



DEPARTMENT OF EDUCATION

GRADE 11

BIOLOGY

MODULE 2



NUTRITION



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# **GRADE 11**

## **BIOLOGY**

### **MODULE 2**

#### **NUTRITION**

**IN THIS MODULE YOU WILL LEARN ABOUT:**

- 11.2.1:           AUTOTROPHIC NUTRITION**
- 11.2.2:           HETEROTROPHIC NUTRITION (FOOD AND DIET)**
- 11.2.3:           HETEROTROPHIC NUTRITION (DIGESTION)**



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**DIANA TEIT AKIS**  
PRINCIPAL



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**TABLE OF CONTENTS**

	<b>Page</b>
Title.....	1
ISBN & Acknowledgments.....	2
Table of Contents.....	3
Secretary’s Message.....	4
 <b>MODULE 11.2 : NUTRITION</b>	 5
Introduction.....	5
Learning Outcomes.....	5
Terminology.....	6
 <b>11.2.1: Autotrophic Nutrition</b> .....	 9
<input type="checkbox"/> Structure of Flowering Plants .....	9
<input type="checkbox"/> Photosynthesis in Plants.....	14
 <b>11.2.2: Heterotrophic Nutrition (Food and Diet)</b> .....	 20
<input type="checkbox"/> Food and Diet.....	21
<input type="checkbox"/> Balanced Diet.....	31
<input type="checkbox"/> Nutrition, Diseases and Diet Problems.....	34
 <b>11.2.3: Heterotrophic Nutrition ( Digestion)</b> .....	 38
<input type="checkbox"/> Digestion and Absorption.....	43
<input type="checkbox"/> Kidneys and What They Do.....	59
 Summary .....	 61
Answers to Learning Exercises.....	64
References.....	68



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## SECRETARY'S MESSAGE

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Achieving a better future by individual students and their families, communities or the nation as a whole, depends on the kind of curriculum and the way it is delivered.

This course is a part of the new Flexible, Open and Distance Education curriculum. The learning outcomes are student-centred and allows for them to be demonstrated and assessed.

It maintains the rationale, goals, aims and principles of the national curriculum and identifies the knowledge, skills, attitudes and values that students should achieve.

This is a provision by Flexible, Open and Distance Education as an alternative pathway of formal education.

The course promotes Papua New Guinea values and beliefs which are found in our Constitution, Government Policies and Reports. It is developed in line with the National Education Plan (2005 - 2014) and addresses an increase in the number of school leavers affected by the lack of access into secondary and higher educational institutions.

Flexible, Open and Distance Education curriculum is guided by the Department of Education's Mission which is fivefold:

- To facilitate and promote the integral development of every individual
- To develop and encourage an education system satisfies the requirements of Papua New Guinea and its people
- To establish, preserve and improve standards of education throughout Papua New Guinea
- To make the benefits of such education available as widely as possible to all of the people
- To make the education accessible to the poor and physically, mentally and socially handicapped as well as to those who are educationally disadvantaged.

The college is enhanced to provide alternative and comparable pathways for students and adults to complete their education through a one system, many pathways and same outcomes.

It is our vision that Papua New Guineans' harness all appropriate and affordable technologies to pursue this program.

I commend all those teachers, curriculum writers, university lecturers and many others who have contributed in developing this course.

**UKE KOMBRA, PhD**  
Secretary for Education



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## MODULE 11.2                    NUTRITION

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### Introduction

There is a large variety of living organisms. These include microorganisms, plants and animals. All living organisms perform activities. Primary activities include movement of limbs, respiration, digestion, and circulation. Other activities include predators chasing a prey or a prey escaping a predator, or arboreal organisms climbing trees to gather fruits, and fish swimming in schools in search for food.

What gives us energy for performing various life processes?

All living organisms require **food** for their survival. Organisms obtain energy from the foods they eat. These foods contain a number of food constituents known as **nutrients**. Nutrients are digested by the body and the process by which living organisms take in food and utilize for their growth and maintenance is called **nutrition**. These complex constituents are broken down by enzymes into simpler forms that can be absorbed by the cells of the body through the process of digestion.

In this module, you will learn the different types of nutrition, types of digestion, the process of digestion and the nutritional food constituents.



### Learning Outcomes

**After going through this module, you are expected to:**

- identify parts of the flowering plants
- define photosynthesis
- investigate and explain leaf physiology and factors enhancing photosynthesis
- investigate the type of gas produced during photosynthesis
- identify main types of food such as carbohydrates, fats and oils, proteins, minerals and vitamins
- discuss the digestive system of a herbivore, carnivore and a omnivore
- define digestion , absorption, assimilation, peristalsis and egestion
- identify the functions of the digestive system
- describe and explain the structure and function of the digestive system and associated organs



## Time Frame

Suggested allotment time: **8 weeks**

If you set an average of three (3) hours per day, you should be able to complete the module comfortably by the end of the assigned week. Try to do all the learning activities and compare your answers with the ones provided at the end of the module. If you do not get a particular activity right in the first attempt, you should not get discouraged but instead, go back and attempt it again. If you still do not get it right after several attempts, then you should seek help from your friend or even your tutor.

**DO NOT LEAVE ANY QUESTION UNANSWERED**



## Terminology

<b>Absorption</b>	The process of passing digested food molecules across the wall of the intestine into the blood or lymph.
<b>Anther</b>	The part of the stamen that produces and contains the pollen
<b>Assimilation</b>	The movement of digested food molecules into the cells of the body where they are used, becoming part of the cells
<b>Analogy</b>	A comparison between one thing and another, typically for the purpose of explanation or clarification
<b>Autotrophs</b>	Organisms prepare their own food from simple raw materials such as water, carbon dioxide and mineral salts in the presence of sunlight
<b>Bile</b>	A green fluid stored in the gall- bladder and delivered to the duodenum by bile duct.
<b>Churn</b>	To move or shake in agitation, as a liquid or any loose matter





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<b>Coronary heart disease (CHD)</b>	A narrowing of the blood vessels to the heart. This reduces the flow of blood to the heart that may cause heart attack. If the body's store of iron is low and there is too little iron in the diet, the symptoms of iron deficiency, anaemia will start to develop. Large amounts of iron can be toxic.
<b>Digestion</b>	The process of break-down of large, insoluble food molecules into small, water soluble molecules using mechanical and chemical processes.
<b>Defecation</b>	The undigested parts of food or those that were not absorbed by the body are eliminated as faeces.
<b>Egestion</b>	Passing out of undigested food, in the form of faeces, through the anus.
<b>Enzymes</b>	Any of various proteins, as pepsin, originating from living cells and capable of producing certain chemical changes in organic substances by catalytic action, as in digestion.
<b>Epidermis</b>	The outer layer of tissues cuticle – waxy protective outer layer of epidermis that prevents water loss on leaves, green stems, and fruits.
<b>Ingestion</b>	Intake of food into the body through mouth
<b>Kwashiorkor</b>	A disease that occurs if your body does not get enough proteins.
<b>Malnutrition</b>	An unhealthy state or condition in which a person's physical functions are temporarily or permanently damaged.
<b>Marasmus</b>	Occurs in young children who don't get enough calories every day. They become weak, underweight and often die.
<b>Osteoporosis</b>	A disease where bones become weak, brittle and break easily. It is caused by severe losses of calcium.
<b>Peristalsis</b>	Muscle contractions in the oesophagus that help move the food down to the stomach.

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<b>Parenchyma</b>	The fundamental tissue of plants, composed of thin-walled cells able to divide.
<b>Petals</b>	The colourful, often bright part of the flower. They attract pollinators
<b>Photosynthesis</b>	The process by which chlorophyll present in the leaves/green parts of the plant converts inorganic raw materials as carbon dioxide and water to chemical energy glucose stored in the form of glucose (sugar).and oxygen in the presence of light energy (sunlight).
<b>Pistil</b>	This is the female part of the flower. It is made up of the stigma, style and ovary
<b>Saliva</b>	A watery liquid made by the salivary glands.
<b>Sepals</b>	Leaf like structures which cover and protect the flower bud before it opens
<b>Stamen</b>	The male part of the flower. It is made up of the filament and the anther. It is the pollen producing part of the plant
<b>Transpiration</b>	The process by which moisture is carried through plants from roots to small pores on the underside of leaves, where it changes to vapour and is released to the atmosphere. Transpiration is essentially evaporation of water from plant leaves



### 11.2.1 Autotrophic Nutrition

Living organisms differ in their mode of nutrition or on how they use simple raw materials or readymade complex material as their food. There are different kinds of relationships between organisms. Different habitats display these relationships in unique ways that show two modes of nutrition among different organisms, first is the **autotrophic** nutrition and second the **heterotrophic** nutrition.

First we will learn about **autotrophic mode of nutrition**.

The term **autotroph** is derived from two Greek words, **auto** which means **self** and **troph** which means **nutrition**. Autotroph means organisms prepare their own food from simple raw materials such as water, carbon dioxide and mineral salts in the presence of sunlight, hence they are called **producers**. All green plants are the examples of this category.

How do plants take in their food? And where do they get their food from? Do they get ready made food for use?

Animals and plants have a great variety of body plans and internal structures that contribute to their being able to make or find food. So what makes up a body of a plant?

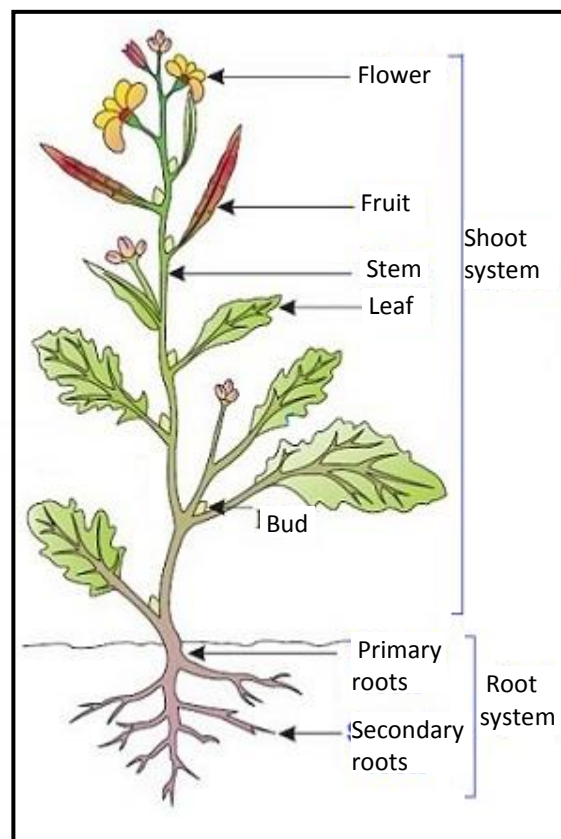
Let us look at the body plan of flowering plants to understand how plants prepare their own food.

#### Structure of Flowering Plants

Plants are organisms that are characterized by their ability to produce their own food. Plants are very diverse and include organisms such as mosses, vines, trees, bushes, grasses, and ferns. Plants can be vascular or nonvascular, flowering or non-flowering, and can be seed bearing or non-seed bearing.

In this topic we describe the characteristics and parts of a flowering plant.

The parts of a flowering plant are characterized by two basic systems, **a root** and a **shoot system**. These two systems are connected by vascular tissues that run from the root through the shoot.





## 1. Root System

The roots of the plant make up the root system. The roots keep the plant anchored in the ground. The roots enable flowering plant to obtain water and nutrients from the soil through tiny roots that extend from the root system. Roots can also store food. However not all plants have roots that originate from underground, some have roots that originate from stem or leaves and above the ground. These roots can provide support for the stem.

## 2. Shoot System

The stems, leaves and flowers of the plant make up the shoot system.

The **stem** provides support for the plant and allows nutrients and water to travel throughout the plant. Within the stem and throughout the plant are tube-like tissues called **xylem** and **phloem**. These tissues carry water, food, and nutrients to all parts of the plant.

Another component of the shoot system of a flowering plant is the **flower**. The flower is responsible for seed development and reproduction.

There are **four main flower parts** in angiosperms.

- (i) **Sepal** is green, leaf-like structure that protects the budding flower.
- (ii) **Petal** is colourful and often scented part of the flower that attracts insects.
- (iii) **Stamen** is considered the male portion of a plant. The part of the flower that produces pollen. Consists of a filament and an anther.
  - **Anther** is the sac located at the tip of the filament that contains pollen.
  - **Filament** is the stalk that connects to and holds up the anther.
- (iv) **Carpel** is considered the female portion. It consists of the stigma, style, and ovary.
  - **Stigma** is the tip of the carpel that is sticky in order to collect pollen.
  - **Style** is the slender, neck-like portion of the carpel that leads to the ovary.
  - **Ovary** is the structure at the base of the carpel that houses the ovule or egg.When the ovule becomes fertilized, it develops into a seed. The ovary, which surrounds the seed, becomes the fruit. Flowers that contain both stamens and carpels are called **perfect flowers**. Flowers that are missing either stamens or carpels are called **imperfect flowers**. If a flower contains all four main parts (sepals, petals, stamens, and carpels), it is called a **complete flower**.

**Leaves** are the principal structure, produced on stems. Leaves can have various shapes and forms, but they all basically consist of external parts, a blade, veins, and a petiole.

### External features of leaves:

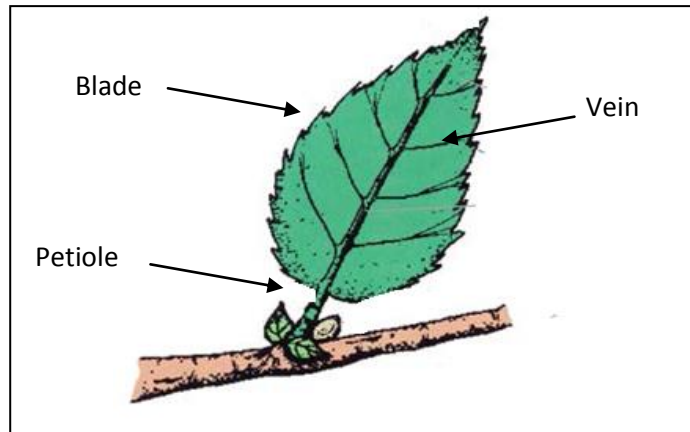
- The **blade** is the flat extended part of the leaf.
- The **veins** run throughout the blade and provide a transport system for water and nutrients.
- The **petiole** is a short stalk that attaches the leaf to the stem.

**Internal features of leaves:**

The leaf blade is composed of several layers as follows:

**Epidermis** is the outer layer of tissues cuticle waxy protective outer layer of epidermis that prevents water loss on leaves, green stems and fruits.

**Palisade layer** is a tightly packed layer of **parenchyma** tissues filled with chloroplasts for photosynthesis.



External parts of leaf

**Chloroplasts** are sub-cellular, photosynthetic structures in leaves and other green tissues. Chloroplasts contain **chlorophyll**, a green plant pigment that captures the energy in light and begins the conversion of that energy into sugars.

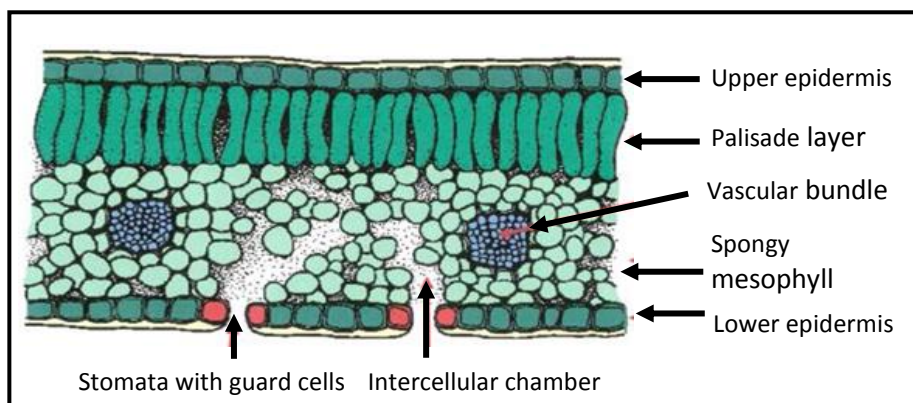
**Vascular bundle** is the xylem and phloem tissues, commonly known as leaf veins.

**Spongy mesophyll** is a layer of parenchyma tissues loosely arranged to facilitate movement of oxygen, carbon dioxide, and water vapour. It also may contain some chloroplasts.

**Stomata** are the natural openings in leaves and herbaceous stems that allow for gas exchange (water vapour, carbon dioxide, and oxygen).

**Guard cells** are specialized kidney-shaped cells that open and close the stomata.

The figure below shows the internal parts of a leaf as seen under the microscope.

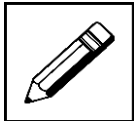


Leaf cross sectional view with stomata

**The leaves are the primary sites where plants make their own food.**



It is now time for you to complete Learning Activity 1. Remember, learning activities are not sent in for assessment. However, this learning activity will help you complete Summative Test 2 (which you will send in for assessment).



### Learning Activity 1



60 minutes

#### Garden Foods

If you take a look around the produce section at a supermarket, you will find a wide variety of plants and plant structures. Lots of foods we eat every day such as fruits, vegetables, and nuts come from plants.

In fact, we eat many different parts of plants such as roots, stems, leaves, fruits, and seeds. When we eat and digest plants, our bodies use the energy and nutrients that are stored in the plant cells.

Supermarket foods like carrots, asparagus, lettuce, oranges, and peanuts are actually edible roots, stems, leaves, fruits, flowers, or seeds. Can you eat the stem, root, or seed of a plant? Test your knowledge by identifying everyday foods as plant parts.

#### Instructions:

- A. Collect at least five (5) samples of supermarket foods as mentioned above. Do sketch or diagram of each sample with the correct name of the food on the box below. Identify and label the sample, if it is a leaf, stem, root, seed, fruit, or flower of the plant.

**Sample food # 1**

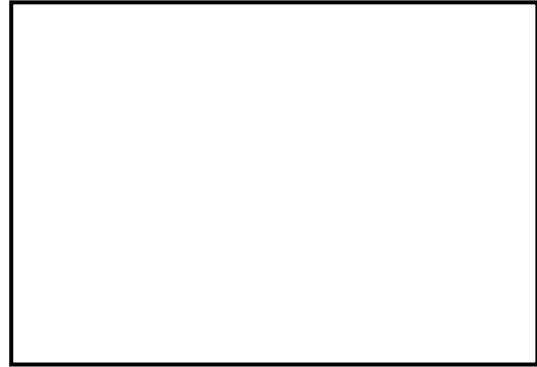
Name: \_\_\_\_\_

Plant part: \_\_\_\_\_

**Sample food # 2**

Name: \_\_\_\_\_

Plant part: \_\_\_\_\_



**Sample food # 3**

**Name:** \_\_\_\_\_

**Plant part:** \_\_\_\_\_

**Sample food # 4**

**Name:** \_\_\_\_\_

**Plant part:** \_\_\_\_\_



**Sample food # 5**

**Name:** \_\_\_\_\_

**Plant part:** \_\_\_\_\_

B. Identify and describe the function of at least 5 parts of the plants.

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_
4. \_\_\_\_\_  
\_\_\_\_\_
5. \_\_\_\_\_  
\_\_\_\_\_



Thank you for completing your Learning Activity 2. Check your work. Answers are at the end of this module.

### How do green plants make their own food?

Is it not interesting to know that plants can prepare their own food? A primary difference between plants and animals is the plant's ability to manufacture its own food. Plants manufacture their own food from simple raw material available from the soil and the atmosphere.

**Photosynthesis** is the process of preparation of food by plants. **Photo** means **light** and **synthesis** means **combination** of components to prepare something. Most plants can prepare their food without much dependence on other living organisms. They are called **autotrophs**.

We can accept all green plants prepare their own food from simple raw material available from the soil and the atmosphere. The process of preparation of food by the plants is called **photosynthesis**.

### Photosynthesis in Plants

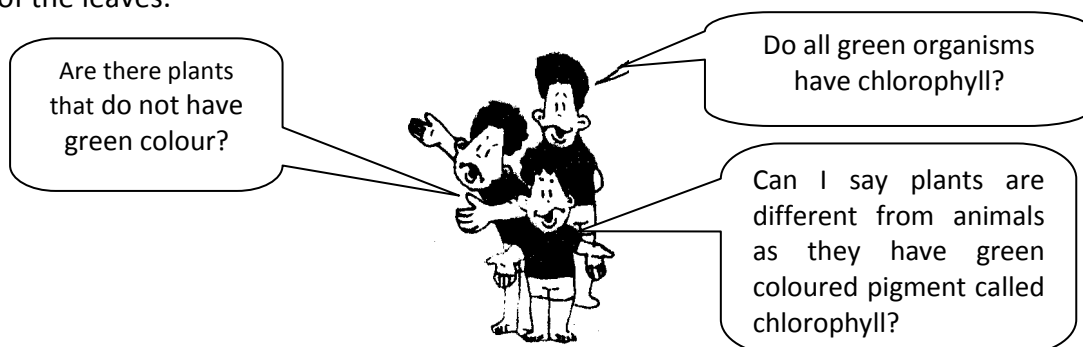
#### What is the special feature present in the plants that makes photosynthesis happen?

In plants, photosynthesis occurs mainly within the leaves, although photosynthesis is not restricted to the leaves. Photosynthesis can occur in any green part of a plant.

The **structure of a leaf is adapted for photosynthesis** example:

- broad leaves provide a large surface area, beneath the apparently flat surface of a leaf is a porous layer of air spaces between the outer layers of cells, particularly on the underside of leaves, quite often the lower surface of leaves feel rougher and 'roughness' means a more disrupted surface of a larger surface area.
- containing green chlorophyll in chloroplasts to absorb light, that is why plants look so green, they contain a relatively high concentration of chlorophyll.

Plants are usually green in colour. This colour is because of a pigment called chlorophyll contained in the chloroplasts in the cells of leaves as discussed previously of the internal parts of the leaves.







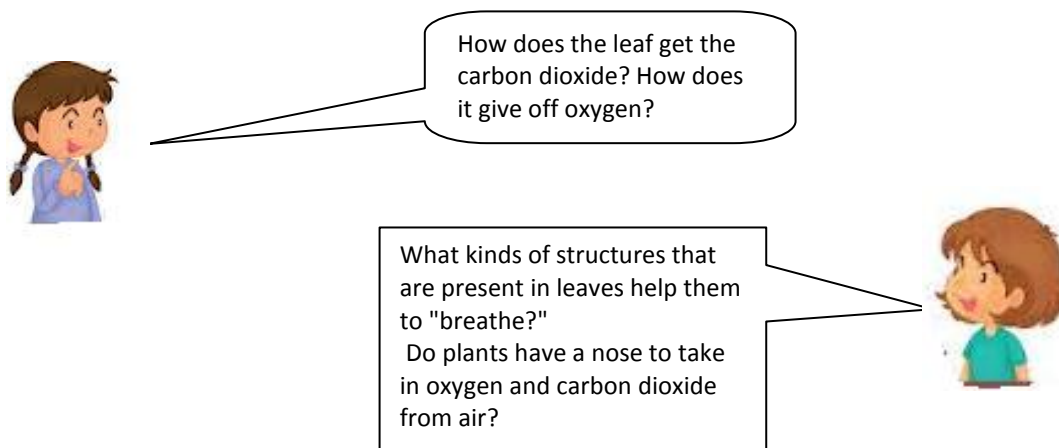
### What does chlorophyll do?

Chlorophyll traps the energy from the sun to convert carbon dioxide and water into oxygen and glucose. It occurs only in the chloroplasts, in the cells of leaves and green stems.

- c) stomata are tiny holes in the leaves which can open and close to let oxygen and carbon dioxide in and out (both associated with photosynthesis and respiration) and water vapour out (transpiration). Stomata is for gas exchange (carbon dioxide, oxygen and water vapour).

Since photosynthesis requires carbon dioxide, water, and sunlight, all of these substances must be obtained by or transported to the leaves.

### Where do they come from? Where do these raw materials get collected in the plants?



1. Carbon dioxide, as we know is present in the air around us. Carbon dioxide is obtained through tiny pores in plant leaves called **stomata**. Oxygen is also released through the stomata.

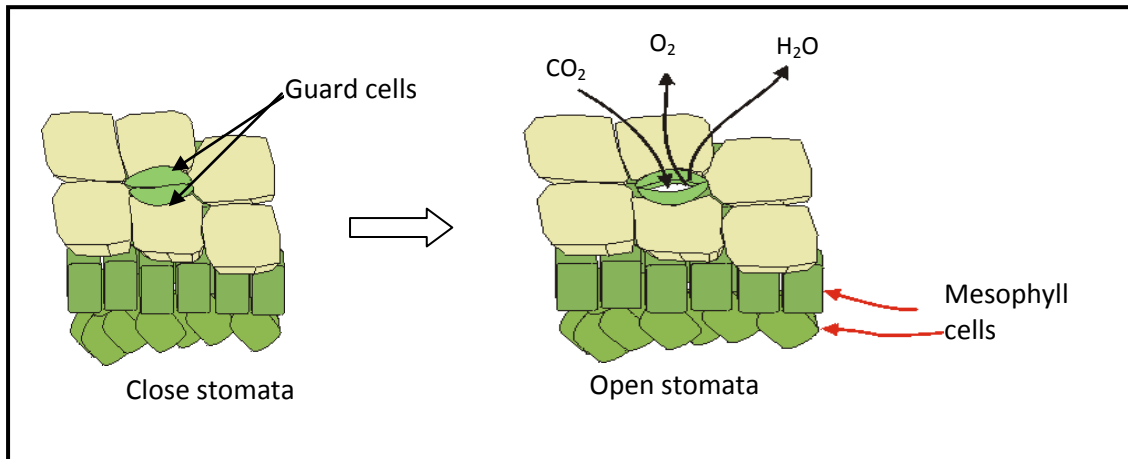
#### Role of stomata/Stomatal pores

Stomata which are known as 'pores' of the plant's skin are located on the underside of the leaves of plants that grows on land.

They provide openings for the exchange of oxygen and carbon dioxide. Water is also released through the stomata in a process called **transpiration**.

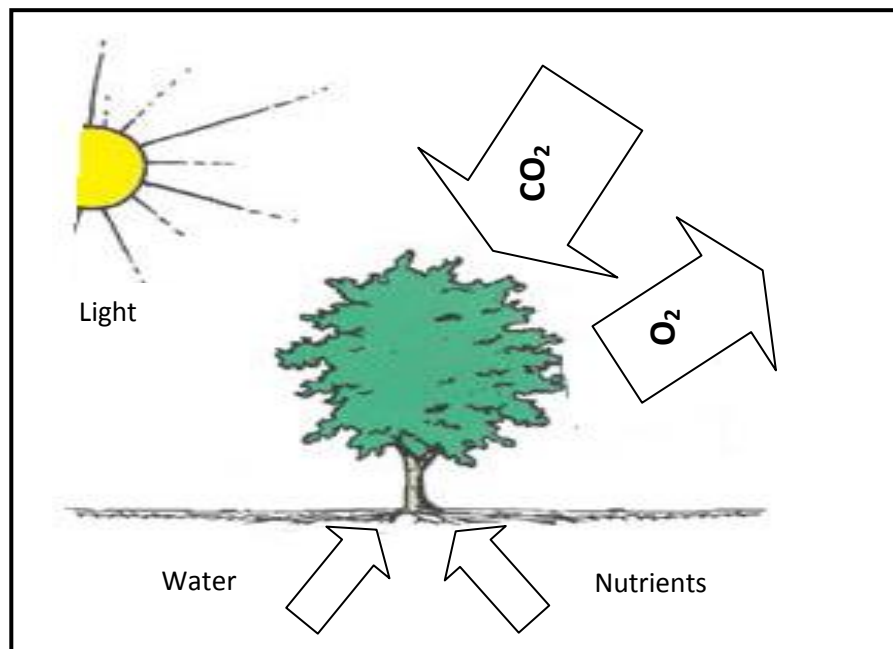
The opening and closing of stomata are regulated by the **guard cells**. These cells swell by the process of osmosis when there is an excess of water in the plant. This swelling causes the stomata to open, allowing water to evaporate.

When the amount of water within the plant begins to lower, below the point necessary for photosynthesis, the guard cells shrink and the stomata closes to conserve water, as shown in the diagram in the next page.



When the guard cells are bowed outwards, the size of the pore expands, and the leaf can take CO or release O<sub>2</sub> and water vapour through the pore. At other times, the guard cells may close the pore to prevent water loss. Stomata are typically open in the daytime and closed at night or during a drought.

2. Water is present in the soil. Water is obtained by the plant through the roots and delivered to the leaves through vascular tissue system.
3. Energy from the sunlight is absorbed by chlorophyll, whereas green pigment present in plants especially in the leaf structures called **chloroplast**. Chloroplasts are the sites of photosynthesis containing several structures, with each having specific functions.



In photosynthesis, the plant uses water and nutrients from the soil, and carbon dioxide from air with the use of light energy from the sun.

**It is now time to complete your Assignment 2 in your Assessment Book 2 before going on to the next topic.**



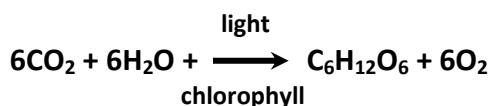
### Photosynthesis equation

**Photosynthesis** literally means **to put together with light**. It is the process by which chlorophyll present in the leaves and green parts of the plant converts inorganic raw materials as carbon dioxide and water to chemical energy stored in the form of glucose (sugar) and oxygen in the presence of light energy (sunlight).

**Carbon dioxide, water, and sunlight are used to produce glucose, oxygen, and water**

Six (6) molecules of carbon dioxide ( $6\text{CO}_2$ ) and six(6) molecules of water ( $6\text{H}_2\text{O}$ ) are consumed in the process, while glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ), six molecules of oxygen ( $6\text{O}_2$ ) are produced.

The chemical equation for this process may be simplified as:



### Rate of Photosynthesis

The reactions of photosynthesis can be divided into two major types: **light reactions** (light dependent) and **dark reactions** (light independent reaction).

The **light reaction** converts energy from the sun into a form that the chloroplast can then use to make sugar from carbon dioxide, in the process producing oxygen as a waste product.

The **dark reaction** uses that energy to make glucose from carbon dioxide and water.

**The rate of photosynthesis may be limited by:**

- (i) **shortage of light** (usually sunlight) slows photosynthesis - since the greater the light intensity, the greater the rate of photosynthesis.

Light is one of the main factors that affect the rate of photosynthesis, which literally means using light to create something new. Plants use energy absorbed from the sun or another light source as fuel for the photosynthesis process. When light intensity increases, the rate at which photosynthesis occur increases as well. Outdoor plants photosynthesize faster on a sunny day as opposed to a cloudy day.

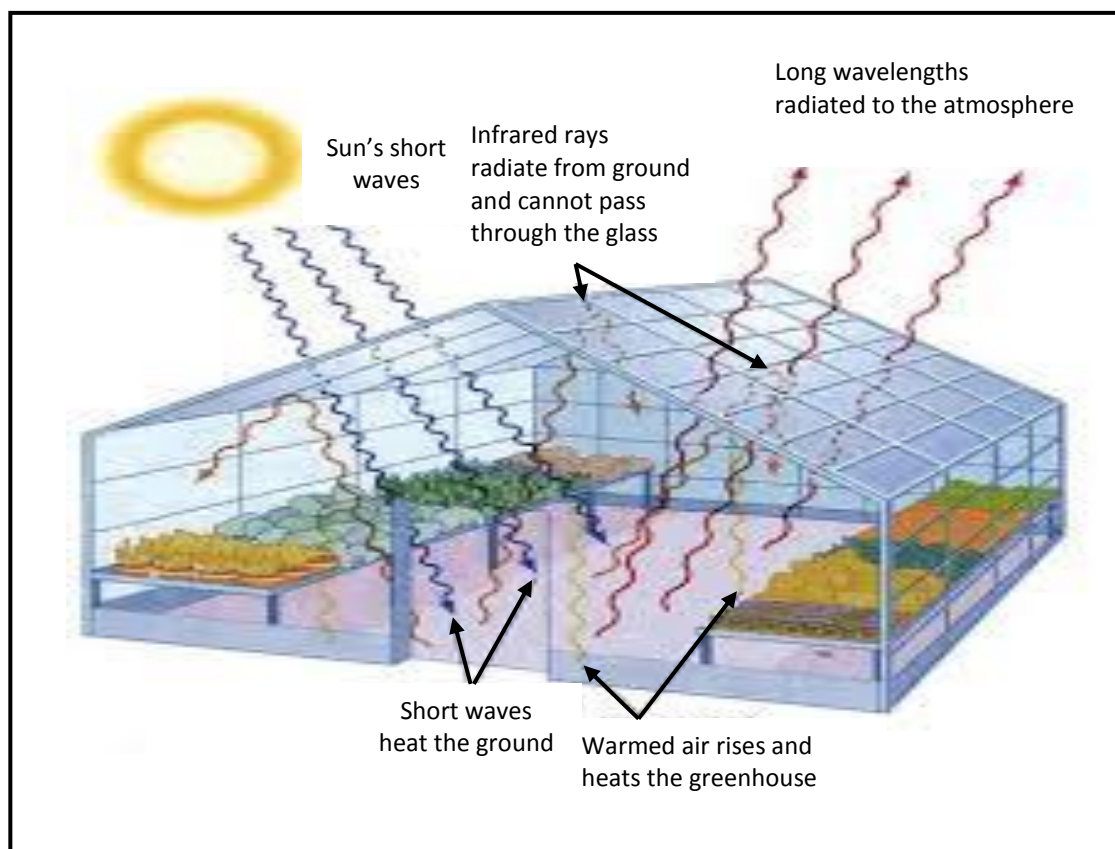
- (ii) **low temperature**, slows down the rate of photosynthesis. It is a general rule for all chemical reactions

Temperature is another factor that affects the rate at which photosynthesis occurs. Photosynthesis is a chemical reaction. Higher temperatures speed up chemical



reactions. This is one of the reasons people grow plants in greenhouses; the greenhouses convert light from the sun into warmth and traps it inside the greenhouse, creating a warmer natural environment for plants, which then photosynthesizes faster. Plants also photosynthesize faster during the summer than the winter because of the warmer temperatures.

A combination of both (i) and (ii) will cause very different rates between photosynthesis in winter (much less, slower) compared to summer (much more, faster).



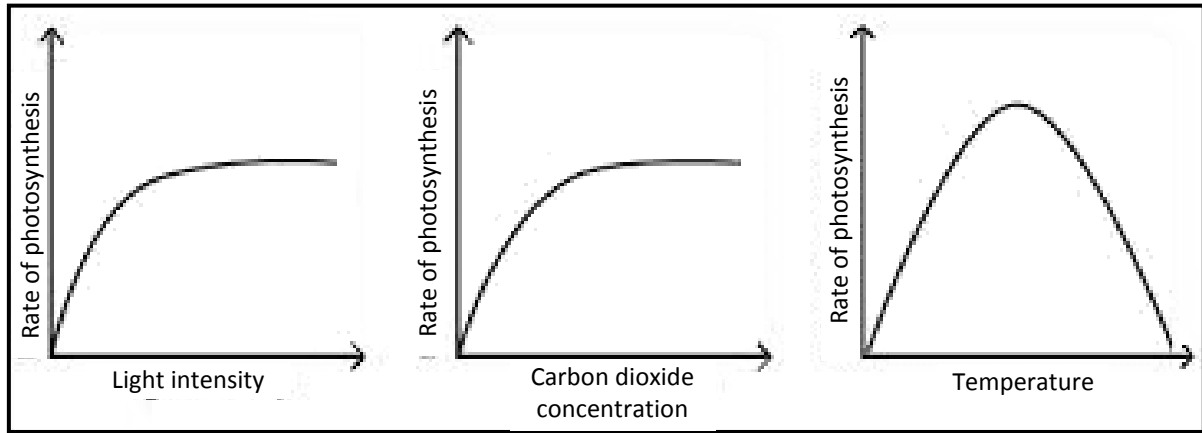
Growing plants in greenhouse

(iii) **shortage of carbon dioxide** will also slow down the rate of photosynthesis,

Carbon dioxide is one of the main elements in the photosynthesis scientific formula. It is converted into oxygen during photosynthesis. When levels of carbon dioxide are increased, the rate at which photosynthesis occur increases also, up to a point. More carbon dioxide leads to faster photosynthesis and more oxygen produced in a shorter amount of time than with less carbon dioxide



So these are three factors affect the rate of photosynthesis. Study the graphs below.



Light, temperature and the availability of carbon dioxide interact and in practice any one of them may be the factor that limits photosynthesis.

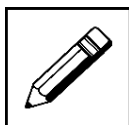
You can relate the principle of limiting factors to the economics of enhancing the following conditions in greenhouses.

Light energy is needed for photosynthesis, so as the light intensity increases; the rate of photosynthesis steadily increases.

However, eventually the rate levels off due to limitation of the carbon dioxide concentration or the temperature.

Light intensity falls to zero at night and there is much less light in winter, so these places limits on photosynthesis.

It is now time for you to complete Learning Activity 2. Remember, learning activities are not sent in for assessment. However, this learning activity will help you complete Summative Test 2 (which you will send in for assessment.)



### Learning Activity 2



20 minutes

**A. Name the following and write your answers on the spaces provided.**

1. Organisms that depend on other organisms for food \_\_\_\_\_
2. Other name of producers \_\_\_\_\_
3. An immediate product of photosynthesis \_\_\_\_\_
4. Form in which the food is stored in the leaves \_\_\_\_\_
5. Food factories of plants \_\_\_\_\_

**B. Fill in the blanks.**

1. The cells that control the opening and closing of stomata are called \_\_\_\_\_.
2. The sunlight required for photosynthesis is trapped by \_\_\_\_\_.
3. Photosynthesis helps to maintain the \_\_\_\_\_ of oxygen and carbon dioxide in the air.

**C. Answer the following questions.**

1. What is nutrition?

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2. Why is photosynthesis important?

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3. Describe an autotrophic mode of nutrition.

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4. Mention the importance of chlorophyll and sunlight in photosynthesis.

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5. What are the end products of photosynthesis?

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Thank you for completing your Learning Activity 2. Check your work. Answers are at the end of this module.

**11.2.2 Heterotrophic Nutrition (Food and Diet)**

**Do plants and animals use similar kind of food and have the same mode of nutrition?**

**What happens to the food prepared by plants?**

A plant uses part of the prepared food for its survival. Rest of the food is stored in different parts of the plant body. Both plants and animals derive food from glucose. In animals, food is broken down to glucose. In plants, the raw materials are processed to give glucose. Certain plants use different mechanisms, other than photosynthesis to obtain their nutrition. They depend on other organisms for their food like the animals. These plants and animals show **heterotrophic mode of nutrition**.



The word **heterotroph** has been derived from two Greek words **hetero** which means **different** and **troph** which refers to **nutrition** of food. The organisms which derive their food from others are known as **heterotrophic organisms**.

They depend for their food on other organisms, hence they are called **consumers**. All animals, human beings and non-green plants like fungi come under this category.

We consume complex organic food prepared by autotrophs or producers and break it into simple form to derive nourishment. Thus, the difference between heterotrophs and autotrophs is basically in the mode of production of food. Due to lack of chlorophyll, heterotrophs cannot synthesize their food while autotrophs can perform photosynthesis.

## Food and Diet

### What we get from food?

What we get from food is the nutrients. The nutrients we get from foods provide the energy needed to support all body functions, maintain good health, proper growth and development and carry out everyday activities. Proper growth and development that help the body function well comes from food. Foods are complex mixtures of different components, providing varying amounts of the nutrients the body needs.

The body cannot produce these nutrients, so they must be obtained from the food we eat. The nutrients in foods are grouped by their similar characteristics and the functions that they carry out in the body. They explain the functions of carbohydrates, protein, fats, vitamins and minerals in the body and their importance in the diet. They provide some examples of foods that are good sources of these nutrients.

### The types of food and their composition

Most foods are a mixture of different nutrients. Certain nutrients are called “**macro**” **nutrients** because the body needs them in fairly large amounts in order to function properly. These are **carbohydrates, protein** and **fats**.

#### A. **Carbohydrates** are fuel-providing macronutrients.

They provide the body’s main source of energy. Plants make carbohydrate from sunlight (photosynthesis) as a way to store the sun’s energy for its own use.

When we eat the plant, we are able to use that stored energy. The energy we get from eating carbohydrates provides the fuel we need, for our activities and growth. They help muscles work better and are necessary for the brain to function.

Some of the carbohydrates we eat are broken down and used for energy the body needs for physical activity. Some are used for growth and overall maintenance and for the renewal of body tissues.



### Types of carbohydrates

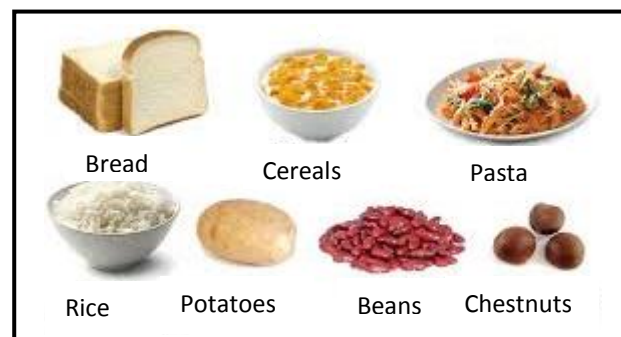
Carbohydrates are found in three forms: **sugar, starch and fibre**. Each form of carbohydrate serves different purposes and is important in our diets.

1. **Sugar** is quickly absorbed into the body and used for energy. There are many types of sugars and commonly used names for sugars.

Sugar, in addition to providing calories for energy, improves the flavour, texture and appearance of foods, it is used in food preservation (as in jam), and in cooking and baking foods. It is found naturally in fruits, milk, honey and the sap of certain trees. It is also made from the processing of sugar cane or beets into table sugar or other sweeteners to be added to foods.

2. **Starch** provides the majority of the calories we eat. Starchy foods are widely grown and usually available in sufficient amounts to provide the main energy source in most diets.

Starchy foods remain in the stomach longer than sugar, giving a sense of feeling “full” for a longer period of time.



Starchy foods

Starch is eventually broken down by the body into simple sugars to be absorbed. Plants that contain starch, or foods made from starchy plants, form the basis of most diets. Starch is found in grains (rice, corn, wheat, millet, oats), roots and tubers (potatoes, cassava, yams), legumes (peas and beans), and certain fruits (breadfruit, banana, water chestnut).

3. **Fibre** cannot be digested and absorbed. This makes fibre very important for “cleaning out” the digestive tract as it passes through the body. Fibre can absorb water and help get rid of the body’s waste products.

Fibre may help prevent certain diseases such as heart disease, cancer and diabetes. While not eating enough fibre can cause constipation and other intestinal problems, eating too much fibre can cause nutrients to pass through the system too quickly to be absorbed.

Different types of fibre exist in foods; some are more ‘woody’ and do not dissolve in water, as can be seen in the hard stems of some vegetables. Some are more ‘gummy’, dissolve in water and exist in the skins and peelings of fruits and vegetables. Each type of fibre has different properties, but all are important for good health.





Foods containing fibre are: wholegrain cereals, starchy roots, fruits, most vegetables, beans, peas and other legumes and oilseeds. Foods that have had little processing or refining have the greatest amount of fibre, as well as higher amounts of vitamins and minerals, which are often lost during refining.

### Sources of carbohydrates

In general, carbohydrates come from plants. Foods rich in carbohydrate are rice, corn, wheat, sorghum and other cereals, foods made from cereals, all types of root crops such as potatoes, yams and cassava, legumes such as peas and beans, vegetables, fruits and sugars. Many of these foods also provide essential vitamins and minerals.

- Carbohydrates provide the body's main source of energy for activity, growth and body functions.
- Carbohydrates exist in three forms: sugar, starch, and fibre.
- Foods rich in carbohydrates are all types of cereals, root crops, legumes, vegetables, fruits, and foods containing sugars.
- Healthful diets include at least half of daily calories from carbohydrates, with foods containing plentiful starch, whole grains and fibre and limited amounts of sugar.



B. **Proteins** provide amino acids for basic body functions.

Amino acids are combined in the body to create protein substances needed to form body tissues. The amino acids in protein are often referred to as the “building blocks” of life.

Almost all of the cells in the body are constantly being broken down and then rebuilt; this process requires a steady supply of protein. They are the main building blocks, as well as the repair kit for the body's tissues, such as muscles, bones and organs, blood, skin and hair.

Proteins are perhaps the most essential nutrient for growth because without protein, the most basic life functions cannot be carried out. Proteins make up the body's hormones, antibodies and enzymes.



- they are necessary for clotting blood and for keeping the immune system strong by developing antibodies to fight disease.
- they repair damaged tissues due to illness or injury.
- they are the major component of the body's transportation system that carries oxygen
- to maintain proper fluid regulation to remain in their appropriate place in veins, arteries and cells, liquid can leak out into body extremities ( feet and legs) and the abdominal cavity. (For example, this is what happens in Kwashiorkor.)



Food containing proteins

We must eat foods that have the necessary amino acids to be used to manufacture body protein. We need to replace the amino acids in the body, as they are lost or used up by the body processes. To help provide all of the amino acids we need, it is important to eat a variety of foods of plant and animal origin.

### Sources of proteins

Protein is found in foods from both animal and plant sources, which provide different combinations of amino acids needed by the body.

All types of meat, poultry, fish, eggs, milk, cheese and yoghurt are foods from animal sources rich in protein. Foods from plant sources high in protein are: dried beans, peas, lentils and other legumes, nuts, pumpkin seeds and soybean.

**As a last resort, after carbohydrates and lipids, protein is also a source of energy. When body energy levels are low, the body will use protein for energy, but this is not the best use of protein. This takes protein away from performing its specific important functions. If energy intake is low for a long period of time, protein will be used for energy by breaking down the tissues and organs to meet energy needs.**

**C. Lipids or Fats** are another energy-providing macronutrient.

You may think of lipids, or fats, as dietary enemies, but they are as necessary to the body's normal functioning as the other essential nutrients.



Food containing fats



Our body needs fat in small amounts. Fats are made up of carbon, oxygen and hydrogen. They store vitamins and produce fatty acids. We need these acids to produce cell membranes.

Among the many functions of fat;

- fat is an energy source that when consumed, increases the absorption of fat-soluble vitamins including vitamins a, d, e and k;
- fat serves to transport and help the body absorb the fat-soluble vitamins A, D, E and K;
- fat also protects our organs from injury and helps to regulate body temperature;
- fat cell stores excess energy and are burned as energy once the body has exhausted all immediate sources in foods.

### Sources of fats

Fats can come from animals or plants. They are in meat and dairy products, like butter and cheese. Other types of fats are in vegetable oils, nuts or seeds.

There are **three main types of fat in food:**

1. **saturated form of fat** is usually solid at room temperature.

Food sources are animal fats such as butter, milk, cheese, cream, and the fat in meat and poultry. Tropical oils like palm and coconut oils also contain large amounts of saturated fat.

Saturated fat is most closely associated with increased health risks. Too many saturated fats produce a high level of cholesterol, a waxy material made by the body. It starts building up in the walls of blood vessels and may block blood as it flows through our body.

For this reason, our saturated fat intake should be limited to no more than 10% of calories. In older adults, this would be about 20 g/day for women and 25 g/day for men.



Food containing saturated fats

2. **monounsaturated fats** appear to lower “bad” cholesterol levels in our blood while increasing “good” cholesterol.

Food sources are canola or peanut oil; margarines made from olive, canola, or peanut oil, and nuts and seeds. Olive oil is one of the richest sources of monounsaturated fat.



3. **polyunsaturated fats** lower total cholesterol levels in our blood, especially when used as a replacement for saturated fats.

These fats are usually found in oils that are liquid at room temperature such as sunflower, corn, and other vegetable oils.

Other food sources include margarines made from these oils, nuts, seeds, and fatty fish such as salmon, trout, mackerel, sardines, and tuna.



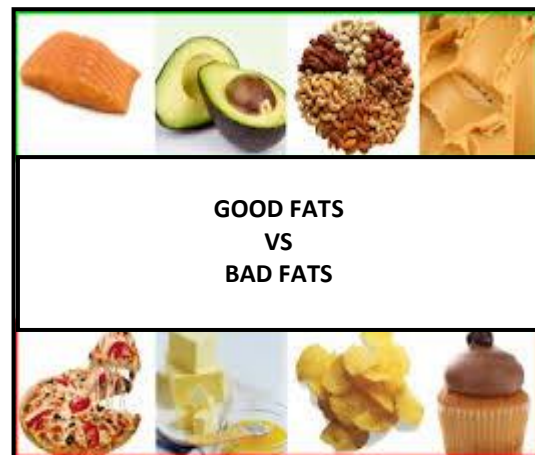
Food containing unsaturated fats

### Cholesterol

Cholesterol occurs naturally in animals and is an essential part of life. It is found in all animal products such as meat, poultry, eggs, milk, and cheese. Plant food sources do not contain cholesterol.

About 80% of cholesterol is made by our liver, while the other 20% comes from our diet. For example, cholesterol-free potato chips or cholesterol-free vegetable oil never contained cholesterol in the first place.

The cholesterol that comes from the diet is low-density lipoprotein (LDL) cholesterol. This is known as the “bad” cholesterol because it contributes to the formation of sticky plaques in our arteries. Due to these plaques, blood flow is reduced and can lead to heart attacks or strokes (brain attacks).



Sources of good and bad fats

High-density lipoprotein (HDL) cholesterol is known as the “good” cholesterol because it can reverse the build-up of plaque in our arteries.

This cholesterol does not come directly from food, but is produced in our body and can be increased through exercise and by increased consumption of vegetables and fruit.

Scientific studies have shown that our blood cholesterol levels are more affected by the amount of saturated fat, rather than cholesterol that we eat.



D. **Water** is also known as the "essential" nutrient

We may live on without the other nutrients for weeks, but we cannot go on without water for more than a few days. Water is found in virtually every parts of the body.

**Importance of Water:**

**Works to keep muscles and skin toned**

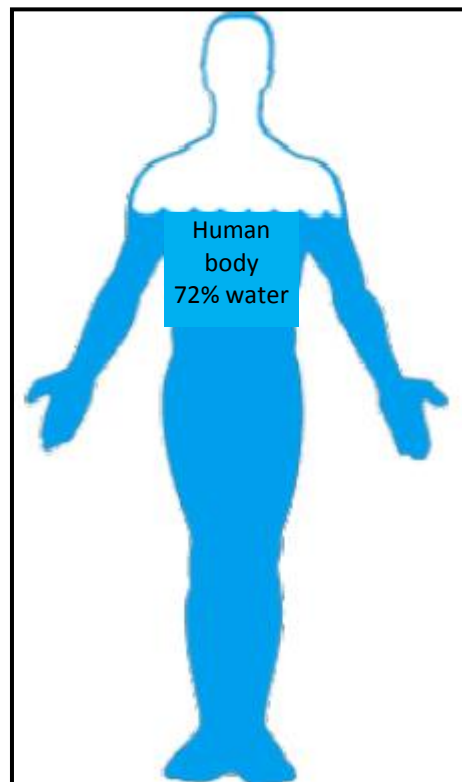
**Aids in weight loss**

**Transports oxygen & nutrients to cells**

**Eliminates toxins & waste from the body**

**Regulates body temperature**

The United States Geological Survey states that up to 60 percent of the human body is made of water: 70 percent of the brain, 90 percent of the lungs, 75 percent of muscles, 22 percent of bones and 84 percent of blood.



Our body needs about 2-3 litres of water a day. We get it from the water and liquids we drink. This fluid does not have to be water alone. It can also be obtained from juice, milk, soup, and foods high in water such as fruits and vegetables, and other food.

Caffeine-containing beverages (coffee, tea, cola) not counted here, because caffeine is a **diuretic**, making us lose water. A great plus for water in comparison to the other fluids is that, it hydrates our body without extra calories.

Water has many functions in our body. It helps break down food. It also cools the body down when it becomes too hot. The body carries away waste products in a watery solution.

Although, water does not give us energy, it is the most important nutrient. It is a macronutrient that mainly focuses on regulatory tasks within the body.

Water regulates body temperature, maintains blood volume, and it is the main conduit for transporting all forms of nutrients and waste products in the body. This is why, it is so important that each day, we consume the recommended 64 oz. or eight glasses, of water.

**Other nutrients, also necessary for body functions, are called "micro" nutrients because the body needs them in very small amounts. These are vitamins and minerals.**



1. **Vitamins** are micronutrients, meaning the body needs them in small quantities.

Vitamins are organic compounds produced by living beings. Our body needs a variety of vitamins to stay healthy. Each of them does a different job.



Vitamin A, for example, helps skin and hair grow. Vitamin C is needed to fight off infections. Vitamin D helps the growth of bones and teeth. Their main regulatory duties are to monitor growth, maintain the body's tissue and help release the energy that is stored in food so the body can use it.

Some vitamins are also involved in the production of blood cells and hormones. Vitamins help to regulate chemical reactions in the body. There are 13 vitamins, including vitamins A, B complex, C, D, E, and K. Because most vitamins cannot be made in the body, they are obtained through the diet.

There are two types, categorized by their solubility, or the means by which they are dissolved in the body.

- Water-soluble vitamins** (B complex and C) dissolve in water, and the excess is expelled as waste.
- Fat-soluble vitamins** (A, K, E and D) are stored in our body's fat until needed, so consuming more fat-soluble vitamins than your body needs can be harmful.

Many people say that they feel more energetic after consuming vitamins, but vitamins are not a source of energy (calories). Vitamins are best consumed through a varied diet, rather than as a supplement, because there is little chance of taking too high a dose.

2. **Minerals** are micronutrients. They are inorganic, not made up of living things

Our body needs different amounts of various minerals. Minerals are needed for growth and their main function is to regulate musculoskeletal functions.

Calcium and magnesium, for example, are important for bones and teeth. We also need small amounts of iron. It is a component of haemoglobin, which carries oxygen to red blood cells. And they also facilitate blood clotting and help maintain a normal heartbeat.



There are 16 minerals, and they are divided into two categories, **major** and **trace**.

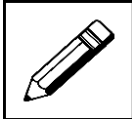
The **major minerals** are: sodium, potassium, chloride, calcium, phosphorus, magnesium and sulphur.

The **trace minerals** are iron, zinc, selenium, molybdenum, iodine, copper, magnesium, fluoride and chromium.

The following table contains two of the main minerals that are especially important for all individuals: **Iron and Calcium**.

Mineral	What is it needed for?	Where is it found?
Iron	Involved in transporting oxygen around the body in the red blood cells. With folate and B12, it prevents anemia.	The best source is red meat for example beef and lamb.  Green leafy vegetables, whole meal breads and fortified breakfast cereals contain iron but it is not absorbed as well from these foods. Having a vitamin C source at the same meal will increase the amount of iron the body absorbs from these foods, example having a fresh orange or orange juice with your breakfast cereal.
Calcium	Bones are composed of several minerals, the most important being calcium. Vitamin D works with calcium.  Calcium requirements are higher during teenage years, pregnancy, in breastfeeding women and post-menopausal women.	In milk, cheese and yogurt, (low fat varieties have the same amount). Smaller amounts are found in white bread, nuts, green leafy vegetables and tinned fish.  NOTE: Watch out in your supermarket for orange juices which have been fortified with calcium.

It is now time for you to complete Learning Activity 3 on the next page. Remember, learning activities are not sent in for assessment. However, this learning activity will help you complete Research /Survey 2 (which you will send in for assessment).

**Learning Activity 3****40 minutes****Use the list of food sources in the box to name the following:**

- a) 3 foods from plant sources high in protein.  
 (i) \_\_\_\_\_ (ii) \_\_\_\_\_  
 (iii) \_\_\_\_\_
- b) 2 foods that could be classed as Saturated Fat  
 (i) \_\_\_\_\_ (ii) \_\_\_\_\_
- c) 3 good sources of Fibre  
 (i) \_\_\_\_\_ (ii) \_\_\_\_\_  
 (iii) \_\_\_\_\_
- d) 3 foods that are Unsaturated Fats  
 (i) \_\_\_\_\_ (ii) \_\_\_\_\_  
 (iii) \_\_\_\_\_
- e) 2 foods that are Carbohydrates  
 (i) \_\_\_\_\_ (ii) \_\_\_\_\_
- f) 5 good sources of animal proteins  
 (i) \_\_\_\_\_ (ii) \_\_\_\_\_  
 (iii) \_\_\_\_\_ (iv) \_\_\_\_\_  
 (v) \_\_\_\_\_

Chicken	Noodles	Cereals	Honey
	Milk	Peas	Rice
Butter	Peanut	Beans	Pasta
	Eggs	Vegetable Oil	Fish
Cheese	Apple	Yoghurt	
	Soybean	Cereals	Table Sugar
	Green Vegetables	Margarine	

Thank you for completing your Learning Activity 3. Check your work. Answers are at the end of this module.





### **What it means to be healthy and well nourished?**

It is about the many factors that affect our health and well-being. It explains how our nutritional status depends on our personal choices based on fundamental conditions, such as **nutritious food, clean water, medical care and education.**

The foundation for good physical health is good nutritional status. Nutritional status is directly affected by the foods we eat and their nutrient content.

Most nutrients cannot be produced by the body. They must be taken in adequate amounts from the food we eat, in order to be healthy and prevent disease. No single food contains all the nutrients needed by the body in the right amounts.

One food may be rich in one or two nutrients, but low in other essential nutrients. It is only by eating adequate amounts of a variety of foods that, we can help ensure that we will take in the right amounts of the nutrients, needed for good health and nutritional status.

**Good nutritional status depends on eating the right amounts and the right variety of safe, good quality foods that provide these nutrients to meet our individual nutritional needs, and prevention of disease.**

### **Balanced Diet**

One of the things we should do is think about the food that we eat, how it is prepared, and whether we have a balanced diet or not. Different types of food help us in different ways. We need to eat more of some than of others. This is known as **balancing your diet.**

A healthy balance of foods provides the energy and nourishment everyone needs to survive and to enjoy life. Eating too little food soon leads to illness, but eating too much or the unbalance of foods can lead to health problems in the long term. It is important to get the balance right, both in the amount and the type of foods you eat.

### **Why is eating a balanced diet important?**

1. Balanced diets include a variety of foods from all the food groups to provide the vitamins , minerals, healthy fat, fiber , protein and carbohydrate you need for good health
2. Making healthy choices from each food group and limiting empty calories from sugary foods or unhealthy fat, can help you maintain a healthy body weight.
3. A balanced diet can reduce the risk of developing certain conditions and diseases, such as obesity, diabetes, certain cancers, hypertension, heart disease, and osteoporosis that will be discussed further in the later topics.



### **The right tool to balance your diet**

Regular physical activity is important for your overall health and fitness. It also helps you control body weight by balancing calories you take in, from food with the calories you use each day. Eat a lot of fruits, vegetables, whole grains, and fat-free or low-fat milk and milk products. Include lean meats, poultry, fish, beans, and nuts. Choose foods that are low in saturated fats, trans fats, cholesterol, salt, and added sugar.

### **Healthy eating guidelines**

1. **Eat for variety.** Foods from all food groups are important. Eat foods from all of the food groups every day. Choose a variety of foods within each food group. For optimum nutrition, eat more foods from the grain, fruit, and vegetable groups than from the meat and dairy groups.
2. **Eat fruits and vegetables at every meal and snack.** Fruits and vegetables are packed with vitamins, minerals, and antioxidants; plus they provide fiber to help keep our bowels regular. Experts recommend that, we get at least five servings of fruits and vegetables combined each day.

Fruits and vegetables that are deep green or orange or red pack the most vitamins and minerals (aim to make one-third of your vegetables a deep green or orange or red variety). It is important to select fruits and vegetables of different colors to get all of their beneficial nutrients.

3. **Go for whole grains.** Whole grains contain more nutrients and fiber than processed or refined grains because the milling process removes the most nutritional part of the grain. Aim to make half of all the grain foods that you eat whole grain.
4. **Limit foods and beverages with added sugar.** Sweet drinks such as soda, fruit punch, lemonade, iced tea, and sport drinks have a lot of sugar but no vitamins or minerals.

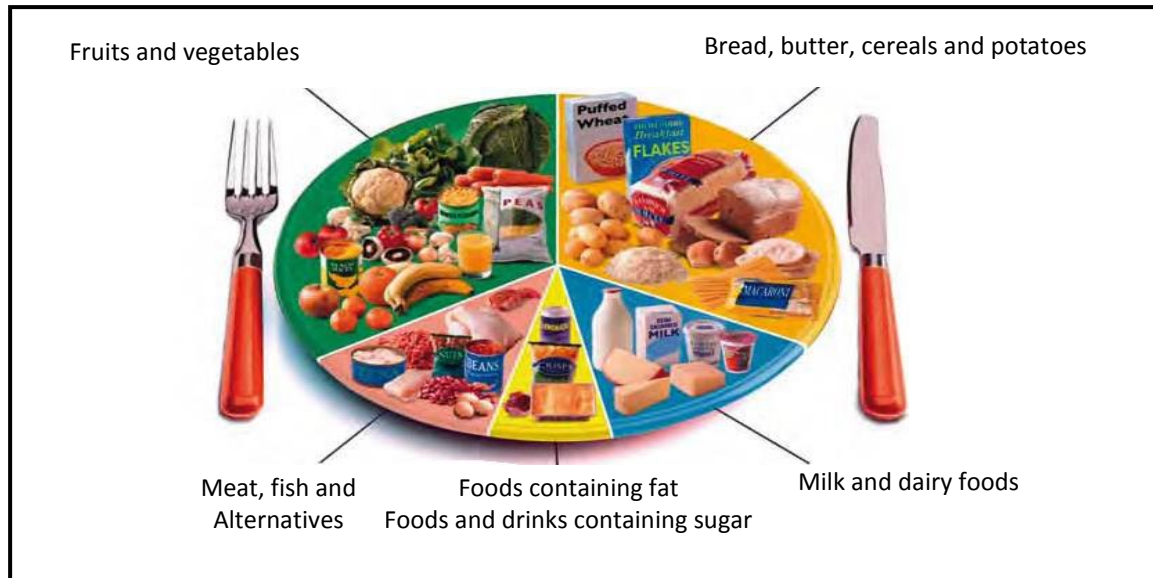
Consuming too many sweet drinks (especially if they replace milk) makes it hard to get all of the vitamins and minerals that your body needs. Soft drinks and sweets such as candy, cake, cookies, and donuts can cause dental cavities, and they add to calorie intake, which makes it hard to keep a healthy weight.

5. **Choose foods with healthy fat.** The fat in our bodies serves several purposes: It protects our organs, keeps us warm, and stores energy. Fat in food provides a feeling of fullness and it adds flavor. Some fat namely, unsaturated fat is healthy for the heart, but other fat the saturated kind can damage arteries and lead to heart disease over time. Trans fat does the most damage and should be avoided



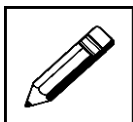
### The balance of good health

Below is a picture of the 'Balance of Good Health' food plate. It shows pictures of the five different food groups split up as a proportion of how much of them we should eat.



Five main groups of valuable foods

It is now time for you to complete Learning Activity 4. Remember, learning activities are not sent in for assessment. However, this learning activity will help you complete Research Survey Activity 2 (which you will send in for assessment).



### Learning Activity 4



20 minutes

Answer the following questions.

1. Name the three (3) main groups of macronutrients.

- (i) \_\_\_\_\_
- (ii) \_\_\_\_\_
- (iii) \_\_\_\_\_

2. Explain the importance in the diet of:

- (i) Iron  
\_\_\_\_\_  
\_\_\_\_\_
- (ii) Carbohydrate  
\_\_\_\_\_  
\_\_\_\_\_



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3. Describe the terms:

(i) Fat-soluble vitamins

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(ii) Water- soluble vitamins

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Thank you for completing your Learning Activity 4. Check your work. Answers are at the end of this module.

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### **Nutrition, Diseases and Diet Problems**

When you do not get the right nutrient and not having enough to eat, you may suffer from illnesses. Poor diet and disease act together, worsening the effects of each other. The combination of too little food and the presence of disease, often results in malnutrition, especially in children.

Having intakes of energy and/or nutrients below or in excess of needs for long periods of time can affect health. This is called **malnutrition**.

**Malnutrition** is an unhealthy state or condition in which a person's physical functions are temporarily or permanently damaged. Poor, inadequate diets weaken the body, making disease and illness more likely.

**Disease**, in turn, often increases the body's need for food. Repeated and prolonged illnesses, such as diarrhea and malaria, contribute to malnutrition, as nutritional needs are higher during and following illness.

#### **Under nutrition**

Worldwide, Kwashiorkor and marasmus are two common diseases caused by a lack of protein and energy.

**Kwashiorkor** is a disease that occurs, if your body does not get enough proteins.

**Marasmus** occurs in young children who do not get enough calories every day. They become weak, underweight and often die.

#### **Over nutrition**

In industrialized countries, people often suffer from eating too much. Too much fat and cholesterol in your body can lead to **heart diseases, obesity and cancer**. High cholesterol levels may make your arteries narrow. The result may be high blood pressure, a heart attack or a stroke.

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**Coronary heart disease (CHD)** is caused by a narrowing of the blood vessels to the heart. This reduces the flow of blood to the heart. If one of the blood vessels becomes completely blocked, the blood supply to part of the heart stops and that part is damaged. This is called a **heart attack**.

#### **Excess weight gain and obesity**

If a person regularly consumes more energy from food and drink than they need, they will start to gain weight, eventually becoming overweight. For example, energy in is greater than energy out. Extra energy from food and drink is stored in the body as fat.

There are a range of weights that are considered healthy for a given height. A person who is very overweight is obese. Obesity is becoming increasingly common in North America, Australasia and Europe.

#### **Problems associated with obesity**

People who are obese are more likely to suffer from coronary heart disease, diabetes, arthritis, high blood pressure and some types of cancers. Being active is important in maintaining a healthy weight. Being slightly overweight is not a risk to health, but it is important not to continue gaining weight.

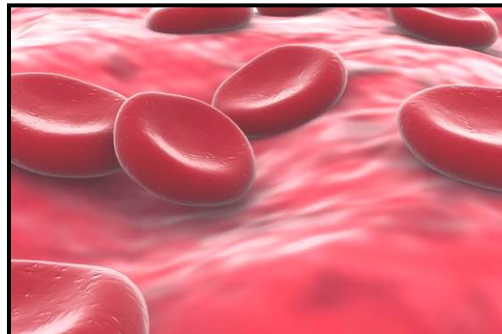
The lack of certain minerals may also lead to illnesses. Not enough iron in your food reduces the blood's ability to make red blood cells, which are needed to transport oxygen through our body.

#### **Anaemia**

The mineral iron is vital for making red blood cells. Iron from the diet forms haemoglobin, which carries oxygen in the blood. If the body's store of iron is low and there is too little iron in the diet, the symptoms of iron deficiency, anaemia will start to develop. Large amounts of iron can be toxic.

Not enough vitamins may lead to illnesses. For example, vitamin D, may lead to bone illnesses. Calcium is important for strong bones. Vitamin D is needed for calcium to be absorbed from food.

**Osteoporosis** is a disease where bones become weak, brittle and break easily. It is caused by severe losses of calcium.



#### **Blood health**

**Iron from animal sources is more easily absorbed than iron from plant sources. Vitamin C increases absorption of iron from plant sources. It is important that the diets of infants and young children contain foods rich in iron.**

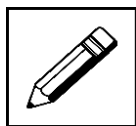
**Bone health**

**Strong bones contain plenty of calcium and their strength is affected by genetics, sex, diet, exercise, body weight, and hormones.**

**Fundamental conditions for good nutritional status**

- Food is the foundation of good nutritional status.
- We need to eat the right amounts and the right variety of safe, good quality food to meet our individual nutritional needs.
- Safe water, clean living conditions, proper sanitation and health services are fundamental for preventing and treating infections and diseases which damage health and nutritional status.
- Knowledge of how to meet the body's dietary needs with available foods and the ability to provide adequate care for all members of the family are essential for improving nutritional status.

Let us check your understanding of some basic facts about nutritional status and diet related diseases. It is now time for you to complete Learning Activity 5. Remember, learning activities are not sent in for assessment. However, this learning activity will help you complete Summative Test 2 (which you will send in for assessment).

**Learning Activity 5**

20 minutes

**A. Nutritional Status: True or False?**

**Tick the box for true if the statement is true or the box for false if the statement is false.**

	<b>True</b>	<b>False</b>
1. The most basic foundation of good nutritional status is a good healthy diet.	<input type="checkbox"/>	<input type="checkbox"/>
2. Most nutrients can be produced by the body.	<input type="checkbox"/>	<input type="checkbox"/>
3. Lack of food during illness can be a serious threat to the health of a malnourished person.	<input type="checkbox"/>	<input type="checkbox"/>
4. Food contains nutrients that help body function well.	<input type="checkbox"/>	<input type="checkbox"/>
5. Disease and illness do not affect nutritional status.	<input type="checkbox"/>	<input type="checkbox"/>
6. Poor eating habits and beliefs about certain foods can prevent people from meeting their nutritional needs.	<input type="checkbox"/>	<input type="checkbox"/>
7. Unsafe water and poor living conditions can lead to the spread of disease that affects nutritional status.	<input type="checkbox"/>	<input type="checkbox"/>



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**B. Overview of diet related diseases. Answer the following questions.**

1. What is a coronary heart attack caused by?

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2. What is the role of the nutrient iron in the body?

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3. Explain the term osteoporosis.

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4. What is lacking in the diet for the two diseases Kwashiorkor and Marasmus to develop?

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5. List four (4) types of diseases obese people are likely to suffer from.

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Thank you for completing your Learning Activity 5. Check your work. Answers are at the end of this module.

**It is now time to complete your Research/ Survey Activity 2 in your Assessment Book 2 before going on to the next topic.**



### 11.2.3: Heterotrophic Nutrition (Digestion)

Where do we get energy? We get energy from food. We have learned from previous topics that we get nutrients from food that we eat. But how do we get these nutrients from food? How does the energy from food get into the body? How do we, humans and animals absorb these nutrients that give us energy and keep us alive?

Nutrition is defined as taking in of nutrients which are organic substances and mineral ions, containing raw materials or energy for growth and tissue repair, absorbing and assimilating them. It includes following stages:

1. **Ingestion**  
Intake of food into the body through mouth.
2. **Digestion**  
The process of break-down of large, insoluble food molecules into small, water soluble molecules using mechanical and chemical processes.
3. **Absorption**  
The process of passing digested food molecules across the wall of the intestine into the blood or lymph.
3. **Assimilation**  
The movement of digested food molecules into the cells of the body where they are used, becoming part of the cells.
3. **Egestion**  
Passing out of undigested food, in the form of faeces, through the anus.

These stages will be discussed further as you read through this topic.

#### How the body uses food?

Multicellular organisms like us exhibit a complex process in obtaining our nourishment. Before nutrients can go to work, food must be broken down so that they can pass into our body. This is called **digestion**. We need to break down complex forms of food into simpler forms, through the process of digestion along the alimentary canal or digestive system.

**Why digestion of food is essential?** The food we eat is made up of large compounds and therefore these have to be broken down into simple and soluble form, so that our bodies' cells can use them.

Digestion of food is carried out by the organs and substances of the digestive system. Almost all animals have a digestive system and different species have different ways of digesting their food. There are specialized structures found in some species that perform special digestive functions.

This topic introduces you to the different organs that make up the digestive system of animals and how they interact with each other to digest food and nourish their bodies. Emphasis is given on the human digestive system and its processes.

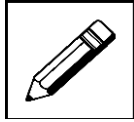




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To start with our discussion on digestive system and its processes let us play a game by performing Learning Activity 6

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## Learning Activity 6



45 minutes

### A “gutsy” game

#### Objectives:

After performing this activity, you should be able to:

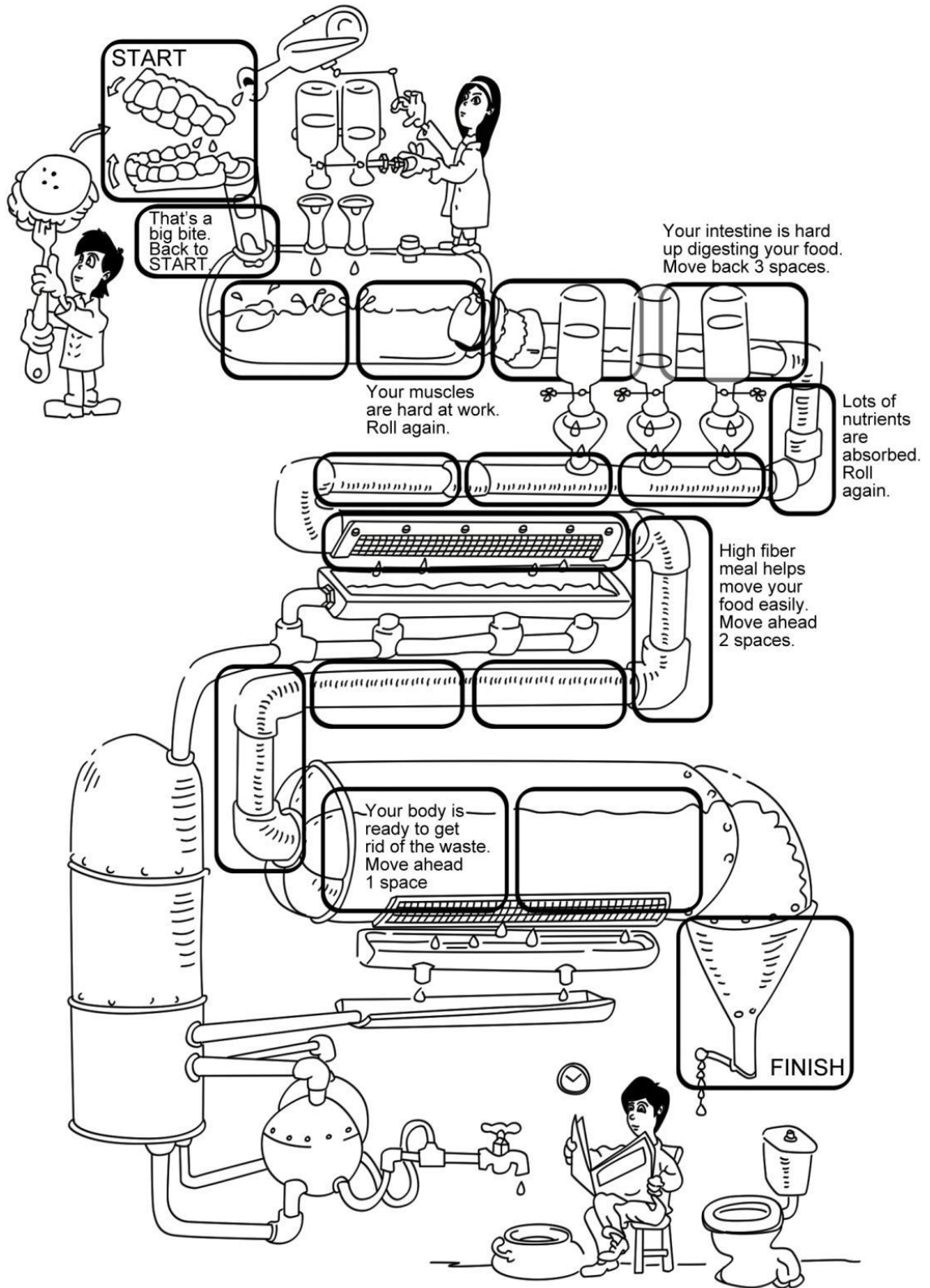
1. identify the organs that make up the digestive system; and
2. describe the function of each organ.

#### Materials Needed:

game board (refer to following page)  
a piece of dice  
tokens or playing pieces

#### Procedure:

1. Find a classmate, or a friend or someone from your house hold with whom you can play the board game.
  2. Choose a token for you and another for your classmate; place the tokens on the board’s starting line. The game you are about to play is an analogy of the digestive system.
    - (i) What do the tokens represent?  
\_\_\_\_\_
  3. Take turns rolling the dice.
  4. The number on the dice determines how many spaces you will move your token.
    - (ii) What do the spaces on the board game represent?  
\_\_\_\_\_
  5. Follow the directions -- if there is any -- on the space you land your token.
    - (iii) What do the directions on some of the spaces tell you about the digestive system?  
\_\_\_\_\_
  6. The player who first makes it all the way through the digestive system and down to the finish line wins the game.
-



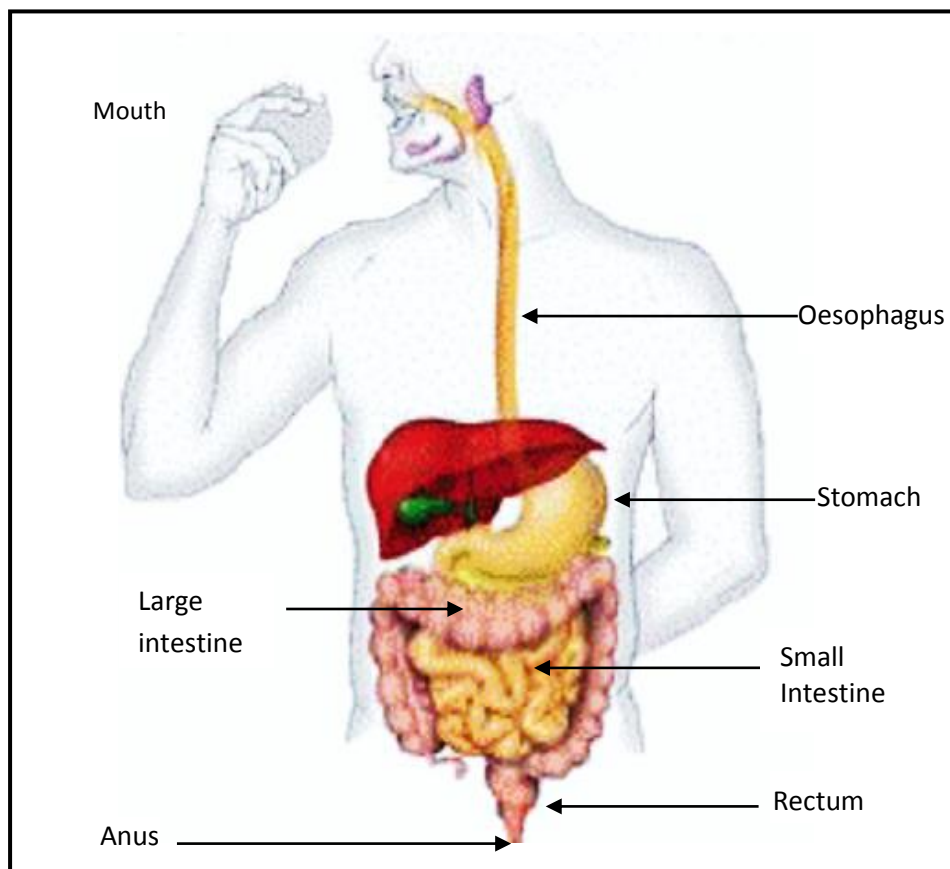


Thank you for completing your Learning Activity 6. Check your work. Answers are at the end of this module.

In Learning Activity 5, describe the illustrations on the board game. What do these illustrations represent? What do the spaces or boxes drawn on the board game represent?

Notice that the board game is just an analogy of the structures of the digestion system and the processes they carry out. You should have inferred that the digestive system is made up of different organs that work together to break down food and nourish the body.

Refer to the diagram below to compare the illustrations on the board game with the actual structures or organs of the digestive system. Are these structures also found in other organisms? Are these structures in the digestive system of humans the same as those found in other organisms? Do they serve the same or similar functions?

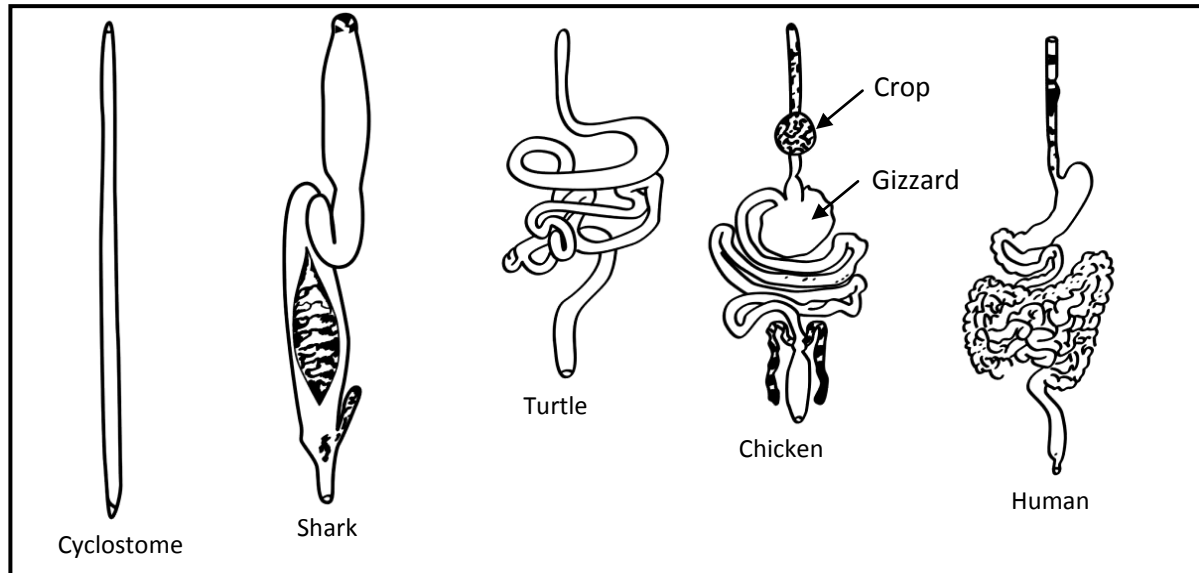


The Human Digestive System

Almost all animals have a tube like digestive system, one end of the tube serves as the mouth, while the other end serves as the anus. This digestive system is called a complete digestive system. Food enters the mouth, passes through the long tube, and exits as faeces through the anus.



Diagram below shows a comparison of the digestive systems of different representative species of animals.



Digestive tracts of different representative species of animals

Digestive system in human beings consists of **alimentary canal** and **digestive glands**.

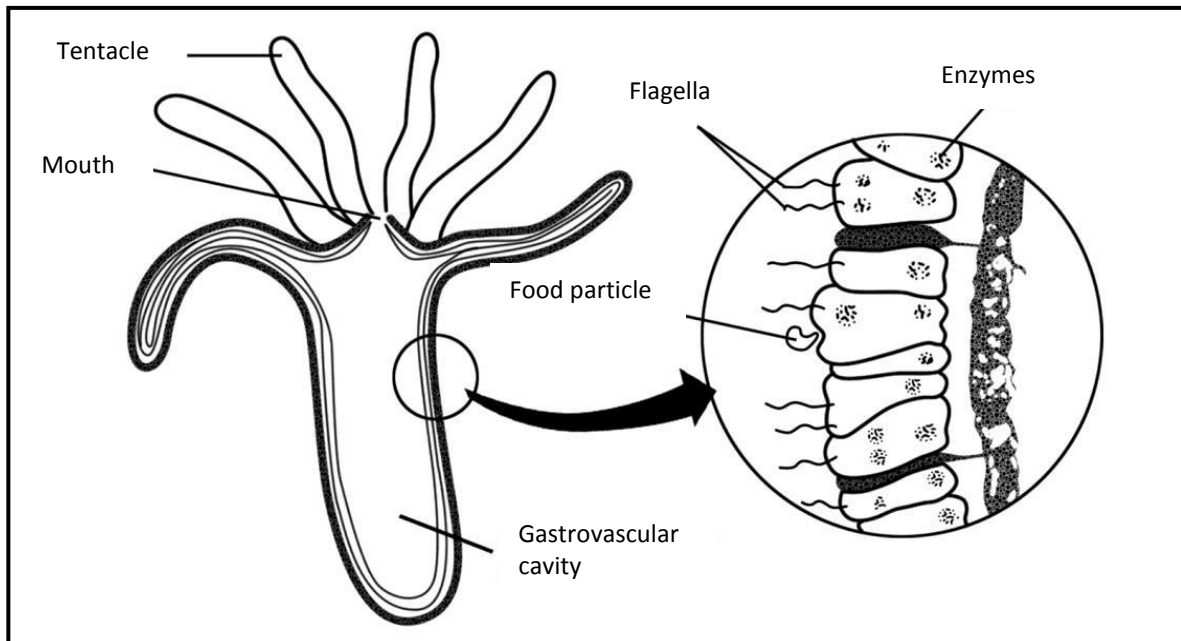
**Alimentary canal** is made up of **mouth, buccal cavity, pharynx, oesophagus, stomach, intestine, rectum** and **anus**.

The smooth muscles of the tubelike digestive organs move the food rhythmically through the system, where it is broken down into absorbable forms. Outside of this tube are attached some accessory organs known as the **digestive glands** which are the salivary glands, the **gastric glands**, the **liver**, the **pancreas** and the **intestinal glands** that also help in the digestion of food.

In what ways are the different digestive systems of animals similar? In what ways are they different?

The digestive systems of animals and the organs that make them up vary across species. Some structures like the **rumen, crop, and gizzard** are found only in some species. The rumen is common among ruminants that include the goats and cows. What do you think is the function of this structure? The crop and gizzard are found in birds and some species of invertebrates like the grasshoppers and earthworms. What functions do you think do these structures perform in digestion?

Primitive animals like the Hydra have a 'digestive system' with only one opening, which is also called an **incomplete digestive system** as shown in the diagram below. These organisms eat and excrete with their mouth which also alternates as their anus!



Hollow body of Hydra. The animal takes in food, digests food in its digestive cavity, and removes wastes through its mouth. Also shown is an enlarged part of the body wall.

What have you eaten today? Why did you choose to eat those foods? What happened to your food after you ate it?

### How does the digestive system break down food to nourish the body?

During digestion, food is broken down to smaller parts -- a fraction of which is made up of nutrients. These nutrients are circulated to the different parts of the body through the bloodstream and assimilated by cells.

### Digestion and Absorption

#### Mouth

Digestion starts when food is taken into the **mouth**. This is called **ingestion**. As you chew, you are breaking the food into small pieces as a means of **mechanical digestion**.

**Teeth** are found in the mouth of vertebrates and are important in mechanical digestion as they break food up into small pieces by biting and chewing. The smaller pieces of food have a greater surface area to volume ratio and this means that digestive enzymes have a greater ability to work effectively.

The teeth differ in size, function, arrangement and structure. Each type of tooth has a specific function.

1. **Incisors** are chisel-shaped teeth at the front and are used for biting.
2. **Canines** have a sharp point and are used for tearing meat.
3. **Premolars** have sharp cutting edges and are used for crushing food.
4. **Molars** have large flat surfaces with blunt ridges and are used for grinding food.



The structure, locations and numbers of teeth can show the diet of a particular organism.

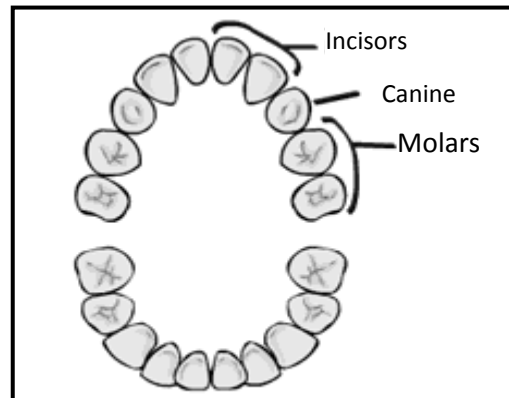
**Herbivores** have incisors that are used to bite off vegetation. They also have specially adapted molars that are broad and crushing. They are specially equipped with ridges to help break open the cellulose cell walls of plants. It is extremely difficult to break down the cellulose physically or chemically.

Furthermore, plants do not provide large amounts of energy for the herbivore, so they must eat for long periods of time. Their teeth are adapted to these situations. Many herbivores have microbes in their gut which increases the rate at which the cellulose is broken. Canine teeth are absent in the herbivores.

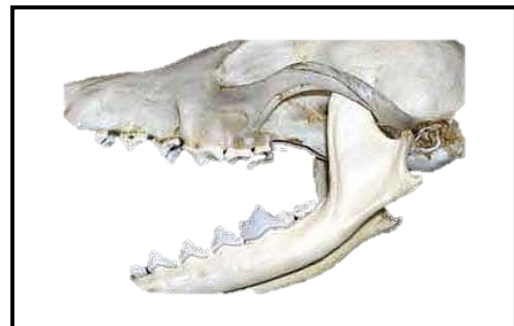
**Carnivores** have powerful jaws and well-developed canine teeth, conical in shape and they are specialised for holding and killing prey and tearing meat from the bones. The meat is torn off in chunks and they have molars with large cusps that briefly chew the meat before digestion.

Smaller carnivores (that are adapted to feed on insects) have teeth adapted for piercing and penetrating the tough cuticle of their prey. They have to puncture the exoskeleton with their premolars and then use these teeth to shear the inner tissues.

**Omnivores** (such as humans) eat both plants and animals, and have broad, flat molars for grinding up a variety of foods. The front teeth are wide, narrow at the tips, and somewhat chisel-shaped, making them useful for biting off chunks of meat or plant material.



First teeth sometimes called "baby teeth"



Fox skull



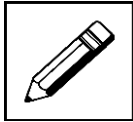
Squirrel jaw



Wide front teeth



It is now time for you to complete Learning Activity 7 on the next page Remember, learning activities are not sent in for assessment. However, this learning activity will help you complete Assignment 2 (which you will send in for assessment)



## Learning Activity 7



45 minutes

### A sweet break!

#### Objectives:

After performing this activity, you should be able to:

1. Describe the process of mechanical digestion.
2. Explain how the physical breaking down of food helps in its digestion.

#### Materials Needed:

two 100 mL beakers or clear containers  
warm water  
two pieces of lollies (hard lollies)  
mortar and pestle (any hard object like a piece of wood)  
paper towel

#### Procedure:

1. Fill the two beakers or clear containers with warm water. Make sure that the amount of water placed in each container is about the same. Label the containers A and B.
2. Prepare two pieces of lollies. Wrap a piece of lolly in a paper towel and crush it using a mortar and pestle or any hard object like a piece of wood.
3. Place one piece of candy into the container of warm water labeled A and place the crushed pieces of candy in the remaining container of warm water labeled B.
4. Observe how long it takes for the whole candy in container A and the crushed pieces of candy in container B to dissolve.
5. Record your observation and answer the following questions:

(i) How does crushing the candy to smaller pieces affect its dissolution?

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(ii) What does crushing the candy represent in the process of digestion?

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Thank you for completing your Learning Activity 7. Check your work. Answers are at the end of this module.



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### Physical and chemical change in digestion

Food undergoes **physical** and **chemical change** as it moves from one part of the gastrointestinal tract to the other. Digestion makes the nutrients found in food available to the different parts of the body for the organism's nourishment and overall wellness.

When food enters the mouth, the **salivary glands** release saliva into the mouth chewing mixes the saliva with the food before you swallow. **Saliva** is a watery liquid made by the salivary glands. It has several functions. It dissolves some of the food, helps to lubricate the food and makes some small pieces stick together.

### Have you noticed that food sometimes tastes sweeter after chewing it for a while?

The next time you eat a cracker or piece of bread, chew slowly and notice the change in the way it tastes. It gets sweeter.

Saliva softens and wets the food in the mouth and also initially starts **chemical digestion** through the enzymes present in it. Human saliva contains a digestive enzyme known as **salivary amylase** which splits starch into units of disaccharide maltose sugar making the food sweeter.

The digestive system produces enzymes to break down the ingested food.

- **Amylase** enzymes break down carbohydrates to glucose.
- **Protease** enzymes break down proteins into amino-acids.
- **Lipase** enzymes break down lipids into glycerol and fatty acids.

**It is now time for you to complete Practical Activity 2 in your Assessment book 2, before going on to the next topic. The investigation we are going to do will help us understand how saliva with enzymes helps with the process of digestion.**

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### Process of swallowing

Saliva and other fluids, including mucus, blend with the food to form a bolus, a chewed, moistened lump of food that is soft and easy to swallow.

- Tongue squeezes food against palate.
- The soft palate close the nasal cavity at back.
- Back of tongue and epiglottis direct food over opening of windpipe (glottis)
- The glottis is also partly closed by contraction of a ring muscle.
- The epiglottis, a flap of cartilage helps to prevent the food form going down the windpipe instead of the gullet.

When you swallow, the bolus slides the epiglottis, a valve like flap of tissue that closes off your air passages, so that you do not choke. The bolus then moves rapidly through the oesophagus to the stomach, where it is digested further.



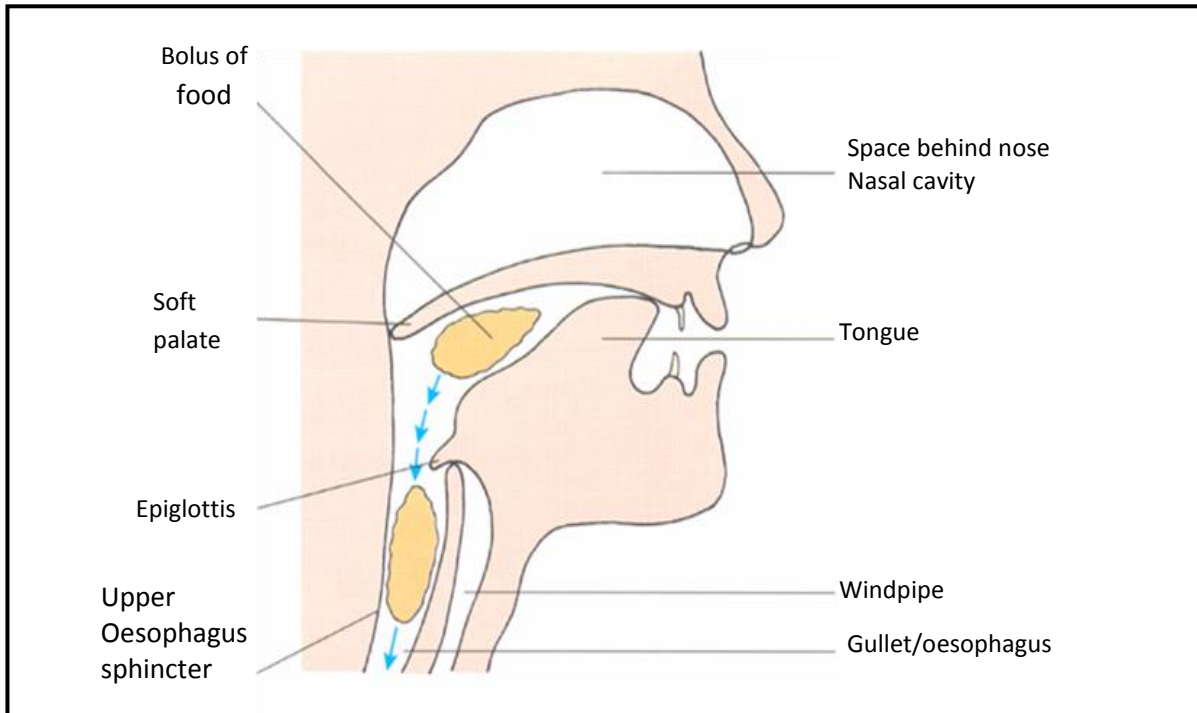


Diagram that shows the process of swallowing

**Why can you not breathe while you are swallowing?**

The airways are cut off. The soft palate closes the nasal cavity; the tongue, the epiglottis and muscles in the glottis, seal the top of the windpipe.

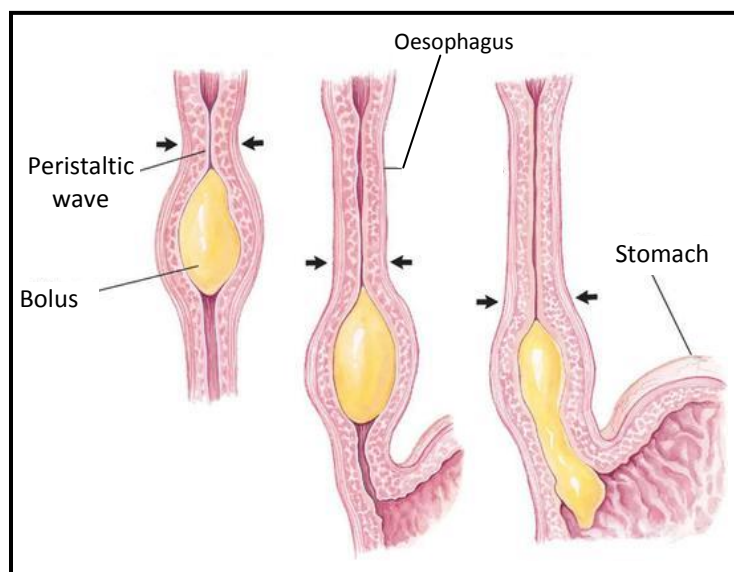
**From the mouth, where does the food enter?**

**Oesophagus**

The oesophagus is a long muscular tube that leads to the stomach. Food does not travel by gravity. It is pushed by a wavelike contraction of muscles known as peristalsis.

The oesophagus makes quick work of this job. It can squeeze food to the stomach in 7 seconds.

Then the food in the form of bolus passes through the **esophageal sphincter**, also called **cardiac sphincter**.

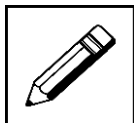


Peristalsis



The sphincter immediately closes to keep the bolus from sliding back into the oesophagus. It prevents the acidic stomach contents from backing up into the oesophagus, causing the pain and tissue damage called heartburn. Muscle contractions in the oesophagus help move the food down to the stomach. This process is called **peristalsis** as shown in the figure from the previous page.

It is now time for you to complete Learning Activity 8. The next activity will simulate how the oesophagus works.



### Learning Activity 8



45 minutes

#### Peristalsis!

##### Objectives:

After performing this activity, you should be able to:

1. describe the process of how food moves from mouth down to the stomach.
2. explain how the process of peristalsis help move the food down to stomach.

##### Materials needed:

1 long balloon, 1 teaspoon of cooking oil,  $\frac{1}{4}$  slice of white bread

##### Procedure:

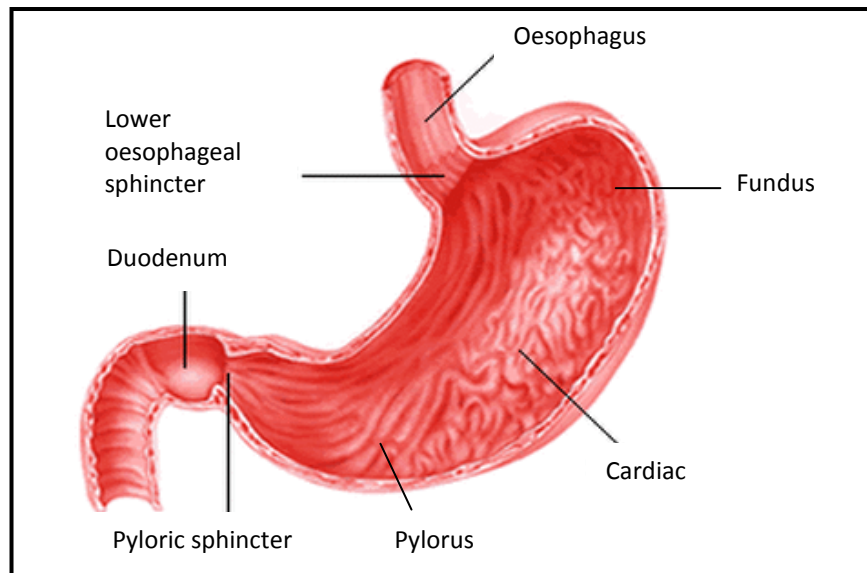
1. Cut the end of the balloon so that it makes a long, flexible tube.
2. Pour 1 teaspoon (5 ml) of cooking oil into the balloon.
3. Take the  $\frac{1}{4}$  piece of bread and make it into a ball about the size of a marble.
4. Stick the bread into one end of the balloon.
5. Squeeze the balloon behind the ball of bread with one hand. Keeping that hand in place, cross your other hand over the first hand, continue squeezing to move the bread down the balloon.
6. Record your observation by answering the following questions:
  - (i) What part of the digestive tract is represented by the balloon? \_\_\_\_\_
  - (ii) What happens to the bread? \_\_\_\_\_
  - (ii) Explain briefly the process of peristalsis. \_\_\_\_\_

Thank you for completing your Learning Activity 8. Check your work. Answers are at the end of this module.



## Stomach

Food from the mouth passes through the oesophagus to the stomach. The stomach is made up of muscles that churn and help mix the food and break it into even smaller parts. The stomach is divided into three compartments, **cardiac**, **fundus** and **pylorus**. The junction of oesophagus and stomach is guarded by a valve which does not allow the food to travel in backward direction.



Parts of the Stomach

### Nutrient digestion in the stomach

The **gastric glands** in the stomach lining produce acids and enzymes juices collectively called **gastric juices**. These chemicals help digest food. These digestive juices could also harm the stomach.

### How does the stomach protect itself from self-digestion?

Did you know that the pH concentration of hydrochloric acid in stomach is as low as 1 to 2? This pH is low enough to melt a solid metal! However, a thick mucus layer helps keep this acidic chemical environment from destroying the tissues of the stomach and prevents the acid from harming the cells of the stomach. Furthermore, sodium bicarbonate buffering prevents the acid from damaging the stomach.

Gastric juice is a combination of **hydrochloric acid**, **enzymes like pepsin, lipase**, and mucous.

- **Hydrochloric acid (HCl)** provides acidic medium for many enzymes to get activated. It kills many of the bacteria taken in with the food.
- **Mucous** lubricates the passage of the food. Protects stomach lining from acid. (protects the tissues from self - digestion).
- **Pepsinogen** helps in the digestion of proteins after getting activated into pepsin by HCl.
- **Enzymes** of the gastric juice bring about digestion of different components of the food. **gastric lipase** helps in emulsification of lipids in the stomach.



### How do these gastric juices affect digestion in the stomach?

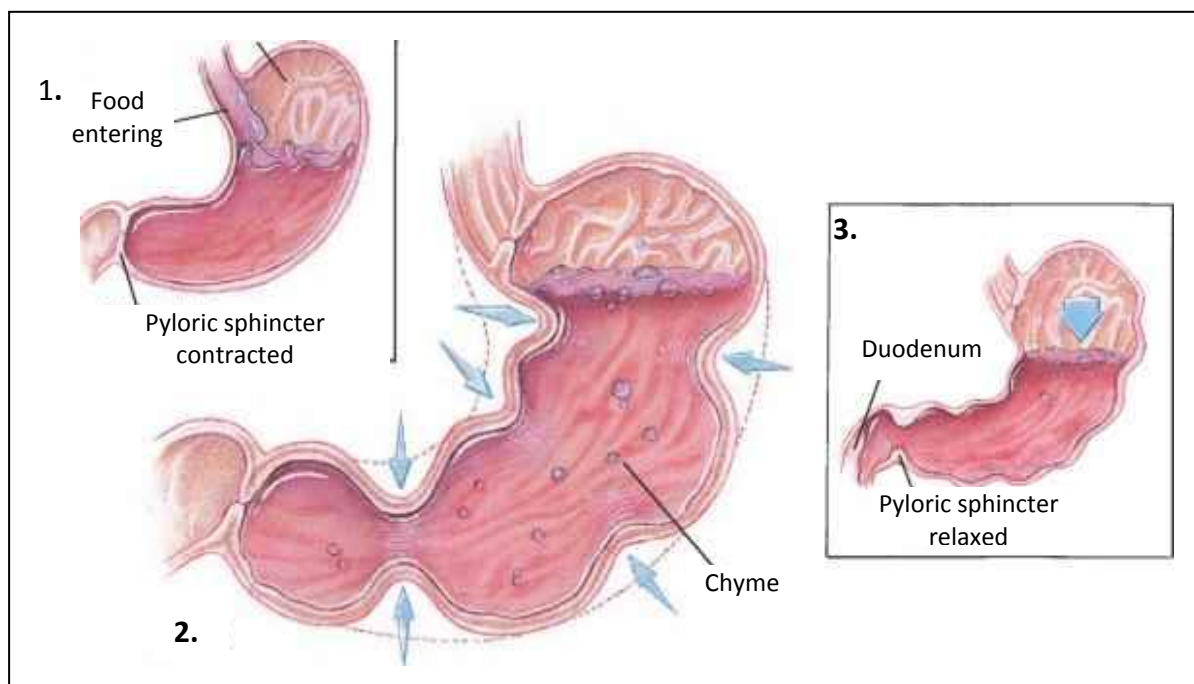
At certain times of the day, you hear your stomach rumbling. This is the sound you hear as the gastric juices are churned in an empty stomach. This indicates that you are already hungry and it is time for you to eat. The stomach and some glands start to produce gastric juices to prepare your stomach for the food you will eat. These gastric juices provide an acidic environment in the stomach to produce the semi liquid **chyme** as partially digested food that passes on into small intestine.

The stomach normally empties in one to four hours, depending on the types and amounts of food eaten. Carbohydrates speed through the stomach in the shortest time followed by protein and fat. Thus, the higher the fat content of a meal, the longer it will take to leave the stomach.

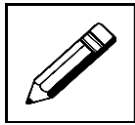
Following are the peristaltic movements inside the stomach, causing the food to be partially digested and transported to small intestine.

1. **Propulsion** is peristaltic waves move from the fundus toward the pylorus part of the stomach.
2. **Grinding** is most vigorous peristalsis and mixing action occur close to the pylorus.
3. **Retropulsion** is the pyloric end of the stomach which acts as a pump that delivers small amounts of chyme into the duodenum, simultaneously forcing most of its contained material backward into the stomach.

The diagrams below show the peristaltic movements inside the stomach.



It is now time for you to complete Learning Activity 9 on the next page. The next activity will simulate what happens to the food inside the stomach.



### Learning Activity 9



25 minutes

#### The Stomach

**Objectives:**

After performing this activity you should be able to:

1. describe how stomach helps in the digestion of food.
2. infer the importance of gastric juices in the process of digestion.

**Materials:**

4 unfrosted animal crackers,  
 zip-lock bag or plastic bag  
 ¼ cup of water

**Procedures:**

1. Place broken cookies and water into the zip-lock bag and squeeze the bag many times.
2. Answer the following questions:
  - (i) Food moves from the mouth to the oesophagus, then through stomach. What do you think the plastic bag represents? Cookie represents? Water represents?

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- (ii) What does the squeezing represent?

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Thank you for completing your Learning Activity 9. Check your work. Answers are at the end of this module.

#### Intestine

The intestine is a muscular tube which extends from the lower end of your stomach to your anus, the lower opening of the digestive tract. It is also called the bowel or bowels. Food and the products of digestion pass through the intestine, which is divided into two sections called the **small intestine** and the **large intestine**.

#### Small Intestine

The small intestine, or small bowel, is a hollow tube about 20 feet long that runs from the stomach to the beginning of the large intestine. The small intestines lie in your gastrointestinal tract between the stomach and large intestines. Although, the small intestine is narrower than the large intestine, it is actually the longest section of your digestive tube, measuring about 22 feet (or seven meters) on average, or three and a half times the length of your body.

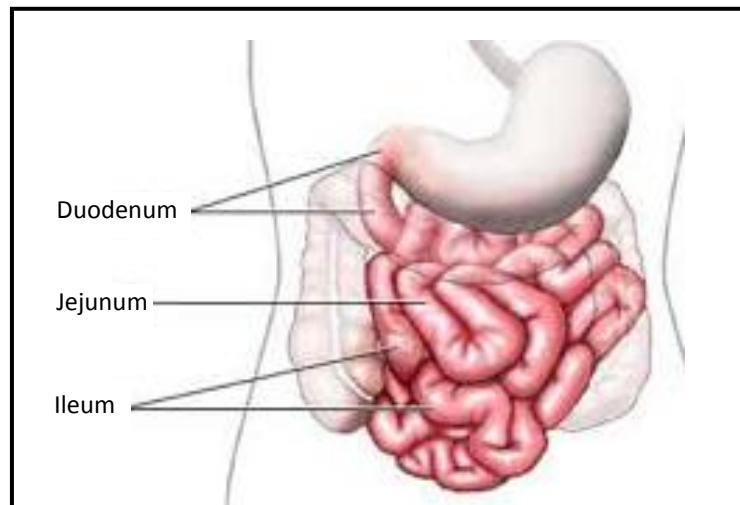


### Parts of small intestines

The small intestine is made up of three segments, which form a passage from your stomach (the opening between your stomach and small intestine is called the pylorus) to your large intestine:

#### 1. Duodenum

The duodenum is the first part of the small intestine. The main role of the duodenum is to complete the first phase of digestion.



Parts of small intestines

This short section is the part of the small intestine that takes in semi-digested food from your stomach through the pylorus, and continues the digestion process.

#### 2. Jejunum

The middle section of the small intestine carries food through rapidly, with wave-like muscle contractions, towards the ileum.

#### 3. Ileum

This last section is the longest part of your small intestine. The ileum is where most of the nutrients from your food are absorbed, before emptying into the large intestine.

### Nutrient digestion in the small intestine

Digested molecules of food are absorbed through the small intestine. The small intestine breaks down food from the stomach and absorbs much of the nutrients from the food.

### How can the small intestine digest so much?

Each day, your small intestine receives between one and three gallons (or six to twelve liters) of this liquid. The small intestine carries out most of the digestive process, absorbing almost all of the nutrients you get from foods into your bloodstream. The walls of the small intestine make digestive juices, or enzymes, that work together with enzymes from the liver and pancreas to do this.

Looking at the small intestine as a pipe, it seems hard to believe that an organ so narrow could do such a big job. However, looks can be deceiving. The absorptive surface area of the small intestine is actually about 250 square meters (almost 2,700 square feet) – the size of a tennis court! How is this possible?



### What characteristics of the small intestine enable it to absorb digested food efficiently?

The small intestine has three features which allow it to have such a huge absorptive surface area packed into a relatively small space:

#### 1. **Mucosal folds**

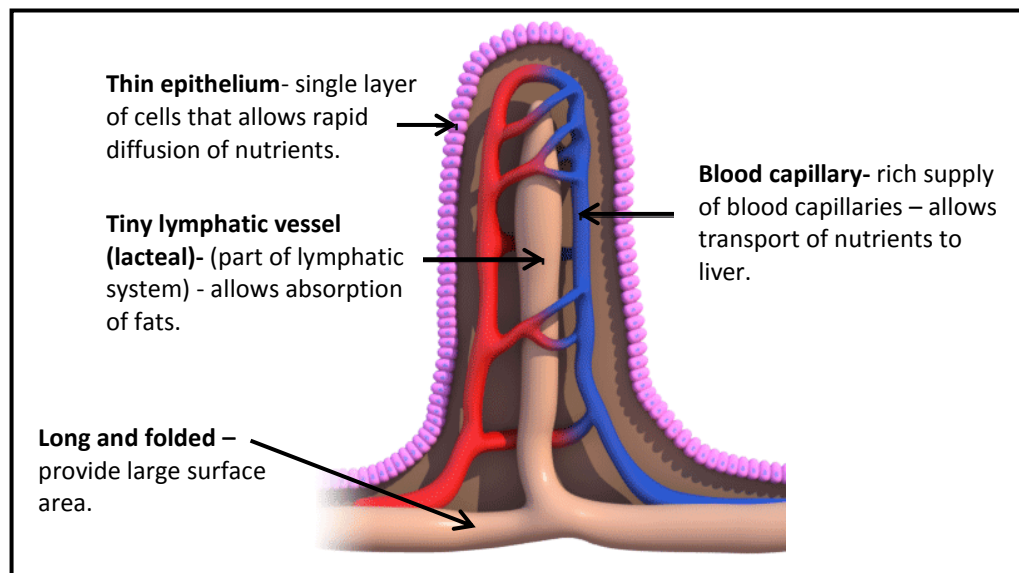
The inner surface of the small intestine is not flat, but thrown into circular folds that protrude out into the intestinal space (called the lumen), creating a series of peaks and valleys nearly the entire length of the intestine. This not only increases the surface area, but helps regulate the flow of digested food through your intestine.

#### 2. **Villi (villus, sing.)**

The folds form numerous tiny projections which stick out into the open space inside your small intestine (or lumen), and are covered with cells that help absorb nutrients from the food that passes through.

#### 3. **Microvilli**

The cells on the villi are packed full of tiny hairlike structures called microvilli. This helps increase the surface of each individual cell, meaning that each cell can absorb more nutrients.



The villus is well adapted for absorbing digested food. The large surface area is one feature that helps describe three other features shown on the diagram which make the villus efficient at absorbing food. Their walls are only one cell thick to allow dissolved molecules to pass through quickly. They contain many blood capillaries which absorb glucose and amino acids. They contain lacteals which are part of the lymphatic system and which absorb fats.

### How the small intestine works?

By the time food reaches your small intestine, it has already been broken up and mashed into liquid by your stomach.

In **duodenum**, food from the stomach is mixed with the enzymes **pancreatic juice** from **pancreas** and **bile juice** from **liver**. The enzymes and bile help break down food.



After food is broken down in the duodenum, it moves to the **jejunum**, where the inside walls absorb the food's nutrients. Nearly all the absorption of digested food takes place in ileum region of small intestine. Why?

The inside walls of the jejunum have many circular folds, which make its surface area large enough to absorb all of the nutrients that the body needs. The inner lining of the jejunum and the later section of the ileum are lined with villi, small fingers containing capillaries that increase the surface area that can absorb nutrients.

**Ileum** absorbs bile acids, which are returned to the liver to be made into more bile, and then stored in the gallbladder for future use in the duodenum. The ileum also absorbs vitamin B12, which the body uses to make nerve cells and red blood cells.

During **absorption**, these nutrients pass through the walls of the intestine and into the bloodstream, where they get transported to the different parts of the body.

### Large intestines

After food is processed in the small intestine, it passes into the **large intestine**, also called the **large bowel or colon**. The large intestine, which is about 5 feet or 1.5 meters long is much broader than the small intestine and takes a much straighter path through your belly, or abdomen.

Its job is to absorb water and salts, from the material that has not been digested as food, and get rid of any waste products left over, or extracts most of the water from this food and distributes it to the body. The remaining material passes through the colon and out of the body as **faeces**. The undigested parts of food or those that were not absorbed by the body are eliminated as faeces. This process is called **elimination** or **defecation**.

The large intestine is made up of the following parts:

1. **Cecum**

This first section of your large intestine looks like a pouch, about two inches long. It takes in digested liquid from the ileum and passes it on to the colon.

2. **Colon**

This is the major section of the large intestine, you may have heard people talk about the colon on its own. The colon is also the principal place for water reabsorption, and absorbs salts when needed. The colon consists of four parts:

(i) **Ascending colon**

Using muscle contractions, this part of the colon pushes any undigested debris up from the cecum to a location just under the right lower end of the liver.



**(ii) Transverse colon**

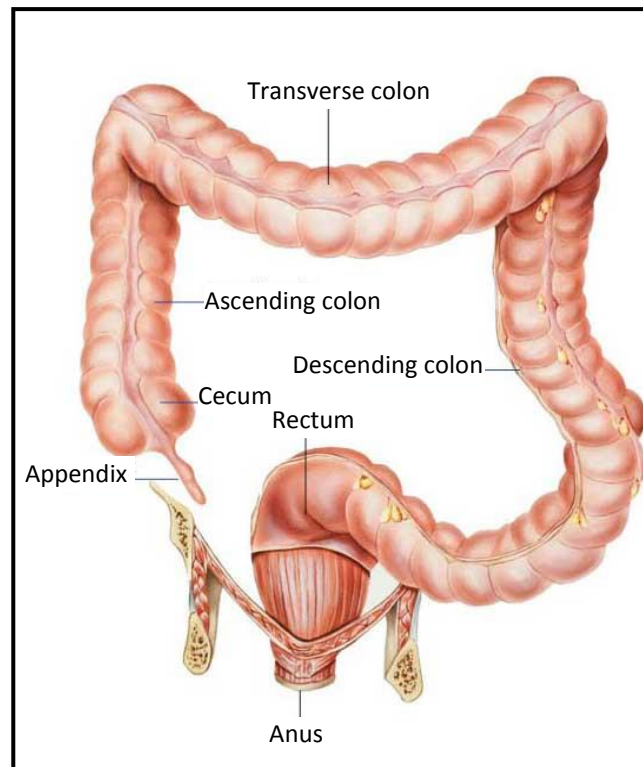
Food moves through this second portion of the colon, across your front (or anterior) abdominal wall, traveling from left to right just under your stomach.

**(iii) Descending colon**

The third portion of colon pushes its contents from just near the spleen, down to the lower left side of your abdomen.

**(iv) Sigmoid colon**

The final S-shaped length of the colon, curves inward among the coils of your small intestine, then empties into the rectum.



Parts of large intestines

**3. Rectum**

The final section of digestive tract measures from 1 to 1.6 inches (or 2.5 to 4 cm). Leftover waste collects there, expanding the rectum, until you go to the bathroom. At that time, it is ready to be emptied through your anus.

**4. Appendix**

This is a small, hollow, finger-like pouch, which hangs at the end of the cecum. It does not have any function in the digestive system of humans. However, it is functional in herbivores such as cows.

**Nutrient digestion in the large intestine**

By the time food mixed with digestive juices reaches your large intestine, most digestion and absorption has already taken place. What is left is mainly fibre (plant matter which takes a long time to digest), dead cells shed from the lining of your intestines, salt, bile pigments (which give this digested matter its color), and water. In the large intestine, bacteria feed on this mixture. These helpful bacteria produce valuable vitamins that are absorbed into your blood, and they also help digest fiber.

**How do digestive juices in each organ of the digestive system break down food?**

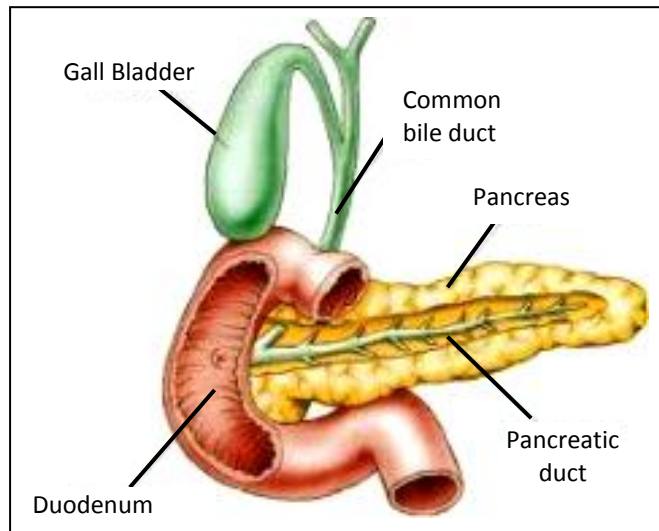
Digestive juices contain enzymes that speed up chemical reactions in the body, that break food down into different nutrients.



### Accessory digestive organs and glands

Though not directly part of the digestive tract, the accessory digestive organs play a major role in digestion. These organs ensure that the functions of the digestive system can take place. Without them, your system would simply not work.

The accessory digestive organs include the salivary glands, pancreas, liver and gallbladder. Glands are organs that secrete digestive juices and hormones.



#### 1. Salivary glands

Saliva produced by the salivary glands moistens food so it moves more easily through the oesophagus into the stomach. Saliva also contains an enzyme that begins to break down the starches from food.

#### Glands in the stomach lining

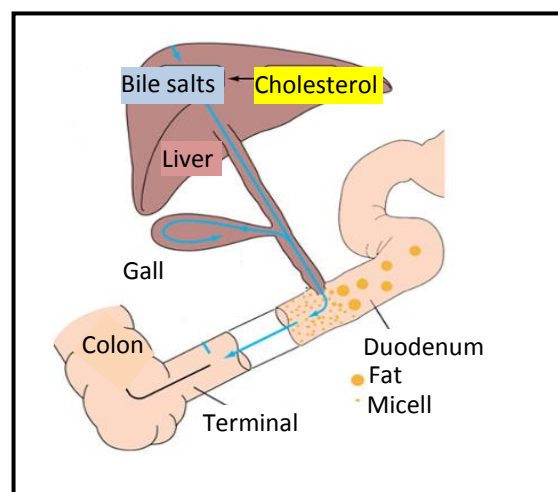
The glands in the stomach lining produce stomach acid and an enzyme that digests protein.

#### 2. Pancreas

A carrot-shaped digestive gland located behind and under the stomach. The pancreas delivers digestive juice to the small intestine through small tubes called **ducts**. It makes number of enzymes, which act on carbohydrates, fats, and proteins in food.

- There are several proteases (like trypsin) which break down proteins to peptides and amino acids.
- Pancreatic amylase converts starch to maltose.
- Lipase digests fat (lipids) to fatty acids and glycerol.

Pancreatic juice also contains sodium hydrogen carbonate which partly neutralizes the acid liquid from the stomach. Medium of digestion is alkaline.



Liver as the body's chemical



### 3. Liver

The liver is the body's chemical-processing centre. The liver produces a digestive juice called bile.

**Bile** is a green fluid stored in the gall- bladder and delivered to the duodenum by **bile duct**.

Bile does not contain any enzymes. Bile contains bile salts which act on fats. Bile salts emulsify the fats in which they break them (fats) up into smaller fat droplets which can be more easily digested by lipase.

**Emulsification** is a type of mechanical digestion.

The **gallbladder** stores bile between meals. When a person eats, the gallbladder squeezes bile through the bile ducts, which connect the gallbladder and liver to the small intestine.

The bile mixes with the fat in food. The bile acids dissolve fat into the watery contents of the intestine, much like how detergents dissolve grease from a frying pan, so the intestinal and pancreatic enzymes can digest the fat molecules.

#### Intestinal glands

As well as receiving enzymes made in the pancreas, the small intestine (ileum) makes some enzymes itself. Cells covering the villi make enzymes. Digestive juice produced by the small intestine combines with pancreatic juice and bile to complete digestion. The body completes the breakdown of proteins, and the final breakdown of starches produces glucose molecules that absorb into the blood. Bacteria in the small intestine produce some of the **enzymes** needed to digest carbohydrates

Examples of enzymes that complete the digestion of food

#### Carbohydrase

Maltase breaks down maltose to glucose.

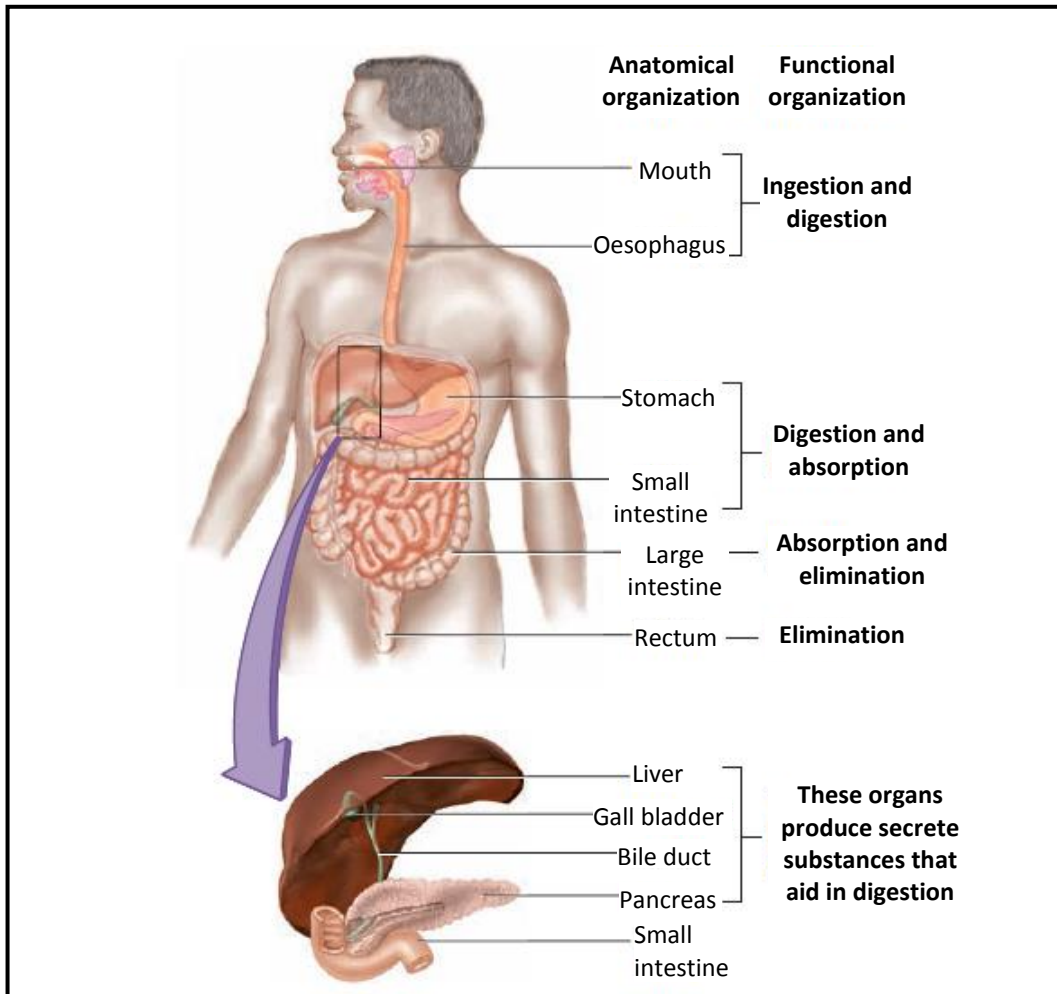
Sucrase breaks down sucrose to glucose and fructose.

Lactase breaks down lactose to glucose and galactose.

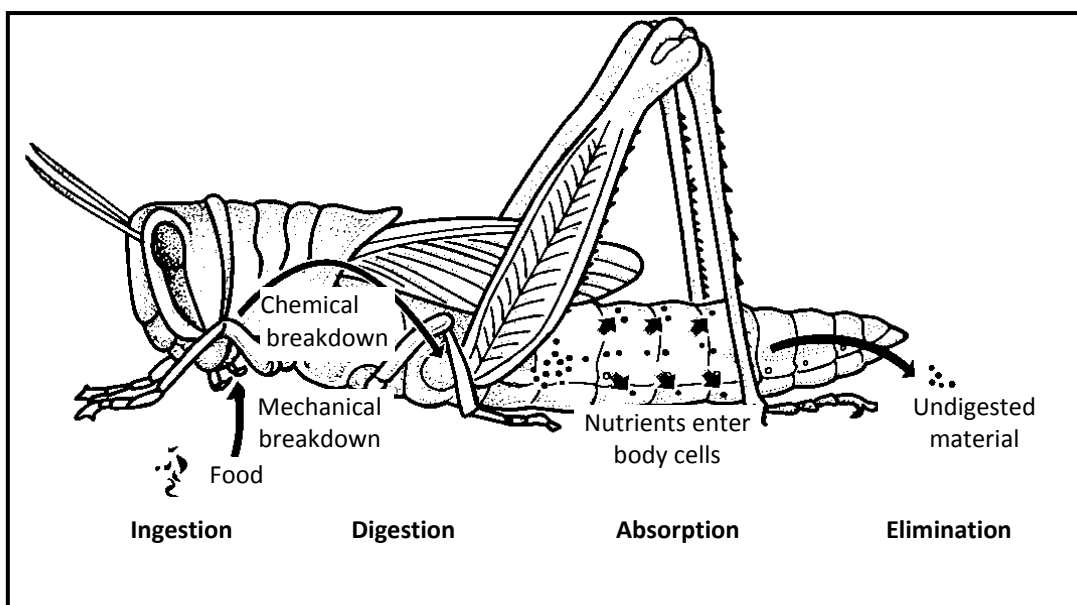
#### Proteases

Proteases digest polypeptides to amino acids.

The diagrams on the next page show how food is changed to soluble forms as it is moved from one part to the next part of the digestive system.



Digestion process in Humans

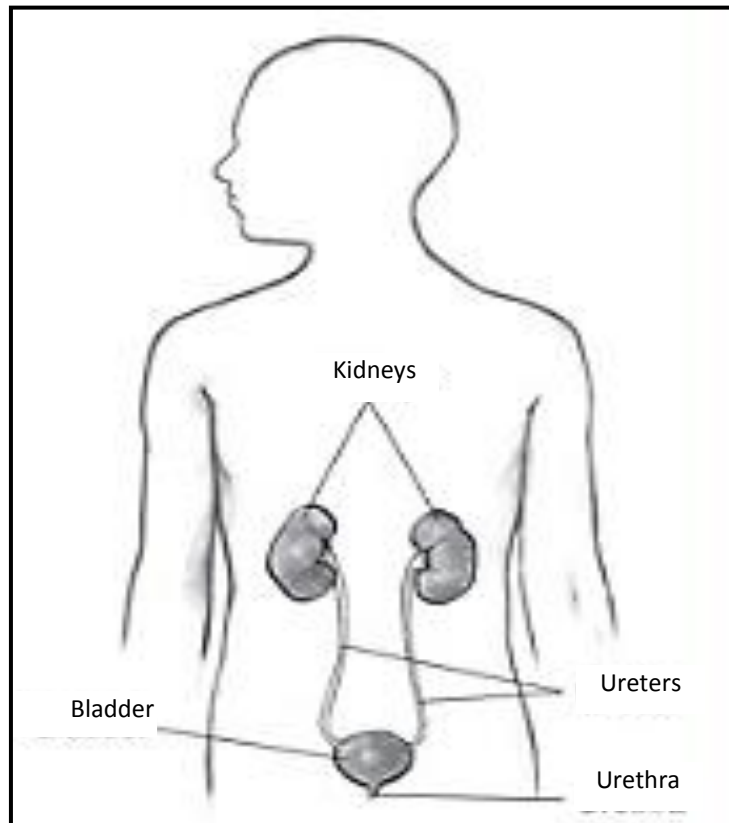


Digestion process in animals (herbivore)



## Kidneys and what do they Do

The kidneys are two bean-shaped organs, each about the size of a fist. They are located just below the rib cage, one on each side of the spine.



Parts of excretory system

Every day, the two kidneys filter about 120 to 150 quarts of blood to produce about 1 to 2 quarts of urine, composed of wastes and extra fluid.

### Why are the kidneys important?

The kidneys are important because they keep the composition, or makeup of the blood stable, which lets the body function.

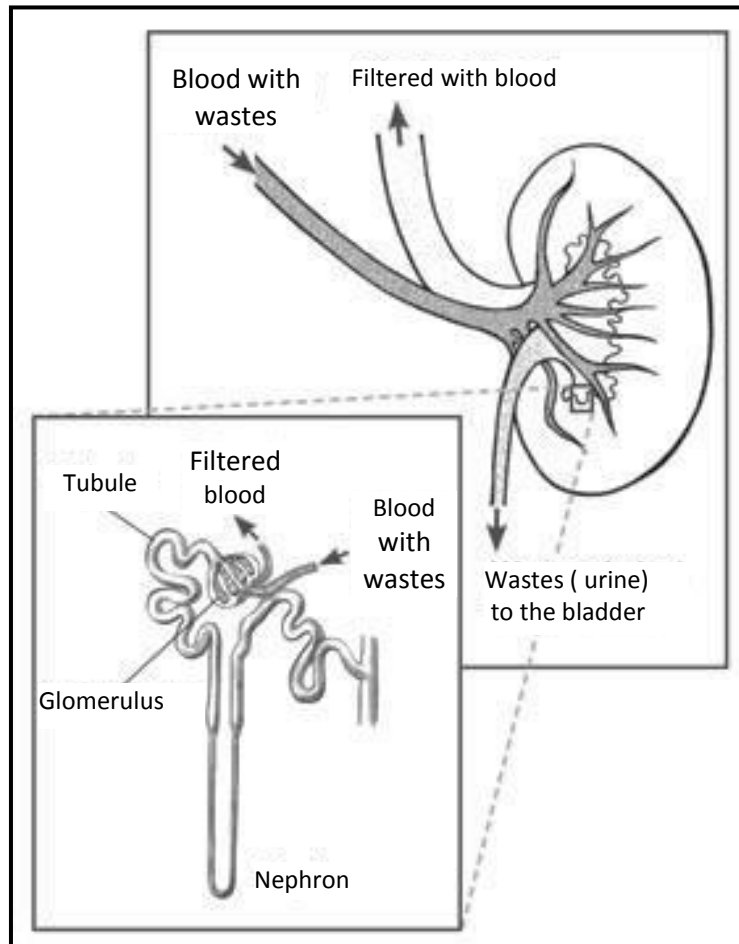
- they prevent the build-up of wastes and extra fluid in the body
- keep levels of electrolytes stable, such as sodium, potassium, and phosphate make hormones that help regulate blood pressure make red blood cells bones stay strong

### How do the kidneys work?

The kidney is not one large filter. Each kidney is made up of about a million filtering units called nephrons. Each nephron filters a small amount of blood. The **nephron** includes a filter, called the **glomerulus**, and a **tubule**. The nephrons work through a two-step process. The glomerulus lets fluid and waste products pass through it; however, it prevents blood cells and large molecules, mostly proteins, from passing.



The filtered fluid then passes through the tubule, which sends needed minerals back to the bloodstream and removes wastes. The final product becomes urine.



The nephrons work through a two-step process

The urine flows from the kidneys to the bladder through two thin tubes of muscle, called **ureters**, one on each side of the bladder.

The bladder stores urine. The muscles of the bladder wall remain relaxed while the bladder fills with urine. As the bladder fills to capacity, signals sent to the brain tell a person to find a toilet soon.

When the bladder empties, urine flows out of the body through a tube called the urethra, located at the bottom of the bladder. In men, the urethra is long, while in women it is short.

**REVISE WELL USING THE MAIN POINTS ON THE NEXT PAGE**



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## SUMMARY

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You will now revise this module before doing **SUMMATIVE TEST 2**. Here are the main points to help you revise. Refer back to module topics if you need more information.

- All living organisms require food for their survival. Organisms are able to obtain energy from the foods they eat. These foods contain a number of food constituents known as **nutrients** which must be digested by the body. The process by which living organisms take in food and utilize for their growth and maintenance is called **nutrition**.
- Living organisms differ in their **mode of nutrition** one is the **autotrophic nutrition** and second the **heterotrophic nutrition**.
- In autotrophic mode of nutrition, the organisms prepare their own food from simple raw materials like water, carbon dioxide and mineral salts in the presence of sunlight hence they are called **producers**. All green plants are the examples of this category.
- All green plants prepare their own food from simple raw material available from the soil and the atmosphere. The process of preparation of food by the plants is called **photosynthesis**.
- Photosynthesis can occur in any green part of a plant containing green **chlorophyll** in **chloroplasts** that traps the sunlight to convert **carbon dioxide** and **water** into **oxygen** and **glucose**.
- Certain plants use different mechanisms, other than photosynthesis to obtain their nutrition. They cannot synthesize their food due to **lack of chlorophyll**. They depend on other organisms for their food like the animals. These plants and animals show **heterotrophic mode of nutrition**. All animals, human beings and non-green plants like fungi come under this category.
- We consume complex organic **food** prepared by autotrophs or producers and break it into simple form to derive nourishment.
- Most foods are a mixture of different nutrients. Certain nutrients are called “**macro**” **nutrients** because the body needs them in fairly large amounts, in order to function properly. These are **carbohydrates, protein** and **fats**.
  - **Carbohydrates** are a **fuel-providing macronutrient**. They provide the body's main source of energy. Plants make carbohydrate from sunlight (photosynthesis) as a way to store the sun's energy for its own use.
    - Carbohydrates are found in three forms: **sugar, starch and fibre**.
  - **Protein** provides amino acids for basic body functions.
    - The amino acids in protein are often referred to as the “**building blocks**” of life. They are the main building blocks as well as the repair kit for the body's tissues, such as muscles, bones and organs, blood, skin and hair.
  - **Lipids or Fats** are another energy-providing macronutrient.
    - Our body needs fat in small amounts.
    - Fat cells store excess energy and are burned as energy once the body has exhausted all immediate sources in foods.



- 
- There are three main types of fat in food: **saturated, mono unsaturated, and polyunsaturated fats**
  - Other nutrients, also necessary for body functions, are called “**micro**” nutrients because the body needs them in very small amounts; these are **vitamins** and **minerals**.
    - **Vitamins** are organic compounds produced by living beings.
    - There are two types, categorized by their solubility, or the means by which they are dissolved in the body: **water-soluble vitamins** (B complex and C), **fat-soluble vitamins** (A, K, E and D).
      - Minerals are inorganic micronutrients, not made up of living things.
      - Our body needs different amounts of various minerals.
      - Minerals are needed for growth and their main function is to regulate musculoskeletal.
      - Minerals are divided into two categories, **major** and **trace** minerals.
      - Two of the main minerals that are especially important for all individuals: **Iron** and **Calcium**.
  - The foundation for good physical health is **good nutritional status**.
  - Good nutritional status depends on eating **the right amounts** and the **right variety** of safe, **good quality** foods to meet our individual nutritional needs, and prevention of disease.
  - **Balanced diets** include a variety of foods from all five food groups to provide the vitamins, minerals, healthy fat, fiber, protein, and carbohydrate you need for good health.
    - Before you buy something, you need to look at the three kinds of information on the labels: **nutrition facts, ingredient list** and the **expiration date**.
    - When you do not get the right nutrient and not having enough to eat, you may suffer from illnesses. **Malnutrition** is an unhealthy state or condition in which a person’s physical functions are temporarily or permanently damaged.
  - Nutrition is defined as taking in of nutrients which are organic substances and mineral ions, containing raw materials or energy for growth and tissue repair, absorbing and assimilating them. It includes following stages: **ingestion, absorption, assimilation, and egestion**.
  - Multicellular organisms like humans exhibit a complex process in obtaining their nourishment. Before nutrients can go to work, food must be broken down so that they can pass into our body. This is called **digestion**.
  - Digestive system in human beings consists of **alimentary canal** and **digestive glands**.
    - Alimentary canal is made up of **mouth, buccal cavity, pharynx, oesophagus, stomach, intestine, rectum and anus**.
    - Digestive glands are the **salivary glands, the gastric glands, the liver, the pancreas** and the **intestinal glands** which also help in the digestion of food.
    - Digestion is a series of physical and chemical changes by which the complex food is converted into simple and absorbable form. Physical digestion involves breaking large pieces of food into smaller pieces. It involves chewing, mastication, peristalsis, churning, emulsification.
-





- Chemical digestion involves breaking down large, insoluble molecules into small, soluble ones. It involves enzymes for breaking down the food nutrient
- Digestion starts when food is taken into the **mouth**. This is called **ingestion**.
- Food is churned in the **stomach** due to regular muscular contractions (peristalsis).
  - Glands in the lining of stomach produce gastric juice
  - Gastric juice contains: **mucous, hydrochloric acid and an enzyme pepsinogen (protease)**
- The digestive system produces enzymes to break down the ingested food: **amylase, protease, lipase**
- Digested molecules of food are absorbed through the small intestine. The small intestine breaks down food from the stomach and absorbs much of the nutrients from the food
- Food and the products of digestion pass through the intestine, which is divided into two sections called **the small intestine** and **the large intestine**.
- The small intestine is made up of three segments, which form a passage from your stomach: **duodenum, jejunum, ileum**
- The inner lining of the jejunum and the later section of the ileum are lined with villi, small fingers containing capillaries that increase the surface area that can absorb nutrients.
- During absorption, these nutrients pass through the walls of the intestine and into the bloodstream, where they get transported to the different parts of the body.
- After food is processed in the small intestine, it passes into the **large intestine**, also called the **large bowel or colon**.
- The undigested parts of food or those that were not absorbed by the body are eliminated as **faeces**. This process is called **elimination or defecation**.
- The accessory digestive organs include the salivary glands, pancreas, liver and gallbladder.
- Glands are organs that secrete hormones and digestive juices, which contain enzymes—substances that speed up chemical reactions in the body, that break food down into different nutrients
- Every day, the two kidneys filter about 120 to 150 quarts of blood to produce about 1 to 2 quarts of urine, composed of wastes and extra fluid.
- The kidneys are important because they keep the composition, or makeup, of the blood stable, which lets the body function.
- Each kidney is made up of about a million filtering units called nephrons. The nephron includes a filter, called the glomerulus, and a tubule. The nephrons work through a two-step process.
- The glomerulus lets fluid and waste products pass through it; however, it prevents blood cells and large molecules, mostly proteins, from passing. The filtered fluid then passes through the tubule, which sends needed minerals back to the bloodstream and removes wastes.

**NOW DO SUMMATIVE TEST 2 IN YOUR ASSESSMENT BOOK AND SEND IN TO THE  
PROVINCIAL COORDINATOR FOR MARKING.**

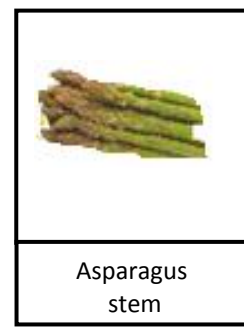
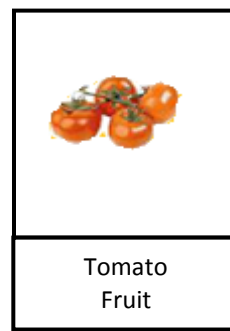
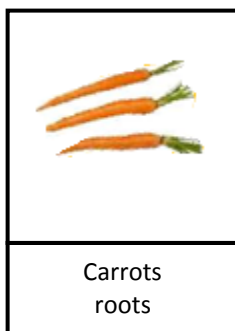
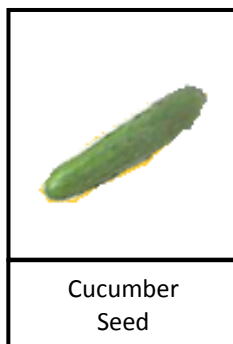
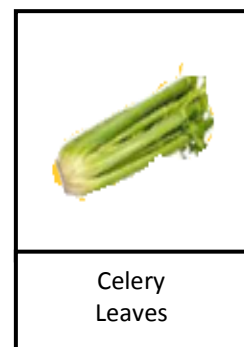
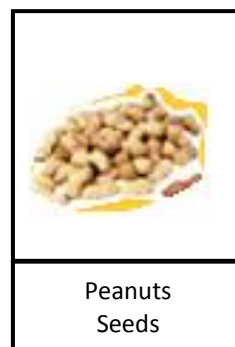
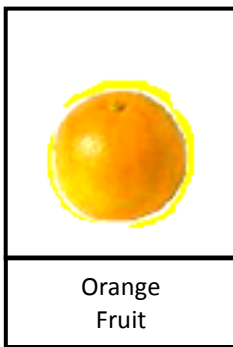


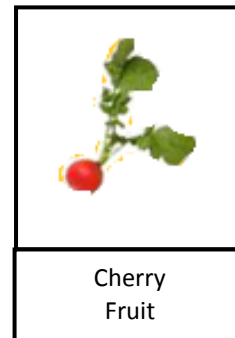
## ANSWERS TO LEARNING ACTIVITIES 1 – 9

### Learning Activity 1

#### Supermarket Botany

A. Any 5 of these supermarket foods are accepted.



**B.**

1. The **roots** keep the plant anchored in the ground. The roots enable flowering plant to obtain water and nutrients from the soil, through tiny roots that extend from the root system. Roots can also store food.
2. The **stem** provides support for the plant and allows nutrients and water to travel throughout the plant. They carry water, food, and nutrients to all parts of the plant.
3. **Leaves** are the sites where plants make their own food.
4. The **flower** is responsible for seed development and reproduction.
5. **Fruit** holds or contains the new seeds that grow into new plant.

**Learning Activity 2****A.**

1. Producer
2. Autotrophs
3. Oxygen
4. Glucose
5. Leaves

**B.**

1. guard cells
2. chlorophyll
3. release

**C.**

1. Nutrition is a process by which living organisms take in food and utilize for their growth and maintenance.
2. Photosynthesis is important for the preparation of food by plants
3. Autotrophic mode of nutrition is mode of nutrition when the organisms prepare their own food from simple raw materials like water, carbon dioxide and mineral salts in the presence of sunlight, hence they are called producers.
4. Chlorophyll traps the sunlight to convert carbon dioxide and water into oxygen and glucose
5. Glucose and Oxygen.

**Learning Activity 3**

- |    |                      |                |                     |
|----|----------------------|----------------|---------------------|
| a) | (i) Beans            | (ii) Peas      | (iii) Soybean       |
| b) | (i) Cheese           | (ii) Butter    |                     |
| c) | (i) Green vegetables | (ii) Apple     | (iii) Cereals       |
| d) | (i) Peanut           | (ii) Margarine | (iii) Vegetable oil |
| e) | (i) Rice             | (ii) Pasta     |                     |
| f) | (i) Beef             | (ii) Eggs      | (iii) Fish          |
|    | (iv) Milk            | (v) Yoghurt    |                     |
- 

**Learning Activity 4**

- Carbohydrates
    - Proteins
    - Lipids or Fats  
(in any order)
  - Iron involved in transporting oxygen around the body in the red blood cells. With folate and B12, it prevents anemia.
    - Carbohydrates are fuel-providing macronutrients. They provide the body's main
  - Water-soluble vitamins (B complex and C) dissolve in water, and the excess is expelled as waste.
    - Fat-soluble vitamins (A, K, E and D) are stored in our body's fat until needed, so consuming more fat-soluble vitamins than your body needs can be harmful
- 

**Learning Activity 5**

- A.**
- |          |          |
|----------|----------|
| 1. True  | 5. False |
| 2. False | 6. True  |
| 3. True  | 7. True  |
| 4. True  |          |

**B.**

- Coronary heart disease (CHD) is caused by a narrowing of the blood vessels to the heart. This reduces the flow of blood to the heart.
  - The mineral iron is vital for making red blood cells. Iron from the diet forms haemoglobin, which carries oxygen in the blood.
  - Osteoporosis is a disease where bones become weak, brittle and break easily. It is caused by severe losses of calcium.
  - Kwashiorkor and Marasmus are diseases that occur if your body does not get enough proteins.
-



5. People who are obese are more likely to suffer from coronary heart disease, diabetes, arthritis, high blood pressure and some types of cancers
- 

### Learning Activity 6

- (i) The tokens represent food.
  - (ii) The spaces on the board game represent the structures of the digestive system.
  - (iii) The directions on some of the spaces are the processes that the digestive organs carry out.
- 

### Learning Activity 7

- (i) Dissolution is faster when the candies are crushed into smaller pieces.
  - (ii) The crushing of the candy represents the process of mechanical digestion.
- 

### Learning Activity 8

- (i) Oesophagus
  - (ii) The bread moved from the top to the bottom of the balloon.
  - (iii) Peristalsis is muscle contractions in the oesophagus help move the food down to the stomach.
- 

### Learning Activity 9

- (i) The baggie represents the stomach, cookie represents food and water represents digestive juices secreted in the stomach.
  - (ii) The squeezing represents the peristaltic movements inside the stomach, causing the food to be partially digested and transported to small intestine.
-



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Provided by Nutrition Services Branch of the North Carolina Division of Public Health.

Chris Newton eHow Contributor

The Digestive System (GRADE 5, LIFE SCIENCE) page 8 LAKE SCIENCE COLLABORATIVE Teacher Does Student Does Concept

U.S. Department of Health and Human Services

U.S. Department of Agriculture

Vee Enne, eHow Contributor

Your Digestive System and How It Works | National Institute of Diabetes and Digestive a...

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2	BUKA	P. O. Box 154, Buka	9739838	72228108	72229073
3	CENTRAL	C/- FODE HQ	3419228	72228110	72229050
4	DARU	P. O. Box 68, Daru	6459033	72228146	72229047
5	GOROKA	P. O. Box 990, Goroka	5322085/5322321	72228116	72229054
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19	RABAU	P. O. Box 83, Kokopo	9400314	72228118	72229067
20	VANIMO	P. O. Box 38, Vanimo	4571175/4571438	72228140	72229060
21	WABAG	P. O. Box 259, Wabag	5471114	72228120	72229082
22	WEWAK	P. O. Box 583, Wewak	4562231/4561114	72228122	72229062

## FODE SUBJECTS AND COURSE PROGRAMMES

GRADE LEVELS	SUBJECTS/COURSES
Grades 7 and 8	1. English
	2. Mathematics
	3. Personal Development
	4. Social Science
	5. Science
	6. Making a Living
Grades 9 and 10	1. English
	2. Mathematics
	3. Personal Development
	4. Science
	5. Social Science
	6. Business Studies
	7. Design and Technology- Computing
Grades 11 and 12	1. English – Applied English/Language & Literature
	2. Mathematics – General/Advance
	3. Science – Biology/Chemistry/Physics
	4. Social Science – History/Geography/Economics
	5. Personal Development
	6. Business Studies
	7. Information & Communication Technology

### REMEMBER:

- For Grades 7 and 8, you are required to do all six (6) subjects.
- For Grades 9 and 10, you must complete five (5) subjects and one (1) optional to be certified. Business Studies and Design & Technology – Computing are optional.
- For Grades 11 and 12, you are required to complete seven (7) out of thirteen (13) subjects to be certified.

Your Provincial Coordinator or Supervisor will give you more information regarding each subject and

**Notes:** You must seek advice from your Provincial Coordinator regarding the recommended courses in each stream. Options should be discussed carefully before choosing the stream when enrolling into Grade 11. FODE will certify for the successful completion of seven subjects in Grade 12.

GRADES 11 & 12 COURSE PROGRAMMES			
No	Science	Humanities	Business
1	Applied English	Language & Literature	Language & Literature/Applied English
2	Mathematics -General/Advance	Mathematics -General/Advance	Mathematics –General/Advance
3	Personal Development	Personal Development	Personal Development
4	Biology	Biology/Physics/Chemistry	Biology/Physics/Chemistry
5	Chemistry/ Physics	Geography	Economics/Geography/History
6	Geography/History/Economics	History / Economics	Business Studies
7	ICT	ICT	ICT

CERTIFICATE IN MATRICULATION STUDIES		
No	Compulsory Courses	Optional Courses
1	English 1	<b>Science Stream:</b> Biology, Chemistry, Physics
2	English 2	<b>Social Science Stream:</b> Geography, Intro to Economics and Asia and the Modern World
3	Mathematics 1	
4	Mathematics 2	
5	History of Science & Technology	

### REMEMBER:

You must successfully complete 8 courses: 5 compulsory and 3 optional.