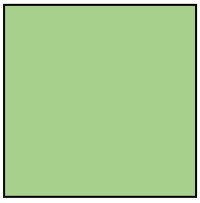
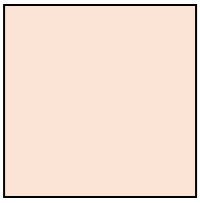
## HOW TO USE THIS BOOK

This book is an easy to read text customized to suit the needs of the form one students. The notes in every section are well researched and presented in a student friendly way. Within the book you will come across text boxes of different tints. The green tinted text boxes contain revision questions that are essential to the students in reviewing the concepts learnt. The REVIEW BOX revision questions can be attempted after reading the content in the associated pages. A senior student interested in revision can also directly use the Review Boxes for revision purposes. Where one comes across questions that are challenging within the Review Boxes, the answers can be obtained within the associated pages. The pink tinted Review Boxes also contain insights and additional tips. The blue tinted text boxes come at the end of every topic. These contain a list of vocabularies that a student needs to review. Questions on definitions are challenging to students. These text box serves as a quick review to learners to ensure they are able to define the key biological words from the topics discussed. In addition, the blue boxes within the topics also highlight the common mistakes students make in examinations.

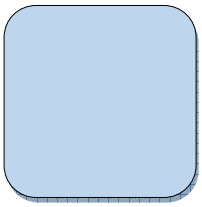
Have fun!



Review questions, additional vital information, common mistakes



Additional information; current issues.



Vocabulary box containing biological terminologies learners should be able to define; also highlight common mistakes learners make.

## Characteristics of Living Things

In primary science, you must have classified things into two broad categories; living things and nonliving things. Living things share a lot of characteristics in common. These characteristics are discussed below.

### *Nutrition*

Nutrition is the process by which living things ***obtain*** and ***utilize*** nutrients. Nutrition is important to living things in that:

a) *The nutrients acquired are used for growth and development.*
b) *The nutrients acquired are broken down during respiration to release energy in the body.*
c) *The nutrients are also vital in repair of worn out and damaged tissues in the body.*
d) *The nutrients are useful building blocks of important biomolecules essential in living systems.*

Nutrition in plants differs from that in animals in that plants make their own food from simpler substances in the environment such as carbon (IV) oxide, water and sun light. Animals, on the other hand do not manufacture their own food. Instead, they depend on already manufactured food materials from plants and other animals.

**Review Box 1.3**

1. Differentiate between respiration and gaseous exchange ***(2 marks)***
2. In what ways does nutrition in animals differ from that in plants? ***(2 marks)***
3. What is the significance of growth and development? ***(1 mark)***
4. What would happen if a given group of living things lose their ability to reproduce? ***(1 mark)***
5. Sate any two uses of energy derived from respiration ***(2 marks)***
6. Highlight three reasons why animals move from one place to another ***(3 marks)***
7. Plants do not move from one place to another. How do they compensate for this inability? ***(3 marks)***
8. Plants do not have complex excretory structures like animals. What could be the reason for this? ***(2 marks)***
9. Discuss the importance of the characteristics of living things ***(20 marks)***

### *Respiration*

Respiration is the process by which food substances are chemically broken down in the cells to release energy. During respiration, oxygen is used while energy, carbon (IV) oxide and water are released. Respiration occurs in all living cells. The energy produced in living things is very useful in that:

a) *It is used for growth and development*
b) *Used for transmission of nerve impulses (messages) within the body.*
c) *The energy is useful for movement and locomotion*
d) *Movement of certain materials within organisms require energy.*
e) *The energy is required for functioning of body organs such as the heart, kidney etc.*
f) *The energy is also used to drive the numerous metabolic processes within the body*

## Collection of Specimen

We have defined biology as the study of living things. For effective study, a biologist may have to collect some living things or some parts of living things for observation and analysis. The living things or parts of living things that are used for biological study are called specimens. Biological studies always take place in laboratories. A laboratory is a building or a room that is designed and equipped for scientific studies.

Collections of living things especially animals may not be very easy. Some of the animals are not easy to catch while some are quite dangerous. While some of the animals can bite or sting, some can also be potential carriers of harmful viruses and other disease causing vectors. Knowledge on proper specimen collection and handling is very important. We will discuss some of the apparatus used in specimen collection.

**Review Box 1.6**

1. Differentiate between movement and locomotion ***(2 marks)***
2. In what three ways does ability to move from one place to another benefit animals? ***(3 marks)***
3. State three ways in which plants compensate for their inability to move from one place to another ***(3 marks)***
4. Define the following terms ***(2 marks)***
    a) Laboratory
    b) Specimen
5. What is the significance of collecting specimen in biology? ***(2 marks)***
6. State the uses of the following apparatus and give one example of an organism that can be collected using each apparatus ***(5 marks)***
    a) Sweep net
    b) Fish net
    c) Bait trap
    d) Pit fall trap
    e) Pooter
7. State three precautions that one should take into consideration when collecting specimen for studies ***(3 marks)***
8. Name the reagents that can be used to preserve specimen in the laboratory ***(3 marks)***
9. What is the importance of specimen preservation? ***(2 marks)***

| **Apparatus** | **Name** | **Function** |
|---|---|---|
|  | Sweep net | Used to catch low flying insects like butterflies. |
|  | Fish net | Used to catch small fishes and other water animals from ponds and other water bodies. |

***Presence and types of fruits can also be used in classification***

- Fruit types and features are also useful in classification; Fruits can be categorized as succulent (juicy/fleshy) fruits or dry fruits. The dry fruits too are of different types. The kind of fruits can be important in grouping plants.

***Some of the leaf and root features in classification***

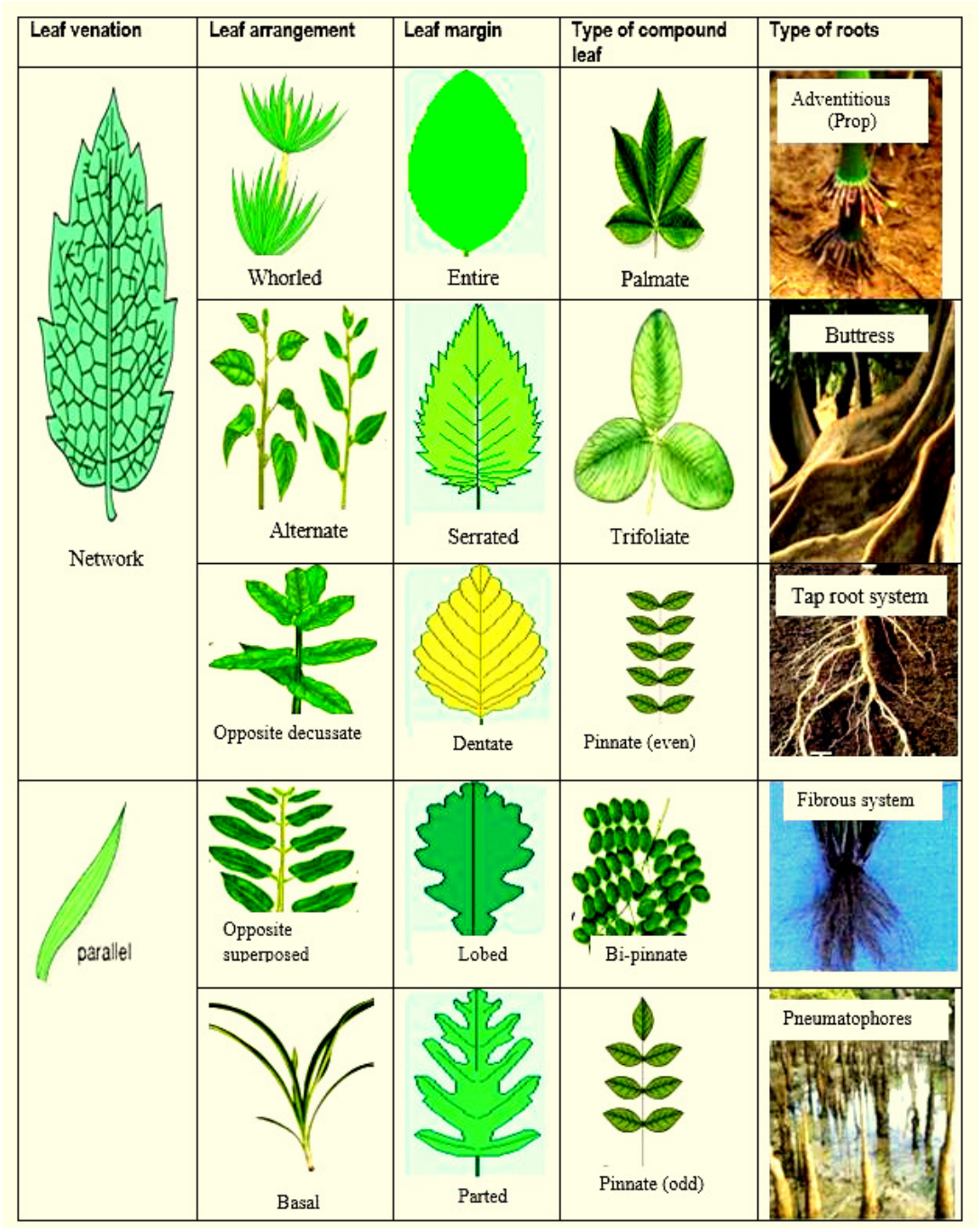



Figure 1. Leaf classification and roots features.

## Family

A family is the next taxon in the hierarchy. A family is a taxon that is composed of closely related genera. The genus **Panthera** (comprised of lions, leopards, tigers) for instance and genus **Felis** (consisting of the domestic cat) are grouped in the family **Felidae**. Note that there are other several genera under this family.

## Order

**NOTE:**
When writing the various taxa e.g. Vertebrata, Annelida, Chordata, they must begin in a capital letter with exception of the species.

An order is a taxon above family. An order is composed of related families. Families that exhibit few similar traits are placed in their own group. Different genera grouped into one family will share many similarities compared to several families grouped under one order. In animals, order **Carnivora** is composed of numerous families including families **Felidae** and **Cancidae**. Ecology and feeding habits are among the features used in classification of orders. As the name suggests, **Carnivora** is comprised of organisms that are predominantly feeding on flesh.

## Class

This taxonomic unit is composed of related orders. In animals, for instance, several orders that are comprised of members who possess fur and have mammary glands among other features are placed in class **Mammalia**. Other classes include **Reptilia, Aves** and **Amphibia**.

## Phylum

This is also known as division in plants and fungi. Related classes that share a few similar traits are placed under one phylum. Animals are classified into several phyla. These include:

a) Phylum **Arthropoda** comprised of insects, spiders etc.
b) Phylum **Chordata** comprised of the vertebrates such as man, fishes, reptiles etc.
c) Phylum **Annelida** comprised of the segmented worms.

## Kingdom

This is the highest taxon comprised of related phyla. The members of the phyla or divisions making up the kingdom can share very few traits. It is important to note that as we classify from species to kingdom we are moving from specific entities to general with similar traits becoming fewer and fewer. In particular the phylum Annelida and phylum **Chordata** are both classified in kingdom Animalia yet a gross comparison of man and an earthworm does not reveal a lot of similarities does it? Presently living world of organisms are classified into five kingdoms that will be discussed in the subsequent sections.

***Note:***

- We can also classify organisms by proceeding from general to specific by placing organisms into groups progressively using their similarities and differences until we are left with final groups having organisms of the same kind which possess virtually all similar traits and can interbreed naturally to give rise to viable offspring (species).
- Presently, the taxonomic systems rely heavily on the DNA sequences and cell structure of organisms in classification.
- The number of different groups of organisms at each level varies greatly but there is only one single type of organism for each species.

d) Dirty lenses should be cleaned using a special soft lens tissue paper or tissue paper moistened with an alcohol. The other parts of the microscope may be cleaned using a microscope.
e) Do not wet any part of the microscope.
f) Make sure the low power objective lens clicks into position in line with the eye piece before and after use.
g) After use, always clean and store the microscope in a safe place, free from moisture and dust.
h) Do not force the coarse and fine adjustment knobs.

### How to set up and use the light Microscope

a) Place the microscope on the bench with the stage facing away from you.
b) Turn the low power objective lens until it clicks into position.
c) Ensure that the diaphragm is fully open.
d) Look through the eye-piece with one eye; meanwhile adjust the mirror under the stage to ensure that maximum light can pass through. The circular area seen is referred to as the **field of view**. When using a light microscope that uses electricity as a source of light then one does not have to set it up on the bench based on light source.
e) Again look through the eyepiece while adjusting the mirror under the stage to ensure that sufficient light is passing through the specimen.
f) Use the coarse adjustment knob to bring the low power objective lens to the lowest point just above the slide (this should be done while looking at the microscope sideways). Viewing through the eye-piece, turn the coarse adjustment knob gently until the specimen comes into focus
g) Use the fine adjustment knob to bring the image into sharp focus. Make a drawing of what you observe.
h) For higher magnifications, turn the medium

**REVIEW BOX 3.2**

1. What is a microscope? ***(1 mark)***
2. Name two uses of a microscope? ***(2 marks)***
3. Name the two lenses that contribute to magnification in a light microscope ***(2 marks)***
4. Highlight three differences between a light microscope and an electron microscope ***(3 marks)***
5. State any three ways of taking good care of a light microscope ***(3 marks)***
6. What is resolution? ***(1 mark)***
7. What two factors will you consider before selecting a microscope to use for biology studies? ***(2 marks)***
8. Describe stepwise procedure that you need to follow when using a light microscope ***(10 marks)***
9. You have set your light microscope for use. However, when you look through the eyepiece, you are not able to see the field of view. State three possible adjustments that can be done to the light microscope ***(3 marks)***
10. You have set up your microscope for use but instead of seeing a circular field of view, you see what appears like a half moon. What could be the problem? ***(1 mark)***
11. State the functions of the following parts of a light microscope ***(5 marks)***
    a) Mirror
    b) Condenser
    c) Coarse adjustment knob
    d) Revolving nose piece
    e) Eyepiece lens
12. Under what conditions would a light microscope be preferred to an electron microscope ***(2 marks)***

## Preparation of Temporary Microscope Slides

Microscopy is a basic protocol in biology. Occasionally, it is important to understand the basic concepts involved in preparing temporary microscope slides for viewing in the light microscope.

***Practical: Preparation of Temporary onion cell slides***

**Requirements**: Onion bulb, scalpel, a pair of forceps, microscope, distilled water, cover slip,

**Procedure**

a) Scale the onion bulb to obtain fleshy inner leaves and cut into quarters.
b) Picking one fleshy leaf, gently bend it backwards until it just breaks (snaps) to expose the epidermis. Alternatively, you can peel off a thin epidermis using a sharp razor/scalpel
c) Trim the piece of epidermis to a size that will completely be covered by the cover slip.
d) The slide and the cover slip to be used are to be clean and devoid of dust or fingermarks.
e) The cut epidermis is then spread on the microscope slide and two drops of water added.
f) The cut out epidermis is then mounted (mounting is attaching/placing of thin cut sections on microscope slides) by gently lowering the cover slip on top of the epidermis using a pair of forceps or mounting needle. Ensure no air bubbles are trapped.
g) Add one or two drops of stain one edge of the cover slip. On the other edge place a piece of dry filter paper. This will "pull" the stain making it move across the specimen.
h) Add drops of distilled water on the edge to drip off the excess stain. Drain excess water and mount slide on microscope for viewing.

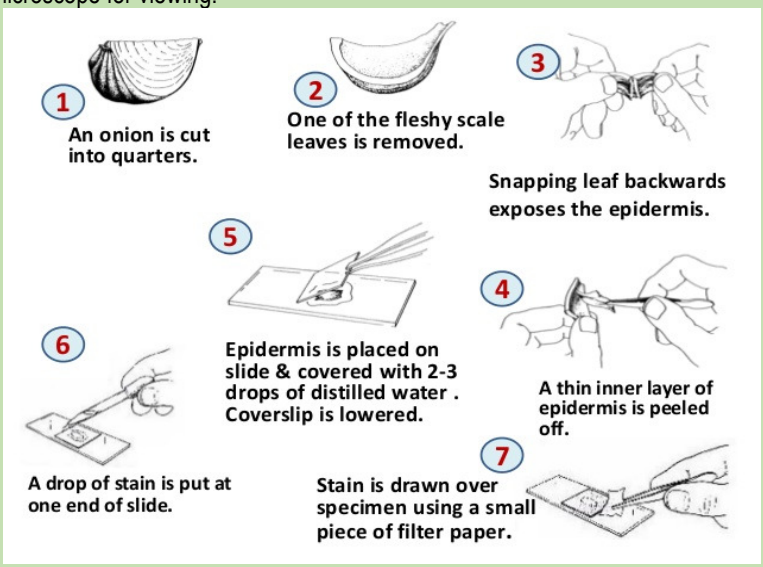



*Figure 10. Temporary slide preparation*

## Addendum on Microscopy

- During light microscopy;
  a) Cutting ***thin sections*** is to allow light to pass through to illuminate specimen
  b) Adding ***drops of distilled water*** is to ensure that the cell structures take up water, swell and become more visible.
  c) ***Staining*** is done to improve contrast of features. Most of the features are colorless and might not be resolved unless staining is done. Different structures take up stains at different rates making it possible to see contrasting structures. We use a number

***Practical: To demonstrate diffusion***

**Requirements**: Potassium manganate (VII) crystals, glass tubing, 250 $cm^3$ beaker, and distilled water

**Procedure**

a) Hold the glass tubing vertically in a beaker in such a way that its one end rests flat on the bottom of the beaker.
b) Carefully introduce a crystal of potassium manganate (VII) through the opening of the glass tubing
c) Close the upper free end of the tubing using your thumb
d) Half fill the beaker with clean water
e) Slowly withdraw the glass tubing without disturbing the crystal at the bottom of the beaker
f) Make observations
g) Explain the observations

## *The Role of Diffusion in Living Organisms*

### In Plants

Diffusion plays an important role in plants in that:

a) It enhances absorption of mineral salts from the soil to the plant. Most salts dissolve in soil water. For those salts whose concentration in soil water is higher than their concentration in the cell sap of root hair cells, they move into the root hair cells through diffusion. Plants require mineral salts for numerous life processes.
b) Diffusion plays a role in gaseous exchange in plants. The respiratory gases (oxygen and carbon (IV) oxide) diffuse across the stomata and lenticels of plants.
c) Diffusion also contributes to the transportation of manufactured food materials from the leaves to other parts of the plant.
d) Diffusion facilitates removal of excess water from plants to the atmosphere through transpiration.
e) Diffusion enhances the spread of fragrances produced by flowers to the atmosphere to attract pollinators.

### In Animals and other organisms

In animals diffusion plays the following important roles

a) It facilitates absorption of digested food materials in the alimentary canal. End products of digestion such as amino acids and glucose diffuse across the wall of the ileum into the blood for transport to other parts of the animal body.
b) Diffusion also plays a significant role in gaseous exchange in animals. In animals, gaseous exchange occurs at certain structures known as respiratory surfaces. These include the skin, gills, lungs, tracheal system and the cell membrane (in unicellular organisms). Gaseous exchange at these surfaces occurs through the process of diffusion.
c) Diffusion is important in excretion of nitrogenous wastes especially in unicellular organisms.
d) Facilitates exchange of materials between foetus and the mother in mammals.
e) Diffusion leads to heat loss in higher organisms which can contribute to thermoregulation.

- ***Hypertonic*** and ***hypotonic*** are also comparative terms used to describe solution concentrations. Hypertonic describes a solution that has a higher concentration of solute particles (but less solvent/water molecules) in reference to another solution.
- Hypotonic solution refers to a solution that has a lower solute concentration (but higher solvent/water molecules) in comparison to another solution.

### Osmotic pressure

When a concentrated solution is separated from distilled water by a semi permeable membrane, the concentrated solution will develop a force with which it draws water through the semi permeable membrane from the distilled water. ***Osmotic pressure refers to the force with which a concentrated solution draws water to itself.*** Osmotic pressure can be measured by a special instrument known as **osmometer.**

### Osmotic potential

This is the tendency of a solution to lose water when separated by another solution by a semi permeable membrane.

### Water Relations in Animals

As discussed earlier, the cell membrane is semi permeable. Let us discuss what would happen if an animal cell say red blood cell is placed in solutions of varying concentrations

*a) Red blood cell in hypotonic solution e.g. distilled water*

Distilled water has a higher concentration of water molecules compared to the red blood cell cytoplasm. When a red blood cell is placed in a hypotonic solution, water will move into the cell through osmosis. The cell will swell and burst. Swelling of red blood cell when placed in a hypotonic solution is referred to as **haemolysis**. The cell is said to be **haemolysed**.

*b) Red blood cell in hypertonic solution*

A hypertonic solution has a low concentration of water molecules compared to the red blood cell cytoplasm. Water will, therefore, be drawn out of the cell (where they are at a high concentration) into the hypertonic solution (where they are at a low concentration). The cell will shrink and become small. The cell is said to be **crenated**. The process by which animal cells shrink and become smaller when placed in hypertonic solutions is referred to as **crenation**. Crenation lumps together the organelles and impairs the normal cell functioning.

**ALERT!!!!!**

Definition of osmosis is always one of the most confusing terms to students. Most student definitions are always ambiguous. In defining osmosis emphasis must be given to the movement of water molecules from their region of high concentration to their region of low concentration. Commonly, students would just say: ***It is the movement of water molecules from a region of high concentration to a region of low concentration across a semi permeable membrane***. This is ambiguous because concentration is always given in terms of solutes. You can simply get it right as:

a) Movement of solvent molecules from a dilute solution to a concentrated solution across a semi permeable membrane
b) Movement of solvent/water molecules from a hypotonic solution to hypertonic solution across a semi permeable membrane.
c) Diffusion of water molecules across a semi permeable membrane.
d) Movement of water molecules from a hypotonic solution to a hypertonic solution across a semi permeable membrane.

Another common mistake is to describe osmosis as movement of "solution" which is very wrong since it is only the solvent molecules moving across the membrane.

- This is aided by the fact that the grana contain chlorophyll molecules that trap sunlight energy for photolysis.
- The oxygen gas produced can either be released into the atmosphere or be utilized by the plant for respiration.

**Water → Hydrogen ions + Oxygen gas + Electrons**

***ii. Formation of adenosine triphosphate (ATP)***

- Some of the sun light energy is used to combine Adenosine Diphospate molecule in the plant tissues with a phosphate molecule to form Adenosine Triphosphate (ATP). ATP is an energy rich molecule that stores energy for use in the dark stage when sunlight energy could be unavailable.

**Adenosine Diphosphate + Phosphate → Adenosine Triphosphate**

- The hydrogen ions and ATP formed during light stage are later used in dark stage.

**b) Dark reaction/Dark stage**

- These reactions are light independent (they can occur in darkness or in light). The energy that propels these reactions is derived from the ATP formed during light stage.
- Also known as carbon (IV) oxide fixation, dark stage involves combination of carbon (IV) oxide molecule with hydrogen ions to form a simple carbohydrate and a water molecule.
- Dark reactions take place in the stroma.

$$CO_{2\,(g)} + 4H^{+}_{(aq)} \rightarrow (CH_2O)_{n\,(aq)} + H_2O_{(l)}$$

- Other food materials are then synthesized from the simple sugars through complex synthesis reactions. The above equation is a summarized reaction leading to formation of simple sugars. In truth, photosynthesis is a multistep reaction with several intermediate compounds.
- The simple sugars for instance can be used to synthesize fatty acids and glycerol that are condensed to form lipids.
- The simple sugars are also combined with inorganic substances such as mineral salts to produce amino acids which join together to form proteins.

**NOTE**

- The glucose formed in dark stage is quickly converted to starch which is osmotically inactive. When a lot of glucose accumulate in the chloroplasts, osmotic pressure of the guard cells would increase causing the guard cells to draw a lot of water through osmosis. This makes the guard cells to bulge and open the stomata. This can result into excessive water loss to the plants. To prevent this, the simple sugars are quickly converted to starch. Besides, glucose is not a good storage molecule as it can easily be oxidized to produce energy. This explains why to test whether photosynthesis has taken place in a leaf or not, we carry out a test for starch and not for reducing sugars (glucose).

## Starch test

We test for starch using iodine solution. This test can also, therefore be referred to as iodine test.

Procedure

a) Place 2 ml of test solution in a test tube
b) Add three drops of iodine solution
c) Shake well

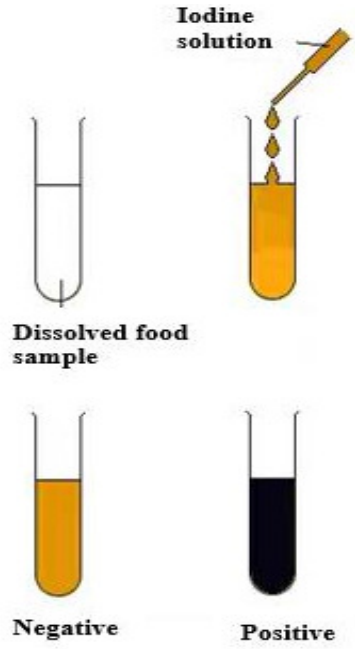
We can also perform starch test using a white tile. When a white tile is provided then the procedure is as follows:

a) Place three drops of test solution on the white tile
b) Add two drops of iodine solution on top of the test solution and observe

**NB**: you can also place iodine solution first before adding the test solution.

**Observations and interpretation**

If a blue black colour is observed then starch is present. Iodine is yellow or brown depending on concentration. When the yellow/brown colour is persists then starch is absent




**NOTE!!!!**
As you will later learn, iodine as an element is naturally solid at room temperature. However, it is important to note that we use the ***iodine solution*** in the starch test. This should be well stipulated.

*Figure 31. Starch test*

## Proteins test

To test for protein we use 10 % sodium hydroxide solution and 1% copper (II) sulphate solutions. This test is also chemically known as Biuret test.

### Procedure

a) Place 2 ml of test solution in a test tube
b) Add 2 ml of sodium hydroxide
c) Add drops of 1% copper (II) sulphate while shaking

- Co- factors include mineral ions like iron, magnesium, copper, manganese, zinc as well as vitamins.
- They are used again and again since like enzymes, they do not get used up during the reactions.

**Review Box 5.14**

1. Differentiate between co-factors and coenzymes ***(2 marks)***
2. State three factors that could denature enzymes ***(3 marks)***
3. Discuss the factors affecting the rate of enzyme activity.
4. How can the effect of competitive enzyme inhibitors be lessened? ***(2 marks)***
5. Highlight three differences between competitive and non-competitive inhibitors ***(3 marks)***

### *g) Co-enzymes*

- These are organic molecules that are required by some enzymes for their efficient functioning. Some enzymes will not function without them.
- Most co-enzymes are derivatives of vitamins.

### *h) Enzyme inhibitors*

- These are chemical substances which slow down and can eventually stop enzyme activity.
- They are of two types:
    1. Competitive
    2. Non- competitive

### *Competitive inhibitors*

- These are chemical substances which are structural analogs of the substrates i.e. they take up the shape of the substrates and compete for the active sites of the enzymes.
- They bind with the enzymes at the active sites and do not disentangle easily (they stay in the enzyme active site for a long time) thereby slowing down the rate of enzyme activity.
- The reaction can be increased by increasing the substrate concentration. Increasing substrate concentration reduces inhibition because with more substrate molecules, there will be increased probability of more enzyme-substrate collisions than enzyme-inhibitor collisions.

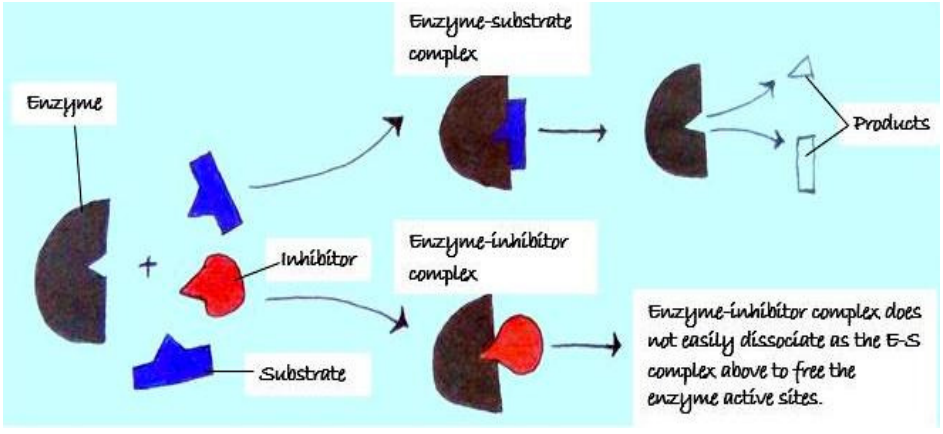



*Figure 38. Competitive inhibition*

## *Summary of digestive system functioning*

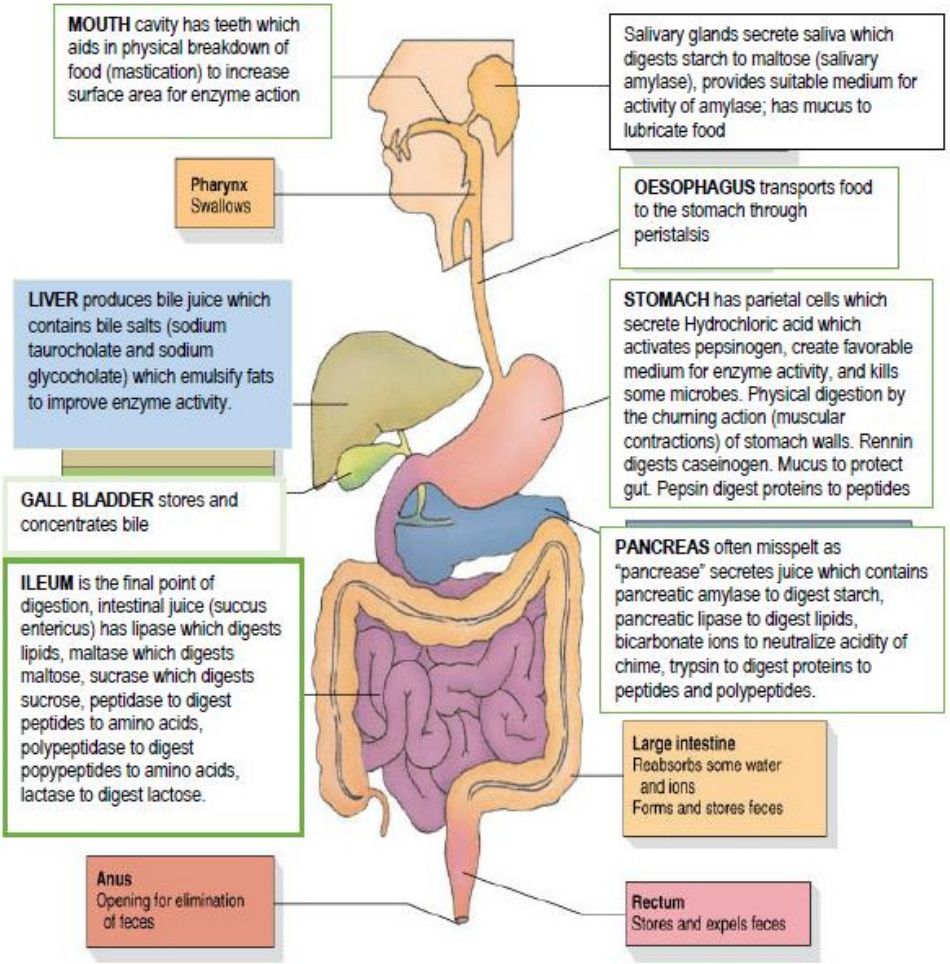



*Figure 45. Summary of the digestive processes*

## *Absorption*

- This is the process through which the soluble end products of digestion are taken across the cellular lining of the villi and into the circulatory system.
- Absorption of micronutrients such as water soluble vitamins, mineral salts and alcohol are absorbed at the stomach. Alcohol is equally absorbed here without undergoing digestion.
- Most absorption of end products of digestion occurs in the ileum.
- Molecules of amino acids and glucose pass through the epithelial lining and capillary walls into the blood system by diffusion and active transport depending on the relative concentrations between the ileum and the bloodstream.
- The capillaries drain into the hepatic portal vein where the absorbed products are transported to the liver before they are circulated to other body parts.

## PLATE QUESTIONS

1. Use plates 1 (a) and 1 (b) to answer the following questions

   a) Name structures labeled A, B and P (3 marks)

   b) State the significance of structure labeled A in plate 1 (a)

   c) With reasons state the mode of feeding of the organisms represented in:

      (i) Plate 1 (a) (2 marks)

      (ii) Plate 1 (b) (2 marks)

   d) How would the length of the digestive systems of the organisms in pates 1 (a) and (b) compare? Account for the difference (2 marks)

2. Plate 2 was excavated from a construction site in an abandoned location during a road construction exercise.

   a) Highlight two observable differences between the jaws represented in plates 2 and 3 (2 marks)

   b) What is the most likely mode of feeding of the organisms whose jaw is represented in plate 2? Give a reason (2 marks)

   c) Give two non-dentition adaptations that can best suit the organism whose jaw is represented in plate 3 to its feeding mode (4 marks)

   d) Name the teeth labeled W and Y (2 marks)

   e) Give one structural and functional difference between the teeth W and Y (2 marks)

   f) What is the significance of structure X? (1 mark)

3. Plate 5 shows a section obtained from an organism.

   a) Identify the organ from which the section was obtained (1 mark)

   b) Give a reason for your answer above (1 mark)

   c) Name X and Y (2 marks)

   d) Highlight two functions of structures Y (2 marks)

   e) How structures are labeled Y adapted to its functions (4 marks)

   f) Give the significance of palisade mesophyll being closer to the upper surface of the leaf (1 mark)

   g) Calculate the magnification of the section represented in the photomicrograph (2 marks)

4. Use plate 6 to answer the questions that follow. The photograph represents a structure found in man.

e) At what sodium chloride concentration was the number of haemolyzed red blood cells equivalent to those not haemolyzed? (1 mark).
f) State the term that would be used to describe the nature of a sodium chloride solution of concentration 5.5 g/cm$^3$ in relation to the red blood cell cytoplasm concentration (1 mark).
g) Highlight two ways in which the cell membrane is adapted to its role in movement of materials in and out of the cells (4 marks).

7. a). Discuss the digestion of carbohydrates in a herbivore (14 marks).
   b). Discuss the factors affecting absorption of amino acids at the ileum (8 marks).
8. a). State four precautions you need to observe when collecting specimen (4 marks)
   b). Discuss specimen collection for biological studies (16 marks)

**Sample Examination Papers**
**231/3 Biology Paper 3**
**1 Hour 45 minutes**

1. You are provided with:
   - Solid A
   - Solid B
   - Solution P
   - Thermometer
   - Benedict's solution
   - Iodine solution
   - DCPIP solution
   - Water bath

a) Place all the provided solid A in a boiling tube. Add 15 ml of distilled water and shake to dissolve. Label this solution A.
b) In a separate clean boiling tube, prepare and label solution B as done with solid A.
(i) Using the reagents provided, carry out food tests and fill the table below (9 marks)

| SOLID | CHEMICAL TEST | PROCEDURE | OBSERVATION | CONCLUSION |
|---|---|---|---|---|
| **Solid A** | DCPIP Test | | | |
| | Benedict's Test | | | |
| | Iodine Test | | | |
| **Solid B** | DCPIP Test | | | |
| | Benedict's Test | | | |
| | Iodine Test | | | |

(ii) Place 2 ml of solution A in a test tube. Add 1 ml of solution P. Incubate the contents in a water bath for 30 minutes. Remove the test tube and add 2 ml of Benedict's solution and heat to boil
   a) Observations (1 mark)
   b) Explain the observation above (3 marks)
   c) Which of the two solids would you recommend as a food to a family whose members are suffering from kwashiorkor? Explain (2 marks)

2. Study the photomicrograph below and answer the questions that follow