

# INCREASING ACCESS TO SECONDARY SCHOOL LEVEL EDUCATION THROUGH THE PRODUCTION OF QUALITY LEARNING MATERIALS

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## JUNIOR SECONDARY LEVEL

# BIOLOGY

## Module 2: The Living Cell

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Mauritius College of the Air, Mauritius

## COMMONWEALTH *of* LEARNING

Suite 600 - 1285 West Broadway, Vancouver, BC V6H 3X8 CANADA

PH: +1-604-775-8200 | FAX: +1-604-775-8210 | WEB: [www.col.org](http://www.col.org) | E-MAIL: [info@col.org](mailto:info@col.org)

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## CONTRIBUTORS TO PROJECT - BIOLOGY

Course Writers

Mrs. S. Tirbhowan

V. Kurrumchand

Course Reviewer

S. Tirbhowan

Course Co-ordinator

R. Dhurbarrylall

Instructional Systems Designer

R. Dhurbarrylall

Editor

C. Sooben

Text Entry

Mrs. S. Deenanath

Mrs. P. Hurgobin

Mrs. S. Chengalanee

Graphic Artist

F. Bredel

Lay-out and Formatting

Mrs. M. A. Frivole

Biology student

Miss. N. Narain

Science Course Materials Management

Mauritius College of the Air

## REVIEW TEAM

Botswana College of Distance and Open Learning

Lawrence Tshipana

Malawi College of Distance Education

Chris F. Layamaman

Namibian College of Open Learning

Joseph Amon

Institute of Adult Education, Tanzania

Andrew Dominick Swai

Emlaladini Development Centre, Swaziland

Simon Siphon Maseko

NDOLA Institute for Skills Training, Zambia

Christopher Chiluband

Ministry of Education, Sport and Culture, Zimbabwe

Luwis Hlombe

## PILOTING TUTORS

Botswana College of Distance and Open Learning

Thandie Keetsaletse

Namibian College of Open Learning

Jona Mushelenga

Sifundzain High School, Swaziland

Saide Richards

Kibasila Secondary School, Tanzania (Ministry of Education)

John Anania

Nilrumah Teacher's College, Zambia

F. Mubanga

NDOLA Institute for Skills Training, Zambia

Christopher Chiluband

Ministry of Education, Sport and Culture, Zimbabwe

Luwis Hlombe



# **JUNIOR SECONDARY LEVEL SCIENCE - BIOLOGY**

## **MODULE 1 – Introduction to Biology and the Classification of Living Things**

Unit 1 The Science of Life

Unit 2 Biological Skills



## **MODULE 2 – The Living Cell**

Unit 1 Cell Structure and Organisation

Unit 2 Levels of Organisation

Unit 3 Compounds of Life

## **MODULE 3 – Energy and Life**

Unit 1 The Need for Energy

Unit 2 Respiration

## **MODULE 4 – Nutrition and Digestion**

Unit 1 Nutrition in Living Organisms

Unit 2 Human Digestive System

## **MODULE 5 – Transport**

Unit 1 Transport in Plants

Unit 2 Transport in Humans

## **MODULE 6 – Support, Movement and Control**

Unit 1 Support and Movement

Unit 2 Hormonal and Nervous Control

Unit 3 Control and Regulation

## **MODULE 7 – Continuity of Life**

Unit 1 Reproduction

## **MODULE 8 – Organisms and the Environment**

Unit 1 Ecological Principles

Unit 2 Population Growth and Regulation

Unit 3 Human Influence on the Environment



# BIOLOGY

## MODULE 2

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# THE LIVING CELL

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## MODULE INTRODUCTION

Almost all plants and animals have one thing in common. They are made up of cells. This Module is about the cellular nature of living organisms. You will also learn about chemical compounds essential for life. You will come to know how substances move in and out of the cell.

## MODULE OBJECTIVES

At the end of this Module you should be able to:

- describe plant and animal cells and different levels of organisation in organisms
  - outline the major properties and functions of **organic** and **inorganic** substances in organisms
  - define and explain **diffusion**, **osmosis** and state their importance.
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# UNIT 1

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## CELL STRUCTURE AND ORGANISATION

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# UNIT 1

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## CELL STRUCTURE AND ORGANISATION

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### INTRODUCTION

A house is made of bricks. The bigger the house, the bigger the number of bricks required to build it. In the same way, animals and plants are made of cells. The same reasoning applies to animals and plants. The bigger the animal or plant, the more cells it has. Whereas we can see the bricks of a house, we cannot see the cells of an organism with the naked eyes.

Your skin, your bones, your muscles, your blood and your brain are all made of cells. This Unit is about cells, how you study them, what they look like and what goes on inside them.

### OBJECTIVES

At the end of this Unit you should be able to:

- state that a cell is the basic Unit of life
- describe the structure of both an animal and a plant cell
- point out that cells become specialised to perform specific functions
- relate structure of cells to their functions.

## 1.0 WHAT IS A CELL?

All living things are made of cells. A cell is a basic unit of life. In other words living things are built from them. They contain important structures with the cell to perform the various activities to keep them alive and for the well being of the living organisms.

Cells are themselves very tiny structures. They are so small that you will not see them with naked eyes or with a magnifying glass. Therefore you must use a light microscope like the one you studied in the previous Unit.

## 1.1 SIZE OF CELL

Cells vary greatly in size and shape. You can express their size in units called micrometres. One micrometre ( $\mu\text{m}$ ) is  $1/1000$  mm. A typical cell is about  $20 \mu\text{m}$  (micrometres) in diameter. Large organisms contain millions of cells. The largest cell is an ostrich egg which is about  $170 \times 135$  mm. The smallest cell is a bacterium which is about  $0.25 \mu\text{m}$  in size. A human red blood cell is about  $7.5 \mu\text{m}$  in diameter.

Our knowledge of cells is increasing with the development of better microscopes and improved techniques. The **electron microscope** has contributed much to our present day knowledge of the cell.

We can say that:

- All living things are made of cells.
- New cells are formed when old cells divide into two.
- All cells are similar in structure and the way they work. However, they are not identical.
- The structure of an organism depends on the way cells are organised in it.
- The way an organism works depends on the functions of its cells.



*Before proceeding further, complete the following activity.*

### Activity 1

1. (a) What is a cell?

.....  
.....

(b) Why are cells **not** seen with naked eyes?

.....  
.....

2. Fill in the blanks.

1. 1 micrometre ( $\mu\text{m}$ ) is equivalent to ----- cm; ----- mm.

2. The largest known cell is -----.

3. A human red blood cell is ----- in diameter.

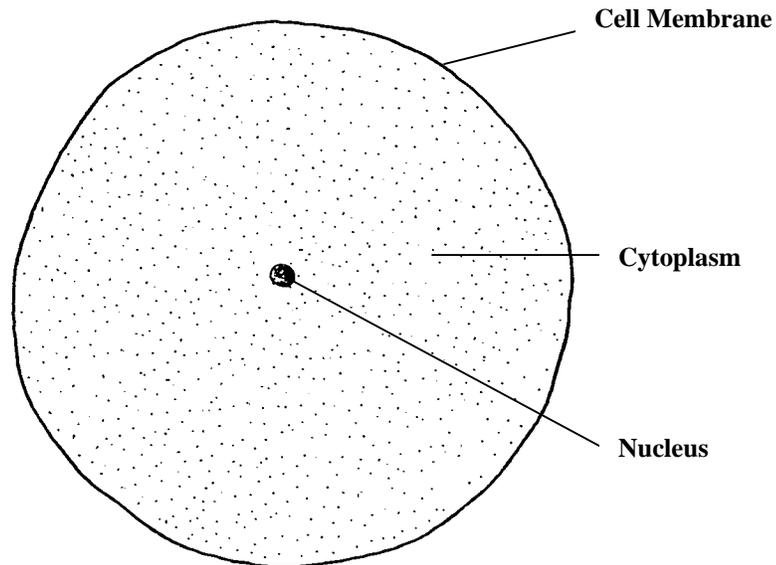
***You will find the answers at the end of the Module.***

You have learnt that cells of all organisms have many features in common. However, there are also differences in animal cells, plant cells and bacterial cells.

We will now turn to the structure of an animal cell and the functions of its various parts.

## 1.2 TYPICAL ANIMAL CELL - STRUCTURE

This is a generalized animal cell. The diagram below shows features which are commonly present in most animal cells.



***Fig. 1 A typical animal cell seen with a light microscope***

You will note that all cells have a cell membrane which is a thin boundary. This encloses the ***cytoplasm***. Most cells have a ***nucleus***. The cell is made of living material called ***protoplasm***.

The protoplasm in fact consists of the:

- Cell membrane
- Cytoplasm
- Nucleus.

### **Cell Membrane**

This is a thin 'skin' which forms the outermost boundary of the cell. It stops the cell contents from escaping. It has tiny pores and is selectively permeable in nature. It controls the movement of substances which enter and leave the cell.

### **Cytoplasm**

The cytoplasm is a thick liquid with particles in it. It contains about 80% water. There are many particles like proteins, oil droplets, glycogen granules and organelles suspended in it. An organelle is a very tiny structure inside the cell. It does a specific function or task.

Many chemical reactions occur in the cytoplasm. These keep the cell alive by providing energy and making substances that the cell needs.

### **Nucleus**

Most animal cells contain one nucleus. This is almost spherical in shape. It is surrounded by a nuclear membrane. This encloses thread-like structures called **chromosomes**. The chromosomes contain hereditary materials (materials inherited from parents) e.g. colour of eyes, shape of nails etc. The nucleus controls activities of the cell and determines the characteristics of an organism. It is essential for the life of the cell.

We can now proceed with an actual investigation.



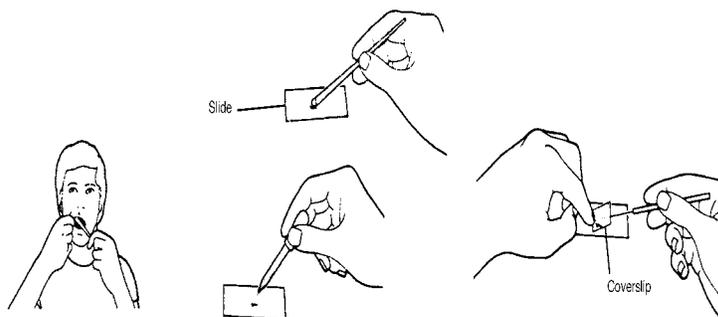
### INVESTIGATION 1: Looking at Animal Cells

**For each investigation you will require the materials indicated.**

The easiest place to find animal cells is on yourself. If you colour or stain the cells they are quite easy to see using a light microscope.

#### Apparatus and materials needed:

- A clean glass slide
- A clean toothpick
- A cover slip
- Dilute methylene blue solution
- A light microscope.

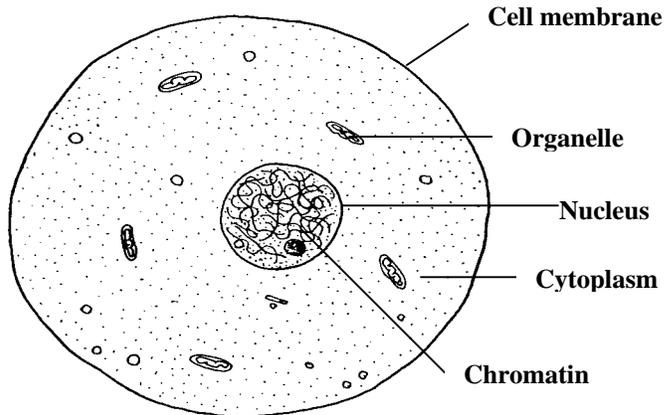


**Fig. 2 Looking at cheek cells**

#### Procedure

1. Use the blunt end of a clean toothpick to gently scrape the inside of your cheek.
2. Put a drop of methylene blue solution on a clean microscope slide.
3. Use the end of the toothpick where the cheek cells are present to spread the methylene blue solution to a thin film.

4. Carefully lower a cover slip over the materials on the slide (as shown in Fig. 2). Try not to trap any air bubbles.
5. Use a filter paper or blotting paper to clean up the slide.
6. Examine your preparation under the microscope. Locate the cells with the lower power.
7. Make a large drawing of one cheek cell. Label your drawing as fully as you can.
8. Compare your drawing of the cheek cell with Figure 3 below.



**Figure 3. A generalised animal cell**

**You should record your answers in the space provided.**

*Which structures shown in the figure are not visible under your ordinary light microscope?*

.....  
 .....  
 .....

*Now, examine a cell from another animal. Try to obtain a piece of fresh chicken or goat’s liver. Then carry out the following investigation.*

**We can now proceed with an actual investigation.**



## INVESTIGATION 2: Examining Liver Cells

**For each investigation you will require the materials indicated.**

### **Apparatus and materials needed:**

- A piece of fresh liver
- Scalpel
- A clean glass slide
- A clean cover slip
- Dilute methylene blue solution
- A light microscope

### **Procedure**

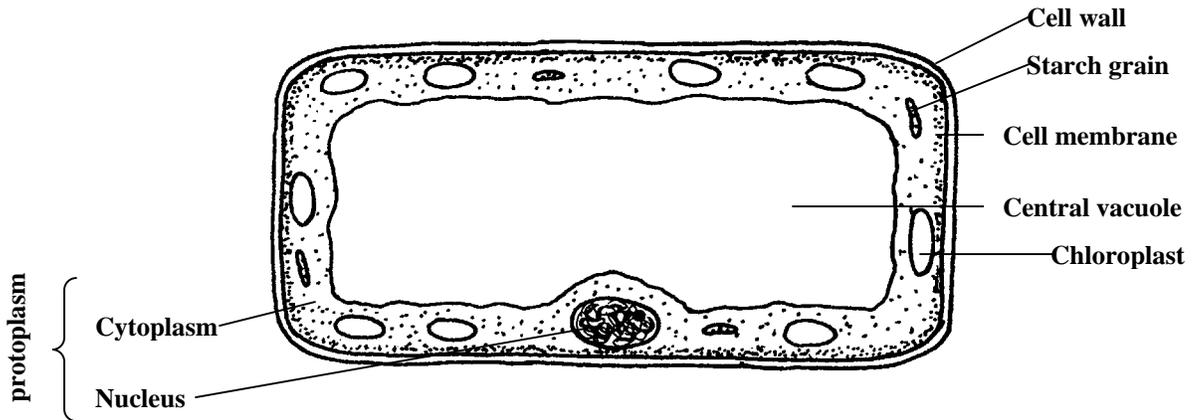
1. *Put a drop of methylene blue solution on a clean microscope slide.*
2. *Scrape the piece of fresh liver with a scalpel.*
3. *Place the scrapings in the methylene blue solution on the glass slide. Spread the solution to a thin film. Carefully put a cover slip on this film (as shown in Figure 2). See to it that no air bubbles are trapped.*
4. *Use a strip of filter paper or blotting paper to wipe off any excess solution around the cover slip.*
5. *Examine your preparation under the microscope. Locate the cells with the lower power.*

<p><b>You should record your answers in the space provided.</b></p>	<p><i>Make a large drawing of one of the cells you observed in the space. Label your drawing as fully as you can.</i></p> <p>6. <i>Which part of the cell stained the darkest blue?</i> ..... ..... .....</p> <p>7. <i>Compare your drawing of the liver cell with that in Figure 3.</i> <i>Which structures shown in the figure are not found in your drawing?</i> ..... ..... .....</p>
---	---

The cells in plants are quite distinct from the animal cell you have just studied. Here we will explore the structure of the plant cell and learn about the functions of its different parts.

## 1.3 TYPICAL PLANT CELL - STRUCTURE

A typical plant cell is shown in Figure 4 below.



**Fig. 4** A typical plant cell seen with a light microscope

### Cell Wall

This cell consists of a rigid cell wall which encloses the protoplasm. The cell wall is made of cellulose which is a tough material. This cellulose cell wall gives shape, support and protection to the cell. The cell wall is freely permeable to water.

### Protoplasm

The structure of the plant cell is almost the same as that of an animal cell. However, it contains the following additional structures:

#### (a) **Chloroplasts**

Many plant cells have chloroplasts. These are found in the cytoplasm. They are oval bodies which contain the green pigment chlorophyll. The chlorophyll absorbs light to make food during photosynthesis. This will be dealt with at a later stage. Cells found in roots and other underground structures of the plant lack chloroplasts.

**(b) Large Central Vacuole**

In the centre of the cell there is a large cavity called the central vacuole. This vacuole is full of a fluid called cell sap. The cell sap is a dilute solution of sugar, salts and other soluble substances. The cell sap helps to feed the cell.

**(c) Starch Grains**

The cytoplasm contains starch grains. This is how plants store food. These are similar to glycogen granules in animal cells.

You will now look at a plant cell. To see cells clearly under a microscope, you need a very thin layer of plant material. It is best if it is only one cell thick. An easy place to find such a layer is inside an onion bulb.

We can now proceed with an actual investigation.



**INVESTIGATION 3: Looking at Plant Cells (Onion Cell)**

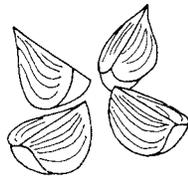
**For each investigation you will require the materials indicated.**

**Apparatus and materials needed:**

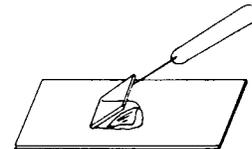
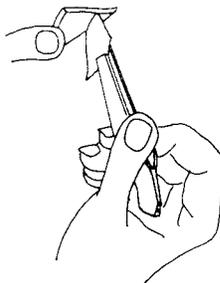
- A clean glass slide
- A cover slip
- A light microscope
- Dilute iodine solution
- A pair of forceps
- A razor blade/sharp scalpel
- A mounted needle
- An onion bulb

**Break the onion scale leaf into two**

**Cut an onion bulb into quarters**



**Take a fleshy scale leaf**



**Lower a cover slip on the stain**

**Fig. 5 Mounting an onion skin on a microscope slide**

**Procedure**

1. *Cut a small piece from an onion bulb.*
2. *Obtain a fleshy scale leaf from the onion bulb.*
3. *Bend the leaf into two, allowing it to break.*
4. *Gently peel off the thin layer (epidermis) from the inner surface of the leaf. Use a pair of forceps for this purpose.*
5. *Cut off a small piece of this thin layer using a razor blade or sharp scalpel.*
6. *Put a drop of iodine solution on a clean glass slide.*
7. *Place the cut piece of thin layer (epidermis) in the iodine solution. Spread it flat.*
8. *Gently cover it with a cover slip. Make sure that air bubbles are not trapped.*
9. *Remove excess stain (iodine solution) by placing a piece of filter paper on one side of the cover slip.*
10. *Examine the prepared slide under the low power of a light microscope.*
11. *Make a labelled drawing of a few cells that you observe.*

**You should record your answers in the space provided.**

12. Name two structures which you can see in these cells, but which you cannot see in the cheek cells.

.....  
.....  
.....

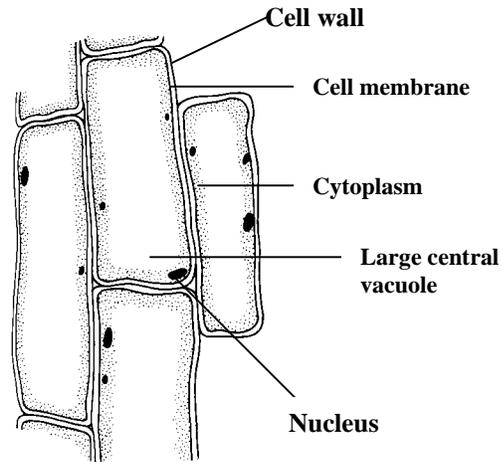
13. State how the cell you have drawn differs from the typical plant cell

14. As shown in Figure 4.

.....  
.....  
.....

15. Most plant cells have chloroplasts, but these cells do not. Suggest a reason for this.

.....  
.....  
.....



**Fig. 6 Diagram of Onion Cells**

Compare your drawings of the onion or leaf cells with that on fig 6. They should be similar.

 Before proceeding further, complete the following activity.

**Activity 2**

1. Make a labelled drawing of a plant cell.

2. (a) Name the main constituent of a cell wall.

.....  
 .....

(b) State the functions of the cell wall.

.....  
 .....

3. Give the functions of the following in the plant cell:

(a) Chloroplasts (b) Central Vacuole (c) Starch Grains

(a) .....

(b) .....

(c) .....

4. Each term in column A is related to one of the following options.

Hereditary material, Sunlight, Support, Storage, Cell sap.

Choose the option which best applies to the terms in column A.

<b>Column A</b>	<b>Column B</b>
Chloroplast	
Chromatin	
Cellulose	
Central Vacuole	
Starch grains	

**You will find the answers at the end of the Module.**

By now you have observed the similarities and differences between plant cells and animal cells. However, many cells have special features which enable them to carry out specific functions in an organism.

## 1.4 ANIMAL AND PLANT CELLS- A COMPARISON

You have learnt that plant cells and animal cells have many features in common. However, as you must have noted, there are also differences between these two types of cells.

### Similarities

Both

1. have a cell membrane
2. have cytoplasm
3. contain a nucleus

### Differences

Plant Cells	Animal cells
1. Have a rigid cellulose cell wall	Cell wall is absent
2. Chloroplasts are commonly present	Chloroplasts are absent
3. There is a large central vacuole containing cell sap	Small or may be absent The vacuole is small
4. Food reserve is mainly in the form of starch granules	Food reserve is mainly in the form of glycogen granules

## 1.5 CELLS - TYPES AND FUNCTIONS

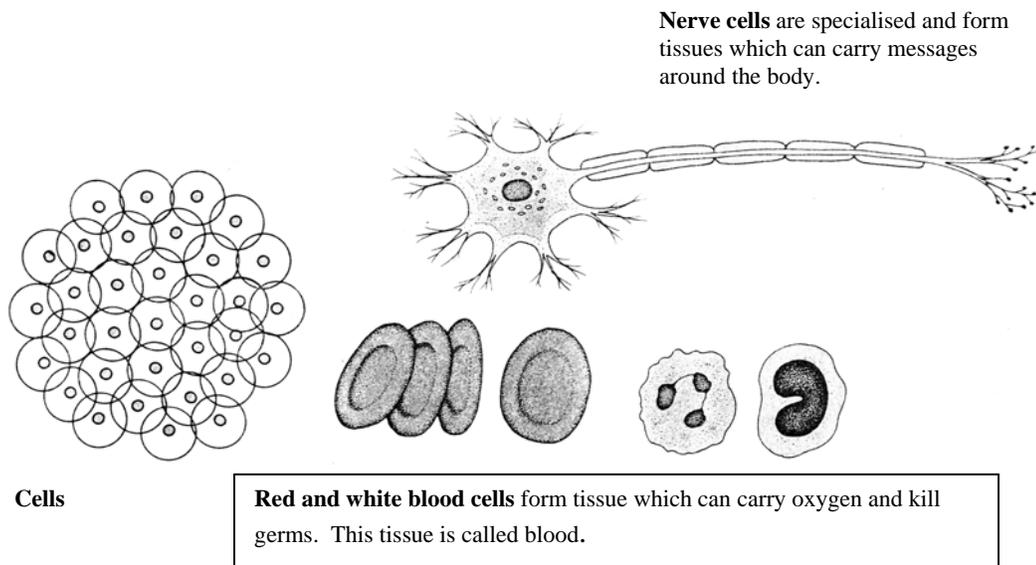
A large organism such as yourself may contain many millions of cells, but all these cells are not alike. Almost all of them perform activities which are characteristic of living things. Many of them specialise in doing some of these activities better than other cells. For example, muscle cells are specially adapted for carrying out movements. Palisade cells in the leaf of a plant are adapted for making food by photosynthesis.

Most cells in multicellular organisms are specialised. This means they are different from each other because they carry out different functions.

### 1.5.1 SPECIALISATION OF CELLS

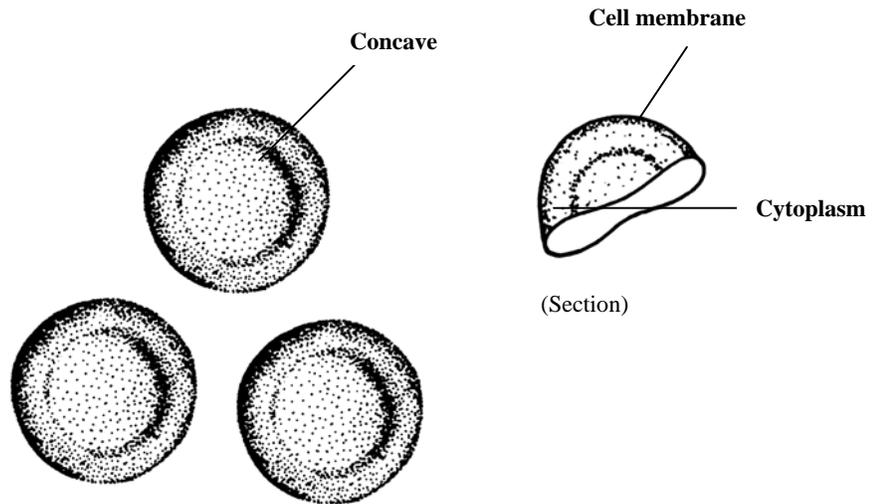
You have just learnt that multicellular organisms have specialised cells. You started life as a single cell – a fertilised egg cell. You grew because that cell divided into identical cells. Most cells, when they have finished dividing and growing, become specialised. This means that:

- (i) they do one particular job or function
- (ii) they develop a distinct shape
- (iii) special kinds of chemical change occur in their cytoplasm.



**Fig. 7 Cells differentiate to become specialised**

A few examples of specialised cells are:

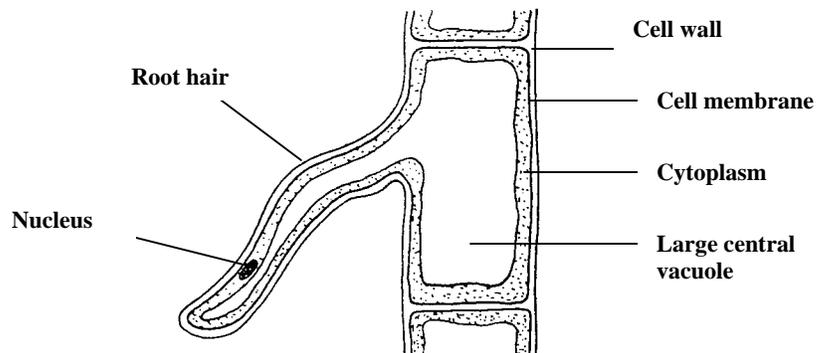


**Fig. 8 Red Blood Cells**

**(i) Red Blood Cell**

The red blood cell is a tiny, bi-concave disc-shaped cell. The mammalian red blood cell does not have a nucleus. Its cytoplasm contains a red pigment called haemoglobin. This haemoglobin helps to transport oxygen.

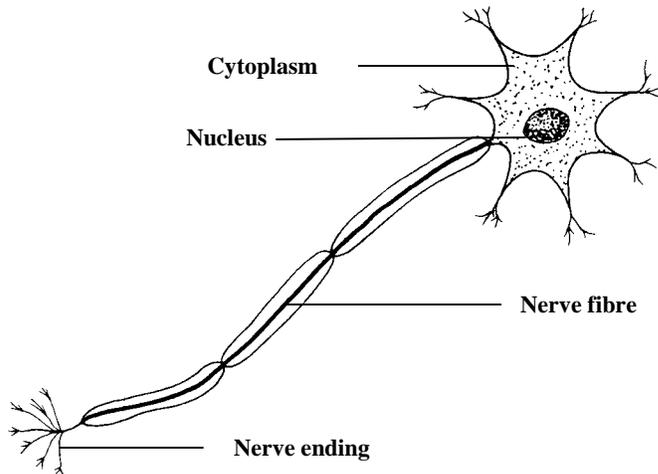
**(ii) Root Hair Cell**



**Fig. 9 Root Hair Cell**

This is an epidermal cell (cell from outermost layer) of the root. It has a finger-like extension. This hair-like extension provides a large surface area for absorbing water and mineral salts in the soil. It also helps to hold the plant firmly in the soil.

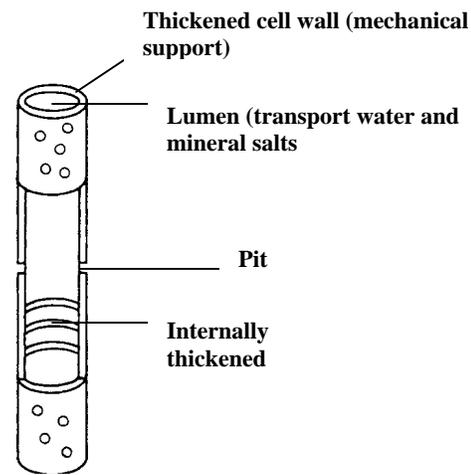
(iii) **Nerve Cell**



**Fig. 10 Nerve Cell**

The nerve cell is also called a neurone. The neurone has a cell body which consists of a nucleus surrounded by a small amount of cytoplasm. This cytoplasm extends to form long nerve fibres. The nerve fibres conduct nerve impulses, that is, they carry messages around the body.

(iv) **Xylem**

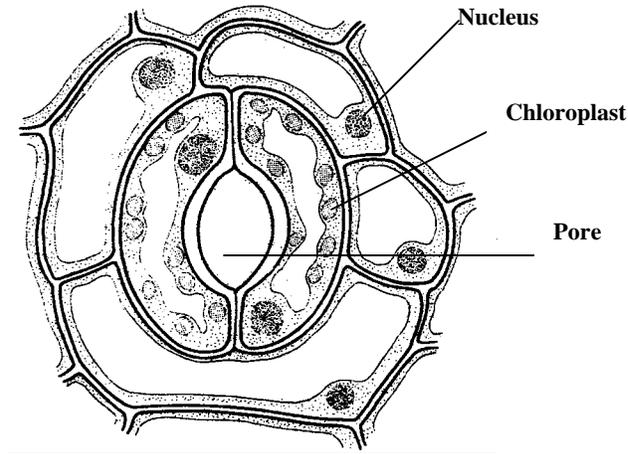


Three dimensional view

**Fig. 11 Xylem Vessel**

Xylem forms part of the tissue responsible for transport in plants. It consists of long hollow dead cells. The cell walls of these cells are thickened due to the presence of an additional cell wall. This thickening provides strength and support to the plant. The xylem also transports water and mineral salts throughout the plant.

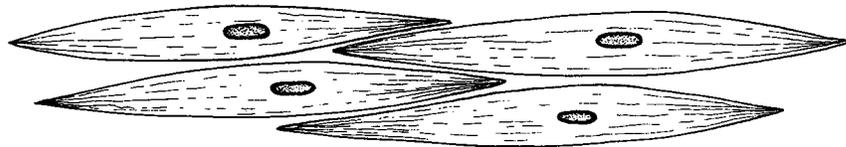
(v) **Guard Cell**



**Fig. 12 Guard Cell**

These are bean-shaped cells commonly found in the epidermis of a leaf. Two guard cells lie adjacent to each other and form a tiny pore as shown in Figure 12. Exchange of gases takes place in a leaf through the stoma. This is an opening between two guard cells. The guard cells can change their shape and thus open or close the stoma.

(iv) **Muscle Cell**



**Fig. 13 Muscle Cell**

The muscle tissue of animals is made up of many muscle cells. These are spindle-shaped or elongated cells. They can contract and relax, to bring about movements.

Groups of specialised cells are called **tissues**.

Several different tissues form an organ; for example the heart and the leaf.

 **Before proceeding further, complete the following activity.**

**Activity 3**

1. State three similarities between a nerve cell and a guard cell.

.....  
 .....  
 .....

2. Complete the table below.

<b>Differences between a plant cell and an animal cell</b>	
<b>Plant Cell</b>	<b>Animal Cell</b>
(i)	
(ii)	
(iii)	
(iv)	

3. (a) Name three different kinds of cells in

(i) your body

.....  
 .....  
 .....

(ii) a mango tree

.....  
 .....  
 .....

(b) Make a labelled drawing of each cell you mentioned in 3 (a) (i) and 3 (a) (ii) in the space below

4. (a) Explain what a specialized cell is?

.....  
.....  
.....  
.....

(b) Give two examples of a specialized cell in

(i) your body

.....  
.....

(ii) a bean plant

.....  
.....

**You will find the answers at the end of the Module.**



## POINTS TO REMEMBER

- Living organisms are made of tiny structures called cells, invisible to the naked eye.
- Animal cells are different from plant cells.
- Cells become specialised performing specific functions in both animals and plants.
- The structure of a cell is related to its function.



# UNIT 2

## LEVELS OF ORGANISATION

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## UNIT 2

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# LEVELS OF ORGANISATION

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### INTRODUCTION

Some microscopic organisms consist of one cell only. This single cell carries out all the processes necessary for its survival. An example of such organisms is an ***Amoeba***.

However, the cells of larger plants and animals cannot survive on their own. A muscle cell cannot obtain its own food and oxygen. Other specialised cells provide the muscle cell with food and oxygen needed for it to live. In an organism like yourself the different types of cells are arranged in a precise way. Often, cells which specialise in the same activity are found together. In this Unit, we explore how cells become specialised to perform specific functions to adapt them to their environment.

### OBJECTIVES

At the end of this Unit you should be able to:

- define and give examples of the terms tissue, organ and organ system
- distinguish between herbs, shrubs and trees
- describe the external structure of the flowering plant organs: roots, stem, leaves and flowers
- state the functions of these organs
- name some organs in the human body and state their functions.

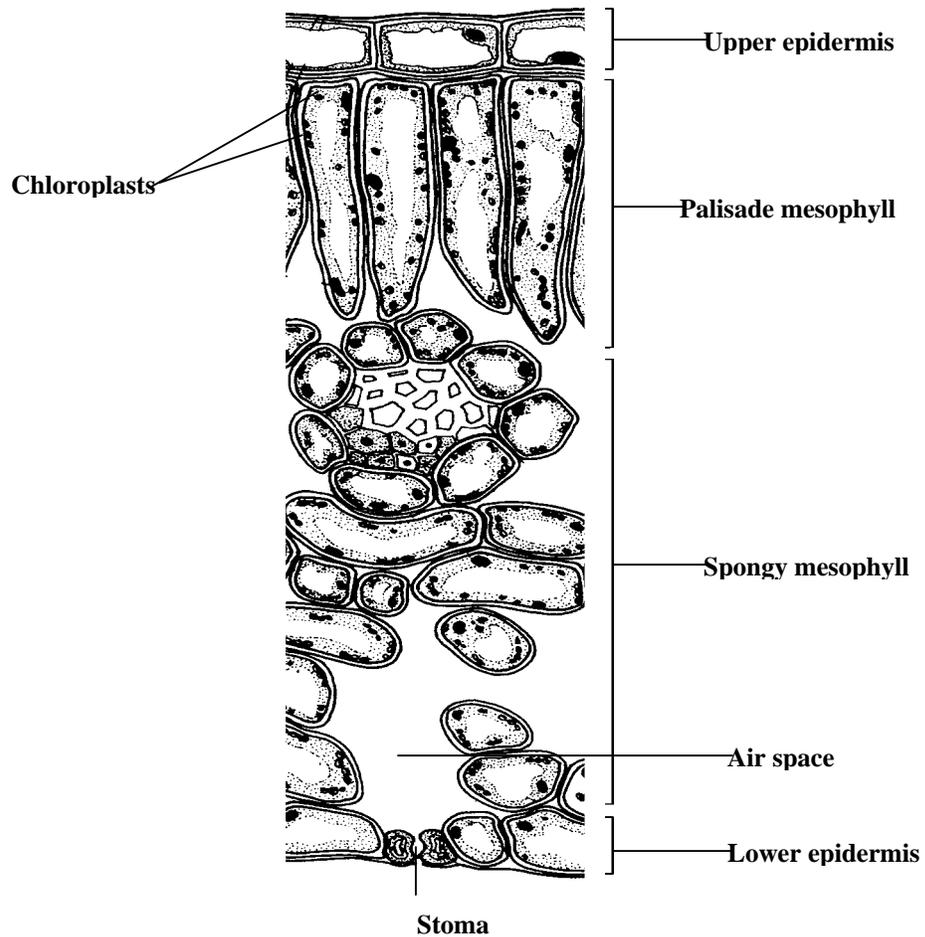
## 2.0 TISSUE, ORGAN AND SYSTEM

### Tissue

Cells having similar structure and functions group together to carry out a particular function. A group of such cells is called a **tissue**.

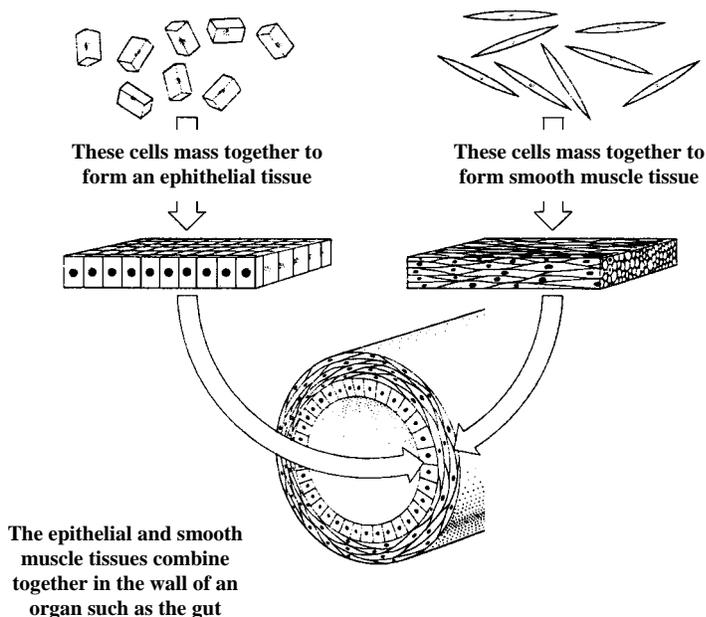
Examples:

- (i) The leaf mesophyll consists of palisade and spongy mesophyll cells. This group of cells is specialised to produce food by photosynthesis.



**Fig. 14 Transverse Section of a Leaf**

- (ii) The epithelium lining your mouth cavity. This consists of a sheet of cells. The cells fit neatly together, like paving stones.



**Fig. 15 Epithelial Tissue**

The following Table shows some of the tissues in animals and plants and their functions.

Animal tissues (based on human tissues)

Name of Tissue	Main Functions
Epithelial tissue	Lines tubes and spaces, forms the skin
Connective tissue	Binds other tissues together
Skeletal tissue	Supports the body and permits movement
Blood tissue	Carries oxygen and food round the body
Nerve tissue	Conducts and co-ordinates messages
Muscle tissue	Brings about movement

Plant tissues (based on flowering plant)

Name of Tissue	Main Functions
Epidermal tissue	Lines the surface of plants
Photosynthetic tissue	Feeds the plant
Packing tissue	Fills in spaces inside the plant
Vascular tissue	Transports water and food substances
Strengthening tissue	Supports the plant

**Organ**

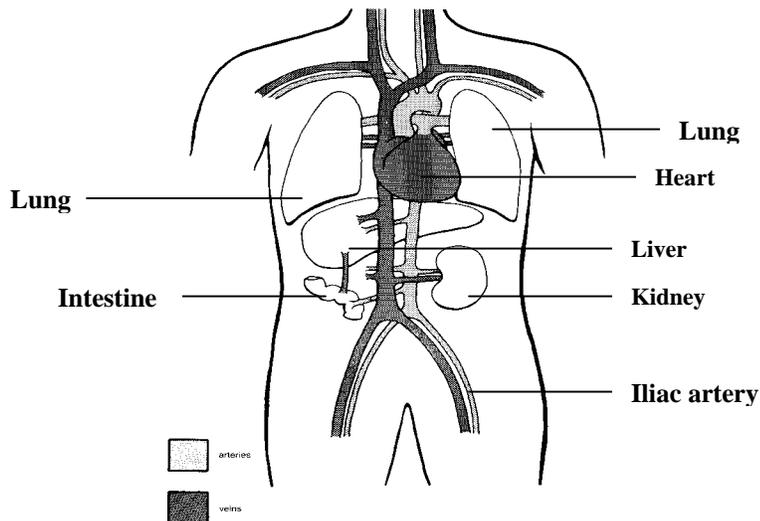
An organ consists of several types of tissues which group together to work as one unit.

*Examples are heart, lungs, brain, eyes, stomach, liver, leaf, flower, stem, root.*

Some organs do just one job. For example, the only job the heart does is pump blood round the body.

Other organs do more than one job. For example, the kidneys remove excretory wastes and also control the amount of water in the body.

The diagram in Figure 16 shows some of the organs in your body.



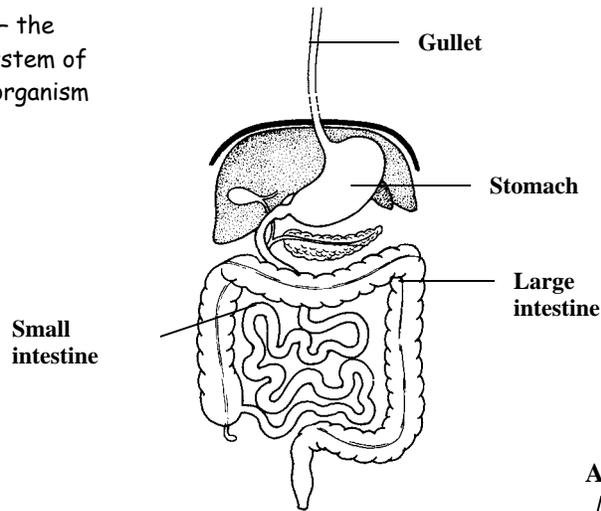
**Fig. 16 Organs in the Human Body**

### System

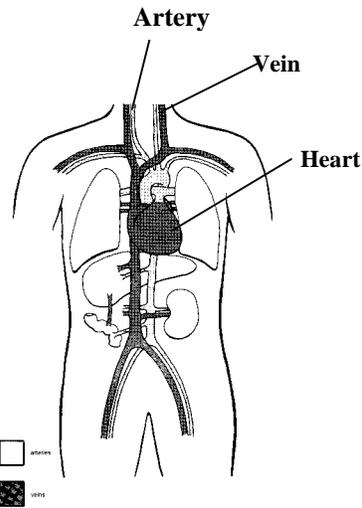
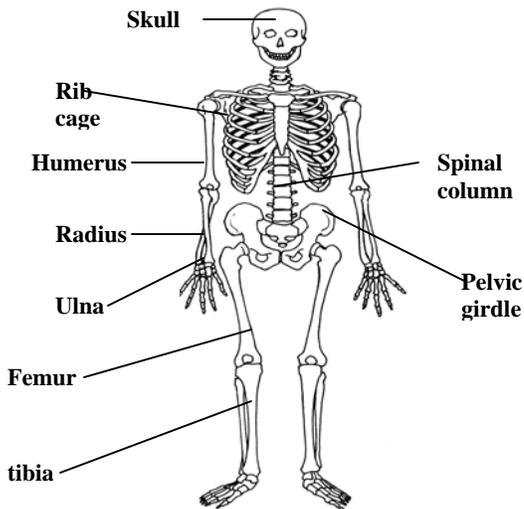
A system consists of several organs which link together to carry out a particular set of functions.

For example, the heart and blood vessels make up the circulatory system. The brain, spinal cord and nerves make up the nervous system. The following illustrates some of the common systems in the human body.

(a) **A system** - the digestive system of the human organism



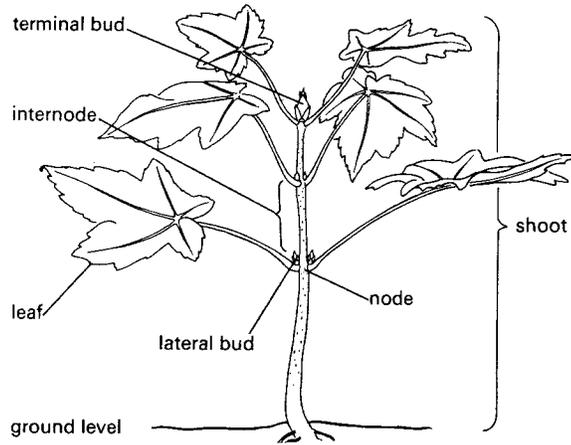
(b) Skeletal system



(c) Circulatory system

**Fig. 17 Systems in the Human Body**

In a flowering plant, the stem, leaves and buds or flowers make up the shoot system.



**Fig. 18 Shoot System in a Plant**

## Organism

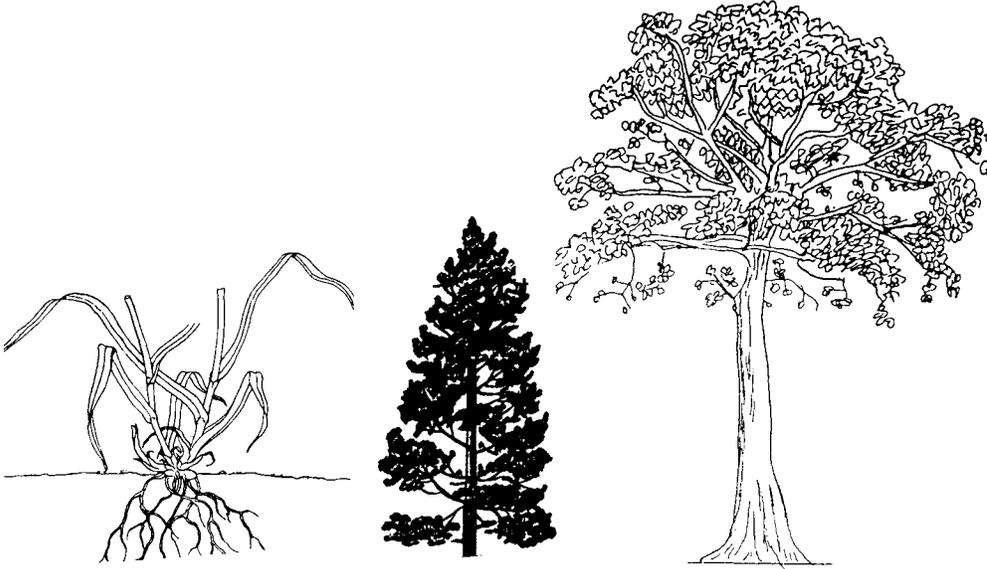
An organism has many systems which work together to keep it alive. It consists of organs and systems which co-ordinate (work together) to produce the independent plant or animal.

Cell → tissue → organ → system → organism

Now that we are familiar with tissues, organs and systems, we are going to focus on the flowering plant's organs. I'm sure there must be many flowering plants in your area.

## 2.1 FLOWERING PLANTS

Have a look at plants growing in a park or a wood near your home to appreciate that they vary greatly in size. You can easily distinguish between three kinds of flowering plants. These are herbs, shrubs and trees.



*Fig. 19 Herbs, Shrubs, Trees*

### Herbs

Herbs do not contain much wood. They are generally small. They vary between a few centimetres to about one metre in height.

Examples include plants like parsley, thym, bean, pea and tomato.

### Shrubs

Shrubs are larger. They contain a good deal of wood and may reach several metres in height. Usually they have a bushy appearance.

Examples are hedgerows, bougainvillea, hibiscus, poinsettia, euphorbia and privet.

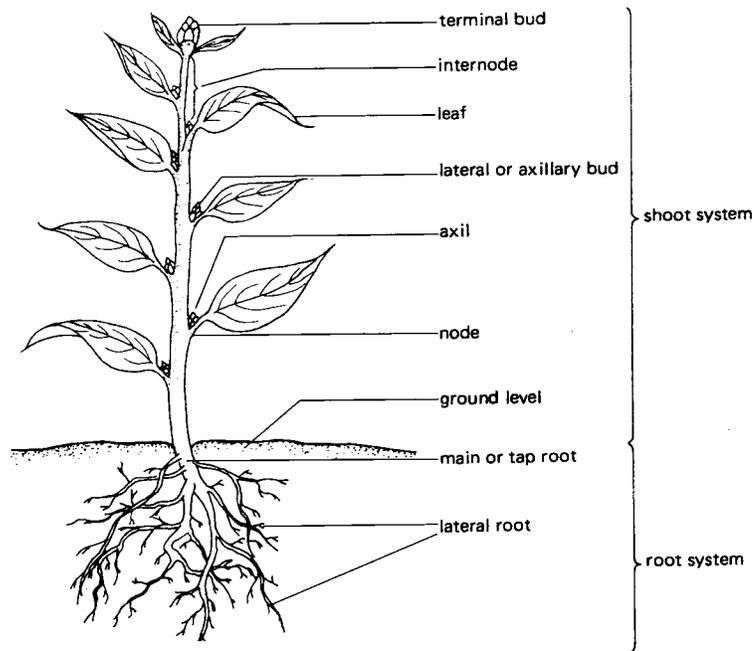
## Trees

Trees are larger still. They have an extremely woody main stem and trunk. This is very strong and can hold up much weight. The trunks of certain trees provide timber.

Examples are *mango, eucalyptus, ebony, pine and teak*.

## Flowering Plant - External Structure

Figure 20 shows the structure of a typical flowering plant. The plant consists of two main parts: the **shoot** and the **roots**.



**Fig. 20 Structure of a Typical Flowering Plant**

### 2.1.1 SHOOT

The main part of the shoot is the **stem**. The stem bears branches, leaves, flowers and fruits.

 **Before proceeding further, complete the following activity.**

**Activity 1**

1. *What are the two main parts of the flowering plant?*  
.....
2. *Which part of the plant is called the stem?*  
.....  
.....
3. *Name two types of stems.*  
.....  
.....
4. *Group the following plants into those having woody stems and herbaceous stems. Litchi, bittergourd, pea, avocado, potato, breadfruit, mango, bean, grass, eucalyptus, maize.*  
  

*Woody Stem - .....*

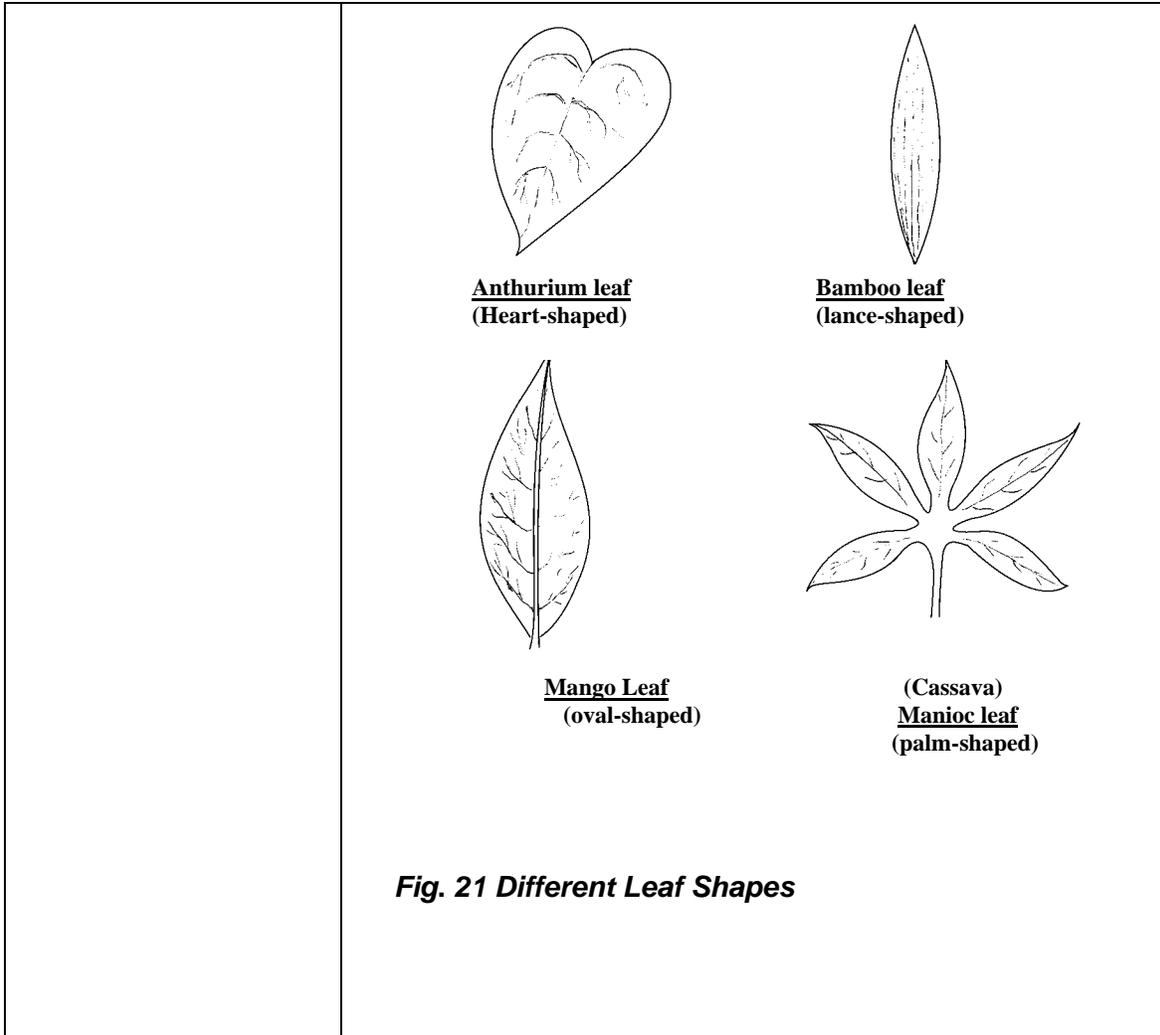
*Herbaceous Stem - .....*
5. *Which of these plants have creeping stems? Watermelon, tomato, pumpkin, sweet potato, groundnut.*  
.....
6. *Name two plants which store their food in their stems.*  
.....
7. *What do roots absorb from the soil?*  
.....
8. *What are the functions of the stem?*  
.....  
.....

**You will find the answers at the end of the Module.**

### 2.1.2 LEAF

The leaf is an important plant organ. It is usually a thin and flat structure which grows on the stem. Most leaves are green but they vary in size and shape. They manufacture food by the process of ***photosynthesis***.





 **Before proceeding further, complete the following activity.**

**Activity 2**

**Functions of the Stem**

You must be quite familiar with a pumpkin plant and a guava plant.

- (a) Compare the stem of the pumpkin plant with that of a guava plant.

Pumpkin .....

Guava .....

You must have observed that the stem of the pumpkin plant is thin, tender and green. It is easy to bend and break. Such stems are called **herbaceous** stems.

- (b) Can you name a few other plants having herbaceous stems?

.....  
 .....

Some plants have herbaceous stems which stand upright. One example is the bean plant.

- (c) Name a few more such plants

.....

Some plants have herbaceous stems but they cannot stand upright. They either creep on the ground or climb on supports.

- (d) Can you name a few such plants?

.....

- (e) In the space below make a labelled drawing of:

(i) a named creeper

(ii) a named climber

*The stem of the guava plant is rigid and pale brown. It cannot be bent or broken easily. Such a stem is called a woody stem. It produces wood. Plants having woody stems can grow into big and tall trees.*

(f) *Name some other plants having woody stems.*

.....  
 .....

(g) (i) *Look at the drawing in Figure 20. What will happen to the leaves, flowers and fruits if the stem is removed?*

.....  
 .....

*You will agree that these structures will then have no support. The stem therefore supports or holds the branches, leaves, flowers and fruits.*

*Water and minerals absorbed from the soil by the roots must be distributed to other parts of the plant. These must pass through the stem. Therefore the stem conducts water and mineral salts to other parts of the plant. Similarly food manufactured in leaves is carried to other parts of the plant through the stem.*

(ii) *Compare the stem of a maize plant to that of a sugarcane plant.*

.....  
 .....

*You will see that both these stems look almost alike. However, the sugarcane skin is sweet and it contains much sugar. The stem of the maize plant is not sweet.*

*Thus the stem of some plants store food.*

**You will find the answers at the end of the Module.**

We can now proceed with an actual investigation.



**INVESTIGATION 2:** To find the surface area of a leaf

<p><b>For each investigation you will require the materials indicated.</b></p> <p><b>You should record your answers in the space provided.</b></p>	<p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>1. Lay the leaf of a hibiscus plant flat on a squared paper.</li> <li>2. Trace with your pencil the outline of the leaf.</li> <li>3. Remove the leaf.</li> <li>4. Count the number of squares within the outline.</li> <li>5. Work out the approximate surface area of the leaf.</li> </ol> <p>.....</p> <p>.....</p>
--	--

**Types of Leaf Veins**

Have a closer look at the veins of the leaves. You will notice that the veins on some leaves are straight and parallel. Examples are: sugar cane and bamboo leaves. The veins on other leaves form a network.

Examples are: *rose and mango leaves.*

Group your leaf specimens into the two types.

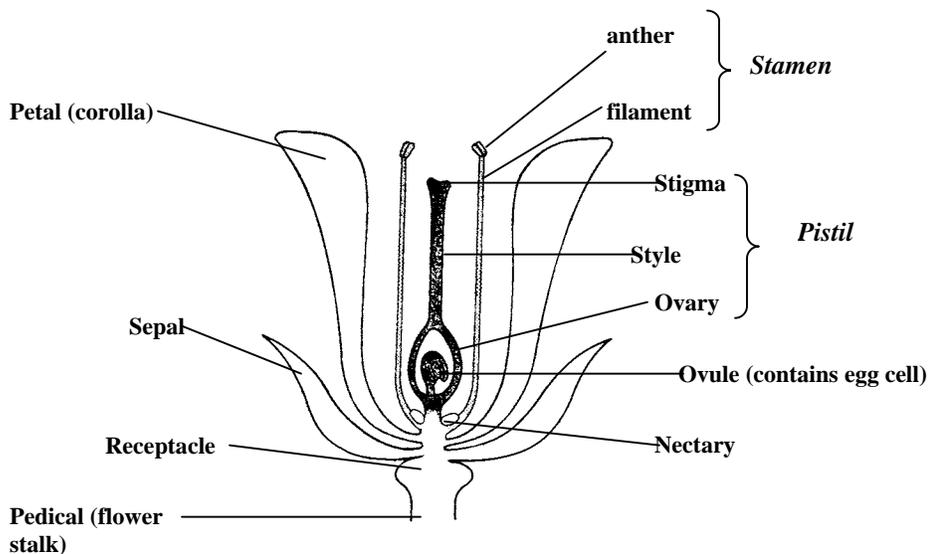
Parallel Veins	Network of Veins
Bamboo	Rose

## Functions of the Leaf

- (i) The leaf manufactures food by the process of **photosynthesis**.
- (ii) The leaf allows exchange of gases. This occurs through very tiny openings called **stomata**.
- (iii) The leaf loses water in the form of water vapour through the stomata. This is called **transpiration**.

### 2.1.3 FLOWER

The flower is the reproductive organ of the plant. Most flowers produce fruits and seeds. Flowers are of different sizes, shapes and colours. Some flowers occur singly and others in groups.



**Fig. 22 Structure of a typical flower.**



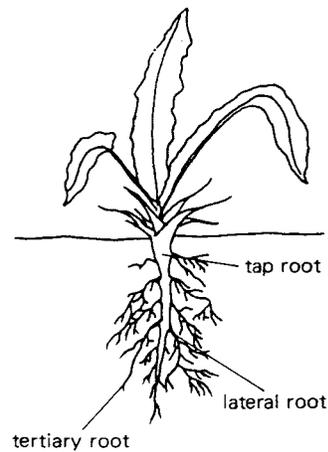


## Functions of the Flower

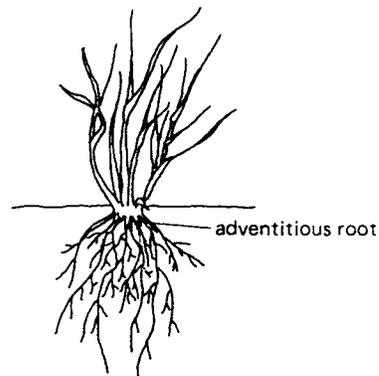
The main function of the flower is to produce fruits and seeds. Some flowers are colourful and have scent. These attract insects for pollination.

### 2.1.4 Root

The root is that part of a plant which is normally below the ground.



**Fig. 23 Tap Root**



**Fig. 24 Fibrous Root**

The root system of some plants consists of a main root called taproot and thinner ones coming from it. These secondary roots are called lateral roots.

Examples of plants with such root systems are bean, balsam, mango, and tomato.

 ***Before proceeding further, complete the following activity.***

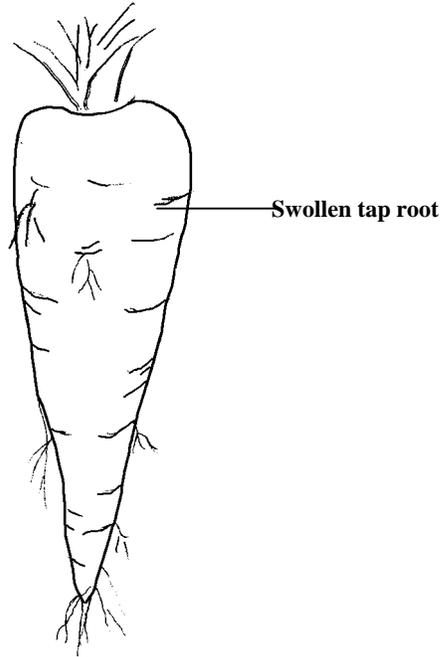
**Activity 3**

- (a) *Can you give a few more examples of plants with tap roots?*  
.....
- (b) *The root system of some other plants has fibrous roots. These roots are of about the same size and length. Examples of plants with a fibrous root system are maize and sugarcane. Name a few more examples of such plants.*  
.....  
.....
- (c) *In some plants like the pumpkin and sweet potato, roots develop from other parts besides the seed. Roots which arise from stems and leaves are called adventitious roots. Name two other plants with adventitious roots.*  
.....  
.....

***You will find the answers at the end of the Module.***



3. In some plants, like the 'carrot', the roots become swollen to store food. Other examples are the sweet potato, cassava.



**Fig. 25 Carrot as a Storage Organ**

***✍ Before proceeding further, complete the following activity.***

**Activity 4**

- (a) Give three examples of plants having roots which act as storage organs.

.....  
.....  
.....

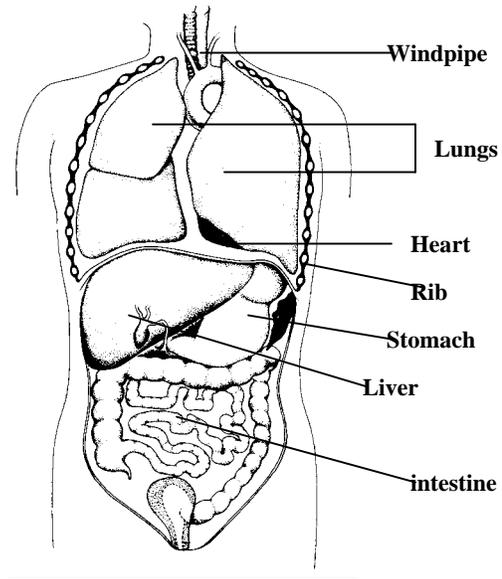
- (b) What is the difference between a tap root system and a fibrous root system?

.....  
.....

**You will find the answers at the end of the Module.**

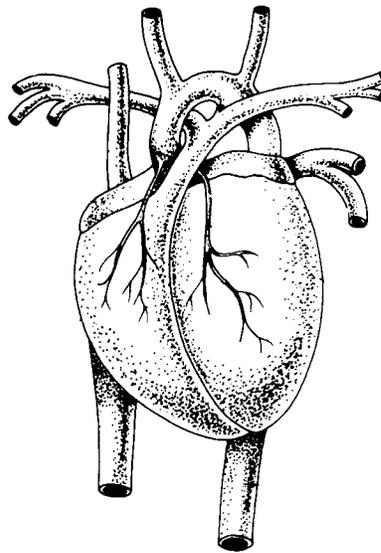
## 2.2 ORGANS IN THE HUMAN BODY

You have learnt that different tissues combine to form **organs**. Let's now look at some common organs in your body and their functions.



**Fig. 26 Different Organs in the Human Body**

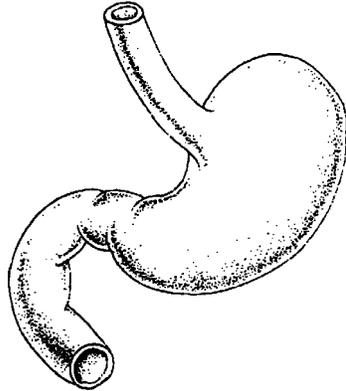
(i) Heart



**Fig. 27 The Heart**

Clench your fist and look at its size. Your heart is about the same size. It is made of a special muscle called the ***cardiac muscle***. It pumps blood around your body.

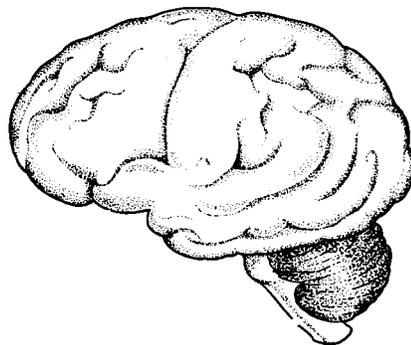
(ii) Stomach



**Fig. 28 The Stomach**

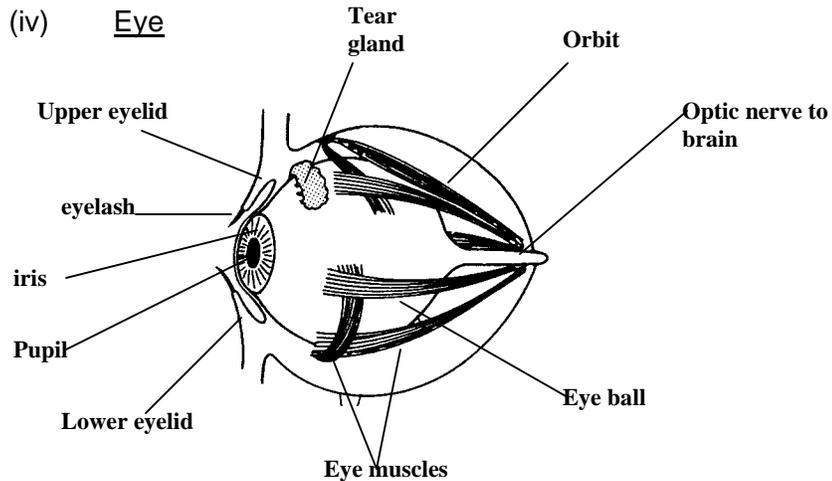
Your stomach is a large sac-like organ lying just beneath the diaphragm on the left side of the body. The human stomach has a capacity of about 1.5-2.0 litres. It is concerned with digestion of food. It stores the food from a meal, temporarily. It then turns the food into a semi-solid and releases this in small quantities into the rest of the alimentary canal.

(iii) Brain



**Fig. 29 The Brain**

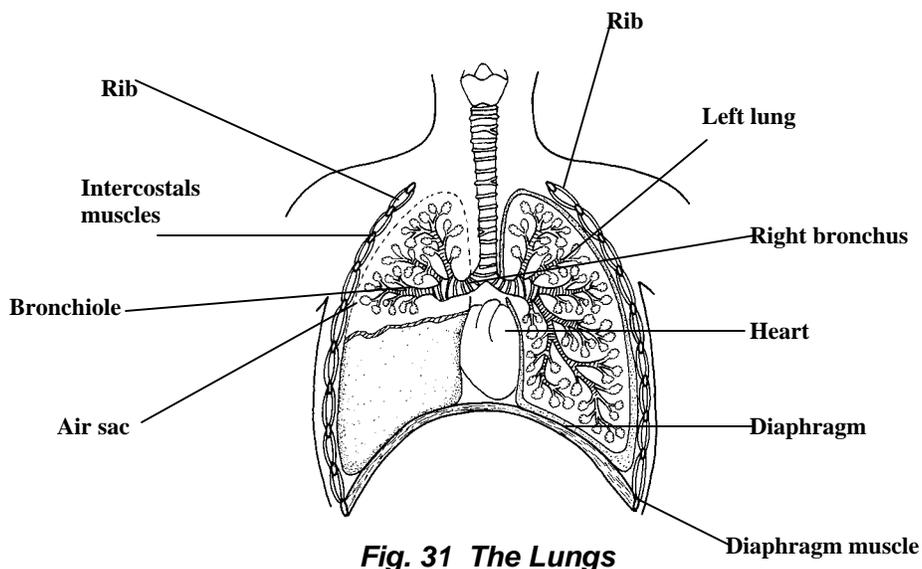
Your brain is shaped like a large mushroom. It is enclosed within a bony case or cranium which is part of your skull. The brain enables you to think, and make decisions. It is the seat of memory, intelligence and it controls different parts of the body.



**Fig. 30 The Eye**

You have a pair of eyes. Your eyes are set in holes called orbits in your skull. The eye is the organ of sight. It enables you to see, but light is essential for this purpose.

(v) Lungs

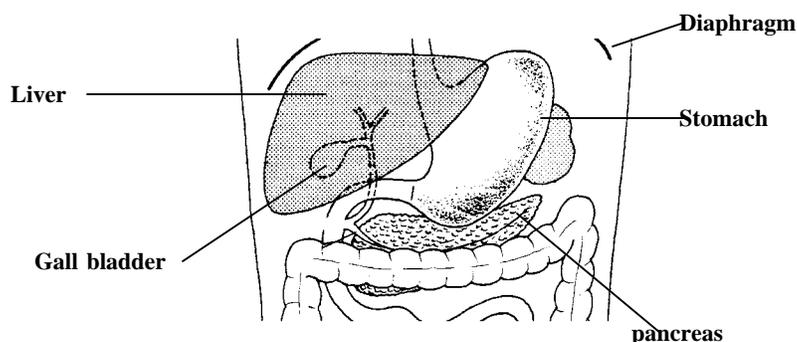


**Fig. 31 The Lungs**

You have a pair of lungs in the chest or thoracic cavity. Healthy lungs are normally pink, soft and spongy. They are protected by the ribs, sternum (breastbone) and vertebral column (backbone). Air is sucked into the lungs through a series of cavities and tubes which together make up the respiratory system.

You use your respiratory system to breathe in oxygen for respiration. You also use it to breathe out carbon dioxide produced by respiration. Thus exchange of gases takes place in your lungs.

(vi) Liver



**Fig. 32 The Liver**

Your liver is the largest organ in your body. It weighs over one kilogram. It is situated at the top of the abdominal cavity just beneath the diaphragm, on the right side. The liver acts as a chemical factory, a food store and a central heating system in your body. It performs many functions which affect our day-to-day health. Here are its main functions.

1. It produces bile. This bile helps in the digestion of fats. It also makes fibrinogen which your body needs to form clots on wounds.
2. It stores glucose as glycogen. It can change this back to glucose when the body needs it. It controls the amount of sugar in your blood.

3. Many chemical reactions take place in the liver. These produce a lot of heat. The blood then evenly distributes this heat around your body to keep you warm.
4. Suppose you eat some food which happens to contain a mild poison. When the poison reaches the liver, the liver turns it into a harmless substance. This process is called **detoxification**.
5. It cannot store surplus proteins. The liver breaks down this excess. The nitrogen part is converted to urea and removed from your body by your kidneys.
6. It stores minerals like potassium, iron and vitamins A, B, D, E.

 **Before proceeding further, complete the following activity.**

**Activity 5**

1. (a) Define the terms:

(i) tissue

.....

(ii) organ

.....

(iii) system

.....

(b) Give two examples of

(i) plant tissues

.....

(ii) animal tissues

.....

(iii) plant organs

.....

(iv) *animal organs*

.....

(v) *plant systems*

.....

(vi) *animal systems*

.....

2. *How can you tell the difference between:*

(i) *a herb and a shrub*

.....

.....

(ii) *a shrub and a tree*

.....

.....

3. *Refer to the labelled drawing of a flowering plant (Fig. 20) and answer the following questions:*

(a) *Which parts of the plant are above the ground?*

.....

(b) *Which part of the plant is below the ground?*

.....

(c) *What are the functions of the (i) stem (ii) roots?*

(i).....

(ii).....

4. (a) *Give the name of a plant having*

(i) *a stem which acts as a storage organ.*

.....

(ii) *a root which acts as a storage organ.*

.....

.....

(b) *What is the difference between a tap root system and a fibrous root system?*

.....

5. (a) *What are the functions of leaves?*

.....  
.....  
.....

(b) *Name two plants whose leaves are used as food by man.*

.....  
.....

(c) *Name two plants whose leaves are used to flavour food.*

.....  
.....

(d) *Name the plant whose leaves are used for making cigarettes.*

.....  
.....

6. (a) *Make a labelled drawing to show the external features of a simple flower, in the space below.*

(b) *Name the*

(i) *male organ of the flower and its parts.*

.....

(ii) *female organ of the flower and its parts.*

.....

(c) *What is the main function of a flower?*

.....

(d) *Name a flower which is consumed as a vegetable.*

.....

7. (a) *Name four organs in your body*

.....

.....

(b) *State the functions of each organ that you name in (a) above.*

.....

.....

.....

.....

(c) *Name two organs in your body which occur in pairs.*

.....

.....

(d) *Where is the liver found in your body?*

.....

.....

(e) *Describe briefly three important functions of the liver.*

.....

.....

.....

.....

.....

.....

.....

***You will find the answers at the end of the Module.***



## POINTS TO REMEMBER

- Groups of specialised cells are called tissues.
- An organ is made up of several different tissues.
- A system consists of several organs which function together to perform a set of tasks.
- Flowering plants can be grouped into herbs, shrubs and trees.
- The flowering plant has a shoot system and a root system.
- Stems can be herbaceous or woody.
- Stems, roots, leaves and flowers have important functions in the plant.
- Leaves help to make food during photosynthesis.
- Flowers produce fruits and seeds and help in reproduction.
- Most flowering plants have either taproots or fibrous roots.
- Different organs in the body perform specific functions.
- The liver is the largest organ in the body. It performs several functions.



# UNIT 3

## COMPOUNDS OF LIFE

### TABLE OF CONTENTS

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ANSWERS TO ACTIVITIES	



## UNIT 3

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# COMPOUNDS OF LIFE

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## INTRODUCTION

All living things including humans are made of chemical substances. These chemical substances comprise different elements. The main elements found in living organisms are carbon, hydrogen, nitrogen, oxygen, phosphorus and sulphur.

Atoms of carbon are able to combine to form long chains. Many of the carbon compounds in living things have large molecules. Often such compounds are formed by small molecules joining up to form large molecules. The carbon compounds in living things are called **organic** compounds. The other substances in the living things are simpler and they usually lack carbon. They are called **inorganic** substances. This Unit looks at these compounds and their importance in living organisms.

## OBJECTIVES

At the end of this Unit you should be able to:

- state that living protoplasm consists of **inorganic** and **organic** substances
- list the major properties and functions of organic substances such as carbohydrates, proteins, lipids
- list the importance of inorganic substances such as water and mineral salts.

## 3.0 LIVING PROTOPLASM - COMPONENTS

The living protoplasm is made of inorganic as well as organic substances. These are mostly the nutrients that we consume.

We can group the main substances found in our body as follows:

Organic Substances	Inorganic Substances
Carbohydrates	Salts
Fats	Water
Proteins	

Each of these substances has certain specific functions.

### 3.1 ORGANIC SUBSTANCES

#### Carbohydrates

Carbohydrates contain the elements carbon, hydrogen and oxygen. The ratio of hydrogen to oxygen is 2:1. They may be simple, soluble sugars or complex materials like starch and cellulose. Carbohydrates are the main source of energy during respiration. A commonly occurring simple sugar is glucose, whose chemical formula is  $C_6H_{12}O_6$ . Simple sugars like glucose, fructose and galactose are sweet and soluble in water.

Double sugars like sucrose and maltose are also soluble in water and they are sweeter than simple sugars. If you eat too much of carbohydrates, your body changes them to fats.

Starch and cellulose are insoluble and tasteless. Starch is the main storage substance in plants. Cellulose forms the structural material in the cell wall of plant cells. It also gives them strength. Common foods that are high in carbohydrates are potatoes, rice, cassava, mealie porridge, and pasta.

## Lipids

Like carbohydrates lipids also contain the elements carbon, hydrogen, oxygen. However, the amount of oxygen here is far less than that in carbohydrates. Lipids are obtained from both plant and animals. At room temperature they exist as solid fat or liquid oils. Lipids give a lot of heat energy. They are the main energy reserve in the body. The fat layer beneath your skin prevents heat loss from the body.

## Proteins

Proteins contain the element carbon, hydrogen, oxygen and nitrogen. Sometimes they may also have sulphur and phosphorus. They are made up of smaller units called **amino acids**. Proteins are very specific substances and they are easily affected at high temperature. Proteins consist of large, complex molecules and they are insoluble in water. Proteins form the main structures of your body. They provide materials for:

- (i) growth
- (ii) body-building and
- (iii) repair of damaged tissues.

Common foods that are high in protein include meat, beans and eggs.

## 3.2 INORGANIC SUBSTANCES

### MINERAL SALTS

These are required in small amounts in your daily diet. They are important for your well-being. Some minerals help in growth and repair of your body. Others control certain body functions. When they are lacking in your diet, you suffer from deficiency diseases.

For example, calcium is needed for making strong bones while iron is needed to make the red pigment called haemoglobin, in the blood cells.

Calcium can be found in milk and milk products – that is one of the reasons that children should drink milk everyday. Foods like spinach and other green vegetables are high in iron content.

## Water

Water makes up about two-thirds of your body weight. It is taken in either directly by drinking or indirectly as part of food. Water is an important component of your diet. It is essential for good health. It is also a major component of your blood. It helps important life processes such as digestion and excretion. Water which evaporates in sweat helps to keep the body cool.

Your body loses and gains water through different activities. However, these losses and gains roughly balance so that the amount of water in the body is nearly constant.

 *Before proceeding further, complete the following activity.*

### Activity 1

1. *List the main elements which make up the body of living organisms.*  
.....  
.....
2. *What is the difference between organic and inorganic substances?*  
.....  
.....
3. *Name **two** organic and **two** inorganic substances found in your body.*  
.....  
.....
4. *Why does your body need*
  - a. *carbohydrates*  
.....  
.....

b. *lipids*  
.....  
.....

c. *proteins*  
.....  
.....

d. *mineral salts*  
.....  
.....

e. *water?*  
.....  
.....

5. (a) *What happens if you eat more carbohydrates than your body needs?*  
.....  
.....

(b) *Young children should have plenty of calcium in the food they eat?*  
.....  
.....

**You will find the answers at the end of the Module.**



## POINTS TO REMEMBER

- The body of living organisms is made up of chemical substances. These are grouped into organic and inorganic substances.
- The most common elements found in living organisms are carbon, hydrogen, oxygen, nitrogen, phosphorus and sulphur.
- Carbohydrates contain carbon, hydrogen, oxygen and they are a main source of energy. They consist of simple sugars, double sugars and larger molecules like starch and cellulose.
- Lipids also contain carbon, hydrogen and oxygen but the amount of oxygen is less compared to carbohydrates. They are good stores of energy.
- Proteins contain the elements carbon, hydrogen, oxygen, nitrogen. They consist of amino acids. They are essential for growth and body building.
- Mineral salts are needed in small amounts. They are important to maintain good health.
- Water is essential for many life processes like digestion, excretion and transport of substances. It is an important constituent of your protoplasm in the cell.

# ANSWERS TO ACTIVITIES

## UNIT ONE

### Activity 1

- (a) A cell is the basic structural and functional unit of life.  
(b) Because they are very tiny structures.
- (a)  $10^{-4}$  cm;  $10^{-3}$  mm      (b) an ostrich egg      (c)  $7.5 \mu\text{m}$

### Activity 2

- Refer to Fig. 4.
- (a) cellulose  
(b) It gives shape, support and protection to the cell.
- (a) Contain chlorophyll which absorbs light for photosynthesis.  
(b) It contains cell sap which feeds the cell.  
(c) They store food.
- Chloroplast      -      Sunlight  
Chromatin      -      Hereditary material  
Cellulose      -      Support  
Central vacuole      -      Cell sap  
Starch grains      -      Storage

### Activity 3

- Both have : cell membrane; cytoplasm; nucleus
- Differences between animal and plant cells:

<u>Plant Cells</u>	<u>Animal cells</u>
1. Have a rigid cellulose cell wall	Cell wall is absent
2. Chloroplasts are commonly present	Chloroplasts are absent
3. There is a large central vacuole containing cell sap	Small or may be absent
4. Food reserve is mainly in the form of starch granules	Food reserve is mainly in form of glycogen granules

3. (a) (i) red blood cell, muscle cell, nerve cell.  
(ii) root hair cell, xylem vessel, guard cell.
- (b) Refer to Figs. 8 – 13, 1.5.1
4. (a) It is a cell with a distinct shape. It carries out a specific function and special kinds of chemical changes occur in its cytoplasm.
- (b) (i) red blood cell, muscle cell.  
(ii) root hair cell, guard cell.

## UNIT TWO

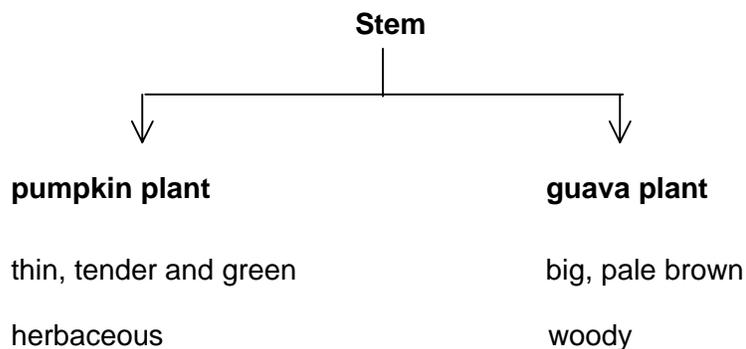
### Activity 1

- the shoot system and root system
- the stem is the main part of the shoot which supports leaves, flowers and fruits.
- herbaceous stem; woody stem
- woody stem – litchi, avocado, breadfruit, mango, eucalyptus.  
herbaceous stem - bittergourd, pea, potato, grass, bean, maize.
- watermelon, pumpkin, sweet potato.
- sugarcane, potato.

7. water and mineral salts.
8. it supports leaves, flowers and fruits. It conducts water and mineral salts to other parts of the plant.

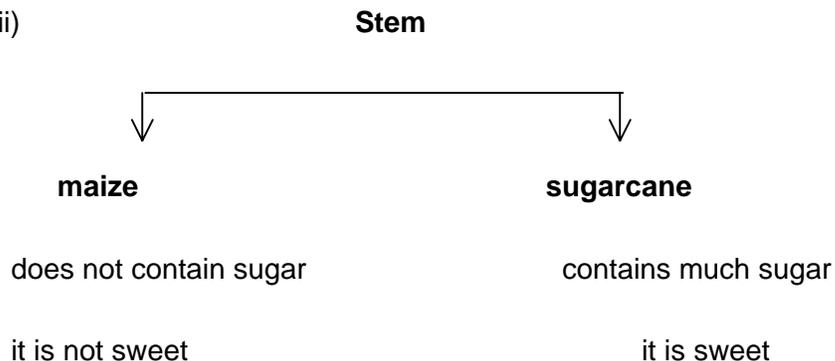
## Activity 2

(a)



- (b) sweet potato, grass, watermelon
- (c) pea, maize, tomato
- (d) sweet potato, 'chouchou' plant
- (e) (i) sweet potato, chouchou, lianas  
(ii) bittergourd, convolvulus
- (f) mango, eucalyptus, pine
- (g) (i) they will have no support.

(ii)



### Activity 3

- (a) plants with tap root - pea, eucalyptus, geranium
- (b) plants with fibrous root - onion, garlic
- (c) plants with adventitious root - grass, sweet potato

### Activity 4

3. (a) plants having roots acting as storage organs:

sweet potato, carrot, beetroot.

- (b) tap root

it has a main root with lateral roots

fibrous root

all roots are about the same size and length

### Activity 5

1. (a) (i) it is a group of cells having similar structure and function.
- (ii) it consists of different tissues which group together to work as a functional unit.
- (iii) it consists of several organs which work together to carry out a particular set of functions.
- (b) (i) photosynthetic tissue; vascular tissue
- (ii) blood tissue; nerve tissue.
- (iii) flower; leaf.
- (iv) liver; heart.
- (v) shoot system; root system
- (vi) digestive system, circulatory system.

2. (a) Herbs contain little or no wood while shrubs contain much more wood.
- (b) Trees are larger than shrubs and they have woody main stems.
3. (a) Shoot system – stem, leaves, flowers
- (b) Root system
- (c) (i) supports leaves, flowers, fruits  
conducts water and mineral salts
- (ii) anchors the plant in the soil  
absorbs water and mineral salts
4. (a) (i) sugarcane
- (ii) sweet potato
- (b) Tap root system has a main root with lateral roots while all the roots are of same size and length in a fibrous root system.
5. (a) To make food during photosynthesis.
- To allow exchange of gases.
- To allow transpiration.
- (b) Lettuce, cabbage.
- (c) Coriander, thyme.
- (d) Tobacco plant.

6. (a) Refer Fig. 22 2.1.3
- (b) (i) Stamen – anther and filament.
- (ii) Pistil – stigma, style and ovary.
- (c) To produce seeds and fruits.
- (d) Cauliflower.
7. (a) Heart, liver, lungs, eyes
- (b) Heart - pumps blood to all parts of the body.
- Liver - produces heat and bile
- stores glycogen, few minerals and vitamins.
- Lungs - allow gaseous exchange.
- Eyes - enable vision.
- (c) eyes, lungs
- (d) Just beneath the diaphragm, on the right side of the body.
- (e) It produces bile which helps in digestion of fats.

It stores glucose as glycogen and controls amount of sugar in blood.

It produces much heat which is distributed around the body to keep you warm.

## UNIT THREE

### Activity 1

1. Carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur.
2. Organic substances are carbon compounds in living organisms. Those substances which lack carbon are called inorganic substances.
3. Organic substances - carbohydrates, proteins.  
Inorganic substances - water, mineral salts.
4. (a) provides energy.  
(b) main energy reserve.  
(c) provides material for growth, body building and repair of damaged tissues.  
(d) control body functions and help in growth and repair of body.  
(e) major component of blood and helps processes like digestion and excretion.
5. (a) It is converted to glycogen and fats and stored in the body.  
This may lead to obesity in the long run.  
(b) To help in the formation of strong bones and teeth.

