Biology and Health Sciences

FOR RWANDAN SCHOOLS

Senior 1
Student's Book

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How to use this book

The book is divided into units.

The key competence is from the curriculum.

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Checklist of learning.

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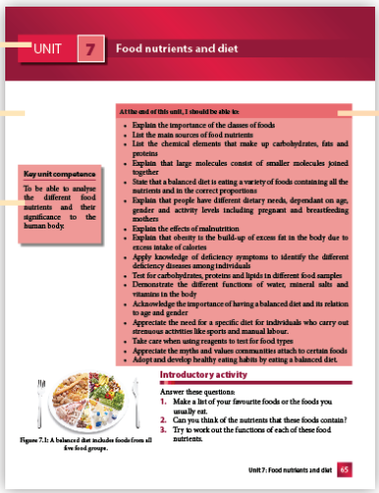

UNIT 7 Food nutrients and diet

At the end of this unit, I should be able to:

- Explain the importance of the classes of foods
- List the main sources of food nutrients
- List the chemical elements that make up carbohydrates, fats and proteins
- Explain that large molecules consist of smaller molecules joined together
- State that a balanced diet is eating a variety of foods containing all the nutrients and in the correct proportions
- Explain that people have different dietary needs, dependant on age, gender and activity levels including pregnant and breastfeeding mothers
- Explain the effects of malnutrition
- Explain that obesity is the build-up of excess fat in the body due to excess intake of calories
- Apply knowledge of deficiency symptoms to identify the different deficiency diseases among individuals
- Test for carbohydrates, proteins and lipids in different food samples
- Demonstrate the different functions of water, mineral salts and vitamins in the body
- Acknowledge the importance of having a balanced diet and its relation to age and gender
- Appreciate the need for a specific diet for individuals who carry out strenuous activities like sports and manual labour.
- Take care when using reagents to test for food types
- Appreciate the myths and values communities attach to certain foods
- Adopt and develop healthy eating habits by eating a balanced diet.

Key unit competence

To be able to analyse the different food nutrients and their significance to the human body.

Introductory activity

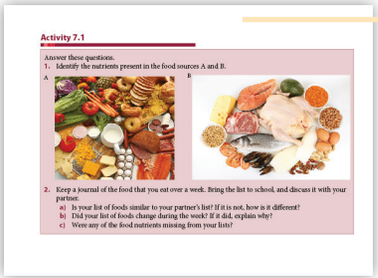
Answer these questions:

1. Make a list of your favourite foods or the foods you usually eat.
2. Can you think of the nutrients that these foods contain?
3. Try to work out the functions of each of these food nutrients.

Figure 7.1: A balanced diet includes foods from all five food groups.

Unit 7: Food nutrients and diet 65

The learning objective says what you will learn.


Activity 7.1

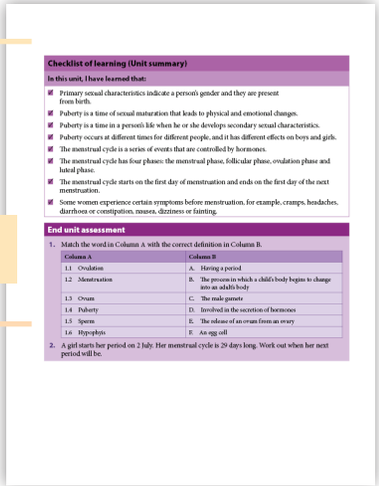
Answer these questions.

1. Identify the nutrients present in the food sources A and B.

A B

2. Keep a journal of the food that you eat over a week. Bring the list to school, and discuss it with your partner.
   a) Is your list of foods similar to your partner's list? If it is not, how is it different?
   b) Did your list of foods change during the week? If it did, explain why?
   c) Were any of the food nutrients missing from your lists?

Every unit has activities and exercises.


Checklist of learning (Unit summary)

In this unit, I have learned that:

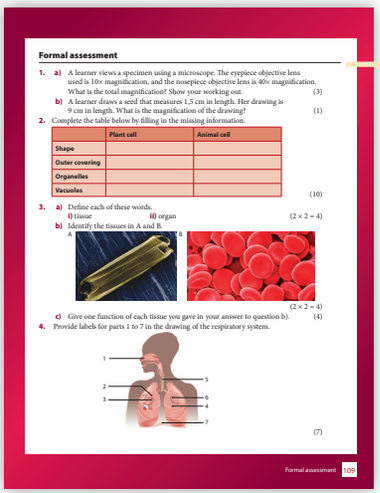
- Primary sexual characteristics indicate a person's gender and they are present from birth.
- Puberty is a time of sexual maturation that leads to physical and emotional changes.
- Puberty is a time in a person's life when he or she develops secondary sexual characteristics.
- Puberty occurs at different times for different people, and it has different effects on boys and girls.
- The menstrual cycle is a series of events that are controlled by hormones.
- The menstrual cycle has four phases: the menstrual phase, follicular phase, ovulation phase and luteal phase.
- The menstrual cycle starts on the first day of menstruation and ends on the first day of the next menstruation.
- Some women experience certain symptoms before menstruation, for example, cramps, headaches, diarrhoea or constipation, nausea, dizziness or fainting.

End unit assessment

1. Match the word in Column A with the correct definition in Column B.

Column A	Column B
1.1 Ovulation	A. Having a period
1.2 Menstruation	B. The process in which a child's body begins to change into an adult's body
1.3 Ovum	C. The male gamete
1.4 Puberty	D. Involved in the secretion of hormones
1.5 Sperm	E. The release of an ovum from an ovary
1.6 Hypophysis	F. An egg cell

2. A girl starts her period on 2 July. Her menstrual cycle is 29 days long. Work out when her next period will be.


Formal assessment

1. a) A learner views a specimen using a microscope. The eyepiece objective lens used is 10× magnification, and the nosepiece objective lens is 40× magnification. What is the total magnification? Show your working out. (3)
   b) A learner draws a seed that measures 1,5 cm in length. Her drawing is 9 cm in length. What is the magnification of the drawing? (1)
2. Complete the table below by filling in the missing information.

	Plant cell	Animal cell
Shape		
Outer covering		
Organelles		
Vacuoles		

(10)

3. a) Define each of these words.
   i) tissue ii) organ (2 × 2 = 4)
   b) Identify the tissues in A and B.

A B

(2 × 2 = 4)

   c) Give one function of each tissue you gave in your answer to question b). (4)
4. Provide labels for parts 1 to 7 in the drawing of the respiratory system.

(7)

Formal assessment 109

Formal assessment with marks.

Self-assessment

TOPIC

1 Biodiversity and classification

Sub-topic	Biodiversity
Unit 1	Introduction to Biology
Sub-topic	Classification of living things
Unit 2	Introduction to classification
Unit 3	The external structure and importance of flowering plants

Figure 1.1: There is a great diversity of living things in Rwanda.

UNIT 1 Introduction to Biology

Key unit competence

To be able to explain the meaning of biology and its application , recall the characteristics common to all organisms and be able to apply safety and first aid in daily life.

At the end of this unit, I should be able to:

- Define Biology and state its main branches
- Explain the importance of studying Biology
- Identify different forms of life from a wide range of organisms
- List the characteristics of living things
- Explain the principles of the first aid and how and when first aid kit is used
- Compare characteristics of life throughout different groups of organisms focusing on their nutrition, respiration, excretion, reproduction, growth, sensitivity and movement
- Compare living things and explain their differences
- Practice rules and regulations governing the laboratory and know how to avoid accidents
- Use first aid kit
- Know what to do if someone is injured in the laboratory
- Acknowledge the diversity and uniqueness of different organisms
- Appreciate the importance of Biology in society.

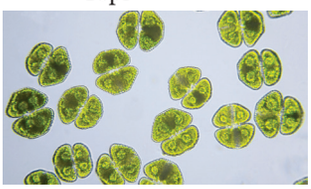
Introductory activity

1. Around you, there are huge number of things. Suggest the ones which are living, are non-living. Which characteristics have helped you to group those things?
2. Name the two main groups of animals and give an example of each?
3. Among the sciences that deal with different studies, which one concerns the living things?
4. Observe the living things below. What are the possible interactions with their environment?

Topi

Water lily

Hippo



Algae, viewed under a microscope

Forest cobra

Black-headed gonolek

Figure 1.2: Different living things

1.1. Introduction to biology and different branches of biology

Meaning of Biology

Activity 1.1

1. Think about the world around us. Every day you see living things. Some of these living organisms are plants, such as trees, grasses and flowers. Others are animals, such as birds, insects and dogs. Where do they get their energy from? How do they move? What are they made of?
2. Discuss the following
   a. What is biology?
   b. What are branches of biology?

The word Biology comes from two Greek words: bios, which means life, and logos, which means knowledge. Biology therefore means the study of life, or living organisms.

Branches of Biology

Biology is a subject that covers many different aspects. Some examples of branches of Biology are shown below.

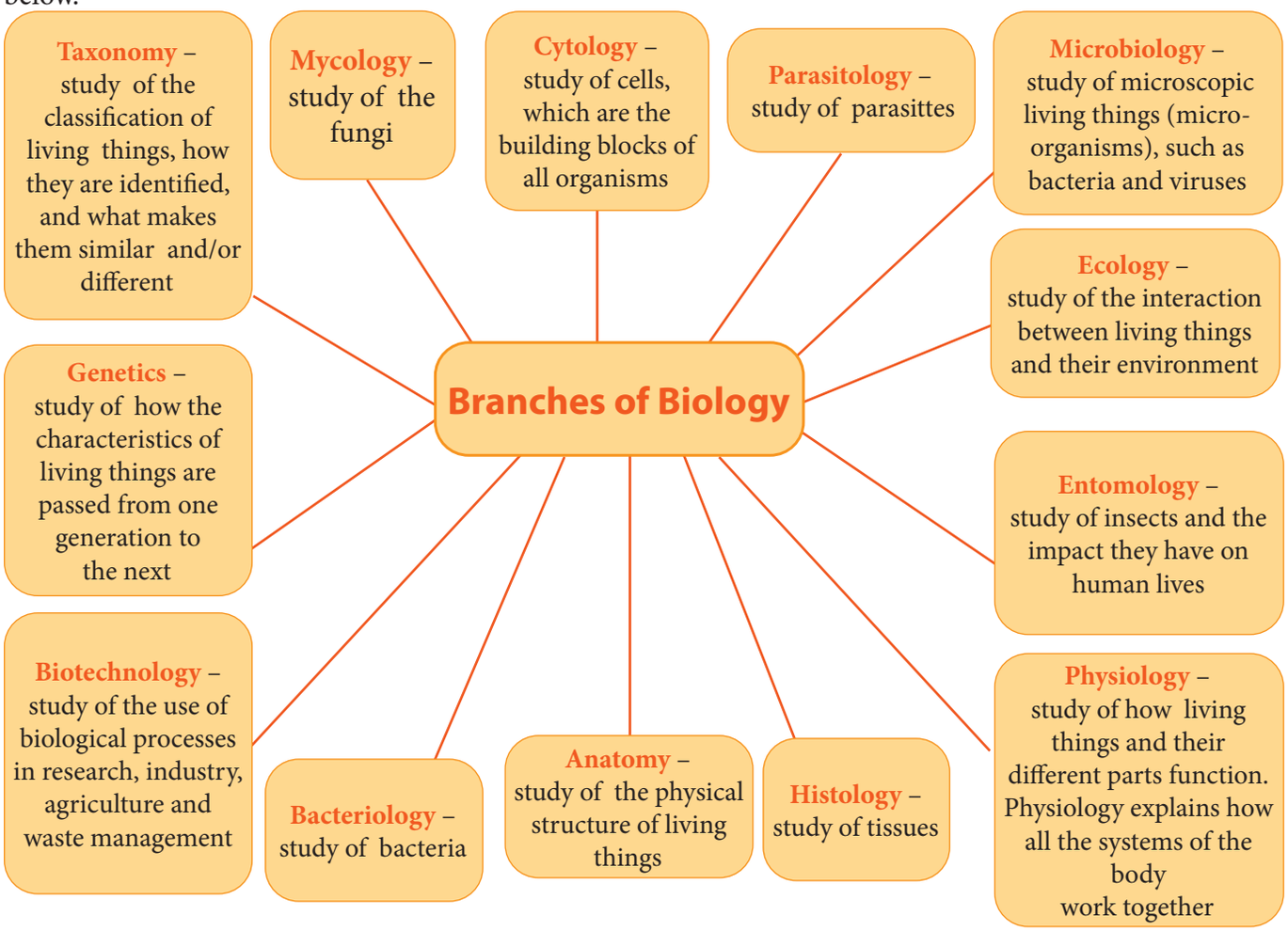


Figure 1.3: Branches of Biology

Self assessment 1.1

1. What does the word 'Biology' mean?
2. Name at least three branches of Biology, and explain what is studied in each branch.
3. Read the following case study and tell to your classmate or parents the key message from it.

Careers in Biology

There are many interesting careers related to different aspects of Biology that you can follow after you leave school. A degree in biological sciences or a diploma in a biology-related field will enable you to work in many different jobs.

For example, biomedical science is the field of biology that has medical applications. Health workers and research workers often have a degree or diploma in this field. Biomedical scientists carry out different tests to identify diseases. They also are involved in finding ways to improve peoples' health.

Biological and biomedical scientists can work in hospital laboratories, blood banks, veterinary laboratories and pharmaceutical companies. They can also work to save endangered plants and animals and help to protect our environment from human impacts. There are even biological scientists on the International Space Station!

1.2. Importance of studying biology

Activity 1.2

Read the case study, and then answer the questions.

Why do we study Biology?

Biology is the study of living organisms in their environments on planet Earth. Since we ourselves are living organisms and we are surrounded by other living organisms, biology is an important subject in schools. It is divided into many different branches. For example, zoology is the study of animals, botany is the study of plants and ecology is the study of living organisms and their environment.

The study of many aspects of biology helps humans in their daily lives. Botanists have helped us to classify plants and appreciate their diversity. We understand their value in medicine, food crops and as shelter for both humans and other animals.

Animal biology and zoology, is important so that we can realise the value of animals. Animals provide us with many resources such as honey, meat, milk and materials for clothing. Biologists also study the interaction between living organisms and their impact on the environment. Maintaining the balance between organisms and Earth is vital for the existence of humans on our planet in the future.

Source: N Ranga Reddy, http://www.rajaha.com/importance-biology

Questions

1. List four resources that humans get from plants.
2. Find out what the word 'diversity' means, and then explain it in your own words.
3. Which group of organisms is the greatest source of medicines?
4. Name any two plants and two animals that are used in Rwanda as food for humans.
5. The case study does not mention one very important group of organisms that can impact on human health. Which organisms would be in this group?

Biology is a science that is growing and developing quickly in the 21st century. Scientists who study Biology are known as biologists. There are many reasons why we study Biology.

- It improves our understanding of diseases and their causes, prevention and treatment.
- It helps us to meet the needs of a growing population; for example, through increased food production.
- We can understand the variety of living organisms on Earth, and why we need to look after all of them.
- We can appreciate how all life on Earth is connected.
- It helps us make decisions about our own health and form our opinions on controversial issues, such as **organ** donation.
- It can provide us with career opportunities.

Figure 1.4: Scientists work in different fields of Biology to improve our lives.

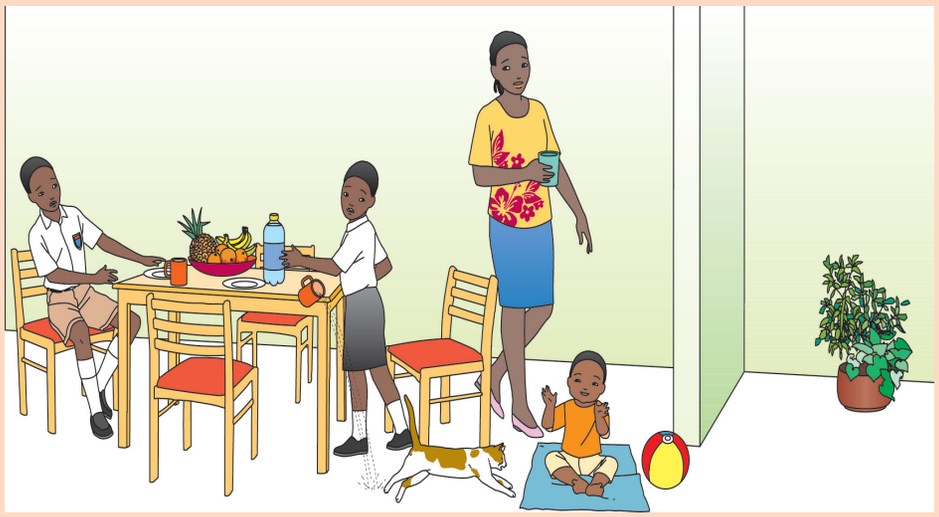
Self Assessment 1.2

1. Explain why the study of ecology is important to both human beings and planet Earth.
2. Write down six reasons why people study Biology. Use your own words.
3. Imagine that a team of biologists is studying the impact of pollution on a forest. Which specialists do you think would be in the team?

1.3. Characteristics of living things

Activity 1.3

1. Look at the picture, and write down all the characteristics of living organisms that you can see.



2. Imagine some living things in your family or school garden. What do you consider to decide that such things are living things?

Scientists use main **characteristics** to decide whether something is living or not. A characteristic is something that an object or organism can do. For example, many animals move. So, movement is one characteristic of living things. Table 1.1 on the next page shows the seven characteristics of living organisms. We think of something as being alive only when it shows all seven of these characteristics. A monitor lizard is used as an example to help you understand.

Figure 1.5: A monitor lizard is an example of a living organism.

Hint

You can remember the main characteristics of life, or life processes, with the words MRS NERG.
M – movement
R – respiration
S – sensitivity
N – nutrition
E – excretion
R – reproduction
G – growth

Table 1.1 describes the main characteristics of living things.

Table 1.1. The characteristics of living things

Characteristic	What it means	Monitor lizard
1. Movement or locomotion	All living things change position and move from one place to another in some way. In animals, this is easy to see. There are some parts of plants that move to get more sunlight, for example.	The lizard can move very quickly to catch food, to run away from predators or to swim in water.
2. Respiration	Respiration is a chemical reaction that takes place inside all living cells in an organism. During respiration, food is broken down to produce energy that the organism can use. Oxygen is needed for the process to happen. Carbon dioxide is produced during the respiratory process.	The lizard breathes in air, which contains oxygen. Oxygen is transported in the blood to the cells of the body, where respiration reactions take place. Respiration reactions use oxygen and nutrients, such as glucose, in the cells to make energy.
3. Sensitivity or irritability	All living things need to be able to respond to changes in their environment so that they can, for example, find food or seek shelter.	The lizards has eyes, a nose and ears. It uses these to pick up changes around it and respond to the changes.
4. Nutrition or feeding	All living things need to get energy to live. They get their energy from food, or nutrients. Different organisms get food in different ways. Animals eat plants or other animals, or both. Plants use the energy from the Sun to make their own food, in a process called photosynthesis.	The lizard eats small insects to get enough energy to stay alive. Through the process of digestion, the nutrients inside the lizard's food are slowly broken down until they are small enough to travel in the blood to the cells of the body.
5. Excretion	Excretion is the process that gets rid of waste from the body of a living thing. If these waste materials are not removed, they will become toxic to the body.	The lizard produces carbon dioxide during respiration. This gas is excreted when the lizard breathes out.
6. Reproduction	All living organisms must have offspring if they are to survive as a species on Earth.	The lizard lays eggs that hatch, and baby monitor lizards are produced.
7. Growth or development	All living things grow.	The lizard hatches from an egg and then grows bigger.

Self assessment 1.3

1. What are the common characteristics between plants and animals? Explain on each characteristic.

1.4. Safety rules and regulations

Activity 1.4

1. Identify the hazards shown in Figure 1.6. Why these are hazards.

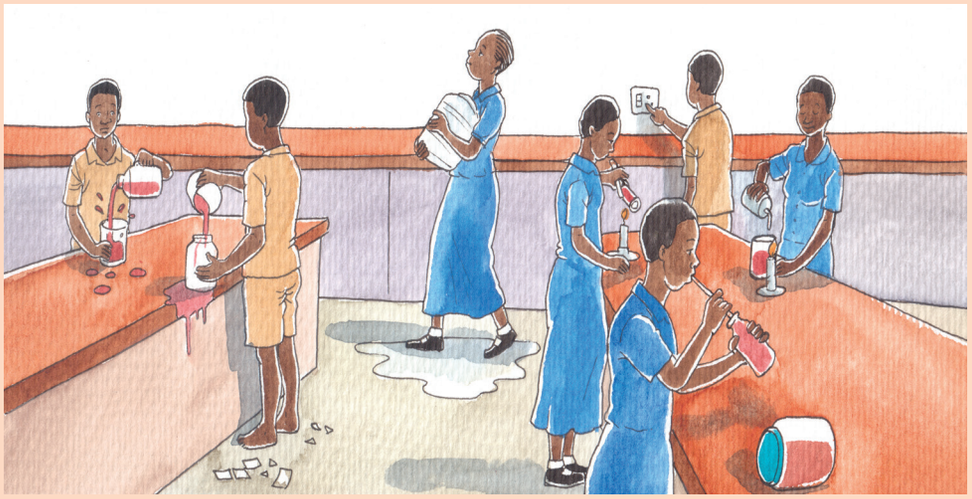


Figure 1.6: Hazards in the laboratory.

2. Discuss other hazards that can be found in a laboratory besides those you identified in Figure 1.6.
3. List all the safety precautions that you will take, when you are in a laboratory?

Biology, like other science subjects, involves practical work that can be done in a laboratory, in a classroom, or outside the classroom.
You will use a variety of materials, chemicals, pieces of apparatus and equipment. You will also use animals and plants. To prevent accidents from happening when we work with these different items, we must take certain safety precautions.

Safety rules

1. Follow instructions.
2. Consider the safety of other learners during practical work.
3. Do not work in the laboratory when your teacher is not present.
4. Do only practical work that has been assigned to you by your teacher.
5. Do not use any chemical until your teacher has explained its use and the precautions you must take when using it.
6. Do not touch apparatus on the demonstration table without instructions from your teacher.
7. Know where fire extinguishers and first aid materials are stored, and find out how to use them.
8. Always be careful when pouring chemicals from their containers. If you spill a chemical, report it to your teacher.
9. Immediately wash off chemicals that get into the eye or onto the skin using running water.
10. Never look into a test tube or point its mouth in the direction of other learners when you heat liquids in the test tube.
11. Close gas burners tightly after use.
12. Ensure that the laboratory is well ventilated when you work in it.
13. Wear an apron and safety glasses whenever necessary.
14. Do not use a flame when you work with volatile or inflammable liquids, such as alcohol.
15. Only your teacher should handle large storage bottles that contain dangerous chemicals.
16. Never pour a chemical back into its bottle or exchange the stoppers of bottles, because contamination could result in dangerous reactions.
17. Never force glass tubing, thermometers or any breakable materials in or out of rubber stoppers and tubing. Use glycerine as a lubricant, and not water.
18. Laboratory animals, whether living or dead, should be handled only with instructions from your teacher.
19. Dispose of solid waste, broken glass and other laboratory waste in their specific containers.
20. Clean and dry laboratory work areas and equipment before the end of class.
21. Do not taste, eat or drink any laboratory materials without instructions from your teacher.
22. Do not touch any electrical device that has just been used, to avoid burns.
23. Report any broken glassware to your teacher.
24. Use sharp instruments with great care.
25. Wash your hands with soap after handling unknown plants or substances.
26. Make sure that you are safe from animals such as snakes, scorpions and wasps when you do field work.
27. Report any accident or injury to your teacher.

Self assessment 1.4

1. Think of some safety rules that you must follow when doing practical work in the laboratory and outside the laboratory.
2. Make a poster that you can dicuss in class.

1.5. First aid and the first aid kit

Activity 1.5

1. Look at the list of safety rules on previous page, and then make a list of injuries that could result if these rules are not followed.
2. Based on your list of injuries, think of first aid equipment that should be kept in the school laboratory.

There are many hazards in the laboratory; for example, chemicals, sharp objects, glass apparatus and gas burners. Learners do not need to be trained in first aid, as one of your teachers will be trained. It is important that there is a first aid kit available, in case someone is injured in the laboratory. The following figure shows the components of the laboratory first aid kit.

Figure 1.7: A laboratory first aid kit

What to do if someone is injured in the laboratory

Follow the instructions given in Table 1.2 for dealing with common types of injury in the laboratory.

Table 1.2. Treating injuries in the laboratory

Injury	Instructions
Heat burn	• Cool the burnt area by holding it under cool running water or water in a basin, until the pain lessens • Cover the burn with a sterile, non-stick bandage or clean cloth • Give the person pain relief • Go to a clinic or doctor
Chemical burn	• Put on gloves and protective clothing to avoid exposing yourself to the chemical • Flood the burnt area using cool water for at least 20 minutes, making sure that the water does not touch your own skin • Do not try to neutralise the burn using another chemical • Cover a small burn with a dry sterile cloth or bandage

Cut	• Stop the bleeding by applying direct pressure on the area • Clean the area using warm water • Apply antiseptic ointment • Cover the cut with a sterile bandage or non-stick plaster • If the cut is deep, go to a clinic or doctor
Chemical in the eye	• Remove any contact lenses immediately • Flush the eye immediately using cool water, and continue for about 15 minutes • Go to a clinic or doctor
Object in the eye	• Wash your hands with soap and water to prevent infection • Flush out the eye using water • Gently pull the upper eyelid over the lower one. This causes tears to form, which may flush out the object • If you can see the object, you may be able to use a clean cloth to gently wipe away the object • If the object cannot be removed, go to a clinic or doctor

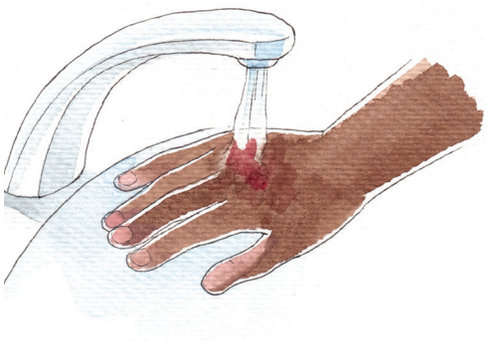


Figure 1.8: Hold the burnt area under cool water

Figure 1.9: Use water to flush out an object in a person's eye.

Self assessment 1.5

1. Make a list of all the items in the first aid kit in your school's laboratory.
2. Work out what each item is used for.
3. Are there items that you think should be included in the first aid kit that are missing?

Checklist of learning (Unit Summary)

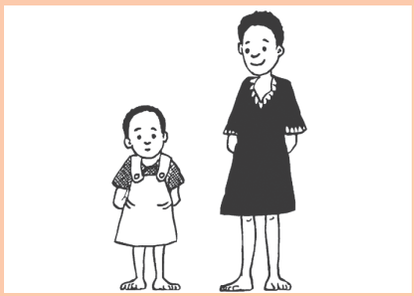
In this unit, I have learnt:

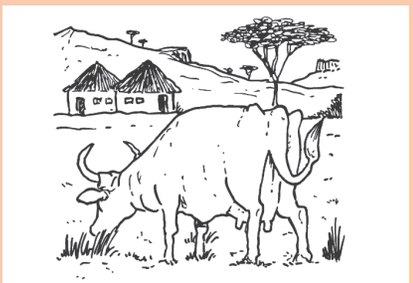
- ✓ Biology is the study of life.
- ✓ There are many branches of Biology, for example, botany, zoology, microbiology and genetics.
- ✓ People study Biology for various reasons, but mainly to understand and to improve the quality of life on Earth.
- ✓ All living organisms have seven characteristics that make them 'living': movement, respiration, sensitivity, nutrition, excretion, reproduction and growth (MRS NERG).
- ✓ When you work in a laboratory, it is important to follow safety rules to prevent injury.
- ✓ There should be a first aid kit in the laboratory that contains all the necessary items to treat injuries that may occur.
- ✓ First aid should be given if someone is hurt in the school laboratory, and a teacher trained in first aid should be available to give assistance.

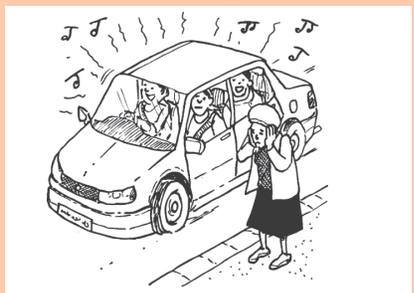
End unit assessment

1. Look at the pictures, and then write down which characteristic of life each one shows.

a. 

b. 

c. 

d. 

2. Match the description in Column A with the correct term in Column B.

Column A	Column B
2.1 Toxic	A. Excretion
2.2 Making energy from the Sun's energy, carbon dioxide and water in plants	B. Poisonous
2.3 Getting rid of waste substances	C. Variety of living organisms
2.4 Responding to the environment	D. Respiration
2.5 Using food molecules and oxygen to get energy	E. Photosynthesis
2.6 Biodiversity	F. Reproduction
2.7 Producing offspring	G. Sensitivity

3. If you spill a chemical on a laboratory bench, what is the first thing that you should do?

4. Describe the treatment you would give to a learner who has cut himself or herself.

5. Choose one of the common types of injury in the laboratory. Prepare a role-play to show the treatment of the injury, and then present it to the class. Discuss with your colleagues what was good about your role-play and also which aspects could have been done better.

UNIT 2 Introduction to classification

Key unit competence

To be able to explain the need for, and apply classification and use identification keys to name unknown specimens.

At the end of this unit, I should be able to:

- Explain why we need to classify living organisms
- Name the five kingdom system of classification
- Name the characteristics of the organisms making up the five kingdoms
- Apply the binomial system of naming species
- Compare living and non-living things and explain their differences
- Explain hierarchical classification
- Explain how organisms are grouped together into different taxonomic categories
- Use simple identification keys to identify given organisms
- Appreciate the need for classification of organisms.

Introductory activity

Observe carefully the living things below and answer the following questions:

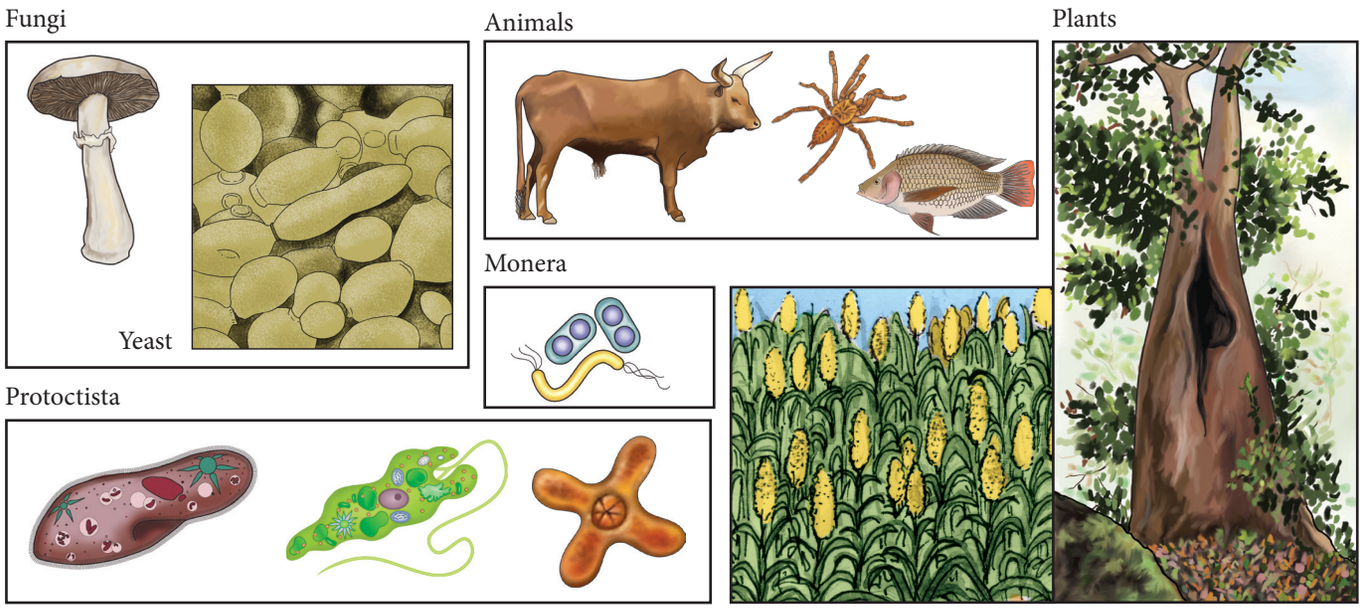


Figure 2.1: Main groups of living things.

1. How do we know that something is living?
2. Make a guess about the number of different animals and plants in Rwanda. Do you think it is a large number or a small number?
3. Think of ways in which you could put these organisms into groups.
4. Do you know the scientific name for some of these organisms?

2.1. The importance of classification

Activity 2.1

Look at the pictures below, and then answer the questions.

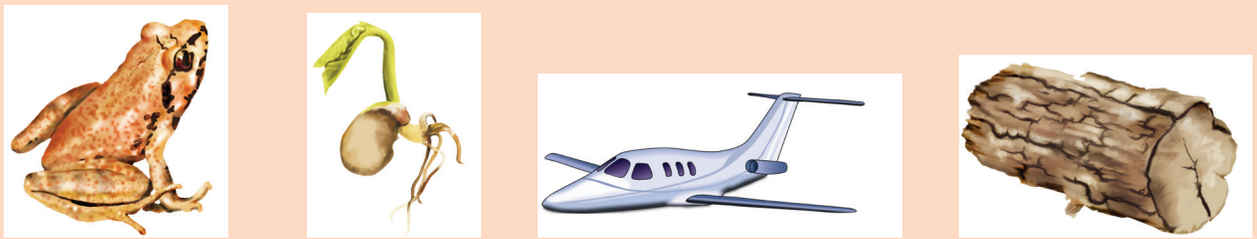


Figure 2.2: Living and non-living things

1. Draw a table with two columns. In one column, write down all the living things that you can see in the picture. In the other column, write down all the non-living things.
2. How did you decide which things were living and which were not?
3. Of the non-living things:
   a) Which were always dead?
   b) Which were once alive, but are now dead?
4. Draw another table with two columns. In one column, write down the names of all the animals you can see in the picture. In the other column, write down the names of all the plants.
5. How did you decide which things were animals and which were plants?

In the introductory activity, you talked about how many different organisms there are in Rwanda. No doubt you realised that there are a large number of different living things in our country. In fact, there are more than 2,000 different types of plants and 500 different types of animals in our country.

Scientists need to sort all living things into groups so that they can recognise and study them more easily. When you were sorting the living things into plants and animals in the activity, you were classifying them. There are so many different organisms on Earth that scientists need to sort them into groups. Classification means sorting things into groups. Think back to how you sorted the living things. You put those that shared certain characteristics into the animal group, and those that shared certain other characteristics into the plant group.

Sorting, or classifying, things into groups according to their similarities and differences is called classification, or **taxonomy**.

Scientists sometimes change the way they classify an organism as they learn more about it. Taxonomists use information from many branches of Biology to classify organisms; for example, genetics, biochemistry and fossils.

Self assessment 2.1

1. Why is it necessary to group organisms?
2. What do the scientists consider to do the taxonomy of oganisms?

2.2. The concept of hierarchical classification

Activity 2.2

By considering the area of administrative entities in Rwanda like village, cell, sector, district, province and country and by estimating the number of people in each administrative entity in Rwanda:

1. Which administrative entity has:
   a) The largest number of people
   b) The smallest number of people
2. How can you compare this with hierarchy of classification?

In Activity 2.1, you grouped different living organisms into two groups: animals and plants. However, there are thousands of different organisms in these two groups, so scientists must classify them into smaller groups. Taxonomists study more similarities and differences between different organisms so that they can classify them into smaller and smaller groups. This is called hierarchical classification.

Self assessment 2.2

1. Arrange the classification groups below into the correct order. Start with the group that contains the smallest number of organisms.

family	species	order	genus	phylum	kingdom	class

2. There are many organisms on earth. How difficult is to put in their hierarchical classes?

2.3. The binomial system

Activity 2.3

By using internet and textbooks, search and explain the nomenclature by binomial system and explain how to write a scientific name of an organism.

Usually, we use an organism's common name, for example, 'cat'. However, the word for 'cat' is different in different languages. So, people in different parts of the world use different words to describe the same organism. This makes it difficult for scientists to accurately communicate their findings about an organism accurately.

To solve this problem, the biologist Linnaeus developed a system accurately give an organism two Latin names. Using two names is called the binomial system. The first word in the name is the genus to which the organism belongs. So for a cat, this would be Felis. The second name is the species to which the organism belongs. A species is a group of closely related organisms that are able to breed with one another and produce offspring that can also reproduce. The species name for a cat is domesticus. So the scientific name for a domestic cat is Felis *domesticus*.

Figure 2.5: Yellow commelina, or Commelina africana

Let us look at another example, one from the plant kingdom. Yellow commelina is a plant found commonly in Rwanda. Its scientific name is *Commelina africana*. The name *Commelina* is its genus name. All commelina plants have the same genus name. The *africana* part of the name is the species name. Only one kind of commelina plant has the species name. So *Commelina africana* is the scientific name for a particular kind, or species, of commelina plant.

How to write scientific names

Look again at the scientific names you have learnt about in this unit: *Ficus carica*, *Felis domesticus* and *Commelina africana*. What do you notice about how they are written?

- The first name is the name of the genus the organism belongs to; it starts with a capital letter.
- The second name is the name of the species the organism belongs to; it starts with a small letter.
- When written by hand, the two names must be underlined separately; when they are printed, they must be in italics. See Figure 2.6.

A
Ficus carica

B
Ficus carica

Figure 2.6: A scientific name written by hand (A), and the same name in print (B)

Self assessment 2.3

1. Give the correct name or word for each of the following:
   a) the biologist who developed the binomial system
   b) the naming and classification of organisms.

2. Match each animal's common name with its scientific name. To help you, here are some Latin words translated into English:*mel* = honey; *taurus* = bull; *terra* = earth; *sapiens* = wise

Common name	Scientific name
2.1 Earthworm	A. *Homo sapiens*
2.2 Honeybee	B. *Bos taurus*
2.3 Rhinoceros	C. *Panthera leo*
2.4 Cow	D. *Apis mellifera*
2.5 Hippopotamus	*E. Diceros bicornis*
2.6 Lion	F. *Lumbricus terrestris*
2.7 Human	G. *Hippopotamus amphibius*

2.4. The five kingdom system

Organisms are grouped into five big groups, called kingdoms. The kingdoms are Animals, Plants, Fungi, Protoctista and Monera.
The features that are used to group organisms into these kingdoms are: body structure, method of getting food and method of reproduction.
The kingdoms are further divided into smaller groups called phyla, classes, orders, families, genera and species. See Figure 2.3.

- Each kingdom is divided into phyla.
- Each phylum is divided into classes.
- Each class is divided into orders.
- Each order is divided into families.
- Each family is divided into genera.
- Each genus is divided into species.

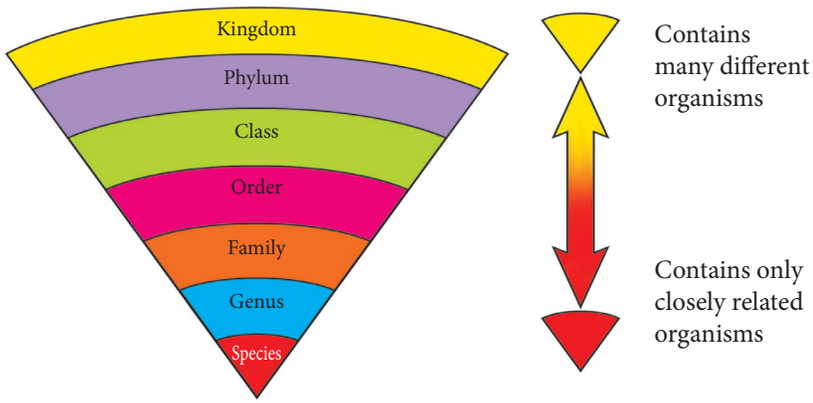
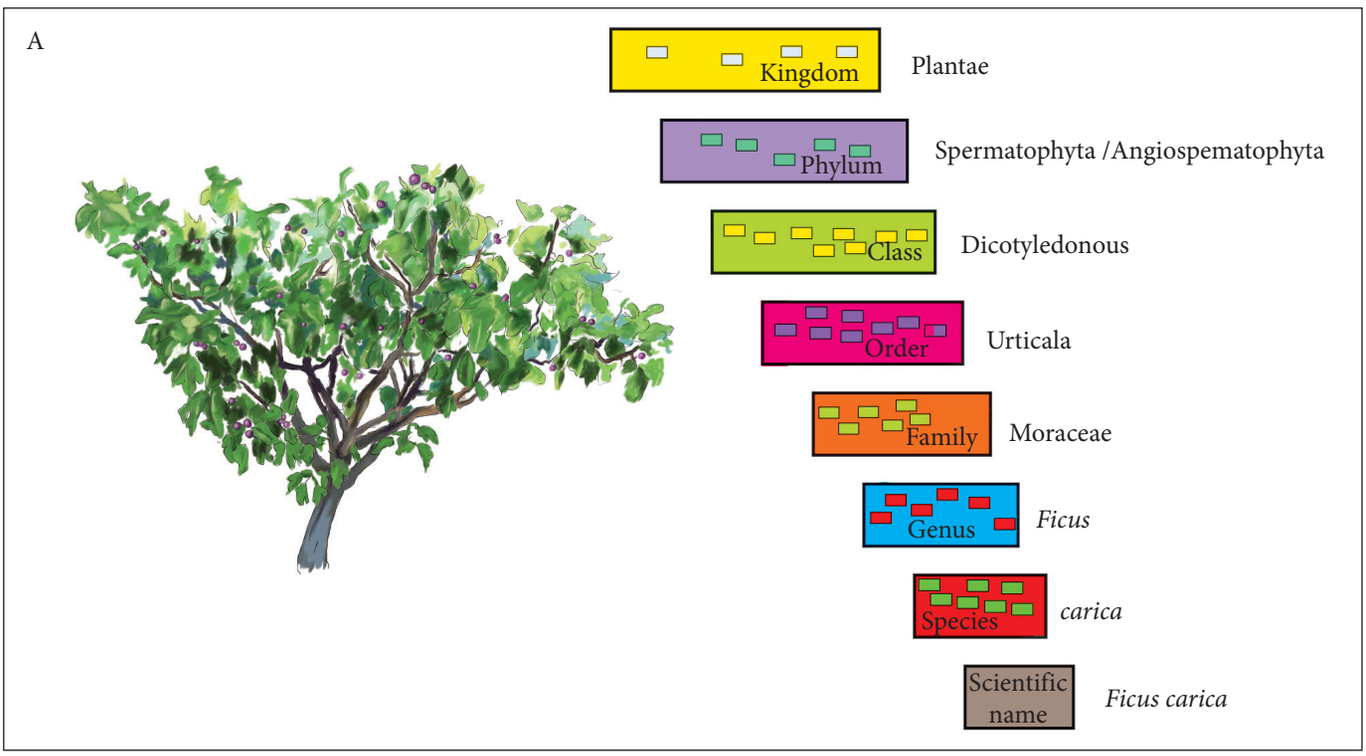


Figure 2.3: A kingdom is made up of smaller groups.

Hint

You can remember the groups with this sentence: King Phillip came over for great spaghetti (K–P–C–O–F–G–S).

The diagram below shows two classification hierarchies. A hierarchy is a way of arranging groups from the biggest group to the smallest. The first is for a fig tree and the second is for a cat.



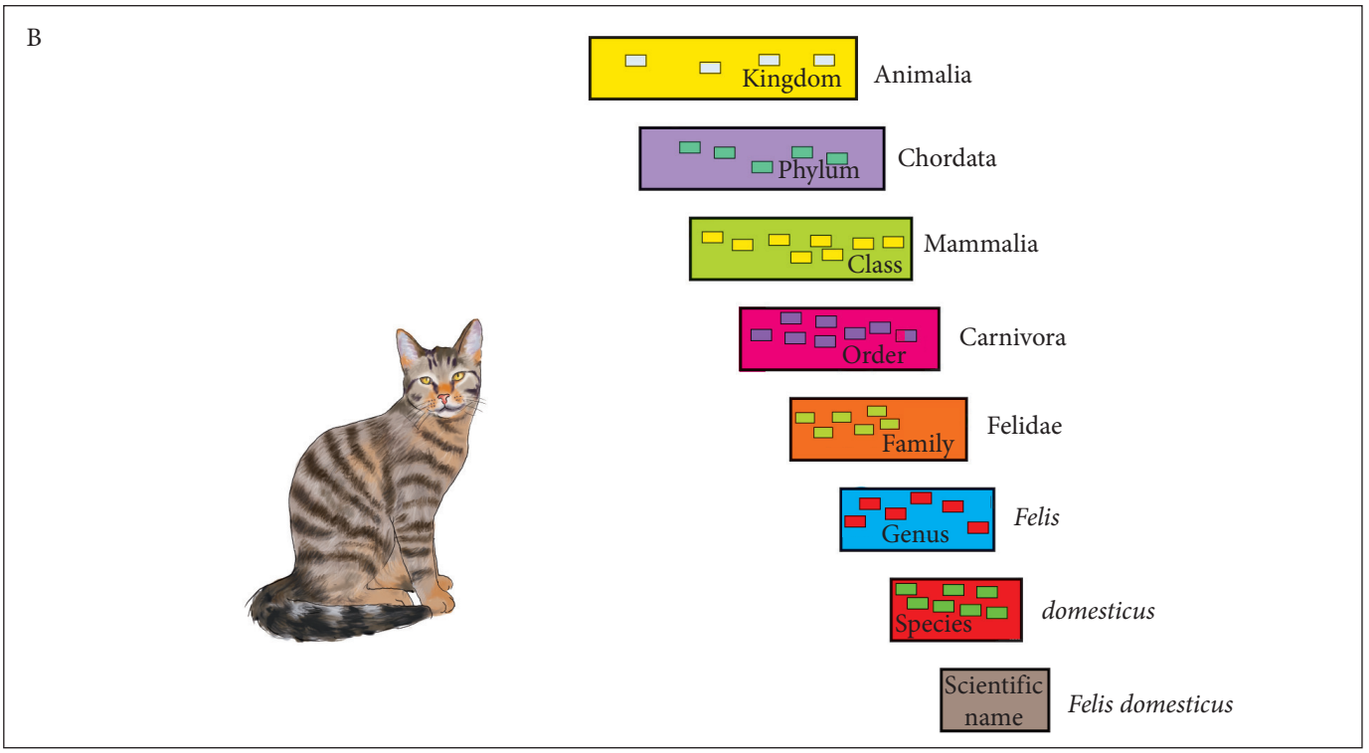


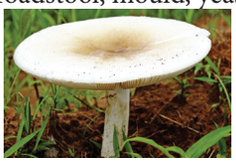
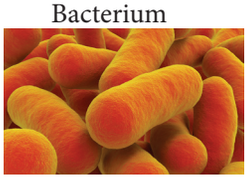
Figure 2.4 The classification hierarchy for a fig tree (A) and a cat (B)

Characteristics of organisms in the five kingdoms

Table 2.2 shows characteristics and examples of organisms in each kingdom.

Table 2.2. Characteristics of organisms in the five kingdoms

Kingdom	Characteristics	Examples
Animalia	• The organisms' cells do not have a cell wall. • The organisms are **multicellular**, feed on other organisms, and move around. • They are heterotrophic oranisms • Most animals have ability to move from one place • Their reproduction is mainly sexual by fusion of a sperm and egg.	Snail, mosquito, snake, bird  *forest cobra*
Plantae	• The organisms' cells have a cell wall. • The organisms contain a green substance called **chlorophyll** and make their own food through photosynthesis.	Moss, fern, maize, fig tree  *fern*

Fungi	• The organisms reproduce by means of spores and not seeds. • The organisms do not photosynthesise. • Some are unicellular (yeast) others are multicellular (rhizopus, penicillium,...) • They have cell wall made up of substance called chitin.	Toadstool, mould, yeas  *toadstool*
Protoctista	• The organisms are single cells or colonies of single cells. • They are euraryotes (have a true nucleus surrounded by a nucleus membrane)	Amoeba, paramecium  *paramecia*
Monera	• The organisms are single cells that do not have a membrane-bound nucleus; they are prokaryotic. • They are the smallest and simplest of all organisms. • Most reproduce by binary fusion.	Bacterium  *bacteria*

Self assessment 2.4

1. Name the five kingdoms of organisms.

2. Identify the kingdom to which each of the organisms described belongs.

a) It has a cell wall and chloroplasts.

b) It is a single cell.

c) It reproduces by means of spores.

3. Copy the table, and then complete it by putting the following animals into their correct groups: buffalo, earthworm, hyena, hare, cheetah, jellyfish, lynx. (Hint: all the animals belong to one group, but only some belong to other groups, too.)

Kingdom	Animalia	
Phylum	Chordata	
Class	Mammalia	
Order	Carnivora	
Family	Felidae (cats)	

2.5. Use simple identification keys

Activity 2.5

Look at pictures A to D alongside, and read the example of a dichotomous key. Then, answer the questions.

Example of a dichotomous key

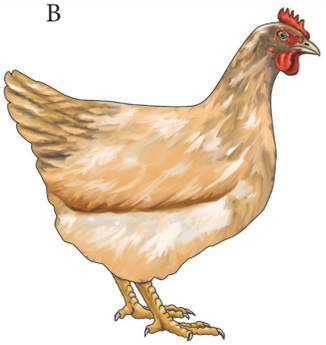
We can identify the animals A, B, C and D by using a dichotomous key like this one:

(i) Has legs _____ **See (ii)**
Has no legs _____ *Snake*
(ii) Has two legs _____ *Chicken*
Has more than two legs _____ **See (iii)**
(iii) Has six legs _____ Grasshopper
Has eight legs _____ Spider

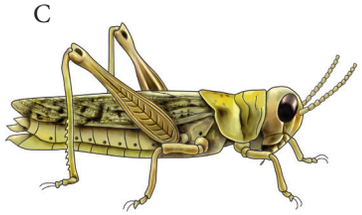
1. The key has three steps. Each step has a pair of statements which describe the animals. Notice that each pair of statements in the key divides the animals into two groups. What characteristic is used in this key to group and identify the animals?
2. Step 1 of the key separates the animals that have legs (A, B and C) from those that do not have legs (D). The first statement in Step 1 says that if the animal has legs, we should move on to Step 2. The second statement says that if the animal has no legs, it is a snake. Therefore animal D is identified as a snake.
3. Read Step 2 of the key. The first statement says that if the animal has two legs, it is a chicken. Of the three remaining animals (A, B and C), only B has two legs. Therefore, animal B is a chicken. This leaves two animals (A and C), which have more than two legs. The second statement tells us to go on to Step 3 to identify these two animals.
4. Step 3 identifies an animal with six legs as a grasshopper. Therefore, animal C is a grasshopper. Using the second statement in Step 3, can you identify animal A?
5. Your teacher will display some specimens or pictures of different organisms in the classroom. Identify their observable characteristics, and then try to make a dichotomous key using their characteristics so that someone else could identify them.

A

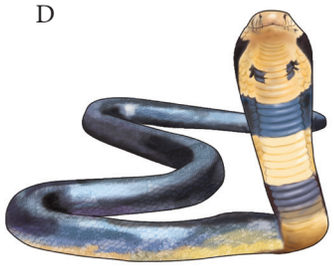
B



C



D



Scientists use identification keys to help them to identify unknown organisms. A key is a list of characteristics. Scientists compare the characteristics of the unknown organism with the descriptions on the key, and so can classify the organism. You will use a dichotomous key in the next activity ('di' means 'two'). A dichotomous key consists of pairs of statements about a characteristic of a particular organism.

Checklist of learning (Unit summary)

In this unit, I have learnt:

- ✓ There are many different organisms on Earth, and scientists classify them into groups.
- ✓ There are five groups, called kingdoms, which each have many organisms; the kingdoms are: Animalia, Plantae, Fungi, Protoctista and Monera.
- ✓ The kingdoms are further divided into smaller and smaller groups; this is called hierarchical classification.
- ✓ The groups in the kingdoms are: phyla, classes, orders, families, genera and species.
- ✓ Organisms have two names in the binomial system: a genus name and a species name.
- ✓ Animals have cells without a cell wall, are multicellular, can move around, and feed on other organisms.
- ✓ Plants have cells with cell walls, contain chlorophyll and can make their own food through photosynthesis.
- ✓ Fungi reproduce by spores instead of seeds and do not photosynthesise.
- ✓ Protoctista are single-celled organisms.
- ✓ Monera are single cells without a membrane-bound nucleus.
- ✓ To appreciate the need for classification of organisms.

End unit assessment

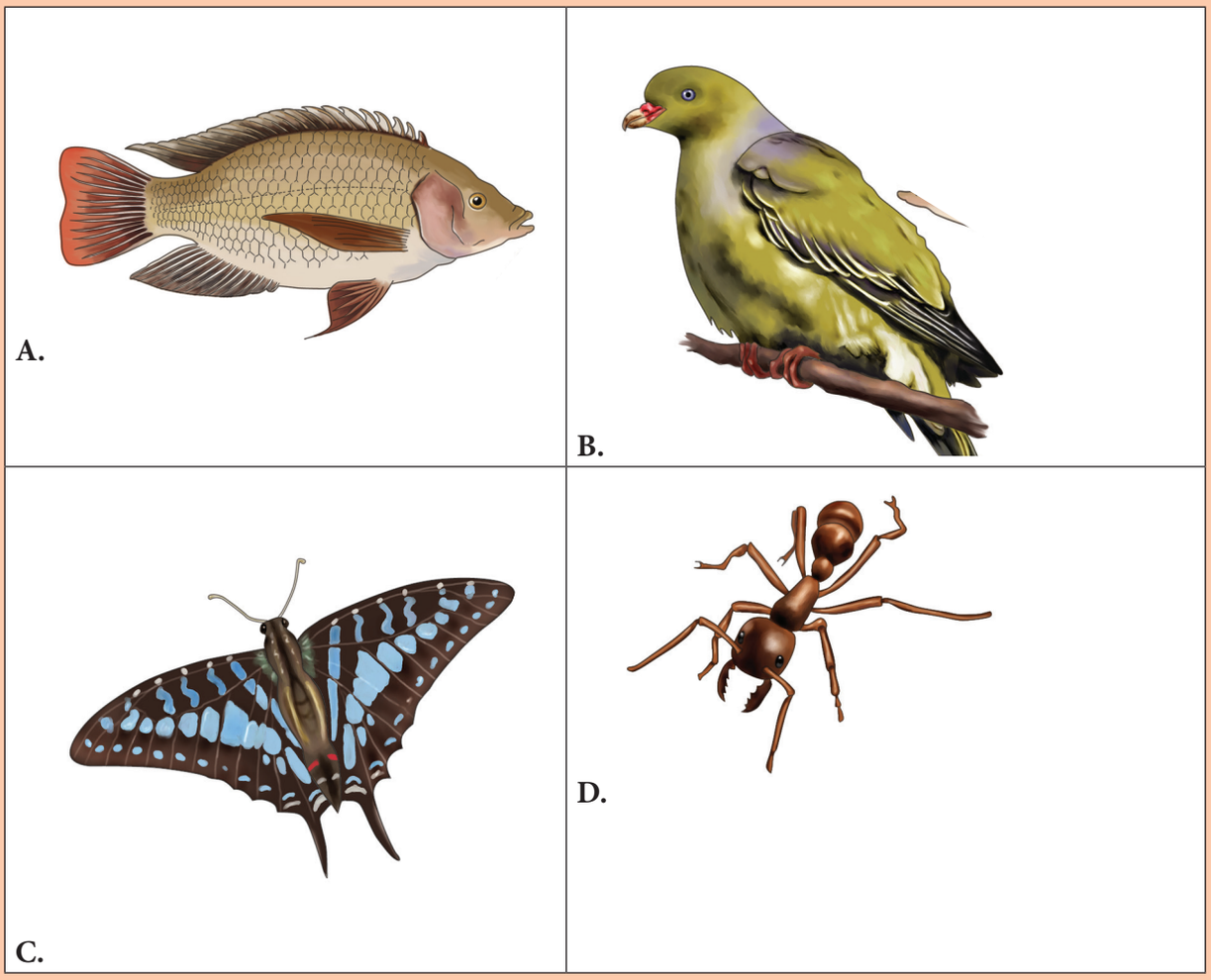
1. The group of classification where organisms resemble one another and are capable of interbreeding together to produce viable offspring is known as:
   - a) Species
   - b) kingdom
   - c) Genus
   - d) Phylum
2. Which one of the following is not a kingdom of living organisms?
   - a) Monera
   - b) Animalia
   - c) Annelida
   - d) Protoctista
3. The following is a list of organisms belonging to various kingdoms: housefly (Musca domestica), maize (Zea mays), Frog (Rana spp), Bat and Eagle.
   - a) Classify these organisms into their kingdoms
   - b) Name any two organisms that are not closely related and give a reason.
   - c) What does the name mays represent?
   - d) Define the term species
4. How are fungi different from members of kingdom plantae?

5. Copy the table, and then complete it by putting the following animals into their correct groups: cow, perch, locust, lion, donkey, leopard.
(Hint: all the animals belong to one group, but only some belong to other groups, too.)

Kingdom	Animalia	
Phylum	Chordata	
Class	Mammalia	
Order	Carnivora	
Family	Felidae (cats)	

6. The figure below shows four animals: A, B, C and D.

a) Construct a dichotomous key that can be used to identify the animals.



b) Discuss the dichotomous keys that you constructed.

UNIT 3 The external structure and importance of flowering plants

Key unit competence

To be able to analyse the external structure of a typical flowering plant

At the end of this unit, I should be able to:

- Identify the external parts of a flowering plant
- Describe how plant organs are organized into systems
- Explain the functions of roots, stem and leaves in plants
- Identify different root, stem, and leaf modifications
- Describe the external structural modifications shown by roots, stem and leaves
- Explain the importance of flowering plants
- Differentiate flowering plants from other plants
- Observe the external structure of leaves and root modifications and how they carry out other functions
- Explain the difference between fibrous and tap root systems
- Carry out home observation on the importance of flowering plants and submit a report
- Appreciate the importance of food storage organs in plants and the value of roots and leaves to man.

Introductory activity

1. In unit 1, you have seen that plants are not able to move from one place to another. In your groups, choose one of the plants in school garden and observe its structure that cause inability for the plant to move. What are parts of the plant that help it to survive though it cannot move for running after food and water.
2. Describe how some plants, such as avocado, maize and cassava reproduce?

A B C

Figure 3.1: The flowering plants maize (A), sorghum (B) and cassava (C) are important food crops

3.1. The external structure of a flowering plant

Activity 3.1

Work out the following:
From your school garden, take a typical dicotyledonous plant with roots, e.g. a bean plant or black jack;. Your will need a hand lens as material.

1. Identify the following parts on your flowering plant: shoot system, root system, bud, node, internode, leaves, stem, flowers, fruits, roots. Use Figure 3.2, to help you.
2. Note the main features of the stem and root.
3. Make a large drawing of your plant specimen, showing all the parts you have identified. Label the diagram carefully.

Flowering plants are a large group of plants and trees. They all have flowers, bear fruit and produce seeds. They are organisms that are made up of different organs, which are called stems, leaves, flowers and roots.

Monocotyledonous and dicotyledonous plants

There are two main types of flowering plants: monocotyledonous and dicotyledonous plants. All flowering plants have seeds with cotyledons, or seed leaves. Some plants have just one cotyledon and others have two. Table 3.1 shows the main differences between these two groups.

Table 3.1. Differences between monocotyledonous and dicotyledonous plants

Monocotyledons	Dicotyledons
One seed leaf, or cotyledon	Two seed leaves, or cotyledons
Fibrous roots	Tap root
Flower parts are in multiples of three	Flower parts are in multiples of four or five
Narrow leaves with parallel veins	Leaves with a net-like pattern of veins
Examples: grasses and cereal plants, such as maize and sorghum	Examples: mangoes, avocados, beans and figs

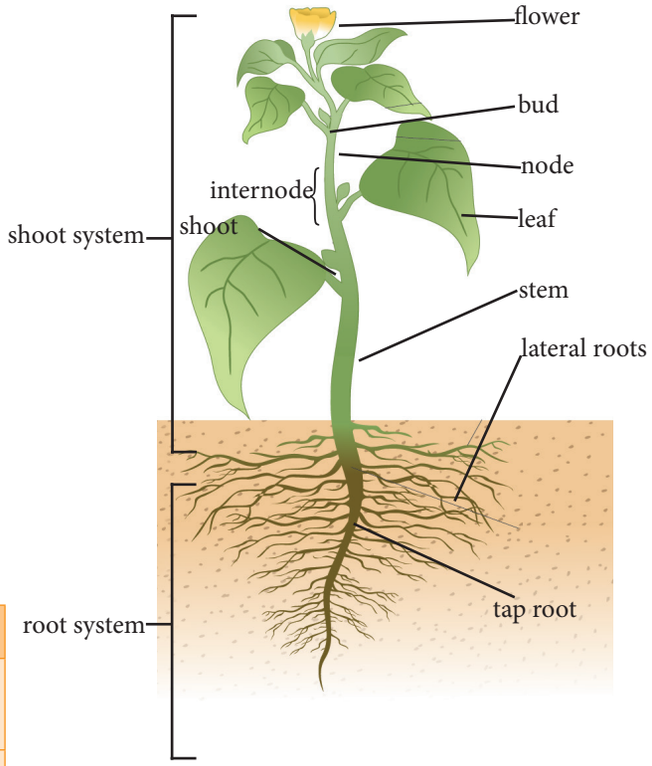
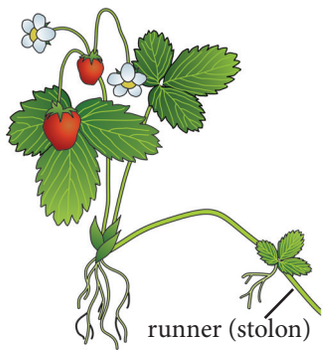


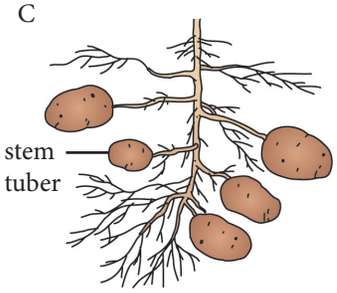
Figure 3.2: A generalised flowering plant

A



B

C



D

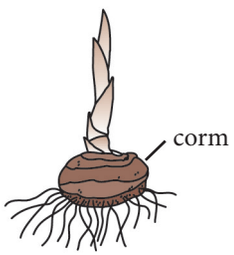


Figure 3.3: Examples of modified stems: strawberry (A), ginger (B), potato (C), yam (D)

a) The stem

The stem is the part of a flowering plant that usually grows above the ground. A stem has buds and side shoots, and bears leaves. Most stems are green as they contain chlorophyll.

The place where a leaf grows from a stem is called a node. The length of a stem between the leaves is called an internode.

Functions of the stem

The stem:

- transports water and mineral salts from the roots to other parts of the plant
- transports sugars (food) from the leaves to all other parts of the plant
- supports and holds buds and leaves so that they can get enough sunlight for photosynthesis
- holds flowers in the best position for pollination
- supports the fruits and seeds in the best position for dispersal
- makes food for the plant through the process of photosynthesis.

Modified stems

Most stems have similar functions, but some stems are modified so they can do other jobs. Modified stems have features that help them to do a particular job. For example, some stems can be modified for asexual reproduction. Plants with such stems can make new plants using their modified stems. The stems can produce small, identical new plants at their ends, or roots can form where a stem touches the ground, and a new plant can grow from there.

For example, in strawberries, bananas and sisal, suckers and stolons can be used to make new plants.

Some stems are modified for food storage, for example, ginger, potatoes, yams and strawberries. Figure 3.3, on page 28 shows some modified stems.

Experiment 3.1

Work on your own.

You will need: specimens or photographs of the following: a rhizome of ginger, a canna lily, couch grass or potato; a creeping stem of oxalis; a corm of coco yam; a stolon of a strawberry; a hand lens

Procedure

1. Examine the different types of stems provided. Note the main features of each stem.
2. Suggest the function of each stem and note how it is suited to its function.
3. Make a drawing of each different stem type, and label the drawings carefully.

b) Leaves

Leaves are attached to a plant's stem at the nodes by a stalk called a petiole (see Figure 3.4). Leaves are usually thin, wide and flat in shape. The wide, flat area of a leaf is called the lamina. Leaves are the main organs of photosynthesis. Leaves are green because their cells contain a lot of chlorophyll, to capture the sunlight that falls on the leaf.

The structure of a leaf is closely related to the job it has to do for the plant. The thin, flat lamina means that leaves have a large **surface area**. Carbon dioxide can easily get into the leaf. The large surface area can also trap lots of sunlight for photosynthesis. Leaves have a system of veins which bring water and minerals to the cells and carry away the sugar made by photosynthesis. The main vein, which connects with the petiole, is called the midrib.

The top layer of a leaf is covered by a waxy waterproof layer called the cuticle. The cuticle prevents water loss through the surface of the leaf.

The arrangement of the veins on a leaf can vary a lot. The veins of a monocotyledonous plant run in parallel lines. The leaves of a dicotyledonous plant have a network of branching veins.

The size and shape of leaves can also vary (see Figure 3.5). Leaves can be split into several parts or have smooth, toothed or lobed edges (margins). Many of these features help us to identify different types of plants.

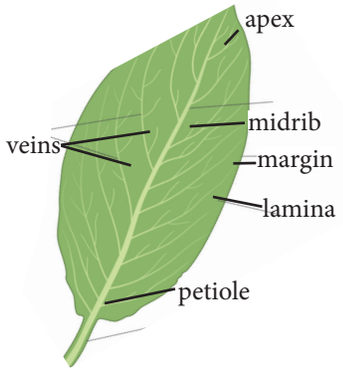


Figure 3.4: The generalised structure of a leaf

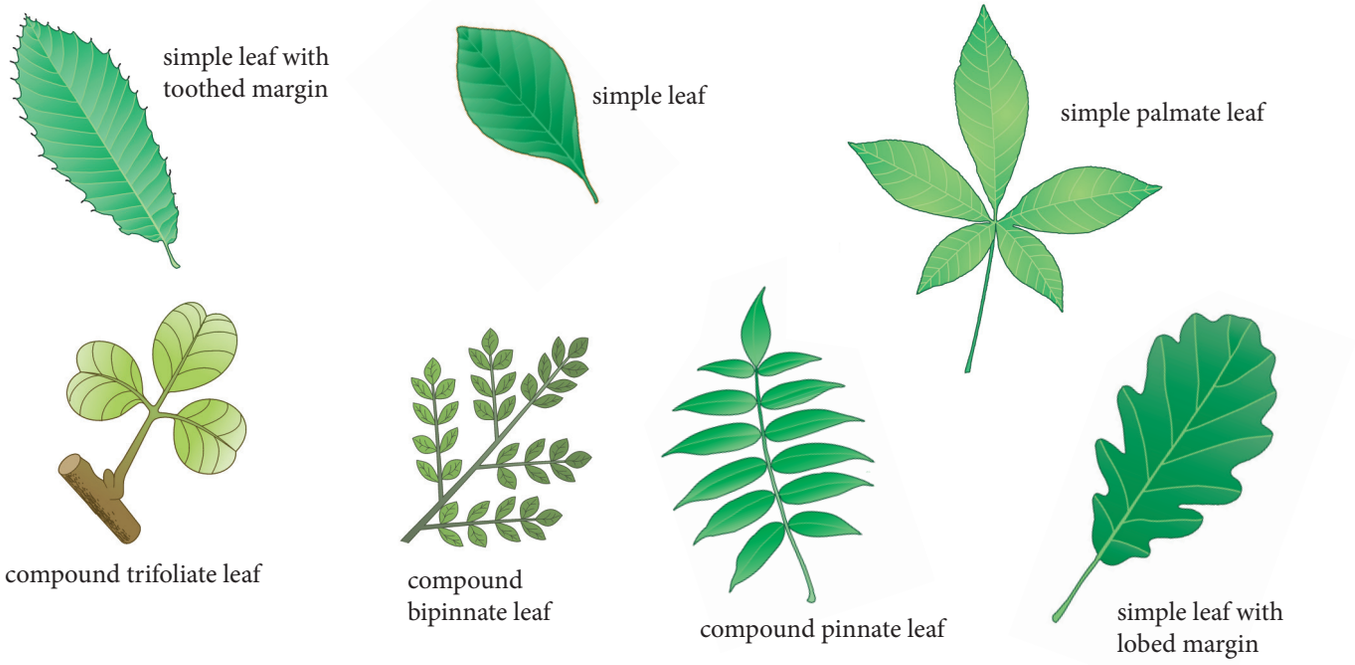


Figure 3.5: Leaves can have different shapes and sizes.

Functions of leaf parts

Table 3.2 describes the functions of the different parts of the leaf.

Table 3.2. Parts of the leaf and their functions

Part	Function
Petiole	• Carries food made by photosynthesis from the leaf to the stem • Transports mineral salts and water from the stem to the leaf • Supports the leaf
Midrib	• Supports the lamina • Carries water and mineral salts from the petiole to the lamina • Transports food from the lamina to the petiole
Veins	• Support the lamina • Distribute water and mineral salts within the lamina • Collect food from the lamina
Lamina	• Contains chlorophyll for trapping light energy, which is needed for photosynthesis

Modified leaves

As with stems, some leaves are modified for different functions. Some of the most common modifications enable the plant to:

- Prevent animals from eating the plant. Such leaves are usually prickly, poisonous or have an unpleasant taste.
- Prevent water loss. These leaves often have a thick, shiny, waxy layer on their surface. They may be reduced to spines (e.g. a cactus), or be covered with a layer of tiny hairs. Some leaves are curled up to prevent water leaving the leaves.
- Store water. These leaves are fleshy and used to store water.
- Store food; examples include onion and garlic.

Exercise

Work out the following:

1. Collect at least three different types of leaves.
2. Draw a table to show the differences between the leaves.
3. Make a labelled drawing of any one of the leaves, showing its main parts.

Figure 3.6: Examples of leaf modifications: a cactus (A), onion (B) and succulent (C)

Leaf arrangement on the stem (phyllotaxis) and leaf venation

In botany, phyllotaxis or phyllotaxy is the arrangement of the leaves on the stem of a plant.

Types of leaf arrangement

1. Opposite leaf arrangement

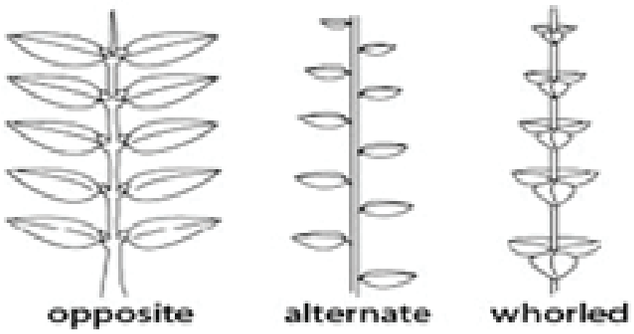
In this case, two leaves grow in opposite directions from the same nodes.
If successive leaf pairs are perpendicular, this is called decussate.

2. Alternate leaf arrangement

Alternate leaf arrangement means that each leaf grows at a single node.

3. A whorled leaf arrangement

It consists of three or more leaves at each node.
A whorled leaf pattern/arrangement can occur as a basal structure where all the leaves are attached at the base of the shoot and the internodes are small or non existent

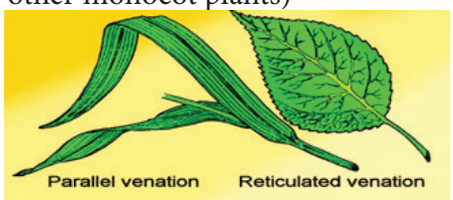


Venation

This is the arrangement of veins in the leaf. There are two types of venation:

(i)Reticulate venation: the veins are arranged in a network (E.g.: Dicot plants)

(ii)Parallel venation: there are several main veins running parallel to one another and connected by short cross branches (E.g.: grass, maize or other monocot plants)



c) Flowers

Flowers are the reproductive organs of a plant. Some flowers form individually on stems, whilst others are arranged in clusters. An arrangement of flowers on a stem is called an inflorescence. Figure 3.7 shows the main parts of a flower. Flowers produce the male and female sex cells, which are called gametes. The female sex cells are inside the ovules. The male sex cells are inside the pollen gains.

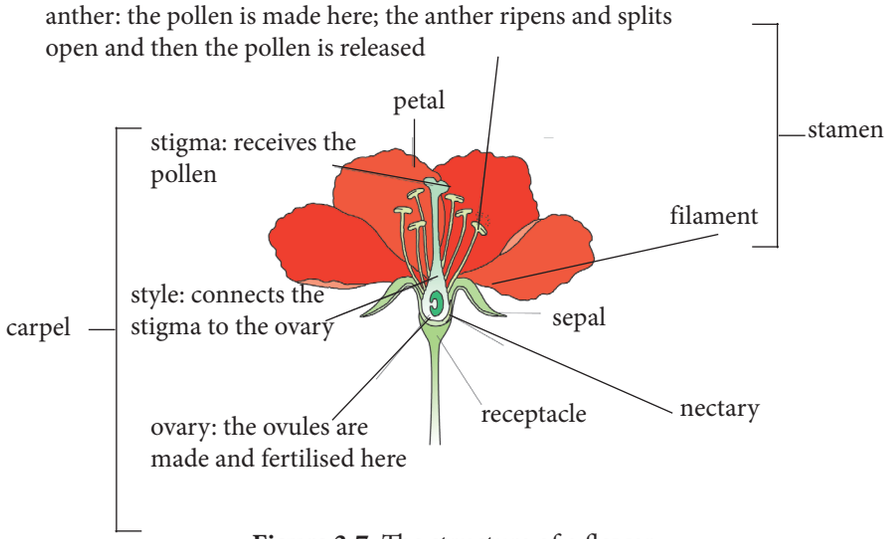


Figure 3.7: The structure of a flower

Experiment 3.2

Work in groups. Complete the experiment, and then answer the questions.

You will need: a razor blade; a hand lens; a large flower such as hibiscus; a grass flower

Procedure

1. Compare the characteristics of both flowers.
2. Carefully dissect the hibiscus flower to observe all its parts.

Questions

1. Explain why some parts of a flower are brightly coloured.
2. Name at least eight parts that you saw on the hibiscus flower.
3. Make a labelled drawing to show the main parts of a flower.

Self assessment 3.1

1. Suggest the functions of all the plant parts you identified in activity 3.1.
2. Explain why potatoes, sweet potatoes and carrots are called tubers.
3. What makes a potato a stem and not a root?
4. Give two functions that different types of modified stems can carry out.
5. Give the meaning of each of these terms.
   a) petiole
   b) pollination
   c) monocotyledon
6. a) List the functions of leaves.
   b) Describe two ways in which leaves are suited to their functions.
7. A plant has a tap root, two cotyledons and a flower with eight petals. Is this a monocotyledonous or a dicotyledonous plant?

3.2. The external structure of a root system

Activity 3.2

Work out the following:

You will need: specimens or photographs of the following: a bean plant, an onion, couch grass or a maize plant, a carrot; a hand lens

Procedure

Use the hand lens to observe the different types of root systems in the specimens.

Questions

1. Suggest two functions of roots.
2. a) Draw and label the parts of the bean plant's root system.
   b) What is the function of each part labelled?
3. Identity the type of root for each plant.
4. a) What root modifications can you see?
   b) What are the functions of modified roots?

The root system of a flowering plant develops from the radicle of the embryo in the seed. Most roots are white, cream or brown in colour. They do not contain chlorophyll and so cannot photosynthesise.

There are two main types of root systems.

- A tap root system consists of a single main root with smaller lateral, or side, roots branching from it. Tap root systems are found in dicotyledonous plants, for example black jack, carrot and bean. See Figure 3.8A.
- A fibrous root system is made up of many roots that grow from one point and that have side roots branching from them. Monocotyledonous plants, such as maize and elephant grass, have a fibrous root system. See Figure 3.8B.

A

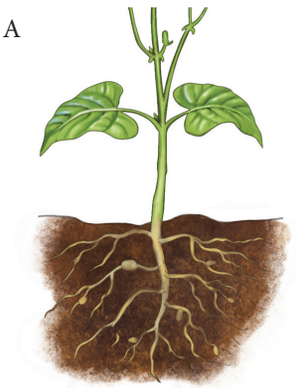


Figure 3.8. A: Root systems: a tap root

B

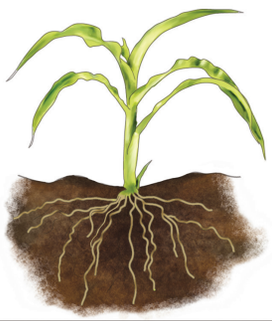


Figure 3.8. B: Fibrous root

Functions of roots

The main functions of roots are to:

- hold the plant firmly in the soil
- absorb water and minerals from the soil
- transport water and minerals to the stem.

Modified roots

Roots can also be modified to carry out other functions. While most roots are underground, sometimes roots grow above the ground for extra support, for example maize and sugarcane. These are called prop roots. Aerial roots grow above the ground and are used for **gaseous exchange**. This is the exchange of oxygen and carbon dioxide between the inside and outside of the root. Many plants that grow in mangroves have aerial roots. Prop roots can grow from aerial roots to give the plant extra support; for example, maize and

sugarcane. Some plants have roots that are used for food storage; for example, carrot and sweet potato. Some modified roots enable the plant to reproduce asexually. Examples include sweet potato and cassava.

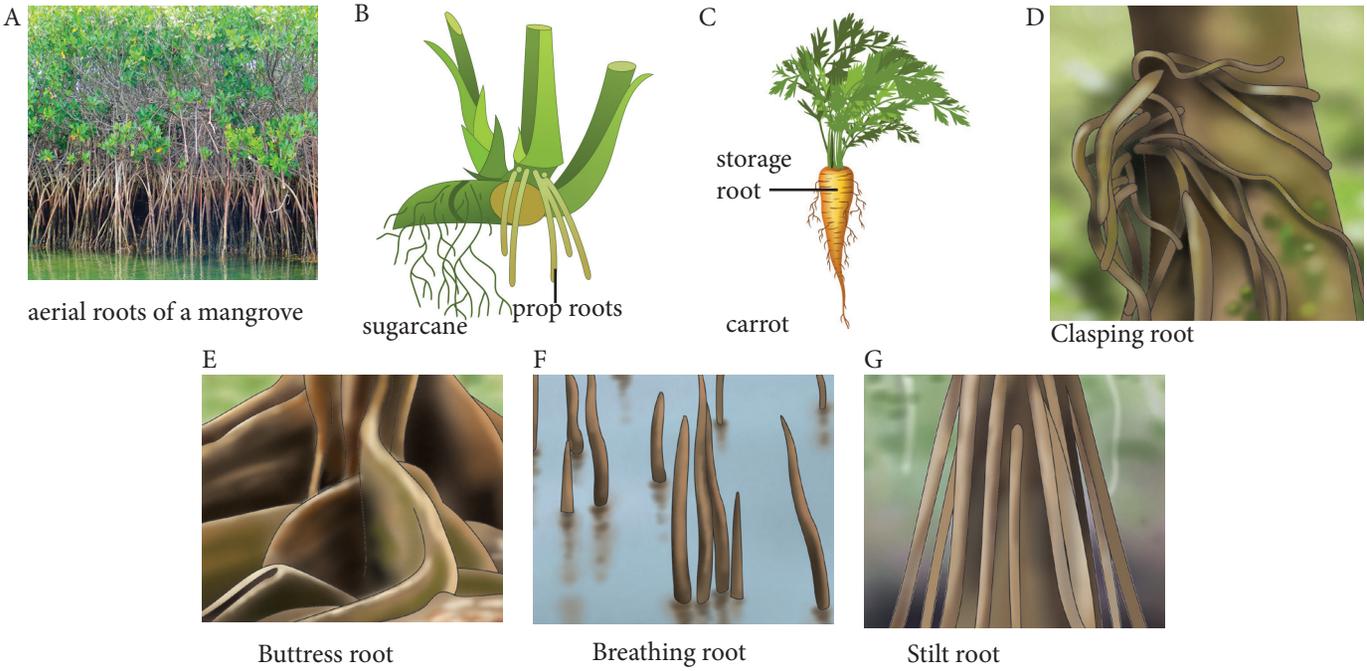


Figure 3.9: Examples of modified roots: aerial roots (A), prop roots (B), a storage root (C), clasping root (D), buttress root (E), breathing root (F) and stilt root (G)

Self assessment 3.2

1. Work out the following:

You will need: specimens or photographs of the following: prop roots of maize or sugarcane; clasping roots of vanilla; aerial roots of Ficus; buttress roots of flamboyant tree; breathing roots of white mangrove; stilt roots of red mangrove; storage root of carrot or sweet potato; a hand lens

Procedure

a. Examine the roots of your specimens, and then make a list of all the root modifications you can see.
b. Describe the main features of each root.
c. Describe how each root type is suited for its functions.
d. Make labelled drawings of the different root types.

2. Collect at least four plants with different types of root systems.What type of root system does each plant have?

3.3. The importance of flowering plants

Activity 3.3

1. List the importance of flowering plants in your own home and community.
2. Try to find examples of plants in Rwanda that their flowers are used with economic purpose?
3. Research the growing of plants using hydroponics. Find out how this practice works, and explore its advantages and disadvantages.

Flowering plants are important for the following reasons.

- They are a food source for many organisms.
- Plants help to maintain a balance of gases in the atmosphere. They remove carbon dioxide from the air, and release oxygen into it during photosynthesis.
- They are important food crops for humans, for example, maize, wheat and sorghum.
- They provide shelter for many animals, such as birds and monkeys.
- Many trees are a source of timber, which is used in construction, to make furniture and for firewood.
- Some plants can be used to make medicines, for example, the quinine tree is used in anti-malarial medicines.
- Some plants, such as cotton, can be used to make fabrics.
- Plants help to make our surroundings beautiful.

Checklist of learning (Unit summary)

In this unit, I have learnt:

- ✓ Flowering plants have flowers, bear fruits and produce seeds.
- ✓ Flowering plants consist of roots, stems, leaves and flowers.
- ✓ There are two main groups of flowering plants: monocotyledons and dicotyledons.
- ✓ The stem is usually green, and it is above the ground.
- ✓ The stem holds the leaves and flowers in place, transports water and mineral salts to the leaves, transports sugars from the leaves to other parts of the plant, and makes food by photosynthesis.
- ✓ Some stems are modified for asexual reproduction and food storage.
- ✓ Leaves are the main organs of photosynthesis, and they are well adapted for this function.
- ✓ Some leaves are modified for water and food storage, and to prevent water loss.
- ✓ Flowers are the reproductive organs of flowering plants.
- ✓ There are two types of root systems: tap roots and fibrous roots.
- ✓ Roots hold the plant in the soil, and absorb and conduct water and mineral salts from the soil into the plant.
- ✓ Some roots are modified for food storage, extra support and asexual reproduction.
- ✓ Flowering plants are important because they balance gases in the atmosphere, provide food and shelter for animals, and are food crops; they beautify our environment and can be used in construction, to make furniture, medicines and fabrics, and as firewood.

End unit assessment

1. Give the correct word or term for each of these descriptions.
   a) the thin, flat, wide area of a leaf
   b) a root system that has one main root and small lateral roots
   c) plants that have their flower parts in multiples of three.
2. Draw a picture of a flower, showing all its parts.
3. Explain how a leaf is adapted to enable it to photosynthesise.
4. Name two types of root systems.
5. List three reasons why flowering plants are important.
5. Find out about biodiversity in Rwanda by researching the following:
   - indigenous plants and animals in Rwanda
   - the names of some endangered species in Rwanda
   - the importance of conservation in Rwanda.

Formal assessment for topic 1

1. Identify animals A to H below by using the key.

A

B

C

D

E

F

G

H

KEY

1. Animal has four legs _____ **See 3**
   Animal has fewer or more than four legs _____ **See 2**
2. Animal has two long legs _____ *Blue crane*
   Animal has eight legs and two pincers _____ *Scorpion*
3. Animal has horns _____ **See 4**
   Animal does not have horns _____ **See 5**
4. Horns are straight and pointed _____ *Duiker*
   Horns are large and curved _____ *Buffalo*
5. Animal is covered with fur _____ **See 6**
   Animal is covered with scales _____ *Nile monitor lizard*
6. Animal has speckled fur all over its body _____ *Mongoose*
   Animal has dark fur on some parts of its body _____ **See 7**
7. Animal has dark fur on its legs _____ *Bat-eared fox*
   Animal has dark fur on its back and tail _____ *Black-backed jackal*

(8)

2. What type of plant structure is each of the following?

a) an onion **b)** ginger **c)** cassava (3)

3. Complete the table by filling in the missing information.

Kingdom	Features	Example
3.1	Have many cells. Need to eat other organisms.	Chimpanzee
3.2	Can photosynthesise.	3.3
Fungi	3.4	3.5
3.6	Are single-celled. Have a nucleus.	Amoeba
Monera	3.7	Bacterium

(7)

4. **a)** Make a labelled drawing to show the structure of a flower. (8)

b) Name two types of root systems. (2)

c) List three reasons why flowering plants are important. (3)

5. Find out about biodiversity in Rwanda by researching the following:

- indigenous plants and animals in Rwanda
- the names of some endangered species in Rwanda
- the importance of conservation in Rwanda.

Present your information as a poster. (14)

Total marks: 45

TOPIC

2 Organisation and maintenance of life

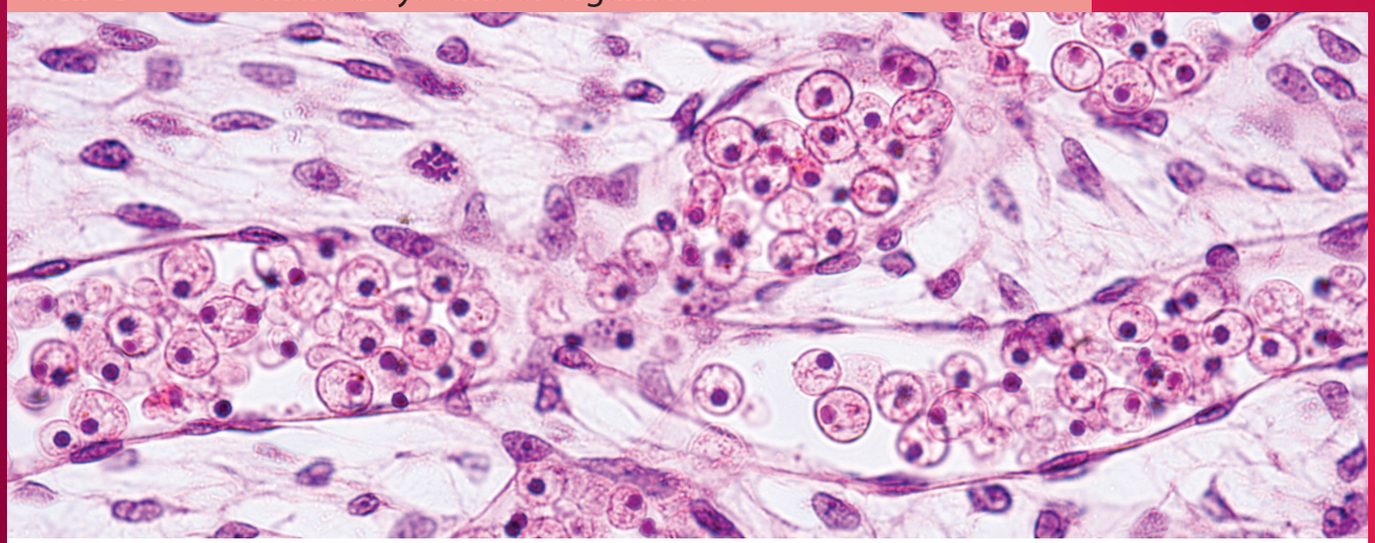


Figure 4.1: Cells are the simplest unit of life; we can see them by using a microscope.

UNIT 4 Magnifying instruments and biological drawings

Key unit competence

To be able to explain the components and demonstrate proper use and care of a hand lens and light microscope.

At the end of this unit, I should be able to:

- Explain why we need to use magnifying instruments
- Identify a given unknown specimen
- Recall that a hand lens is a simple magnifying glass for observing relatively small objects
- Identify the different components of a light microscope and explain their functions
- Recall that microscopes are delicate instruments that need great care
- Explain that the light microscope has various levels of magnification
- List the features of a good biological drawing
- Explain that magnification is the number of times larger an image is than the object (specimen) under the microscope
- Manipulate a hand lens to observe relatively small specimens
- Manipulate a light microscope to observe various specimens from prepared slides
- Illustrate the biological specimens observed under a light microscope
- Illustrate well labelled biological diagrams of specimens
- Compare the relationship between the actual size of the specimen and its image
- Measure and calculate the magnification of a given specimen
- Appreciate the need for using a light microscope and a hand lens in observation of specimens
- Show perseverance when making scientific observations
- Show care and proper use of the magnifying instruments.

Figure 4.2: Microscopes are important instruments for observation.

Introductory activity

Observe the figure 4.2 and answer the following questions:

1. Give two reasons why scientists need to observe things using instruments that make these things bigger.
2. Work out a definition of the word 'magnify'.
3. Discuss whether you have ever used a magnifying instrument. If you have, then describe what you used it for and what you saw.

4.1. Why do we need magnifying instruments?

Activity 4.1

Work out the following:

You will need: a hand lens; a light microscope; newsprint; moss plants; a pencil; paper

Procedure

1. Place the lens just above the newsprint, and then look down through the lens.
2. Move the lens closer to your eyes, and then further away from your eyes.
3. Repeat step 2, above, using a moss plant. Identify the small green leaves and the tiny transparent rhizoids.

Questions

1. How does the image appear when the hand lens is close to the object and when it is further away from the object?
2. Make a simple drawing of a moss plant, and label the structures you have identified; for example, the leaves, rhizoids and stem.

Biologists make many observations when they work. Observations enable them to see the details of living things. Many things are too small for us to see using only our eyes, so they need to be made bigger, or **magnified**. There are two instruments that biologists use for this. When they work outside the laboratory, they can use a hand lens. Inside the laboratory, they can use a microscope.

Hand lenses

A hand lens is a magnifying instrument that is held in the hand. We use it to look at small things, such as insects, flowers and animal parts, that are too big to put on a microscope slide.

Microscopes

The first microscope was invented by Robert Hooke in 1665. He used it to look at cells. Today, we can use powerful microscopes to see viruses, bacteria and cells. There are many types of microscopes.

Figure 4.3: Hand lens

Figure 4.4: The first microscope, invented by Robert Hooke, in 1665

4.2. Parts of a microscope

Activity 4.2

Work out the following:
You will need: a microscope, or you can use the diagram below if your school does not have a microscope

Procedure

1. Look at the microscope and Figure 4.5, which shows the parts of a light microscope.
2. What are the functions of the main parts of a microscope?

In the following experiment, you will learn about the different parts of a light microscope and what the function of each part is.

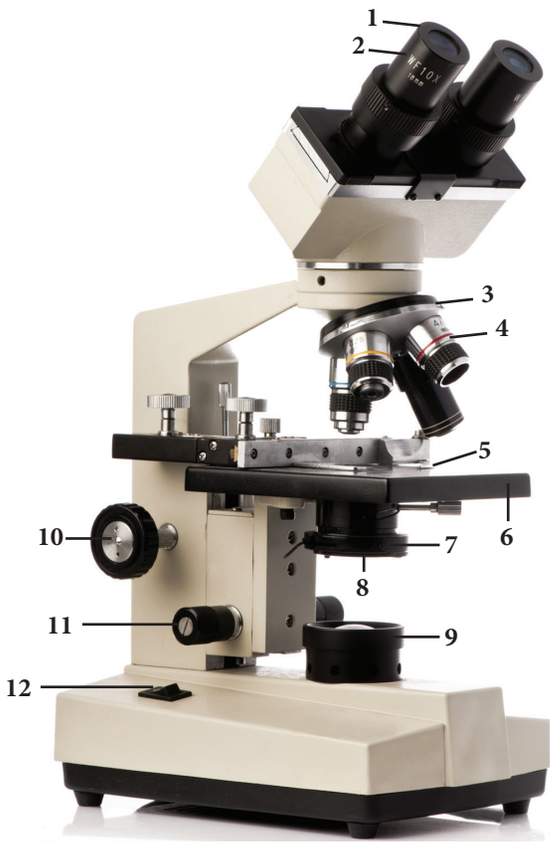


Figure 4.5: Light microscope

1 **eyepiece** – the lens that you look through; it usually has 10× or 15× power

2 **body tube**

3 **nosepiece** – holds two or more objective lenses; it is rotated to change power

4 **objective lenses** – lenses of different magnification; the shortest lens has the lowest power; the longest lens has the highest power

5 **stage clip** – holds the slide in place

6 **stage** – the flat platform where you place your slides; it can be moved left and right to view the slide and up and down to focus

7 **diaphragm** – a rotating disk with holes of different sizes; it is used to vary the intensity and size of the cone of light that is projected upwards into the slide

8 **condenser** – focuses the light onto the slide

9 **light source** – bulb or lamp; if the microscope has a mirror, it is used to reflect light from an external light source up through the bottom of the stage

10 **coarse focusing knob** – brings the specimen into focus under a low-power objective lens; it cannot be used with high-power objective lens

11 **fine focusing knob** – brings the specimen into focus under medium- and high-power objective lenses

12 **light switch** – turns the light source on

4.3. The functioning of a microscope

Activity 4.3

Work out the following:

1. Carefully carry a microscope to your workbench or desk using both hands. One hand should be on the arm of the microscope and the other underneath, below the base.
2. Identify the different parts of the microscope using Figure 4.5, on page 42, to help you. Do not touch the surface of the lenses.
3. Turn the nosepiece so that the objective lens with the lowest magnification is in position.
4. Turn the coarse focus knob and observe what happens to the objective lens.
5. Turn the mirror so that light is reflected through the lens.

The following are the steps in using a microscope

1. Make sure that the lowest power objective lens is in place.
2. Turn the coarse focus knob until the lens is as far away from the stage as possible.
3. Put the slide onto the stage and clip it in place. Move the slide until the specimen is directly under the lens.
4. Slowly turn the coarse focus knob until the specimen is in focus. You can use the diaphragm above the mirror to change the amount of light passing through the specimen.
5. Once the specimen is in focus with one lens, it will be nearly in focus with the other lenses. Now you will need to turn only the fine focus knob.
6. Turn the nosepiece so that a more powerful objective lens is in place above the slide.
7. Use the fine focus knob to bring the specimen into focus.

How to store and care a microscope

Care of a microscope

Microscopes are expensive instruments that can be damaged easily, so it is important to handle them with care. These are some of the ways of caring for a microscope.

1. Always place the microscope in its box when it is not in use, or cover it with a plastic cover.
2. Avoid touching any lens surface of the condenser and objectives. Polish these regularly using a tissue.
3. Never force the coarse and fine focus adjustments beyond the end of their range of movement.
4. Always carry a microscope by the arm and stand, and use two hands.
5. Keep the stage dry and clean.
6. Always cover the specimen on the slide with a cover slip, to protect the objective lens.
7. Always move the lens up when focusing, to avoid breaking the slide.
8. Clean the mirror occasionally using a tissue.
9. Never unscrew the lens components.

4.4. Biological drawings

Biologists need to make careful and accurate observations. They need to record what they see, and so they need to draw accurate biological drawings of their specimens. We can learn the skill of drawing biological specimens accurately, through practice.

A good biological drawing should:

- have a detailed, underlined title at the top of the page
- have smooth, fairly thin, solid pencil lines made by controlled movements of the hand
- be large enough to show all the parts
- be neat
- show the magnification (you will learn about this in the next section).

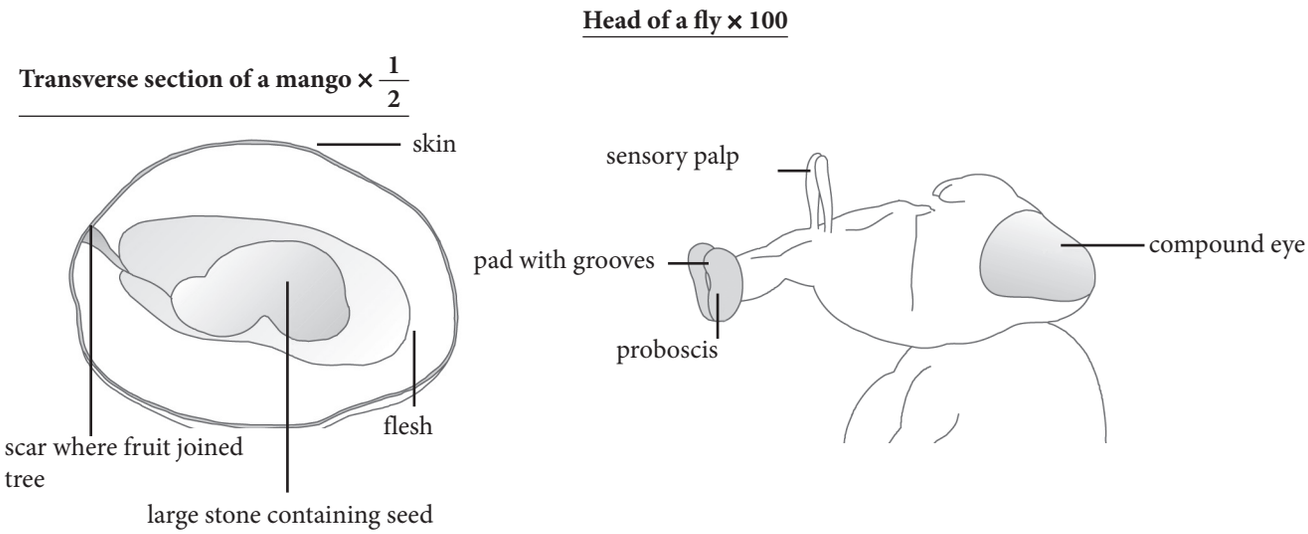


Figure 4.7: Examples of biological drawings

4.5. Magnification

The **magnification** of a specimen is a measure of how much bigger it is when viewed with a hand lens or a microscope compared with its actual size.

The magnification of a hand lens is usually written on it. Hand lenses can magnify specimens between 2 and 6 times.

For a light microscope, the magnification of each lens is written on its side. It can be written in the form of '×40', or '40×' or simply '40'. There are two lenses: the eyepiece lens and the objective lens. The total magnification of an image through a microscope is calculated as follows:

Total magnification of microscope = eyepiece magnification× objective lens magnification

Worked example: Calculate total magnification

A learner views a specimen using a microscope with an eyepiece lens that has a magnification of 10×. She uses an objective lens of 50×.

What is the total magnification?

We use this formula.

Total magnification = eyepiece magnification × objective lens magnification

So total magnification = 10 × 50

= **500×**

Magnification of biological drawings

When you draw a specimen, you usually also magnify it. Your drawing will be bigger than the image that you see through the hand lens or microscope.
If you have an image or biological diagram of a specimen, you can work out how many times it has been magnified. You work with three factors when working out the magnification of an object. These are:

- the image size (how large an image is or how big a drawing of the specimen is)
- the actual size of the specimen (how large it is in the real world)
- the magnification (how much larger the image size is compared with the actual size; how many times the image has been enlarged).

We use this formula to work out the magnification of a drawing.

$$\textbf{Magnification} = \frac{\textbf{size of drawing}}{\textbf{actual size of specimen}}$$

In this formula, size could be length or breadth, but the same measurement must be taken of both the specimen and the drawing.
Always include a magnification or scale bar on your drawing.

Worked example: Calculate magnification of a drawing

Uwimana measures a bean seed. It is 3 cm long. She makes a biological drawing of the seed. The length of the seed in her drawing is 15 cm. By how much has the bean seed been magnified?

$$\text{Magnification} = \frac{15}{3}$$

$$= 5\times$$

This means that the drawing is five times bigger than the bean specimen.

Self assessment 4.1

1. A leaf measures 4 cm in length. A diagram of the leaf that appears in a Biology textbook measures 12 cm. By how much has the leaf been magnified?
2. A group of learners use a microscope to view a cell. The eyepiece lens magnifies objects 10× and the objective lens that they use magnifies 25×. What is the total magnification?
3. A learner looks through a microscope using a 20× eyepiece lens and a 40× objective lens. What is the total magnification that the learner is using?

Experiment 4.1

Work out the following:
You will need: a microscope; a hand lens; slides; glycerine; a razor blade; pollen grains; cover slips; a needle; forceps or small tweezers;
a dropper; an onion bulb; iodine solution; a dead fly or mosquito

Procedure

Part A

1. Use the hand lens to look at the insect specimen.
2. Discuss how much detail you can see.

Part B

You will now prepare a slide for viewing using a light microscope. Look at Figure 4.6, on page 45, to help you as you work.

1. Make sure that the glass slide is clean. Use a tissue to clean it if it is dirty. Try to hold the slide on the edges.
2. Place a small drop of iodine in the centre of the slide (see A in Figure 4.6).
3. Use forceps to peel off the thin outer layer that surrounds the fleshy white storage leaves of the onion (see B). This layer is the **epidermis**; it is made up of a single layer of cells.
4. Carefully, use a razor blade to cut off a small piece of the epidermis, about one centimetre square.
5. Place the piece of onion skin in the drop of iodine (see C). Try to flatten it against the slide, using the needle.
6. Hold one side of the cover slip as shown in the diagram, and slowly lower it on top of the iodine (see D). Do this carefully to avoid trapping air bubbles.
7. If there is iodine around the slip cover, clean it away using a tissue (see E).
8. Place the slide onto the stage of the microscope (see F).

Part C

1. Adjust the microscope to view the specimen (as you learnt to do in Activity 4.2).
2. Make an accurate drawing of what you see.
3. Make other slides using specimens such as a fly's wing and pollen grains. Use glycerine instead of iodine for these slides.

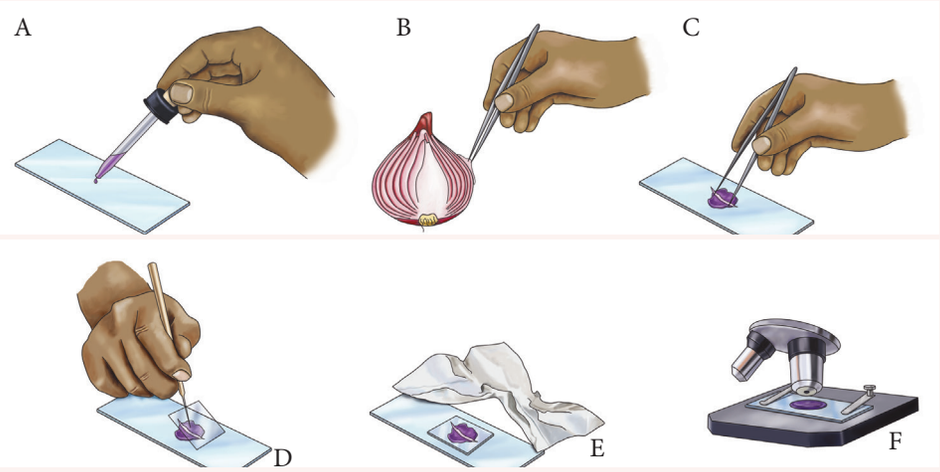


Figure 4.6: Preparing a specimen for viewing under a microscope

Checklist of learning (Unit summary)

In this unit, I have learned that:

- ✓ Biologists use two types of instruments to observe things: hand lenses and microscopes.
- ✓ These instruments magnify things, which means that they make them appear larger than their actual size.
- ✓ A hand lens is often used outside on fieldtrips as it is easy to carry and use.
- ✓ Microscopes are used in laboratories, and specimens can be seen at higher magnifications than when using a hand lens.
- ✓ The different parts in a microscope are designed to make it function properly.
- ✓ Biologists need to observe specimens and record their observations by drawing biological drawings.
- ✓ The total magnification of a specimen when viewed with a microscope can be calculated by multiplying the eyepiece magnification by the objective lens magnification.
- ✓ The magnification of a biological drawing of a specimen can be calculated by measuring the size of the drawing and dividing it by the actual size of the specimen.

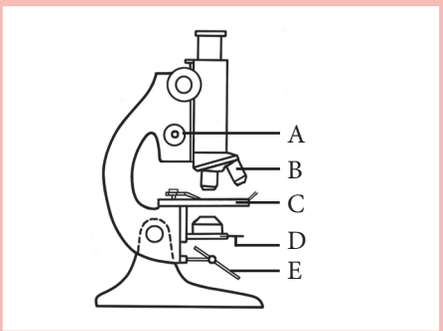
End unit assessment

1. Name two types of instruments that can be used to magnify things.
2. List two differences between a hand lens and a microscope.
3. Give one advantage of using a hand lens and one advantage of using a microscope for magnifying specimens.
4. Explain why you must NOT use the coarse focus adjustment knob when the high power objective is in place.
5. Complete the table.

Eyepiece magnification	Objective lens magnification	Total magnification
5×	25×	
10×		100×

6. Look at the drawing of a bee. If the bee's actual length is 1,5 cm, how many times has it been magnified in the drawing?

Provide labels for the microscope parts A to E.



7. Follow the instructions and do the following:

a. Collect two biological specimens. They can be a flower, leaf or plant you collected outside the classroom.

b. Use a hand lens to view your specimens.

c. Make careful biological drawings of your specimens. Label anything you can. Remember to give the magnification of your drawing.

d. Which part of this activity did you find the most difficult? Explain what you would do differently if you had to do the activity again.

UNIT 5 Plant and animal cells

Key unit competence

To be able to differentiate between animal and plant cells using a light microscope.

At the end of this unit, I should be able to:

- Explain the role of a cell in a living organism
- Describe the structure of a plant and animal cells
- Identify the different parts of the cell
- Explain the uses of the various structures seen under the light microscope in the plant and animal cell
- Explain that cells with high rates of metabolism contain large numbers of mitochondria for sufficient energy
- Organize a science practical setup according to given instructions
- Prepare slides of human cheek cells and epidermal cells of an onion
- Explain the differences in the structure of plant and animal cells seen under a light microscope
- Demonstrate that plant and animal cells differ in shape
- Appreciate the importance of cells in organisms
- Show perseverance when observing slides of plant and animal cells
- Pay attention while handling delicate slides and sharp instruments to avoid injury.

Introductory activity

Observe well the following structures and think about what you learnt in the previous unit and try to work on given questions

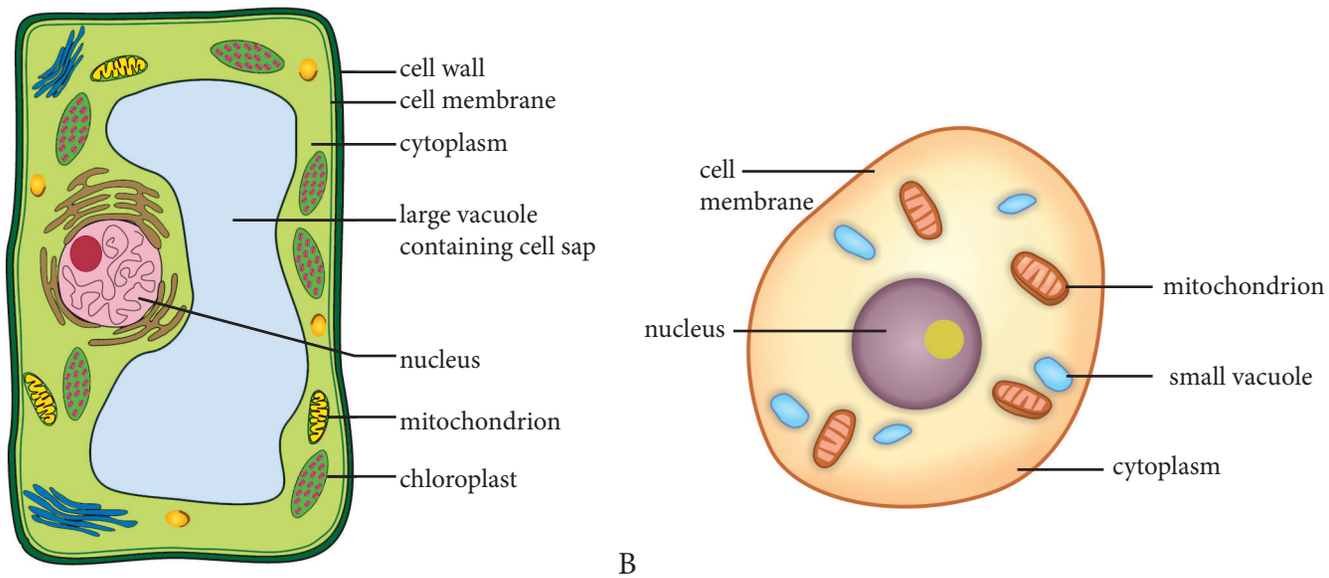


Figure 5.1

1. Between the above cells suggest the animal cell and the plant cell

2. Use a Venn diagram to compare the two cells provided in this activity

5.1. The cell

Activity 5.1

Think about what you learnt in the previous unit and earlier grades. Then, brainstorm the answers to these questions.

1. Arrange these structures in the correct order, starting with the smallest structure: tissue, organ, cell, organism.
2. What different types of microscopes are available for biologists to use to view cells?
3. How would a biologist choose the type of microscope he or she should use to view a cell?

Hint

Microscopes are useful for identifying organisms that cause diseases in Rwanda

Cells are the basic units of all living organisms. Cells are made of molecules such water, proteins, carbohydrates and fats. These molecules are made up of atoms such as carbon, hydrogen and oxygen. Cells are the building blocks of living organisms.

Some organisms, such as bacteria, are made up of only one cell. These are called unicellular organisms ('uni' means 'one'). Other organisms, such as humans and trees, are made up of many cells. They are called multicellular organisms ('multi' means 'many').

Because cells are too small to be seen with the naked eye, scientists use microscopes to see the structure of cells. Sometimes they use powerful microscopes called electron microscopes to view structures that are too small to be seen with a light microscope.

Structures found in plant and animal cells

All cells have the same basic structure. Cells contain cytoplasm and **organelles**. The cytoplasm is a living, jelly-like substance in which the organelles are found. Many chemical reactions take place inside the cytoplasm. It is made mainly from water, in which substances such as sugars and gases are dissolved. The organelles in the cytoplasm carry out special functions inside the cell. Examples of organelles include the nucleus, chloroplasts and mitochondria. A cell membrane surrounds the cytoplasm.

Figure 5.2 shows typical plant and animal cells and their organelles.

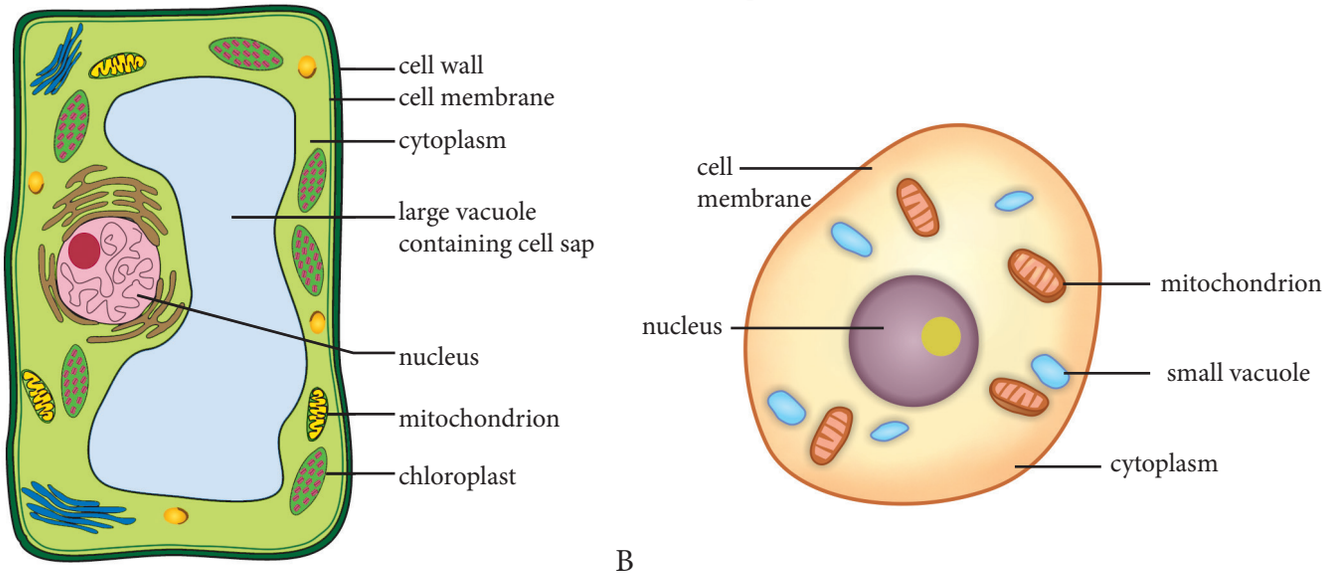


Figure 5.2: A generalised plant cell (A) and an animal cell (B)

Experiment 5.1

Work out the following:
You will need: a microscope; prepared slides of onion epidermis and human cheek cells; drawing paper

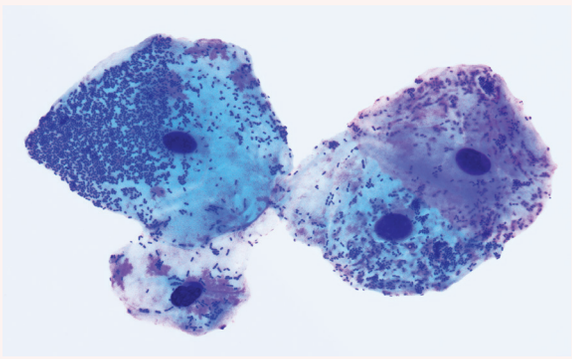
Procedure

1. Look at Activity 4.1, on page 43, to remind yourself how to use a microscope to view specimens.
2. View the prepared slides that your teacher will give you.
3. Make careful drawings of the two different types of cells using. Figure 5.3, below, to help you. Only draw the structures that you can see on the slide.

Questions

1. Mention two things that you did to ensure that you avoided any injuries whilst doing this activity.
2. How do the two types of cells differ in shape?
3. Which structures are present in the onion cells but absent in the cheek cells?
4. What was the total magnification that you used to view these specimens?

A **Figure 5.3**: A micrograph of an onion epidermis



B Human cheek cells, as seen under a light microscope

There are many different types of plant and animal cells. Although they all have slightly different structures (depending on their functions), they all have these organelles:

- cell membrane
- nucleus
- mitochondria
- vacuole
- cytoplasm.

Cell membrane

The cell membrane surrounds the cytoplasm and keeps the cell contents in place. It is **selectively permeable**, which means that it can control the movement of substances into and out of the cell.

Nucleus

The nucleus is the control centre of the cell. It is easily seen inside the cell. The nucleus is round and found near the centre of an animal cell and on the side of a plant cell.

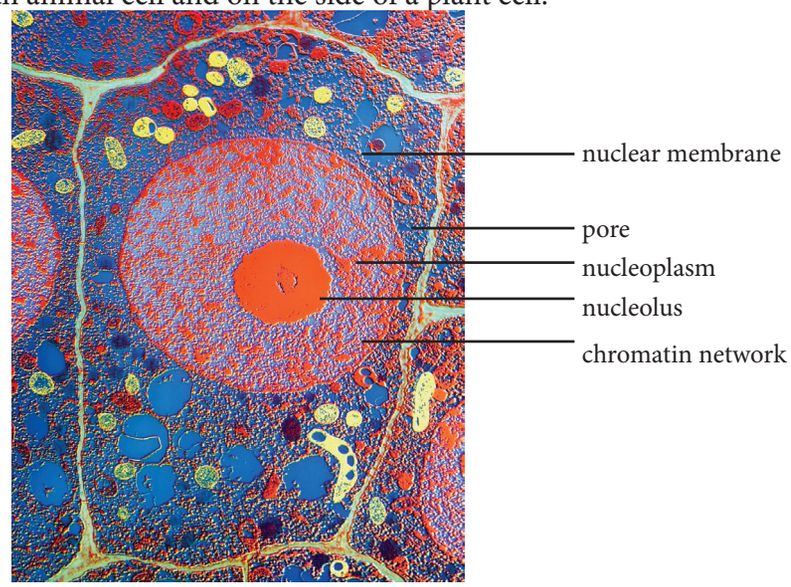


Figure 5.4 The nucleus, as seen using an electron microscope, is the control centre of the cell.

The nucleus plays an important role when the cell divides to make new cells. It contains the **hereditary**, or genetic, information that is passed from parents to their offspring during reproduction.

Mitochondria

Mitochondria (singular = mitochondrion) are the organelles inside plant and animal cells where the reactions of cellular respiration take place. Energy that the cell can use is made in the mitochondria. Some cells, depending on their function, have more mitochondria than others. For example, muscle cells (which need a lot of energy to work) have several thousand mitochondria.

Vacuoles

Vacuoles are organelles that usually contain fluid. They are surrounded by a membrane. Animal cells have small vacuoles or no vacuoles. The fluid in animal vacuoles often contains substances such as **enzymes**, or stored food or waste products. Plant cells have large vacuoles that take up a lot of space inside the cell. Plant vacuoles usually contain water and dissolved substances, such as mineral salts and food molecules. Plant vacuoles are important for keeping the cell rigid.

Self assessment 5.1

1. Define each of these terms:
   a) unicellular
   b) multicellular
   c) organelle
2. Give one example each of a unicellular and a multicellular organism.
3. What is the function of each of the following?
   a) the cell membrane
   b) the nucleus
4. Which organelle in the cell makes energy?
5. a) What is sometimes stored inside vacuoles?
   b) What is the difference between the vacuoles found in animal cells and those found in plant cells?
6. Use the library or the Internet to find out about the structure and the functions of each of the following cell organelles: nucleus, mitochondrion, ribosome, Golgi body, endoplasmic reticulum, lysosome and chloroplast.

5.2. Differences in the structure of plant and animal cells

Activity 5.2

Observe again the animal & plants cells on figure 5.2 in previous page and answer the following questions:
a. What are the common parts they have.
b. What are the parts specific to plant cell?
c. Establish a comparison between the two cells.

a) Structures that are found only in plant cells

Two important structures are found in plant cells but not in animal cells: cell walls and chloroplasts.

Cell wall

The cell wall is a rigid structure found around the outside of plant cells. It is not living, and it is made up of a substance called cellulose.
The cell wall gives the plant cell its shape. Because the cell wall is rigid, it protects the contents of the cell. It is fully **permeable**, which means that substances can move freely into and out of the cell through the cell wall.

Chloroplasts

Chloroplasts are the organelles found in plant cells that carry out the process of photosynthesis. They contain a green pigment called chlorophyll. Chloroplasts are also found in the cells of algae and some bacteria.

b) Plant cells versus animal cells

Although plant and animal cells have many features in common, there are some obvious differences. Table 5.1 lists the main differences between plant and animal cells.

Table 5.1. The main differences between plant and animal cells

	Plant cell	Animal cell
Shape	• Have cell walls • The cell wall is rigid and has a fixed shape	• Do not have cell walls • Because there is no cell wall, they vary in shape
Chloroplasts	Contain chloroplasts, which are used for photosynthesis	Animals do not photosynthesise, so cells do not have these organelles
Vacuoles	Have a large, central vacuole	Have no vacuoles or one or more small vacuoles (which are much smaller than plant vacuoles)

Self assessment 5.2

1. a) What is the function of the cell wall in plants?
b) What substance is the cell wall made of?
2. a) What is the function of chloroplasts?
b) What pigment is found inside chloroplasts?

Checklist of learning (Unit summary)

In this unit, I have learned that:

- ✓ Cells are the basic units of life; they are the building blocks of living organisms.
- ✓ Some organisms consist of only one cell (unicellular), whilst other are made up of many cells (multicellular).
- ✓ We can view cells using either a light microscope or an electron microscope.
- ✓ All cells contain cytoplasm and organelles such as a nucleus, mitochondria, a cell membrane and vacuoles.
- ✓ The cytoplasm is a jelly-like substance in which the organelles are found inside the cell.
- ✓ The cell membrane surrounds the cytoplasm and controls what goes in and out of the cell.
- ✓ The nucleus is the control centre of the cell and contains hereditary material.
- ✓ Mitochondria are the organelles in the cell where energy is made; cells that need more energy, such as those found in muscles, have more mitochondria.
- ✓ Vacuoles are membrane-bound organelles that contain fluid; plants have large vacuoles and animals have no vacuoles or small vacuoles.
- ✓ Only plant cells have a cell wall, which gives the cell a rigid shape and allows substances to pass in and out of the cell.
- ✓ Chloroplasts are organelles in plant cells where the reactions of photosynthesis take place.

End unit assessment

1. Match the organelles in Column A with the correct function in Column B.

Column A	Column B
1.1 Nucleus	A. Living, jelly-like fluid in which reactions take place inside the cell
1.2 Mitochondria	B. Control centre of the cell
1.3 Cell wall	C. Produces energy
1.4 Cell membrane	D. Controls what goes in and out of the cell
1.5 Chloroplast	E. Photosynthesis takes place here
1.6 Cytoplasm	F. The rigid structure on the outside of plant cells that keeps the shape of the cell

2. Give the meaning of each of these terms.

a) permeable
b) hereditary
c) enzymes
d) photosynthesis

3. Draw a table to show the differences between a plant and an animal cell. Include these headings: Shape, Outer covering, Organelles, Vacuoles.

4. Copy this table, and then complete it.

	Plant cell	Animal cell
Shape		
Outer covering		
Organelles		
Vacuoles		

UNIT 6 Levels of organisation in multicellular organisms

Key unit competence

To be able to explain specialisation of cells, and the link between levels of organisation in multicellular organisms

At the end of this unit, I should be able to:

- Recall that a cell is a basic structure of an organism
- Describe the different types of cells in this unit and state their functions
- Describe the different cell structures found in animals and plants and how they relate to their functions
- Identify different levels of organisation in multicellular organisms
- Observe and illustrate different types of cells and tissues under light microscope or micrographs
- Categorize plant and animal tissues using observation of micrographs or slides
- Illustrate well labelled structures of xylem and phloem tissue from slides or micrographs of sections of vascular plants
- Sequence the levels of organization of multicellular organisms from the simplest to the most complex
- Differentiate the relationship between the structure and function of specialised cells
- Appreciate the complexity of life from the tiny cell through to the tissue, organ, system and organism levels of organisation
- Be aware that an organism is a complex organisation of cells, an important unit of life.

Figure 6.1. Red blood cells are part of blood and are specialised to transport oxygen.

Introductory activity

Think back to what you learnt in the last two units. Then, brainstorm the answers to these questions.

1. Why is the cell referred to as the 'basic unit of life'?
2. Are all cells the same? If not, in what ways are they different?
3. What structures do plant cells have to help them carry out photosynthesis?
4. Are all organisms made up of many cells? What do we call single-celled organisms? What do we call organisms that consist of many cells? Give an example of an organism that has many cells in its body.

6.1. Cell specialisation

Activity 6.1

1. Multicellurar organisms have different cells.
a) What are the special cells do they have?
b) Why those cells are considered as specialised cells?
2. Work out the following
You will need: a microscope; prepared slides or micrographs
Procedure
a. Use a microscope to look at the prepared slides of different tissues that your teacher will give you. Remember the rules for using a microscope. If your school does not have slides, use the micrographs that your teacher gives you.
b. Identify the tissues shown in the slides/micrographs. Decide which slides/micrographs show plant tissue and which show animal tissue. Discuss the reasons for your choice in your group.
c. Can you identify specialised cells in the tissue specimen?
d. Draw labelled biological diagrams of each tissue specimen in the slides/micrographs

Hint

Understanding how our bodies are made up can be useful in health related careers in Rwanda

In the previous unit, you learnt about plant and animal cells. Not all cells look the same or work in the same way. There are many different types of cells and each type can carry out different functions. For example, in animals, cells in muscles are specialised to bring about movement. These cells contain lots of mitochondria so that they can make energy for the muscles to work.
Blood cells in animals are another **specialised** type of cell. They transport oxygen. A plant's leaf cells are specialised to perform photosynthesis, whereas its root cells are **adapted** to take in water and nutrients from the soil. The cells are able to do these different functions because they are slightly different in structure from one another.
In this unit you will find out more about some specialised cells in animals and in plants. You will also learn how their structure is linked to their functions.

Examples of some specialised animal cells

In this section, we look at examples of different types of animal cells whose structures have been adapted to enable them to perform different functions.

Ciliated cells

Ciliated cells have tiny hair-like structures, called **cilia**, on their surfaces. There are also other specialised cells, called goblet cells, amongst the ciliated cells. Goblet cells make a substance called **mucus**.
Ciliated cells line the surfaces of some parts of the body, such as the air passages. Air passages take air to and from the lungs. The cilia trap dust particles and stop them from going into the lungs. Mucus from the goblet cells also traps dust.

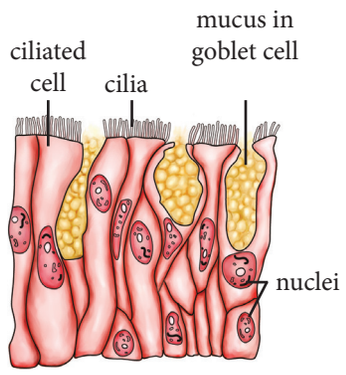


Figure 6.2. Ciliated cells have hair-like structures, called cilia.

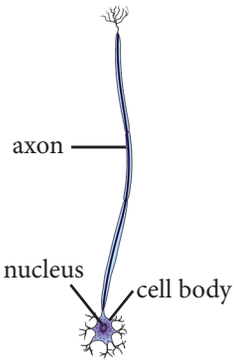


Figure 6.3 Nerve cells can transmit nerve impulses.

Ciliated cells are also found in the female reproductive organs. You will learn about their function in this part of the body later on.

Nerve cells

Nerve cells, or neurons, are specialised to conduct **nerve impulses** in the nervous system. They carry information from one part of the body to another part.

Nerve cells are long and thin, and are grouped together in bundles to form nerves. Their shape makes them suitable for conducting nerve impulses over long distances.

Red blood cells

Red blood cells are specialised cells that are found in the blood. They transport oxygen around the body.

Red blood cells are small and have an unusual shape. They are referred to as biconcave discs. This shape gives them a large surface area on which oxygen molecules can bond. Red blood cells do not have a nucleus. They are packed full of a special substance called **haemoglobin**. Haemoglobin attracts oxygen molecules, which makes red blood cells well suited for carrying oxygen around they body. The cells are elastic, so they can easily squeeze through narrow tubes in the blood system.

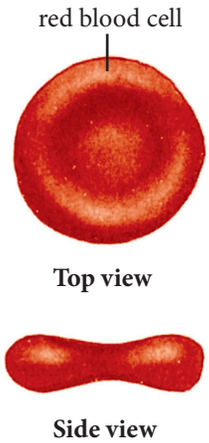


Figure 6.4. Red blood cells are specialised to carry oxygen.

Sperm cells

Sperm cells are male sex cells. They are made inside the male reproductive system in structures called the testes.

Sperm cells are specialised for joining, or fusing, with the female sex cell, the egg. Sperm cells have a tail, called a flagellum, which they use to swim. Because sperm cells can move, we say that they are **motile**. There are large numbers of mitochondria in the middle region of a sperm cell. These mitochondria make energy to help the flagellum to move. The flagellum enables the sperm cell to swim towards the egg when it is inside the female reproductive system.

In the head of the sperm, there are special enzymes inside the **acrosome**. These enzymes break down the membrane around the female egg cell. The sperm nucleus contains genetic material. The nucleus enters the egg cell and fuses with the nucleus of the female egg during fertilisation.

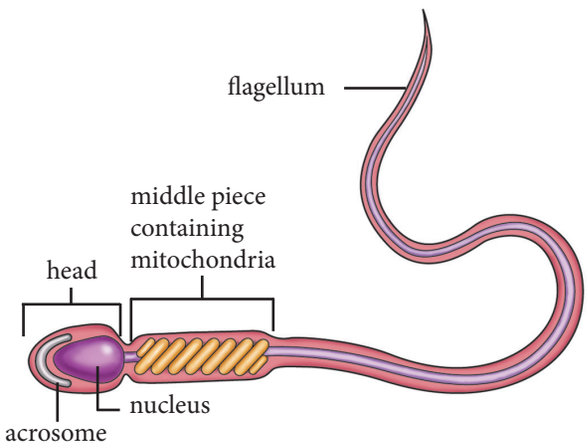


Figure 6.5: A sperm cell is a male sex cell

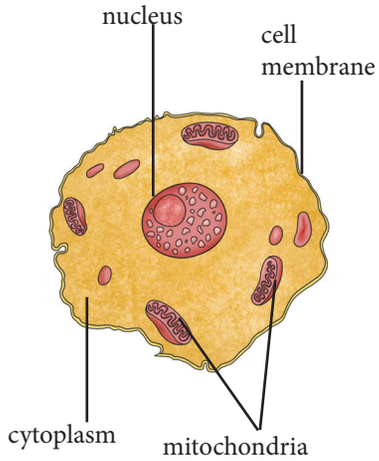


Figure 6.6: An egg cell is a female sex cell.

Egg cells

Egg cells are female sex cells. They are also called **ova** (singular = ovum). They are produced in the ovaries of the female reproductive system.

Egg cells are large cells that have a large nucleus, and they can be seen with the naked eye. The cytoplasm contains many nutrients. Each egg cell has a special cell membrane that allows only one male sperm cell to pass through it. There is genetic material in the egg's nucleus. The egg and sperm nuclei fuse to form a single cell, called a **zygote**.

Examples of some specialised plant cells

Examples of plant cells that have been specialised to do different functions include root hair cells, xylem cells and mesophyll cells.

Root hair cells

Root hair cells are found on the outside layer of roots, where they absorb water and dissolved nutrients from the soil.

Look at the diagram of a root hair cell in Figure 6.7. You can see that the cell has a long, thin extension that pushes between the soil particles. This increases the surface area of the root cell, which enables more water to pass into it. Root hair cells have a large vacuole which water can pass into. Their cell wall is permeable, so water passes easily into the cell.

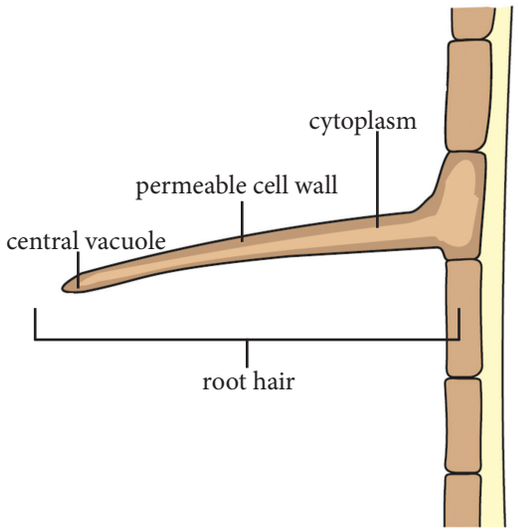


Figure 6.7: Root hair cells are specialised for taking up water from the soil.

Xylem cells

Xylem cells are sometimes called xylem vessels. They transport water up from the roots to the other parts of the plant.
Xylem cells are non-living cells. The end of each cell has holes in its wall and the cells are arranged one on top of the other, to form a long narrow tube. These tubes, rather like long straws, are ideal for transporting water.

Phloem cells

Phloem is a living tissue. It transports food made by the leaves during photosynthesis to all parts of the plant. Figure 6.8 shows the difference between the xylem and phloem. In the xylem, water flows in one direction only from the roots to the leaves. In the phloem, the food flows in both directions.

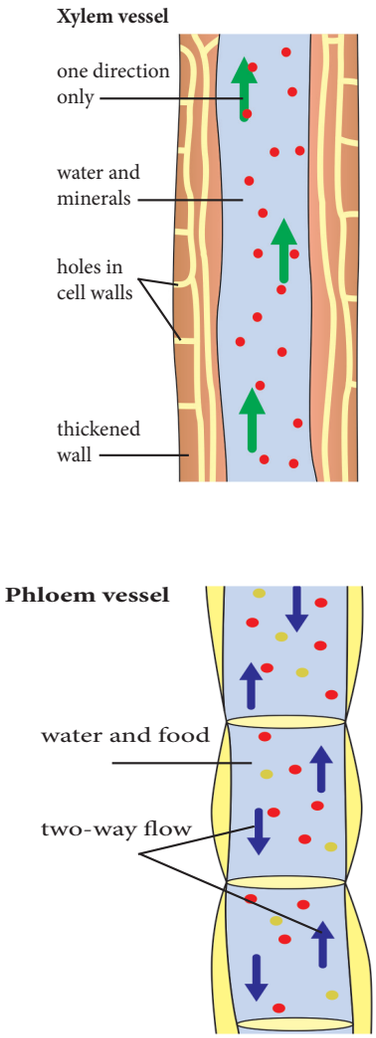


Figure 6.8: Difference between Xylem and phloem cells.

Mesophyll cells

Most cells inside a leaf are found between the upper and lower surfaces. (see Figure 6.9). This region of the leaf is called the mesophyll. Mesophyll cells are specialised for photosynthesis, which is their main function. Look at the diagram below, which shows the inside of a leaf.
There are two types of mesophyll cells and they are found in different places in the mesophyll. These cells are called **palisade mesophyll cells** and **spongy mesophyll cells**. Palisade mesophyll cells are long, thin cells which are full of chloroplasts. They are found near the upper surface of the leaf. It is easy for them to trap lots of light in this position. Spongy mesophyll cells also have lots of chloroplasts and they are loosely packed in the leaf. This makes it easy for gases, such as carbon dioxide, which is needed for photosynthesis, to move into and out of these cells.

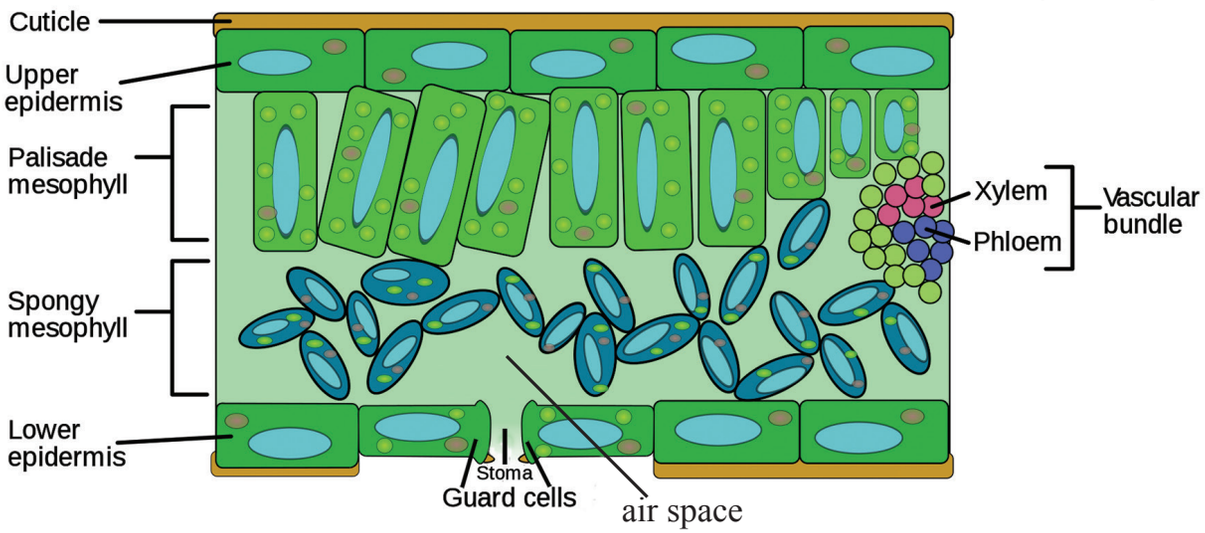


Figure 6.9: Palisade and spongy mesophyll cells are leaf cells specialised for photosynthesis.

Self assessment 6.1

1. Give the meaning of each of these words.
   - **a)** specialised
   - **b)** cilia
   - **c)** neurons
   - **d)** haemoglobin
2. **a)** What is the function of ciliated cells?
   b) List two ways in which ciliated cells are adapted to their function.
3. **a)** What is the function of red blood cells?
   b) List two ways in which red blood cells are suited to their function.
   c) Make a neat, labelled drawing of some red blood cells.

Advantages of specialisation of cells

Specialisation of cells occurs only in multicellular organisms and not in unicellular organisms.
Cell specialisation gives these advantages to multicellular organisms.

- It enables them to grow bigger.
- It enables them to carry out complex processes. Different cells carry out different functions.
- Specialised cells can work together to form tissues, organs and organ systems.

6.2. Organisation in multicellular organisms

Activity 6.2

Structures of similar level in an organisms may be grouped togother. What will be the relationship between
a) Cells and tissues?
b) Tissues and organs?
c) Organs and organ systems?

There are four levels of organisation in multicellular organisms such as plants and animals: cells, tissues, organs and **organ systems**. An organism is made up of many organ systems which enable it to function for life.

Cells

These are the most basic units of life. There are many different types of cells in a multicellular organism. They are specialised to do a certain function.

Tissues

In multicellular organisms, similar cells are grouped together to form tissues. A **tissue** is a group of specialised cells that have a similar structure and function. For example, muscle tissue is composed of muscle cells, which function to help the animal move, by contracting and relaxing. Examples of tissues in plant leaves are xylem, phloem and mesophyll. As you have learnt, xylem is made up of xylem cells, which are able to transport water. Phloem transports food in the plant. Xylem and phloem are found in leaf veins. Mesophyll tissue is made up of mesophyll cells and makes food.

Organs

Organs are structures that are made up of tissues. For example, your stomach is an organ for digesting your food. A particular organ may contain several different tissues. For example, your stomach contains muscle tissue (for mixing up the food) as well as glandular tissue (which produces digestive juices). Animal organs include the skin, heart, liver, brain, lungs and kidneys. Roots, stems, flowers, leaves and fruits are plant organs.

Organ systems

Organ systems are the highest level of organisation. A system consists of several organs working together to perform a function of life. For example, your digestive system consists of your stomach and your intestines (amongst other organs), which function to digest your food. In plants, the leaves, stems and roots work together to form a transport system.

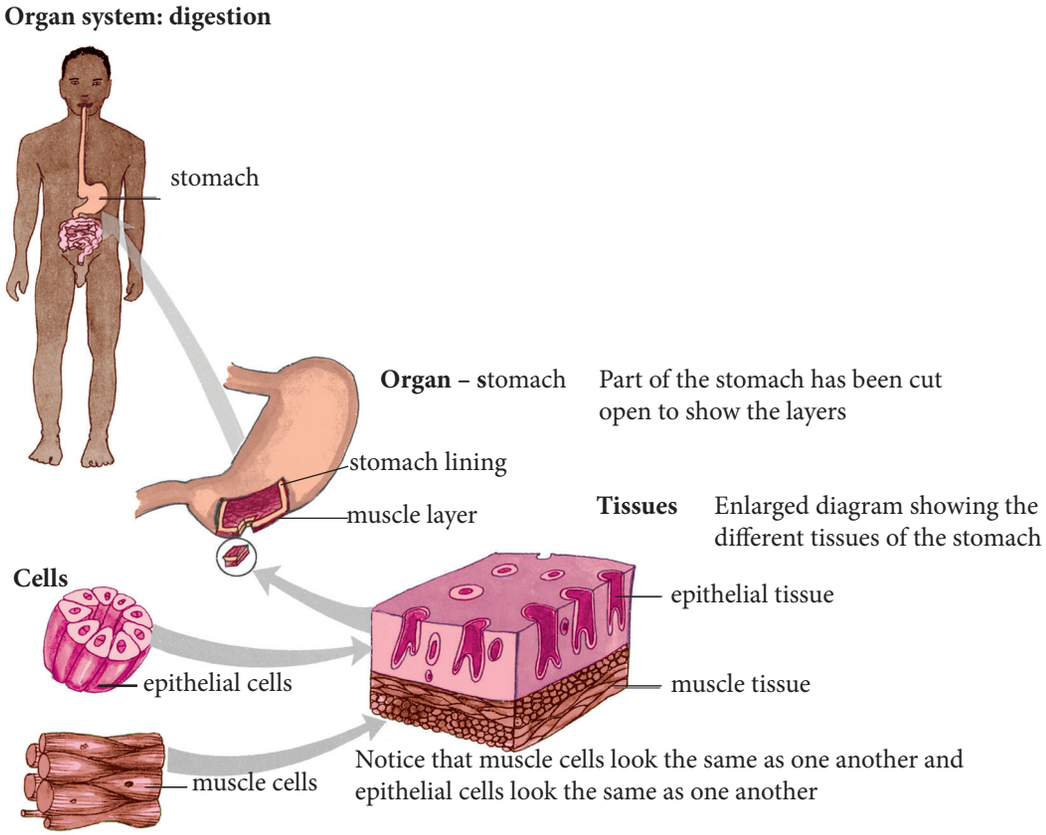


Figure 6.10: Levels of organisation of a human being: cell, tissue, organ, system

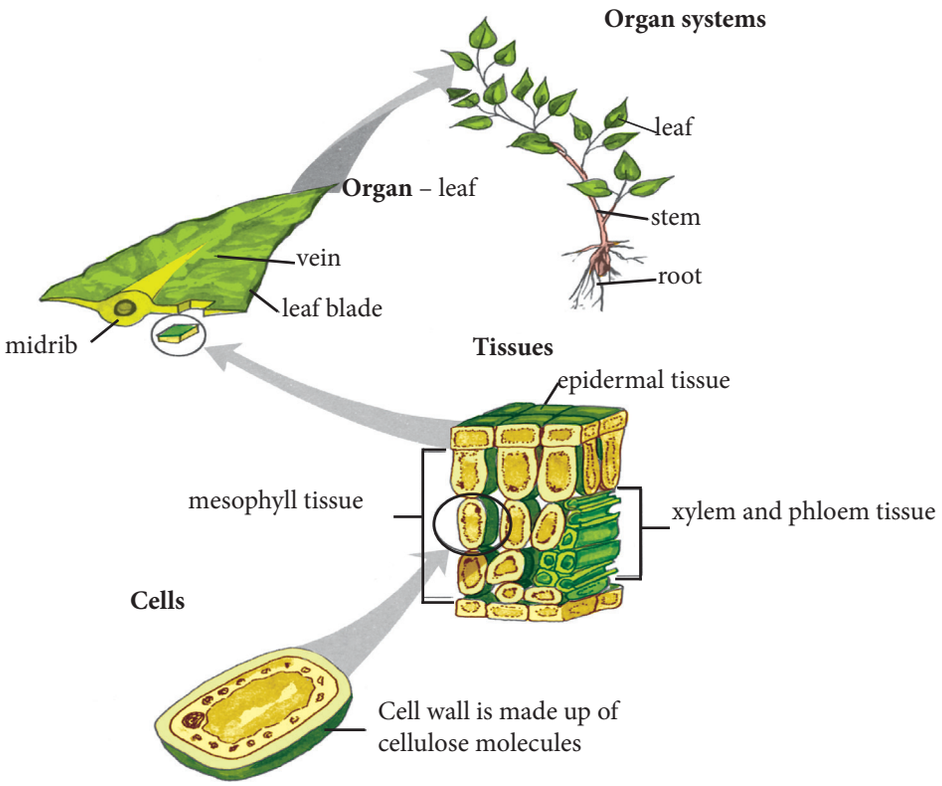


Figure 6.11: Levels of organisation of a multicellular plant organism: cell, tissue, organ, organ system

Self assessment 6.2

1. Define each of these words.
   - **a)** cell
   - **b)** tissue
   - **c)** organ
   - **d)** organ system
2. Give an example for each of the words in question 1.
3. Make a simple drawing showing organisation in multicellular organisms. Use Figure 6.10, on page 64, and Figure 6.11, above, to help you.
4. Name two animal tissues and two plant tissues.

Checklist of learning (Unit summary)

In this unit, I have learned that:

- ✓ In multicellular organisms, cells are specialised to perform certain functions.
- ✓ Examples of specialised cells in animals include ciliated cells, nerve cells, red blood cells, sperm cells and egg cells; examples in plants include root hair cells, xylem cells and mesophyll cells.
- ✓ A group of similar cells is called a tissue.
- ✓ Plant tissues, such as mesophyll tissue and xylem and phloem tissue, consist of similar cells that are structurally adapted to their functions.
- ✓ Mesophyll tissue in the leaves contains cells with lots of chloroplasts, where the reactions of photosynthesis take place; xylem tissue transports water around the plant.
- ✓ Animal tissues, such as muscle tissue, consist of similar cells that work together to perform a function.
- ✓ Organs consist of many tissues that work together to do a certain function.
- ✓ Animal organs include the skin, heart, liver, brain, lungs and kidneys; plant organs include roots, stems, flowers, leaves and fruits.
- ✓ An organ system consists of many organs working together, for example, the digestive system in animals and the transport system in plants.
- ✓ The specialisation of cells in multicellular organisms gives them advantages over unicellular organisms.

End unit assessment

1. Give the meaning of each of these words.
   - **a)** flagellum
   - **b)** motile
2. **a)** What is the function of sperm cells?
   - **b)** List three ways in which sperm cells are suited to their function.
   - **c)** Make a neat, labelled drawing of a sperm cell.
3. **a)** What is the function of egg cells?
   - **b)** What happens when a sperm cell meets an egg cell?
   - **c)** How is the egg cell suited to its function?
4. Arrange these structures in the correct order, starting with the smallest.

organ	tissue	cell	organ	system organ

5. Give definitions for each of these words.
   - **a)** specialisation
   - **b)** permeable

6. Identify each cell structure or organelle from its description below.

a) Site of protein synthesis

b) Manufactures ATP in animal and plant cells

c) Controls the activity of the cell, because it contains the DNA

d) Carries out photosynthesis

e) Partially permeable barrier only about 7 nm thick2.

7. Which organelles are found in high numbers in muscle cells? Why is this so?

8. Explain the functions of each of these cells:

a) red blood cells

b) xylem cells

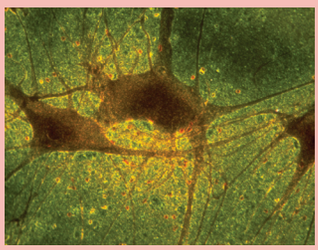
9. Look at the micrographs, and then answer these questions.

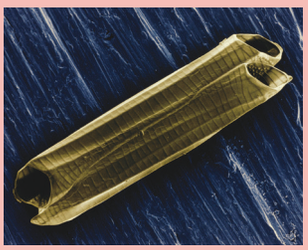
a) Identify each type of cell shown in pictures A to D.

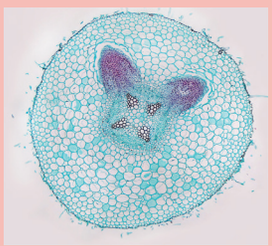
b) Identify each type of cell as either an animal cell or a plant cell.

c) Give one function for each type of cell.

d) Explain how cell D is suited to its function.

A 

B 

C 

D 

UNIT 7 Food nutrients and diet

Key unit competence

To be able to analyse the different food nutrients and their significance to the human body.

At the end of this unit, I should be able to:

- Explain the importance of the classes of foods
- List the main sources of food nutrients
- List the chemical elements that make up carbohydrates, fats and proteins
- Explain that large molecules consist of smaller molecules joined together
- State that a balanced diet is eating a variety of foods containing all the nutrients and in the correct proportions
- Explain that people have different dietary needs, dependant on age, gender and activity levels including pregnant and breastfeeding mothers
- Explain the effects of malnutrition
- Explain that obesity is the build-up of excess fat in the body due to excess intake of calories
- Apply knowledge of deficiency symptoms to identify the different deficiency diseases among individuals
- Test for carbohydrates, proteins and lipids in different food samples
- Demonstrate the different functions of water, mineral salts and vitamins in the body
- Acknowledge the importance of having a balanced diet and its relation to age and gender
- Appreciate the need for a specific diet for individuals who carry out strenuous activities like sports and manual labour.
- Take care when using reagents to test for food types
- Appreciate the myths and values communities attach to certain foods
- Adopt and develop healthy eating habits by eating a balanced diet.

Figure 7.1: A balanced diet includes foods from all five food groups.

Introductory activity

Answer these questions:

1. Make a list of your favourite foods or the foods you usually eat.
2. Can you think of the nutrients that these foods contain?
3. Try to work out the functions of each of these food nutrients.

7.1. Food nutrients

Activity 7.1

Answer these questions.

1. Identify the nutrients present in the food sources A and B.

A

B

2. Keep a journal of the food that you eat over a week. Bring the list to school, and discuss it with your partner.

a) Is your list of foods similar to your partner's list? If it is not, how is it different?

b) Did your list of foods change during the week? If it did, explain why?

c) Were any of the food nutrients missing from your lists?

Nutrients are chemical substances that organisms need to live. In Unit 1 you learnt that all living things need nutrition in order to live. Animals get their nutrients from the food they eat. Plants get their nutrients from the air, water and soil.

Food nutrients give organisms:

- energy for daily activities
- the building blocks for growth and cell repair
- substances that enable the organisms to function properly and stay healthy.

There are six types, or classes, of food nutrients: carbohydrates, proteins, **lipids** (fats and oils), vitamins, mineral salts and water. Food nutrients are made up of **elements** such as carbon, hydrogen and oxygen, and sometimes nitrogen, phosphorus and sulphur.

Sources of food nutrients

Table 7.1 shows sources of food nutrients for human beings.

Table 7.1 Sources of nutrients

Food nutrients	Foods
Carbohydrates (sugars and starches)	Bread, pasta, potatoes, cassava, maize, sorghum, rice, fruits, sweets, sugar
Lipids (fats and oils)	Nuts, fish oils, meat, milk, butter, cheese, cooking oil
Proteins	Meat, milk, chicken, fish, eggs, groundnuts, soya beans, seeds
Vitamins	Fruits, vegetables, meat, fish, milk, wholegrain cereals, nuts
Mineral salts	Salt, milk, meat, fruits, fish, eggs
Water	Drinking water, fruit and vegetable juices, food

Sources of nutrients.

Carbohydrates

Carbohydrates are nutrients made up of the elements carbon (C), hydrogen (H) and oxygen (O). Some carbohydrates, such as glucose, are small, simple molecules. Other carbohydrates, such as starch and cellulose, are large, complex molecules.

Simple sugars such as glucose are the basic units of all carbohydrates. We call these units sugars, or **monosaccharides** ('*mono*' means 'single' and 'saccharide' means 'sugar'). Examples of monosaccharides include glucose and fructose. Monosaccharides can join together to form **disaccharides**; for example, sucrose. **Polysaccharides**, such as starch, are made up of many single units ('*poly*' means 'many').

Figure 7.3 shows how polysaccharides are formed.

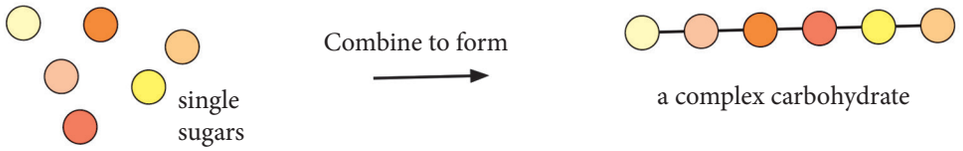


Figure 7.3 Formation of large carbohydrates.

Starch is an important storage carbohydrate in plants. Glycogen is an important storage carbohydrate in animals. It is stored in the muscles and liver. Cellulose is another large carbohydrate. It is found in plant cell walls.

Lipids

Lipids are fats and oils. Fats are lipids that are solids at room temperature. They are used mainly to store energy in the bodies of living things. Like carbohydrates, lipids are made of the elements carbon (C), hydrogen (H) and oxygen (O). Lipid molecules consist of one molecule of glycerol joined to three long fatty acid molecules.

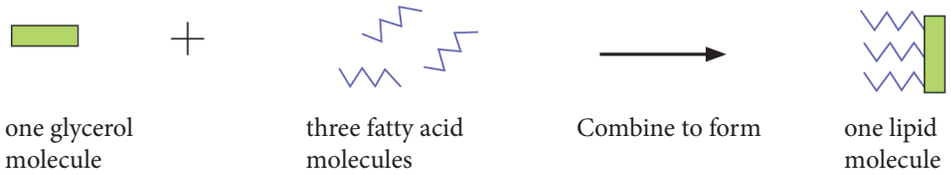


Figure 7.4 A lipid molecule consists of a glycerol molecule joined to three fatty acid molecules.

Proteins

Proteins are nutrients made up of the elements carbon (C), hydrogen (H), oxygen (O) and nitrogen (N). Some proteins also contain the element sulphur (S). Proteins are large molecules that consist of chains of smaller molecules called amino acids. There are over 20 different types of **amino acids**. They can be joined in different combinations to make many different proteins.

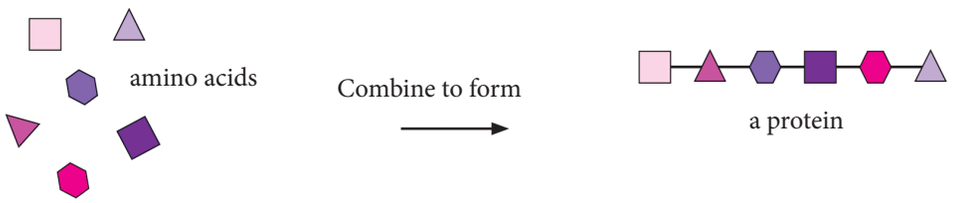


Figure 7.5 Proteins consist of long molecules of amino acids joined together.

7.2. The importance of food nutrients

Table 7.2 below shows the importance of the different food nutrient groups.

Table 7.2. Food nutrient groups and their importance

Food nutrients	Importance
Carbohydrates (sugars and starches	• Provide the body with energy
Lipids (fats and oils)	• Provide energy • Help with absorption of fat-soluble vitamins A, D, E and K • Form a layer beneath the skin that **insulates** the body and reduces heat loss • Form a layer around organs to provide protection from injury
Proteins	• Needed for growth • Needed for repair of damaged tissues • Needed for producing the enzymes required for chemical reactions in the body
Vitamins	Needed in small amounts for different functions in the body, for example: • Vitamin C is needed to fight infections and heal wounds, and for healthy bones, teeth, skin and gums • Vitamin D helps the body to absorb calcium from food, which is needed for healthy bones and teeth
Mineral salts	Needed in small amounts for many different functions in the body, for example: • Iron is needed to make haemoglobin, a substance in red blood cells that transports oxygen around the body • Calcium is needed for strong bones and teeth
Water	• Needed for chemical reactions in the cells • Keeps body temperature constant • Helps the movement of joints • Helps digestion of food • Helps to remove poisonous substances from the body

7.3. Food tests

We can test for the presence of food nutrients in different foods. In the next activity, you will work in groups to find out whether food samples contain carbohydrates, proteins or fats. You will use chemicals called **reagents** to do this. Remember to work carefully while doing these experiments.

Experiment 7.1: Experiments for food test

Tests for carbohydrates, proteins and lipids.

You will need: some bread, maize porridge or other complex carbohydrate; test tubes; a white tile; droppers; iodine solution; cooked chicken; meat or egg; butter; water; nuts (crushed); sodium hydroxide solution; copper sulphate solution; ethanol; test tube racks; permanent markers; test strips for testing proteins, fats and glucose (if your school has these)

Procedure

Part A

1. Copy the table below. You will need this to record your results.

	Colour change		
Food sample	**Iodine**	**Biuret test**	**Ethanol**
1. Bread			
2. Maize porridge			
3. Chicken			
4. Meat			
5. Egg			
6. Butter			

2. Set up your test tubes in a test tube rack. For each test, you need to test all your food samples. Use the marker pen to label each test tube with the number that matches the table.

Part B

Starch is a carbohydrate. We can easily test for its presence in a food sample by using iodine.

1. Put a small piece of each food sample into a test tube or onto a white tile.
2. Use a dropper and add two drops of iodine to each food sample.
3. Observe what happens, and then record any colour changes in the table.

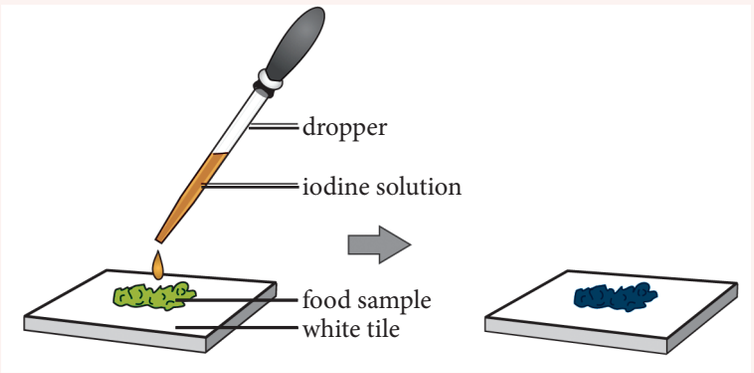


Figure 7.6. Test for carbohydrates

Part C

We test for proteins in a food sample by using the Biuret test. If proteins are present in the food, it will turn purple when we add sodium hydroxide solution (colourless) and copper sulphate solution (blue) to the sample. If there are no proteins in the food, the sample will remain blue.

1. Put a small piece of each food sample into a test tube and add some water.
2. Use a dropper to add about 20 drops of sodium hydroxide solution to the test tube.
3. Use another dropper to add about 2 drops of copper sulphate solution to the test tube.
4. Gently shake each test tube.
5. Observe what happens, and then record any colour changes in the table.

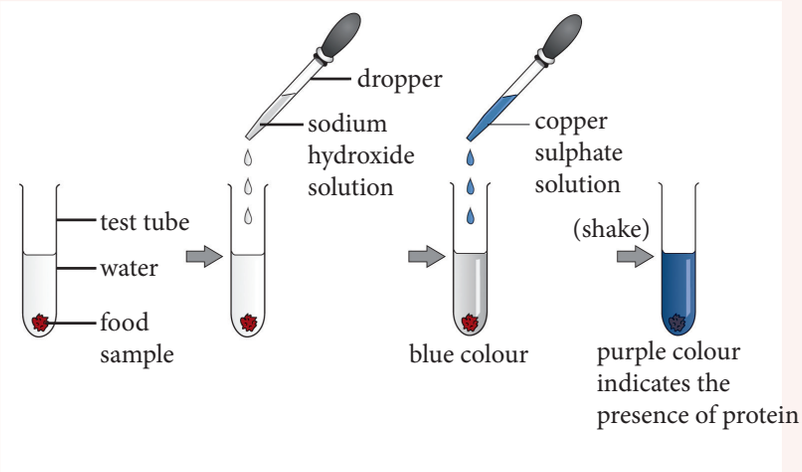


Figure 7.7. Test for proteins.

Part D

We test for lipids by using organic solvents such as ethanol. If lipids are present, they will dissolve in the ethanol. When water is added to the ethanol, the water will turn milky.

1. Put a small piece of each food sample into a test tube and add some ethanol. Shake the test tube well and then allow the contents to settle.
2. Add the same amount of water to the test tube and shake it well.
3. Observe what happens, and then record what you see.

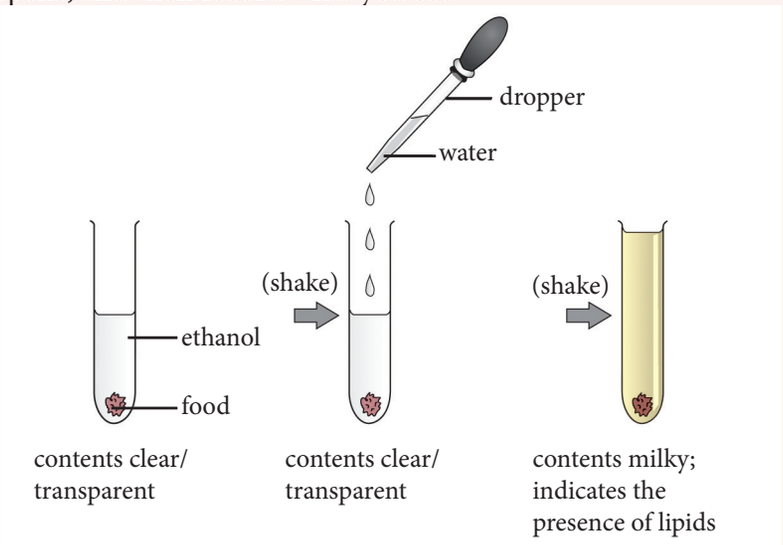


Figure 7.8. Test for lipids.

Questions

1. Make a list of the foods that you tested that contained carbohydrates, proteins and lipids. Some food samples may contain more than one nutrient.
2. Did you take any precautions when you were doing these tests?
3. Is there anything that you would change if you did the tests again?

7.4. A balanced diet

A person's diet consists of all the foods and liquids that he or she eats and drinks. A **balanced diet** gives us all the nutrients we need in the right amounts, as well as enough energy for our body to function well. The amount of energy we need is measured in kilojoules (kJ).

Figure 7.9. A balanced diet includes foods from all five food groups.

You have learnt about the groups of food nutrients your body needs to stay healthy. Your body needs different amounts of each food nutrient. The 'pie chart' in Figure 7.9 shows the relative amounts of each food group that we need for a balanced diet. Water is also an essential part of a balanced diet.

Table 7.3 describes the importance of each food group and gives the **proportion** each group should make up in the diet.

Table 7.3. Food groups and their percentages in the diet

Food group	Importance	Examples	% of diet
Carbohydrates	Provide energy for growth and development. Wholegrain forms are best because they provide extra **fibre**.	Bread, maize and cassava	33%
Fruits and vegetables	These foods provide vitamins and minerals needed for a healthy immune system. They also provide fibre. You should aim to eat five portions of these foods per day.	Bananas, spinach and tomatoes	33%
Dairy foods	These foods provide fat for energy, protein for muscle and nerve development, calcium for bone development and vitamins for fighting infections.	Milk, yoghurt and sour milk	15%

Non-dairy proteins	These foods provide protein needed for muscle and nerve development, and for tissues to repair after infections.	Meat, eggs, beans	12%
Foods high in sugar or fat	These foods should be limited to prevent excessive weight gain or problems with blood sugar.	Cakes, biscuits, fried foods, chocolate and cooldrinks	7%

Exercise

Work in pairs.
The amount of energy different people need is shown in the bar chart in Figure 7.10. Look at the chart, and then answer the questions.

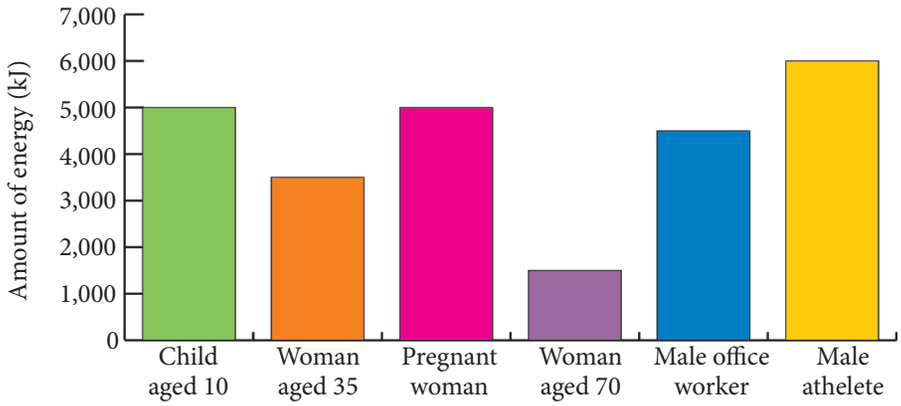


Figure 7.10: The amount of energy needed by different people

1. Which person needed:
   a) the most energy **b)** the least energy?
2. Explain your answers to question 1.

Balanced diets for different people

In previous exercise, you saw that different people need different amounts of nutrients and energy. A person's needs depend on their age, gender, level of activity and whether or not the person is ill. For example, males need more energy per day than females of all ages, and people with very active jobs need more energy than people who stay seated all day.

Young people

Children grow quickly and are very active, so they need a diet that provides lots of food nutrients and energy. When they reach their teenage years, they have times of rapid growth called growth spurts, when extra nutrients and energy are needed. A balanced diet for a school child should contain similar proportions of foods to those shown in Figure 7.9 (see page 75), but in amounts that provide them with enough energy. The child should also drink plenty of water.

Pregnant and breastfeeding women

Pregnant and breastfeeding women need more energy per day than the average adult woman. A pregnant woman needs extra nutrients and energy for the healthy growth and development of her baby.

A balanced diet for a pregnant woman should contain similar proportions of foods to an average adult woman, but should include extra fruits and vegetables, dairy foods, non-dairy proteins and water.

A breastfeeding woman needs extra energy and nutrients to make breast milk. Her diet should contain similar proportions of foods to an average adult woman, but with extra carbohydrates, dairy foods, non-dairy proteins and water.

Sports players

People who play sport need extra energy for their sporting activities. They also need extra nutrients to build and repair their muscles and to replace the minerals lost in their sweat. A balanced diet for people who play sport should contain similar proportions of foods to a healthy man or woman, but should include extra carbohydrates and non-dairy proteins, as well as extra water and other fluids.

7.5. Nutritional disorders

A nutritional disorder is also called **malnutrition**. It happens when a person's body has either too little or too much of a certain food nutrient. As a result, their body does not grow or function properly. Examples of nutritional disorders include deficiency **diseases**, starvation, obesity and constipation.

There are many reasons for malnutrition. It can be caused by poverty, where people are either too poor to buy enough food, or can only buy cheap food that does not provide all the nutrients they need. Malnutrition can also be caused by poor food choices and poor cooking methods.

Figure 7.11. A child with rickets

Deficiency diseases

Deficiency diseases occur when a person has too little of a vitamin or mineral. Examples of deficiency diseases include scurvy, rickets and anaemia.

Figure 7.12: The gums and teeth of a person with scurvy

Table 7.4, shows the causes, symptoms and prevention of some deficiency diseases.

Table 7.4. Deficiency diseases

Deficiency	Deficiency disease	Symptoms	Prevention and treatment
Vitamin C	Scurvy	Soft, bleeding gums, tooth loss, bleeding under the skin, and increase in the amount of time that wounds take to heal.	Eat citrus fruits such as oranges and lemons, as well as guavas, papayas, potatoes and fresh green vegetables.
Vitamin D and calcium	Rickets	If the body does not have vitamin D, it cannot absorb the calcium it needs to make bones. People with rickets have soft bones that bend as they grow because they cannot support the weight of the body. Deficiency in calcium may lead to osteoporosis (brittle bone disease) in adult females.	Eat sources of vitamin D such as eggs, butter, cheese, milk, and liver. Sunlight encourages the manufacture of vitamin D in the skin. Calcium is found in dairy products and some green vegetables.
Iron	Anaemia	Less oxygen can be transported around the body by the red blood cells. People with anaemia have a pale complexion, lack energy, and suffer from tiredness and weakness.	Eat sources of iron such as liver, eggs and green leafy vegetables. Iron tablets are also a good source of the mineral.

Starvation

Starvation occurs when a person does not eat enough food. There are two forms of starvation: marasmus and kwashiorkor.

Marasmus is caused by not eating enough of almost all nutrients, but especially energy-rich foods such as carbohydrates, fats and proteins. Marasmus causes extreme loss of body fat and muscle. A sufferer of marasmus is very thin. Other symptoms of marasmus include lack of energy, severe hunger and swelling of the hands and feet.

Kwashiorkor occurs when a person's diet does not include enough proteins, vitamins and minerals. Mainly children are affected. Sufferers have a swollen stomach, while the rest of their body is very thin and has little muscle. Other symptoms of kwashiorkor include changes in hair colour, skin rashes, swollen hands and feet, and loss of appetite.

Figure 7.13: A child with marasmus

Figure 7.14: A child with kwashiorkor

Obesity

Obesity is caused by eating a diet that contains too many energy-rich carbohydrates and fats. These foods are usually called junk foods and contain very few nutrients. The body stores the extra energy as body fat. Obesity can lead to serious health problems such as heart disease, stroke and diabetes.

Figure 7.15: Obesity can lead to serious health problems.

Impact of deficiency diseases

Deficiency diseases can affect a person negatively if they are left untreated. Some of the effects are: stunted growth, increased likelihood of getting infections, blindness (in the case of untreated vitamin A deficiency), being unable to take part in everyday activities, deformity, and death.

When children get sick, parents or guardians and other family members have to care for them. So, there is less time to do other activities that are necessary for the family's well-being. This can have negative effects on the family.

At a community and national level, caring for sick people takes up valuable resources that could be used for the development of the community and nation. In this way deficiency diseases, which are easily preventable, can slow down the development of the community and nation.

Case study

Work in pairs. Read the case study and then discuss how soya milk can improve children's health.

Life-saving soya milk

Soya milk contains all the proteins necessary to replace meat and milk. In a village in eastern Rwanda, women have learnt how to extract soya milk from soya beans. Soya milk contains more proteins than cow's milk and many adults and children prefer it. Malnutrition amongst children in this area has decreased in the last few years since the women's soya milk production has started. There has also been a decrease in the number of childhood illnesses in this area.

Constipation

Constipation occurs when a person does not eat enough fruits and vegetables. Their stools become hard and difficult to pass. We can prevent constipation by eating food rich in fibre and by drinking plenty of water.

Checklist of learning (Unit summary)

In this unit, I have learned that:

- ✓ All living things need food nutrients to provide energy, build and repair cells and keep them functioning properly.
- ✓ The main food groups are carbohydrates (sugars and starches), proteins, lipids (fats and oils), vitamins, mineral salts and water.
- ✓ Different foods contain different nutrients.
- ✓ Simple carbohydrates are made up of single sugars, such as glucose; complex carbohydrates, such as starch and glycogen, consist of many single sugar units joined together.
- ✓ Lipid molecules are made up of a molecule of glycerol and three fatty acids.
- ✓ Protein molecules are large molecules that are made up of amino acids.
- ✓ Foods can be tested using reagents to find out which nutrients they contain.
- ✓ A balanced diet contains all the food nutrients that a person needs in the right quantities.
- ✓ Different people need different diets depending on their age, gender, level of activity and whether or not they are ill.
- ✓ A nutritional disorder occurs when a person does not have enough food or when their diet is lacking certain vitamins or minerals.
- ✓ Scurvy, rickets, anaemia, starvation and obesity are examples of nutritional disorders.

End unit assessment

1. Name six food nutrients.
2. Give an example of a food that contains:
   a) carbohydrates **b)** proteins **c)** vitamins.
3. Name the elements that are found in each of the following:
   a) carbohydrates **b)** proteins **c)** fats.
4. Give the basic units of each of the following:
   a) carbohydrates **b)** proteins **c)** fats and oils.
5. What is a balanced diet?
6. Name three deficiency diseases.
7. **a)** Discuss some of the nutritional disorders that occur in your local community. Include the causes, prevention and treatment of each disorder.

b) What impact do these disorders have on:
- **i)** an individual
- **ii)** a family
- **iii)** a community
- **iv)** the nation?

8. Kalisa recorded the number of children at his local clinic that suffered from nutritional disorders over three months. His results are shown in this table.

Nutritional disorder	January	February	March
Rickets	5	4	6
Kwashiorkor	1	3	1
Anaemia	6	3	4

a) How many children in total had kwashiorkor?
b) In which month were there the most children with anaemia?
c) Which foods should children with anaemia eat?
d) Which vitamin and mineral should children with rickets eat more of in their diet?

9. Match the word in Column A with the correct statement in Column B.

Column A	Column B
1.1 Carbohydrates	A. Needed for healthy skin and gums
1.2 Iron	B. Needed to build new cells
1.3 Proteins	C. Helps make haemoglobin in red blood cells
1.4 Vitamin C	D. Needed for energy

10. Name the reagents that are used to test for the presence of the following in a food sample:
a) proteins
b) starch.

11. A family has four members: an 80-year-old grandfather, a 35-year-old father, and 28-year-old pregnant mother, and a 2-year-old boy.
a) Between the boy and the grandfather, who should be given more milk?
b) Why?

12. Miss Umutoni visited a doctor as her gums were bleeding and she complained that she was always tired. The doctor told her to eat two oranges, spinach and plenty of red meat every day for one month. After two weeks, Miss Umutoni felt better and went to thank the doctor.
Discuss the causes of Miss Umutoni's symptoms, and explain why her treatment was successful.

UNIT 8 Structure and functions of the human gas exchange system

Key unit competence

To be able to describe the structure and functions of the human gas exchange system.

At the end of this unit, I should be able to:

- Identify the structures of the human gas exchange system namely the larynx, trachea, bronchi, bronchioles, alveoli and associated capillaries
- List the functions of the parts of the human gas exchange system
- Observe the structure of gas exchange system and relate it to its functions
- Demonstrate the structure of human gas exchange system using models
- Appreciate the similarity between the human gas exchange system and that of other mammals.

Figure 8.1: We need oxygen to make energy for exercise.

Introductory activity

Think back to your earlier grades. Then, discuss these questions.

1. What is respiration?
2. Why does respiration take place in the cells of the body?
3. Which gas is needed for respiration?
4. Which gas is produced by respiration?

8.1. Structure of the human gas exchange system

Activity 8.1

1. Name the respiratory organs in humans.
2. Do all organisms have the same respiratory organs?
3. Try to remember the pathway that air follows when we breathe in until it reaches the respiratory organs.

Most living organisms need oxygen gas (O_2) for **respiration**. You learnt in Unit 1 that respiration is a characteristic of living things. During respiration, glucose is broken down using oxygen, to release energy in cells. During this process, carbon dioxide (CO_2) is produced as a waste product. So, the cells must take in O_2 and get rid of CO_2 at the same time. The movement of gases across a surface or a membrane in opposite directions is called gas exchange. Gas exchange enables the movement of gases. It takes place in our lungs and in our cells.

How does gas exchange work?

In Figure 8.2, you can see that O_2 molecules move from one side of the gas exchange surface to the other side. The O_2 molecules move from the side where there are lots of them to the side where there are fewer of them. The CO_2 molecules move in the opposite direction through the gas exchange surface. However, they too move from where there is a high concentration of CO_2 molecules to where there is a lower concentration of CO_2 molecules.

The movement of molecules from a place where they are in a high concentration to a place where they are in a lower concentration is called diffusion. So, gas exchange takes place by **diffusion**.

Do not confuse gas exchange with **breathing** in mammals. Breathing is the movement of air into and out of the lungs.

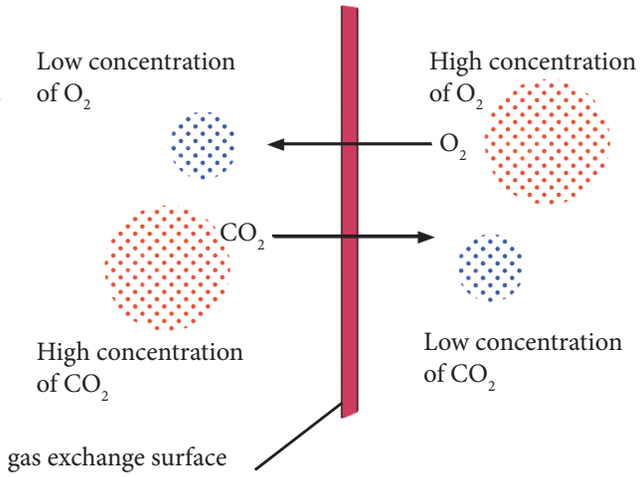


Figure 8.2: The process of gas exchange

The structure of the lungs

Air moves in and out of the lungs. Humans get the oxygen they need from the air. They get rid of carbon dioxide in the air that leaves the lungs. The lungs are part of the gas exchange system in humans.

Air is taken in from the outside, or inhaled, through the nose and mouth. The nose has two **nostrils**, which lead to the nasal cavity. The nasal cavity is lined with hairs and mucus, which filter and moisten the incoming air. They also trap dirt and bacteria. Blood vessels warm the air as it passes through the nasal cavity.

Air passes from the nasal cavity down a tube called the **trachea**, or windpipe. There is a flap of cartilage at the top of the trachea that flaps over it during swallowing. This stops food from entering the trachea. The trachea is held open by C-shaped rings of cartilage.

The trachea branches into two smaller tubes called **bronchi** (singular = bronchus). One bronchus leads to each lung and branches into many smaller tubes called **bronchioles**. The bronchioles end in many bunches of small, thin-walled air sacs called **alveoli** (singular = alveolus). The alveoli are the gas exchange surfaces. The alveoli provide a very large surface area for gas exchange. The inside surfaces of the alveoli are kept moist by water that diffuses out of the blood. The walls of the alveoli are only one cell thick, and many small blood capillaries surround them.

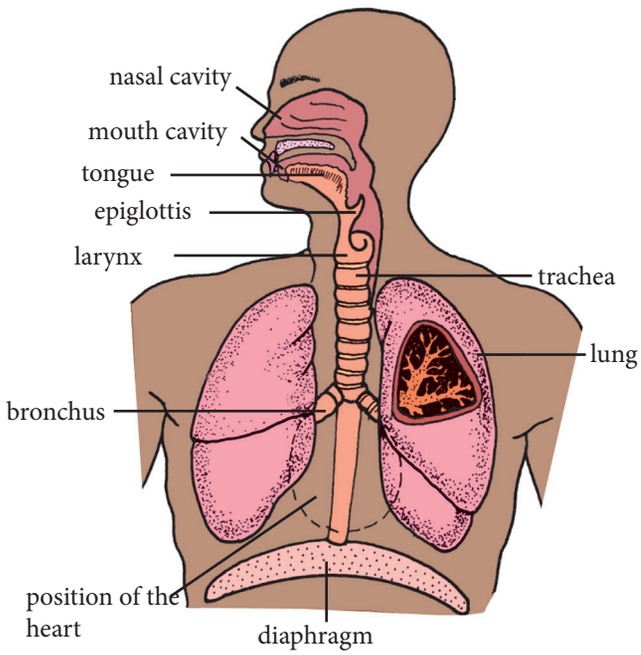


Figure 8.3: The structure of the human gas exchange system

Experiment 8.1

Dissect a lung.
You will need: a dissecting set; plastic sheeting; a hand lens; a lung of a goat, sheep or cow (with the trachea and bronchi intact); water; a container; a towel; soap; disinfectant; rubber tubing

Procedure

1. Wash the lungs carefully with enough water to remove the blood. Do not allow water to enter the trachea.
2. Place the lungs on a piece of plastic sheeting on a bench. Position the lungs so that you can see the tubes leading into them. You may have to cut away some pieces of flesh to fully expose the lungs.
3. Use Figure 8.3, above, to identify the various parts of the lungs.
4. Insert the rubber tubing into the trachea. Take a deep breath, and blow into the lungs very hard. Do you notice any movement of the lungs? Describe this movement. Do you think your lungs behave in a similar way when you breathe in? Explain your answer.
5. Examine the sides of the trachea and bronchi very closely. Do you see the rings on the trachea and bronchi? What colour are these rings? Next, feel the sides of the trachea and bronchi, and then the surface of the lungs. Do you notice any differences between them? Describe these differences.
6. The thin layer of skin covering the lungs is called the **pleural membrane**. What do you think is the function of this membrane?
7. Bend the trachea until the open end faces downwards, and then let it go. Was it easy to bend? What happened to the trachea when you let go? Next, try to close the trachea by squeezing it with your fingers, and describe what you feel. What happens to the trachea after you stop squeezing it? What function do the rings have?
8. Cut off one bronchus from the trachea to separate a lung. Next, cut along the bronchus until you expose the inside of the lung. Use the hand lens to see whether the bronchus divides further into smaller tubes. What are these sub-divisions of the bronchus called? What other details inside the lung have you observed? Describe the inside of the lung.
9. Figure 8.3, on page 86, shows the human lung in detail. Could you see this much detail when you examined the lung? Why can you not see the alveoli?
10. Put the lungs and other parts into the container and bury them in the ground. Carefully wash the bench and plastic sheeting with soap, and then disinfect them.
11. Wash your hands thoroughly with soap.

Table 8.1 describes the functions of the different parts of the human gas exchange system.

Table 8.1. Functions of parts of the human gas exchange system

Part	Functions
Nasal passages	• Hairs in the nostrils trap dust and other small particles • Mucus lining the nasal passages traps germs
Pharynx	Warms and moistens the air entering the lungs as the air passes over blood vessels
Epiglottis	Stops food and liquids from going into the trachea during swallowing
Trachea and bronchi	• Provide an open passage for air to enter and leave the lungs • Mucus lining the inside walls traps dust and germs • Move mucus, which contains dust and germs, to the pharynx, using hair-like structures (cilia) that line the inside walls
Alveoli	Enable the exchange of gases between the blood passing through the lungs and the air in the lungs

Self assessment 8.1

1. Draw a labelled diagram of the human lungs.
2. Describe the function of each of the following:
   a) rings of cartilage
   b) mucus inside the trachea and bronchi.
3. What are alveoli?
4. The inside of the lung is spongy. Explain the word 'spongy'.
5. Copy the table below, and then complete it.

Part	Functions
Trachea	
Rings of cartilage in the bronchi	
Cilia in the nasal passage	

8.2. Functions of the parts of the human gas exchange system

In humans, gas exchange takes place in two places: in the alveoli in the lungs and in the cells of the body.

Gas exchange in alveoli

Air, which contains oxygen, is breathed into the lungs. Oxygen moves from the alveoli into the blood in the capillaries that surround the alveoli. Carbon dioxide moves out of the blood into the alveoli. Carbon dioxide is breathed out.

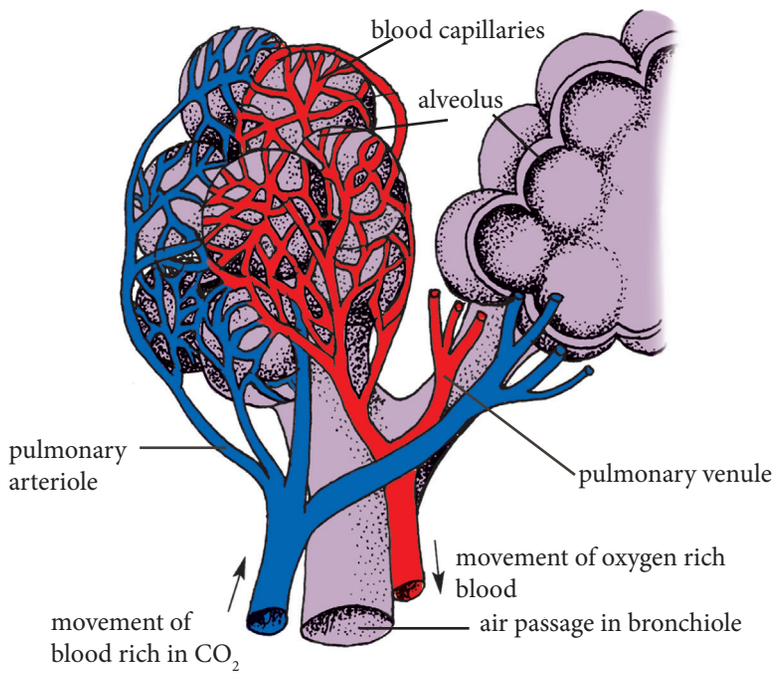


Figure 8.4: Structure of the alveoli

Gas exchange in cells

Blood containing oxygen flows from the heart to the body cells. Oxygen molecules move by diffusion from a high concentration in the blood towards a region where there is less oxygen inside the cells. Inside the cell, oxygen is used in the process of respiration. Carbon dioxide is made during respiration in the cells. This means that there is a high concentration of carbon dioxide molecules inside the cells. Carbon dioxide moves out of the cells into the blood where there is a lower carbon dioxide concentration.

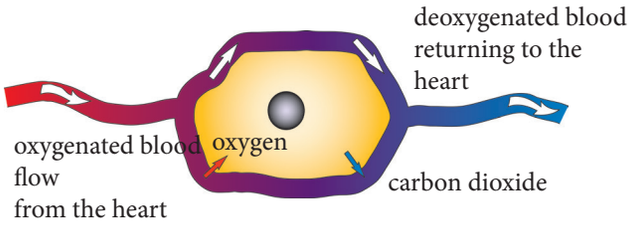


Figure 8.5: Gas exchange in a cell of the body

Experiment 8.2

Make a model to demonstrate breathing.

You will need: rubber bands or string; a glass rod; a rubber sheet of a size that will cover the bottom of a bell jar; a bell jar; two balloons; a Y-shaped tube; a rubber bung or cork

Procedure

1. Using a rubber band, tie the glass rod to the rubber sheet. Secure the rubber sheet around the open end of the bell jar using rubber bands. The rubber sheet represents the diaphragm.
2. Tie a balloon around each arm of the Y-shaped tube. Push the other end of the tube through a rubber bung or a cork. The balloons represent the lungs and the Y-shaped tube represents the trachea and bronchi. Assemble the apparatus as shown in Figure 8.6, below.
3. Pull the rubber sheet downwards using the glass rod. This represents an inhalation. Note what happens to the balloons when the rubber sheet is pulled downwards. Explain what happens.
4. Push the rubber sheet upwards using the glass rod. This represents an exhalation. Note what happens to the balloons when the rubber sheet is pushed upwards. Explain what happens.

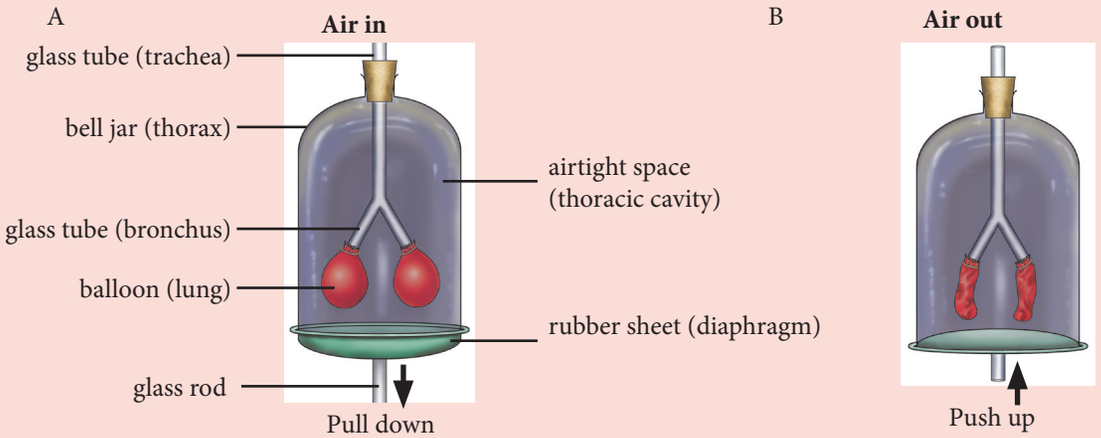


Figure 8.6: Experiment to demonstrate inhalation (A), and exhalation (B)

Exercise

Work in pairs.

1. Use a microscope to examine the microscope slides that your teacher will give you. You can also use the micrographs in Figure 8.7 if you do not have slides.
2. Make a labelled drawing of what you see. What magnification did you use?

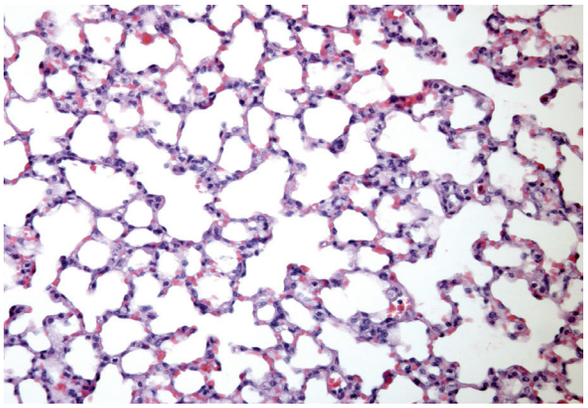
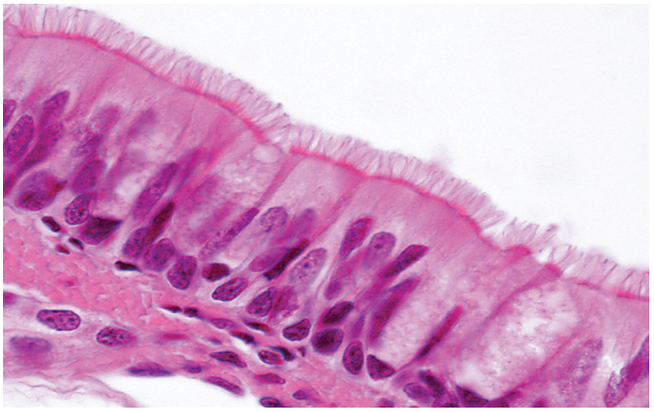
A  B. 

Figure 8.7: Micrographs showing alveolar cells (A) and ciliated epithelium (B)

Checklist of learning (Unit summary)

In this unit, I have learned that:

- ✓ Gas exchange is the movement of gas molecules across a surface or membrane which is called the gas exchange surface.
- ✓ The movement of gas molecules takes place by diffusion.
- ✓ All organisms need to make energy through respiration, so they need oxygen and they produce carbon dioxide.
- ✓ In humans, gas exchange takes place inside the lungs and in the cells of the body.
- ✓ The human gas exchange system consists of the nostrils, nasal passages, trachea, bronchi, bronchioles and alveoli.
- ✓ The walls of the alveoli are only one cell thick; the alveoli are surrounded by small blood capillaries.
- ✓ Air, which contains oxygen, is breathed in; oxygen molecules diffuse through the walls of the alveoli into the blood.
- ✓ Blood that contains oxygen flows to the cells of the body; oxygen molecules diffuse across the cell membrane into the cell, where they are used for respiration.
- ✓ Carbon dioxide diffuses out of the cells into the blood.
- ✓ Blood that contains carbon dioxide flows into the lungs; carbon dioxide molecules diffuse through the walls of the alveoli into air in the lungs, and are breathed out.

End unit assessment

Choose the correct answer.

1. What are the tiny sacs in the lungs called?
A bronchi **B** alveoli **C** capillaries

2. What happens during gas exchange in the lungs?
A Oxygen passes into the blood and carbon dioxide passes out of the blood.
B Oxygen passes out of the blood and carbon dioxide passes into the blood.
C Oxygen and carbon dioxide pass into the blood.

3. Which structures does the trachea lead to in the lungs?
A pleural membranes **B** bronchioles **C** bronchi

4. The alveoli are suited for gas exchange because they have:
A a small surface area **B** a large surface area **C** walls that are many cells thick

5. The cilia in the air passages:
A trap dust **B** trap bacteria **C** trap dust and bacteria

6. Explain the difference between:
a) gaseous exchange and breathing
b) diffusion and breathing.

7. List the pathway for air from the nose into the lungs.

8. Name two places where gas exchange takes place in humans.

9. **a)** What type of cells line the trachea?
b) How are these cells specialised for their function?

10. Research gaseous exchange in the following animals:
a) insects
b) fish
c) spiders.

UNIT 9 Tropic responses

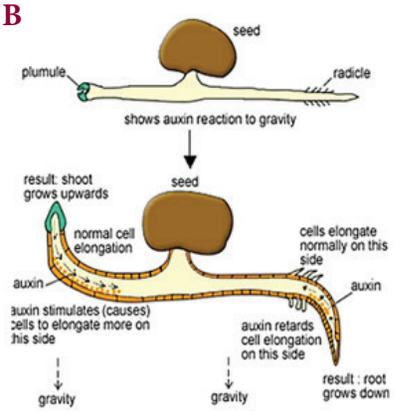
Key unit competence

To be able to explain a plant's response to light and gravity and explain the importance of tropic responses in plants.

At the end of this unit, I should be able to:

- Recall that plants have a root system
- Identify the parts of the shoot that respond to light
- Define phototropism as a response in which parts of a plant grow towards or away from the light source
- Explain that gravitropism is a response in which parts of a plant grow towards or away from gravity
- Describe the change in shape of the shoot and root tips when exposed to light and ground level
- Explain the importance of phototropism and gravitropism in plants
- Carry out investigations showing the response of a plant shoot towards light and gravity
- Observe and illustrate plant shoots growing toward stimuli of light and gravity
- Show that plants respond quite differently compared to animals
- Appreciate the importance of tropisms in plants
- Show patience and perseverance when carrying out experiments that take a long time to get results.

B



Introductory activity

Think back to the structure of a flowering plant. Then, talk about these questions.

1. What do you do when you see a fierce dog charging at you? Why and how?
2. When you touch a hot object, you directly remove the hand from it. Why?
3. Look at the plants A and B on the left. According to you, what caused the plant in picture A to bend? Why? The next picture shows a germinating seed, why the shoot and radical grown as you see it in the picture? How do we call these kinds of responses? Do you now have an idea what this unit is about?

9.1. Meaning and types of tropism

Activity 9.1

1. Name two types of root systems.
2. Give two functions of roots.
3. In what ways are roots well suited to their functions?

In Unit 1, you learnt that all living things need to respond to their environment. This response is known as **sensitivity**. It is one of the characteristics of living organisms. Organisms are sensitive to a **stimulus** (plural = stimuli). Light is an example of a stimulus. When we go into bright light, the pupils of our eyes get smaller, to protect the eye. The response to a stimulus involves many different parts of an organism, such as the sense organs and nervous system. Animal responses to stimuli are easy to see, as they are quick. The animal's sense organs and nervous system are involved. Plants do not have sense organs or a nervous system, but they still need to respond to changes in their environment. For example, they need to grow towards light and water. Although plants cannot move from one place to another, they can move their stems, roots, leaves and flowers towards or away from a stimulus. This movement takes place by growth. For example, shoots grow upwards towards light, and roots grow downwards towards water.

The word '**tropism**' refers to plant growth towards or away from a stimulus. When part of a plant grows towards a stimulus, this is called a positive tropism. When a plant part grows away from a stimulus, this is called a negative tropism.

In this unit, you will learn about two types of tropisms: phototropism and gravitropism.

Stimulus	Tropism
Light	Phototropism
Gravity	Gravitropism or geotropism
Chemical	Chemotropism
Water	Hydrotropism
Touch	Thigmotropism

Phototropism

'Photo' means light. Plants can respond to the stimulus of light. This is called **phototropism**. Their shoots grow towards the light. For example, if you leave a plant near a window, the stem will start to bend towards the light. We say that the plant is positively phototropic.

There exist two types of phototropism:

- Positive Phototropism: Stem tip growing toward the light
- Negative Phototropism:Root tip growing away from the light

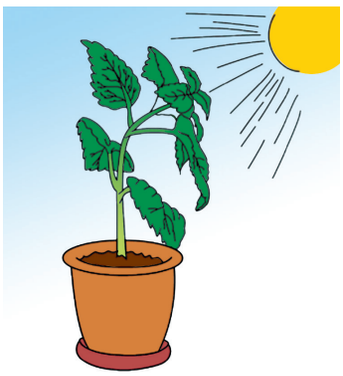


Figure 9.1: Plants grow towards light.

The importance of phototropism is that ithelps leaves be in the best position possible to receive enough light for photosynthesis.

Experiment 9.1

Demonstrate phototropism in plants.

You will need: two bean plants; cotton thread; ink; a ruler; a cardboard box; a pair of scissors

Procedure

1. Mark the stem of both plants at two-millimetre intervals using cotton that has been dipped in ink. See Figure 9.3.
2. Put one plant in a place where it can get light on all sides. Or, place it on a **clinostat**, if your school has one.
3. Make a slit in the cardboard box so that light can get in. Place the second plant inside the box.
4. Make sure the plants are watered and leave them for a few days.

Questions

1. Examine the plants. In which direction did the plant grow that had received:
   a) light on all sides
   b) light from one side?
2. Describe the growth of a stem using the words 'phototropic' and 'positive'.

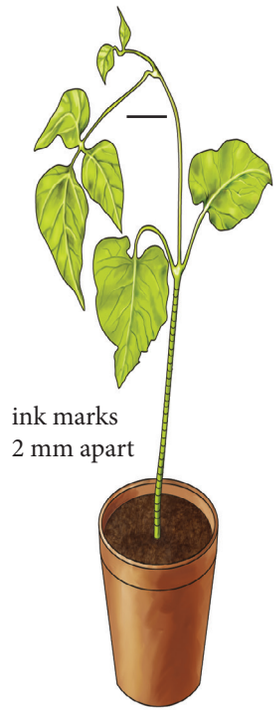


Figure 9.2: Mark the bean plants at two-millimetre intervals.

Gravitropism (Geotropism)

Gravitropism also called geotropism is the response of plants' stems and roots to the effect of gravity. Gravity is a downward pull towards the centre of the Earth. Plant stems grow upwards, against gravity. They are negatively gravitropic. However, plant roots grow downwards, in the same direction in which gravity acts. We say that they are positively gravitropic.

If a seedling is planted on its side, the radicle, or first root, will start to grow downwards and the shoot will grow upwards.

The importance of gravitropism is that it pulls roots down to anchor a plant and roots can get needed water and minerals.

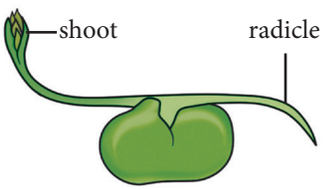


Figure 9.3: Plant roots grow downwards, in the same direction as gravity.

Experiment 9.2

Demonstrate gravitropism in plants.

You will need: bean seeds that have been soaked in water overnight; paper towels; elastic bands; marker pens; four glass jars; a pot plant

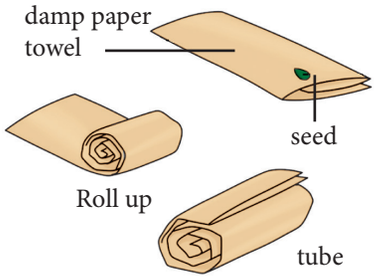


Figure 9.4: Rolling seeds into a paper towel

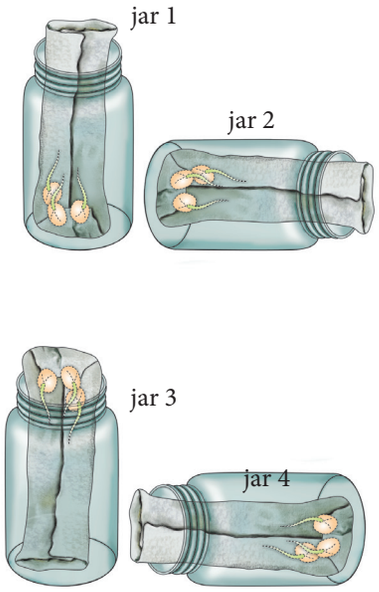


Figure 9.5: Position of the seedlings with the roots facing in different directions.

Procedure

1. Fold each paper towel into a narrow strip that is 12 cm long (see Figure 9.5). Make about 15 strips.
2. Moisten each strip with water, so that it is damp.
3. Place one seed on the end of each strip and roll it up. Wrap an elastic band around the seed to keep it inside the paper towel.
4. Place the pot plant on its side and put it into a dark cupboard for a few days.
5. Leave the seeds for a few days, but keep them damp with water.
6. Choose the twelve seedlings that have grown the longest roots and shoots. Do not remove the seedlings from the paper towels.
7. Label the jars 1, 2, 3 and 4, and then do the following (see Figure 9.6):
   - **a)** Place three seedlings into jar 1 with the roots facing upwards.
   - **b)** Place three seedlings into jar 2 with the roots pointing sideways to the right.
   - **c)** Place three seedlings into jar 3 with the roots facing downwards.
   - **d)** Place three seedlings into jar 4 with the roots pointing sideways to the left.
8. Check the seedlings every second day for ten days. Examine the roots and record your observations in a table like this one.

Date	Observations			
	Jar 1 Roots facing upwards	Jar 2 Roots facing sideways to the right	Jar 3 Roots facing downwards	Jar 4 Roots facing sideways to the left

Questions

1. What did you notice about the direction in which the seedlings' roots and stems grew?
2. Describe the seedlings' root and stem growth using the words 'gravitropic', 'positive' and 'negative'.
3. **a)** What happened to the growth of the pot plant?
   b) Can you explain why the pot plant grew like this?
   c) Explain why the pot plant was put into a dark cupboard.

9.2. Why do plants respond to light and gravity?

Activity 9.2

Work in pairs.

1. Your teacher will show you a plant that shows another type of tropism: the plant responds to touch.
   a) How does the plant respond when something touches it?
   b) Make a drawing to show how the plant responds.
2. Research other types of plant responses, for example, hydrotropism, chemotropism and thigmotropism. Write up your findings using these headings: Stimulus; Name of tropism; Positive response of plant part; Negatice response of plant part.

Plants need light for photosynthesis.
Photosynthesis is a process in plants that is used to make food using light energy, carbon dioxide and water. The green pigment, chlorophyll, is also needed. Near the tips of plant shoots, there are special chemicals that are sensitive to light. These chemicals cause shoots to grow towards light.
Plant roots grow downwards into the soil to find water and minerals. There are special cells near the tips of roots that cause the root to grow in the direction of gravity.
Some plants respond to other stimuli besides light and gravity. One of these stimuli is touch. This is called thigmotropism (see Figure 9.7 and 9.8).
In the next activity, you will research other plant responses.

Figure 9.6: A climbing plant responds to touch by growing tendrils towards the place where it touches a structure.

Self assessment 9.1

1. Give the meaning of these words:
   a) tropism
   b) stimulus
   c) response
   d) phototropism.
2. Give one reason why plant shoots respond to:
   a) light
   b) gravity.
3. Make a labelled drawing to show how the shoot and root grow in a seedling.

Figure 9.7: When touched, the feathery leaves of the shrub *Mimosa pudica* curl inwards.

Checklist of learning (Unit summary)

In this unit, I have learned that:

- ✓ All organisms respond to changes in their environment; sensitivity is a characteristic of life.
- ✓ Plants respond to stimuli by growing towards or away from the stimulus; this is called a tropic response.
- ✓ Plants' response to light is called phototropism, and their response to gravity is called gravitropism.
- ✓ Plant stems grow towards light; they are positively phototropic.
- ✓ Plant roots grow downwards in the same direction as the force of gravity; they are positively gravitropic.
- ✓ Plant shoots grow towards light so that they can receive more light for photosynthesis.
- ✓ Plant roots grow into the soil so that they can absorb water and mineral salts.
- ✓ Other examples of tropisms include hydrotropism (the response to water), chemotropism (the response to chemicals) and thigmotropism (the response to touch).

End unit assessment

1. Do plants and animals respond to changes in their environment in the same way? If you answer no, then explain how their responses differ.
2. Complete the sentences below using these words: towards, phototropism, roots, stimulus, negatively.
   - **a)** The growth of a stem _____ or away from a light _____ is called _____.
   - **b)** Plant stems are _____ gravitropic.
   - **c)** Plant _____ are positively gravitropic.
3. Explain why plants respond to light.
4. Draw a diagram to show what will happen if a pot plant is left to grow on its side for a while.
5. Explain how you would demonstrate that roots are positively gravitropic. Use the following headings: Materials; Method; Results (what you expect to happen); Conclusion (what you found out).

UNIT 10 Skeletal systems of organisms

Key unit competence

To be able to analyse the different types of skeletons and identify the main parts of a human skeleton.

At the end of this unit, I should be able to:

- Recall the different types of skeleton in organisms
- List the characteristics of hydrostatic skeletons, exoskeletons and endoskeletons
- Explain the role of the different types of skeletons
- State the functions of the human/ mammalian skeletal system
- Describe the general structure of the human skeleton and identify the bones of the central and peripheral parts
- Recognise the different parts of the human skeleton from models in class
- Practice illustrating and labelling the major bones
- Research on the skeleton and presentation of the findings
- Take care of your bones so your skeleton stays strong and healthy.

Introductory activity

Think back to what you have already learnt about skeletons and answer the following questions:

1. What structures support our bodies?
2. What is attached to these structures that help us to move?
3. Which organs in our bodies need to be protected?
4. Do all organisms have bones? If not, how are their bodies supported?
5. Are different animals able to move differently? If so, how do they move? Are their skeletons adapted for this movement? If so, think of ways in which they are adapted.

Figure 10.1: Humans have a strong skeleton that helps them to move.

10.1. Types of skeletons

Activity 10.1

1. Look at the pictures or specimens of different animals. Are their skeletons the same?
2. How each animal is able to move and how its skeleton helps it to do this?
3. Find an earthworm and an insect (e.g. a locust, grasshopper or cockroach). Place your specimens in glass jars that have had holes punctured in their lids for air. Place some moist soil into the jar with the earthworm, so that it does not dry out. All specimens must be alive and unharmed. Your teacher will show you pictures of a small frog, bird or mammal.
4. Observe the locomotion of each animal, and discuss the structures that enable each animal to move.
5. Return the specimens to the places where you collected them.

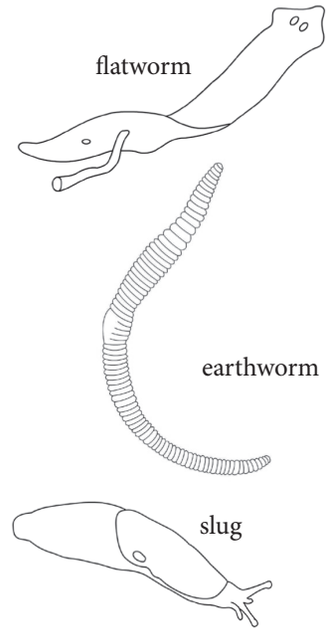


Figure 10.2: Soft-bodied animals have hydrostatic skeletons.

All animals need a **support system** that can help them stay upright and move. This support system is the **skeleton**. Animals in water need less support than animals on land because the water supports them as well. On land, animals need to overcome the force of gravity to be able to move. They also need protection for the soft tissues and organs inside their bodies.

A skeleton is a structure on the inside or the outside of the body that gives support to the body and protects the softer parts of the organism. There are three types of skeletons: hydrostatic skeletons, exoskeletons and endoskeletons.

Hydrostatic skeletons

Hydrostatic skeletons are found in animals that have soft bodies. Such skeletons are not made up of hard structures such as bones. Instead, these animals have a liquid skeleton. There is fluid inside their bodies. Muscles in the animal's body can work against the fluid that keeps their bodies firm. Examples of animals with hydrostatic skeletons include earthworms, slugs, snails, jellyfish, leeches and flatworms.

Exoskeletons

Figure 10.3: Insects moult so that they can get bigger.

Some animals have a skeleton on the outside of their bodies. This is called an **exoskeleton** ('exo'- means 'outside'). This type of skeleton is found in insects, crabs, spiders and scorpions.

These are some of the features and functions of an exoskeleton.

- An exoskeleton lies outside the muscles of an animal's body.
- It is made by the animal's skin.
- It protects the internal body parts from injury.
- It provides protection against predators.
- Its colour may help the animal to hide or to attract a mate.
- It is waterproof, and it prevents the animal from losing too much water.

Exoskeletons are not made from living cells, so they do not grow with the animals. As an animal grows, the non-living skeleton needs to be replaced. The animal sheds its protective outer skeleton and a new, larger skeleton takes its place. This is called **moulting**. The new skeleton is soft just after moulting. This makes the animal easy prey for predators at this time.

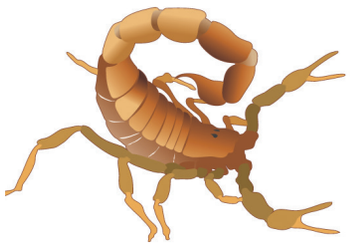
At certain places in the exoskeleton, there are **joints**. In these places the exoskeleton is soft and **flexible**. Muscles are attached to different places on the joints.

Figure 10.4 shows different animals that have an exoskeleton.

Insects have hard exoskeletons.

Crabs have an exoskeleton that is shaped like a shield.

Spiders have a leathery exoskeleton.



Scorpions have an exoskeleton similar to that of insects.

Figure 10.4: Examples of different animals that have an exoskeleton

Endoskeletons

Some animals, such as humans, have a skeleton inside their body. This is called an endoskeleton ('endo' means 'inside'). In most animals, the endoskeleton is made up of bones and **cartilage**. The endoskeleton is living tissue.

An endoskeleton supports an animal's body. Animals need to move from one place to another in search of food or a mate. An endoskeleton provides a place where the muscles can be attached. Some bones are fused together and other bones form joints that help the animal to move. As the bones are on the inside of the body, they grow as the animal grows. This means that animals that have an endoskeleton do not need to moult.

Animals that have endoskeletons include fish, frogs, birds, reptiles and mammals. All of these animals have a **backbone**. All animals that have a backbone are vertebrates. Animals with endoskeletons nearly all have the same basic parts: a backbone, four limbs (arms and legs), a skull and ribs. Some animals have bones in their skeletons that are adapted to suit their way of life. For example, the bones of a bird are adapted for flying.

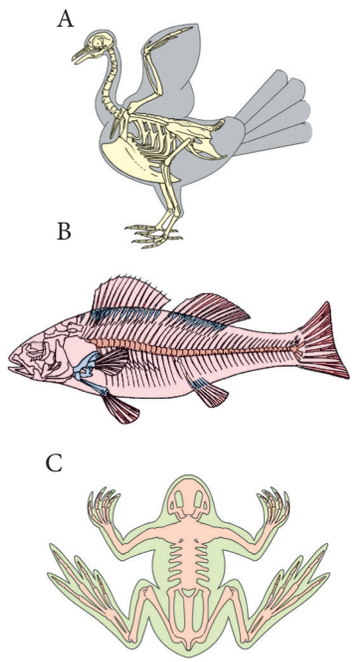


Figure 10.5: Animals with endoskeletons: a bird (A), a fish (B) and a frog (C)

Characteristics of hydrostatic skeletons, exoskeletons and endoskeletons

Table 10.1 shows the characteristics of the three skeleton types you have learnt about.

Table 10.1 Characteristics of hydrostatic skeletons, exoskeletons and endoskeletons

Hydrostatic skeleton	Exoskeleton	Endoskeleton
• Inside the body • Made of fluid • Muscles around the fluid can press against it	• Outside the body • Made of non-living material • Muscles are attached to the inside of the skeleton • Does not grow, so it needs to be shed to enable the animal to grow	• Inside the body • Made of living material • Muscles are attached to the outside of the skeleton • Grows inside the animal

Self assessment 10.1

1. Name two animals that have a hydrostatic skeleton.
2. What makes up a hydrostatic skeleton?
3. Name three different animals that have an exoskeleton.
4. a) What is 'moulting'?
   b) Explain why animals that have an exoskeleton have to moult.
5. How do animals that have an exoskeleton move?
6. Write down two ways in which an exoskeleton helps an animal.
7. What do we call endoskeletons?
8. Describe the animals with endoskeletons and give examples.

10.2. The human skeleton

Activity 10.2

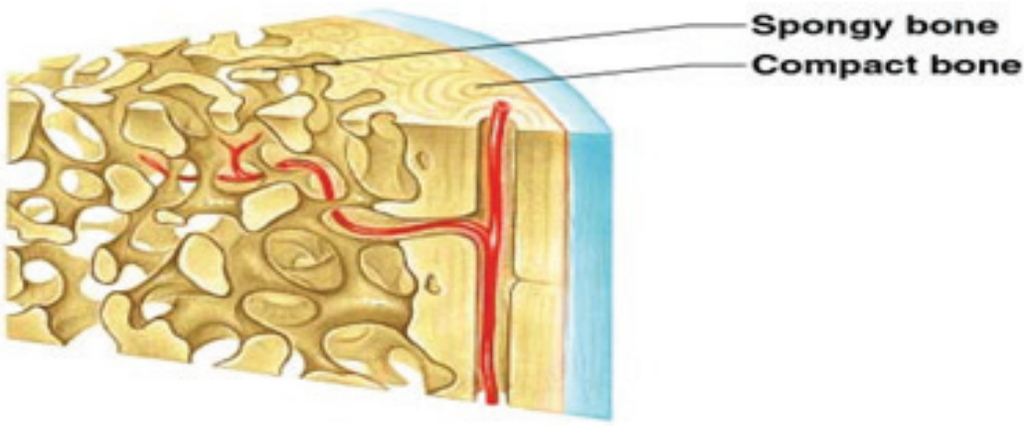
Think back on what you learnt and answer the following:

1. Are there bones in the head? If yes, name them.
2. Are there bones in thorax? If yes, name them.
3. Are there bones in the legs? If yes, name them.

The human endoskeleton is made up of 206 bones. The human skeleton is different to all other animal skeletons because humans walk on two legs and other animals usually walk on four legs. The bones in the skeleton are made from living cells. They can break and grow.

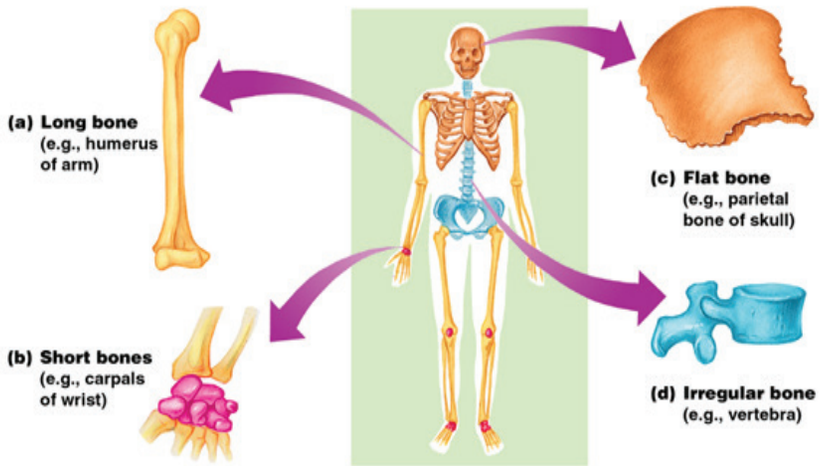
There are two basic types of bone tissue

- Compact bone
- Homogeneous Spongy bone



Bones are classified basing on their shapes

1.Long- bones are longer than they are wide (arms, legs)
2. Short- usually square in shape, cube like (wrist, ankle)
3.Flat- flat , curved (skull, Sternum)
4.Irregular- odd shapes (vertebrae, pelvis)



The bones of the human skeleton

Look at Figure 10.6. It shows the bones that make up the human skeleton. The human skeletal system is divided into the central skeleton and the peripheral skeleton, which you will learn about in the sections to follow.

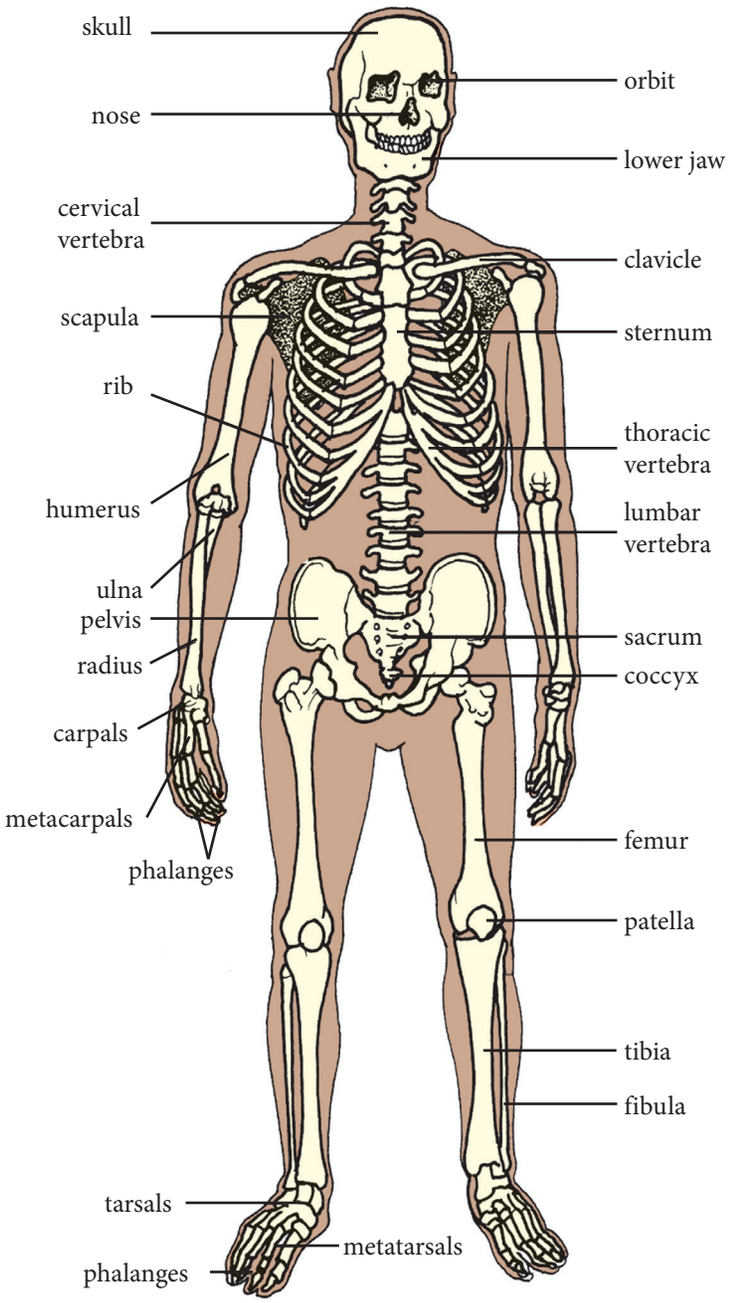


Figure 10.6: The bones of the human skeleton

Central skeleton

The central skeleton consists of the skull, the vertebral column and the thoracic cage.

Skull

The skull is made up of different bones all fused, or joined, together to form a type of case for the brain. The skull has openings for the eyes and nose. It protects the brain, the eyes, and the parts of the ears that are inside the skull.

Vertebral column

This is the part of the skeleton that enables us to walk upright, bend over, crouch, bend and turn. It is also called the backbone. It is made up of lots of bones, called **vertebrae**. The vertebral column works like a chain. Each vertebra can only move a little, but as a whole it moves better than one solid bone. The vertebral column needs to be strong and flexible, to give us good support. From the side, it is S-shaped.
The bones of the vertebral column form a hollow tube through which the spinal cord passes. The spinal cord is the part of the brain that extends into the back. The vertebrae protect the **spinal cord**.
The vertebral column also supports the **thorax** (chest), and the **ribs** are attached to it.

Thoracic cage

The thoracic cage consists of 12 pairs of ribs that are attached to the vertebral column at the back and a bone called the sternum in front of the chest. Ribs are thin bones. They play a very important function in protecting the heart and lungs. There are muscles between the ribs that help us to breathe in and out.

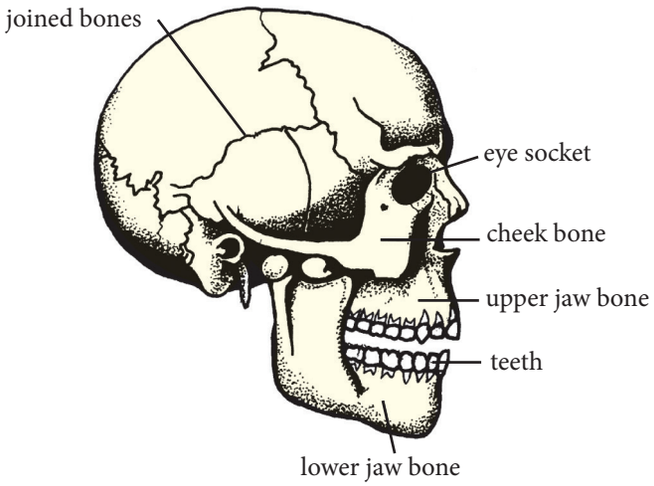


Figure 10.7: The structure of the skull

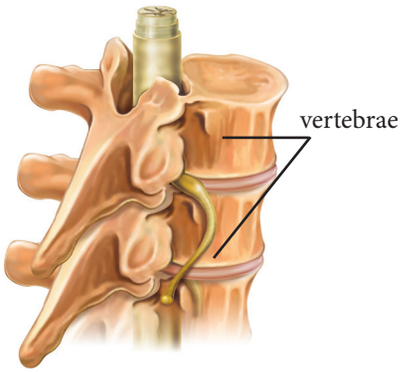


Figure 10.8: Vertebrae of the backbone

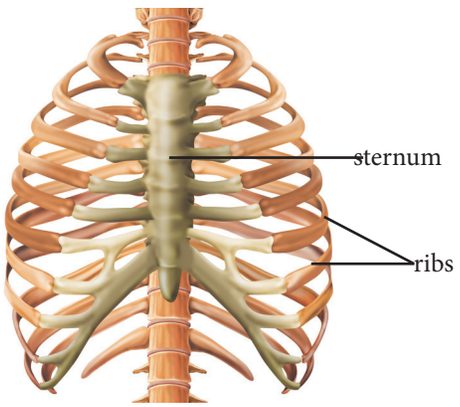


Figure 10.9: The ribcage protects the heart and lungs.

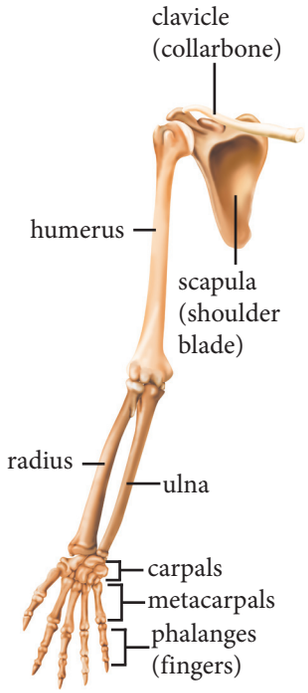
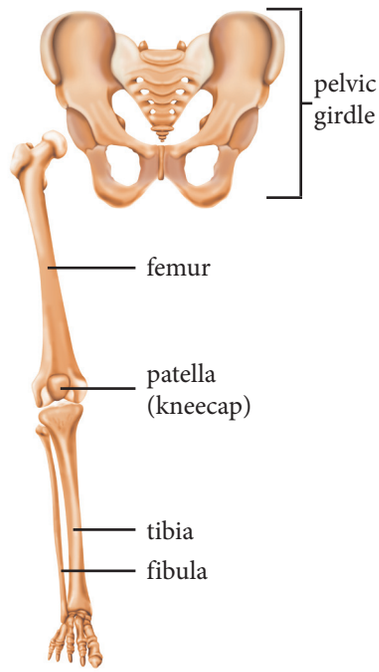


Figure 10.10: Bones of the pectoral girdle and arm



Side view of foot

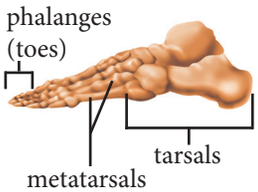


Figure 10.11. Bones of the pelvic girdle and legs

Peripheral skeleton

The peripheral skeleton consists of the upper and lower limbs, pectoral girdle and pelvic girdle.

Upper limbs

The arms are the upper limbs. The upper limb is made up of the humerus, radius and ulna, carpals, metacarpals and phalanges (see Figure 10.10 alongside). The bones of the upper arm are joined to the lower arm at the elbow joint. The lower arm is joined to the hand by the wrist joint. Each hand has five fingers. The arms and hands are used to do countless activities, such as grasping, writing and eating.

Pectoral girdle

The bones of the upper arm are attached to the pectoral girdle. The pectoral girdle is made up of the collarbone (clavicle) and shoulder blade (scapula) (see Figure 10.10). The collarbone is a long, thin bone below the front of the neck. The shoulder blades are the large, flat bones that you can see in the back view of the skeleton. These bones help to protect the heart and lungs. Together with the collarbones, the shoulder blades form joints for the bones of the upper arm.

Pelvic girdle

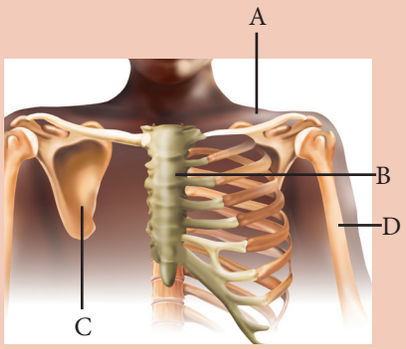
This is made up of a ring of bones and includes the base of the vertebral column (see Figure 10.11, on the next page). The hip bones are large flat bones. They protect the internal parts of the body that are important for reproduction. The **hip bones** form joints for two legs.

Lower limbs

The legs are the lower limbs. The bones of the lower limbs include the femur, patella, tibia and fibula, tarsals, metatarsals and phalanges (see Figure 10.11). The bones of the upper leg are joined to the lower leg at the knee joint. The lower leg is joined to the foot by the ankle joint. Each foot has a heel and five toes. The legs are the organs of locomotion.

Self assessment 10.2

1. What is the main function of the skull?
2. How many ribs are there in the human skeleton?
3. a) What is another name for the vertebral column?
   b) What are the bones that make up the vertebral column called?
4. Which bones protect the heart and lungs?
5. Which bones form joints with the hip bones?
6. What is the function of the backbone?
7. List the bones of each of the following:
   a) thoracic cage
   b) pectoral girdle
   c) lower limbs.
8. The diagram below shows part of a skeleton. Provide labels for bones A to D.



10.3. Functions of the skeleton

Activity 10.3

You will need: a variety of different bones; a sharp pencil; a ruler; an eraser; drawing paper

1. Make a drawing of the bone shown in Figure 10.12, alongside.
2. Make a neat labelled drawing to show the structure of the pectoral girdle and the pelvic girdle.

Figure 10.12 A human femur

Table 10.2 summarises the functions of the skeleton.

Table 10.2. Functions of the skeleton

FUNCTION	DESCRIPTION
Support.	As most animals with an endoskeleton live on land, they need support for the mass of their bodies
Protection	The bones of the skeleton are strong, and so they protect important organs inside the body. The bones of the skull protect the brain, the vertebrae protect the spinal cord, the ribs protect the heart and lungs, and the pelvis protects some of the digestive organs and the female reproductive organs.
Movement	The skeleton helps the animal to move. It is used for the attachment of muscles. Joints help parts of the skeleton to bend; for example, the elbow joint makes it possible to bend the arm.
Production of blood cells	The bone marrow manufacture the blood cells. The red blood cell are made in red bone marrow while the white bone marrow are made in white bone marrow
It gives the shape of the body	The body shape depends on the shape of the bones.
Storage of minerals	Huge number of minerals in the body are stored in bones. Examples: Calcium 99%, Phosphorus 89%, and it stores also small amount of Magnesium and Sodium

Self assessment 10.3

1. Give a definition for each of these terms.
- **a)** exoskeleton
- **b)** joint
- **c)** endoskeleton
- **d)** hydrostatic skeleton

2. Give an example of an animal that has:
- **a)** an exoskeleton
- **b)** a hydrostatic skeleton.

3. List the bones in the:
- **a)** upper arm
- **b)** pectoral girdle
- **c)** pelvic girdle.

4. Give three functions of the human skeleton.

Case study

Looking after our skeletal system

Work in groups. Read the Case study below, and then answer the questions.

Care of our bones

There are three things that we need for healthy bones: calcium, exercise and sunshine.

Calcium

Calcium is an important building block for bones. It gives them their strength. We measure healthy bones by their density. Bones with a high density are strong. Bones store calcium that can be used when we do not have enough calcium in our diet. We must replace the used calcium to keep our bones strong. Different people need different amounts of calcium, depending on their age, gender and stage of life. Bone building takes place mainly during childhood and early adulthood. Bone calcium decreases as we age. We should exercise and eat calcium-rich foods to keep our bones strong.

Exercise

When we exercise, our muscles pull on our bones. This helps to build healthy, denser bones. Bones respond better to weight-bearing exercises such as walking, stair climbing, jogging and aerobics. Exercises that offer resistance to movement like weight training and high impact exercises like skipping and jumping are also good for healthy bones.

Sunshine

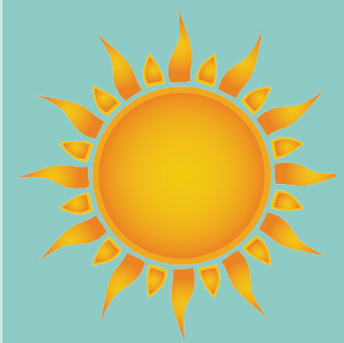
Vitamin D forms in our skin when it is exposed to sunlight. It is difficult to take in enough vitamin D from our diet alone. Vitamin D improves bone strength by increasing the amount of calcium that is absorbed into the body.

Questions

1. What can you do to make sure that you have strong bones.
2. Talk about your diets, the amount and type of exercise that you do, and the amount of time you spend outside in the sun.

Dairy products are rich in calcium.

Exercise builds healthy, dense bones.



The body makes vitamin D when the skin is exposed to sunlight.

Checklist of learning (Unit summary)

In this unit, I have learned that:

- ✓ Animals have skeletons to support their bodies.
- ✓ There are three types of skeletons: hydrostatic skeletons, exoskeletons and endoskeletons.
- ✓ Hydrostatic skeletons are found in soft-bodied animals and consist of fluid.
- ✓ Exoskeletons are found in animals such as insects, crabs and scorpions and are on the outside of the animal's body.
- ✓ Endoskeletons are found inside the bodies of animals, for example, humans.
- ✓ The human skeleton consists of a central and peripheral skeleton.
- ✓ The central skeleton is made up of the skull, vertebral column and thoracic cage.
- ✓ The peripheral skeleton is made up of the upper and lower limbs, pectoral girdle and pelvic girdle.
- ✓ A skeleton is important as it provides support, protects important organs and enables the animal to move.
- ✓ We need to look after our bones by eating enough calcium, getting enough exercise and making sure that we are sometimes exposed to the sun.

End unit assessment

1. What structures make up an endoskeleton?
2. An exoskeleton does not grow, so how do animals with an exoskeleton grow?
3. Name two soft internal parts of the body that ribs protect.
4. What is the name of a place where two bones meet?
5. Which part of the skeleton protects the brain?
6. Which bones make up the vertebral column?
7. What is the function of the backbone?
8. Give three reasons why animals with an exoskeleton are able to move.
9. The table shows how the amount of calcium in a person's diet relates to their bone density.

Amount of calcium in diet (mg/day)	Bone density (units)
25	500
30	600
40	800
60	1,000

   a) What do you notice about the relationship between the amount of calcium a person eats and their bone density?
   b) Name and explain two other factors that affect a person's bone density.
10. Give functions of the human skeleton.
11. **a)** What is synovial joint?
    b) What function does each of the following havein a joint.
    (i) A tendon (ii) A ligament (iii) Synovial membrane.
    (iv) Synovial fluid. (v) A cartilage.

Formal assessment for topic 2

1. **a)** A learner views a specimen using a microscope. The eyepiece objective lens used is 10× magnification, and the nosepiece objective lens is 40× magnification. What is the total magnification? Show your working out. (3)

b) A learner draws a seed that measures 1,5 cm in length. Her drawing is 9 cm in length. What is the magnification of the drawing? (1)

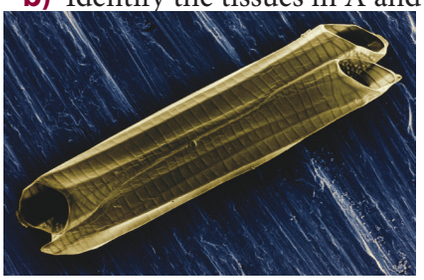
2. Complete the table below by filling in the missing information.

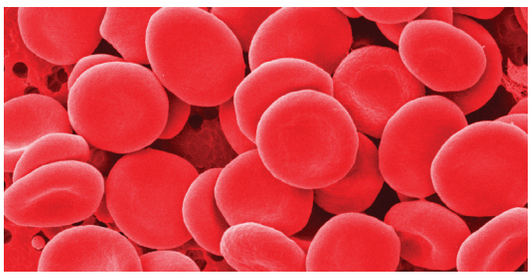
	Plant cell	Animal cell
Shape		
Outer covering		
Organelles		
Vacuoles		

3. **a)** Define each of these words.

i) tissue **ii)** organ (2 × 2 = 4)

b) Identify the tissues in A and B.

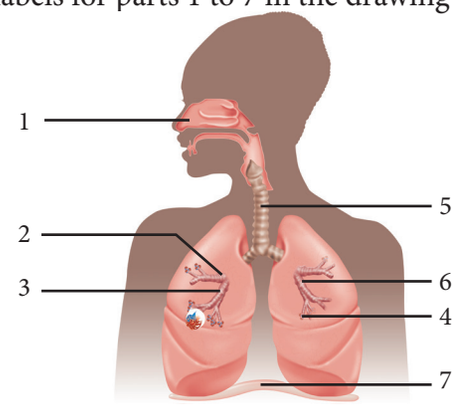
A 

B 

(2 × 2 = 4)

c) Give one function of each tissue you gave in your answer to question b). (4)

4. Provide labels for parts 1 to 7 in the drawing of the respiratory system.



(7)

5. The table below shows the amount of food nutrients in 100 g of breakfast cereal.

Food nutrient	Amount per 100g
Protein	15,9 g

Carbohydrate	53,5 g
Fat	20,2 g
Vitamin C	3 mg
Iron	5 mg
Vitamin B	4 mg

a) Which food nutrient is present in the cereal in:
i) the highest amount **ii)** the lowest amount? (2)
b) Name two vitamins that are in the cereal. (2)
c) Name one mineral that is found in breakfast cereal. (2)
d) Name the deficiency disease that results if a person does not eat enough:
i) iron **ii)** vitamin C. (2)

6. A learner did some food tests on a sample of food. He recorded his results in a table.

Name of reagent used	Colour before test	Colour after test
Iodine	Orange	Blue-black
Ethanol	Clear	Clear
Sodium hydroxide and copper sulphate	Blue	Purple

a) Which food nutrients are:
i) present in the sample **ii)** absent from the sample? (3)
b) Describe how the learner tested the food sample for the presence of starch. (6)

7. Conduct research to find out why cells in organisms are specialised, and then present your findings in a report.

a) Under the heading 'Cell specialisation in animals':
- Give two examples.
- Make a labelled drawing of each example.
- Discuss how the specialisation makes the cells well suited to their functions.

b) Under the heading 'Cell specialisation in plants':
- Give two examples.
- Make a labelled drawing of each example.
- Discuss how the specialisation makes the cells well suited to their functions. (18)

Total marks: 68

TOPIC

3 Health and disease

Figure 11.1: Rwandans need to grow up fit and healthy so that they can become strong adults that help Rwanda grow.

UNIT 11 Classification of diseases

Key unit competence

To be able classify diseases and explain ways of preventing the spread of infectious diseases.

At the end of this unit, I should be able to:

- Define good health as a state of mental, social and physical wellbeing
- Define disease as any physical or mental disorder or malfunction with a characteristic set of signs and symptoms
- Explain how infectious diseases (cholera, tuberculosis, malaria, Ebola, HIV/AIDS) are spread
- Explain ways in which infectious and non-infectious diseases can be prevented
- Classify diseases into infectious, non-infectious, inherited, degenerative, social, mental, eating disorder and deficiency diseases
- Adopt and encourage the practices that enhance good health
- Be aware that the clearing of bushes and grasses in the habitats of the anopheles mosquitoes and the treatment of the stagnant water for the anopheles larvae are necessary for eradicating malaria.

Introductory activity

Some people are healthy, but others are sick. Sometimes sick people need to go to hospital. In groups, talk about these questions.

1. What is good health?
2. Name some diseases that occur in your community.
3. Discuss whether or not people get these diseases from other people.
4. Talk about ways to prevent sick people from spreading disease.
5. Work out a definition for the terms 'disease' and 'good health'.

Figure 11.2: Many people go to the local clinic when they are sick.

11.1. Health and disease

Activity 11.1

You may have heard the saying 'prevention is better than cure'. Describe five good practices that can prevent a person from getting a disease.

When we say that a person is in 'good health', we mean that the person is in a good mental, physical and social state.
The word 'disease' refers to a physical or mental disorder or malfunction that has a particular set of signs and symptoms. A person that has a disease is sick and may need to be treated by a health worker.
Some diseases do not cause symptoms, so we may not know that the person is sick. However, other diseases cause a clear set of signs and symptoms.

Figure 11.3: A nurse taking care of a patient in hospital

Practices that promote good health

We can follow these good practices to prevent disease and stay healthy.

- Eat a balanced diet.
- Eat at regular intervals.
- Get enough sleep.
- Maintain good hygiene of the body, clothes, the home and foods.
- Drink safe water.
- Exercise regularly.
- Avoid eating too much salt.
- Wash your hands before each meal and after going to the toilet.

Self assessment 11.1

1. List five types of diseases.
2. Explain the meaning of each of these terms.
   a) infectious disease
   b) hypertension
   c) immunisation
   d) haemoglobin
3. Design a poster to show how washing your hands helps to prevent the spread of infectious diseases. Include information about how and when we must wash our hands.

Classfication of diseases

There are two main types of diseases: infectious and non-infectious diseases.

11.2. Infectious diseases

Activity 11.2

1. What is an infection?

2. **a)** Find out the names of at least five infectious diseases.

b) Research how each of these diseases is transmitted, and then suggest preventive measures for each one.

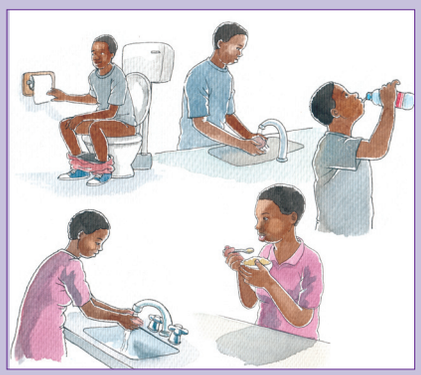
tuberculosis	malaria	Ebola fever	HIV/AIDS

3. The wall chart below shows some ways to prevent cholera. Analyse it, and then answer these questions.

a) Use the wall chart to suggest ways to prevent cholera.

b) Suggest any two other ways to prevent cholera.

c) How can we help someone with cholera?



Infectious diseases are diseases that are passed on, or transmitted, to a person by another organism, such as a bacterium or virus. Organisms that cause disease are called **pathogens**. They attack the body's cells or release poisons called **toxins**. Nearly all pathogens are micro-organisms, so they are microscopic. When a person has an infectious disease, he or she can spread it to another person. Table 11.1 lists some examples of pathogens and the infectious diseases that they cause.

Figure 11.4: Malaria is caused by a parasite (plasmodia) that is transmitted to humans when a mosquito (anophele) bites.

Table 11.1. Pathogens and infectious diseases

Type of pathogen	Examples of infectious diseases
Bacteria	Cholera, tuberculosis, typhoid fever
Protists	Malaria, sleeping sickness
Fungi	Thrush, athlete's foot, ringworm
Viruses	HIV/AIDS, influenza, chicken pox, measles
Parasitic worms	Guinea worm disease, bilharzia

Figure 11.5: Ringworm is caused by a fungus that forms a distinct ring on the skin.

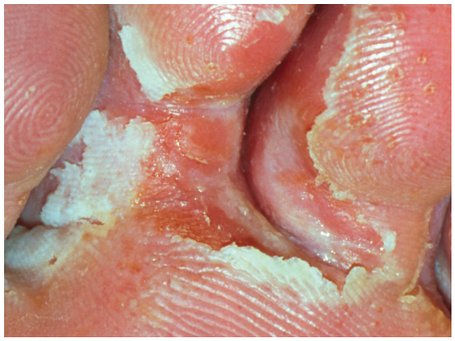


Figure 11.6: Athlete's foot is an infectious fungal skin disease that occurs mainly on the feet.

The spread and prevention of infections

You have learnt that infectious diseases can be transferred, or transmitted, from one infected person to another. Another name for an infectious disease is a **communicable disease**. Communicable diseases are transmitted by **infections**.

Infectious diseases can spread through:

- water (e.g. cholera); these are called waterborne diseases
- air (e.g. measles, tuberculosis)
- blood (e.g. HIV/AIDS)
- sexual intercourse (e.g. gonorrhoea).

There are several ways to prevent the spread of infectious diseases, including the following:

- Inform and warn people about a particular infectious disease, for example, cholera or Ebola fever. Offer health education at all levels of the country.
- Improve public hygiene measures; for example, remove the remains of dead animals, have rubbish collection points around schools and cities, and provide safe drinking water and sewage systems.
- Isolate or quarantine infected people in places where they have little contact with people other than health workers.
- Immunise people against infectious diseases. This is an injection that helps our bodies to fight a disease.
- Build more healthcare centres.

Figure 11.7: A patient suffering from tuberculosis (TB), which is an infectious disease

Self assessment 11.2

1. What are the vectors of infections diseases and give examples of diseases each.
2. Copy the table below, and then complete it.

Name of disease	Causes
Sickle cell anaemia	
Allergy	
Stroke	

3. Follow the steps on the next page to prepare an oral rehydrating solution (ORS) that you can use as a first aid to help a patient suffering from cholera. ORS is a mixture that is made from clean water, table salt and sugar.

You will need: sugar (table sugar); table salt; two teaspoons; a clean one-litre bottle with a lid; boiled water; a clean measuring cylinder or any suitable container; soap

Procedure

1. Wash your hands with soap and water. Wash the teaspoons, bottle and measuring cylinder with soap and clean water and leave them to dry.
2. Put 750 ml of boiled water into the bottle.
3. Measure out one level teaspoonful of table salt. Remove half of the salt from the spoon. Add the remaining half (2,5 ml) to the water in the bottle.
4. Measure out one level teaspoon of sugar (use the other teaspoon to level the sugar with the edge of the spoon). Add the teaspoonful of sugar (about 5 ml) to the 750 ml of water in the bottle.
5. Repeat step 4 until you have added six level teaspoonsful (30 ml) of sugar.
6. Put the lid on the bottle and shake it until all the sugar and salt have dissolved. You have now prepared an oral rehydration solution (ORS). Taste it; it should be no more salty than the tears from your eyes.

11.3. Non-infectious diseases

Activity 11.3

Kalisa and Nyirasafari still have their grandparents, who are 90 years old. They like to visit their grandparents. One day, their grandmother fell and broke her arm. The doctor said that her arm broke because of osteoporosis, which is an age-related disease.

1. Do research in the library or on the Internet, and then explain the words 'ageing' and 'osteoporosis'.
2. What are the signs of ageing?
3. Is ageing a non infections disease? Explain
4. With examples, what do we call non infections disease?

Non-infectious diseases cannot be passed from one person to another by living organisms. They develop because the body does not work properly, or they may be caused by a person's lifestyle. Examples include sickle cell anaemia, allergies, ageing, osteoporosis, cancer, cardiovascular diseases, eating disorders, **deficiency diseases** and mental illnesses.

Sickle cell anaemia

Sickle cell anaemia is a disease of the red blood cells. Sickle-shaped red blood cells are unable to carry oxygen as well as normal red blood cells can. They can also easily get stuck in narrow blood vessels. This prevents oxygen from reaching the cells of the body.

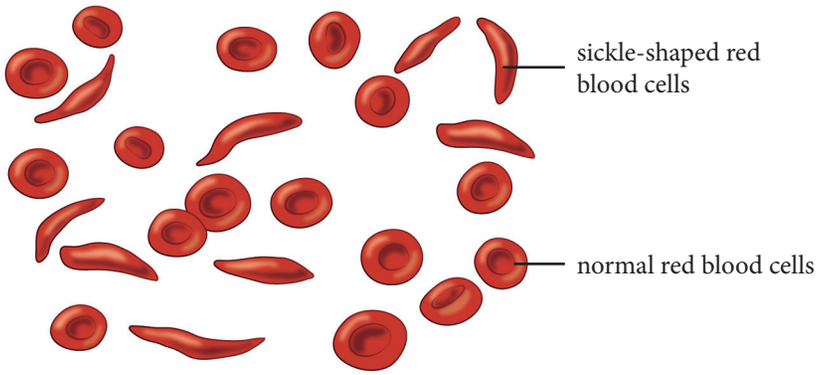


Figure 11.8: Sickle-shaped red blood cells and normal red blood cells

Sickle cell anaemia is caused by a change in a **gene** that makes haemoglobin, the molecules that give your blood its red colour. Haemoglobin helps red blood cells to carry oxygen from the lungs to all the cells in the body.
The sickle cell gene is passed from one generation to the next. If both a mother and father have the sickle cell gene and pass it to their child, then their child will have sickle cell anaemia. If only one parent has the sickle cell gene and it is passed to his or her child, then the child will be able to make both normal and sickle cell haemoglobin. This child will be a carrier of the sickle cell gene. There are tests available to find out if a child has sickle cell anaemia. Although there is no cure for sickle cell anaemia, medications can relieve the symptoms.

Allergies

An allergy is a reaction by the **immune system** to a substance in the environment. A substance that causes an allergy is called an allergen. Some people are allergic to certain foods, for example, nuts or shellfish, or to substances in the environment, for example, dust, pollen or pesticides. When someone is allergic to something, they sneeze, get itchy eyes, get a rash or have swelling on their body. There are different medicines available to treat allergies.

Ageing

Ageing is the process of becoming older. Many physical, mental and social changes take place. For example, older people do not walk or think as fast as younger people do. Ageing is a natural process that we will all go through.

Figure 11.9: As you get older, organs and systems are likely to suffer from age related diseases. Nelson Mandela lived to a very old age of 95, and then he passed on due to age related diseases.

Osteoporosis

Osteoporosis is a bone disease that occurs mostly in women after **menopause**. The bones become very porous, and they break easily and heal slowly. The disease can lead to curvature of the spine after the vertebrae collapse.

Cancer

Cancer is a non-infectious disease that develops when cells of the body do not divide normally. Cancer can start almost anywhere in a person's body. Cancer may lead to the growth of tumours. There are many ways to treat cancer, but it is important to find it early on.

Cardiovascular diseases

These are diseases of the heart and blood vessels. Examples include coronary heart disease (CHD) and strokes. CHD can lead to a heart attack, which is when the heart muscles do not get enough oxygen. A stroke occurs when too little oxygen is transported to the brain cells.

Eating disorders

Eating disorders lead to diseases that are caused by undereating or overeating. You have already learnt about some diseases that occur from undereating, such as kwashiorkor and marasmus.

Obesity is caused by eating more food calories than are used up by physical activity. Excess energy is stored as fat. Obesity is becoming more common as people eat more unhealthy 'fast' foods and spend less time exercising.

Deficiency diseases

Deficiency diseases occur when a person's diet lacks certain vitamins and minerals. For example, a deficiency of vitamin C can lead to scurvy. You learnt about some of these diseases in Unit 7 in Table 7.4, on page 79.

Mental illnesses

Diseases that affect a person's mind include depression, anorexia and schizophrenia. There are many ways to treat these diseases. Table 11.2 summarises different types of diseases and gives examples of each disease.

Activity 11.4

1. Look at the diseases given in the blocks below.

high blood pressure (hypertension)	tuberculosis (TB)	cystic fibrosis	obesity
kwashiorkor	malaria	HIV/AIDS	anaemia

Put each disease into one of these categories:

- **a)** infectious disease
- **b)** non-infectious disease
- **c)** inherited disease
- **d)** eating disorder
- **e)** deficiency disease.

2. Name four other diseases, and classify each disease into one of the groups above.

Table 11.2. Different diseases and their descriptions

Type of disease	Description	Examples
Infectious disease	A disease caused by an invading organism; it can be transmitted from one person to another	Cholera, malaria, tuberculosis, Ebola
Non-infectious disease	A disease that cannot be transmitted from one person to another	Stroke, sickle cell anaemia, scurvy, high blood pressure
Inherited disease	A disease caused by a genetic fault that may be passed from parents to children	Sickle cell anaemia, haemophilia, cystic fibrosis
Degenerative disease	A gradual decline in function, often associated with ageing	Arthritis
Social disease	Drug dependence, often caused by social pressure and certain types of social behaviour	Alcoholism
Mental illness	A disorder of the mind	Anorexia, schizophrenia
Eating disorder	A disease caused by undereating or overeating	Anorexia, obesity
Deficiency disease	A disease caused by a poor diet that lacks one or more essential nutrients	Scurvy, rickets

Checklist of learning (Unit summary)

In this unit, I have learned that:

- ✓ A person's health includes their mental, social and physical well-being.
- ✓ There are two main types of diseases: infectious and non-infectious diseases.
- ✓ Infectious diseases are caused by pathogenic organisms, and they can be transmitted from one person to another unless preventive measures are taken.
- ✓ Preventing the spread of infectious diseases is important and includes quarantine and immunisation.
- ✓ Cholera is an infectious disease that is caused by a bacterium and spread through contaminated water.
- ✓ Some diseases are non-infectious; they include sickle cell anaemia, allergies, ageing, osteoporosis, cancer, cardiovascular diseases, eating disorders, deficiency diseases and mental illnesses.

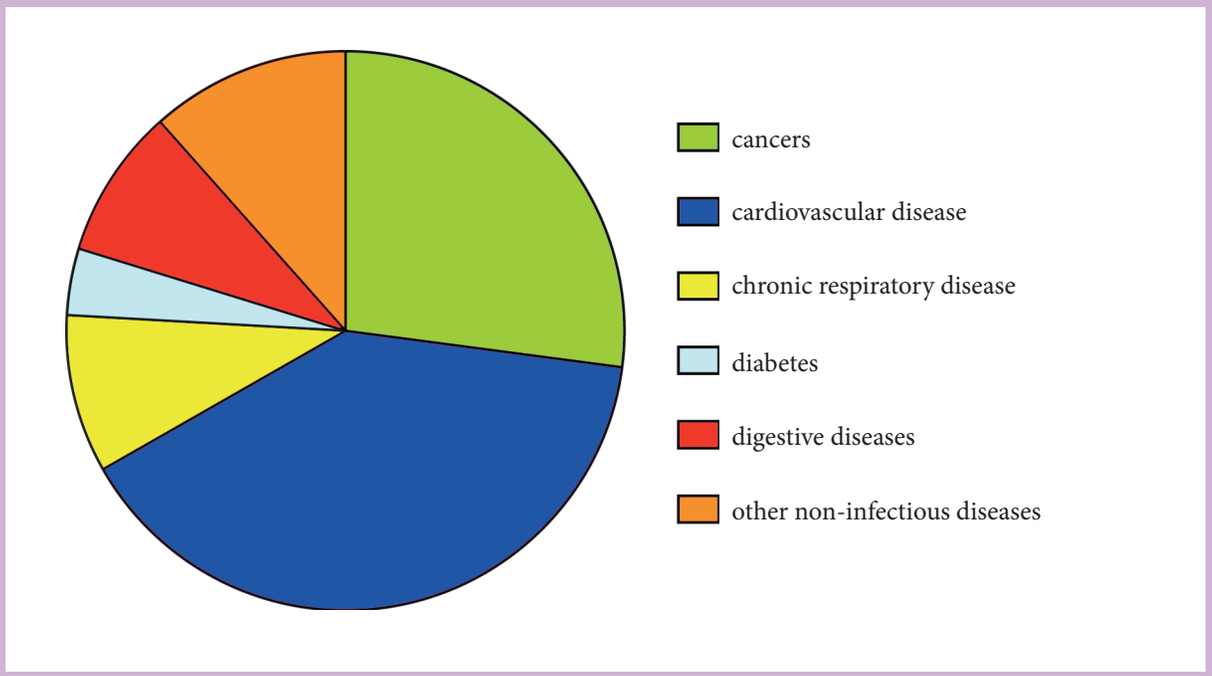
End unit assessment

Look at Table 11.2, on previous page, and then answer these questions.

1. Name:
   - **a)** three infectious diseases
   - **b)** two inherited diseases
   - **c)** one degenerative disease.
2. Give the meaning of the following terms:
   - **a)** degenerative disease
   - **b)** social disease
   - **c)** deficiency disease.
3. Which vitamin is deficient when a person has:
   - **a)** scurvy
   - **b)** rickets?
4. Look at the photographs below, and then comment on the health of each child.

5. Ask your partner to look at the pie chart, and then to tell you, according to the data presented, which disease causes:

a) the most deaths **b)** the fewest deaths.



Number of deaths caused by the main non-infectious diseases worldwide

Source: http://www.who.int/gho/ncd/mortality_morbidity/ncd_premature_text/en

6. Describe to your partner two measures for preventing the spread of infectious diseases.

7. We often hear in the news that people in refugee camps die from cholera. Ask your partner to explain factors that make cholera common in such camps.

8. **a)** Discuss with your partner the preventive measures the Rwandan government uses to eradicate malaria.

b) Despite the measures taken by the government, malaria still causes the death of many Rwandans. What factors are causing this failure to eradicate malaria?

9. The Rwandan government encourages its citizens to participate in sport. Discuss with your partner the impact that sport can have on our health.

UNIT 12 Human reproductive system

Key unit competence

To be able to analyse the structure, functions and processes of the human sexual and reproductive system and relate to the understanding of sex and gender.

At the end of this unit, I should be able to:

- Describe the structure and function of the human sexual and reproductive system
- List the external and internal organs of the male reproductive system
- List the external and internal organs of the female reproductive system
- Explain the production of sex cells: gametogenesis
- Compare the size and shape of ovum and sperm
- Explain the role of hormones in growth, development and the regulation of the reproduction organs and sexual functions
- Define sex determination
- Analyse how culture, tradition and religious practices influence one's thinking about sex, gender and reproduction
- Appreciate that gender stereotypes are not biologically determined and can be challenged.

Introductory activity

In groups, talk about these statements.

1. What do you see on following figures?
2. How does a female getpregnant?
3. What is the importance of reproduction?

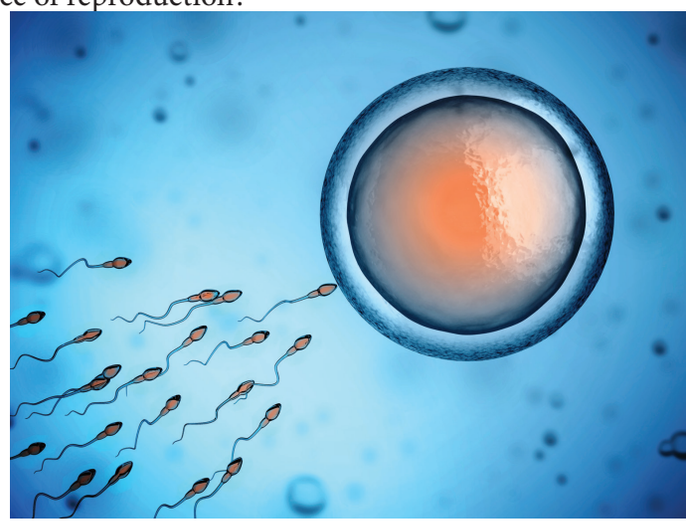


Figure 12.1: Male sperm cells and a female egg.

12.1. Reproductive organs

Activity 12.1

When you observe the boy and the girl, directly you see or you imagine some of their parts that make the difference between them.

1. List the parts that make the differences between boy and girl.
2. In the reproductive system, the male and female organs play their role. Which one involves more than another and why?

The reproductive organs in humans are structures that are involved in reproduction. You learnt in Unit 1 that reproduction is a characteristic of living things. In this unit, you will learn about the structure and functions of the male and female reproductive systems.

The reproductive organs are important for:

- producing male and female sex cells, or gametes
- transporting the male sex cells to the female sex cell
- producing chemicals called hormones
- enabling a baby to grow inside the female's body.

The male and female human reproductive systems have external and internal parts.

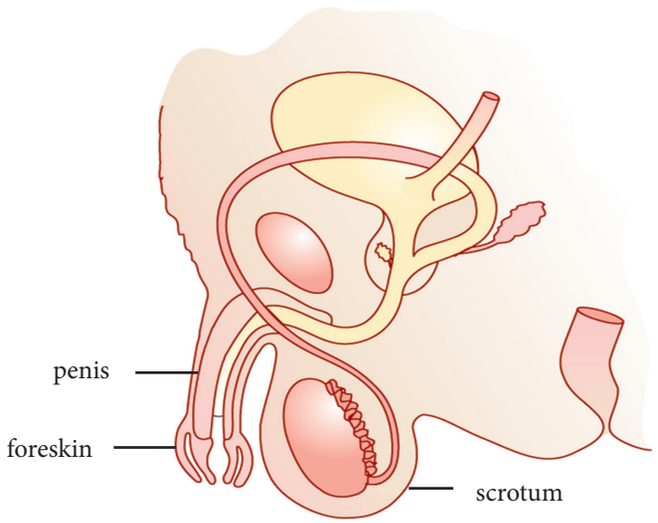
A. Male reproductive organs

The male reproductive organs are the testes, **penis**, **epididymis**, **sperm ducts**, **Cowper's glands**, **seminal vesicles**, prostate gland and **urethra**.

External organs

There are two **testicles**, or testes, which are surrounded by a sac called the **scrotum**. The testes produce male gametes, called sperm, and secrete the male hormone **testosterone**.

The penis is important for the transfer of sperm to the female during sexual intercourse. The penis is covered by skin called the foreskin. This is removed during **circumcision**.



Side view

Figure 12.2: The external male reproductive structures

Internal organs

Table 12.1 describes the internal male reproductive structures.

Table 12.1 The internal male reproductive structures

Structure	Description
Epididymis	A tightly coiled tube 5 to 6 metres in length. It stores sperm, and it is the place where sperm cells mature.
Seminiferous tubules	Long, coiled tubes inside the testes. They contain germinal cells that can divide to produce sperm cells.
Sperm ducts	A sperm duct transports sperm from the epididymis to the urethra. The sperm duct is also called the vas deferens. There are two sperm ducts, one from each testis, that open into the urethra.
Cowper's glands	Secrete mucus that lubricates the urethra.
Seminal vesicles	Produce and release seminal fluid into the sperm duct. This fluid helps to **neutralise** the acidity that the sperm will meet inside the female's reproductive structures. There are also nutrients in the seminal vesicle secretion that provide energy for the sperm.
Prostate gland	The **prostate gland** surrounds the urethra. It also secretes a fluid into the urethra as the sperm passes through during **ejaculation**. This fluid helps to neutralise the acidity of urine residue that the sperm will meet inside the urethra. The secretions of both the seminal vesicles and the prostate gland improve the motility, or movement, of the sperm.
Urethra	A passage for both urine and semen, at different times. Semen is a fluid that contains sperm, neutralising chemicals and nutrients.

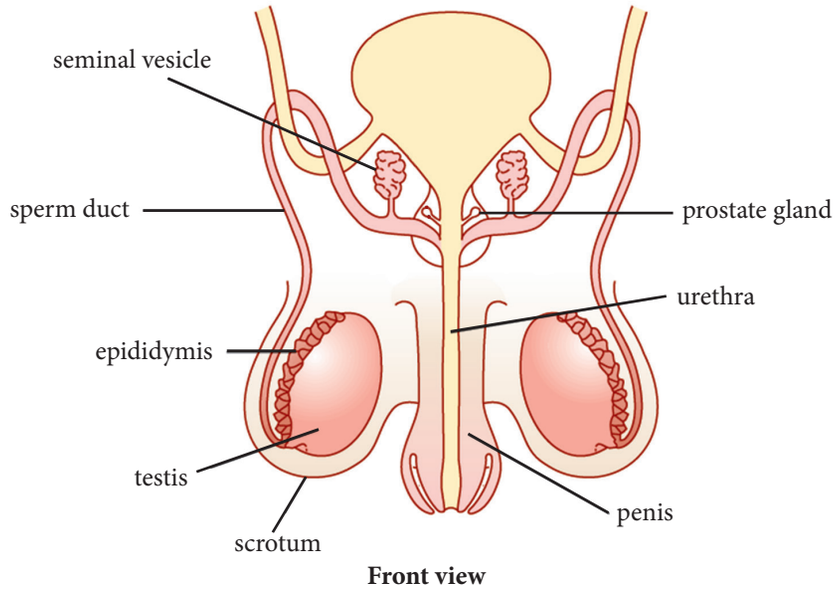
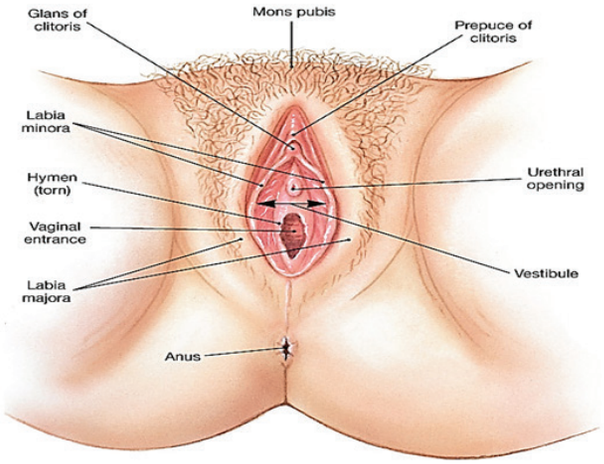


Figure 12.3: The internal male reproductive structures

B. Female reproductive organs

The female reproductive organs include the vulva, ovaries, oviducts, uterus, cervix and vagina. The female reproductive system produces female gametes, called ova (singular = ovum) inside the ovaries. The ovaries also produce the female sex hormones **oestrogen** and **progesterone**.

External organs



The external organs are collectively called the vulva.

Table 12.2 describes the different parts of the vulva.

Table 12.2. The parts of the vulva

Structure	Description
Labia majora	An outer fold of skin that covers the labia minora.
Labia minora	An inner fold of skin that protects the openings of the urethra and vagina.
Clitoris	A female **erectile** organ that is important during sexual intercourse.
Vaginal opening	The opening into the **vagina** is important during sexual intercourse and during childbirth. The vaginal opening in a virgin girl is covered by a membrane called a **hymen**. During sexual intercourse, the hymen is broken.

Internal organs

Table 12.3 describes the internal organs of the female reproductive system.

Table 12.3. Th.e internal organs of the female reproductive system

Structure	Description
Vagina	A narrow, muscular tube. It is also known as the birth canal as it is a passage for the birth of a baby. The vagina has folded walls that can be easily stretched. It has a rich supply of mucus for lubrication. During sexual intercourse the penis is inserted into the vagina to deposit the male gametes.
Cervix	At the top of the vagina is a narrow opening called the **cervix**. The cervix is a ring of muscle that is important during childbirth.
Uterus	The **uterus** is a pear-shaped organ where the baby develops. It has thick, muscular walls that are lined with a mucous membrane called the **endometrium**. During menstruation, the endometrium is shed. The muscular walls of the uterus contract powerfully during childbirth to help with the delivery of the baby.
Ovaries	The two **ovaries** are about three centimetres in length. They are inside the abdomen, one on each side of the uterus. They are attached to the uterus by ligaments. Every 28 days an ovum is released from one ovary. This is called **ovulation**.
Oviducts	The **oviducts** are tubes that extend from the ovaries to the uterus. The ovum is released into a funnel at the end of each oviduct. The oviducts are sometimes called Fallopian tubes. The ovum is moved along the oviduct towards the uterus by the action of tiny hairs called cilia. Fertilisation takes place in the oviduct.

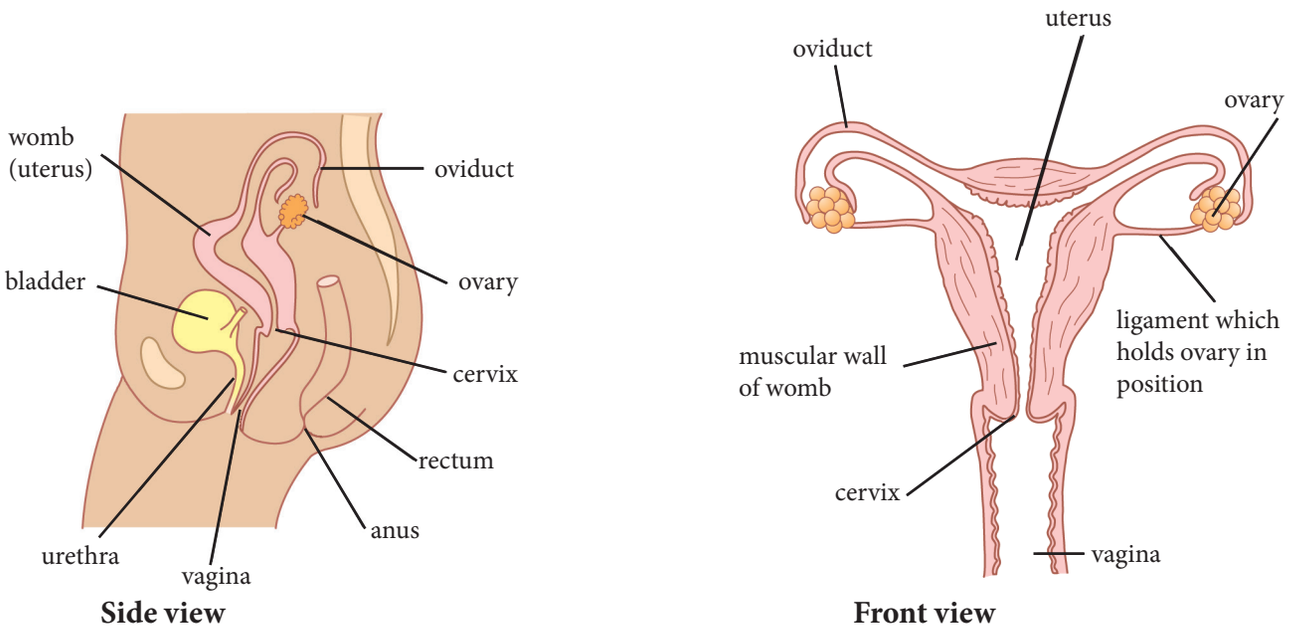


Figure 12.4: The internal organs of the female reproductive system

Self assessment 12.1

1. Copy the table, and then complete it using what you have learnt about the female reproductive system.

Structure	Function

2. **a)** Name two female reproductive hormones.
   b) In which part of the female reproductive system are these hormones produced?
3. Give a reason for each of the following:
   a) the uterus has powerful muscles
   b) the oviducts are lined with ciliated epithelium.

12. 2. The process of sperm and ovum production.

Activity 12.2

Study and discuss the following structures.

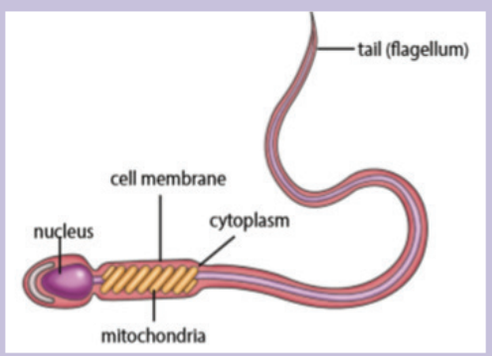


Figure 12.5: Structure of a sperm cell

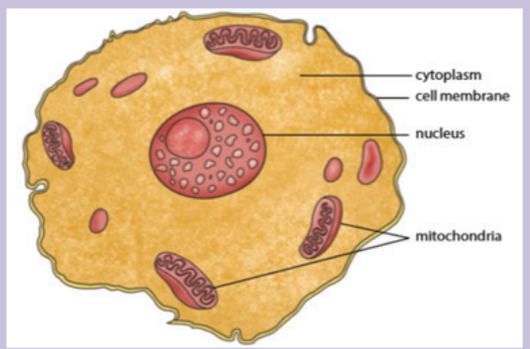


Figure 12.6: Structure of an ovum

a) Which of the above structures is a male or female sex cell?

b) Use a Venn diagram to compare the two cells

Introduction

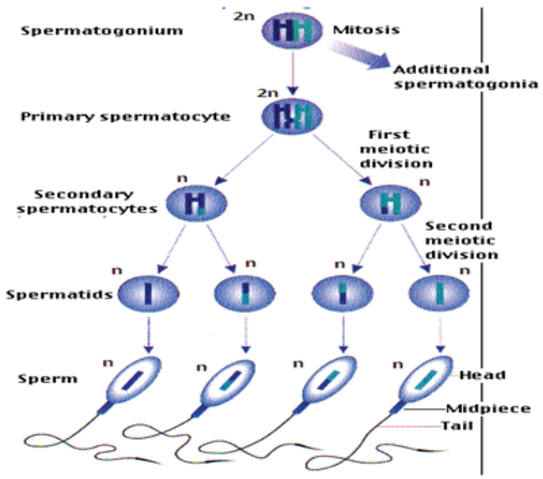
Gametogenesis is the process involved in the formation of gametes. In human being, the formation of female gametes is known as oogenesis or ovogenesis and occurs in the ovaries while the formation of male gametes is called spermatogenesis and occurs in the testes.

Gametogenesis

This is the process by which gametes are formed. It occurs in the gonads.
In humans, the female has different types of gonads from the male. These are located in different parts of the body.
In the females, the gonads are known as ovaries and they lie in the dorsal abdominal cavity below the kidneys.
In the females, the ovary produces the ova through the process called oogenesis orovogenesis.
In the males, the gonads are called testes and they are found hanging outside the body.
In the males, the testes produce spermatozoa through the process called spermatogenesis.

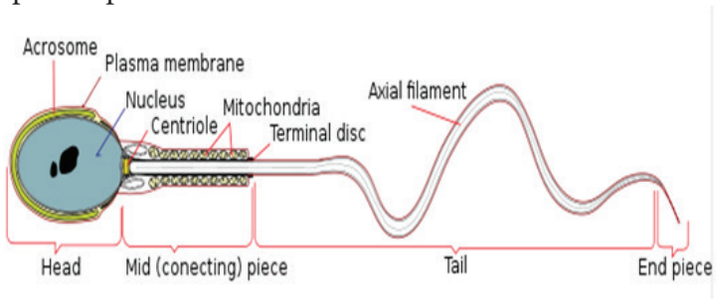
Spermatogenesis.

Sperms are produced in seminiferous tubules inside the testes.The walls of the seminiferous tubules contain cells called the germinal epithelium that produce sperm cells by meiosis.



The process includes the following stages:

- Diploid epithelial cells in the seminiferous tubules of the testes undergo mitosis producing spermatogonia (single: spermatogonium).
- The spermatogonia divide by mitosis to produce primary and secondary spermatocytes.
- The spermatocytes divide by meiosis to produce haploid spermatids.
- The spermatids develop into spermatozoa.



Oogenesis or ovogenesis.

This is the formation of the egg cell or ovum.
The ova begin to develop before a baby girl is born. About 70000 potential ova are present at birth, though only about 450 will mature within the ovaries.
Ovogenesis is similar to spermatogenesis and has the following stages

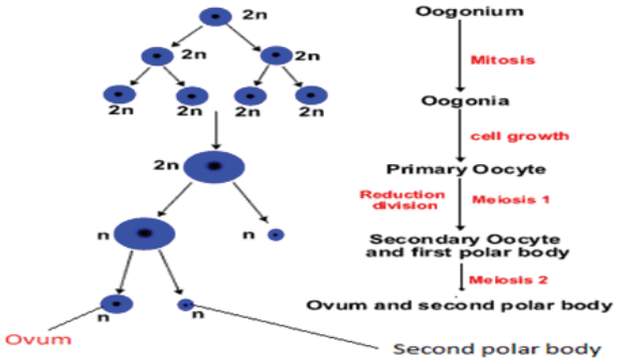


Table 12.4 lists the differences between the processes that produce sperm and ova. cell division as it is shown here below

Table 12.4. Differences between the processes that produce sperm and ova

Production of sperm	Production of ova
Occurs in the testes of the male	Occurs in the ovaries of the female
Many sperm per germinal cell are produced	One egg cell per germinal cell is produced
Sperm are small but motile	Ova are large but non-motile
Starts at puberty and does not stop	Starts in the embryo and stops at menopause
Sperm can survive for about four days inside the female's body	An egg cell can survive for about two days inside the female's body

12.3. The role of hormones in reproduction

Activity 12.3

1. Why some persons may reproduce at very early age and other at late age?
2. Is it possible to accelerate the time of reproduction? How?

Male and female hormones are important in the growth, development
and regulation of reproductive organs and their functions. Table 12.5, on the next page, lists some of the hormones in males and females, and describes where the hormones are made and their functions. You will learn more about these hormones in Unit 13.

Table 12.5. Hormones in males and females

	Place where made	Functions
Male hormone		
Testosterone	Testes	• Involved in the development of male characteristics during puberty • Involved in the production of sperm
Female hormones		
Follicle stimulating hormone (FSH)	In a part of the brain called the hypophysis	Involved in the production of ova
Luteinising hormone (LH)	In the **hypophysis**	Causes ovulation to take place
Oestrogen	Ovaries	• Involved in the development of female characteristics during puberty • Involved in the development of an ovum in the ovary • Plays a role in the **menstrual cycle** and pregnancy
Progesterone	Ovaries	Plays a role in the menstrual cycle and pregnancy

Self assessment 12.2

1. Make a neat, labelled drawing of a sperm cell and an ovum.
2. Name one male hormone.
3. a) Name four female hormones.
   b) Give the functions of each female hormone you named.

12.4. Sex determination

Activity 12.4

Work in pairs, and role play how a person's sex is determined by chromosomes. Show how male and female gametes from a couple determine the sex of their baby.
You could use different coloured cards. Females would have two cards of the same colour and males would have two cards with different colours. Place two different coloured cards in one bag and cards of the same colour in another bag. Randomly pick one card from each bag. Do you have a male or female? Work out the chance of having a male or female baby.

Looking at the outside of the body, a person's sex, is indicated by his or her external reproductive organs. These include the penis and testes of males and the vagina of females. However, the sex of a person is actually controlled by **chromosomes** in the sex cells, or gametes. Chromosomes are structures that are found in the nucleus of all cells. They give an organism its characteristics. A person's sex is determined when fertilisation takes place.
In human cells, there are 22 pairs of non-sexual chromosomes and one pair of sex chromosomes. It is the sex chromosomes that determine the sex of an individual. Girls have two X chromosomes in all their cells while boys have one X and one Y chromosome. There is only one sex chromosome in the sex cells.

There can only be an X chromosome in ova but some sperm will have an X chromosome and some will have a Y chromosome. When the ovum fuses with a sperm once again there will be two sex chromosomes. If an ovum with an X chromosome fuses with a sperm that also contains an X chromosome, then the baby will be a girl (XX). If an ovum with an X chromosome fuses with a sperm that contains a Y chromosome, then the baby will be a boy (XY).

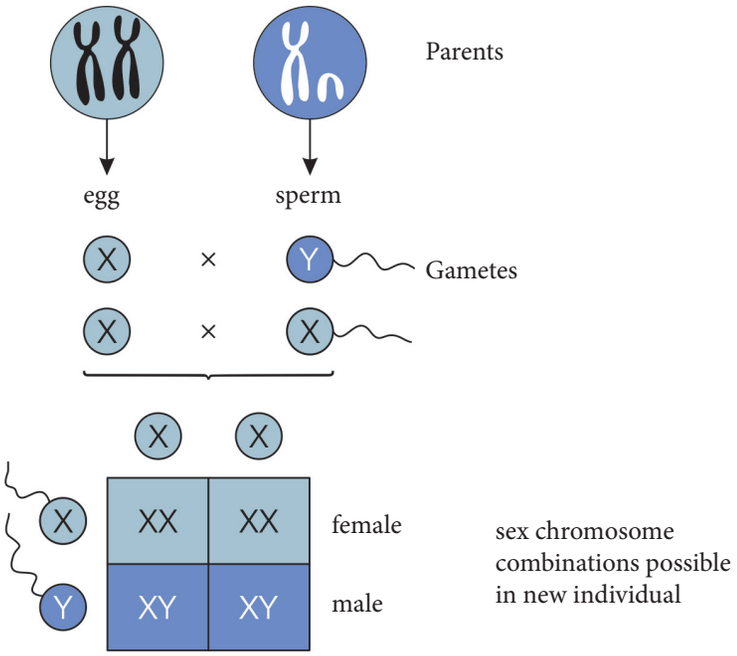


Figure 12.7: An individual's sex is determined by chromosomes.

Self assessment 12.3

1. State two ways in which a person's sex is indicated.
2. What is a chromosome?
3. Which two chromosomes determine a person's gender?
4. A male sperm has a Y chromosome and it fuses with the female ovum. Will the baby that results be a boy or a girl?
5. Explain why it is the father who determines the sex of a baby.

12.5. Influence of culture, tradition and religion on sex, gender and reproduction

Activity 12.5

1. Give examples of characteristics and behaviours that are seen as 'male' and 'female' in your community. Discuss whether these characteristics and behaviours are biological or social.
2. In African families, girls and boys often grow up together. However, they have different tasks to do and they are treated differently by others. The table below lists different attitudes towards boys and girls. Copy the table and complete it by putting a tick (✓) next to a statement when it applies to boys or girls and a cross (✗) when it does not.

3. Explain your opinions.

Statement	Boys	Girls
Should learn all domestic tasks, e.g. cooking and mopping.		
Should be allowed to visit friends and relatives freely.		
Should look down as a sign of politeness whenever he or she is talking to an adult.		
Should not cry, even at a mourning ceremony such as a funeral.		
Should be clever from early childhood.		
Should not be allowed to take part in certain sports, e.g. boxing, karate or bicycle riding.		
Should inherit his or her parents' wealth.		
Should stop going to school if the family cannot afford it.		
Should be judged by society when he or she dresses in an unacceptable way.		
Should receive presents from the family on the day of his or her wedding.		

Most societies expect people of a particular **gender** to perform certain tasks. This happens for cultural reasons or as a result of customs, traditions and religious views. For example, hunting was traditionally assigned to men and mourning to women. As our society has changed, the role of the different genders has also changed. **Gender equality** means that males and females are equal. In the activity you will discuss this important issue.

Self assessment 12.4

1. Look at the picture of the family below, and then assess how they live in terms of gender equality. Then, answer the questions.

An example of gender roles in a family

1. Would you like to be a husband or a wife like the people shown in the picture? Would you like to have a wife or a husband like that? Why or why not?

2. Talk about how you could encourage gender equality in your community. For example, you could do a drawing, tell a story or write a poem.

Checklist of learning (Unit summary)

In this unit, I have learned that:

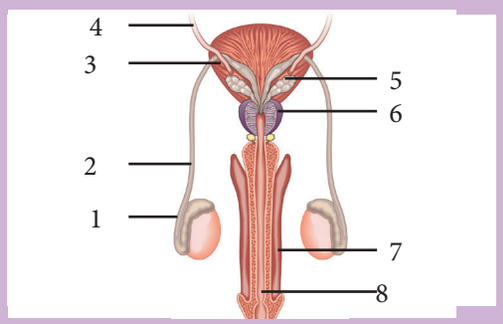
- ✓ The reproductive organs are important for producing sex cells, transporting the male sex cells to the female's sex cell, producing hormones, and enabling a baby to grow inside the female's body.
- ✓ The external male reproductive organs are the testes and penis; the internal organs are the epididymis, sperm ducts, Cowper's glands, seminal vesicles, prostate gland and urethra.
- ✓ The female external reproductive organ is the vulva; the internal organs are the ovaries, oviducts, uterus, cervix and vagina.
- ✓ The production of sex cells is called gametogenesis; the sperm are produced in the testes, and the ova in the ovaries.
- ✓ The sex of a baby is determined by chromosomes and occurs at fertilisation.
- ✓ The sex chromosome in the sperm can be either X or Y; the sex chromosome in all ova is X.
- ✓ Hormones play a major part in the growth, development and regulation of the reproductive organs and sexual functions.
- ✓ Cultural, traditional and religious practices have an important influence on one's thinking about sex, gender and reproduction.

End unit assessment

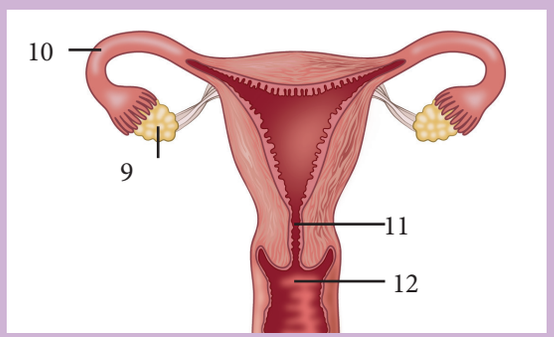
1. The diagrams below show the human male and female reproductive systems. Look at the diagrams, and then answer these questions.

- **a)** Provide a heading for each diagram (A and B).
- **b)** Name parts 1 to 8 in diagram A.
- **c)** Name parts 9 to 12 in diagram B.
- **d)** Suggest the function of each part in diagram A.
- **e)** Suggest the function of each part in diagram B.

A



B



2. On your own, write a paragraph in which you discuss how cultural, traditional and religious practices influence peoples' ideas about sex, gender and reproduction. Hand it in to your teacher for evaluation.

UNIT 13 Puberty and sexual maturation

Key unit competence

To be able to analyse the physical, emotional and social changes related to puberty.

At the end of this unit, I should be able to:

- Define puberty and how it affects the body emotionally and physically
- State the key emotional and physical changes during puberty
- Describe the hormones that bring about these changes
- Describe the various phases of the menstrual cycle
- Analyse the physical, emotional, and social changes associated with puberty between girls and boys
- Show respect for diversity in when and how peers develop and change during puberty.

Introductory activity

Think about changes that occur in boys and girls during their teenage years. Then, answer these questions.

1. Are teenagers treated differently to people of other ages? If so, talk about ways in which they are treated differently.
2. Are girls and boys treated differently from one another when they are teenagers? If so, how?
3. Are there educational opportunities for teenagers in Rwanda? How do these compare to opportunities that were available ten years ago?
4. Do teenagers have any responsibilities? If so, what does society expect of them?

Figure 13.1: The teenage years are fun filled, but teenagers also have responsibilities.

13.1. Puberty

Activity 13.1

Observe the figure 13.2 and answer the following questions:

1. What are the differences in females of different age?
2. What are the differences in males of different age?
3. What are the differences between childhood and puberty in terms of external characteristics?

Puberty is the time when boys and girls become sexually mature. Biological changes take place in the person's body in preparation for reproduction. Puberty involves both physical and emotional changes. Some changes can be stressful, but it helps to realise that puberty is a natural step in the development of every person.
Puberty occurs at different times for different people, and it has different effects on boys and girls. Puberty occurs sometime between the ages of nine and sixteen.
All organisms have features or characteristics that make them male or female. Primary sexual characteristics are physical characteristics that indicate whether a person is male or female. These characteristics are present from birth, for example a penis or vagina. Secondary sexual characteristics develop only at puberty.
In males, the testes begin to produce the hormone testosterone during puberty. It brings about the development of male secondary sexual characteristics. In females, the ovaries begin to produce the hormone oestrogen during puberty. It brings about the development of female secondary sexual characteristics.

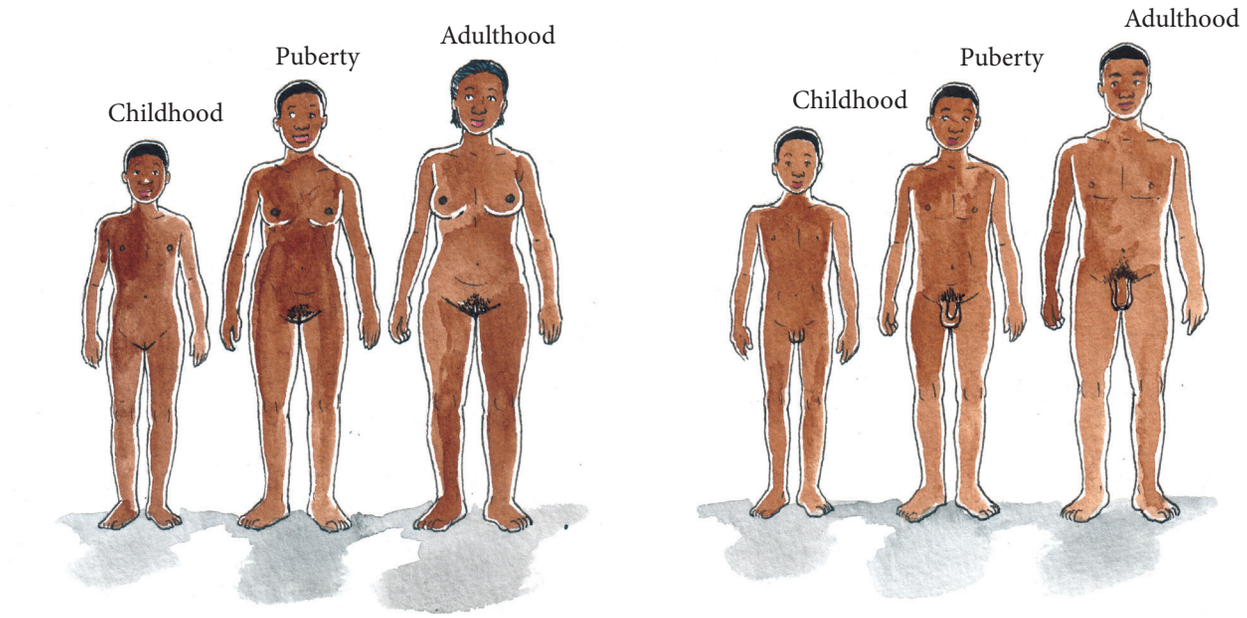


Figure 13.2: Puberty brings about physical changes in girls and boys.

Table 13.1, on the next page, shows some secondary male and female sexual characteristics that appear during puberty.

Table 13.1. Secondary sexual characteristics

Changes in boys	Changes in girls
• Facial, pubic and underarm hair starts to grow • Voice deepens • Body size increases and becomes more muscular • Sex organs increase in size • Sperm are produced in the testes • Acne may occur	• Pubic hair starts to grow • Breasts enlarge • Fatty tissue is deposited on the hips and thighs • Hips broaden • Menstruation starts • Ova are released from the ovaries • Acne may occur

Hormones and puberty

Male and female hormones differ, and they have a major influence on the emotional and physical changes that occur over a person's lifetime.

At puberty, the hypophysis secretes two hormones in both boys and girls: follicle stimulating hormone (FSH) and luteinising hormone (LH). These hormones cause the testes in boys and the ovaries in girls to develop. As the testes develop, they produce testosterone, the main male sex hormone that leads to the development of male secondary sexual characteristics. Inside the ovaries, oestrogen and progesterone start to be produced. They lead to the development of female secondary sexual characteristics.

13.2. The menstrual cycle

Activity 13.2

The picture alongside shows the menstrual cycle. Analyse the picture, and then answer the questions.

1. How many days does one menstrual cycle last?
2. What happens on the first day of the menstrual cycle?
3. According to the diagram, how many days does menstruation last?
4. What happens during ovulation?
5. On which days can a female fall pregnant if she has unprotected sexual intercourse? Explain your answer.
6. What happens if the egg cell is not fertilised?

The menstrual cycle is a series of changes that the female body goes through to prepare for possible pregnancy. It is a pattern of changes in the ovaries and the secretion of different hormones over about 28 days. Different people have menstrual cycles of different lengths.

The *menarche* is the first menstrual cycle that occurs at puberty when the ovaries begin to release ova. The menstrual cycle continues until menopause, when the ovaries gradually become inactive between 40 and 54 years of age.

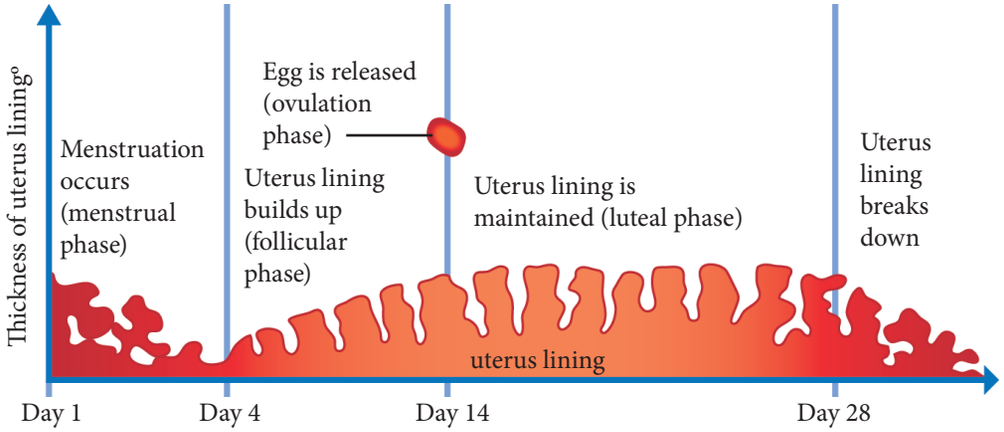


Figure 13.3: The events of the menstrual cycle

Phases of the menstrual cycle

The menstrual cycle can be divided into different phases, based on events that occur within the female reproductive system. These phases are the menstrual phase, follicular phase, ovulation phase and luteal phase.

Menstrual phase

The menstrual phase, or menstrual period, starts from the first day of menstrual bleeding. On day 1 of the phase, the thickened lining, or endometrium, of the uterus begins to pass out of the body through the vagina. A normal menstrual period can last from three to seven days.

Follicular phase

During the follicular phase, one of the ovaries gets ready to release an egg. At the same time, the uterus starts producing a new lining to prepare for a possible pregnancy.

Ovulation phase

During this phase, an ovary releases an egg into the oviduct. This is called ovulation.
The egg then moves down the oviduct towards the uterus. Immediately after ovulation, a woman can fall pregnant by having unprotected sexual intercourse.

Luteal phase

During this phase, the lining of the uterus becomes thicker. If an egg is fertilised by a sperm it then attaches to the uterus lining and a pregnancy begins. If the egg is not fertilised or does not attach, the uterus lining begins to break down and bleeding occurs.

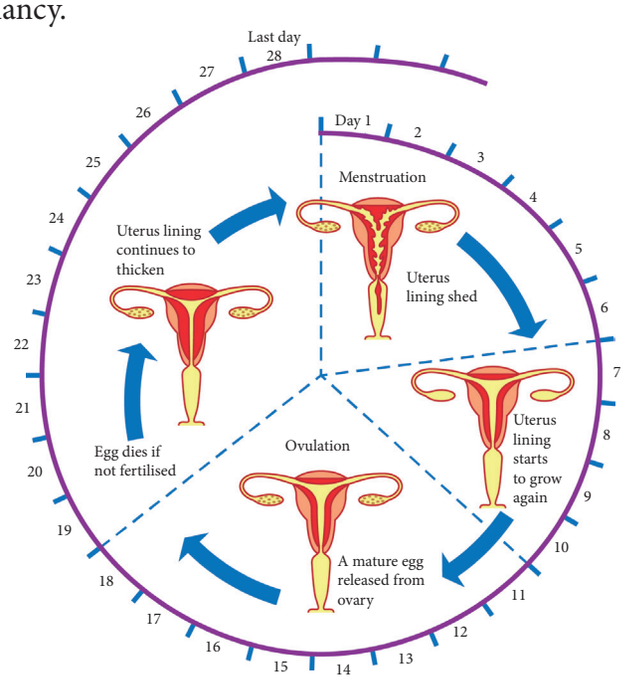


Figure 13.4: The menstrual cycle

Self assessment 13.2

1. Explain the difference between primary sexual characteristics and secondary sexual characteristics.
2. Which hormones influence puberty in: **a)** boys **b)** girls?
3. **a)** Copy Figure 13.4, on the previous page.
   b) On what day does ovulation take place?
   c) Does ovulation always take place on this day? Explain.
   d) On which day does menstruation start?
   e) Does menstruation always start on this day? Explain.
4. Explain: **a)** menopause **b)** Follicular phase.

13.3. Social issues and puberty

Activity 13.3

1. What can be done to avoid early pregnancies?
2. Do you think all boys and girls have enough information to avoid pregnency in puberty? If no, how can be done?

At puberty, boys and girls can produce a baby if they have unprotected sexual intercourse. However, they are too young to manage the responsibilities of having a child. They will lose out on many educational and career opportunities, which could affect their future lives negatively. The unintended pregnancy will also cause family disruption. Rwandan society prepares boys and girls for their gender responsibilities. Adults warn girls and boys about avoiding unintended pregnancies.

Self assessment 13.3

Discuss how an unintended pregnancy can disrupt the life of a teenage boy and girl.

Checklist of learning (Unit summary)

In this unit, I have learned that:

- ✓ Primary sexual characteristics indicate a person's gender and they are present from birth.
- ✓ Puberty is a time of sexual maturation that leads to physical and emotional changes.
- ✓ Puberty is a time in a person's life when he or she develops secondary sexual characteristics.
- ✓ Puberty occurs at different times for different people, and it has different effects on boys and girls.
- ✓ The menstrual cycle is a series of events that are controlled by hormones.
- ✓ The menstrual cycle has four phases: the menstrual phase, follicular phase, ovulation phase and luteal phase.
- ✓ The menstrual cycle starts on the first day of menstruation and ends on the first day of the next menstruation.
- ✓ Some women experience certain symptoms before menstruation, for example, cramps, headaches, diarrhoea or constipation, nausea, dizziness or fainting.

End unit assessment

1. Match the word in Column A with the correct definition in Column B.

Column A	Column B
1.1 Ovulation	A. Having a period
1.2 Menstruation	B. The process in which a child's body begins to change into an adult's body
1.3 Ovum	C. The male gamete
1.4 Puberty	D. Involved in the secretion of hormones
1.5 Sperm	E. The release of an ovum from an ovary
1.6 Hypophyis	F. An egg cell

2. A girl starts her period on 2 July. Her menstrual cycle is 29 days long. Work out when her next period will be.

UNIT 14 Reproduction, pregnancy and childbirth

Key unit competence

To be able to analyse the process of reproduction, pregnancy and childbirth.

At the end of this unit, I should be able to:

- Describe male and female reproductive systems
- Explain the process of fertilisation
- Explain how a pregnancy occurs
- Describe the signs of pregnancy, and the stages of foetal development and childbirth
- Define maternal mortality and list major causes of maternal mortality
- Describe ways that poverty and gender inequality lead to death among pregnant women and how these outcomes can be prevented
- List health risks associated with early pregnancy and birth
- Analyse using simulations of stages of pregnancy and discuss the signs and behavioural symptoms of pregnancy
- Appreciate the importance of the steps that should be taken to promote safe pregnancy and childbirth
- Show concern about maternal mortality as an issue in the region.

Introductory activity

1. Name two main functions of the human reproductive system.
2. During which time in a woman's menstrual cycle is she most likely to fall pregnant after unprotected sex?
3. Discuss how unintended pregnancy can occur.
4. What are the consequences of unintended pregnancies?

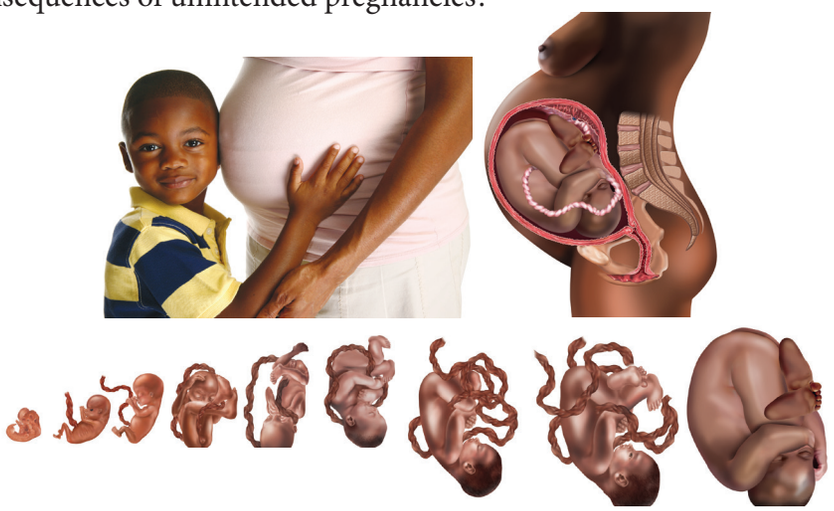


Figure 14.1: Pregnancy can be an exciting time.

The male and female reproductive systems

In unit 12 you learnt about the male and female reproductive organs and how they are involved in reproduction. Reproduction is the production of offspring or new individuals from their parents. Human reproduction is sexual reproduction, as it requires sex cells, or gametes, from male and female parents. The gametes fuse, or join, to form a new cell. A new organism develops from this cell.

The reproductive organs are important for two reasons: they play a role in sexual intercourse and, in females, they provide a place for a new baby to develop. You will find out about these two roles in this unit.

14.1. Sexual intercourse

Activity 14.1

By using internet and textbooks, search and explain the processes of sexual intercourse and fertilization.

The male sex cells, or sperm, are produced in the testes of the male reproductive system. So the sperm need to be transferred to the inside of the female body to enable one of them to fuse with the ovum. This takes place during sexual intercourse.

Sexual arousal occurs when a man and a woman interact and their senses are stimulated. The pulse rate, breathing rate and blood pressure increases. The male penis fills with blood and becomes erect. The external female reproductive parts become sensitive to touch and the vagina secretes mucus for lubrication during intercourse.

The erect penis is placed inside the vagina. In the male, the movement of the penis inside the vagina stimulates a reflex and causes ejaculation. This is a rhythmic muscular contraction of the male reproductive system from the testes to the penis. It results in the release of semen from the urethra. Male orgasm happens at the same time as ejaculation. In the female, the movement of the penis to and from vaagina leads to orgasm. An orgasm is the peak of sexual arousal and is a combination of pleasurable physical and emotional sensations.

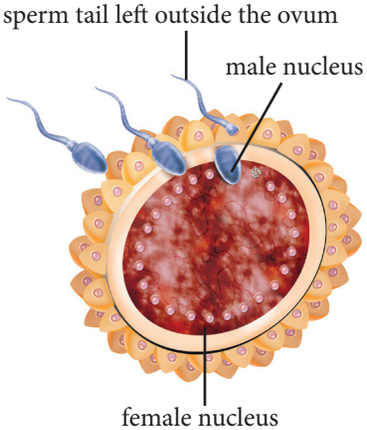


Figure 14.2: Fertilisation is the fusion of a sperm and an ovum to form a zygote.

Fertilisation

During sexual intercourse, the male ejaculates between two and six millilitres of semen that contains about 300 million sperm. Semen is deposited inside the female vagina near the cervix. Sperm in the semen swim upwards into the oviducts. If an ovum is in an oviduct, the sperm can reach it within five minutes.

The ovum is surrounded by a tough outer coat that makes it difficult for the sperm to penetrate into the ovum. After a few minutes, the strongest sperm passes through the coat around the ovum and attaches to the membrane. Only the head of the sperm penetrates the ovum; the tail stays outside. The nuclei of the ovum and the sperm fuse; this is called **fertilisation**. The fertilisation event is called **conception** – a new human being has been created. The new cell that forms after fertilisation is called a zygote.

Self assessment 14.1

1. List the parts of the male reproductive system in which:
   a) sperm are produced
   b) semen leaves the male body.
2. Write down the pathway of an ovum from the time it is released until it leaves the female body.
3. In which part of the female reproductive system do the following take place?
   a) fertilisation
   b) development of the foetus

14.2. Foetal development

Activity 14.2

By using internet and textbooks, search and explain the processes of Foetal development in placenta during pregnancy.

After fertilisation, the zygote continues to divide. It divides into two cells, then four, then eight, and so on. Eventually a ball of cells is formed. After about seven days, it develops into a fluid-filled cavity surrounded by a single layer of cells.

The cilia move the ball of cells down the oviduct towards the uterus. After about ten days, the ball of cells burrows into the wall of the uterus. This process is called **implantation**. There it continues to divide into more specialised cells and an **embryo** is formed. From the eighth week until birth (around 40 weeks), the developing organism is called a **foetus**.

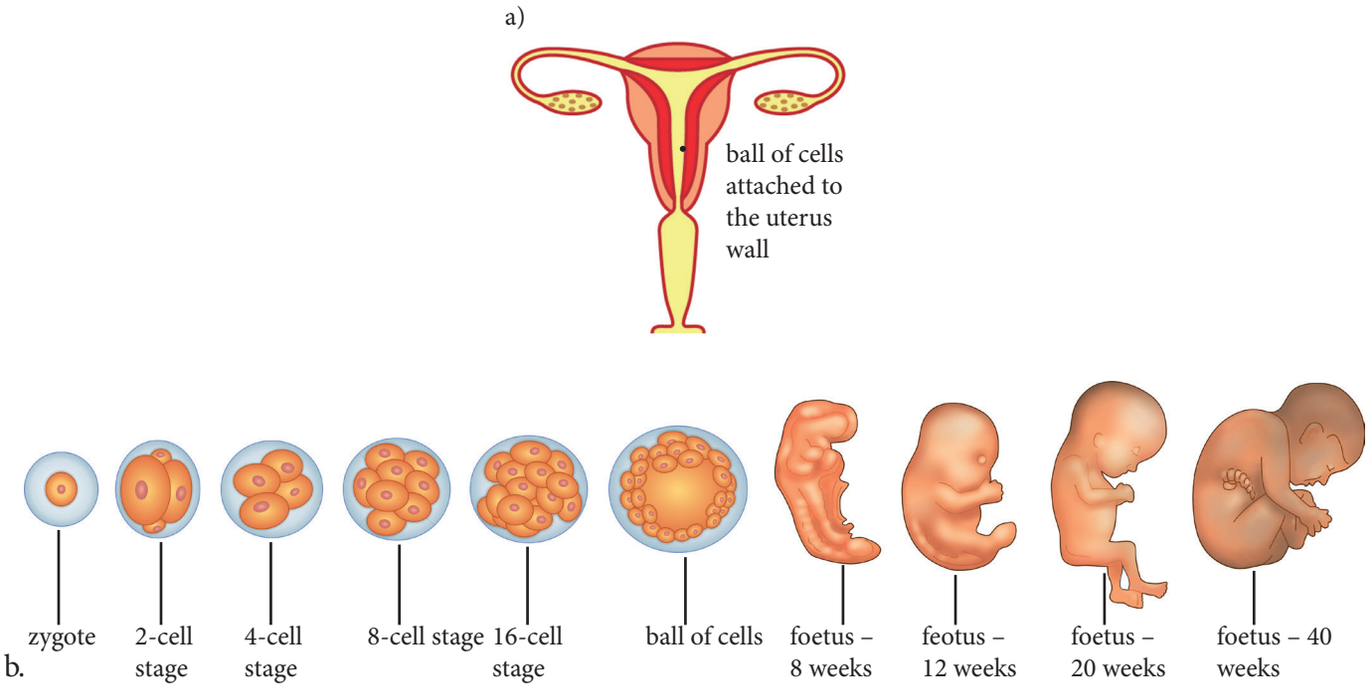


Figure 14.4: a) Implantation of the ball of cells, b) Development of the foetus over 40 weeks

The placenta

Part of the embryo forms a structure called the **placenta**.
The functions of the placenta are:

- to provide the foetus with nutrients
- to remove waste products from the foetus' blood
- exchange oxygen and carbon dioxide between the foetus' blood and the mother's blood
- act as a filter for harmful substances, although some substances, such as nicotine, drugs and alcohol, as well as viruses such as HIV, can pass through it and reach the foetus
- to secrete hormones.

There is no direct contact between the mother's blood and the blood of the foetus. The **umbilical cord** transports substances between the placenta and the embryo. The umbilical cord contains blood vessels and it extends from an opening in the foetus' stomach to the placenta.

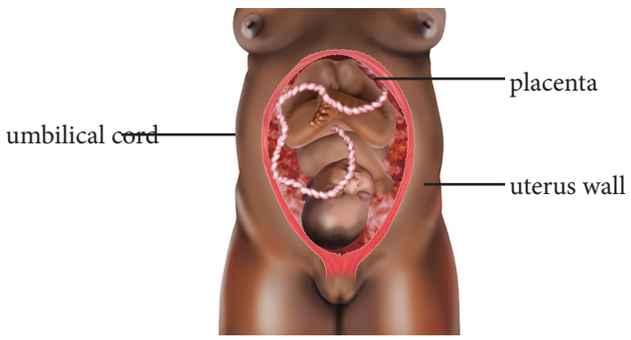


Figure 14.5: The position of the placenta

Self assessment 14.2

1. Define each of these words.
   a) zygote
   b) fertilisation
   c) conception
   d) placenta
2. a) List five functions of the placenta.
   b) Explain why pregnant women should avoid drugs and alcohol during their pregnancy.

Signs of pregnancy

Pregnancy starts on the day of fertilisation. There are no signs of pregnancy at this time, but as time passes the following signs appear:

- there is no menstrual period
- slight bleeding or cramping as the embryo implants in the uterus
- tender breasts
- extreme tiredness
- backache
- nausea or sickness
- needing to urinate more often
- headaches, due to the sudden rise of hormones in the body
- darkening of the skin around the nipples
- food cravings or aversions
- emotional sensitivity and outbursts, due to high hormone levels.

14.3. Process of childbirth

Activity 14.3

By using internet and textbooks, search and explain the process of Childbirth

Childbirth, which is also known as **labour** or parturition, brings pregnancy to an end. It results in one or more newborn infants being expelled from a woman's uterus. There are three stages of labour.

First stage (about 12 hours)

The cervix dilates, or widens, and the uterus begins to contract. Fluid called amniotic fluid is released. This is sometimes called 'breaking
of the waters' and it signals that the second stage of labour is about
to begin.

Second stage (20 minutes to 1 hour]

The muscles of the uterus and abdomen contract to push the baby out of the uterus, cervix and vagina. This is known as delivery of the baby. In normal childbirth, the head of the baby comes out first. The umbilical cord is cut.

Third stage (10 to 30 minutes after birth)

The placenta is expelled from the woman's body. The expelled placenta is known as the afterbirth.

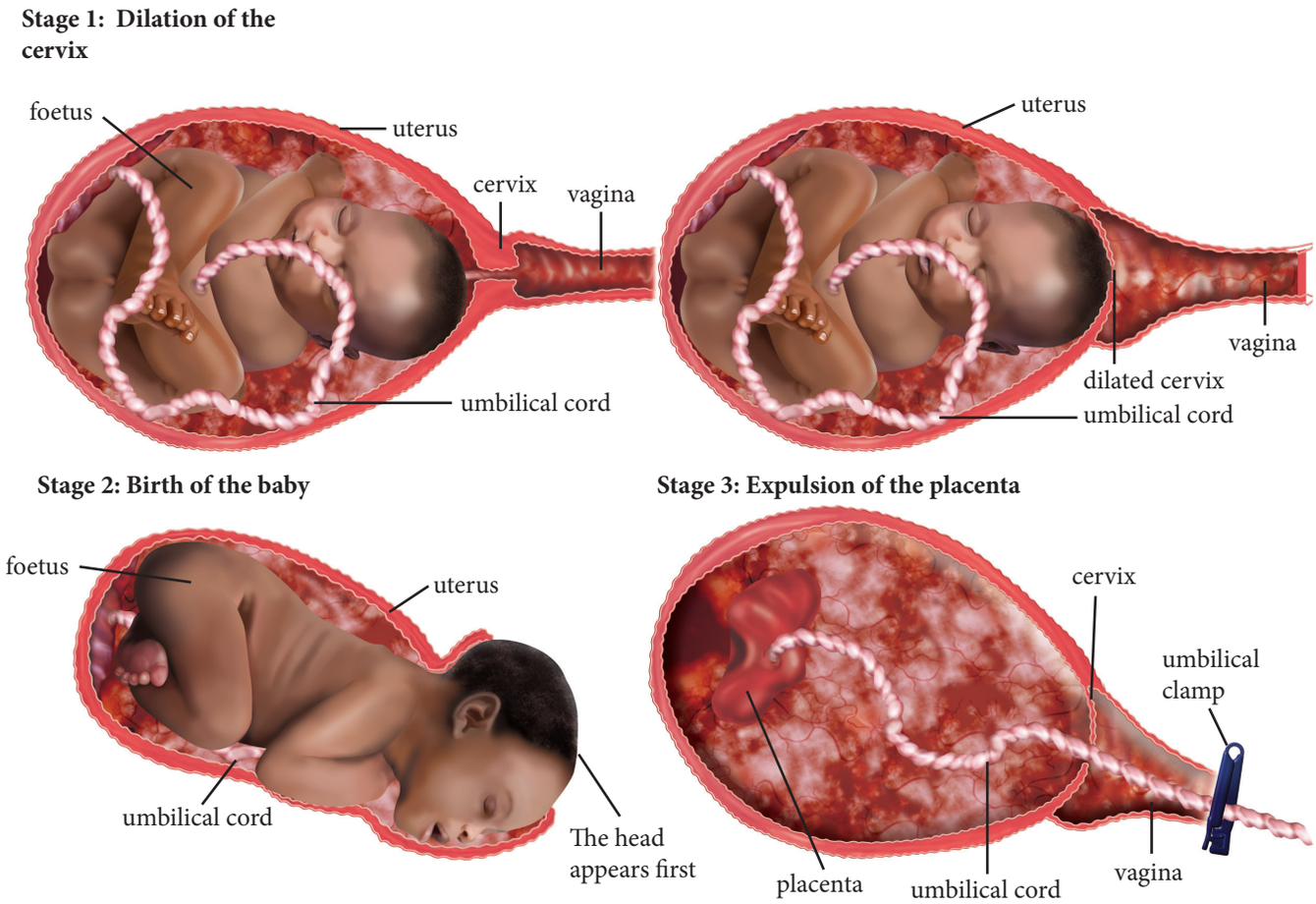


Figure 14.6 Stages of childbirth

Problems during birth

If the mother or the baby experience difficulties during the birth, then a **Caesarian section** may be done. This is a surgical procedure during which the doctor cuts through the abdominal wall and uterus to deliver the baby.

According to the World Health Organization, every day worldwide 800 women die of causes related to pregnancy or childbirth. This is called maternal mortality. Nearly all maternal deaths occur in developing countries, and the incidence is higher in rural areas and among poorer communities.

Women die as a result of complications such as:

- severe bleeding after childbirth
- infections
- high blood pressure during pregnancy
- complications from delivery
- unsafe abortion.

Inadequate health care, lack of information, poverty, distance to travel to health clinics and cultural practices are some of the reasons why women do not receive help during their pregnancy.

Unintended pregnancy

An **unintended pregnancy** is any pregnancy that is unplanned or unwanted. Pregnancy in unmarried women and pregnancy after rape are examples of unintended pregnancies.

Causes of unintended pregnancy include not using contraception or not using it properly, contraceptive failure, lack of knowledge about sex and reproduction, lack of planning and rape.

Self assessment 14.3

1. Give the meaning of each of these terms.
   a) embryo **b)** zygote **c)** labour
2. Distinguish between an embryo and a foetus.
3. List four complications that can occur during childbirth.
4. What is meant by an 'unintended pregnancy'?

Design a poster for a clinic in Rwanda to display in their waiting room. Show the steps a pregnant woman should take for a healthy pregnancy and childbirth.

14.4. Teenage pregnancy

Activity 14.4

Think about the following:
1. Events and circumstances that can bring about unintended pregnancy
2. Consequences of teenage pregnancy
3. Reasons for maternal mortality.

Teenage pregnancy is pregnancy in girls under the age of 20. A girl can fall pregnant after puberty if she has unprotected sexual intercourse. Every day in developing countries, 20 000 girls under the age of 18 give birth.

Health risks associated with teenage pregnancy

Pregnant teenagers face many of the same problems as other pregnant women. However, teenage pregnancy results in greater health risks to both the mother and baby. These include the risk of:

- the baby having a low birth weight
- the mother going into premature **labour**
- the mother dying as a result of complications during pregnancy or childbirth.

Other consequences of teenage pregnancy

As well as health risks, there are also emotional and socioeconomic consequences of teenage pregnancy. For example, a girl may be excluded from her family and community after she falls pregnant. Teenage pregnancy also affects girls' education and income potential as they may be forced to drop out of school. This threatens future opportunities and economic prospects.

According to the United Nations Population Fund (UNFPA), 'Pregnancies among girls less than 18 years of age have irreparable consequences. It violates the rights of girls, with life-threatening consequences in terms of sexual and reproductive health, and poses high development costs for communities, particularly in perpetuating the cycle of poverty.'
Teenage pregnancies can be prevented by sex education and access to birth control.

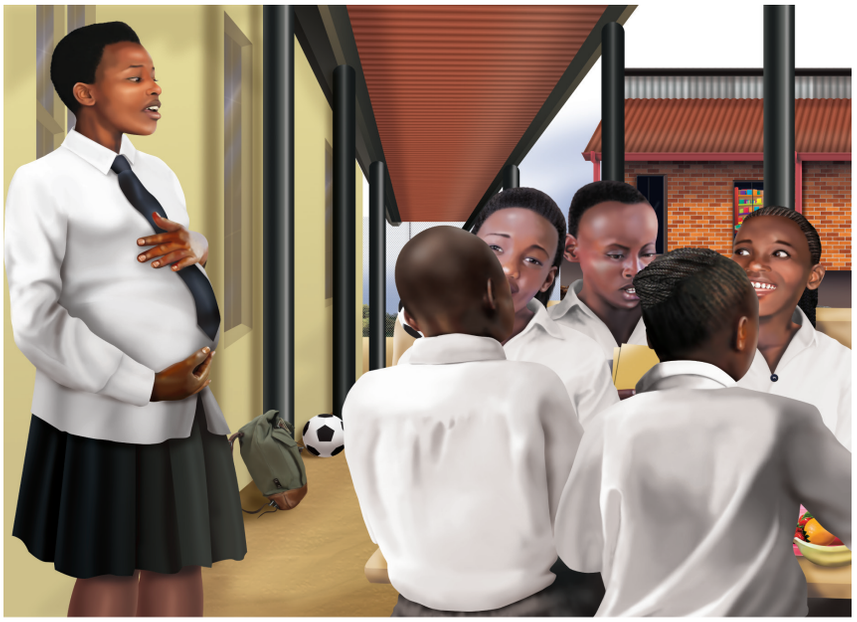


Figure 14.7: Teenage pregnancy has health, emotional and socio-economic consequences.

Steps to promote safe pregnancies and childbirth

Antenatal, or prenatal, care refers to looking after and protecting a pregnant woman and her foetus during pregnancy and childbirth. The first few months of pregnancy are the most critical for the developing infant because major steps in foetal development take place at this time.
A woman should take these steps to care for herself and her unborn child during pregnancy:

- As soon as she finds out that she is pregnant, she should see a doctor or health worker. She will be given vitamins to take, such as folic acid, to reduce the risk of birth defects.
- She should rest often.
- She should eat a healthy, balanced diet.
- She should avoid foods that can cause food poisoning, for example, shellfish, as food poisoning can cause miscarriage.
- She should avoid caffeine, alcohol and cigarettes. Cigarette smoking has been linked to a low birth weight.
- She should not change cats' litter boxes as she could get toxoplasmosis, which is a very serious illness.
- She should eat only well cooked meat as undercooked meat can contain harmful pathogens.
- She should arrange for a health worker to assist at the birth or arrange to go to a hospital for the birth.

Postnatal care

Postnatal care refers to care of the mother and baby after childbirth. After the birth, the mother produces breast milk. Breast milk is the ideal food for infants. It contains a perfect balance of proteins, carbohydrates, fats, minerals and vitamins, and the infant can digest it easily. It also contains antibodies that boost the infant's immune system.

Postnatal care for the mother include provide to her with enough balanced meal, hygiene, avoid conflicts with her; Postnatal care for the newborn include enough breast feeding, protection against bad wealth, pathogens, parasites and diseases.

Checklist of learning (Unit summary)

In this unit, I have learned that:

- ✓ Human reproduction is sexual reproduction as it requires gametes from male and female parents.
- ✓ The sex organs play two major roles: sexual intercourse and pregnancy.
- ✓ Sexual intercourse occurs when the penis is inserted into the vagina and ejaculation, the release of semen, takes place.
- ✓ Fertilisation is the fusion of the egg and sperm nuclei in the oviduct to form a zygote.
- ✓ After fertilisation, the zygote undergoes a series of cell divisions to increase the number of cells.
- ✓ Implantation occurs when the embryo burrows into the wall of the uterus.
- ✓ The symptoms of pregnancy include no menstrual period, nausea, fatigue, headache and backache.
- ✓ Antenatal care aims at protecting the mother and her foetus, especially during early pregnancy, when most of the foetal organs are forming.
- ✓ Childbirth has three main stages: the cervix widens and the uterus begins to contract in preparation for birth; the baby is delivered; the placenta is delivered.
- ✓ Teenage pregnancy and childbirth carry great health, emotional and socioeconomic risks for the young mother and her baby.

End unit assessment

1. State two roles of the sex organs.
2. Define each of these words.
   a) intercourse
   b) implantation
   c) labour
3. State any four causes of unintended pregnancy.
4. Suggest any four antenatal care measures for safe pregnancy and childbirth.
5. State any six signs of pregnancy in women.
6. In Rwanda, what is the significance of the placenta?

Formal assessment for topic 3

1. Choose the correct answer from the options given.

1.1 Malaria is an example of:

- **A** an inherited disease
- **B** a social disease
- **C** a communicable disease
- **D** a degenerative disease

1.2 Pneumonia is transmitted from one person to another by:

- **A** water
- **B** air
- **C** blood
- **D** an insect

1.3 What name is given to the female external sex organs?

- **A** vagina
- **B** vulva
- **C** penis
- **D** testis

1.4 In what part of the female reproductive system does fertilisation of the ovum take place?

- **A** uterus
- **B** cervix
- **C** oviduct
- **D** vagina

1.5 In which part of the male reproductive system are sperm produced?

- **A** penis
- **B** prostate
- **C** seminiferous vesicles
- **D** seminal vesicles

1.6 Figure 1 shows the structure of a human sperm.

What is the role of the part labelled A on the diagram?

- **A** to produce energy
- **B** to help sperm swim and reach the ovum
- **C** to fuse with the egg cell during fertilisation
- **D** to produce the male gametes

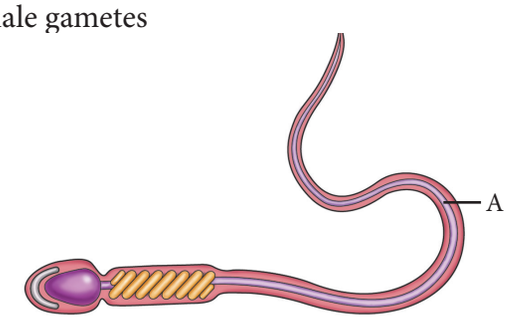


Figure 1

1.7 The ball of cells that forms a few days after fertilisation is called the:

A zygote
B embryo
C morula
D foetus (7 × 2 = 14)

2. Figure 2 shows the male and female reproductive systems.

a) Identify parts 1 to 8 in diagram A. (8)
b) Redraw diagram B and give labels for parts 1 to 6. (6)

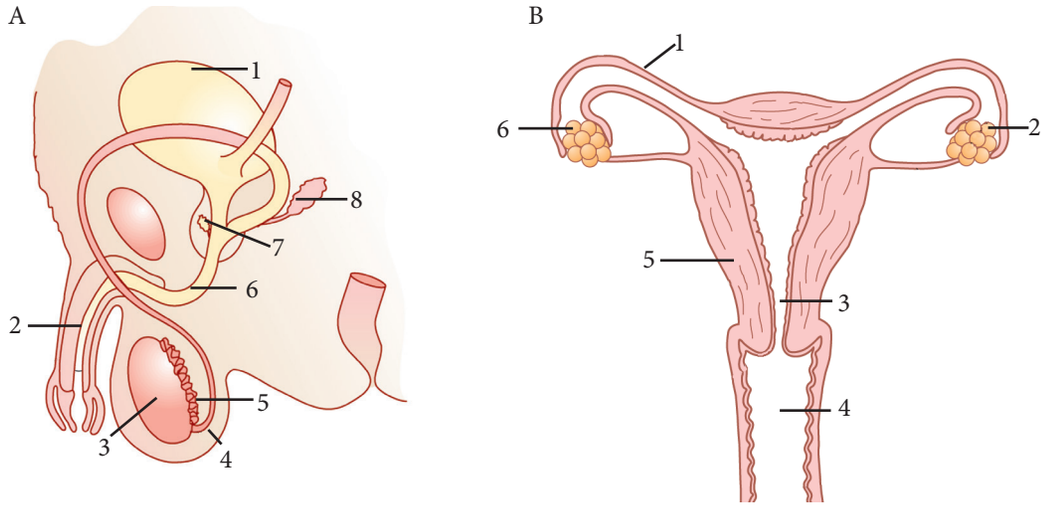


Figure 2

3. Figure 3 shows causes of maternal death worldwide by percentage.

a) What percentage of women died as a result of:
i) severe bleeding **ii)** high blood pressure? (2 × 2 = 4)
b) **i)** Does maternal mortality occur more frequently in urban areas or in rural areas? (2)
ii) Give two reasons for your answer to question (b) (i). (2 × 2 = 4)

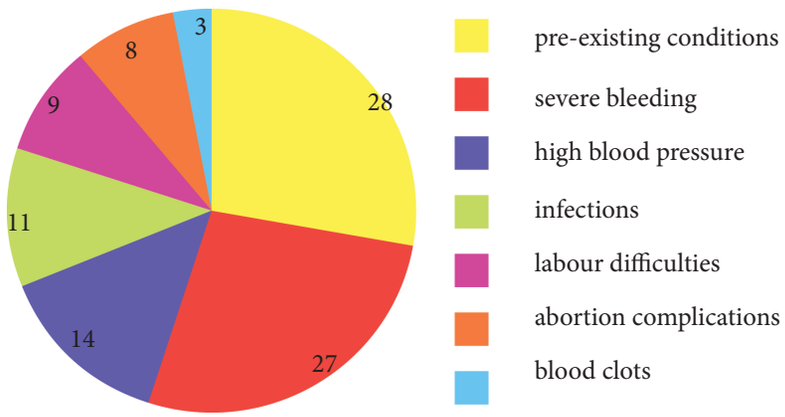


Figure 3: *[Source: http://www.who.int/mediacentre/factsheets/fs348/en/]*

4. Give three consequences of teenage pregnancy. (3 × 2 = 6)
5. List three ways in which the transmission of communicable diseases can be prevented. (3 × 2 = 6)

Total marks: 50

Glossary

acrosome – the part of a sperm cell that makes enzymes

adapted – modified or changed to do a particular function

alveoli – small sacs that enable the exchange of gases

amino acids – the building blocks of proteins

backbone – a column of bones that is found in the back of an animal; also called a vertebral column

balanced diet – a diet that contains a combination of the food nutrients needed for healthy living, in the right amounts

breathing – the movement of air into and out of the lungs, in mammals

bronchi – tubes that branch from the trachea

bronchioles – smaller tubes that branch from the bronchi

Caesarian section – a type of birth, when a surgical procedure is done

carbohydrates – nutrients made from carbon, hydrogen and oxygen, e.g. simple sugars and starch

cartilage – a type of tissue that is found in some places in an endoskeleton

cervix – a narrow opening at the top of the vagina

characteristics – features of something, such as an organism

chlorophyll – a green pigment molecule in leaves that is important for photosynthesis

chromosomes – long coiled structures made from special molecules called DNA; they carry genetic information

cilia – hair-like extensions on the membrane of some animal cells

circumcision – a surgical procedure that is performed to remove the foreskin

clinostat – a motorised machine that turns

clitoris – a sensitive area in the female external sex organs

communicable disease – a disease that can be transmitted from one person to another

conception – the fusion of the nuclei of the male and female sex cells

Cowper's gland – a gland that produces seminal fluid

deficiency diseases – diseases caused by a shortage of a food nutrient, such as a particular vitamin

density – how hard or compact a substance is

diffusion – the movement of molecules from a high concentration to a lower concentration

disease – a disorder in structure or function in a person's body

diversity – variety

ejaculation – a reflex action in which semen is released from the body

elements – the simplest substances on Earth; they cannot be made smaller

embryo – an unborn human during the first eight weeks after fertilisation

endometrium – the lining of the uterus

endoskeleton – a support system that is found inside an organism's body

enzymes – special molecules that take part in chemical reactions in cells

epidermis – a single layer of cells on the outside of some organisms

epididymis – a coiled tube inside the testes that stores sperm until they are released

erectile (tissues) – tissues that can fill with blood and become hard

exoskeleton – a support system that is found on the outside of an organism's body

fertilisation – the fusion of male and female sex cells to form a zygote

fibre – substances in the diet that help food to move through the digestive system

flagellum – a tail on a cell that enables it to move

foetus – an unborn human from the ninth week after fertilisation until birth

gametogenesis – the process by which sex cells are made

gas exchange – the movement of oxygen and carbon dioxide across a membrane in opposite directions

gender – being masculine or feminine

gender equality – when males and females are considered to be equal

gene – a unit that can be passed from parents to their children

germinal cells – special cells that line the ovaries and the seminiferous tubules and are able to make the female and male sex cells

gravitropism – the response of plants to the effect of gravity

haemoglobin – a molecule found in red blood cells that helps to transport oxygen

health – a person's physical, mental and social state

hereditary – something that is passed on from one generation to another; inherited

hip bones – large flat bones to which the leg bones are attached

hydrostatic skeleton – a support system found inside an organism's body; the muscles work against fluid that is trapped inside spaces in the body

hymen – a membrane over the opening of the vagina that is broken during sexual intercourse

hypophysis – a part of the brain that secretes some hormones; also called the pituitary gland

immune system – a system in the body that fights substances that should not be inside the body

implantation – the process during which the ball of cells burrows into the wall of the uterus

infection – when a person has an organism inside their body that makes them sick

insulate – to keep at a constant temperature

joint – a structure found where bones come together

labia majora – an external skin fold near the opening of the vagina

labia minora – a skin fold that protects the openings of the urethra and vagina

labour – the process during which the foetus, membranes, umbilical cord and placenta is expelled from the uterus

lipids – food nutrients made up of carbon, hydrogen and oxygen; their molecules consist of one molecule of glycerol joined to three fatty acids

magnification – how many times bigger an image is compared to the actual object

magnified – made larger using a scientific instrument or by drawing

malnutrition – when a person does not eat enough, or eats too much, of a food nutrient

menopause – the time in a woman's life when she stops menstruating

menstrual cycle – a series of events that prepares the uterus for pregnancy

monosaccharides – simple sugars, such as glucose

motile – able to move

motility – the ability to move

moulting – shedding an outer covering of the body

mucus – a sticky substance that is made by some animal cells

multicellular – multi-celled; refers to an organism that consists of many cells

nerve impulses – a signal transmitted along a nerve fibre in the body

neutralise – to keep the level of acidity constant

nostrils – two openings in the nose

nutrients – food substances that organisms need to live and grow

oestrogen – a female hormone that is secreted by the ovaries and stimulates the production of secondary sexual characteristics; it is also involved in the menstrual cycle

organ – a group of tissues that form a structure that performs a function, e.g. the heart

organ system – a group of organs that work together to perform a function, e.g. the digestive system

organelles – structures found inside cells; they perform different functions

ova – female sex cells

ovaries – the female sex organs that produce female sex cells and hormones

oviducts – tubes that lead from each ovary to the uterus; the pathway for the female sex cells

ovulation – the release of an ovum from an ovary into an oviduct

palisade mesophyll cells – long thin cells found in leaves; they are specialised for photosynthesis

pathogens – disease-causing organisms, such as bacteria

penis – the part of the male reproductive system that is used to place sperm in the female vagina during intercourse

permeable – a structure that lets molecules pass through it

photosynthesis – a life process that happens in green plants and that uses sunlight, carbon dioxide and water to make food molecules, such as glucose

phototropism – the reaction of a plant to light

placenta – an organ that develops in the uterus

pleural membranes – two membranes found inside the chest: one covers the outside of the lungs; the other lines the inside of the chest

polysaccharides – nutrients made from many simple sugars joined together

porous – a substance that has holes in it

progesterone – a female hormone that prepares the uterus for pregnancy

proportion – the different sizes of objects relative to one another

prostate gland – a gland that produces seminal fluid

proteins – food molecules made up of carbon, hydrogen, oxygen, nitrogen, and sometimes sulphur

puberty – a time during which secondary sexual characteristics develop in males and females

reagents – chemicals used for testing substances

respiration – a chemical process for the making of energy using food molecules and oxygen

ribs – the thin bones that protect the lungs and heart

scrotum – a sac that covers the testes

selectively permeable – a structure that allows only certain molecules to pass through it

seminal vesicles – structures that produce and release seminal fluid into the sperm duct

seminiferous tubules – long coiled tubes in which sperm are produced

sensitivity – being able to respond to a change in the environment

skeleton – a structure on the inside or the outside of the body that gives support to the body and protects the softer parts

specialised – changed, to do a special function

sperm duct – a tube that transports sperm out of the testes

spinal cord – part of the nervous system; an extension of the brain in the backbone

spongy mesophyll cells – cells in leaves that contain lots of chloroplasts and have air spaces between them

stimulus – something that causes a reaction

support system – a system that gives strength and holds the body upright

surface area – the area on the outside of a structure

taxonomy – the classification of things, especially organisms, into groups based on their similarities and differences

testicles – a male reproductive structure in which male sex cells are made; also called testes

testosterone – a male hormone that is important in the development of sperm and secondary sexual characteristics

thorax – the scientific name for the chest cavity

tissue – a group of similar cells that perform a function; e.g. muscle tissue

toxic – poisonous

toxins – poisons

trachea – a tube that leads from the throat into the lungs

tropism – a movement of a plant in a certain direction in response to a stimulus

umbilical cord – the organ that connects the foetus to the placenta

unicellular – single-celled; refers to an organism that consists of a single cell

urethra – a tube that is a passage for urine from the bladder to the outside of the body; it also transports sperm during intercourse

uterus – the place where a baby develops; also called the womb

vagina – the birth canal

vertebrae – bones that make up the backbone

zygote – a single cell that forms when the nucleus of a sperm cell fuses with the nucleus of an ovum

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