kingdom Animalia**: hydra, tapeworms, bees, human beings etc.

A **kingdom** is divided into **Phyla** in animals or divisions in plants and sorts out organisms based on body plan and form.

Plan is the adaptation to a special way of life.

The **Class** is further divided into small groups; **Orders** using structural features.

Orders are divided **into families** using structural features, then Families into **Genera** (singular genus) –based on recent common ancestral features that are less adaptive.

Genus is divided into **species** i.e. kind of plant, or animal.

Down the hierarchy, the number of organisms in each group decreases but their similarities increases.

The Species group members naturally interbreed to produce fertile off springs.

Minor differences are exhibited in the species groups e.g. on colour of the skin in human beings and varieties of plants.

The groups of the species are termed to as varieties, races or strains.

Classification of A human being and a maize plant

Taxonomic unit	Human being	maize	bean
kingdom	Animalia	plantae	plantae
Phylum or division	Chordata	Angiospermaphyta	Angiospermae
class	Mammalia	monocotyledonae	Dicotyledonae
order	Primates	Graminales	Rosales
family	Hominidae	Graminaceae	Leguminosae

genus	homo	zea	Phaseolus
species	sapiens	mays	Vulgaris

Scientific name *Homo sapiens* *Zea mays*
phaseolus vulgaris

Scientific Naming Of Living Organisms

Present naming was developed by carolus Linnaeus 18th c, where organisms were given 2 names in Latin language.

Living organisms have their scientific names and common names i.e. local or vernacular names.

Scientific naming uses the double naming system—**Binomial system**.

In binomial system, an organism is given both the **genus** and **species** name.

Binomial nomenclature (Double –naming system)-Is the assigning of scientific names to living organisms governed by a definite set of rules recognized internationally.

Principles of binomial nomenclature

- a) The first, genus name, should begin with a capital letter and the second name, species, should begin or written in small letters e.g.

Lion---- *Panthera leo*

Leopard----- *Panthera pardus*

Domestic dog----- *Canis farmiliaris*

Human being--- *Homo sapiens*

Maize plant---*Zea mays*

Lion and Leopard are closely related ---Same genus but distantly related—different species.

- b) The scientific names must be printed in italics in textbooks and where hand written to be underlined e.g. *Panthera leo*.
- c) The specific name (species) is frequently written with the name of the scientist who first adequately described and named the organism e.g. *Phaseolus vulgaris* i.e. Vulgaris is the scientist who described and named the bean plant.
- d) Biologists should give a Latinized name for a newly described animal or plant species where Latin name is missing e.g.

Meladogyne kikuyuensis – Is a scientific name of a nematode from kikuyu.

Aloe kilifiensis --- A member of Aloeaceae family from Kilifi discovery.

Garinsoga parviflora waweruensis --- a member of Macdonald eye family discovered by Waweru.

Study Question 1

Complete the table below

Taxon	Lion	Domestic dog	Garden pea	Napier grass
kingdom				
Phylum/division				
class				
order				
family				
genus				
species				

Scientific name _____

Revision Questions:

CLASSIFICATION 1

- ❖ *Review of the magnification lens*
- ❖ *Calculating Magnification*
- ❖ *External characteristics of plants and animals*

Diversity of Living Organisms

- Organisms with similar characteristics are placed under one group called **taxon (taxa)**.
- The science of classification is known as **taxonomy**.
- Biologists who study taxonomy are called **taxonomists**.

Need For Classification

1. Help in identifying living organisms into their correct groups for reference.

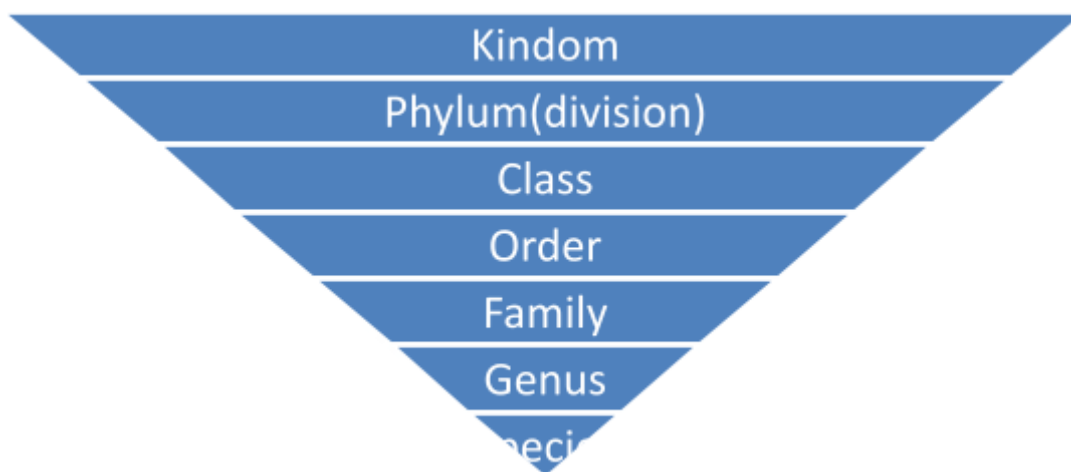
2. It brings together organisms with similar characteristics and separates those with different features.
3. Help to organize information about living organisms in an orderly manner avoiding any confusion.
4. Help to understand the evolutionary relationship between different living organisms.

Historical Background of Classification

- Long time ago classification was artificial where living things were classified as either plants or animals.
- Plants were classified as herbs, shrubs and trees.
- Animals were further divided into carnivores, herbivores and omnivores.
- Today modern classification uses evolutionary relationships between living organisms.

Taxonomic Units of Classification

- This refers to the groups into which living organisms are placed in classification.
- These units start from the first largest and highest group (**kingdom**) to the smallest and lowest unit (**species**).
- There are seven taxonomic units as shown below.



1. Kingdom

Carolus Linnaeus (1707-1778) initially introduced the two kingdom system of classification. However many new life forms have been

discovered which are neither animals nor plants. This has led to a more accepted classification system that adopts five kingdoms. These are;

- i.) **Monera .eg bacteria**
- ii.) **Protoctista e.g algae and protozoa**
- iii.) **Fungi e.g. mushrooms, moulds and yeast.**
- iv.) **Plantae e.g. maize, ferns and all types of trees.**
- v.) **Animalia e.g. man, cow tapeworm, flies etc.**

Kingdom is further divided into several phyla in animals or divisions in plants.

2. Phylum (phyla) or Division in plants.

It is the second largest and further divided into classes.

3. Class

Each class is divided into several orders.

4. Order

Orders are divided into smaller groups called families.

5. Family

Family is divided into several **Genera**.

6. Genus

Here members are closely related. It is further divided into the species.

7. Species

This is the smallest unit of classification.

*Species is defined as a group of organisms whose members **naturally interbreed** to produce **fertile offspring's**.*

Members of a given species have small differences such as skin colour, height etc.

Classification of Man and Maize plant. (Table 2.1 Page 15 KLB Bk 1)

Scientific Naming of Living Organisms.

- Today organisms are given two names in Latin language. This was developed by **Carolus Linnaeus**.
- Latin language was used because it was widely spoken during his time.
- In scientific naming, an organism is given the **genus** and the **species name**.

- This double naming system is known as *Binomial* system (two name System)

Binomial Nomenclature.

This is the *double naming* system of organisms where organisms are assigned two names i.e. the *generic* name and the *specific* name.

In binomial nomenclature the following rules are observed.

- i.) Generic name is written first followed by the specific name. First letter in the generic name is in capital and the rest are in small letters. Specific name is written in small letters.
- ii.) The two names are underlined separately when handwritten or italicised when printed.
- iii.) Newly discovered species must be given Latinized names.
- iv.) Specific name is frequently written with the name of the scientist who first adequately described and named the organism.

Examples

Revision Questions

CELL PHYSIOLOGY

- This is the study of the functions of cell structures.

Membrane Structure and Properties

- A membrane is a surface structure which encloses the cell and organelles. Membranes regulate the flow of materials into out of the cell or organelle.
- Examples of membranes: cell membrane, tonoplast (membrane surrounding the vacuole), nuclear membrane, mitochondrial membrane, chloroplast membrane etc.

The Cell Membrane

- It has three layers, two protein layers and a phos-pholipid layer sandwiched in between the two.

Diagram

Properties of Cell Membrane

1. **Semi-permeability.** – It has small pores allowing for the passage of molecules of small size into and out of the cell. **Cell Wall** however allows all materials to pass through it hence it is referred to as being **Permeable**.
2. **Sensitivity to Changes in Temperature and pH** – Extreme temperature and pH affects the cell membrane since it has some protein layers. Such changes alter the structure of the membrane affecting its normal functioning.
3. **Possession of Electric Charges** – it has both the negative and positive charges helping the cell to detect changes in the environment. These charges also affect the manner in which substances move in and out of the cell

Physiological Processes

- The ability of the cell to control the movement of substances in and out of the cell is achieved through physiological processes such as **Diffusion, Osmosis and Active Transport**.

Diffusion

- *This is a process by which particles move from a region of **high concentration** to a region of **low concentration**.*

Practical Activity 1

To demonstrate diffusion using potassium permanganate (VII)

- The difference in concentration of particles between the region of high concentration and the region of low concentration is known as the **diffusion gradient**.

Role of Diffusion in Living Organisms

1. Absorption of Materials

- Mineral salts in the soil enter the root by diffusion since their concentration in the soil is greater than in the root hair cells.
- Digested food (glucose and amino acids) diffuse across the wall of the ileum into the blood for transport to rest of the body.

2. Gaseous Exchange in Plants and Animals

- In both plants and animals, respiratory gases (oxygen and Carbon (IV) oxide) are exchanged through simple diffusion depending on their concentration gradient.

3. Excretion of Nitrogenous Wastes

4. Transport of Manufactured Food form Leaves to other Plant Parts.

5.

Factors Affecting Diffusion

a) Diffusion Gradient

- A greater diffusion gradient between two points increases the rate of diffusion.

b) Surface Area to Volume Ratio

- The higher the ratio the greater the rate of diffusion and the lower the ratio the lower the rate.
- This means that small organisms expose a large surface area to the surrounding compared to large organisms.
- Small organisms therefore depend on diffusion as a means of transport of foods, respiratory gases and waste products.

Diagrams

c) Thickness of Membranes and Tissues

- The thicker the membrane the lower the rate of diffusion because the distance covered by the diffusing molecules is greater. The thinner the membrane, the faster the rate.

● Size of the Molecules

- Small and light molecules diffuse faster than large and heavy molecules.

d) Temperature

- Increase in temperature increases the energy content in molecules causing them to move faster.

Osmosis

- *This is the process where solvent molecules (water) move from a lowly concentrated solution (dilute) to a highly concentrated solution across a semi-permeable membrane.*

Diagram fig 4.6

- The highly concentrated solution is known as **Hypertonic Solution**.
- The lowly concentrated solution is called **Hypotonic solution**.
- Solution of the same concentration are said to be **Isotonic**.
- Osmosis is a *special type of diffusion* because it involves the movement of solvent (water) molecules from their region of high concentration to region of low concentration across a semi permeable membrane.

Practical activity 2

Practical activity 3

Osmotic Pressure

- This is the pressure which needs to be applied to a solution to prevent the inward flow of water across a semi permeable membrane. This is the pressure needed to nullify osmosis.
- Osmotic pressure is measured using the **osmometer**.

Osmotic Potential

- This is the measure of the pressure a solution would develop to withdraw water molecules from pure water when separated by a semi permeable membrane.

Water Relations in Animals

- Cell membrane of the animal cell is semi permeable just like the dialysis/visking tubing.
- Cytoplasm contains dissolved sugars and salts in solution form.
- If an animal cell e.g. a red blood cell is placed in distilled water (hypotonic solution), water flows in by osmosis.
- The cell would swell up and eventually burst because the cell membrane is weak. The bursting of the red blood cell when placed in hypotonic solution is called **Haemolysis**.
- If a similar red blood cell is placed in a hypertonic solution, water is drawn out of the cell by osmosis. The cell will shrink by a process called **Crenation**.
- Body fluids surrounding the cells must therefore have same concentration as to that which is found inside the cell.

Diagrams

Water Relations in Plants

- When a plant cell is placed in a hypotonic solution it gains water by osmosis and distends outwards.
- As the cell gains more water, its vacuole enlarges and exerts an outward pressure called **turgor pressure**. As more water is drawn in, the cell becomes firm and rigid and is said to be **turgid**.
- The cell wall in plant cell is rigid and prevents the cell from bursting unlike the case in animal cells.
- The cell wall develops a resistant pressure that pushes towards the inside. This pressure is equal and opposite the turgor pressure and is called **wall pressure**.

Diagrams

- When a plant cell is placed in hypertonic solution, water molecules move out of the cell into the solution by osmosis. The cell shrinks and becomes **flaccid**.
- If the cell continues to lose more water, plasma membrane pulls away from the cell wall towards the center.
- The process through which plant cells lose water, shrink and become flaccid is called **plasmolysis**.
- Plasmolysis can be reversed by placing a flaccid cell in distilled water and this process is called **deplasmolysis**.

Study Question 5

Practical Activity 4

Wilting

- When plants lose water through evaporation and transpiration, **cells lose turgidity**, shrink and the plant **droops**. This is called **wilting**.
- If water supply from the soil is inadequate, plants do not recover hence **permanent wilting**.

Study Question 6

Role of Osmosis in Organisms

1. Absorption of water from the soil

- Root hair cells of plants absorb water from the soil by osmosis.

2. Support

- Cells of herbaceous plants, which are less woody, absorb water, become turgid hence support.

3. Opening and closing of the stomata

- During the day, guard cells synthesize glucose, draw in water, become turgid hence open the stomata.
- During the night, they lose turgidity since there is no photosynthesis. As a result, they shrink thus closing the stomata.

4. Feeding in insectivorous plants

- These plants are able to change their turgor pressure on the leaves which close trapping insects which are digested to provide the plant with nitrogen.

5. Osmoregulation

- In the kidney tubules, water is reabsorbed back to the body by osmosis.

Factors Affecting Osmosis

- i.) Concentration of Solutions and Concentration Gradient.* The greater the concentration gradient between two points, the faster the rate of osmosis.
- ii.) Optimum Temperature as long as it does not destroy the semi-permeability of the membrane.*

Active Transport

- This is the process that moves substances across cell membranes ***against a concentration gradient***.
- This process ***requires energy*** to move these substances across cell membranes and involves ***carriers***.
- Substances such as amino acids, sugar and many ions are taken in by living organisms through active transport.

Role of Active Transport

- i.)* Re-absorption of sugars and useful substances by the kidney
- ii.)* Absorption of some mineral salts by plant roots

- iii.) Absorption of digested food from the alimentary canal into the blood stream
- iv.) Accumulation of substances in the body to offset osmotic imbalance in arid and saline environment
- v.) Excretion of waste products from body cells

Factors Affecting Active Transport.

- i.) Oxygen concentration.
- ii.) Change in pH.
- iii.) Glucose concentration.
- iv.) Temperature.
- v.) Enzyme inhibitors.

NB/ Any factor affecting energy production affect the rate of active transport.

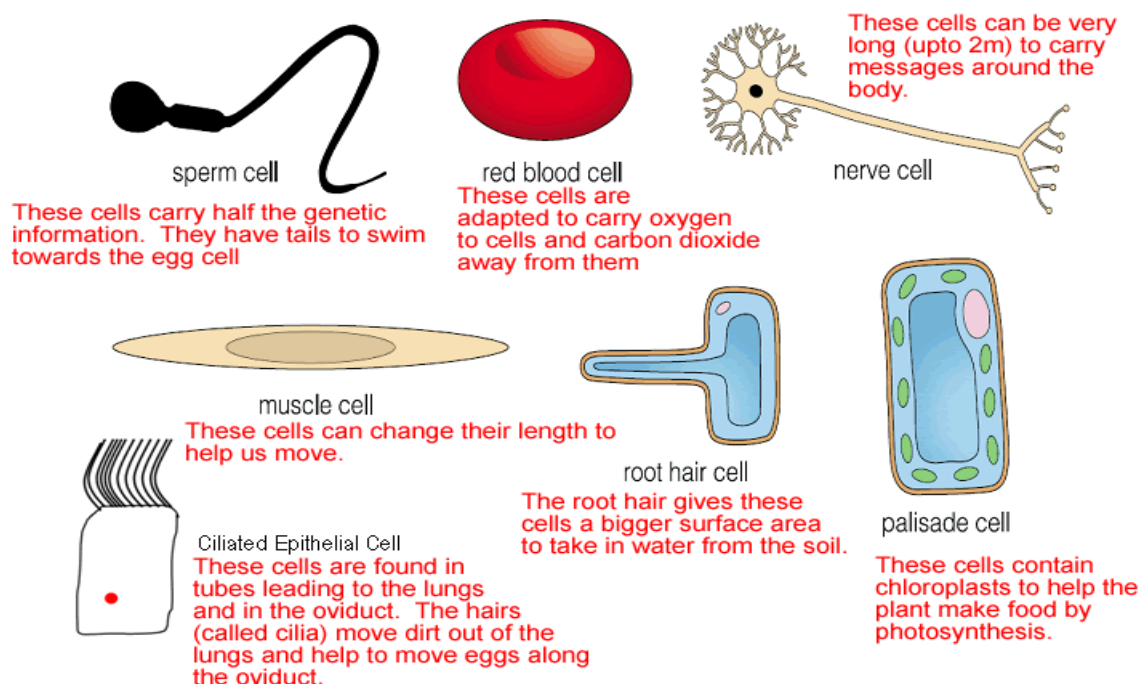
Revision Questions.

Cell Specialization, Tissues, Organs and Organ Systems

1. Cell specialization

- This is where cells are modified to perform specific functions. Such cells are said to be specialized.
- Examples include the sperm cell which has tail for swimming and the root hair cell which is extended creating large surface area for water absorption.

Specialised Plant and Animal Cells

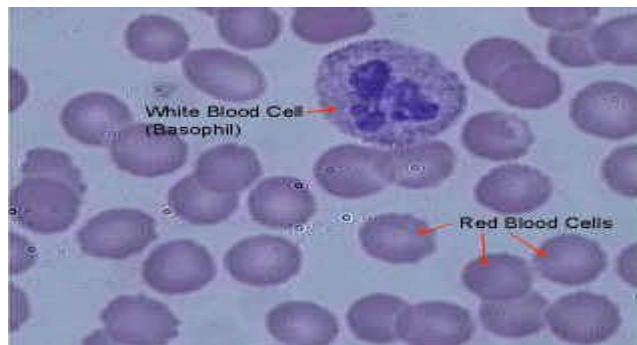


2. Tissues.

- These are cells of a particular type that are grouped together to perform the same function.

Animal tissues include;

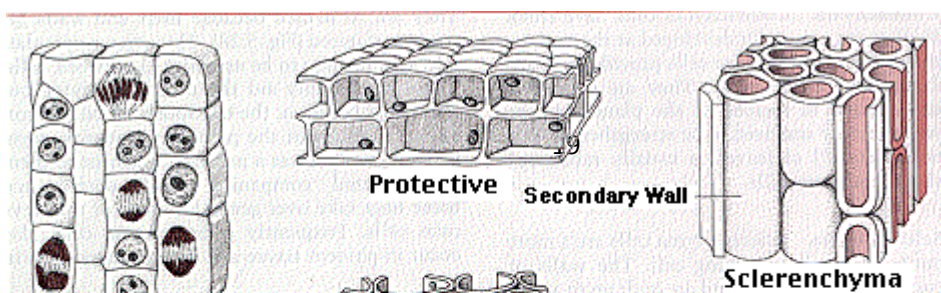
- **Epithelial tissue** – which is a thin continuous layer of cells for **lining and protection** of internal and external surfaces.
- **Skeletal** – it is a bundle of elongated cells with fibres that can contract. Its contraction and relaxation brings about movement.
- **Blood tissue** – this is a fluid containing red blood cells, white blood cells and platelets. It transports many substances and protects the body against infections.



- **Connective tissue** – made up of strong fibres that connect other tissues and organs holding them together.

Plant tissues include:

- **Epidermal tissue of a plant** – this is a single layer of cells protecting the inner tissues of the plant.
- **Palisade tissue** – this is a group of cells rich in chloroplasts containing chlorophyll. They absorb light energy during photosynthesis.
- **Parenchyma tissue** – it is made thin walled irregularly shaped cells. They store water and food.
- **Vascular bundle** – consists of the xylem and phloem. Xylem conducts water and mineral salts while phloem conducts food substances.



3. Organs

- Many tissues become specialized and grouped together to perform a functional unit called the **organ**.
- Examples of organs in plants include; roots, leaves, flowers and stem.
- In animals they include heart, lungs, kidney, brain, stomach and the liver.

4. Organ systems.

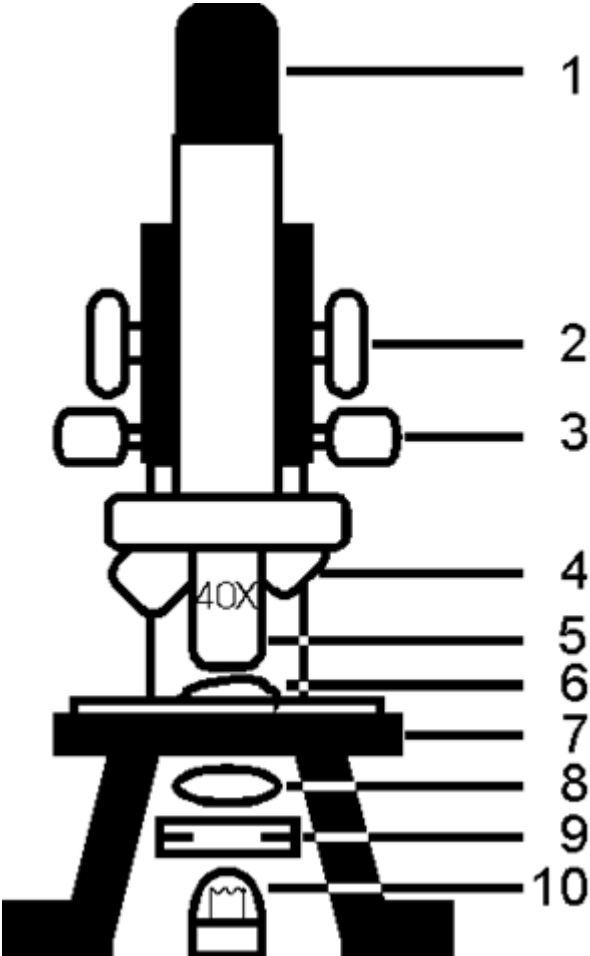
- This is made of several organs whose functions are coordinated and synchronized to realize an effective action is called an **organ system**. Examples include; digestive, circulatory, excretory, respiratory, reproductive and nervous system.

Revision Questions

MICROSCOPE

Microscope Parts & Function

Parts of the *Microscope*

	1. Eyepiece	Contains a magnifying lens that focuses the image from the objective into your eye.
	2. Course Adjust	For focusing under low magnification
	3. Fine Adjust	For focusing under high magnification or low
	4. Low Power Objective	For large specimens or overview
	5. High Power Objective	For detailed viewing or small specimens
	6. Specimen on glass slide	What you want to look at
	7. Stage	Supports specimen in correct location to lens
	8. Condenser	Focuses the light on specimen

	9. Diaphragm (iris or disc)	Regulates amount of light and contrast
	10. Light Source	Illuminates the specimen for viewing

Handling and Care of the Microscope

The following rule should be observed:

1. Use both hand when carrying the microscope. One hand should hold the base and the other holds the limb.
2. Never place the microscope too close to the edge of the bench.
3. Do not touch the mirror and the lenses with the fingers.
4. Clean dirty lenses using soft tissue.
5. Clean other parts using a soft cloth.
6. Do not wet any part of the microscope.
7. Make sure the low power clicks into position in line with the eye piece before and after use.
8. Always store the microscope in a safe place free from dust and moisture.

Using the Microscope

1. Place microscope on the bench with the stage facing away from you.
2. Turn the low power objective lens until it clicks into position.
3. Ensure the diaphragm is fully open.
4. Look through the eyepiece with one eye. Adjust the mirror to ensure maximum light can pass through.
5. Place the slide containing the specimen on the stage and clip it into position. Make sure the slide is at the centre of the field of view.
6. Again look through the eyepiece while adjusting the mirror to ensure maximum light reach the specimen.

7. Use the coarse adjustment knob to bring the low power objective lens to the lowest point. While viewing through the eyepiece, turn the coarse adjustment knob gently until the specimen comes into focus.
8. Use the fine adjustment knob to bring the image into sharp focus.
9. Make a drawing of what you see.
10. For higher magnification, turn the medium power into position and adjust the focus using the coarse knob. Use the fine adjustment knob for sharper focus.
11. For even large magnifications, turn the high power objective lens into position. In this case use only the fine adjustment knob to bring details into sharper focus.

Magnification

- Magnification of the object viewed under the microscope is calculated by;
Magnification = Eye Piece Lens Magnification X Objective Lens Magnification.
- If the eyepiece lens has the magnification of x5 and the low power objective lens has a magnification of x10, the total magnification is $5 \times 10 = 50$.

Study Question 1

Fill the table below.

Eye piece lens magnification	Objective lens magnification	Total magnification
X5	X4	
X10	X5	
X10		X100
	X40	X600
X10	X100	

Practical Activity 1

Cell Structures as Seen Under the Light Microscope

- The following cell organelles can be seen under the light microscope.

- Cell wall.
- Cell membrane
- Cytoplasm
- Nucleus
- Vacuole.
- Chloroplasts.

Diagrams- plant and animal cells

The Electron Microscope.

- It is more powerful than the light microscope.
- It can magnify up to 500,000 times and has high resolving power.
- The high resolving power of the electron microscope enables it to separate objects which lie close to one another.
- Electron microscope uses a beam of electrons instead of light to illuminate the object.

Study Question 2

Practical Activity 2

Cell Structures as Seen Under the Electron Microscope

Diagrams – Plant and Animal Cells

The Cell Organelles

i) Cell membrane (Plasma Membrane).

- It has three layers i.e. one layer of phospho-lipid layer sandwiched between two protein layers.
- It is flexible with pores and has the following main functions.
 - a) Encloses all the cell contents.
 - b) It allows selective movement of substances into and out of the cell since it is semi-permeable.

Diagram

ii) Cytoplasm

- It is a fluid medium in which chemical reactions take place.
- It has some movement called cytoplasmic streaming.
- It contains organelles, starch, glycogen, fat droplets and other dissolved substances.

iii) *Nucleus*

- It has double membrane called the nuclear membrane.
- The membrane has pores allowing passage of materials into and out of the cell.
- Nucleus has a fluid called ***nucleoplasm*** in which the ***nucleolus and chromatin*** are suspended.
- Nucleolus manufactures ***ribosomes*** while chromatin contains the hereditary material.

iv) *Mitochondria(Mitochondrion)*

- They are sausage shaped and are the ***respiratory sites***.
- Mitochondrion has two membranes. Inner membrane is greatly folded into ***cristae*** to increase the surface area for respiration.
- Cells that require a lot of energy have large number of mitochondria e.g. muscle cell, sperm cell, kidney cell etc.

Diagram

v) *Endoplasmic Reticulum (ER)*

- Some endoplasmic reticulums have granules called ***Ribosomes*** on their surfaces hence referred to as ***rough endoplasmic reticulum***.
- Others do not contain ribosomes hence the name ***smooth endoplasmic reticulum***.
- Rough endoplasmic reticulum ***transport proteins*** while the smooth endoplasmic reticulum ***transports lipids***.

Diagrams

vi) *Ribosomes*

- They are spherical in shape and form the site for ***protein synthesis***.

vii) *Lysosomes*

- They contain ***lytic enzymes*** which break down large molecules, destroy worn out organelles or even the entire cell.

viii) *Golgi Bodies (Golgi apparatus)*

- Their function is to package and transport ***glyco-proteins***.
- They are also associated with ***secretion*** of synthesized ***proteins and carbohydrates***.

Diagram

ix) Centrioles

- They are rod shaped structures that are used in ***cell division*** and in the formation of ***cilia and flagella***.
- Plant cells lack the Centrioles.

x) Chloroplasts

- They are egg shaped and contain two membranes.
- Chloroplast has chlorophyll which traps light energy to be used during photosynthesis.

xi) Vacuoles

- These are sacs filled with a fluid called cell sap.
- Animal cells contain small vacuoles while plant cells have large vacuoles.
- Sap vacuoles store sugars and salts.
- Food vacuoles store and digest food while contractile vacuoles excrete unwanted materials from the cell.

xii) Cell wall

- It is a rigid outer cover of the plant cells made of ***cellulose***.
- It gives the plant cell a ***definite shape*** while providing ***mechanical support*** and ***protection***.
- Cell wall also allows water, gases and other materials to pass through it.

Study Question 3

Differences between Plant and Animal Cells

Preparation of Temporary Slides

Practical Activity 3

Estimation of Cell Sizes.

NUTRITION IN PLANTS AND ANIMALS

Nutrition

- This is the process by which organisms ***obtain and Assimilate*** nutrients.

- There are two modes of nutrition; **Autotrophism** and **Heterotrophism**.

Autotrophism

- This is where living organism *manufacture its own* complex food substances from simple substances such as carbon (iv) oxide, water, *light or chemical energy*.
- Where sunlight is used as a source of energy, the process is referred to as **photosynthesis**.
- **Photo** means light while **synthesis** means to make.
- Some **none green plants** make their own food using energy obtained from certain chemicals through a process called **chemosynthesis**.
- Organisms that make their own food are referred to as **autotrophs**.

Heterotrophism

- This is where organisms *take in complex food* materials such as carbohydrates, proteins and fats obtained from bodies of plants and animals.
- Organisms that feed on already manufactured foods are called **Heterotrophs**.

Autotrophism

External Structure of a Leaf

A leaf is a flattened organ which is attached to the stem or a branch of a plant.

Diagrams

Parts of a leaf

Lamina: This is the flat surface. It is green in colour and contain the photosynthetic tissue.

Midrib: This is a thick structure running through the middle of the leaf

Veins: They arise from the midrib to forming an extensive network of veins.

Leaf Apex: This is the tip of the leaf and usually it is pointed.

Petiole: It attaches the leaf to the stem or branch.

In some monocotyledonous plants the leaves are attached to the stem by the leaf sheath.

Practical Activity 1: To examine the External Features of a Dicotyledonous and Monocotyledonous leaf

Study Question 1

Internal Structure of a Leaf

- Internal structure of the leaf is composed of the following parts.

i.) Cuticle.

- It is a thin waterproof and transparent layer that coats the upper and lower surfaces of the leaf.
- It reduces excess water loss and protects the inner tissue of the plant against mechanical injury.
- It also prevents entry of disease causing micro organisms.
- Since it is transparent, it allows penetration of light for photosynthesis.

ii.) Epidermis.

- It is a one cell thick tissue on both the upper and lower leaf surfaces.
- It secretes the cuticle and also protects the inner tissues from mechanical damage and prevents entry of pathogens.
- Epidermal cells have no chloroplast except the **guard cells**.
- Guard cells are special bean shaped cells. They have chloroplast and are able to carry out photosynthesis hence controlling the opening and closing of the stomata.
- Air moves into and out of the leaf through the stomata.

iii.) Palisade layer.

- This is layer of cells located beneath the upper epidermis.
- It is made of cylindrical shaped cells ***closely packed*** together. They have ***numerous chloroplasts*** containing chlorophyll.
- Their position and arrangement enables them to receive maximum light.

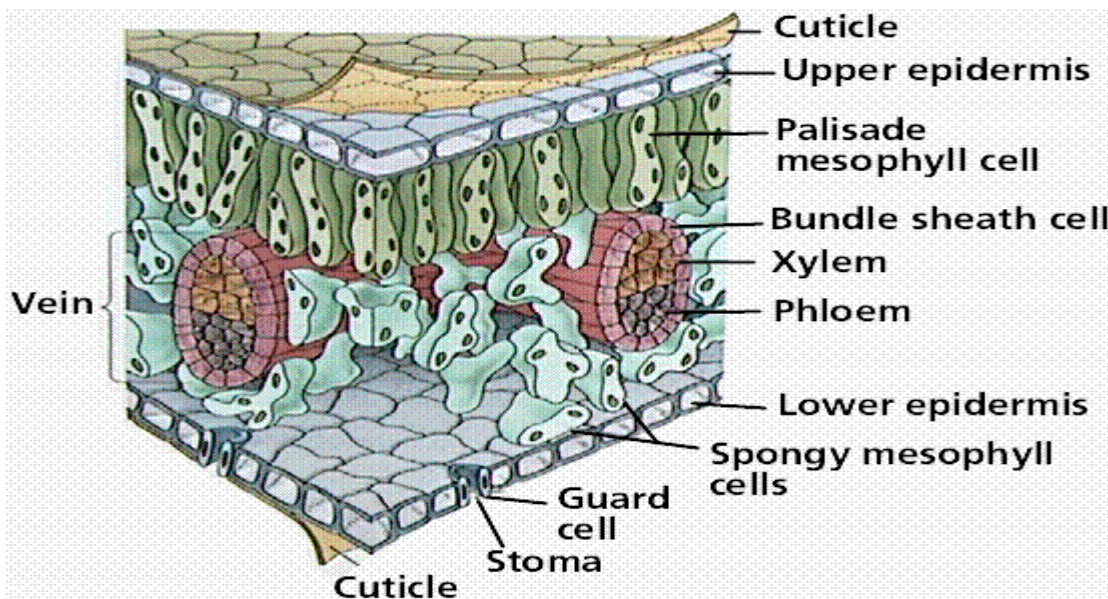
iv.) Spongy Mesophyll Layer.

- This is below the palisade layer. The cells are ***irregularly shaped and loosely packed*** creating large air spaces in between them.

- The *air spaces allow gases to diffuse* in between the cells. They contain fewer chloroplasts as compared to the palisade cells.

v.) Leaf Veins.

- Each vein is a vascular bundle consisting of xylem and phloem.
- Xylem conducts water and mineral salts from the roots to the leaves while the phloem translocates manufactured food from the leaves to the rest of the plant.



Study Question 2

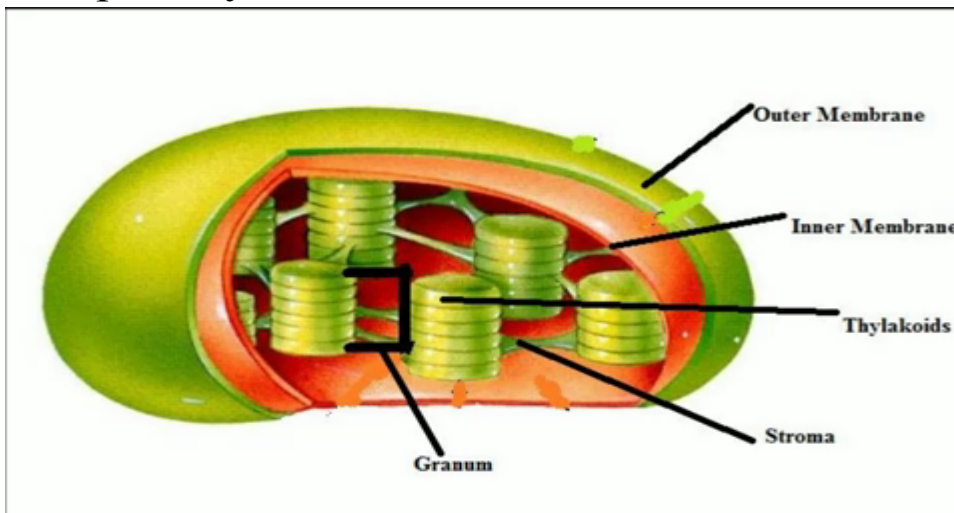
Adaptations of Leaves to Photosynthesis.

1. Broad and flat lamina to increase surface area of Carbon (IV) oxide and sunlight absorption.
2. Thin transparent cuticle and upper epidermis; to allow easier penetration of light to photosynthetic cells;
3. Thin; for faster diffusion of gases;
4. Palisade cells placed next to the upper surface; to trap maximum light for photosynthesis;
5. Palisade cells with numerous chloroplasts; to trap maximum amount of light for photosynthesis;
6. Large/ intercellular air spaces in the spongy mesophyll layer; for storage of Carbon (IV) oxide for easier gaseous exchange;
7. Waxy water proof cuticle; to reduce water loss and reflect excess light;

8. Leaf mosaic/ non-overlapping leaves; for maximum exposure to light;
9. Guard cells, modified cells to open and close stomata; to control amount of water loss from the leaf and allows gaseous exchange;
10. Leaves have leaf veins; xylem to conduct water to photosynthetic cells, Phloem to translocate products of photosynthesis to other parts of plant;

The Chloroplast

- They are disc shaped organelles found in the cytoplasm of plant cells.
- Each chloroplast has a double membrane; the inner and outer membrane.
- Chloroplasts are made of layers of membranes called *lamellae* contained in a fluid matrix called *stroma*.
- Several lamellae come together to form the *granum (grana)*.
- Granum contains *chlorophyll molecules* and other *photosynthetic pigments*.
- The stroma contains *enzymes* that speed up the rate of photosynthesis.



Practical Activity 2: To Observe Distribution of Stomata

Study Question 3.

The Process of Photosynthesis

- The raw materials for photosynthesis are; water and carbon (IV) oxide. The process however requires the presence of sunlight energy and chlorophyll pigment.
- The products of photosynthesis are glucose and oxygen. The process can be summarized using an equation as shown below.



Water + Carbon (IV) oxide $\longrightarrow$ Glucose + Oxygen.

The above chemical equation translates as:

Six molecules of water plus six molecules of carbon (IV) Oxide produce one molecule of sugar plus six molecules of oxygen

- The process of photosynthesis is however more complex than shown in the above equation and can be divided into two stage; the *light* and *dark* stages.

Light stage (Light Dependent Stage)

- Occurs in the grana containing chlorophyll which traps / absorbs sun light energy.
- This Energy is used to split water molecules into hydrogen ion and oxygen gas.
- This process is called **photolysis** of water and is shown below.



- Hydrogen atoms produced here enter into the dark stage.
- Oxygen gas removed through stomata or is used for respiration within the plant;
- Some Light energy is used in *Adenosine Triphosphate* (ATP) formation; **ATP** an energy rich compound.
- ATP is later used in the dark stage.

Dark stage. (Light Independent Stage)

- Carbon (IV) oxide combines with hydrogen atoms to form glucose/simple carbohydrate.
- This is called *Carbon (IV) Oxide fixation*.



- This stage takes place in the stroma and proceeds whether light is present or not.
- ATP Energy from light stage is used to provide the required energy in this reaction;
- Simple sugars formed are used for respiration to provide energy or are converted to storable forms e.g lipids, proteins, starch, cellulose, etc.

Study Question 4

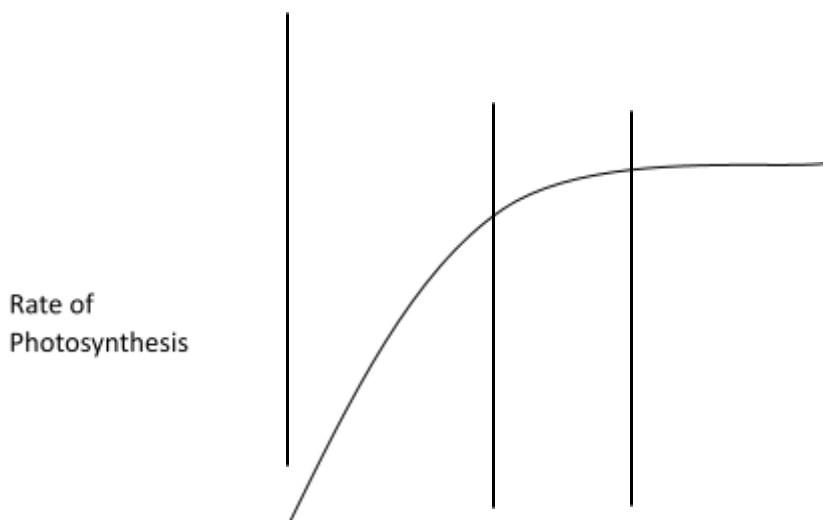
Practical Activity 3: To Investigate the Presence of Starch in a Leaf.

Study Question 5

Factors Affecting the Rate of Photosynthesis

i.) Light Intensity.

- Increase in light intensity increase the rate of photosynthesis up to a certain level where it slows down and finally levels off.
- Very bright sunshine may damage the plant tissues due to high amount of ultra violet light.
- Light quality or light wavelength also affects the rate of photosynthesis.
- Red and blue wavelengths of light are required by most plants for photosynthesis.



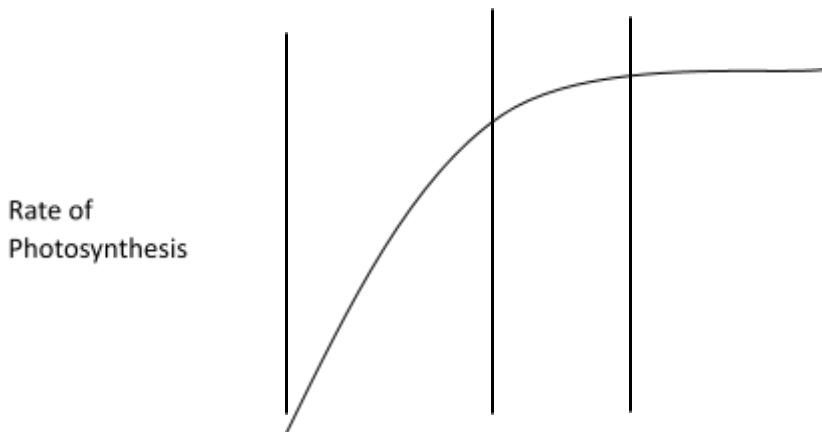
Range of optimum light intensity



Light intensity

ii.) Carbon (IV) oxide concentration

- Increase in Carbon (IV) oxide concentration increases the rate of photosynthesis linearly up to a certain level after which it slows down and levels off.



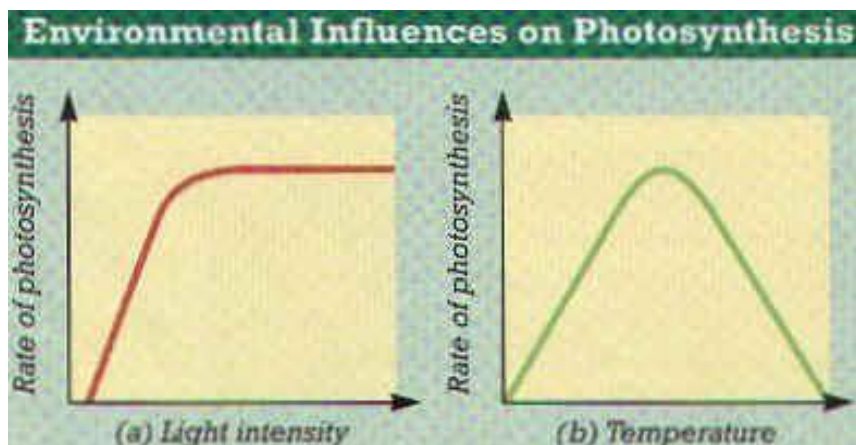
Range of optimum CO₂ concentration



Carbon (IV) oxide concentration

iii.) Temperature

- Photosynthesis is an enzyme controlled process, therefore increase in temperature increase the rate of photosynthesis up to the optimum temperature.
- Increase in temperature beyond the optimum decreases the rate sharply as the enzymes become denatured.



iv.) Water

- Plants need water for photosynthesis. Hydrogen atoms required in the dark stage during Carbon (IV) oxide fixation are derived from water during photolysis.

Study Question 6

Practical Activity 4: To Investigate Factors Necessary for Photosynthesis.

a) Light

Study Question 7

b) Carbon (IV) oxide.

Study Question 8

c) Chlorophyll.

Study Question 9

Study Question 10

Practical Activity 5: To Investigate the Gas Produced During Photosynthesis.

Study Question 11

Chemical Compounds Which Constitute Living Organisms

- Cells, tissues and organs are made of chemicals which are referred to as *chemicals of life*.
- The study of chemical compounds found in living organisms and reactions in which they take part is called **Biochemistry**.
- Chemicals of life include carbohydrates, lipids and proteins.

a) Carbohydrates

- They are compounds of carbon, hydrogen and oxygen in the ratio of 1:2:1 respectively.

- Carbohydrates have a general formula of $(\text{CH}_2\text{O})_n$ where n represents the number of carbon atoms in a molecule of carbohydrate.
- Carbohydrates are divided into three groups; **Monosaccharide's, Disaccharides and Polysaccharides.**

i) Monosaccharides

- They are the simplest carbohydrates and have a general chemical formula of $(\text{CH}_2\text{O})_n$ where $n = 6$.
- Their chemical formular is therefore $\text{C}_6\text{H}_{12}\text{O}_6$. They include; glucose, fructose, galactose etc.

Properties of Monosaccharides

- They are soluble in water to form sweet tasting solutions.
- They are crystalisable.
- They have the reducing property where they reduce copper sulphate in Benedicts solution to red copper (I) oxide.

Functions

- They are oxidized to release energy during respiration.
- When condensed together, they form polysaccharides such as starch, cellulose or glycogen.

ii) Disaccharides

- They are formed by linking two Monosaccharide molecules through the process of condensation where a molecule of water is liberated.

Condensation

Monosaccharide + Monosaccharide $\xrightarrow{\hspace{1.5cm}}$

Disaccharide + Water.



Examples



Water.



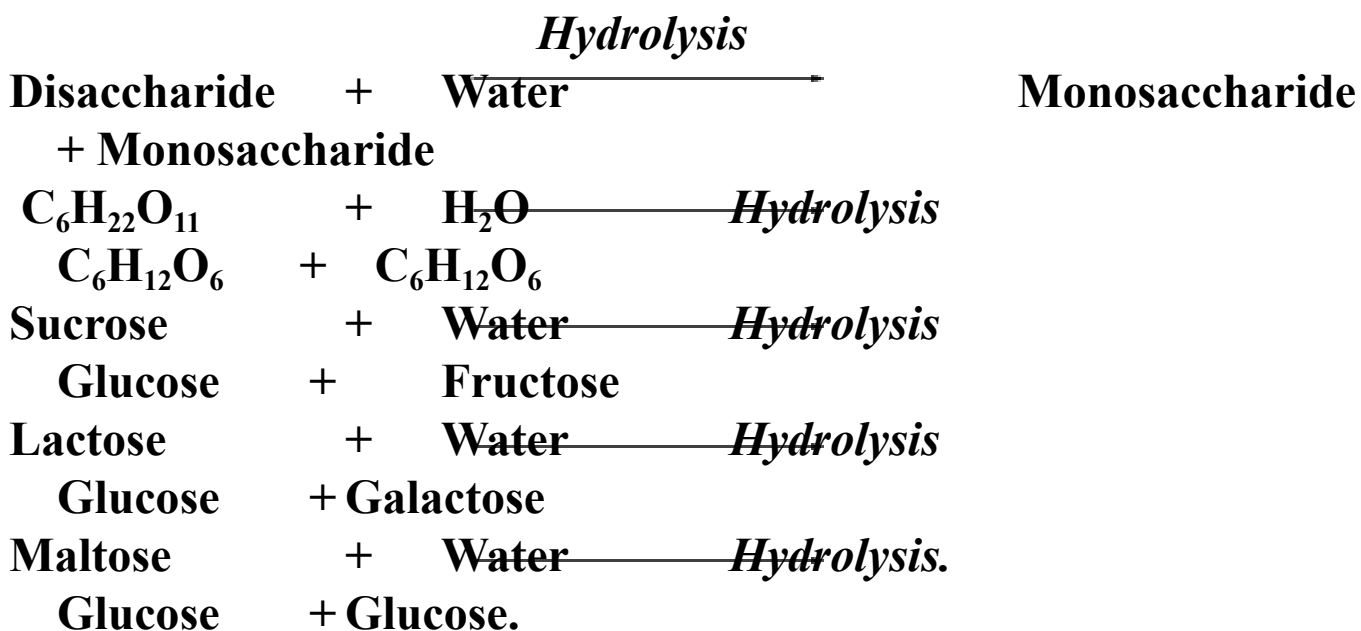
Water



- The type of disaccharide formed depends on the monosaccharide units that condense together.

Properties of Disaccharides

- Soluble in water to form sweet tasting solutions
- They are ***non reducing sugars***. Some such as the maltose can reduce copper sulphate in Benedict's solution when heated together and are therefore referred to as ***complex reducing sugars***.
- They are readily broken into their constituent monosaccharide molecules in a process known as ***Hydrolysis*** in the presence of water.



- Naturally disaccharides are hydrolyzed by enzymes. In the laboratory, hydrolysis is achieved by boiling them in dilute Hydrochloric acid.

Functions

- They are hydrolyzed by enzymes into monosaccharide's which are then oxidized to produce energy.
- Polysaccharides.** They are made of many monosaccharide molecules hence are long and more complex.
 - They have a general formula of $(\text{C}_6\text{H}_{10}\text{O}_5)_n$; where the value of **n** is a very large number.

Examples of polysaccharides

i) **Starch**

- It is present as stored food in plant tissues e.g. maize, wheat, potatoes, rice etc.

ii) **Cellulose**

- This is the component of the cell wall in plants. Cellulose gives the plant cells their definite shape.

iii) **Glycogen**

- This is the form in which carbohydrates are stored in animal tissues. Excess glucose is converted into glycogen for storage in the liver.

Properties of Polysaccharides

- All are insoluble in water.
- Do not have a sweet taste hence are referred to as non-sugars.

Study Question 12

Practical Activity 6: To Carry out Food Tests for Carbohydrates

i) **Starch**

ii) **Reducing sugars**

iii) **Non Reducing Sugars**

b) Lipids

- These are the fats and oils. Fats are found in animals while oils are found in plants.
- Oils are liquid while the fats are solid at room temperature.
- They contain carbon, hydrogen and oxygen just like the carbohydrates. However they contain fewer number of oxygen atoms than in carbohydrates.
- Lipids are made up of three *fatty acid molecules* and one molecule of *Glycerol*.
- The nature of a lipid formed, depends on the fatty acids it contains. Glycerol remains the same in all lipids.

Diagram

- Complex lipids are formed through condensation of many lipid molecules just like in carbohydrates.
- Examples of complex lipids include; phospholipids, waxes, steroids and cholesterol.

- Presence of lipids in a food sample is detected using the ***grease spot test or emulsion test***.

Properties of Lipids

1. When fats are heated they change into liquid while oils solidify under low temperature.
2. Both fats and oils are insoluble in water. They however dissolve in organic solvents such as alcohol to form emulsions and suspensions.
3. Lipids are inert hence can be stored in the tissues of organisms.

Functions of Lipids

i) Source of energy

- They give almost twice as much energy as the Monosaccharides.

ii) Source of metabolic water

- When oxidized, lipids release more water than Monosaccharides. Such water is referred to as **metabolic water**.

iii) Structural compounds

- Lipids are constituents of plasma membrane and protoplasm.

iv) Heat insulation

- Fats are deposited under the skin of animals forming the adipose tissue which acts as a heat insulator.
- Mammals in the temperate regions have thick adipose tissue to greatly reduced heat loss.
- Thick adipose tissue in aquatic animals helps them to be buoyant in water.

v) Protection

- Fat is deposited around the major organs such as kidney, heart etc where they act as shock absorber.
- Wax in plant cuticles reduces excessive water loss.

Study Question 13

Practical Activity 7: testing for the Presence of Lipids

i) The Grease Spot

ii) The Emulsion Test

c) Proteins

- Like carbohydrates and lipids, proteins are compounds of carbon, hydrogen and oxygen.
- In addition they contain ***nitrogen*** and sometimes ***phosphorous and sulphur***.
- Some proteins such as haemoglobin contain other elements such as iron.
- Proteins are made up of small units called amino acids. There are about 20 different types of amino acids.
- All amino acids contain the amino group ($-\text{NH}_2$) which consists of hydrogen and nitrogen.
- Two amino acids combine to form a **dipeptide molecule** through the process of condensation.
- The bond between two amino acids is called **peptide Bond**. Many amino acids join together to form a long protein chain called **polypeptide chain**.
- The ***type and sequence*** of amino acids contained in such a chain determine the ***uniqueness*** of the protein being formed.

Properties of Proteins

- i.) They dissolve in water to form ***colloidal suspensions*** (not true solutions) where particles remain suspended in water.
- ii.) They are ***denatured by temperatures above 40 °C***. Heat alters the structure of the protein molecule. Chemicals such as detergents, acids, bases and organic solvents also denature proteins.
- iii.) They are ***amphoteric*** whereby they have both acidic and basic properties. This property enables them to combine with non-protein compounds to form ***conjugated proteins*** such as mucus, and haemoglobin. In mucus the non protein compound is a carbohydrate while in haemoglobin, iron is a non protein.

Functions of Proteins

i.) *Structural Functions*

- Proteins make the framework of living systems e.g. plasma membrane, connective tissues, muscle fibres, hair, nails, hooves, skeletal materials etc.

ii.) *Metabolic Regulators*

- These are divided into two

a) *Enzymes*

- Enzymes are ***organic catalysts which speed up*** the rate of metabolic reactions such as respiration, photosynthesis, digestion etc.

b) *Hormones*

- They are ***chemical messengers which regulate many body processes*** such as growth, reproduction, amount of sugars, salts and water in the blood etc.

iii.) *Source of Energy*

- Under extreme starvation, proteins are broken down to release energy.

Study question 14

Practical Activity 8

To Test for Proteins

Enzymes

- They are organic catalysts which are protein in nature. They speed up or slow down the rate of chemical reactions in the body without themselves being used up.

- They are divided into two;

a) *Extracellular Enzymes*

- Extracellular enzymes are produced within the cells but are used outside the cells which produce them e.g. the digestive enzymes.

b) *Intracellular Enzymes*

- They are secreted and used within the cells which produce them e.g. the respiratory enzymes.

Naming of the Enzyme

- There are two methods on naming enzymes;

i) **Trivial Naming**

- Enzymes are given names of persons who discovered them.
- The names end in **-in** such as pepsin, trypsin ptyalin etc.

ii) **Use of suffix –ase**

- This is the modern method of naming. The suffix –ase is added to the substrate (type of food) or the reaction the enzyme catalyzes.

Example 1

Substrate	Enzyme
Carbohydrate	Carbohydrase
Starch e.g. amylose	Amylase
Sucrose	Sucrase
Maltose	Maltase
Protein	Protease
Lipid	Lipase

Example 2

Reaction	Enzyme
Hydrolysis	Hydrolase
Oxidation	Oxidase
Reduction	Reductase

Properties of Enzymes

1. They are protein in nature hence are affected by changes in temperature and pH.
2. They are substrate specific.
3. They are efficient in small amounts as they are not affected by the reactions they catalyze. They can be used again and again.
4. They are catalysts that speed up the rate cellular reactions and are not used up in the reactions they catalyses.
5. Most of the enzyme controlled reactions are reversible.

Factors Affecting the Rate of Enzyme Controlled Reactions

i.) Temperature

- Enzymes are sensitive to changes in temperature and pH since they are protein in nature.

- Enzymes work best within a narrow range of temperature called the optimum temperature.
- Above the optimum temperature, reaction decreases sharply as the enzymes are denatured.
- Most enzymes have optimum temperature between 35-40°C.
- Very low temperature inactivates the enzymes hence decrease rate of reaction.

Diagrams

ii.) *pH*

- Most enzymes have a pH of close to 7.
- Some however work best in acidic pH e.g. pepsin while others work best in alkaline conditions.
- As pH changes from the optimum, enzyme activity decreases.
- Extreme acidity or alkalinity denatures most enzymes.

Diagrams

iii.) *Specificity*

- Enzymes are specific in nature where a particular enzyme acts on a particular specific substrate.
- For example, sucrose works on sucrose and not any other substrate.

iv.) *Substrate Concentration and Enzyme Concentration.*

- When substrate concentration increases, the rate of enzyme reaction also increases upto a certain level.
- Further increase does not increase the rate of reaction as ***all the active sites*** of an enzyme are occupied.
- When enzyme molecules are increased, the rate of reaction increases proportionally.

Diagrams

v.) *Enzyme Co-factors and Co-enzymes*

- Co-factors are non protein substances which activates enzymes. They are required in small quantities and they include metallic ions such as those of iron, magnesium, zinc, copper etc. Some are vitamins.

- Co-enzymes are non protein molecules that work in association with particular enzymes. Most co-enzymes are derived from vitamins.

vi.) *Enzyme Inhibitors*

- Inhibitors compete with the normal substrate for the active sites and they take up the active site of the enzyme permanently.
- There are two types of inhibitors;

a) Competitive Inhibitors

- These are chemicals closely related to normal substrate and they compete for active sites with the normal substrate. They slow down the rate of reaction.

b) Non Competitive Inhibitors

- They do not compete with the substrate. They combine permanently with enzyme molecules thus blocking the active sites. They include poisons such as cyanides, mercury and silver-arsenic compounds.

Importance of Enzymes

- Enzymes speed up the rate of cellular reactions and also control them. This way, they help prevent violent reactions in the cells.

Study Question 15

Practical Activity 9

Study Question 16

Study Question 17

Practical Activity 10

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