BIOLOGY FOR GRADE TEN

Introduction

When you were in grade nine(9) you were studying environmental science in general. The science you did is divided into three subjects i.e. Biology, Chemistry and Physics. In this module and the subsequent modules you are going to be looking at biology.

Biology is a branch of science which deals with the study of living things. You will look at the details of living things in Unit 1.1. Biology can further be divided into branches and some of which includes the following:

- Botany
- Zoology
- Physiology
- Genetics
- Biochemist
- Micro biology
- Geology
- Virology, etc

In this subject you will discover a lot of interesting things as you will learn more about animals and plants.

At the end of your studies you will be required to write an examination. The examination consist of three papers, i.e. paper I, paper II and paper III. Papers I and II are theory papers while paper III is a practical paper.

UNIT 1.1

In this unit you are going to study your environment and the organisms which are found in your environment, and their characteristics.

Objectives: PSBAT: State characteristics of living organisms.
PSBAT: distinguish between living and non living organisms.

Activity 1.1.

Visit your back yard garden and observe the organisms which are found there.

Questions

(i) What things are in your garden?
(ii) List down the living and non living things in your garden
(iii) What are the common characteristics between man and the living things you noticed in the garden?

Living and Non Living Things

A live goat, dog, plant, etc are examples of living things while a dead goat, dog, plants are examples of non living things. Both living and non living things are made up of matter. In Chemistry you defined matter as anything which occupies space and has mass. The non living things which were live before are made up of organic matter; while those which have never lived before are made up of inorganic matter. Examples are air, rocks, metals, water while those which consist of organic matter are, wood, petroleum, feaces, etc.

Although living things have different sizes, shapes, etc they have several similarities which makes them be identified as living things. Generally they carry out similar general life processes.

Processes in living organisms

Living organisms can be distinguished from non living organisms by the processes they carry out. The chemical reactions are what gives us the seven characteristics in living organisms. Below is the list of the characteristics:

(I) Reproduction

a) What is reproduction?
b) What type of organisms reproduces in your environment? Name them.

Definition: Reproduction is the process by which living organisms produces their young ones. Some living organisms reproduces by sexual reproduction while others by a sexual reproduction. You will learn more about reproduction in the third module.

Question: Why do you think reproduction is necessary to living organisms. Through reproduction organisms replace their dead species and also each type of the organism is able to increase in population.

(II) Movement

Movement is more prominent in animals, fish, birds, insects, etc. These organisms move the entire body from one place to another. In plants, movement is by growth.

Question: a) Which organisms in your garden showed movement?
b) A motor bike is able to move, is it a living thing and why?

Movement in living things is at will, while in non living things is not. Non living things are moved by external forces.

(III) Growth

Growth is permanent increase in the size of the organism. It is accompanied by an increase in the number and the mass of the cells in the living organisms or simply the mass of the cell in case of the unicellular organisms (single celled organism).

Activity 1.2

(a) Observe the plant in your back yard garden for a period of a month. Measure its height every week. What happens to its height after each week?
(b) Measure the mass of the chickens in the poultry for two months. What happens to its mass every one week.

When the height and mass of the plant and the chicken respectively are monitored it will be observed that the permanent increase in height and mass of the organisms will be recorded. These are indications of growth in living organisms.

(IV) Feeding

All living organisms feed. They take in materials from their environment into their bodies for use by the body. Different groups of organisms feed by different methods, others make their own food from simple materials e.g. green plants, while some feed on already manufactured food, e.g. (animals, insects, etc).

Activity 1.3

Observe the organisms in your backyard garden and see how they feed.

(V) Respiration

- What is respiration?
- What type of organisms respire?
- Why do organisms respire?

Definition

Respiration is the process by which living organisms obtain energy by breaking down the carbohydrates in their cells. The energy released from respiration is used for growth, warmth, reproduction etc.
Some living organisms respire anaerobically while others respire aerobically. Both plants and animals respire.

(VI) Excretion

Excretion is the removal of the waste metabolism substances from the body of living organisms. Chemical reactions such as respiration, produces harmful substances which have to be eliminated from the body, or else they may intoxicate the body tissue. The liver for instance produces urea, and uric acid which are also harmful to the body.

(VII) Sensitivity (Irritability)

Sensitivity is the ability of an organism to detect and respond to various stimuli in the environment.

Activity 1.4

Get an insect and get it close to heat and see how it behaves.

Observation: The insect will move away from the source of heat. This is an example of a response in living organisms.
Differences between living and non living organisms.

Questions:

(i) What are the differences between a live and a dead chicken in terms of the characteristics?
(ii) When do we say an organism is dead?

Study the table below. The table is about the differences between living and non living things.

No.	Living organism	Non Living organism
i.	Living organisms respire	Non living organisms do not respire
ii	Living organisms feed	They do not feed
iii	They excrete	They do not excrete
iv	They respond to various stimuli	They do not respond to stimuli
v	They reproduce	They do not reproduce
vi	They grow	They show no growth
vii	They move at will	No movement at will

Exercise

1. Both plants and animals are both living organisms, state the differences in characteristics between animals and plants.
2. What type of food do you obtain from your environment and why do you need food?
3. List down the differences in characteristics between beans as a plant and fish.

UNIT 1.2

CELLS

In this unit we are going to study the smallest units in living organism known as cells. In all living organisms, life start with cells. We will study both plant and animal cells.

Objectives: PSBAT: Plants and animal cells
PSBAT distinguish between animal and plant cells

Definition:

A cell is a functional unit of a living organism. All the chemical reactions which occurs in the living organisms takes place in the cells. Cells can not be seen with our naked eyes. We can only see details of animal or plant cells using a microscope.

- **Microscopes**

Microscopes are instruments which are used to in large small objects which are invisible to our naked eyes.

Types of microscopes

There are several types of microscopes and these are:

(i) Hand lens

A hand lens is a simple type of a microscope made up of a convex lens fixed in a frame with a handle. Check figure 1 below.

Most hand lenses have numbers such as x2.5, or 5.0. The numbers are magnifying powers of the hand lens.

How to use a hand lens

When using a hand lens, put the object to be magnified on a flat surface, a short distance from the lens itself, and then view the object from the lens. To see distinct image move the hand lens up and down above the object to be viewed.

Activity 1.2

Requirements: You need a hand lens, and a leaf

Method:

Place the leaf on a flat surface.

Using a hand lens observe the details of the leaf.
Draw the structure of the leaf as seen using a hand lens.

Question:

What details of the leaf have you seen which you can not see using naked eyes?

(ii) The second type of a microscope is known as a compound microscope. It consist of two sets of lenses fitted at the opposite ends of the body tube. The lens closer to the eye is known as the eye piece, and the one closer to the object is known as the objective lens. Compound microscopes have different pourers of magnification. The diagram below shows a typical compound microscope.

A Compound microscope

How to use a compound microscope

When using a compound microscope the following should be observed:

(i) Always position the microscope on plat surface.
(ii) Make sure the microscope is always upright whether in use or not.
(iii) As a safety precaution do not focus through the microscope at the sun directly. This may damage your eye.
(iv) Hold the microscope by the handle with the other hand supporting the base. Whenever carrying the microscope.
(v) Ensure that both the eye piece and the objective lenses are ever clean.

Viewing objects through a compound microscope:

(i) When viewing objects, the microscope must be illuminated to light. The mirror must be set to direct through the microscope lenses.
(ii) Place the microscope slide with object on the stage
(iii) Fix the objective lens to be used in line with the eye piece by twisting the revolving nose piece. Ensure that a click sound is heard when the objective lens is set in position.

(iv) With one eye focused through the eye piece, turn the coarse adjustment knob slowly while looking through the eye piece. The turning increases or reduces the distance between the object and the lenses until a focused is obtained.

N/B: When focusing always start with a low powered objective lens. To obtain a very sharp image use the fine adjusting knob to focus the image.

Activity 1.3

Observing the structure of onion cells materials: glass slide, cover slide, dropper, absorbent paper, e.g. tissue, a pair of forceps, iodine solution, shallow container, Petri dish, onion bulb, mounted needle, razor blade.

Methods: Peel off the thin inner layer of the onion skin with the harp of the pairs of Forceps. Cut a small piece of onion skin and place it on a drop of water on the slide. Using a mounted needle cover the specimen with a cover slid slowly. Remove the bubbles of air from the preparation if present.

Note: If there is any air bubbles present, add water to one side of the slide and drain it from the other side using the absorbent paper.
Put the slide on the microscope and make observations.

Exercise

Draw the cells as seen under:

(i) low powered lenses of the microscope
(ii) high powered lenses of the microscope

Remove the slide from the stage and stain the specimen with iodine solution.

Check if you can identify some more parts of the cell after staining the specimen.

The following diagram shows what is likely to be seen under the microscope as the structure of the onion skin.

The Basic Structures of the Cells

Although cells vary in structures, size and shapes, they are generally made up of common basic structures.

Figure 7.0 below shows the generalized structures of animal and plant cells. Compare the two diagrams.

(i) What are the similarities between the animal cell and the plant cells
(ii) What differences exist between the animal cell and the plant cell.

Cells are made up of smaller units which are known as cell organecles. A cell organelle is a unit of a cell surrounding by cell membrane.

The nucleus (Latin nucleus means Kernel). The nucleus is the major part of the cell. It performs the following functions:

(i) Controls all the cell activities
(ii) Contains hereditary materials i.e. the ribonucleic acid (RNA) and Deoxynucleic acid (DNA).

The nucleus works like a manager in an institution.

Question

What are the functions of the manager in an institution.

Answer:

In any given institution the manager takes care and controls all the activities of the institutions.

The nucleus contains the fluid known as the nucleoplasm which is surrounded by a cell membrane.

Remember in the activity 1.3 when the specimen was stained with iodine solution the nucleoplasm was seen stained as a black sport in the cell.

The cytoplasm: (Greek: Kylos-hollow, Plasm-mould)

All chemical reactions in the cell takes place in the cytoplasm. It is made up of a transparent jelly like fluid which surrounds the nucleus. What are the components of the cytoplasm? In the cytoplasm are dissolved substances like amino acids, mineral salts, glucose. Water is the main solvent in which the substances listed above the dissolved. The cytoplasm also consist of suspended cell organelles e.g. the mitochondria, ribosome, chloroplast.

The Cell Membrane

The cell membrane consist of an extremely thin membrane boundary the cell. It is about 7.5 nanometers (7.5nm). The cell membrane is made up of fats and proteins.
The cell membrane controls the substances entering or leaving the cell. This is because it is selectively permeable membrane.

The mitochondria (Power house)

The mitochondria is about one micrometer which is about 1/1000 of a metre. It is in the mitochondrion where respiration takes place. In organisms the number of the mitochondria in the cells depends on how much energy is needed by the cell's chemical activities. The most active cells have more mitochondria than those which have more mitochondria than those which use less energy.

Ribosomes

The ribosomes can be found floating in the cytoplasm, or on the rough endoplasmic reticulum – The function of the ribosomes is to make proteins e.g. enzyme, hormones, and material for making new cells.

Endoplasmic reticulum

The endoplasmic reticulum is a complex net work of membranes, which serves as transport system of materials in and out of the cells as well as within the cell. For instance, in a mining company the endoplasmic reticulum can be thought to be a conveyer belt taking materials taking the materials to and from one part of the plant.

The Golgi bodies

These look like stacks of flattened vesicles which makes a body or apparatus. In plants the golgi bodies are also used in formation of the cell wall, but in both animals and plant the main function of the golgi apparatus is to transport materials from the endo plasmic reticulum to the sites of reaction. In the factory think of what machine can represent the golgi apparatus.

The cell wall (Only plant cell)

The cell wall is made up of cellulose. Its function is to maintain the shape of the cell as well as protecting the inner parts of the cells. Animals do not have a cell wall. Their first layer is the cell membrane.

Chloroplasts (only in plant cells)

The chloroplasts contains the photosynthetic pigment known as chlorophyll – chlorophyll is only found in the green parts of the plant.
Cell vacuole (only in plant cells) and few cases in animal cells.
The cell vacuole contains cell sap, much is a mixture of sugars, salts and water. In some animals it presents the cell vacuole is very small. The cell vacuole is surrounded by the membrane known as the tonaplasm.

Differences between animal and plant cells.

(i) Complete the table below to show the differences between animal cells and plant cells

	Animal cell	**Plant cell**
Presence of cellulose cell wall		
Vacuoles	If present normally small and many	
Shape	Irregular	
Chloroplast		
Nucleus	Large and central	

Size	Small	

(ii) Look at the two diagrams of both animal and plant cell. What are the common features which exist between the animal and plant cells.

Cell Specialisation

Look at a factory. Do workers in the factory do the same work e.g. sugar processing factory. Why do you think so? In a sugar processing factory some workers are accountants, others biochemists, managers, labourers, etc. The workers are specialized to do their work in the factory because of the training they did. Similarly in the body of multicellular organisms different cells are specialized to carry out specific function. The specialization of cells makes the cells have different structures.

Below are some specialized plant and animal cells.

The red blood cells

Front view **Side view**

The red blood cells are specialized in carrying oxygen and carbon dioxide from one part of the body to another. This is because they have haemoglobin and contains no nucleus.

The muscle cells

The muscle cells contracts and relaxes. This action brings about movement. Muscle cells are made up of centractile fibres and are spindle shaped.

The nerve cell

The nerve cell conducts electrical messages – this is because it has a long nerve fibre.

The ciliated cells

These are specialized in trapping and removing dust particles. They have cilia and globlet. Cells which produces mucus for trapping the foreign particles from the respiratory track. The white blood cells (phagocyte).

It is specialized in engulfing and digesting the bacteria in our bodies, hence defending the body against diseases. This is because they can change their shape when engulfing the bacteria.

The sperm cell.

The male reproductive sex cell has a long tail and a diploid number of chromosomes in its nucleus. The tail is for propelling in the female sexual organs. The chromosomes it contains are heritable factors.

The root hair cell

The cell is specialized in absorbing water and salts from the soil. This is because it has an elongated outgrowth – which increases its surface area. The root hair also lacks lignin (wood). This makes it selectively permeable.

The palisade cell

The palisade consist of a lot of chloroplasts. The cells are specialized in photosynthesis. This is because they contain chlorophyll.

The phloem sieve tubes

The sieve tubes have no nucleus, and are long. They are used for transporting manufacturing food.

The spongy cell

The spongy cells are spherical, and this allows large air spaces in between the cells. They also have some chloroplast. This makes them also be photosynthetic.

Exercise

Copy and label the numbered parts of the cells shown.

(i) Name the parts labeled A – G.
(ii) What are the functions of the parts A, B, E and F
(iii) What are the differences between the cell in figure A and figure B
(iv) Which cell is from;
(a) an animal
(b) a plant
Give a reason for your answer
(v) List down the common parts found in both the cell in figure A and figure B

i. ……
ii. ……
iii. ……
iv. ……
v. ……

(v)b List down other common features found in both figure A and figure B not necessarily visible in figures above.

i. ……
ii. ……
iii. ……

UNIT 1.3

CELL ORGANISATION

In this unit we are going to look at how organism's structures are built up. We will look at systems, organelles, organs, organisms. All these together form various parts of an individual.

Objectives: PSBAT: Define the terms; tissue organ, system, organism.
PSBAT identify the stated subjects in both plants and animals

Tissue

Question

(i) Identify different cells in your body, and the cells which work together or perform the same function.
(ii) Take a close look at your body and list down the parts you have identified.
(iii) Do the listed parts perform the same function?

Explanation

In higher animals and plants the cells differ in shapes because they are specialized to do specific functions in the organisms. If we have a group of cells which are similar in structure and performs a specific function in an organism then we have a tissue.

How can you then define a tissue? Examples of tissue in animals includes:

Muscle tissue: The tissue consist of a shaped cells made up of contractile fibre, which contracts or relaxes and this causes movement.

Nerve tissue: The nerve tissue which consist of nerve cells conducts electrical impulses from the sensory organs to the sites of action.

Adipose tissue: These are made up of fats. The tissue is important for energy storage. It also insulate the body from energy loss.

In plants examples of tissue includes the following:

Pallisade tissue: The palisade are photosynthetic tissue. They are made up of thin walled elongated columnar mesophyll cells which are separated by narrow air spaces. They contain a lot of chloroplasts.

Xylem tissue: The woody part of the plant is made up of the xylem tissue. The young xylem tissue conducts water and dissolved mineral salts from the soil up the leaves.

Phloem tissue: The phloem tissue consist of long tubes which have sieve plates at both ends. The phloem transports manufactured food from the leaves to various parts of the plant.

Exercise

The other tissues in both plants and animals are:

(i) Blood
(ii) Connective tissue (ligaments)
(iii) Root hair tissue
(iv) Spongy tissue

For each tissue stated above, state its function and how it is specialized for its function.

Organ

An organ is made up of a group of different tissue performing a specific function. The different tissue are put together to form one structure known as an organ.

Examples of organs in animals are:

(i) The stomach – which is an organ of digestion
(ii) The eye – an organ of sight it is made of tissue like nerve, blood, choroids, retina, sclera, etc.
(iii) The kidney – organ of excretion, etc.

Examples of organs in plants are:

(i) The leaf – which is an organ of photosynthesis. It has tissue like palisade, xylem, phloem, the spongy.
(ii) The stem – is another organ in plants

System

A group of organs performing inter-related functions are known as system. E.g. Digestion made up of organs like the tongue, stomach, liver, pancreas intestines, the digestive system prepares the food we eat ready for use by the body. Other systems in animals are: Endexrine, reproductive, circulatory, and the nervous. We will learn more about these systems in the next units.

Organisms

An organism is made up of different systems working together and forming an independent individual when you look at your body you consist of organs, systems, tissue. Examples of organisms are, man, dog, paw-paw plant, etc.

In order of complexity the following summarises the cell organization

Cell → Tissue → Organ → System → Organism

Exercise

1. Arrange the following starting with the most complex to the simplest.

   Cell, Organ, Organism, System, Tissue

2. Name the part of the cell that:

   (i) is made up of the cellulose
   (ii) is selectively permeable
   (iii) manufactures proteins
   (iv) produces enzymes
   (v) contains cell sap
   (vi) acts as transport system with the cell only
   (vii) controls all the cell activities
   (viii) contains DNA and RNA

3. March the terms in column A with their characteristics or related functions in column B.

Column A	**Column B**
Cell membrane	site of energy production
Ribosome	food storage
Vacuole	synthesis of proteins

Mitochondria	selectively permeable
Cell wall	contains chlorophyll
Palisade	maintains the shape of the cell

UNIT 1.4

DIFFUSION AND OSMOSIS

Objectives: PSBAT: Define diffusion, osmosis
PSBAT: Demonstrate diffusion in liquids, gases, and state the application of diffusion and osmosis in animals and plants.

Diffusion

Activity 1.4

To investigate the movement of particles in air.

Materials: Onion tuber, ripe orange, razor blade.

Method:

(i) Find a partner
(ii) Cut the orange into small pieces using a razor blade without your partner knowing what has been cut.
(iii) Let your partner from a distant detect the smell of the cut substance and identify it.
(iv) Repeat the activity and now cut the onion this time.
(v) Exchange with your partner so that you now do the identification while your partner does the cutting of the specimen.

Question

(i) How did the smell reach your nose?
(ii) What happens to the smell as the distance between the specimen and the nose is reduced.

Definition

Diffusion is the movement of particles from their region of higher concentration to their region of lower concentration down the concentration gradient. From this definition of diffusion we can say that by diffusion particles move from the place where they are more to the place where they are few.

Concentration gradient

The difference in the concentrations of particles between two or more areas is known the concentration gradient. Diffusion can occur in solids, liquids or gases, and this depends on the type particles diffusing.

Activity 1.5

Take a container with 98% ethanol and leave it open for 5 – 10 minutes in a room.

Questions

(i) What happens to the level of ethanol in the container after 5 – 10 minutes.

(ii) What happens to the room in terms of smell.

Explanation

The molecules of ethanol are in a higher concentration in the container than in the room, therefore by diffusion the ethanol molecules will leave the container (left open) after evaporation into the surrounding of the room. The smell of ethanol will be detected through out the room. When checked the level of ethanol in the container will decrease.

Activity 1.6

To observe diffusion in liquids.
Suggested materials: A glass vessel, e.g. 250ml beaker, glass tube, funnel, potassium permanganate, water.

Method:

(i) Set the experiment as shown below.

(ii) Leave the experiment in a room for some time e.g. over night.

Observation:

(i) What happened to the colour of water after some time?
(ii) What could be the best explanation for your observation?

Repeat the experiment in activity 1.6, now instead of leaving it overnight heat the mixture gently.

Observation

(i) What happened to the colour of water after heating.
(ii) What is the best explanation of your observation?

Explanation

By diffusion the particles of potassium permanganate moved from the bottom of the beaker to the top of the beaker where they were in a lower concentration. The movement continued until the distribution of the solute became equal in the beaker. This caused the whole liquid in the beaker to be coloured purple.

When heated in the second experiment diffusion was fast. This means that in warm liquids the rate of diffusion is faster than in cold liquids.

Factors affecting the rate of diffusion. There are several factors which affects the rate of diffusion and they include the following:

(a) temperature
(b) thickness of the membrane for diffusion
(c) size of molecules diffusing
(d) concentration gradient of the molecules diffusing

- **Temperature**

The rate of diffusion increases with the increase in the temperature of diffusing molecules, this is because an increase in the temperature is followed by an increase in the kinetic energy possessed by particles diffusing.

- **The thickness of the membrane.**

The rate of diffusion is higher if the membrane at which the diffusing particles are to cross from their region of higher concentration to their region of lower concentration is thin.

- **Size of diffusing particles**

Smaller particles diffuse faster than bigger particles. This is because smaller particles are light, therefore, moves faster from one region to another.

- **The concentration gradient**

When the concentration gradient is high the rate of diffusion will also be high. At a high concentration gradient there are many particles to move from one area to another.

N/B The rate of diffusion is also high at moistured membranes.

Osmosis

Osmosis is a special type of diffusion in which only the water molecules are considered to be diffusing.

We can therefore define osmosis as the movement of water molecules from their region of higher concentration to their region of lower concentration across a selectively permeable membrane. In terms of diffusion, osmosis is also defined as diffusion of water molecule across a selectively permeable membrane.

Activity 1.7

To investigate osmosis in plant tissue.

Suggested materials: Irish potato, water, sugar, razor blade.

Method

(i) Using a razor blade cut the potato into half and scoop some tissue from the other end of the potato as shown in the diagram below:

(ii) Using a razor blade peer off part of the skin from the lower part of the potato. See the figure above.
(iii) Add crystal sugars up to the half level of the scooped part of the potato tissue.
(iv) Fill the beaker with water and leave the potato in water for over night. see the figure below.

Observation

(i) What happened to the sugar in the experiment? Explain your answer.
(ii) What happened to the level of water in the beaker, and give two ways which could have been responsible for the change in the level of water.

Explanation

By osmosis water molecules will be absorbed from the beaker into the potato tissue, and finally into the part of the potato with sugar. This will cause the sugar to form a solution. Osmosis will continue until the point of concentration equilibrium is reached. The loss of water by the beaker causes the level of water in the beaker to decrease.

N/B: Some water in the beaker is lost by evapouration.

(iii) What do you think caused osmosis in the experiment above?
(iv) What was the purpose of removing part of the potato tissue in the experiment.

A simple osmometer

Osmosis can be measured using an instrument known as an osmometer. In the laboratory we can make a simple osmometer from the locally available materials – see if you can construct one.

Requirements: Capillary tube, beaker, water, visking tube

Method:

Set the arrangement as shown below.

Observation:

When the experiments is left for sometime the level of the solution in the capillary but increases. The reading of the increase can be taken from graduations on the capillary tube.

(i) What do you think caused the rise in the level of the solution in the capillary tube?
(ii) What should be done to the solutions if the level of the solution in the capillary is to rise further.
(iii) Why do you think after some time the level in the capillary will not continue rising.

Explanation

The water molecules by osmosis will move from the beaker (dilute solution) into the visking tube (concentrated solution) across the selectively permeable membrane. As more water enters the visking tube, the level of the solution in the capillary tube rises. If we want to increase this level further then we make the solution in the visking tube more concentrated by adding more sugar.

Osmosis in animal and plant cells

Animal cells only have the elastic cell membrane which encloses the internal structures. If animal cells are left in two dilute solutions they will absorb water by osmosis, this will cause their membrane to stretch hence making the cell to swell. If osmosis continues, the elastic membrane will break and the cell will burst. The bursting of the cell caused by over stretching of the cell membrane due to inward osmosis is known as lysis. On the other hand, if the animal cells are left in solutions which are too concentrated than the solution in their cytoplasm, the cell will lose water to the outside solution by osmosis. If the loss of water continues, the membrane will crinkle, as the cell shrinks. This condition is known as cremation.

The figures below shows cell lysis and cell creation.

As we discussed in unit 1.2, plant cells are surrounded by the cell wall. The cell wall is slightly elastic but mostly rigid structure. If plant cells are left in a dilute solution, the cells will absorb water by osmosis. As more water enters the cell, the cell wall resist the stretching of the membrane. This resistance will prevent further entry of wall in to the cells and the cell therefore will remain fully bulged without bursting. This condition is known as turgid. Turgid cells feels firm or hard when touched. When plant cells loses water to their surrounding, the cell membrane and the cytoplasm shrinks. If more water diffuses out of the cell, the cell membrane detouches its self from the cell wall. In this state, the cell is said to be plasmolysed, and the condition is known as plasmolysis. When touched the cells feels soft, and we say the cells are flaccid. The diagrams below shows osmosis in plant cells.

N/B Conditions of plasmolysis, lysis and crenation causes death of cells if not controlled. In both animals and plants there is a process which controls the level of water in order to avoid such conditions e.g. in animals we have osmoregulation, we will learn more about osmoregulation in unit 6.0

Activity 1.6

Osmosis in animal cells.

Requirements: two eggs, water, sugar, dilute acid, two beakers.

Method:

(i) Remove the egg shell by immersing the egg in an acid (The acid will dissolve to egg shell so that the egg membrane now becomes the first layer of the egg).
(ii) Make a concentrated solution of sugar
(iii) Leave one egg in a sugar solution and the other one in water for over night as shown in the diagrams below.

Question

(i) What happened to the egg in 'a' and 'b'
(ii) Explain your answer for each observation

Activity 1.8

To illustrate osmosis in plant cells

Requirements: one Irish potato, sugar/solution, two beakers, razor blade.

Method:

(i) Cut two potato cubes (without the skin)
(ii) Make a concentrated solution of sugar and leave one potato cube in sugar solution while the other in pure water for over night.

See the diagrams below

Observation:

(i) Feel the two cube at a time and see if you can squeeze each with your fingers. Complete the table below for your observation.

Cube a	**Cube b**

(ii) Explain your observations above in terms of osmosis.

Exercise

1. Distinguish between osmosis and diffusion
2. List down any three conditions which affects the rate of diffusion.
3. State two areas in plants and animals where diffusion and osmosis takes place.
4. Explain what it means by referring to the cell membrane as being selectively permeable.

UNIT 1.5

ENZYMES

In this unit we are going to look at enzymes. Enzymes controls the life processes in our body. Basically all the chemical reactions which takes place in living organisms are known as metabolic reactions. The metabolic reactions can be classified into two groups which includes the following:

(i) catabolism or catabolic reactions. These are the reactions which involves breaking down of larger molecules into smaller units.
(ii) Anabolism or anabolic reactions. These reactions involves building of smaller units into larger and complex units.

Both catabolic and anabolic reactions in our body are controlled by the chemical substances known as enzyme. You will find this unit to be very interesting.

Objectives: PSBAT define the term enzymes. State the characteristics and the use of enzymes.

Definition:

Enzymes are defined as biological catalysts. A catalyst is any substance that controls the rate of a reaction but its self does not chemically change during the reaction. Enzymes are not living organisms but organic substance. We can understand more about enzymes by looking at their characteristics.

Characteristics properties of enzymes

Enzymes have several physical and chemical properties. The following are the properties of enzymes.

(i) *Enzymes are protein in nature*. This means that enzymes are made up of proteins.
(ii) *Enzymes are affected by pH*. Ph is the measure of degree of acidity or alkalinity of the substance. Some enzymes work in alkaline medium, others in acid medium, while the other group of enzyme in a neutral medium. The enzyme which work well in alkaline can not work if put in an acid-environment, and vice-versa. The diagram below shows the relationship between enzymes activity and pH. The ph at which a particular enzyme work best is known as optimum pH.

(iii) *Temperature*: Enzymes are sensitive to temperature changes. At very low temperatures the enzymes controlled reactions are very low and at temperatures beyond 40 – 45 degree Celsius most enzymes are denatured (destroyed). Enzymes work well within a narrow range of temperature between 30 – 45 degree Celsius. The graph below shows the effects of temperature changes on the enzyme controlled reactions. The temperature at which the enzyme work best is known as the optimum temperature.

(iv) *Enzymes are catalysts*. They do not take part in a chemical reaction, and therefore enzymes in any reaction they control are not reactants, but just facilitates the rate of reaction they control.

(v) *Enzymes are specific in their reactions*. A particular enzyme will control a certain chemical reaction, this is because enzymes have specific shapes which suits their substrates active sites. The relationship between an enzyme and the substance it acts on, (substrate) can be compared to that of a key and a lock, where a key can only open or close a lock meant for it. Similarly one kind of an enzyme can only act on a substrate meant for it. The region of the enzyme which participates directly into conversion of substrates into products is known as the active site. See the figure below.

(vi) Enzymes can catalyze both forward and backward reaction see the figure above.

(vii) Enzymes being specific in their reaction, it is therefore true to say in all enzyme controlled reaction, for a particular enzyme the end product will always be the same e.g.

$$\text{Starch} \xrightarrow{\text{Amylase}} \text{maltose}$$

$$\text{Fats} \xrightarrow{\text{Lipase}} \text{fatty acids and glycerol}$$

N/B: Some enzymes properties stated above can be investigated by way of experimentation.
Caution: The experiment described below involve the use of saliva; do not touch or share saliva with your friend's. Therefore you are advised to do the experiment alone.

In saliva there is an enzyme known as amylase. Amylase acts on starch to break it down to maltose.

Activity 1.9

To investigate the nature of enzymes

Requirements: water, rubber, biuret reagent, test tubes

Method:

- Rinse the mouth with water to remove any food particles in the mouth.
- Chew a piece of rubber to stimulate the release of saliva; and collect $5cm^3$ of saliva in a test tube.
- Test $5cm^3$ of saliva for proteins. See unit 2 for details on testing for proteins. Repeat the experiment using water.

Explanation

When proteins are tested using Biuret reagent the mixture turns purple. Similarly the activity above the mixture will turn purple. Saliva contains the following substances, i.e. Mucus, water, and amylase. The only protein in saliva is amylase which is an enzyme (enzymes are proteins).

Activity 2.0

To investigate the effects temperature on enzymes

Materials required: Saliva, two test tubes, starch solution, iodine solution, source of heat.

Method

- Obtain $5cm^3$ of saliva as in activity 1.9
- Divide the $5cm^3$ of the saliva into two equal portions
- To one test tube with saliva add $2.5cm^3$ of starch solution and leave it for some time in a water bath at $36C^0$ about 15 minutes.
- To the other test tube with saliva heat the saliva until it boils followed by addition of $2.5cm^3$ of start solution. Leave it for some (15 minutes).

After some time test the two mixtures for starch. See unit 2.0 for details on testing for starch.

Observation

Activity	Observation	Conclusion
1. 9		
2.0		

Explanation:

In activity 2.0, the amylase was denatured due to boiling, therefore amylase had no effect on starch. Experiment two therefore showed the presence of starch. In activity 1.9 the enzyme was not denatured, and converted starch to maltose. After 15 minutes when the mixture was tested for starch it showed the absence of starch.

Question

Given the following materials, iodine solution, water, starch solution, dilute hydrochloric acid, describe an experiment you would use to show the effect of changing pH on the enzyme controlled reactions.
N/B: Amylase does not work in acid medium.

Classification of enzymes

Enzymes can be classified in two classes and these are, Intracellular enzymes and extra cellular enzymes.
The enzymes that controls the chemical reactions that occurs within the cells are known as intracellular enzymes and those that controls the reactions that occurs outside the cells are known as extra cellular enzymes. Examples of extra cellular enzymes includes the digestive enzymes e.g. lipase trypsin, pepsin, etc.
Respiratory enzymes and catalysts are examples of intracellular enzymes.

Industrial application of enzymes

Science and technology has simplified human life. Research on enzymes from animals and plants tissue has led to discover the other uses of enzymes in our day to day life. Some industrial applications of enzymes are discussed below.

(i) In biological washing detergent.

Biological washing detergents contains enzymes like protease, lipase, and amylase, meant to remove food stains. The enzymes digest the stains of plant and animal materials from clothes.

(ii) In beer brewing

Carbohydrates are fermented and during this process enzymes in maltose help to convert carbohydrates to ethanol (alcohol). This process is anaerobic respiration in yeast.

(iii) In baking industries

In bakeries flour is mixed with yeast and in a series of reactions enzymes in the white convert starch to glucose. The enzymes in yeast acts on glucose to produce carbon dioxide. The gas makes the dough to rise and be aerated, and this make the heat to be even distributed during baking.

(iv) In tanning

Animal skins are hard and thick. To process them into leather, the skin are first softened by tannic acid and the enzyme solution which breaks down some tissue.

Exercise

(i) Define the term enzyme
(ii) State any three characteristic of enzymes
(iii) State the three industrial application of enzymes
(iv) Study the diagram below and answer the question that follows.

(a) State three characteristics of enzymes shown in the diagram above.
(b) State three other characteristics of enzymes not necessarily shown in the diagram above.

(v) Enzymes are sometimes named by substituting their last three letters of their substrates by ASE e.g. lactase, Amylase

e.g. Cellulose _____ Cellulase (enzyme)

complete the table below on naming of enzymes. The first one has been done for you.

Substrate	**Enzyme**
Lactose	Lactase
Sucrose	
Lipids	
Maltose	
Carbohydrates	

UNIT 1.6

CLASSIFICATION

Science has put different organisms into groups, classes kingdoms, etc. In this unit you are going to look at various organisms and their groups according to their closeness in relationships.

Objectives: PSBAT: classify various animals and plants
PSBAT: construct simple keys to classify plants and animals
PSBAT: use the keys to identify plants and animals.

Activity 2.1

Educational trip

Take some time to visit a 200 or an animal farm in your area, preferably in 200 will give a good experience.

Observe various animals as well as plants in the 200 closely, and list them all. Find out their local names and scientific names.

Study their similarities and differences. You may consider the following; plants with narrow leaves, or broad leaves, animals with horns or without horns and many more characteristics, etc.

(a) Place the animals you have listed in groups of similarities. Question. How many groups do you have?
(b) Place the plants in groups of similarities. How many groups do you know?

Classification is a scientific method of placing organisms in related groups. It is an orderly grouping of all organisms. Taxonomy is a branch of biology concerned with classification of organisms. It is also called biological classification.

System of classification

The system of classification mostly used by biologists is natural classification. In this system most closely related organisms are placed into groups. Most biologist use the system of classification, which arranges organisms in groups of descending hierarchy. These groups are: kingdom, phylum or division, class, order, family, genus and species. The largest group of classification is known as the kingdom, followed by phylum, class, order, genus, and the species as the smallest group.

A kingdom consist of different phyla and a phylum consist of different classes, etc. as the hierarchy descends members become closely related. In the hierarchy the most, closely related members are those found in the same species.

Below is a full classification of maize. The biological name of maize is zeamays.

Kingdom - Plantae
Phylum - Tracheophyta
Class - Angiospermea
Order - Poales
Family - Poacae
Genus - Zea
Species - Mays

Naming of organisms

Organisms are known by different names and this depends on different regions of the world, however each organisms has only one correct scientific name which scientist world wide use to recognize the organism. The scientific system of naming the organism is known as Binomial system of nomenclature. In binomial nomenclature the organism is given

two names of which the first one is the organism's generic name (also known as the genus name). The second name is known as the specific name (also known as species name). the generic name is written first starting with the capital letter followed by the species name which starts with the small letter.
Example, the full scientific name of a human being is homo-sapien, homo-generic name sapien – species name. In the same vein the scientific name for maize is Zeamaysi, Zea – generic name, mays – species name – Kingdoms.

Kingdoms are largest groups in which living organism can be classified. We can define the kingdom as the largest unit of biological classification. There are five many kingdoms in which organisms can be classified below is a list of kingdoms.

(i) Animalia kingdom

This kingdom consist of multicellular eukaryotic, heterotrophic organisms which usually move about. This kingdom is the largest group with more than a million of different kinds of organisms. The organisms in the kingdom animalia have complex body features, organized systems, tissue and organs e.t.c. The kingdom is divided into several phyla like.

a) *Porifera*. This phyla covers all fresh water sponges and most marine.
b) *Coelenterata*. These animals have a sac like bodies and symmetry bodies. They have two layers of cells. These include hydra, corals, jelly fish and anemones.
c) *Platythel minthes*. This phyla covers the animals with flat bodies which are normally longish. They are normally referred to as flat worms, e.g. tape worms, hook worms.
d) *Annelida*. The phyla includes animals like earth worms, leech and rag worm. These animals are divided into rings and have true body cavities.
e) *Nematoda*. The phyla covers animals which have round long bodies e.g. round worms, hook worms.
f) *Mollusca*. The phylum mollusca consist of soft bodied animals that have no bones and their bodies are not segmented. The mollusca have hard shells which protects them e.g. shigs, snails, oysters, octopus, clams.
g) *Arthropoda*. This phylum consist of the animals which have hard exoskeleton, and jointed limbs. Insects belong to this kingdom.
h) *Chordata*. This phylum covers all amphibians, fish, reptiles, birds and mammals.
i) *Echinodermata*. The phylum covers animals with five arms and are arranged in a circular plan normally these animals have external spines e.g. sea urchins, starfish, sea cucumbers.

(i) The Plantae Kingdom

The kingdom consist of multicellular eukaryotic photo autotrophic organisms. All green trees and grass belong to this kingdom. The plants in this kingdom contains chlorophyll.

(ii) The fungi kingdom

The fungi kingdom is made up of eukaryotic heterotrophic organisms. The organisms in this kingdom are generally saprophytes or parasites. Their cell walls are made up of the material known as chitin. We will look at the details of fungi in unit 3.5. mushrooms, yeast, bracket fungi belong to this kingdom.

(iii) The Protista Kingdom

The kingdom is made up of the organism which are unicellular and filamentous with a well defined nucleus. The organisms in this group cannot well be defined as animals or plants e.g. algae (green, red and brown), diatoms, protozoa. The kingdom has both autotrophs and heterotrophs. The figures below shows some of the protista.

(iv) The kingdom Monera

he kingdom consist of unicellular organisms whose cells have not cell nucleus and nuclear membrane. They are simply simple organisms which includes autotrophs and heterotrophs. The bacteria, blue and green belong to this kingdom.

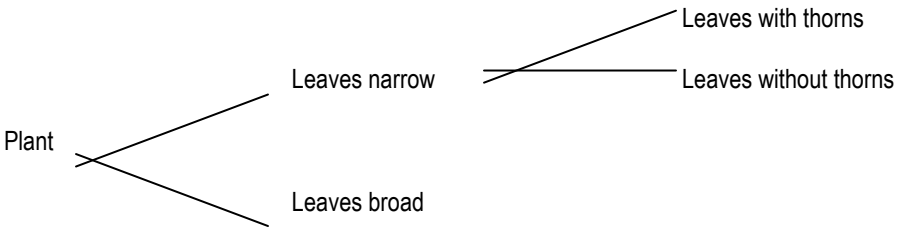
Viruses

Viruses do not belong to any kingdom simply because they differ in many ways from unicellular organisms. They are not also clearly defined as whether they are living or non living.

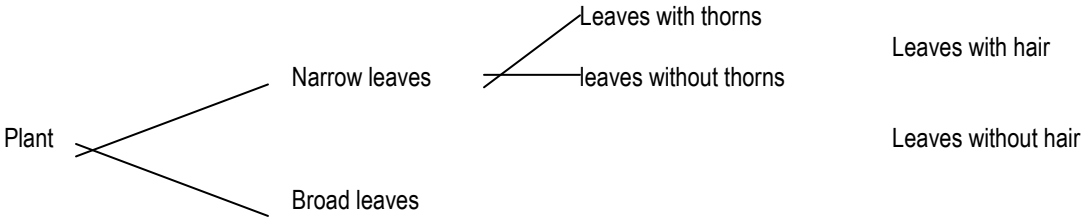
Construction of simple classification keys

The differences which exist between organisms can be used to identify organisms especially new ones. A classification key is a device which is used for easy identification of unknown organism. The external characteristics of an organism are usually used for this purpose.

In the key the biologist is presented with a sequence of choices. For instance, we can separate two plants using leaves, e.g.



We can further classify the plant by adding hair so that key may look as follows.



A key is guide to identification of a group of organisms. We can arrange the characteristics of the organisms in a key in systematic way. For example, a soil worm can be identified as follows:

Key to worm

1. Body divided into rings or segments …….. 2
   Body not divided into rings or segments …….. 4

2. Body composed of more than fifteen segments
   Class oligochaeta …… 3

Body composed of less than fifteen segments not worm but insect larva.

3. Small thin worm usually grey or white (pot worm) pink or brownish …….. earth worm.
4. Body somehow pointed and enclosed in a rigid cuticle …… round worm.

Activity 2.2

Make your own key

Suggested materials: flowering plants (grass and bean) with flowers, hand lens.

Method

Make a similar key to that of identifying the worms. Use the questions below to help you construct the key.

(i) How do the root system differ?
(ii) How do plant forms differ?
(iii) How do the leaves differ?
(iv) How do the flowers differ?

N/B each point should separate the two plants.

Exercise

1. In how many kingdoms can living organisms be classified and name them?
2. Arrange the following in order of relationships starting with the most closely related.
   Phylum, Genius, Class, family, order.
3. Why do you think the viruses are not part of the kingdoms you have mentioned in question 1.
4. Make classification key which will lead to classification of man following the hierarchy.

UNIT 2.0

NUTRITION

2.1 Classification of nutrients

Objectives: PSBAT: identify different types of nutrients and state its biological importance in our bodies.
PSBAT: conduct food tests to identify the nutritional value of various food samples.

The food nutrients are substances present in food which are needed for the health growth of our bodies. There are seven food nutrients and these includes the following:

(i) carbohydrates
(ii) proteins
(iii) fats
(iv) vitamins
(v) mineral salts
(vi) water
(vii) roughage

- **Carbohydrates**

Carbohydrates are compounds which contains the mineral elements, carbon, hydrogen and oxygen. Examples of carbohydrates includes starch, glycogen and sugars. We get energy for our various body activities like, walking, reproduction, brain activities e.t.c. by eating carbohydrates. From 7g of a carbohydrate the body gets 16 kilojoules of energy.

What type of food should we eat in order to obtain carbohydrates.
Wheat, cassava, potatoes, maize, honey, etc.

Basically there are three classes of carbohydrates and these are:

a) monosaccharides
b) disaccharides
c) polysaccharides

- **Monsaccharides ($C_6H_{12}O_6$)**

Monosaccharides are the simplest form of carbohydrates. They are soluble in water and taste sweaty. Examples of monosaccharides are glucose, present in honey, fructose present in fruits and galactose present in milk. Monosaccharides though represented by the same molecular formula they have different structural formulate.

- **Disaccharides $(C_{12}H_{22}O_{11})_n$**

Disaccharides are made up of two monosaccharides which are chemically combined by the process known as condensation, during which a water molecular is lost. Like monosaccharides, disaccharides are soluble in water and taste sweaty.

The diagram below shows the chemical combination of monosaccharides to form disaccharides e.g. sucrose.

(i)

(ii) Lactose → Galactose + Glucose

(iii) Maltose → Glucose + Glucose

- **Polysaccharides $(C_6H_{10}O_5)_n$**

Polysaccharides consist of a long chain of monosaccharides joined together by condensation, starch, cellulose and glycogen are examples of polysaccharides. Unlike monosaccharides and disaccharides, polysaccharides are insoluble in water and do not taste sweaty. Sources of polysaccharides like starch are cassava, wheat, rice, etc. The diagram below shows how polysaccharide units are formed by condensation of monosaccharides.

- **Proteins**

Proteins are compounds of the mineral elements, carbon, hydrogen, oxygen, nitrogen and sometimes sulphur and phosphorous.

Proteins are made up of smaller units called amino acids. The amino acids are combined together to form a protein unit by condensation. The bond between each unit of an amino acid in a protein unit is known as a peptide bond or amide bond.

There are more than twenty amino acids known today e.g. valine, teucine, and tyrosine, e.t.c. Since there are many amino acids, it also follows that main proteins are made. E.g. we have proteins like; haemoglobin, albumin, keratin, hormones and enzymes.

Uses of proteins

(i) For growth and repair of worn out tissue
(ii) Making of enzymes and hormones
(iii) Secondary source of energy 1g protein = 16kj of energy
(iv) Formation of antibodies

Sources of proteins are; meat, beans, fish, family, chicken, milk.

- **Lipids (Fats)**

Just like carbohydrates, fats contains the mineral elements, carbon, hydrogen and oxygen. Unlike in carbohydrates in fats there is twice less oxygen as in carbohydrates. This makes the fats to be saturated.
Lipids consist of basic units fatty acids and glycerol. To one glycerol units there are three fatty acids bonded by condensation.

At room temperature and pressure, fats are solids and lipids are liquids.

Uses of fats

(i) Formation of cell membrane
(ii) Formation of connective tissue
(iii) Insulation against heat or gain from the body
(iv) Stores fat soluble vitamins
(v) Protects the nerve fibres in the neurone (myelin sheath)
(vi) Source of energy – from 1g of a fat when oxidized gives 39 kilojoules of energy
Sources of fats
Ground nuts, margarine, cooking oil, e.t.c.

- **Vitamins**

Vitamins are organic materials needed for the health growth of the body. They are needed by the body in small quantities but still vital to the body. The word vitamins comes from the word vitamin means life. The absence of vitamins from the diet causes vitamin deficiency diseases. Lets now look at some vitamins which our body needs.

Vitamin A (Retinol)

The chemical name of vitamin A is known as Retinol. Retinol is present in foods like, yellow fruits and vegetables, like paw-paw, mango, carrots, apricots; liver, egg yolk are also rich in vitamin A.
Vitamin A is needed for the following in our body:

(i) formation of visual purple in the eyes
(ii) to keep the lining of the gut, nose, etc.

Deficiency in vitamin A will result in night blindness, unhealthy skin, sore eyes.

Vitamin C (Ascorbic acid)

The chemical name of vitamin C is ascorbic acid. It is present in fresh fruits and vegetables e.g. lemons, oranges, mango, spinach, etc. Vitamin C is a water soluble. The vitamin is needed for:

(i) formation of connective tissue
(ii) formation of blood vessels
(iii) development of strong bones and teeth
(iv) fast wound healing

Deficiency in vitamin C will result in gum bleeding, slow wound healing.

Vitamin D (Calciferol)

Vitamin D is known as calciferol. It increases the absorption of calcium and phosphorous from the intestines into the blood stream. Lack of vitamin D will result in rickets (weak bones). Sources of vitamin D includes egg yolk, butter, oils, groundnuts, etc.

Vitamin K

Vitamin K is essential for normal blood clotting. It speeds up the formation of the enzyme known as prolhrombin by the liver. Sources of vitamin K include the vegetables, tomato, egg yolk.
Lack of vitamin K will lead to an individual experiencing prolonged bleeding.

Mineral elements

Mineral elements are inorganic substances present in food and are needed in several metabolic reactions of the body. They are also needed by cell chemicals known as A.T.P. Below are some of the mineral elements.

Calcium (Ca)

Calcium is required in our bodies for formation of strong bones, and teeth, proper muscular contraction, and transmission of nerve impulses. Sources of calcium are, cheese, milk, eggs, fruits, vegetables, butter, baking powder, meat, etc. lack of calcium will result directly in rickets especially in infants.

Iron (Fe)

Iron is needed for formation of haemoglobin in the red blood cells. Sources of iron are; egg yolk, liver, kidneys, beans yeast, spinach, e.t.c. lack of iron will result in anaemia.

Iodine (I)

Our body needs iodine for formation of thyroxine, a hormone produced by the thyroid glands. We get iodine by eating iodised salty cheese, sea foods, drink water, onion, e.t.c. Lack of iodine will result in reduced growth and goiter.

Nitrogen (N)

Nitrogen is needed for making proteins, hair, nails, muscles and the skin. We obtain nitrogen from meat, eggs, milk, fish, e.t.c.

Water

About three quarters of our body is water. It is found in all the body fluids. Water performs the following functions in the body:

(a) as a solvent in our body
(b) as a coolant
(c) as a reactant in all the hydrolysis reactions

Lack of water in the body will result in the body being dehydrated. We get water in our body by taking fluids, water itself, fresh fruits, fresh vegetables.

Roughage (fibre)

Roughage is found in vegetables, maize, rice and fruits. It adds bulk to the food, this is because it is indigestible in the human alimentary canal. The function of roughage is to stimulate peristalsis. The movement of food in the alimentary canal. Lack of roughage will result in constipation.

Food Tests

The food tests mainly covers part of your practical examination at grade twelve level. The aim of food tests to try and find out the nutrients present in food we consume. In this unit you are going to test for the presence of fats, proteins, starch, reducing sugars and non reducing sugars in the food you consume. Food, therefore, are important component of your coarse study.

Iodine test (test for starch)

Starch is identified by adding 3 – 4 drops of iodine solution of $2cm^3$ – $5cm^3$ of the food sample, and the mixture must be shaken. A blue-black colouration shows the presence of starch while a yellowish – brown stain shows the absence of starch.

Test for Reducing Sugars (Benedicts test)

Reducing sugars are identified by adding $2cm^3$ – $5cm^3$ of Benedict solution to $2cm^3$ – $5cm^3$ of the sample followed by gentle heating. The colour changes from blue – green – yellow – orange – brick red, shows the presence of reducing sugars, or any colour change in the sequence e.g. from blue to green. A blue color (no colour change) shows the absence of starch.

Non Reducing Sugars Test

The presence of non reducing sugars can be investigated by first adding $1cm^3$ of dilute hydrochloric acid, to $2cm^3$ – $5cm^3$ of the food sample followed by gentle heating. The mixture is allowed to cool and then 1cm3 solution hydroxide solution is added to the mixture after cooling.
To the mixture of the food sample, hydrochloric acid and sodium hydroxide above equal amount of Benedict reagent is added and the mixture gently heated.

The presence of non reducing sugars is indicated by a series of colour changes from blue – green – yellow – orange – brick red. While the absence of non reducing sugars is shown by a blue colour.

In the experiment hydrochloric acid is added to the food sample and heated gently to breakdown non reducing sugars to reducing sugars. Sodium hydroxide solution is added to the mixture to neutralize the dilute hydrochloric acid.

Test for proteins (Biuret test)

To test for proteins $2cm^3$ to $5cm^3$ of the food sample is obtained to which $2cm^3$ – $5cm^3$ of sodium hydroxide solution is added followed by 2 to 3 drops of dilute copper(II) sulphate. The mixture is shaken and colour changes are observed. A purple or violet colour shows that proteins are present, while a blue colour shows the absence of proteins. If you have Biuret reagent just add $2cm^3$ – $5cm^3$ of biuret reagent to $2cm^3$ – $5cm^3$ of the food sample, shake the mixture and observe for any colour change, violet/purple shows the presence of proteins, while blue shows the absence of proteins.

Test for fats

There are two tests you can do to determine the presence of fats in a food sample. One is a physical test while the other one is a chemical test.

a) Grease spot test (physical test)

Rub the food substance against the filter or brown paper. The presence of fats is indicated by a translucent mark made by a fat, while if there is no translucent mark then fats are absent.

b) Emulsion test (chemical test)

Add the food substance to $5cm^3$ of ethanol and shake the mixture and wait for it to dissolve for five minutes. Get another clean test tube fill it with $5cm^3$ of distilled water and 3 to 4 drops of a mixture of ethanol and sample and shake the mixture. A white emulsion shows the presence of fats in a food sample, while a clear mixture shows the absence of fats in the sample.
N/B if the sample is in solid state, crush it into smaller particles first before adding ethanol, and it is in liquid state obtain $2cm^3$ to $5cm^3$ and then add equal amount of ethanol.

Now do the following activities on food tests:

- To do the activities below you need the following test tubes, source of heat (spirit, lamp, Bunsen burner), test tube holder, test tube rack, water, ethanol, sodium hydroxide solution, copper (II) sulphate solution, Benedicts reagent, iodine solution, dilute hydrochloric acid, filter paper.
- Study the activities and arrange the apparatus and the chemicals according to the activity.

Activity 2.2.

Test for reducing sugars and proteins

Obtain the groundnuts and glucose powder or tomato, for each makes a solution or just a suspension by adding water. Now test each sample for reducing sugars and proteins complete the table below.

Test method	Observation	Conclusion
Proteins	i. ii.	
	iii.	
Reducing sugars	i.	
	ii.	

Activity 2.3

Test for non reducing sugars and starch

Get starch powder and cane sugar. Make a suspension or a solution of each and test them for starch and non reducing sugars. Complete the table below:

Test method	Sample	Observation	Conclusion
Non reducing sugar	Starch powder		
Starch	Sugar cane		

Test for fats

Test a sample of cooking oil and starch powder for fats as follows:

a) Smear starch powder and cooking oil on a filter each at a time and observe for any translucent mark.

Observation: (i) Cooking oil ……
(ii) Starch powder ……

Conclusion: (i) Cooking oil ……
(ii) Starch powder ……

b) Now test cooking oil and starch powder for fats using the ethanol (emulsion test). Complete the table below.

Test method	Observation	Conclusion
	Cooking oil	
	Starch powder	

Exercise

(i) Name the seven food nutrient which makes up a balanced diet.
(ii) What is a balanced diet?
(iii) What nutritional deficiency disease is one likely to suffer from as a result of deficiency in each of the following:
   a) calcium
   b) vitamin A
   c) vitamin C
   d) proteins
   e) proteins and carbohydrates
(iv) Describe briefly how you can test for starch and proteins in a food sample
(v) Why are the food tests necessary in our day to day life.

UNIT 2.2

DENTITION

Welcome to unit 2.2. In this unit we are going to look at one part of mammals which is the mouth and in the mouth we will look at the teeth, their structure, functions and how they can be cared for.

Objectives: PSBAT: define dentition and identify various types of teeth in a given mammal
PSBAT: relate the structure of the teeth of their functions.
PSBAT: draw and label internal structures of the tooth.
PSBAT: state the dental formulae of the carnivores, herbivores and omnivores.

Look at your mouth in a mirror, analyze your teeth as seen using a mirror.

(i) How many teeth do you have?
(ii) Do all your teeth look the same?
(iii) List down others animals which have teeth.

Types of teeth

Dentition is reflected to as the study of the type and arrangement of teeth in mammals. There are four types of teeth in mammals. These are incisors, pre molars, canines and the molars. The teeth are inserted in the jaw bone. To study each type of teeth in an animal we study half jaw of the mammal. This is because in animals each jaw is a symmetrical. The figure below illustrates this clearly.

(i) *Incisors*: The incisors are chisel shaped with sharp edges. They are used for cutting and biting off pieces of food. they have one root. Below is the external structure of the incisor.

In the mouth incisors are positioned in front.

(ii) *Canines*: the canines have a sharp and pointed edge. They are used for tearing food.

(iii) *Premolars*: The premolars have a flat and ridged surface meant for grinding food. unlike the incisors and the canines, premolars have roots.

(iv) *Molars*: Molars have similar structure to that of the premolars, only that molars are larger than the premolars and have three roots instead of two. Molars are used for chopping and grinding food. See the structure of a molar below.

The internal structure of a tooth

Although teeth may differ in shapes, they have the same structure. The diagrams below shows the longitudinal of a canine and molar.

The tooth is divided in three sections namely the enamel, the dentine, and the pulp. The tooth can also be divided into the crown, the root and the neck.

The enamel

The enamel is a non-living substance it consist of a lot of calcium and phosphates. The mineral composition in the enamel makes the enamel the hardest part of the tooth. The entire crown is covered with the enamel. The function of the enamel is to prevent the tooth from wearing out, however it can be dissolved by acids.

The dentine: This is the second layer from the enamel. It is similar to the bone structure. Although the enamel is non living, it has strands of living cytoplasm penetrating it.

The Pulp

The pulp is the inner most layer of the tooth. It has nerves and blood capillaries which supplies food and oxygen, while the nerves are sensitive to heat, cold and pressure. The pulp is the living part of the tooth.

Relationships between teeth and diet

The number of and types of teeth possessed by a mammal varies according to its diet.

Carnivores: the carnivores whose diet is flesh (meat) have long and pointed canines for killing their prey. Their molars and premolars are large. The largest molars in carnivores are called carnassial teeth.

Herbivores: The herbivores whose diet is plants have a long toothless gap between their incisors and premolars. This is called a diostema. The diastema in some animals is used for manipulating the plant materials in their mouth during chewing.

Omnivores: These eat both plants and fresh. E.g. pigs, man, monkey, have all types of teeth. This enables them handle different types of food.

Dental formulae

The dental formulae is the formular which shows a number of each type of teeth in a half jaw of a mammal. In a dental formula. The letters 'I' stands for incisors, 'c' – canines, 'pm' – premolars, 'm' – molars.

The following are some of the dental formulae of some mammals:

Omnivore

Man $i\ ^{2}/_{2}$, $c\ ^{1}/_{1}$, $pm\ ^{2}/_{2}$, $m\ ^{3}/_{3}$

In man the total number of teeth is 32, the dental formula shows half the number of teeth in each jaw.

Cat $i\ ^{3}/_{3}$, $c\ ^{1}/_{1}$, $pm\ ^{3}/_{2}$, $m\ ^{1}/_{1}$ (carnivore)

Cow $i\ ^{0}/_{3}$, $c\ ^{0}/_{1}$, $pm\ ^{3}/_{3}$ $m\ ^{3}/_{3}$ (herbivore)

Rat $i\ ^{1}/_{1}$, $c\ ^{0}/_{0}$, $pm\ ^{0}/_{0}$, $m\ ^{3}/_{3}$

The total number of teeth in a mammal is found by adding the total number of teeth in the dental formula and then multiply by 2.

The incisors are found in front of the mouth followed by the canines, premolars and finally molars, which are at the back of the baccal cavity.

Caring of teeth

Tooth decay and gum diseases are very common diseases. They are mainly caused by bacteria infections. When food accumulates in the teeth it leaves a film on the teeth which builds up to form a hard layer called plaque. The bacteria in the plaque can infect the gums and teeth, hence causing the gums to smell and bleed leading to the disease of the gums known as periodontal disease. In this condition the gums become soft and flabby making them to unable to support the teeth. The bacteria on the plaque will also feed on carbohydrates and in the process producing acid which can dissolve. The enamel, the dentine and finally the acid will enter the pulp cavity. In the pulp cavity the acids damages the blood capillaries and nerve endings, leading to the condition known as dental caries. The result of dental caries causes toothache. Tooth may result in tooth extraction as treatment.

How to reduce getting tooth decay and gum diseases.

(i) Avoid eating too much sweaty foods e.g. sweats, biscuits.
(ii) Brushing the teeth regularly after every meal.
(iii) Visiting the dentist about once every six months.
(iv) Making good use of teeth – avoid biting hard objects which may break the enamel.

Exercise

(i) List the functions of each of the following teeth.
   (a) incisors
   (b) canines
   (c) molars

(ii) How does a dog canine differ from that of human beings

(iii) Details of the teeth in animals are given below. Construct the dental formula

(a) upper jawi = 4, c = 2, pm = 4, m = 6
lower jaw i = 4, c = 2, pm = 4, m = 6

(b) upper jawi = 0, c = 2, pm = 6, m = 2
lower jaw i = 0, c = 2, pm = 4, m = 2

(c) upper jawi = 2, c = 0, pm = 0, m = 6
lower jaw i = 2, c = 0, pm = 0, m = 6

4. Derive the dental formula from the skulls below:

UNIT 2.3

ANIMAL NUTRITION

Objectives: PSBAT: describe holozoic nutrition digestion and assimilation of proteins, fat and carbohydrates.
PSBAT: state the main region of the alimentary canal and associated organs.
PSBAT: describe extra cellular digestion in the human alimentary canal.
PSBAT: identify the common ailments of the alimentary canal.

Holozoic nutrition in man

In unit 1.1 we discussed the characteristics of living organism. Among them we said feeding various organisms obtain their nutrients in various ways. Green plants make their own food while non greens don't, though others do. Animals feed on already made food. This mode of feeding on already made food is known as holozoic nutrition. Holozoic nutrition involves the feeding on complex food molecules, which then digested, absorbed and assimilated. During holozoic nutrition the undigested food is egested. Animal feed on food like carbohydrates, proteins, fats, etc.

Definition of some terms

Ingestion. This is the taking in of food molecules by the mouth.
Digestion: This is the process of breaking down complex food molecules into simpler and soluble molecules e.g. proteins --------- amino acids.
Absorption: This is the movement of digested food molecules from the alimentary canal into the blood stream.
Egestion: This is the removal of the waste undigested food from the alimentary canal through the anus.

The alimentary canal and its associated organs

The alimentary canal consist of a tube which runs from the mouth up to the anus. In an average adult the alimentary canal is about 9m – 10m long.

The general functions of the alimentary canal.

(i) Ingestion
(ii) Digestion
(iii) Absorption
(iv) Egestion

The alimentary canal in general we can say prepares the food for use by the body.

The diagram below shows human alimentary canal.

The human alimentary canal consist of the following parts:

(i) the mouth
(ii) the oesophagus
(iii) the stomach
(iv) the duodenum
(v) the small intestine
(vi) the large intestine
(vii) the rectum
(viii) the anus

To carry out some of its functions the alimentary canal is assisted by the glands and organs like; the tongue, the salivary gland, the liver, the pancreas, the gall bladder. Check these in figure 1.0 above.

Digestion in the human alimentary canal

Digestion in animals is divided into two that is (i) physical digestion and (ii) chemical digestion.

Physical digestion

Physical digestion of food starts from the mouth up to the small intestines.

- physical digestion in the mouth.

In the mouth solid food is broken down into smaller food particles by the action of the teeth chewing also known as mastication. The purpose of chewing the food is to increase the surface area of food in order to prepare the food enzymic digestion.

- Physical digestion in the stomach

In the stomach due to peristaltic movement food is churned into chime (semi solid food). this also increases the surface area for chemical digestion of food.

- Physical digestion in the duodenum

In the duodenum the bile salts splits the large fat into fat droplets. This process is known as emulsification.

Chemical digestion

Digestion in the Buccal cavity

When the food is ingested in the mouth, the saliva is secreted in the mouth as food is being chewed. Saliva contains the following substances:

(i) water
(ii) mucus
(iii) salivary amylase an enzyme

Salivary amylase converts cooked starch into maltose.

$$\text{Starch} \xrightarrow{\text{Amylase}} \text{Maltose}$$

Since the food does not last long, not all the cooked starch is converted to maltose by the enzyme.

Mucus – mucus lubricates the food so that the food can easily be swallowed.

Water – water is very vital in digestion of food in the alimentary canal it serves the following purposes:

(i) Solvent. Water acts as the solvent during digestion
(ii) Reactant: Digestion being a hydrolysis reaction water is part of the reactant used to breakdown food into smaller units e.g.

$$\text{Starch} + \text{water} \xrightarrow{\text{Amylase}} \text{maltose}$$

(iii) Coolant. Since water has a high heat capacity is also used as a coolant, to reduce heating of the body during the chemical digestion. The figure below shows the longitudinal section of the buccal cavity.

Swallowing of food

Before food is swallowed it is shaped into a ball like structure known as the bolus (boli plural) by the tongue. During swallowing, the tongue forces the bolus against the soft palate thereby closing the nasal cavity. To prevent the food particles from entering the trachea, the glottis (larynx) is closed by the epiglottis, and this makes the bolus to be pushed into the oesophagus.

The oesophagus and peristals

There is no chemical digestion of food in the oesophagus, but only the effect of salivary amylase. The bolus is propelled down the oesophagus by the action known as peristalsis.

The walls of the oesophagus and entire alimentary canal has two sets of muscles and these are: the circular muscle, and longitudinal muscles. The propelling of food down the alimentary canal is done by these muscles. The peristalsis in the oesophagus makes the food reach the stomach.
Figure 10.3 shows the structure of the oesophagus and peristic action.

- Digestion in the stomach

The human stomach is a muscular organ which can hold up the maximum volume of two litres of food. It is made of thick muscles.
The stomach walls contains the gastric glands. The glands produces the juice known as gastric juice. This juice is discharged in the stomach as the food reaches the stomach.

The gastric juice contains the following

(i) enzymes
(ii) hydrochloric acid

- Dilute hydrochloric Acid

In the stomach walls the acid is produced by the oxyntic cells. In the stomach dilute hydrochloric acid performs the following functions:

(i) Sets the appropriate pH for the enzymes in the stomach i.e. pepsin and rennin. The enzymes in the stomach function in acid medium. The pH value in the stomach is pH 2.0 which the pH of dilute hydrochloric acid.

(ii) Dilute hydrochloric acid also activates pepsinogen into active pepsin. Pepsin is produced in form of pepsinogen by the gastric glands. In order to prevent self digestion (i.e. if pepsin is produced as pepsin and not pepsinogen it would digest the gastric glands first).

(iii) The acid also breaks down sucrose into glucose and fructose

(iv) Destroys the bacteria present in food. This prevents us from getting sick as a result of bacteria present in food.

Enzymes action:

Chemical digestion of proteins starts in the stomach where the enzyme pepsin hydrolyses proteins into peptides, while rennin coagulates soluble milk protein caseinogen into insoluble milk protein caesin. The caesin is then acted upon by pepsin and is converted to peptides.

To prevent the corrosive and digestive properties of hydrochloric acid and the enzyme respectively. The stomach lining is covered with a layer of mucus. The mucus is produced by the globlet cells located in the walls of the stomach. If the protection is not effective then an individual will suffer from stomach ulcers.

The figure below shows the structure of the stomach wall.

Question:

How long does the food last in the stomach?

This depends on the nature of food consumed. Fats lasts longer than carbohydrates: Glucose lasts only for a few minutes. On average food last for about 2 hours in the stomach.

The figure below shows the part of the oesophagus up to the duodenum.

Figure 10.4

- Digestion in the small intestines

The small intestines are divided into three portions namely:

(i) the duodenum
(ii) the jejunum
(iii) the ileum

Various digestive enzymes are released in the small intestines in order to complete the digestion of food. in an average adult the small intestines about seven metres long.

- Digestion in the Duodenum

Food enters the duodenum from the stomach through the pyrolic sphincter. The acidic nature of food from the stomach caused the duodenum walls to secrete the hormone known as secretin. The hormone is then carried to liver and the pancreas through the blood stream. Both the liver and the pancreas are then stimulated to digestive juices.

- The liver

The liver produces bile pigments (greenish yellow pigment). The pigment once produced is stored in the gall bladder. When the food is in the duodenum, the gall bladder discharges bile pigments in the duodenum.

- The Pancreas

The pancreas produces pancreatic juice which contains digestive enzymes as well as sodium hydrogen carbonates. The bile emulsifies the fats and this lowers their surface tension, while the sodium hydrogen carbonates in pancreatic juice and the bile salts neutralizes the acid present in food from the stomach. Sodium hydrogen carbonate also provides the suitable pH for the enzymes in the duodenum i.e. Alkaline pH

Enzymic action in the duodenum

The pancreatic juice contains three enzymes namely

(i) trypsin produced as trypsinogen
(ii) pancreatic amylase
(iii) lipase

(a) Trypsin hydrolyses proteins to peptides
(b) Amylase. This amylase breaks down both cooked and uncooked starch to maltose
(c) Lipase converts lipids/fats to fatty acids and glycerol. Digestion of fats ends here as well.

- Digestion in the ileum

Once the food is in the jejunum. The brunners gland produces intestinal juice (succus entericus) which contains the enzymes for final digestion. The enzymes includes:

Peptidase, sucrase, lactose, maltose.

Below is the summary of final digestion in the jejunum

Maltose $\xrightarrow{\text{Maltose}}$ Glucose

Peptides $\xrightarrow{\text{Peptase}}$ Amino Acids

Sucrose $\xrightarrow{\text{Sucrase}}$ Glucose and fructose

Lactose $\xrightarrow{\text{Lactase}}$ Galactose and glucose

From the jejunum food is pushed to the other portion of the small intestines by peristalsis. Digestion of food ends in the jejunum.

Absorption of food

After digestion of food the following will be present in the ileum. Glucose, fructose, fatty acids, glycerol, amino acids, vitamins, mineral salts, water, dietary fibres, and undigested food substances. Glucose, amino acids, fatty acids, glycerol, galactose and fructose are directly absorbed by the ileum.

The internal structure of the small intestine (The ileum)

The structure of the villus

- Adaptation of the ileum to absorption of digested food.

The following are the ways in which the ileum is adapted to absorption of food.

(i) it is long enough (about 5m) and is heavily folded. This presents a large surface area for absorption of food.
(ii) it has numerous villi and microvilli, which further increases the surface area for absorption of food.
(iii) it is lined with numerous mitochondria which supplies the ileum with energy for absorption of food by active transport.
(iv) Each villi has a dense net work of blood capillary for absorbing, amino acids, vitamins, mineral lines, glucose fructose and the lacteal for absorbing fatty acids and glycerol. The lacteal is the part of lymphatic system.
(v) The ileum has a small epithelium which is an advantage to absorption as it reduces the distance by which the food is suppose to cross from the ileum into the blood stream.

The end products of digestion are absorbed by diffusion and active transport. After absorption, the fatty acids and glycerol absorbed by the lacteal are transported to the lymphatic system, which the products absorbed by the blood capillaries are transported to the liver through the hepatic portal vein.

- The large intestines

In man the large intestine is made up of the colon and the rectum. The colon is divided into three sections. These include the ascending colon, the horizontal colon, and the descending colon. By peristaltic movement of food, the food material (undigested) is pushed in the large intestines. In the colon there is no digestion of food as it does not contain any digestive enzymes and also digestion of food ends in the jejunum. Then what is the function of the colon and the large intestine as a whole.

(i) in the large intestine, water is absorbed from the undigested food into the blood stream. This is the main function of the colon. Water is absorbed by osmosis.
(ii) In the colon there are some bacteria much breaks down cellulose into ammonium compounds and vitamin K. The body benefits by absorbing the vitamin K much needed for blood clotting while the bacteria obtain energy from cellulose. The ammonium compounds gives the faeces their characteristic smell, while the bile pigments gives the faeces their characteristic colour e.g. green – yellowish.

Question

What are the substance present in faeces.

Faeces contains undigested food, cellulose, ammonium compounds, bile pigments, dead cells and water.

Faeces are temporarily stored in the rectum before being egestion through anus. The figure below shows part of the small intestines and large intestines.

The liver

As discussed earlier, the liver is one of the associated organs of the alimentary canal. It also performs other functions in the body which are not connected to digestion.

The following are the functions of the liver

(i) Balancing of blood sugar (glucose): At any given time the blood is suppose to contain 80mg of blood sugar exceeds this level, the liver with the help of the hormone known as insulin converts excess blood sugar to glycogen. The liver also changes glycogen to glucose if the blood sugar level falls down below is the summary.

Glucose ⟵ Insulin / ⟶ Glucagons Glycogen (storageable form of carbohydrates)

(ii) Deamination: In the liver excess amino acids are broken down to give glucose, urea and uric acid. This process is known as deamination. Urea, uric and ammonia produced as a result of deamination are waste products which expelled from the body by excretion.
(iii) The liver destroys alcohol, bacteria used up hormones.
(iv) The liver breaks down the old Red Blood cells, during this process, bile pigments are manufactured and iron is extracted and stored.
(v) In infants (babies) the liver manufactures the RBCs and the WBCs.
(vi) The liver makes some blood proteins e.g. haemoglobin, fibrinogen and prothrombin.
(vii) It changes the structure of fats in order to make it available for respiration.
(viii) Being the most active organ of the body the liver generates heat energy which is used to maintain to the body temperature.
(ix) As a storage organ the liver stores vitamin A, iron, copper, potassium and glycogen.

We can summarise the general functions of the liver in the five major groups.

(i) Metabolic functions – i.e. metabolism of carbohydrates, proteins, etc.

(ii) Circulatory functions i.e. Involvement in transfer of blood from hepatic portal vein to the systemic circulation, synthesis of blood cells (RBCs).
(iii) Excretory function – formation of bile withdrawal of substances e.g. heavy metals from blood.
(iv) Protective function – e.g. detoxication of the body
(v) Haematologic functions – blood related functions e.g. destruction of old RBCs.

Exercise

1. Complete the table below to summarise digestion in man.

Site of action	Source	Secretion	Enzyme	Substrate	Product
Buccal cavity		Saliva		Starch	
Stomach		Gastric juice	Lipase trypsin	Fats	
Small intestine			Lactose	Peptides	Amino acids

2. Complete the table below to summarise the functions of some parts of the alimentary canal.

Part	Function
Mouth	Ingestion
Oesophagus	Storage of food, digestion of proteins
Illenum	
Colon	
Anus	

3. Complete the statement. The tongue is an organ of tasting, _____ and _____.
4. Name the end products of digestion of fats, proteins, starch.
5. Name process in animal nutrition described below:

   a) glucose passing from the ileum into the blood stream
   b) sucrose converted into glucose and galactose
   c) mango taken into the buccal cavity
   d) proteins in the stomach converted into peptides.

6. Name the regions in the human alimentary canal in which you can find physical digestion and describe the kind of physical digestion food.
7. Why do you think the amylase produced by salivary glands stops working in the stomach.
8. Describe how the villi is adapted for absorption of food.
9. Explain why emulsification of fats is referred to as physical digestion and not chemical digestion.

UNIT 2.4

PLANT NUTRITION

Objectives: PSBAT explain photosynthesis
PSBAT test for starch in green leaves
PSBAT describe the conditions needed for photosynthesis
PSBAT describe the structure of rhizopus and its feeding system.

In this unit we are going to learn more about the feeding system in plants. In the previous unit we were looking at nutrition in man.

Photosynthesis

Plants like any other living organisms needs food various chemical reactions e.g. respiration, growth etc. unlike animals green plants are autotrophs i.e. make their own food.

Definition

Photosynthesis is the process by which green plants make their own food by combining simple inorganic materials i.e. water and carbon dioxide to form glucose in the presence of sunlight. During photosynthesis chlorophyll is used to trap sunlight. The word photosynthesis can be divided into photo which means light and synthesis which means building up.

The equation below summarises photosynthesis in green plants.

$$\text{Carbon dioxide + water} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{Glucose + Oxygen}$$

$$6Co_2 + 6H_20 \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2$$

The chemistry of photosynthesis.

Photosynthesis is a two stage process namely light reaction and dark reaction.

- *Light reaction*

During the light stage, chlorophyll absorbs sunlight and converts it to chemical energy. The chemical energy is used to split water into hydrogen and oxygen. This process is known as photolysis. During the light reaction, oxygen is also given out as a by product. Part of the chemical energy is converted into Adenosine Tri Phosphate (ATP)

$$\text{Water} \xrightarrow{\text{energy}} \text{Hydrogen + Oxygen}$$

Hydrogen and ATP then proceeds to the next stage, the dark reaction.

- *Dark reaction*

During the dark stage, using energy from ATP hydrogen combines with carbon dioxide to form glucose. This process does not require light energy.

The diagram below summarises the process of photosynthesis in green plants.

Testing for starch in a green leaf.

Activity 2.1

Suggested materials: A plant with green leaves, source of heat, water, boiling tube and alcohol.

Method:

(i) Allow the plant to photosynthesize by leaving it in sunlight for about 6 to 12 hours.
(ii) Boil the leaf from the plan in water for five minutes. This is done in order to stop the chemical reactions in the leaf.
(iii) Boil the leaf in alcohol using a water bath. Reason; to remove chlorophyll from the leaf, see the diagram below.
(iv) Wash the leaf in warm or cold water. Reason; to make the leaf soft. This is because when the leaf is boiled in alcohol it becomes hard and brittle.
(v) Spread the leaf on a white tile and add a few drops of iodine solution. Reason; to test for starch.

Results: Starch present

If starch is present the leaf will be turned blue black

Starch absent

If starch is absent the leaf will be stained yellowish brown.

- *The leaf*

The leaf is an organ for photosynthesis. Its responsibility to the plant is to make food for the plant.

The external structure of the leaf

The internal structure of a leaf

Vascular bundles: The vascular bundles are made up of the xylem and the phloem vessels. The function of these tissue is to transport materials to and from one part of the plant. The xylem carry water and mineral salts while the phloems transports manufactured food, and hormones from leaves. We will look at transport in plants in details in unit 3.

The palisade – These contain numerous chloroplasts. Most of photosynthesis occurs in the palisade cells. The chloroplast are also found in the spongy cells. The other region in the leaf which contains chloroplasts is the guard cells. The number of chloroplasts in the spongy are not as many as in palisade cells. The spongy cells are irregular, this makes them leave air spaces between them for free air circulation.

The lower and the upper epidermis protects the leaf's internal structures. On the lower epidermis are stomata which are used for gas exchange between the leaf and the atmosphere. The opening and closing of the stomata is regulated by the guard cells. In the guard cells are a few chloroplasts. This means that the guard cells can also photosynthesis.

The palisade and the spongy layer together make up the mesophyll layer.

Leaf adaptation for photosynthesis.

The following are the ways in which the leaf is adapted for photosynthesis.

(i) They have a lot of chloroplasts on the palisade to make them trap as much light as possible..
(ii) Leaves have a large surface area. This makes them trap as much light as possible.
(iii) Have air spaces between the spongy cells for rapid diffusion of gases.
(iv) Contains vascular bundles. These serve in transport of materials within the leaf.
(v) Contains stomata on the lower epidermis – This is for easy entry and exist of gases.
(vi) The leaf lamina is thin – This facilitates easy penetration of light and gases.

- **Conditions necessary for photosynthesis to take place.**

There are four conditions which are necessary in order for photosynthesis to take places and these are:

(i) Light
(ii) Chloroplasts (chlorophyll)
(iii) Carbon dioxide
(iv) Water

If any of the conditions stated above is missing in the plant photosynthesis would not occur.

- Light

Activity 3.

To show that light is necessary for photosynthesis to take place suggested materials: potted plant, aluminum foil, ethanol, water, beaker, source of heat.

Method:

(i) Before proceeding with the experiment the leaves on the plant must be de-starched by leaving the entire plant in total darkness for 24 hours.
(ii) Test one of the leaves for starch to ensure that there is no starch present in the plant.
(iii) Arrange the experiment as shown in the diagram below.

(iv) Cover the leaf on the plant with aluminum foil partially as shown above and leave the plant in sunlight for 4 to 6 hours.
(v) After 6 hours remove the aluminum foil from the leaf and test it for starch.

Question:

Which part of the tested leaf turned blue-black, and which part was stained yellowish brown.

Interpretation

The part which was covered with aluminum wall be stained yellowish brown, and the part not covered will turn blue black. The uncovered part received sunlight and photosynthesized.

Conclusion:

Sunlight is needed for photosynthesis

Activity 3.0

To see if carbon dioxide is needed for photosynthesis.

Suggested materials:

Potassium hydroxide, sodium hydrogen carbonate, source of heat, ethanol, potted plant.

Method:

(i) De-starch the leaves of the potted – plant by leaving the plant in sunlight 24 hours and check for the presence of starch in the de-starched plant.
(ii) Arrange the experiment as shown below and test the leaves from A and b for starch.

Question:

What is the purpose of the following chemicals:

(i) sodium hydroxide
(ii) sodium hydrogen carbonate.

Observation:

The leaf in A will be stained yellowish while the one in B will turn blue black. What is the conclusion for this experiment?

Activity 3.1

To show that chlorophyll is needed for photosynthesis.

Materials:

Plant with variegated leaves, pencil, ethanol, source of heat, iodine solution.

Method:

(i) De-starch the plant with variegated leaves (green and non green leaves) green patches of the leaf contains chlorophyll while non green have no chlorophyll.
(ii) Leave the plant in sunlight for 6 hours.
(iii) Remove the leaf from the plant and test it for starch.

Question:

What are the colour changes after testing the leaf for starch.

Interpretation:

The non green parts of the leaf will be stained brown because they do not contain chlorophyll hence no photosynthesis while the green patches with chlorophyll turned blue-black showing the presence of starch and photosynthesis.

Plant Nutrients (Mineral elements)

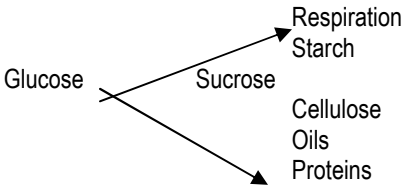
Plants needs mineral elements for various purposes. E.g. nitrogen for synthesis of proteins, phosphorous for making of strong roots, and magnesium for synthesis of chlorophyll. The mineral ions are absorbed from the soil. The table below shows some of the mineral ions needed by plants and the deficiency caused if there are lacking in plants.

Element	Source	Function	Deficiency effect
Nitrogen	Nitrates, Ammonium compounds	Making of chlorophyll, proteins	- yellowing of leaves - stunted growth
Magnesium	Magnesium salts	Making chlorophyll	- yellowing of leaves
Phosphorous	Phosphates salts	Formation of strong roots	- weak root system

The importance of Photosynthesis

Photosynthesis is of great importance to many living organisms. The organic materials produced through photosynthesis are used up by both photosynthetic and non photosynthetic organisms.

From glucose which is the first product of photosynthesis plants are able to make fats, proteins, cellulose and starch, which are of benefit to both plants and other living organisms. Through photosynthesis animals are also able to obtain oxygen. Photosynthesis also removes carbon dioxide from the atmosphere and this helps to



Saprophytic Nutrition

In green plants the type of nutrition is said to be autotrophic this is because green plants can make their own food. however, there are some other organism which feel on already made food, such organisms are known as heterotrophs and the type of nutrition is known as heterotrophic nutrition. The type of heterotrophic nutrition in which heterotrophs feeds on dead organisms is known as saprophytic nutrition, e.g. fungi, mushrooms, moulds, yeast saprophytes are vital in the ecosystem as they bring about decay of dead materials, and helps in returning nutrients in the ecosystem.

Rhizopus

Rhizopus is fungi. It forms a network of small strands on its food. The fungus that forms the net work of small strands on its food is known as a mould. Therefore, the Rhizopus falls in this group of moulds. We find the rhizopus on food like bread, fruits and nshima. The conditions favoured by the rhizopus are warm and moistured conditions.
When viewed with our naked eyes the rhizopus is seen as a grayish, white mass growing on food. it later turns black after sometime. The fungi grows on food left un preserved for a longer period of time. If a hand lens or a microscope is used, the individual parts of the rhizopus can clearly be seen.

The structure of the rhizopus

The figure below shows the structure of the rhizopus

Rhizopus has filaments called hyphae. Sometimes the hyphae grows horizontally forming a wood net work of fibres called the mycelium. A horizontal hyphae is known as the stolon, while a vertical hyphae is known as the sporangiosphere. The part of the hyphae which penetrates into the food substance is known as the rhizoid. The end part of the sporangiosphere forms the structure known as the sporangium, which contains the spores. Spores are the a sexual reproductive cells of the rhizopus.

Digestion in Rhizopus

Rhizopus obtains food from the substrate where they grow. The hyphae tips (Rhizoids) secretes enzymes on the substrate. The enzymes breaks down the food into soluble and simpler units which are then absorbed by the hyphae, e.g. A rhizopus growing on starch will break down starch to glucose. The type of digestion in rhizopus is extra cellular digestion. The food obtained by the rhizopus is required for various purposes e.g. respiration, growth reproduction, e.t.c.

Activity 3

To investigate the growth and the structure of the rhizopus

Materials required: A small container, water, pieces of bread, light microscope, slide, cover slips; methylene blue.

Method:

- Cut the bread into small pieces and place them on a small container
- Add a little water to just moisture the bread and then leave the container in a secure place at room temperature.
- Cover the container to prevent the evapouration of the moisture.
- Leave the experiment for seven days and make observations each day.

Question

- On which day does the rhizopus appear?
- When is the whole substrate covered with the Rhizopus.

Task:

- On the seventh day stain the specimen with methylene blue and draw the specimen as seen on the microscope
- Identify the hypae and the sporangiosphere.

Exercise

(i) What is photosynthesis?
(ii) State the materials which green plants need to manufacture glucose.
(iii) Name the mineral element needed by plants to add to glucose in order to make proteins.
(iv) (a) Arrange the following parts of the leaf in order of the quantity of the number chloroplasts, they contain:
- palisade cells
- guard cells
- spongy cells

(b) Arrange the tissue above in order of the quantity of starch after 4 hours of photosynthesis.

(v) Give the name of the name work of hyphae formed by the Rhizopus
(vi) Why do mushrooms grow in areas where they are more trees.
(vii) How is saprophytic nutrition similar to holozoic nutrition?
(viii) The diagram below is used to show that oxygen is produced during photosynthesis, study it and answer the question that follow.

(a) If the plant is allowed to manufacture its food, name the gas that will be collected in the test tube.
(b) How you can test for the gas named in 'a' above.
(c) Name the gas that will be collected if the green plant was removed.
(d) Which part of the day do you think does photosynthesis occurs at its best.
(e) Design an experiment which can be used to show the effects of light intensity on the rate of photosynthesis.

Glossary

Active Site	-	The actual place on enzymes which converts substrates into products.
Antibody	-	A protein produced in an organism to defend itself against foreign proteins.
Breakdown	-	To divide into other substances
Catabolism	-	breaking down reactions
Diffusion	-	The movement of molecules from the region of higher concentration to lower concentration.
Deficient	-	Lacking
Chlorophyll	-	Green pigment found in plant leaves
Digestion	-	The breaking down of complex insoluble food to simple soluble food.
Excretion	-	Removal of waste metabolic waste from the body
Metabolism	-	All the chemical reactions which takes place in the body.
Osmosis	-	Diffusion is the movement of molecules across a selectively permeable membrane.
Peristalsis	-	Movement of food in the oesophagus by alternative contraction and relaxing of muscles
Ribosomes	-	Sites in cells which make proteins
Substrate	-	A substance on which an enzyme works
System	-	A group of organs performing inter related functions
Xylem	-	Tubes which conducts water and mineral salts