

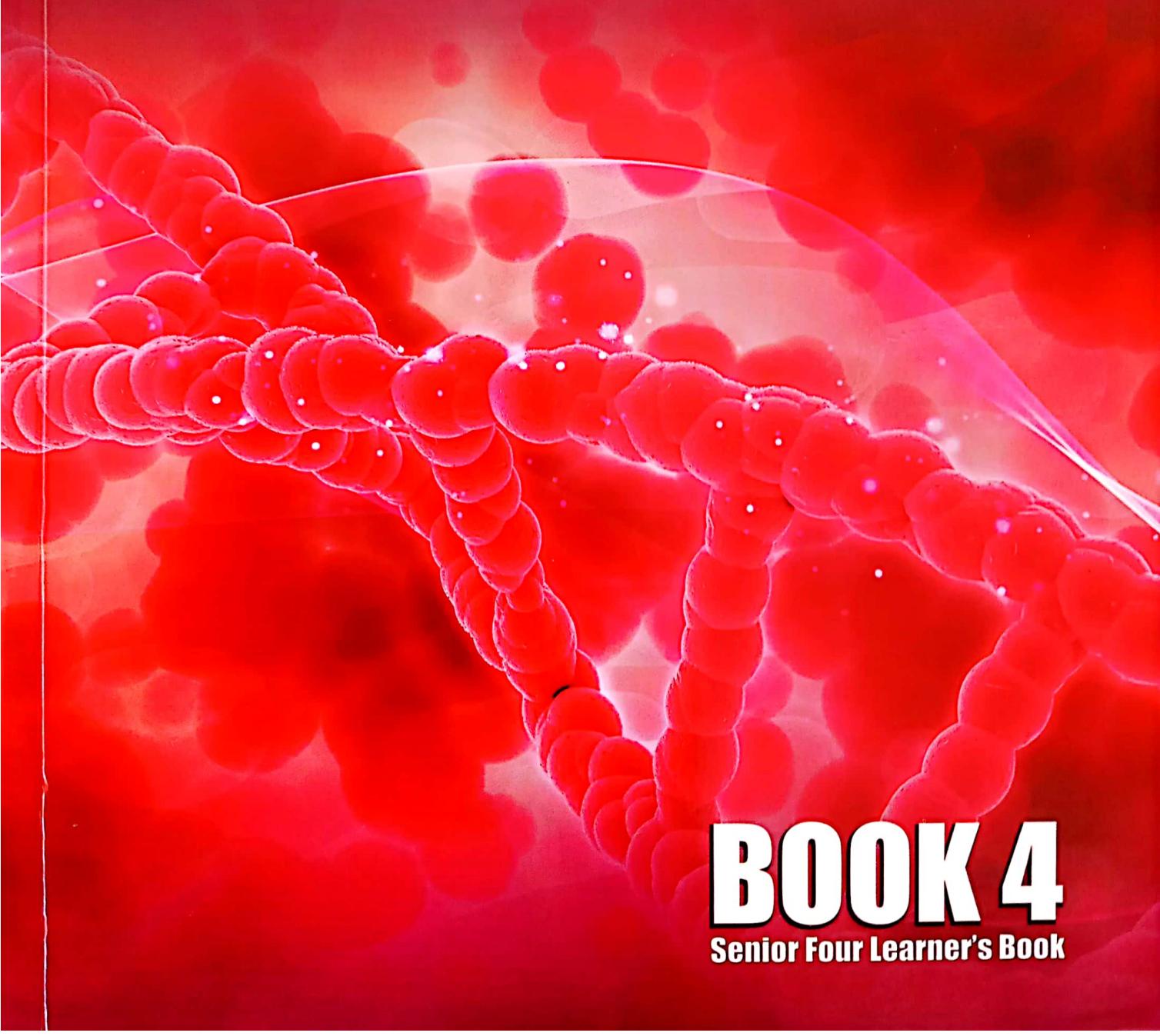
Baroque

New Lower Secondary School Curriculum

BIOLOGY

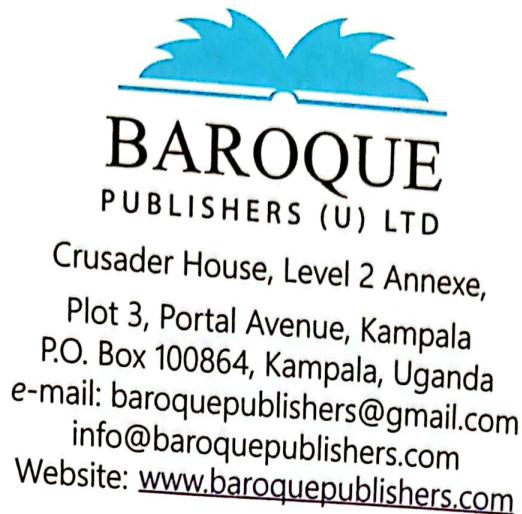
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New Generation Books



BOOK 4
Senior Four Learner's Book

BAROQUE
SENIOR FOUR BIOLOGY
LEARNER'S BOOK



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1st Print 2023

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Acknowledgement

Baroque Publishers (U) Limited is deeply indebted to all who participated in the development of *Baroque Senior Four Biology Learner's Book*.

Particular thanks go to **Mr Apollo Tumusiime**, **Mr Isaac Kanyomoza**, **Mr Mwebaze Onesmas** and **Mr Kaija Emmanuel**.

Special acknowledgement goes to the editorial team, **Ms Lydia Kisakye** and our graphics team, **Ms Otin Isaac**.

Notes of appreciation go to Baroque Publishers' staff who assisted in a number of ways. Publishing Managers, **Ms Bukenya A. Pamela**, **Mr Tumusiime E. Walter**, **Mr Muhangi Joel** and **Ms Muraza Monica**. Staff; **Ms Katusiime Carroline**, **Mr Moruleng Alex** and **Mr Mubazi Eric**.

Special thanks go to **Mr Jasper K. Kazebisha**, the Director Baroque Publishers (U) Ltd for his valuable insights and advice on all publishing matters.

The initiative and guidance of the publishing partners, Ministry of Education and Sports (MoES) and National Curriculum Development Centre (NCDC) in development and implementation of the New Lower Secondary Curriculum are highly appreciated.

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Preface

Baroque Senior Four Biology Learner's Book is developed in response to the new competence-based **Lower Secondary Curriculum** for Uganda, developed by the Ministry of Education and Sports of Uganda (MoES) under the National Curriculum Development Centre of Uganda (NCDC) and launched in 2020.

The book is a result of extensive research from several credible **Biology** resources as well as the input from experienced teachers and experts.

Baroque Senior Four Biology Learner's Book entails;

- a competence, active and learner-centred approach
- appropriate and accurate content
- adequate and relevant activities and projects that trigger discovery, critical thinking, creativity, problem-solving and inter-activity
- acceptable, appropriate, standard and grammatically correct English, which encourages vocabulary development as well as correct representation of technical terms
- accurate, relevant, clear, and adequate illustrations that enhance learning
- intuitive methods, illustrations, activities, and projects that have been explored to instil the principles of **Biology**.

In pursuit of competency-based society, there is a need for new generation learning books that are sufficiently researched; innovative and learner centred.

Baroque Senior Four Biology Learner's Book lays a firm foundation for learners who would like to pursue a career in **Biology** related fields and seeks to equip all learners with the ability to apply **Biology** knowledge in day-to-day activities.



Keywords

- asexual
- vegetative propagation
- cultivar
- layering
- reproduction
- grafting
- suckering
- suckers
- tissue culturing

By the end of this chapter, you should be able to:

- a) know the meaning of asexual reproduction
- b) understand how plants reproduce asexually
- c) understand that asexual reproduction in plants has important commercial applications

1.0 Introduction

Reproduction is the process by which a living organism gives rise to offsprings. Reproduction is important because it ensures continuity of species. Plants like other living organisms, undergo this process to multiply. Plants reproduce both sexually and asexually. In this chapter, you will understand asexual reproduction in plants and appreciate the fact that different parts of plants can grow into new plants.

1.1 Meaning of Asexual Reproduction

Asexual reproduction in plants involves giving rise to new plants from other plant parts other than seeds, and the resulting offsprings are genetically identical to the parent plant. Asexual reproduction in plants is also known as **vegetative propagation**. Which plants are reproduced by farmers by the means of other plant parts other than seeds? Which parts of these plants are used by farmers to achieve this goal? In Activity 1.1 below, you will identify different plant parts other than seeds that can be used to obtain new plants.



Activity 1.1: Identifying different plant parts other than seeds used for reproduction

Key question: Which plant parts other than seeds can be used in reproduction?

What you need:

- Pen
- Notebook
- Hand lens

What to do:

1. In groups, move around the school compound or school garden or farm, and identify plants that can reproduce asexually.
2. Identify possible parts that have been or could be used to get new plants of the same kind.
3. Suggest what enables the plant parts to grow into new plants.
4. Report your findings in a table with drawings. A possible table is shown below. Copy and complete it.

Data sheet/ observations.

Name of the plant	Part used for asexual reproduction	Drawing of plant showing part used for asexual reproduction	What enables the part to grow into new plants

5. Using examples, explain why some plants that bear seeds are propagated asexually?

1.2 Forms of Asexual Reproduction in Plants

There are different forms of asexual reproduction in plants. Some forms occur naturally; this is known as natural vegetative propagation. On the other hand, are forms of asexual reproduction in plants that occur by human intervention. This is known as **artificial propagation**.

Methods of artificial vegetative propagation

Artificial vegetative propagation is the reproduction of new plants from portions of vegetative organs such as stems, leaves and roots through human intervention. In which ways have humans influenced the propagation process of plants? Many farmers and horticulturists employ different vegetative reproductive techniques to give rise to new and sometimes novel plants. In *Activity 1.2 (b)*, you will find out how certain crops are grown by vegetative propagation in your area. The most common types of artificial propagation methods used include; use of cuttings, layering, grafting and budding, suckering and tissue culturing (see Figures 1.2 (a), (b), (c) and (d)). In *Activity 1.2 (a)* below, you will explore different methods of artificial vegetative propagation.

a) Propagation by cutting

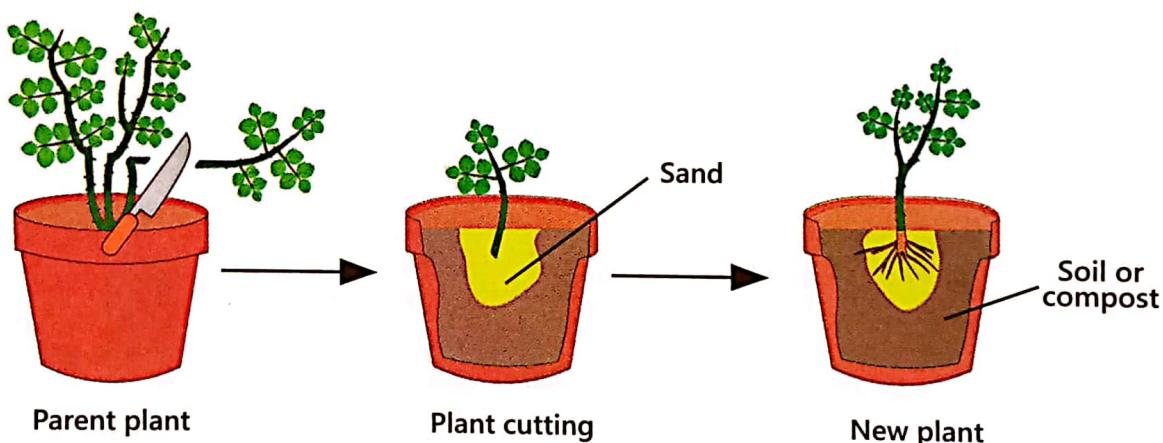


Figure 1.2 (a)

b) Propagation by layering

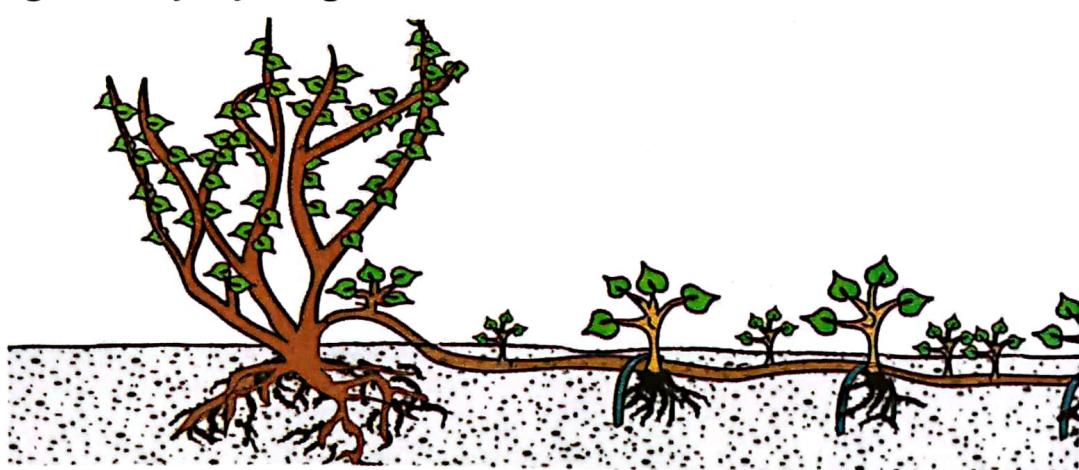


Figure 1.2 (b)

c) Propagation by grafting

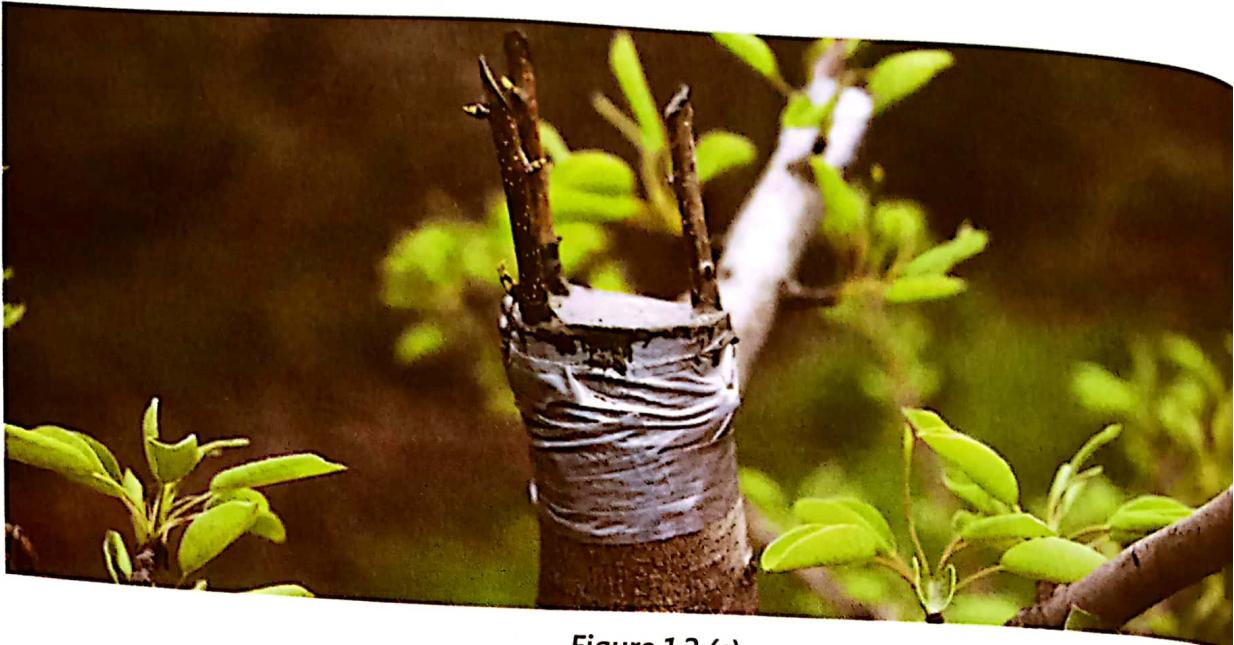


Figure 1.2 (c)

d) Propagation by budding

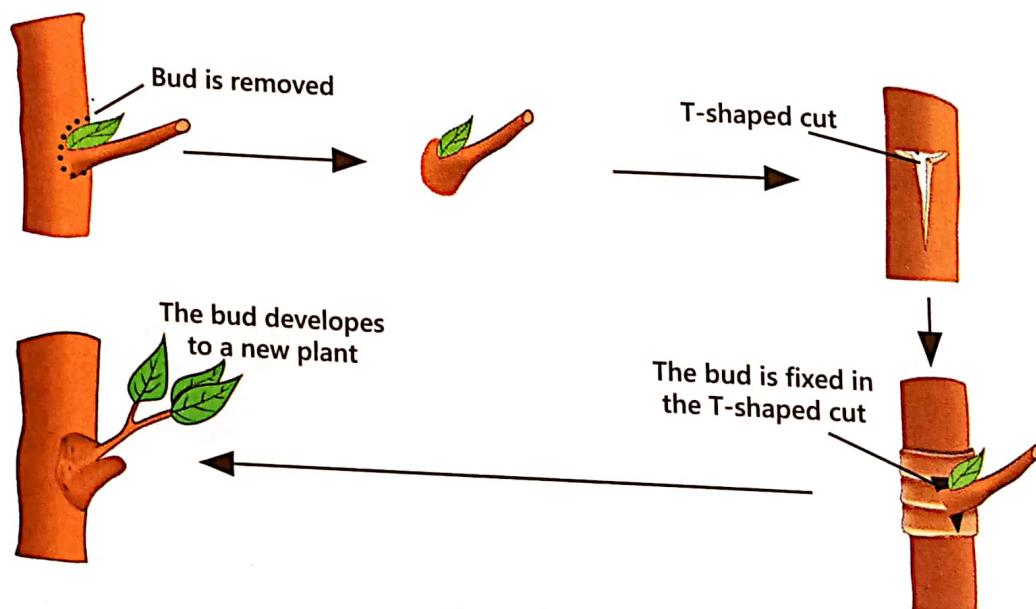


Figure: 1.2 (d)



Activity 1.2(a): Exploring methods of artificial vegetative propagation

Key question: What is the principle behind each method of artificial vegetative propagation?

What you need:

- Pen
- Notebook
- textbook/internet

What to do:

In groups,

1. Research about the different methods of artificial vegetative propagation.

2. Explain the principle applied during vegetative propagation of crops using each method.
3. State the precautions taken to ensure success of propagation while applying each method?
4. Suggest examples of crops that can be propagated using each method.
5. Select any one of the crops suggested in (4) above, and describe how it is propagated.
6. Make a write up and present your findings to the rest of the class.



Activity 1.2(b): Identifying crops that are grown by vegetative propagation in your area

Key question: Which crops are cultivated on a large scale by vegetative propagation in your area?

What you need:

- Pen
- Notebook
- Biology textbooks/internet

What to do:

In groups,

1. Carry out research or interview farmers in your area or school farm on the different types of crops they cultivate by vegetative propagation.
2. Identify the methods of vegetative propagation used to grow these crops.
3. State the advantages of the different types of vegetative propagation carried out by farmers in your community.
4. Identify plants grown on a large scale using vegetative propagation.
5. Prepare a report of your findings and discuss with the class. Make use of ICT tools to present your work.



Career: AN ARBORETUM WORKER

One can become an Arboretum/ Botanical Garden/ Horticultural Garden Worker through study and specialisation in asexual reproduction in plants. It involves planting and maintaining plant collections in naturalised, systematic or aesthetic arrangements.

They also propagate plants, teach, and/or conduct research. They are employed by arboreta, botanical gardens, city parks, colleges/universities, historical sites, nature preserves, public and private gardens and recreational areas.



Exercise 1.1

1. What is a stem tuber?
2. Explain why offsprings produced by asexual reproduction have similar characteristics with the parent plant.
3. Explain why a gardener might choose to propagate a plant asexually.

1.3 Commercial Applications of Vegetative Propagation

From previous activities and study, vegetative propagation has both good and bad implications. You will find out the good and bad implications of vegetative propagation in Activity 1.3.



Activity 1.3: Finding out advantages and disadvantages of vegetative propagation in plants

Key question: What are the advantages and disadvantages of vegetative propagation in plants?

What you need:

- Pen
- Notebook
- Biology textbooks/internet

What to do:

- As a class, carry out a debate on the motion "**Vegetative propagation has more advantages than disadvantages.**" Consider both short- and long-term impacts of vegetative propagation on society, economy, and the environment.
- Record points from each side.

In groups,

1. Suggest ways in which the disadvantages can be worked around during propagation.
2. *Figure 1.3 shows banana plants.*



Figure 1.3: Banana plants

- a) Name the type of reproduction in *Figure 1.3*.
 - b) Describe two advantages of this type of reproduction to banana growers.
 - c) Identify the part of the banana plant used during vegetative propagation?
3. Banana plants can be killed by fungal diseases such as black sigatoka and panama disease. Explain why a population of bananas produced by the method shown in the diagram above could all be wiped out by the same disease.



Project Work: Growing plants in school by artificial propagation

Key question: How would you grow certain plants by artificial propagation?

What you need

- Notebook
- Pen/ pencil
- Old tins
- Soil
- Plant materials

What to do:

1. In groups, select a healthy plant to be propagated. The plant may be a food crop, a landscape plant, or a wild plant.
2. Make research about the plant to learn how it can be propagated and record your findings in your notebook under the title 'Plant Journal'.
3. Conduct the propagation of the selected plant.
4. Monitor the plant and provide the necessary conditions required for its growth.
5. Take note of the any reasons for success or failure of propagation depending on the results obtained.
6. Write a report of your project; ensure to include a step by step procedure of your propagation process, challenges faced and recommendations.



Sample Activity of Integration

Mr. and Mrs. Odongo are farmers in Agule village, and they own a large piece of land. They majorly grow fruit crops such as mangoes and oranges. However, the fruit crops are of poor variety, and they produce few fruits of small size. As a result, the family has little to feed on or plant during the next season.



Task:

Using knowledge of asexual reproduction, write a letter advising the family on how to solve the challenges of their fruit crops.



Chapter Summary

In this chapter, you have learnt that:

- All organisms multiply or reproduce their own kind.
- In plants, there are two modes of reproduction, asexual and sexual.
- Asexual reproduction occurs without fusion of gametes. New plants develop from different parts of a plant.
- Asexual reproduction can occur naturally or be influenced by man under a process known as artificial propagation.
- Asexual reproduction can be carried out using: buds, corms, bulbs, rhizomes, stolons, suckers, tubers and stem cuttings.
- Artificial propagation techniques include: cutting, layering, grafting and budding, suckering and tissue culturing.
- In vegetative propagation, new plants are produced from different vegetative parts such as leaves, stems and roots.
- Vegetative propagation can be economically beneficial for commercial growers to clone a certain plant to ensure consistency throughout their crops.
- Vegetative propagation prevents species genetic diversity leading to reductions in crop yields.

**Keywords**

- fertilisation
- fruit
- gametes
- pollination
- seed
- flower
- pollen
- ovule
- fusion

By the end of this chapter, you should be able to:

- a) recognise the flower structures that are involved in the processes of pollination, fertilisation, fruit and seed development and outline their functions
- b) know the processes of pollination, fertilisation and fruit formation
- c) understand the difference between cross- and self-fertilisation and the advantages of each method
- d) differentiate between seeds and fruits structurally and functionally
- e) understand the importance of seed dispersal
- f) recognise the structures and types of fruits and seeds, and relate their structures to the methods of dispersal

2.0 Introduction

As learnt in your earlier classes, sexual reproduction involves fusion of specialised male and female gamete cells to form a zygote which develops into a new organism. In plants, this process occurs just as it does in other sexually reproducing organisms. Where does sexual reproduction exactly take place in plants? In plants, sexual reproduction occurs in the flower. The flower produces the male and female gamete cells upon whose fusion, a series of events take place to produce seeds. You are aware that seeds develop into new plants when planted under the right conditions. In this chapter, you will appreciate that the flower is a specialised organ in plants in which all events of a plant's sexual reproduction occur.

2.1 Structures of a Flower

Structurally, flowers differ in size, shape, colour combinations, and even whether both male and female structures are present or not. Some of these differences can be observed from the variety of flowers in *Figure 2.1*. In *Activity 2.1 (a)*, you will explore different varieties of flowers to see how they differ from each other.



A: Hibiscus flower



B: A flower of grass

Figure 2.1: Different forms of flowers

In *Activity 2.1 (a)*, you will explore different varieties of flowers to see how they differ from each other.



Activity 2.1(a): Exploring different varieties of flowers

Key question: How do different varieties of flowers differ from each other structurally?

What you need:

- Pen
- Notebook
- Hand lens
- Biology textbook/ internet

What to do:

In groups,

1. Move around the school compound or farm and observe the different flowers you come across.
2. Identify how the flowers differ from one another.
3. Note down the differences and share your findings with the rest of the class.

Parts of a flower

The flower consists of parts that are either directly involved in reproduction known as essential parts and those that are not directly involved in reproduction known as non-essential parts. Group parts of a flower into essential and non-essential parts. In Activity 2.1(b), you will examine the different parts of a flower.



Activity 2.1(b): Examining the different parts of a flower

Key question: What are the functions of different parts of a flower?

What you need:

- Pen/pencil
- Notebook
- Hand lens
- Blade
- Internet
- Biology reference materials
- Specimens: hibiscus flower and grass flower

What to do:

In pairs,

1. Observe the specimens provided; taking note and making drawings of the outer structures.
2. Carefully peel off the petals and sepals of the flower, then draw and label what you observe.
3. Remove the androecium as carefully as possible and observe it. Using a hand lens, observe, draw and label the male part of a flower.
4. Under the guidance of your teacher, dissect the gynoecium to reveal the ovary. Using a hand lens, observe, draw and label the female part of a flower.
5. Outline the functions of the different parts of a flower.
6. Present your findings to the rest of the class.



Career: A FLORIST



Floristry is the production, commerce, and trade in flowers. It involves flower care and handling, floral design, or flower arranging, merchandising, production, display and delivery. Wholesale florists sell bulk flowers and related supplies to professionals in the trade. Retail florists offer fresh flowers and related products and services to consumers.



Exercise 2.1

1. What is the function of a flower to a plant?
2. Name two cells of a mature pollen grain.
3. Describe the parts of a typical angiospermic ovule.

2.2 Pollination, Fertilisation, Seed and Fruit Formation

There are a series of processes in sexual reproduction in plants. These include pollination, fertilisation, seed and fruit formation.

Pollination

Pollination is the process by which pollen grains are transferred from the anther to the stigma of a plant. How does this process occur in plants? Perform Activity 2.2 below to find out.



Activity 2.2(a): Examining diagrams of insect pollinated flowers

Key question: How does pollination take place in plants?

What you need:

- Pen/Pencil
- Notebook
- Textbook/internet

What to do:

In groups,

1. Research using internet or textbooks and examine diagrams of insect pollinated flowers.
2. Identify the two forms of pollination in plants and describe each of them.
3. Note your findings; and include diagrams illustrating the process; attach short explanations.
4. Present your findings to the rest of the class.

From Activity 2.2 (a) above, you have learnt about pollination, and noted how the process occurs. You should have noticed that pollination is aided by agents such as wind or insects. Basing on the agent of pollination, flowers are categorised into either wind or insect pollinated flowers. Flowers under each category have specific characteristics that adapt them to be pollinated by the aid of either wind or insects.



Figure 2.2 (a): Wind pollinated flower



Figure 2.2 (b): Insect pollinated flower

In Activity 2.2 (b) below, you will examine the structure of wind and insect pollinated flowers, compare them, and explain how each is adapted to the process of pollination.



Activity 2.2(b): Examining structures of wind-pollinated and insect-pollinated flowers

Key question: How are wind pollinated and insect pollinated flowers adapted to their mode of pollination?

What you need:

- Pen/Pencil
- Notebook
- Textbook/internet
- Biology reference materials
- Microscope
- Specimens: hibiscus flower, morning glory flower, a guava flower, banana flower, maize flower, grass flower, bougainvillea, crotalaria flower and bean flower.
- Prepared slides of pollen grains of insect and wind pollinated flowers.

What to do:

In groups,

1. Examine flower structures of the specimens provided.
2. Compare the following parts of the specimens:
 - a) stamens/anthers
 - b) stigmas
 - c) Petals
3. Categorise the specimens into insect pollinated and wind pollinated flowers depending on their characteristics.
4. Compare the microscope slides of pollen grains of wind-pollinated and insect-pollinated flowers by observing them through a light microscope.
5. Describe how each of the two groups of flowers is adapted to its mode of pollination.
6. Outline how self-pollination is prevented in flowers.
7. Produce a table comparing the two types of flowers and their pollen grains.
8. Share and discuss your findings with the class.

Fertilisation, seed and fruit development

Fertilisation in plants involves the fusion of the male and female gametes just as it is in all other sexually reproducing organisms. What are female and male gametes in plants? Fertilisation in plants is internal and takes place inside the ovary in the structure called embryo sac. How does the process of fertilisation occur in plants? After fertilisation, several changes occur to the different parts of the flower resulting into fruit and seed formation and development

In Activity 2.2 (c), you will examine images of insect pollinated flowers to find out how fertilisation as well as seed and fruit formation and development occur in plants.



Activity 2.2(c): Examining diagrams of insect pollinated flowers to find out how fertilisation, seed formation and development occur

Key question: What events take place from the time a pollen grain is released from the anther up to when a fruit is formed?

What you need:

- Pen/Pencil
- Notebook
- Textbook/internet
- Biology reference materials

What to do:

1. In groups, research and discuss how the following processes occur in plants:
 - Fertilisation
 - Fruit and seed formation and development
2. Individually, produce labelled diagrams with explanations on how the processes of fertilisation as well as seed and fruit formation and development occur.
3. Share your findings with the class using suitable ICT.

2.3 Cross-fertilisation and Self-fertilisation

Pollination sometimes takes place between different flowers but of the same species. If the pollen grains fertilise the ovules of a flower on a different plant, such kind of fertilisation is known as **cross-fertilisation** (see Figure 2.3 (a)). Pollination can also occur between different flowers on the same plant or in the same flower (see Figure 2.3 (b)). If pollen grains fertilise the ovules of the same flower or a different flower on the same plant, such kind of fertilisation is known as **self-fertilisation**. Fertilisation takes place only after successful pollination.

Plants have modifications that favour a given type of fertilisation. What are some of these modifications? You will find these out in Activity 2.3.

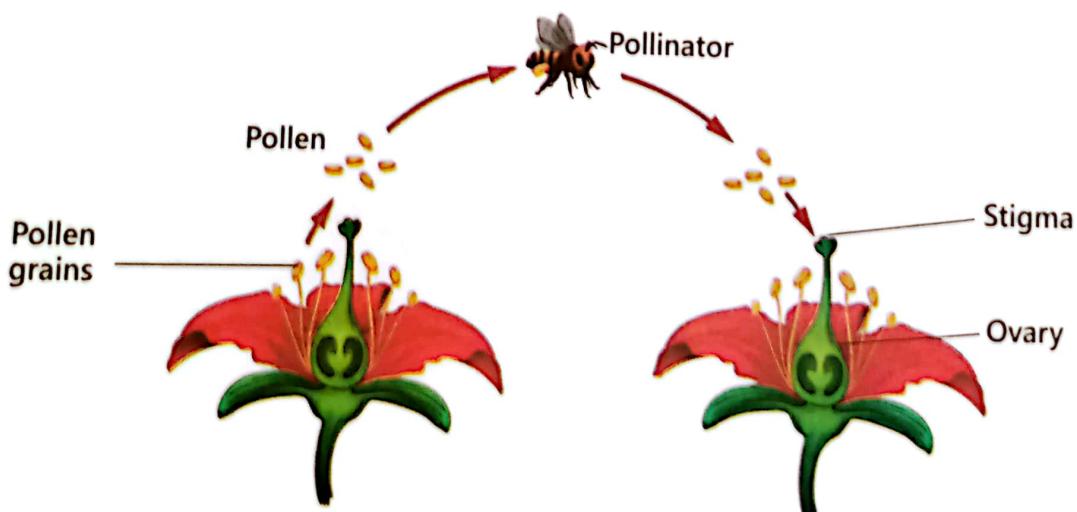


Figure 2.3 (a): An illustration of cross-pollination

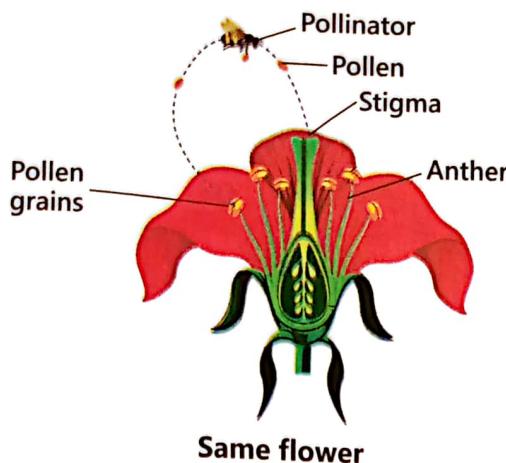


Figure 2.3 (b): An illustration of self-pollination



Activity 2.3: Exploring how plants are adapted to cross and self-fertilisation

Key question: How are plants adapted to cross-fertilisation and self-fertilisation?

What you need:

- Pen/Pencil
- Notebook
- Textbook/internet

What to do:

In pairs,

1. Make research on how plants are adapted to self and cross fertilisation.
2. Identify the advantages and disadvantages of each of the type of fertilisation.
3. Make a write up of your findings.
4. Present your findings to the rest of the class.

2.4 Seeds and Fruits

Categories of fruits

Fruits are categorised based on the part of the flower they developed from and how they release their seeds. Depending on the part of the flower from which they are developed, fruits may be classified as simple, aggregate, multiple or accessory. Depending on how they release their seeds, fruits can be categorized as **dehiscent** or **inindehiscent**. Dehiscent fruits readily release their seeds upon drying, while indehiscent fruits rely on decay to release their seeds. In Activity 2.4 (a); you will categorise different examples of fruits.

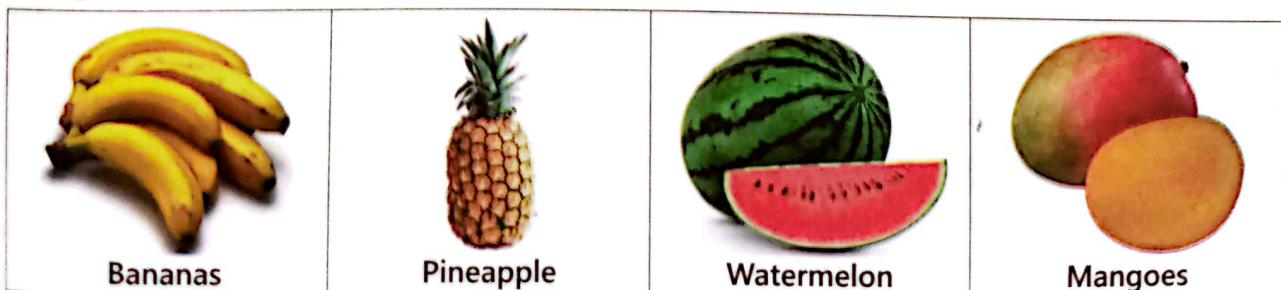


Figure 2.4: Examples of fruits



Activity 2.4(a): Categorising different examples of fruits

Key question: What characteristics determine the category to which a given fruit belongs?

What you need:

- Pen/pencil
- Notebook
- Knife/Cutting blade
- Internet/textbooks
- specimen/at least two fruits under each category

What to do:

In groups,

1. Examine the fruits provided, and note down their characteristics.
2. Cut through them where necessary to observe the nature of seeds they contain and the arrangement of seeds around the placenta.
3. Categorise the fruits depending on their characteristics into dry or fresh, simple, aggregate, multiple, or accessory, dehiscent or indehiscent.
4. Define the term placentation in regard to fruits.
5. Identify the kinds of placentation existing in the fruits examined. Provide examples of fruits under each category of placentation.
6. Write your findings and present to the class.

Categories of seeds

Seeds are categorised depending on the number of cotyledons they contain. What are these categories and their examples? Find out in Activity 2.4 (b).



Activity 2.4(b): Exploring the different categories of seeds

Key question: What structural differences exist between the different categories of seeds in plants?

What you need:

- Pen/pencil
- Notebook
- Knife/Cutting blade
- Hand lenses
- Internet
- Specimens of both monocotyledonous seeds and dicotyledonous seeds (For example beans and maize)

What to do:

In groups,

1. Examine the specimen of the monocotyledonous and dicotyledonous seed provided.
2. Cut through each of the specimen to observe its internal parts. Which of the two specimen could easily split? Be careful while using the knife/cutting blade not to hurt yourself.
3. Make labelled drawings of both external and internal parts of each specimen.
4. Note the structural difference between the two kinds of seeds.
5. Develop a write up of your findings and present them to the class.

Differences between seeds and fruits

Seeds and fruits are both a result of sexual reproduction in plants. Although these result from the same processes, they are different. In *Activity 2.4 (c)* below, you will find out the differences between seeds and fruits.



Activity 2.4(c): Differentiating between seeds and fruits

Key question: What is the difference between seeds and fruits?

What you need:

- Pen/pencil
- Notebook
- Biology reference materials/Internet
- Seeds for example avocado seed, millet grain
- Fruits for example orange, Mango, Bean pod

What to do:

In pairs,

1. Examine specimens provided or diagrams of fruits and seeds.
2. Discuss and explain the structural and functional difference between different fruits and seeds.
3. Make notes and a presentation from your discussion.
4. Share your work with the class.



Career: A POMOLOGIST

A pomologist is a scientist who is responsible for ensuring the healthy growth and breeding of fruits and nuts, as well as the trees and bushes on which they grow. Often found in laboratories, orchards, greenhouses, and on farms, pomologists can be employed by governments, colleges and universities, private research facilities and agricultural organisations.

A pomologist is also known as a fruit farmer.

2.5 Fruit and Seed Dispersal

Many of us have fruit trees or plants that sprouted in our localities without our will and intervention. How did these plants come to exist at that particular spot? The process by which fruits and seeds move away from their parent plants to other areas is called fruit and seed **dispersal**. *Figure 2.5* shows seeds of dandelion being dispersed.



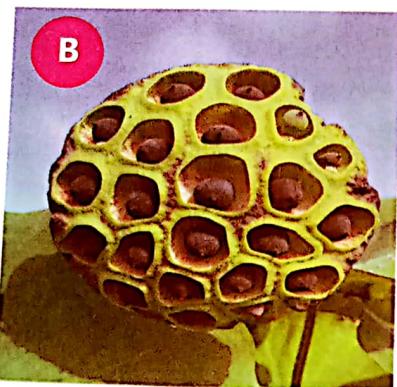
Figure 2.5: Seeds of Dandelion being dispersed from parent plant

2.6 Methods of Fruit and Seed Dispersal

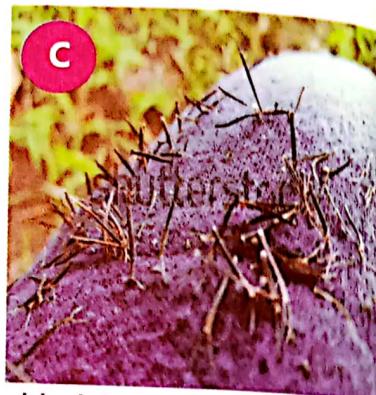
Some fruits and seeds require different agents in order to be dispersed. These include wind, water, animals etc. On the other hand, there are fruits and seeds that do not require agents. The method by which the fruit or seed is dispersed depend on the agent involved in the process. What are the different methods of fruit and seed dispersal? Each fruit or seed has structures that enable it to be easily dispersed by its dispersal agents. These are known as **adaptations**. In Activity 2.6, you will analyse Figures 2.6 (A) to (H) to identify the adaptations of fruits and seeds for the respective methods of dispersal.



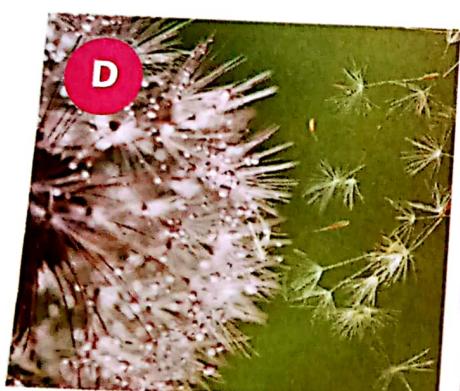
bean seeds being dispersed



lotus seeds



black jack seeds hooked on cloth



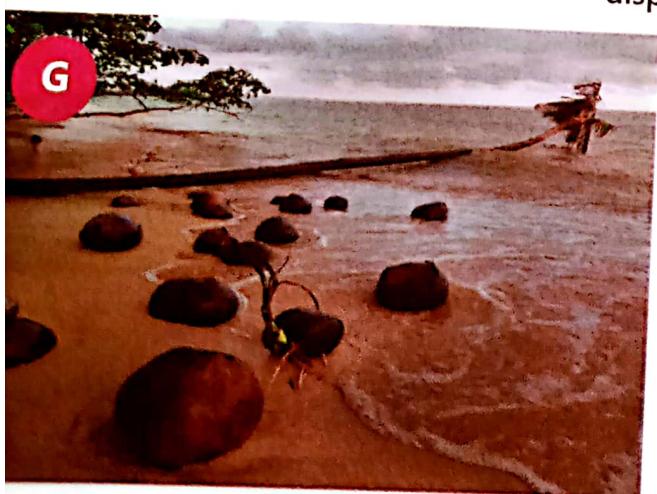
dandelion seeds being dispersed



milkweed seeds being dispersed



burdock seeds attached at sheep's fur



coconut seed being dispersed



walnut seeds being dispersed

Figure 2.6: Methods of fruit and seed dispersal



Activity 2.6: Analysing the adaptations of fruits and seeds to their respective modes of dispersal

Key question: How are the fruits and seeds adapted to their different modes of dispersal?

What you need

- Pen/Pencil
- Notebook
- Textbook/internet
- Different specimen of fruits and seeds under each mode of dispersal.

What to do

In pairs,

1. Make research and discuss about each mode of fruit and seed dispersal.
2. What examples of fruits and seeds fall under each mode of dispersal?
3. Study images in *Figure 2.6 (A) to (H)* and identify the mode of dispersal represented.
4. Study the specimen provided and group them according to their mode of dispersal.
5. Outline the characteristics you have based on to have the different fruits and seeds grouped into a given mode of dispersal.
6. Describe the adaptations of these fruits and seeds produced for their mode of dispersal.
7. Make a write up of your findings and present to the class using suitable ICT.

2.7 Importance of Fruit and Seed Dispersal

Fruit and seed dispersal is critical for the survival of plant species. In *Activity 2.7* below, you will find out the importance of fruit and seed dispersal.



Activity 2.7: Finding out the importance of dispersal

Key question: What is the importance of seed and fruit dispersal?

What you need:

- Pen
- Notebook
- Biology textbook/internet

What to do:

1. In groups, read and discuss the importance of fruit and seed dispersal.
2. Individually, write an essay on the importance of fruit and seed dispersal.
3. Present your findings to the class.

Place of Interest: GENE BANKS

Seed banks, or gene banks are one of the primary methods of conservation. A seed bank is a place where seeds, cuttings, or important genetic material from crops, both domesticated and wild are stored, cataloged, and preserved for future research. These places ensure that species of plants are not lost in case of worldwide

disasters. Kiziba community gene bank, located in Kabwohe, Sheema district one of the many gene banks in Uganda. Do you know of any gene banks in your district?



Sample Activity of Integration

Nami is a large scale commercial farmer who grows beans on his farm. In the previous season, Nami's farm was attacked by a strange pest. He bought a pesticide from a shop and sprayed his farm. The pesticide killed all the pests. After a short time, Nami noticed that all the flowers in his garden had withered, but the rest of the plant parts remained fresh and healthy. Some people have advised Nami to abandon his garden because his crops will not bear seeds, but Nami still hopes for a good yield from his crops.



Task:

Using your knowledge of sexual reproduction in plants, write a report to help Nami understand the situation on his farm and give him advice on what to do to ensure a good harvest.

Chapter Summary

In this chapter, you have learnt that:

- Sexual reproduction in flowering plants involves the fusion of male and female gametes, and that the flower is the reproductive structure of a plant.
- Sexual reproduction in plants involves the processes of pollination, fertilisation, fruit and seed development.
- Adaptations such as bright colours, strong fragrances, special shapes and nectar guides attract pollinators like bees, flies, wasps, butterflies and moths.
- Insects and flowers both benefit from their specialised relationship; plants are pollinated while insects obtain valuable food sources.
- Flowers have different modifications for the different types of pollination.
- Fruits have modifications suitable to their modes of dispersal.



Keywords

- abortion
- abstinence
- antenatal
- contraception
- erectile dysfunction
- oestrogen
- genitalia
- implantation
- menstrual cycle
- progesterone
- stigmatisation
- testosterone

By the end of this chapter, you should be able to:

- a) understand the structure and functions of the male and female reproductive system
- b) understand the changes that take place during the menstrual cycle
- c) relate the male and female gametes
- d) appreciate the process of fertilisation of an ovum and the developments of the zygote up to birth
- e) know the role of the placenta during pregnancy
- f) understand the importance of antenatal care
- g) understand the aspects of care for the baby after birth
- h) recognise the health risks and complications associated with teenage pregnancy and abortion
- i) identify the common birth control methods in uganda and give the biological principle they employ and their effectiveness
- j) identify and explain common issues associated with reproductive systems
- k) know the causes, signs and understand the mode of transmission of common STIs and STDs
- l) appreciate the preventative measures for named STIs and STDs
- m) identify challenges faced by people living with HIV/AIDS and how to overcome them

3.0 Introduction

For many centuries, different cultures around the world believed that males were responsible for giving life. They believed that females simply carried the seed planted by a male, bringing it to fruition. They also believed that males gave seed to male offsprings while females gave birth to female offsprings. Modern science, however, has disproved these myths. Have you heard of any myths and beliefs on where children come from? Can you share them with your neighbour? In this chapter, you will understand that sexual reproduction involves two parents with specialised reproductive systems.

3.1 The Human Reproductive System

Humans have specialised systems responsible for their sexual reproduction. These include the male and the female reproductive systems. The systems fully develop during a period known as puberty that extends from the age of 12 to 15 in normal human beings. The human reproductive system enables achievement of internal fertilisation through sexual intercourse in humans.

The male reproductive system

The male reproductive system is a complex network of various organs in males as illustrated in *Figure 3.1(a)*. Organs of the male reproductive system are located outside the body and within the pelvis. The external features are known as the genitals. Mention parts of the male reproductive system. Every feature of the male reproductive system plays an elaborate role in the functioning of the system as a whole.

During reproduction, the male reproductive system is responsible for;

- Production and storage of sperms
- Production of hormones like testosterone
- Delivery of sperms into the female reproductive system

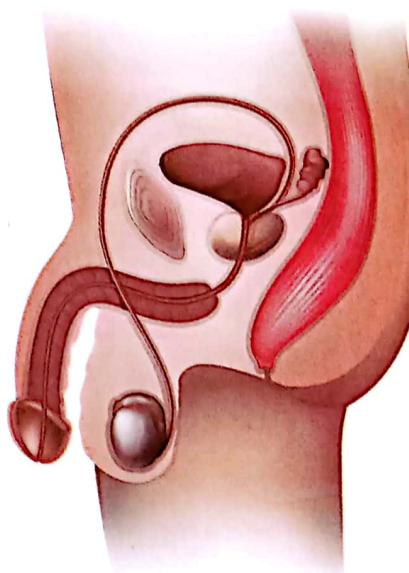


Figure 3.1(a): The male reproductive system

The female reproductive system

The female reproductive system is made up of a complex network of organs in females. *Figure 3.1 (b)* illustrates the female reproductive system. The external structures are called genitals. Mention structures of the female reproductive system. Every feature of the female reproductive system plays an elaborate role in the functioning of the system as a whole.

During reproduction, the female reproductive system is responsible for:

- Production of the ova
- Receiving sperms from the male reproductive system
- Production of hormones such as estrogen and progesterone
- Providing suitable condition for the fetus in the event of pregnancy



Figure 3.1(b): The female reproductive system



Activity 3.1: Identifying parts of male and female reproductive systems and their functions

Key question: What role does each of the parts of the male and female reproductive systems play?

What you need:

- Pen
- Well sharpened pencils
- Notebook
- Informative Chart(s) or biology textbook

What to do:

In pairs or groups,

1. Carry out research and examine chart(s) or drawings in biology textbooks of male and female reproductive systems.
2. Draw and label the male and female reproductive systems.
3. State the function(s) of each part.
4. Make a write up of your findings.
5. Share your findings with the class.

3.2 The Menstrual Cycle

This is a monthly series of hormonal and physical changes that occurs in the body of a female in preparation for pregnancy. The menstrual cycle starts at puberty and ends when a woman enters menopause. At which age does puberty and menopause begin? The menstrual cycle occurs every month in absence of fertilisation; it involves the development and release of a mature egg by the ovaries and then menstruation.



Female humans are born with all the eggs they will ever produce; these are about 400-500. The process of releasing these eggs known as ovulation starts at puberty and ends at menopause. Males are able to produce sperm only after puberty and this process does not end until the person dies.



Activity 3.2(a): Exploring the menstrual cycle

Key question: What are the major events of the menstrual cycle?

What you need:

- Pen
- Notebook
- Biology resource textbooks/internet

What to do:

In groups,

1. Research and discuss about the following;
 - a) Menstruation
 - b) Follicular phase
 - c) Ovulation
 - d) Luteal phase
2. State hormones involved in the menstrual cycle.
3. Describe circumstances under which menstruation occurs. Explain why.
4. Compile a report of your findings.
5. Share your findings with the class.

Hormonal changes during the menstrual cycle

A number of hormones control the menstrual cycle. As seen in *Activity 3.2 (a)* above, the concentration of these hormones changes during the cycle which leads to a number of changes in the body of a female, but more specifically, to the uterine wall. In *Activity 3.2 (b)* below, you will examine the effects of these hormones on the uterine wall.



Activity 3.2(b): Examining the effect of hormones on the uterine wall

Key question: How does the concentration of different hormones involved in the menstrual cycle affect the uterine wall?

What you need:

- Pen
- Notebook
- Biology resource textbooks or research journals/ internet

What to do:

In groups,

1. Research and discuss the following;
 - a) Interaction of different hormones during the menstrual cycle.
 - b) The effect of different hormones on the uterine wall.
2. Using graphs, illustrate the interaction of different hormones and their effect on the uterine wall.
3. State the importance of the menstrual cycle.
4. Explain the concept of safe days.
5. Discuss your findings with the class.
6. After class discussion, individually record the events in charts/diagrams.



Career: A GYNAECOLOGIST

A gynaecologist is a doctor who specialises in women's health. More specifically, they manage the medical and surgical problems that affect women's reproductive and urological systems.

3.3 The Male and Female Gametes

Gametes are specialised cells produced by the reproductive systems. They are responsible for giving rise to off springs. Female gametes are called **ova or egg cells** (see *Figure 3.2(a)*) while male gametes are called **sperms** (see *Figure 3.2(b)*). The ova and sperm are both formed through a special type of cell division known as **meiosis**. This will be covered in chapter four.



Figure 3.2 (a): 3D illustration of an ovum



Figure 3.2 (b): 3D illustration of a sperm cell

In Activity 3.3 below, you will compare the male and female gametes cells.



Activity 3.3: Comparing male and female gametes

Key question: What are the similarities and differences between a sperm and an ovum?

What you need:

- Manila paper/plain paper
- Pen
- A computer with Internet and biology books
- Glue
- Paper
- Scissors/a blade
- Other art supplies

What to do:

In groups,

1. Research about differences and similarities between a sperm and an ovum. Draw and label the different parts of the cells.
2. Make models of the gametes to show the positions of the different organelles in the cells while making sure that the cells are up to scale.
3. State similarities and differences between the sperm and ovum.
4. Explain why the ovum is larger than the sperm.
5. Explain why the sperm and ovum contain each, only half of the number of chromosomes present in other human body cells. Why is it important?
6. Discuss your findings with the class, and display your models of the gametes.

Exercise 3.1



1. Copy and complete the sentences below about the male reproductive system. You may use each of the words in the list once, more than once, or not at all. (**Oestrogen, prostate, tests, oviducts, secondary, testosterone, primary, sperm, ureter, progesterone, sperm ducts, urethra**).

Sperms are made in the _____ and can travel along the _____ and then the _____ to the outside of the body. The _____ gland produces a fluid that nourishes and serves as a medium for transportation of the sperms.

The testes make a hormone called _____. This causes _____ production to begin, and it also causes the development of _____ sexual characteristics in males.

2. Write the name of the parts of the female reproductive system that match each description below.
 - a) the organ in which an embryo develops.
 - b) the place where an egg is fertilised.
 - c) the organ where eggs are made.
 - d) a ring of muscle at the base of the uterus.

3.4 Fertilisation and Pregnancy

Fertilisation takes place when a sperm and the ovum meet to form a zygote. The formed zygote undergoes a series of changes to form a blastocyst which attaches to the walls of the uterus. When this happens, a woman is said to be pregnant. In Activity 3.4, you will explore the events that take place before, during and after fertilisation.

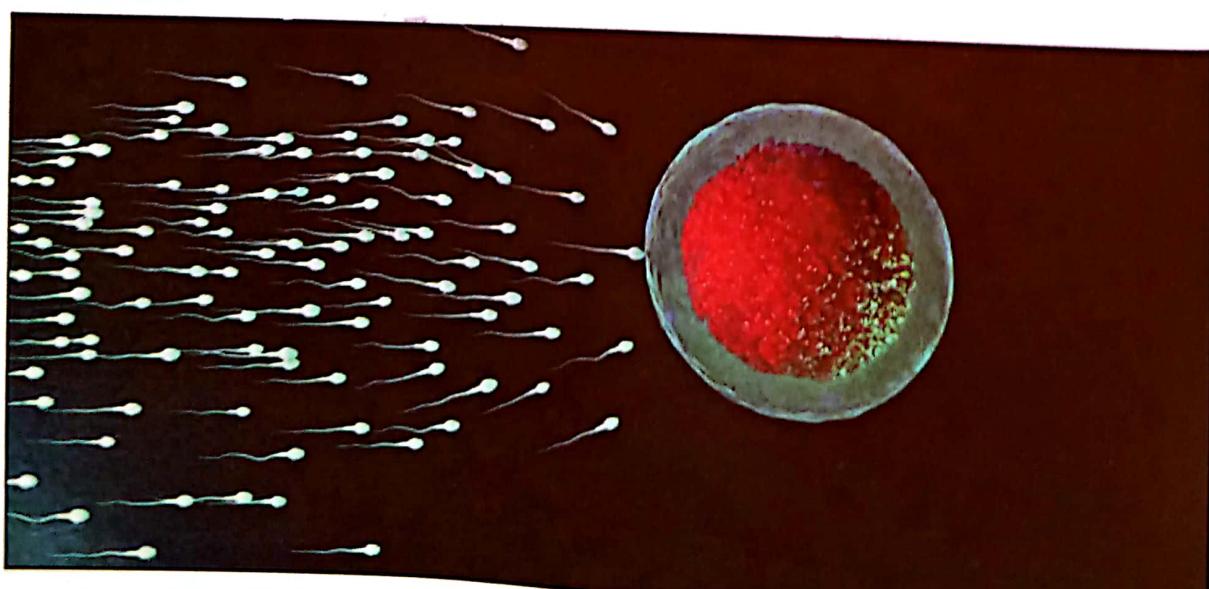


Figure 3.3: A 3D illustration showing sperm cells swimming towards the egg cell to fertilise it.



In 1654, a Dutch scientist, Anton van Leeuwenhoek, observed a sample of his semen. He became the first person to see sperms and formulated the homunculus theory that suggests that each sperm contains a tiny human with a tail, a homunculus. The homunculus is believed to absorb the mother's characteristics as it developed in her uterus. Later on, in 1827, Karl Ernst von Baer observed the mammalian ovum, and he realised that both the sperm and ovum are important in the formation of a foetus. He later was considered the father of embryology.



Activity 3.4: Exploring the events that take place before, during and after fertilisation

Key question: What series of events take place before, during and after fertilisation?

What you need:

- Manila/large sheet of paper
- Pen
- Biology textbooks and computer with internet
- Markers
- Notebooks

What to do:

In groups,

1. Make research on;
 - a) fertilisation
 - b) implantation
 - c) changes the zygote undergoes to become a foetus and finally a baby.
2. Describe how an ovum ensures that only one sperm fertilises it.
3. Explain why the uterine walls become thick and spongy before ovulation.
4. Make a write up of your findings and share them with the class.



Career: AN EMBRYOLOGIST

An embryologist is a fertility specialist that helps to create viable embryos to either be used in In Vitro Fertilisation (IVF) right away or to be frozen for later use. Embryologists are highly trained medical professionals, usually holding a Master's degree or a PhD due to the specialised nature of their work.

3.5 The Role of the Placenta During Pregnancy

The placenta is a vital fetal organ that develops as an attachment to the uterus and fetal umbilical cord during pregnancy. (See Figure 3.4). The placenta plays a crucial role in the development of the fetus up to the time of birth. In Activity 3.5, you will explore the role of the placenta during pregnancy.

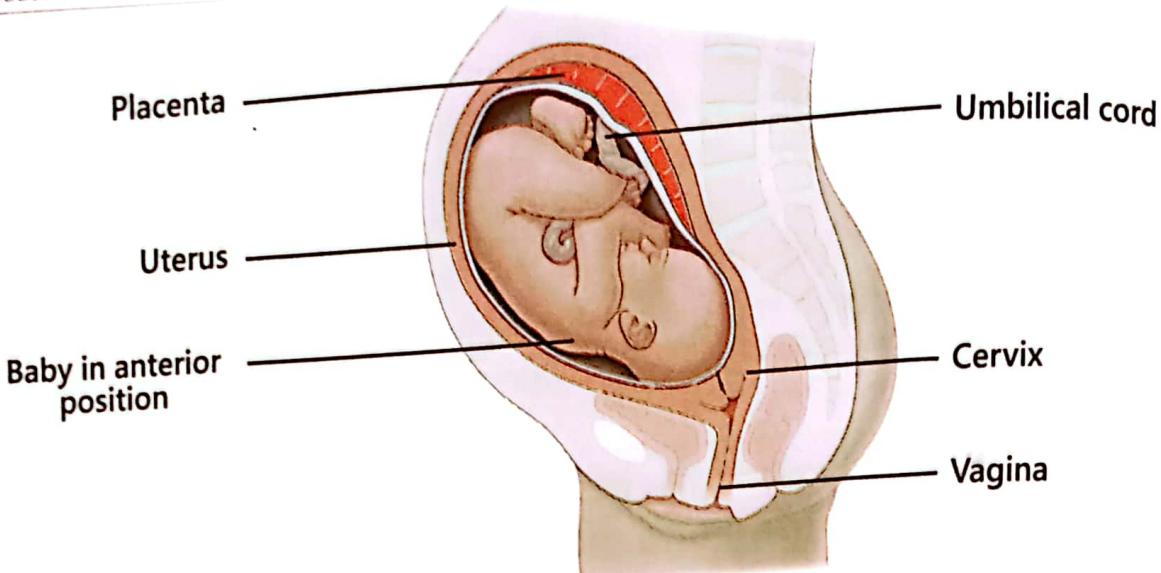


Figure 3.4: A photograph showing the fetus and anterior placenta



Activity 3.5: Exploring the role of the placenta during pregnancy

Key question: How is the placenta adapted to its function?

What you need:

- Well sharpened pencils
- Pen
- Notebooks
- Biology textbooks and computer with internet

What to do:

In groups,

1. Read about the structure and function of the placenta.
2. State major functions played by the placenta.
3. Describe how the placenta is adapted to its function.
4. Using illustrations, show and describe how blood flows in a placenta between the mother and fetus.
5. Explain the significance of blood circulation in the placenta as described in (4) above.
6. Explain why the blood pressure of a fetus is different from that of the mother?
7. Suggest any two substances that pass from the mother's blood into the fetus's blood.
8. Using suitable ICT, make a write up of your findings
9. Share and discuss your findings with the class.

DID YOU KNOW?

- By 12 weeks of pregnancy, the fetus fills the entire uterus.
- By about 14 weeks, the sex of the fetus can be identified.
- By about 16 to 20 weeks, the pregnant woman can feel the fetus moving and women who have been pregnant before, feel fetus movements about 2 weeks earlier than women who are pregnant for the first time.
- By about 24 weeks, the fetus has a chance of survival outside the uterus.

3.6 Importance of Antenatal Medical Care

From a medical perspective, pregnant women are expected to pay regular visits to health centers for checkup in regard to their health and the health of the unborn baby. This is termed as Antenatal medical care. Antenatal medical care has several aspects to it and it is of great importance to both the mother and the unborn baby. In Activity 3.6 below, you will find out the different aspects of antenatal medical care and their importance.



Activity 3.6: Exploring the importance of various aspects of antenatal care

Key question: What is the importance of various aspects of antenatal medical care?

What you need:

- Pen
- Notebooks
- Biology textbooks/ computer with internet

What to do:

1. In groups, research on the key aspects of antenatal care.
2. Study pictures A-E in *Figure 3.5*.

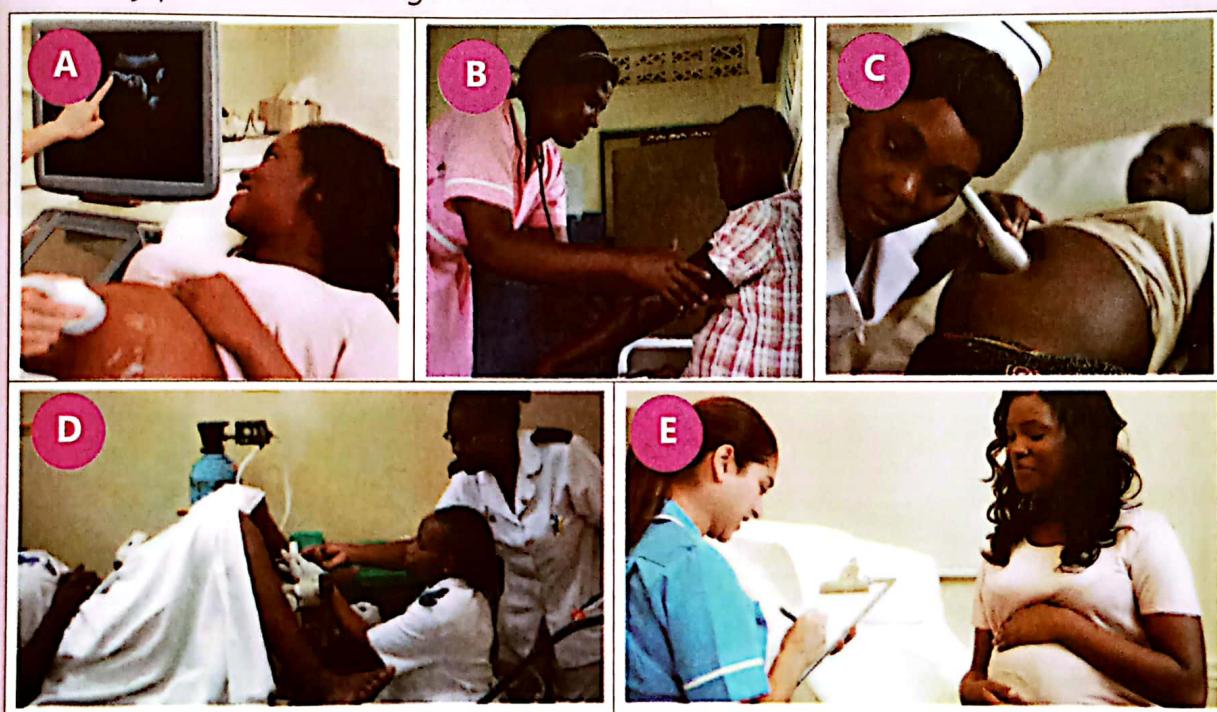


Figure 3.5: Aspects of antenatal care

3. Identify what is happening in each of the pictures A-E.
4. Describe the importance of activities A-E to the mother and the unborn baby.
5. Suggest possible reasons as to why some women may not attend recommended antenatal visits during their pregnancy.
6. Explain why men accompany their pregnant wives to health centers during antenatal visits.
7. Make a write up, and present your findings to the rest of the class.

- b) Severe seizures or fits that happen during pregnancy or after giving birth. This is known as **Eclampsia**. This poses serious risks to both the mother and baby's health and it requires urgent medical attention.
- c) Infection and inflammation of the uterus lining after childbirth. This known as **Puerperal endometritis**. It causes discomfort, fever, and potential complications if not promptly treated.
- d) Abortion among teenage mothers which may result into infertility and sometimes death especially if not carried out right. Sometimes it is difficult to access abortion and post abortion care in many countries due to the stigma and reservation around it. This increases the risks faced during the abortion.
- e) Babies of adolescent mothers face higher risks of low birth weight, premature birth, critical newborn condition.

Over all, preventing teenage pregnancy and its adverse impacts are important to achieving positive health outcomes in our society as well as achieving the SDG related to maternal and newborn health.



Discussion Questions

1. State what the passage is about.
2. Describe the causes of teenage pregnancy.
3. Describe the health risks associated with teenage pregnancy and abortion according to the passage.
4. State some of the society views on teenage pregnancy and abortion.
5. Describe the role you can play in the fight against teenage pregnancy and abortion in your community.
6. Design a poster sensitising people on ways of reducing teenage pregnancy and abortion.
7. Share your findings with the class.

3.9 Common Birth Control Methods in Uganda

Birth control methods also known as contraception methods are methods used to prevent unwanted pregnancies. These work by either preventing fertilisation or implantation. Also, they help to prevent spread of sexually transmitted diseases. There are various types of birth control methods ranging from pills to implants in the body. Can you mention some of the birth control methods that you know? The safest and recommended birth control method for young adolescents like you who are still in school is abstaining from sexual intercourse. In Figure 3.9, you will learn about various methods that are currently being used by different people in Uganda to avoid unwanted pregnancy.

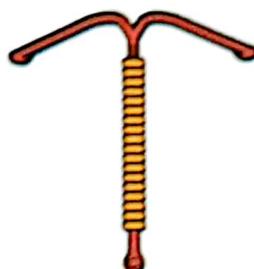
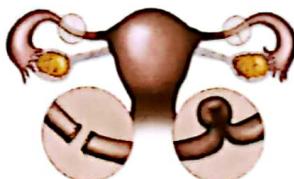
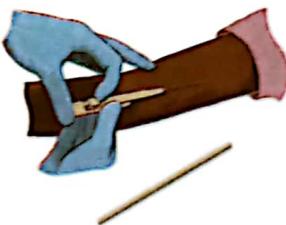
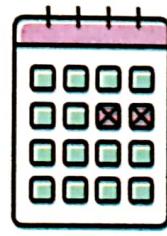
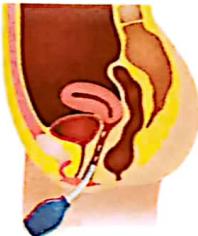
			
Male condom	Female condom	Oral contraception	UID
			
Hormonal ring	Surgical sterilisation	Implant	Diaphragm/cap
			
Calender rythm method	Vaginal douche	Coitus interruptus (Withdrawal)	Contraceptive injection

Figure 3.9: Different items and methods used for birth control in Uganda



Activity 3.9: Analysing the common birth control methods in Uganda

Key question: What are the common birth control methods in Uganda?

What you need:

- Pen and Pencil
- Notebook
- Health professional (doctor, school nurse)
- A computer with Internet or Biology books

What to do:

In groups,

1. Visit a health facility (it could be the school clinic/ infirmary) or, listen to a visiting professional, either in person or on video and carry out research on:
 - a) The common birth control methods practised in Uganda.
 - b) The biological principle each method employs and its effectiveness.
 - c) Side effects of each method.
2. Explain why the usage of birth control methods is on a rapid increase among the young adolescents and what can be done to address this issue.
3. Produce a report explaining the points above.

3.10 Common Issues Associated with Reproductive Systems

There are cases where reproductive systems fail to function properly and end up with disorders. What causes these disorders? The disorders of reproductive systems can be brought about by hormonal irregularity, genetic factors, malnutrition and poor hygiene/sanitation. The common disorders associated with the reproductive system include menstrual abnormalities and erectile dysfunction. These can be prevented by various ways; however, the best way is by monitoring one's body system by having regular check-ups. How often do you go to the doctor to have your reproductive system checked?



Figure 3.10(a): Extremely painful periods

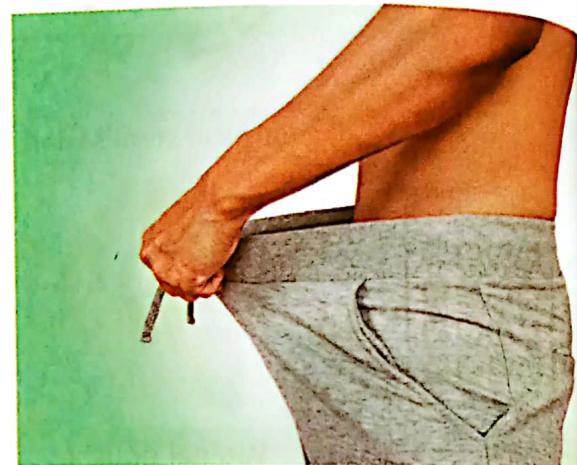


Figure 3.10(b): Erectile dysfunction

In Activity 3.10, you will explain the common issues associated with reproductive health.



Activity 3.10: Explaining common issues associated with reproductive health

Key question: What causes reproductive abnormalities and how can they be corrected?

What you need:

- Pen
- Notebook
- A computer with Internet or Biology books

What to do:

In groups,

1. Gather information on menstrual and erectile abnormalities in young people.
2. Describe how the abnormalities in 1 (above) can be treated.
3. Write a report and share your findings with the class.

3.11 Sexually Transmitted Infections

Sexually transmitted infections are passed on by having unprotected sexual intercourse with infected persons. These infections are caused by both viruses and bacteria, and they cause a lot of pain and discomfort to infected persons in addition to the many other negative effects. What examples of sexually transmitted diseases do you know? Images in *Figures 3.11 (a) and (b)* show the effects of sexually transmitted infections on people infected. The best way to prevent these infections is by abstaining from sex.



Pus build up in the eye



Herpes



Syphilis rash



Vaginal discharge by gonorrhoea patient



Yellow eye



Oral Thrush



Skin rash by a syphilis patient

Figure 3.11 (a)

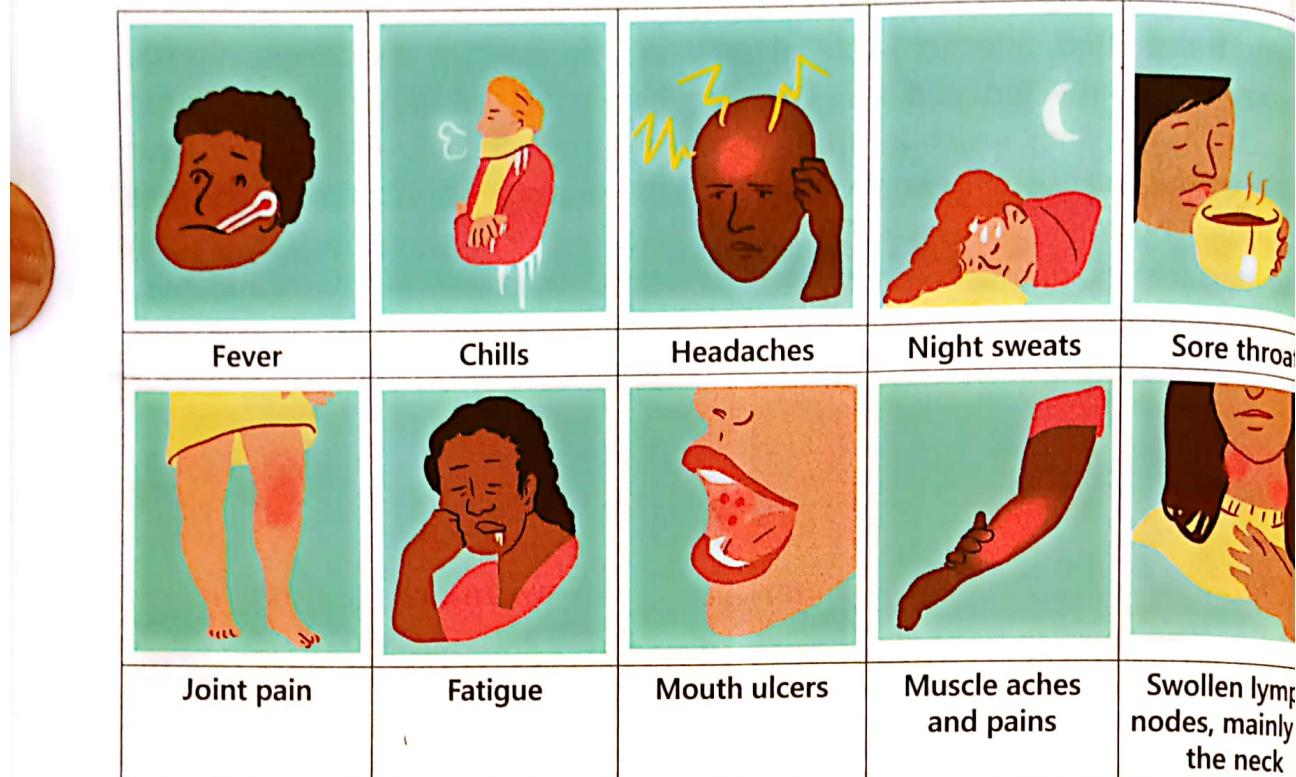


Figure 3.10 (b): Symptoms of HIV

In the Activity 3.11, you will examine common sexually transmitted infections identify their causes, signs and symptoms.



Activity 3.11: Examining sexually transmitted infections

Key question: What are the causes, signs and symptoms of sexually transmitted infections?

What you need:

- Pen
- Notebook
- Health worker
- Guiding questions

What to do:

In groups,

1. Interview a health worker about the following sexually transmitted infections

a) Syphilis	d) Gonorrhea	f) Candida
b) HIV/AIDS	e) Hepatitis B	
c) Human Papilloma Virus (HPV)		
2. Take note of their causes and mode of transmission, signs and symptoms.
3. Make individual reports and present your findings to the teacher.

3.12 Preventive Measures and Cures for STIs

Although some of the sexually transmitted infections (STIs) are incurable, they can be prevented. How do you protect yourself from sexually transmitted infections? The safest method of preventing STIs at your level is by saying no to premarital sex as illustrated in *Figure 3.12*. In Activity 3.12, you will find out other preventive measures and the cures for STIs.

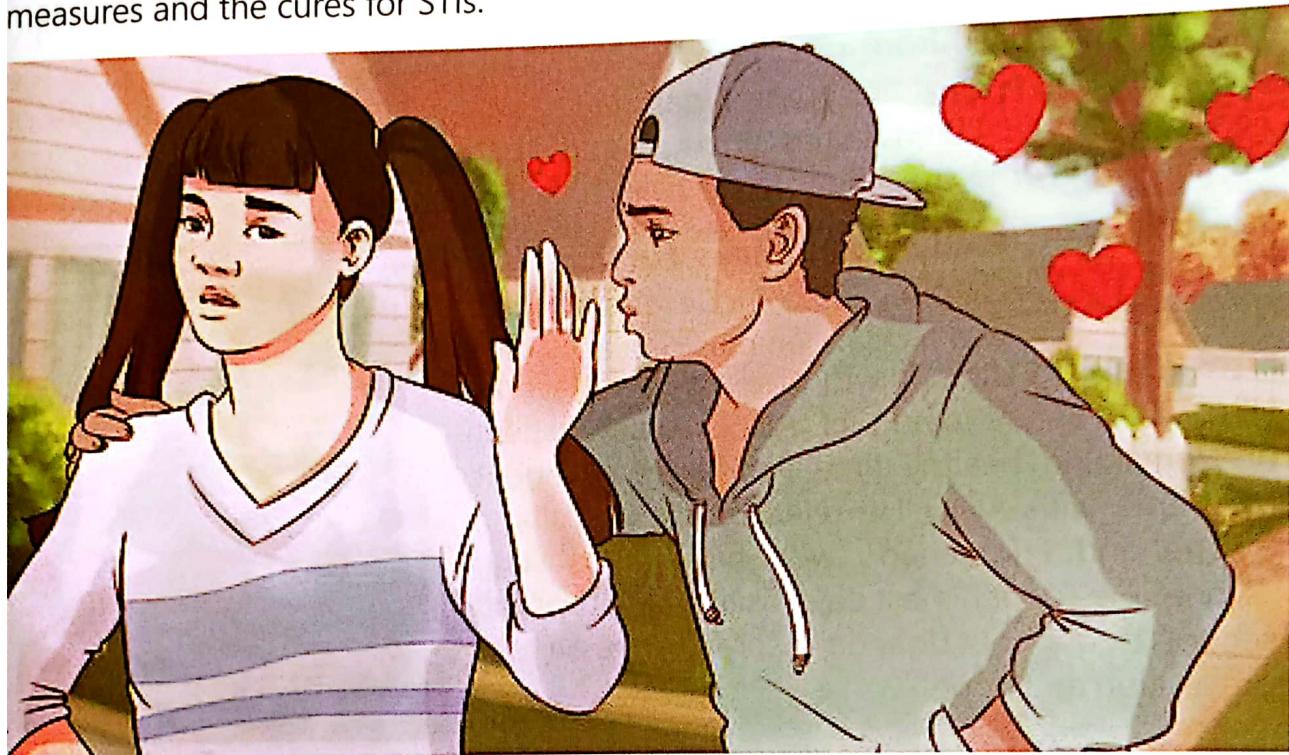


Figure 3.12: Say no to premarital sex



Activity 3.12: Finding out prevention and cure for STIs

Key question: How can STIs be prevented?

What you need:

- Pen • Notebook
- Biology textbook or internet

What to do:

In groups,

1. Listen to a talk by a health worker, or watch a video clip about prevention and cure of sexually transmitted infections.
2. Describe how you can stay safe and raise awareness about sexually transmitted diseases both in your school and community?
3. Using your findings, design a poster demonstrating how to fight against STIs
4. Share your work with the class.

3.13 Challenges Faced by People Living with HIV/AIDS

Despite massive efforts to prevent and control the spread of HIV/AIDS, the number of cases and deaths from the disease continues to grow in such a way that AIDS is known as the fourth main cause of death around the world. According to a publication by the Uganda AIDS Commission Secretariat, the number of people living with HIV in Uganda increased from 1.2 million in 2010 to 1.4 million in 2020. Apart from the physiological effects of the disease, people living with HIV/AIDS face a number of challenges in their communities. What are some of these challenges? In Activity 3, you will identify the challenges faced by people living with HIV/AIDS.

DID YOU KNOW?

Philly Bongoley Lutaaya (19 October 1951 – 15 December 1989) was a Ugandan musician and the first prominent Ugandan to give a human face to HIV/AIDS. Before dying of AIDS, Lutaaya spent his remaining healthy time writing songs about his battle with AIDS. He released his last album “Alone and Frightened”, with his famous song “Alone”. He spent his last days visiting churches and schools throughout Uganda to spread a message of prevention and hope.



Activity 3.13: Identifying the challenges faced by people living with HIV/AIDS

Key question: What stigmas do people living with HIV/AIDS face?

What you need:

- Pen
- Notebook
- Audio player

What to do:

1. In groups, listen to, read, and recite the lyrics of the song “Alone and frightened” by Philly Bongoley Lutaaya.

1

Somewhere out there
Alone and frightened
Of the darkness
The days are long
Life is hiding

No more making new contacts
No more loving arms
Thrown around my neck

2

Take my hand now
I'm tired and lonely
Give me love
Give me hope
Don't desert me
Don't reject me

All I need is love and understand

<p>3</p> <p>Today it's me Tomorrow someone else It's me and you We've got to stand up and fight We'll shed a light in the fight against AIDS Let's come on out Let's stand together and fight AIDS In times of joy In times of sorrow Let's take a stand and fight on to the end With open hearts Let's stand out and speak out to the world We'll save some lives Save the children of the world Let's be open Advise the young ones A new generation To protect and love</p>	<p>4</p> <p>Hear them singing Playing, laughing Let's give them everything In truth and love Take the message Cross the frontiers Break the barriers We'll fight together The doors are open We'll lead the struggle We won't bow down In defeat we'll fight on.</p>
---	---

2. In your groups, discuss the stigma/discrimination portrayed in the song and the significance of the song in Uganda.
3. Write a poem about HIV/AIDS and attitudes faced by its sufferers from their communities.
4. Present your poem to the class, and the best one to the whole school.

People living with HIV/AIDS face many challenges like discrimination, loss of social status and trust, changes in the patterns of intimacy in their relationships, loss of jobs and financial resources and face stigmatisation. What role can you play in a campaign to end stigmatisation of victims living with HIV/AIDS?



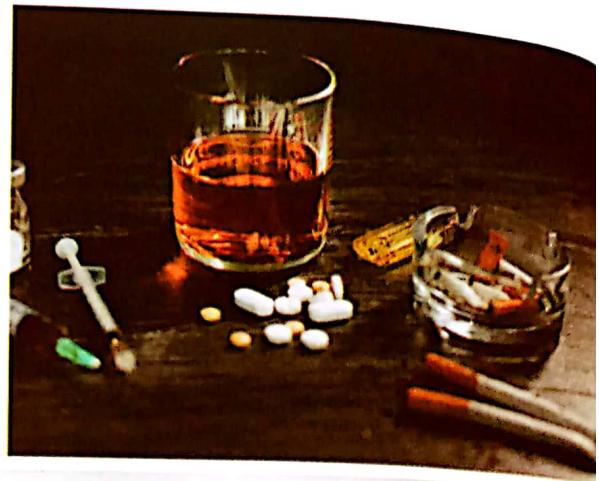
Sample Activity of Integration

There is increasing levels of urbanisation in one of the villages in Uganda due to industrialisation. As a result, it has been observed that the youth are increasingly embracing and indulging in behaviours such as alcoholism, drug abuse, as well as unprotected sexual intercourse with multiple partners. The village local council chairperson has organised a sensitisation session, and you have been invited as an informed youth to deliver a speech and counsel fellow youth in this village.



Task:

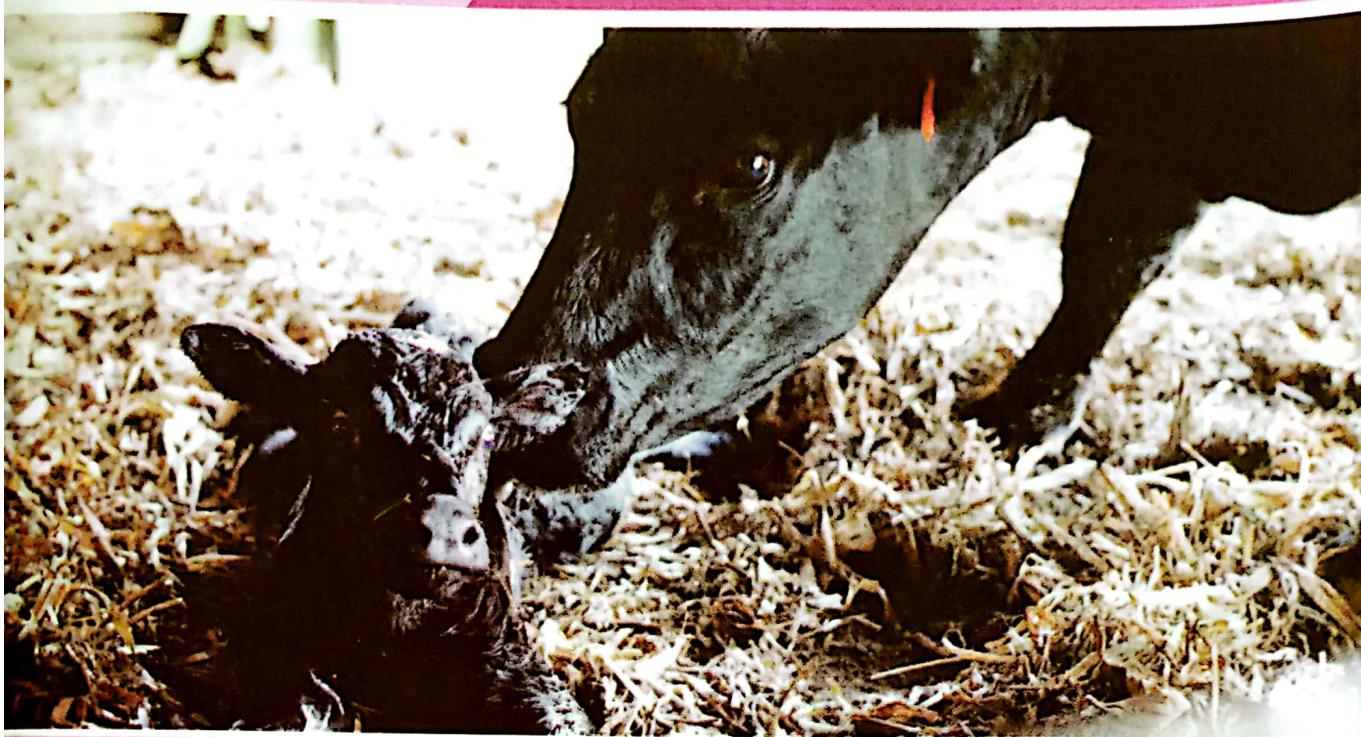
Write a speech to be delivered to the youth at the village meeting.



Chapter Summary

In this chapter, you have learnt that:

- Male gametes are sperm produced in the testes. The female gametes are ova and they are produced in the ovaries
- Fertilisation takes place in the oviduct; it happens when the sperm enters an ovum and the sperm and ovum nuclei fuse
- The fertilised ovum is known as a zygote
- The zygote develops into an embryo which is embedded in the uterus and gets food and oxygen from the mother through the placenta
- The blood of the embryo is pumped through the umbilical cord to the placenta, and attached to the uterus. It obtains nutrients and goes back to the embryo without mixing with the mother's blood
- The safest method of birth control is abstaining from sex
- HIV/AIDS has greatly impacted the lives of people in sub-Saharan Africa through deaths and multiple infections
- The best way to avoid sexually transmitted infections is through abstinence

**Keywords**

- allele
- chromosomes
- dominant
- genes
- genotype
- heterozygous
- homozygous
- inheritance
- meiosis
- mitosis
- phenotype
- recessive

By the end of this chapter, you should be able to:

- a) understand the process of cell division and significance of meiosis
- b) understand the concept of inheritance using genetic diagrams
- c) understand and explain sex determination in humans
- d) understand and explain sex linkage in humans

4.0 Introduction

Resemblance is a common occurrence between related organisms. For example, children always bear several characteristics similar to those of their parents. These include height, eye colour and ear shape among others. Have you ever wondered how this is made possible? In this chapter, you will understand how characteristics are passed on from parents to their offsprings through a process called **heredity**.

4.1 Cell Division

Cell division is a process that involves splitting of a body cell into two or more other cells (see *Figure 4.1*). There are two forms of cell division that occur in living organisms: mitosis and meiosis. Mitosis occurs in somatic body cells resulting in growth of organisms and repair of tissues. Meiosis on the other hand occurs in germinal layer resulting into production of sex/gamete cells. In *Activity 4.1*, you will examine meiotic cell division.



Figure 4.1: 3D illustration of mitosis



Activity 4.1: Examining meiotic cell division

Key question: What events occur during the different stages of meiotic cell division?

What you need:

- Notebook
- Pen/pencil
- Textbooks
- An animation of meiotic cell division
- Manila papers, flip charts and coloured pencils
- Resource materials
- Computer with internet connection

What to do:**In groups,**

1. Watch an animation of meiotic cell division.
2. Using other sources, research and identify the stages of meiosis.
3. Using well-labelled diagrams, describe what occurs at each phase.
4. State the significance of meiosis in living organisms.
5. Write a report of your findings and share with the class.

4.2 Genetics

Genetics is the study of genes, heredity and variation of inherited characteristics. It shades light on how certain characteristics are passed on from parents to offsprings. Most of the present research on genetics stems from the discovery of the laws governing the inheritance of traits as illustrated by Gregor Mendel in the 19th century. Although he was not a scientist, Mendel suspected that traits were inherited as discrete units. Mendel began series of experiments on garden pea plants in the monastery garden. *Figure 4.2* illustrates the theory Mendel proposed when he predicted that each parent would randomly contribute one or the other gene to its offspring.

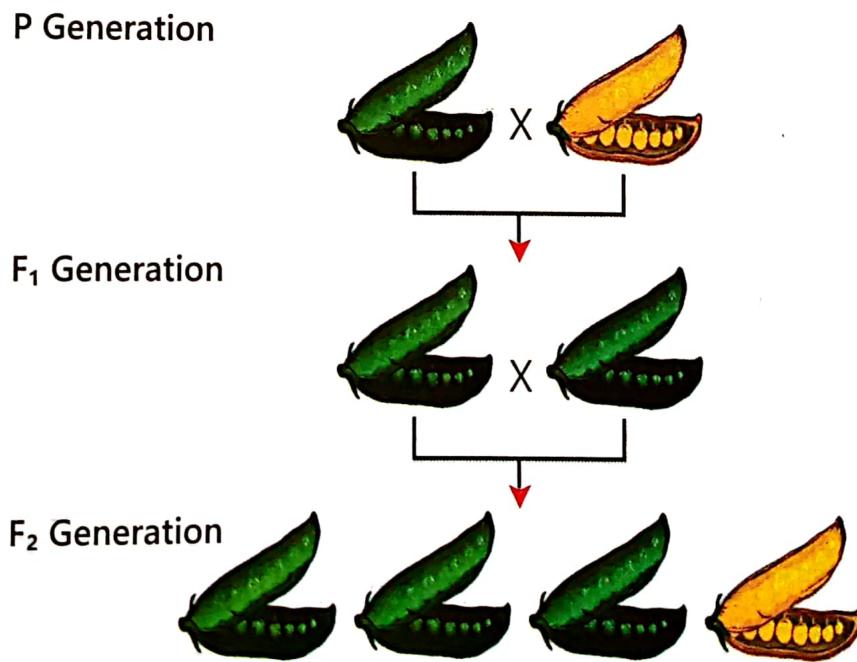


Figure 4.2: Results of two generations of cross-breeding two pea plants, one green and the other yellow

Terms used in genetics

There are various terminologies used in the study of heredity (genetics). In Activity 4.2 (a), you will explore the meanings of these terminologies.



Activity 4.2(a): Finding out the meaning of terms used in genetics

Key question: What do the different terms used in genetics mean?

What you need:

- Notebook
- Computer with internet
- Pen/pencil
- Textbooks

What to do:

In groups,

1. Research and prepare a report on the meaning of the following terms;
 - a) allele
 - b) haploid
 - c) diploid
 - d) gene
 - e) dominant allele
 - f) recessive allele
 - g) phenotype
 - h) genotype
 - i) homozygous genotype
 - j) heterozygous genotype
 - k) ploidy
 - l) chromosome
 - m) chromatin
 - n) locus
2. Include an illustrative example for each term where applicable.
3. Present your findings to the class.

Genetic diagrams

Genetic diagrams are tools that show how chromosomes divide and combine during sexual reproduction in organisms. They show how characteristics are inherited. The commonly used genetic diagrams include; genetic cross diagrams, pedigree and Punnett square.

A **Punnet square** is used to show possible ways that genes combine at fertilisation. Study Figure 4.3. Note that a dominant gene is shown with a capital letter. The recessive gene is shown with a small letter. Letters representing the parents' genes are placed on the outer sides of the Punnet square. Letters inside the boxes of a Punnet square show the possible gene combinations for an offspring. For each cross between two parents, there is a one in four chance of the offspring receiving anyone of the four combinations of genes shown in the Punnet square. These genes may represent a trait for height.

Pure tall × Pure short

T → Tall
t → pure

		Pure tall	
		T	T
Pure short	t	Tt	Tt
	t	Tt	Tt

Figure 4.3: A Punnet square



Activity 4.2(b): Analysing the concept of heredity

Key question: How does chance affect the combination of genes?
What you need:

- Pen
- Notebook
- 2 paper bags
- 40 red beads
- 40 white beads
- Internet
- Biology reference materials

What to do:

In groups,

1. Place 20 red beads and 20 white beads into a paper bag. Place 20 red beads and 20 white beads into a second paper bag. The beans represent genes for flower colour.
2. Label one of the bags "female" for female parent. Label the other bag "male" for the male parent.
3. Use a Punnet square to predict how many red/red, red/white and white/white combinations will be selected.
4. Without looking inside the bags, remove one bead from each bag. The two beads represent the gene combination that results when sperm and egg join.
5. Draw a table like the one shown. Record colour combination of the beads each time you remove two beads. Then return them to the original bags, and shake the bags.
6. Repeat steps 5 and 6 thirty-nine times.
7. Count and record the total numbers of red/red, red/white and white/white bead combinations in the data table below.

Beans	Red/Red	Red/White	White/white
Total			
Class total			

- a) Identify the combination that occurred most often.
- b) If red is dominant and white is recessive, state the number of plants with hybrid genes.
- c) State the ratio of red/red to red/white to white/white.
- d) Compare your predicted (expected) results with the observed (actual) results.
8. Calculate the chances of selecting the same colour in a gene pair each time.
9. Describe how chance affects gene combination.
10. Outline how the results in a small sample compare with the results in a large sample.
11. Explain how the knowledge of inheritance can be used to prevent genetic disorders.
12. Compile and record your class totals.

Incomplete-dominance and Co-dominance

Occasionally within heterozygous organisms, the dominant allele of the two inherited alleles, each from one parent does not completely mask the effect of the recessive alleles. This results into both alleles expressing themselves within the organism and therefore, a blend of the phenotype they each represent. This is termed as incomplete dominance. It is common in traits such as skin colour and height among others. A cross between a black dog and a white dog resulting into a grey dog is an example of incomplete dominance. Suggest other examples of incomplete dominance.

Closely related is the incident where both alleles are phenotypically expressed within an offspring, each allele being inherited from one parent. In this case, none of the alleles can block or mask the expression of the other. This incident is called **co-dominance**. Such situations include: individuals who have a blood group AB where the alleles for blood group antigen A and B express each other dominantly.

Blood groups in humans

Blood group is controlled by a gene with three alleles. These alleles are A, B, and O. The three alleles cannot occupy the same locus at the same time, therefore only two alleles can be present in an individual. Alleles A and B are co-dominant. Allele O is recessive to both allele A and allele B. In Activity 4.2(c), you will explore the inheritance of blood groups in humans.



Activity 4.2(c): Exploring how blood groups are inherited in humans

Key question: How are blood groups inherited in humans?

What you need

- Pen
- Notebook
- Figure 4.5
- Biology textbooks or a computer with internet

What to do

In groups,

1. Carefully study *Figure 4.5* about the blood groups in four generations of a family.

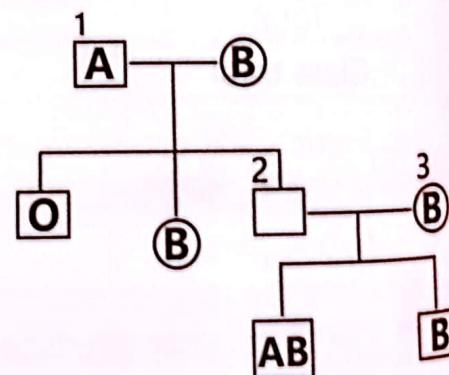


Figure 4.5: Family tree diagram

Note

Squares represent males and circles represent females.

2. Using the genetic diagrams;
 - a) Determine the genotypes of person 1 and 3.
 - b) Work out the blood group of person 2.



Exercise 4.1

Two women gave birth in the same hospital on the same afternoon. Their babies were taken away, and then brought back to them one hour later. One of the women was worried that she had been given the baby who was not hers. She asked for blood tests to be carried out. The hospital found that she was group A and her husband was group O. The other mother was group AB and her husband was group A. The woman with blood group A had been given the baby with blood O. The woman with blood group AB was given the baby with blood group B. Use genetic diagrams to determine whether the women had been given the right babies.



4.3 Sex Determination in Humans

In humans, sex determination is the process that defines the biological sex of an offspring and as a result, the sexual characteristics that they will develop. Humans typically develop as either male or female depending on the combination of sex chromosomes that they inherit from their parents. The chromosomes primarily responsible for defining sex are the **x** and **y** chromosome. In *Activity 4.3*, you will examine how sex is determined in humans.



Activity 4.3: Examining sex determination in humans

Key question: How do humans become either male or female?

What you need:

- Notebook
- Computer with internet
- Pen
- Markers, ruler
- Flip charts/Manilla papers
- Biology reference books

What to do:**In groups,**

1. Research and discuss how sex is determined in humans.
2. Use genetic diagrams to illustrate the chances/probability of a child being a male or female.
3. Write a report and present your findings to the class.

4.4 Sex Linkage in Humans

Sex linkage is the phenotypic expression of an allele that is dependent on the sex of an individual and is directly tied to the sex chromosomes. This results into various sex linked characteristics in humans. In *Activity 4.4*, you will analyse sex linkage in humans, and describe the different sex linked characteristics that exist.



Activity 4.4: Analysing sex linkage in humans

Key question: What is the effect of different sex linked characteristics in humans?

What you need:

- Notebook
- Computer with internet
- Pen/pencil
- Biology textbooks

What to do:

In groups,

1. Research on and discuss sex linkage in humans.
2. Using relevant examples and genetic diagrams, give an account of different sex linked characteristics in humans.
3. Outline how sex linked traits are advantageous or disadvantageous to those with them.
4. Explain why males are mostly affected by sex linked diseases compared to women.
5. Explain why a colour-blind male inherits the condition from his mother.
6. Make a report and present it to the class.



Exercise 4.2

A man who is red-green colour-blind marries a woman with normal vision. They have three sons and two daughters. One of the sons is red-green colour blind. All the other children have normal colour vision.

- a) Draw a genetic diagram to suggest an explanation for this.
- b) What is the chance that the couple's next child will be a colour-blind boy?



Sample Activity of Integration

In Aka village, there lived a very rich man known as Mr. Oti. He had no relatives living close by. At the time he died, Mr. Oti was living alone with no wife or children. After the death of Mr. Oti, disputes arose on who will take his property. At his burial, three women claimed to have children with Mr. Oti, two boys and one girl. The village leader would like to confirm whether these are biological children of Mr. Oti. However the village leader does not have enough money to carry out the DNA sequencing test.

Support material

- Mr. Oti had blood group AB; he was very tall and both his parents were very tall, and no one in his family lineage was short.
- Mr. Oti's mother is said to have been red-green colour blind.



Task:

Using your knowledge of inheritance, prepare a write up with a criteria which the village leader can use to solve this dispute.

Chapter Summary

In this chapter, you have learnt that:

- Inheritance is the passing of genes on chromosomes from parents to offspring.
- Meiosis is cell division resulting in sex cells. Sex cells have half the number of chromosomes of body cells.
- Some forms of an inherited trait are dominant and mask receive forms of the trait.
- An inherited trait is controlled by a pair of genes located on a pair of chromosomes.
- One half of an offspring's gene comes from one parent, and the other half comes from the other parent.
- Genetic diagrams are tools that show how chromosomes divide and combine during sexual reproduction in organisms. They are used to predict inheritance.



Keywords

- artificial selection
- cross breeding
- evolution
- genetic disorders
- mutation
- natural selection
- variation
- selective breeding

By the end of this chapter, you should be able to:

- a) appreciate that variation in organisms is due to external and internal factors and that mutations can be beneficial, harmful, or neutral
- b) identify diseases associated with genetic disorders e.g. sickle cell anaemia, albinism and down's syndrome
- c) understand the concept of natural selection as a mechanism of evolution
- d) understand the use of artificial selection in selective breeding

5.0 Introduction

When you look at the skin colour of your classmates, you realise that there is difference in every individual. This difference in the appearance of every individual skin colour is called **variation**. Variations occur in nature between individuals of the same species and between those of different species.

Variations may affect the ability of organisms to survive in a changing environment. The survivors reproduce and pass on these variations to their offspring. The ability of the individuals to survive and reproduce based on their variations is called **selection**. In this chapter, you will understand that variation is a result of changes in the genetic make-up of an organism.

5.1 Variation in Organisms

Variations in organisms occur when individuals possess characteristics different from others of the same species or population. There are two types of variation: continuous and discontinuous. In continuous variation, there are no clear-cut differences since the variation is gradual. For example, earlobe shapes in different people show continuous variation (see *Figure 5.1 (a)*). In discontinuous variation, differences are clear cut. For example, each person's finger prints are unique in adults (see *Figure 5.1 (b)*). The variations can exist due to random genetic changes or they can be traits influenced by environmental conditions.



Figure 5.1 (a): variation in earlobe shapes



Figure 5.1 (b): variation in finger prints in adults

Variations in organisms can be major or minor. Major variations can include albinism among certain people, fruits without seeds, or a person born with extra fingers or toes (see *Figure 5.1(c)*). Examples of minor variations include: differences in hair colour, middle finger length, sweetness of a fruit, number of petals and colour of corn kernels as seen in *Figure 5.1(d)*.



Figure 5.1(c): A person born with extra fingers



Figure 5.1(d): Genetic variation in the colour of corn kernels

In Activity 5.1 (a), you will explore some variations among humans.



Activity 5.1(a): Exploring variations among humans

Key question: Which variations exist amongst members of your class?

What you need:

- Tape measure or metre rule
- Weighing scale

What to do:

In groups,

1. Obtain a tape measure or metre rule and measure the height of each group member.
2. Measure the weight of each group member using a weighing scale.
3. Record your results in the table below.

Student	Sex	Height (cm)	Weight (kg)
A	F	150	51
B			
C			

4. From the results in the table, which differences exist among the group members?
5. Observe each individual's skin colour and whether or not they can roll their tongues. Identify the differences.
6. Share your findings to the class.

Causes of variations

In Activity 5.1 (a), you discovered that variations exist in the sex, height, weight and skin colour among class members. These variations are caused by various factors. You will examine these factors in Activity 5.1 (b).



Activity 5.1(b): Examining the causes of variations

Key question: How do variations come about amongst organisms?

What you need:

- Pen
- Notebook
- Computer with Internet / biology textbooks

What to do:

In groups,

1. Research the causes of variations in organisms.
2. Identify which of the following features show continuous or discontinuous variation.
 - a) Blood group in humans
 - b) Foot size in humans
 - c) Leaf size in species of trees
 - d) Presence of horns in cattle
3. For each of the features in (a) to (d) above, suggest whether the variation caused by genes alone or by both genes and environment.
4. Make a Microsoft PowerPoint presentation of your findings, and include examples from your environment and community.
5. Share your findings to the class.

Mutations

Consider the word ‘cool’, when the second last ‘o’ is removed, it becomes ‘col’; which has no meaning. When that ‘o’ is replaced by ‘a’, the word becomes ‘coal’ which has a different meaning. Likewise, when the DNA in the cell of an organism undergoes changes in structure and amount, an occurrence referred to as **mutation**, there is change in information carried by the DNA. Such changes in the genotype of organisms are eventually manifested in its phenotype. For example, *Figure 5.2* shows the normal hairy rat and the hairless rat resulting from genetic mutation.

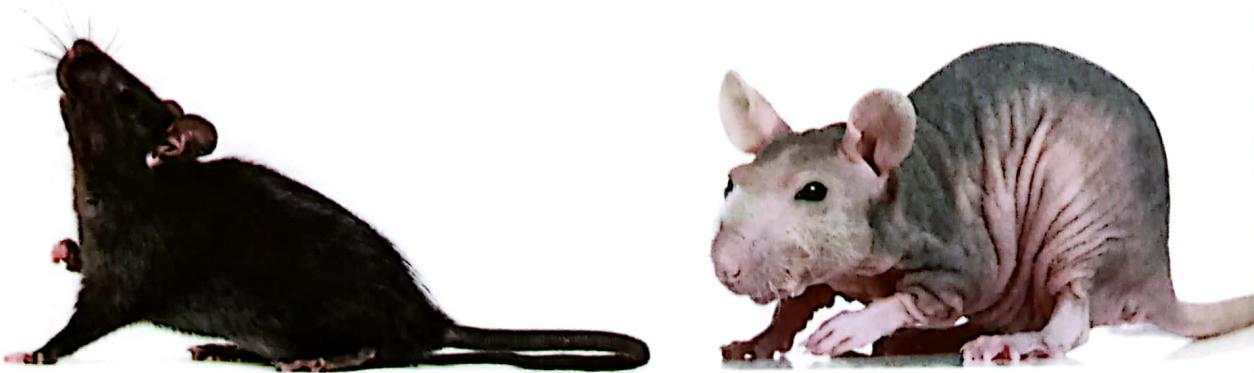


Figure 5.2: Normal hairy rat versus the hairless mutated rat

Mutations can be beneficial, harmful, or neutral. Mutations are caused by environmental factors called **mutagens**. These include radiation, chemicals and

infection agents. Mutations may also be spontaneous in nature, or they may be caused by errors induced during DNA repair. In *Activity 5.1 (c)*, you will analyse the significance of mutation in organisms.



Activity 5.1(c): Analysing the significance of different forms of mutations in organisms

Key question: What is the significance of variations to organisms?

What you need:

- Notebook
- Pen

What to do:

In groups,

1. Classify the following examples of mutations in organisms as beneficial, neutral, or harmful.
 - a) A dark-skinned person compared to an albino.
 - b) A cow with horns versus a cow without horns.
 - c) A plant with no pigment versus a plant with pigment.
 - d) A brown Kob in a brown savannah grassland compared to a black Kob in brown savannah grassland.
 - e) A rat with fur compared to the rat without fur.
 2. Explain why the mutations above are classified as beneficial, harmful, or neutral.
- Copy and complete the record table below.

Beneficial mutations	Harmful mutations	Neutral mutations

3. Discuss other examples of mutations in the environment that are beneficial, neutral or harmful.
4. Share your findings with the class.

5.2 Diseases Associated with Genetic Disorders

You have learnt that some mutations are harmful and bring harmful effects in individuals that possess them. These effects can be manifested in form of disease, short life span and decreased resistance to environmental stress factors. The commonest examples of these diseases include sickle cell anaemia, albinism, and Down's syndrome. In *Activity 5.2*, you will examine these diseases to understand their causes and how they manifest in individuals.



Activity 5.2: Examining diseases associated with genetic disorders

Key question: What diseases are associated with genetic disorders, and how do they come about?

What you need:

- Notebook
- Pen
- Computer with Internet/ Resource materials
- Newspapers

What to do

In groups,

1. Carry out research to identify the diseases/disorders shown in *Figure 5.2*.

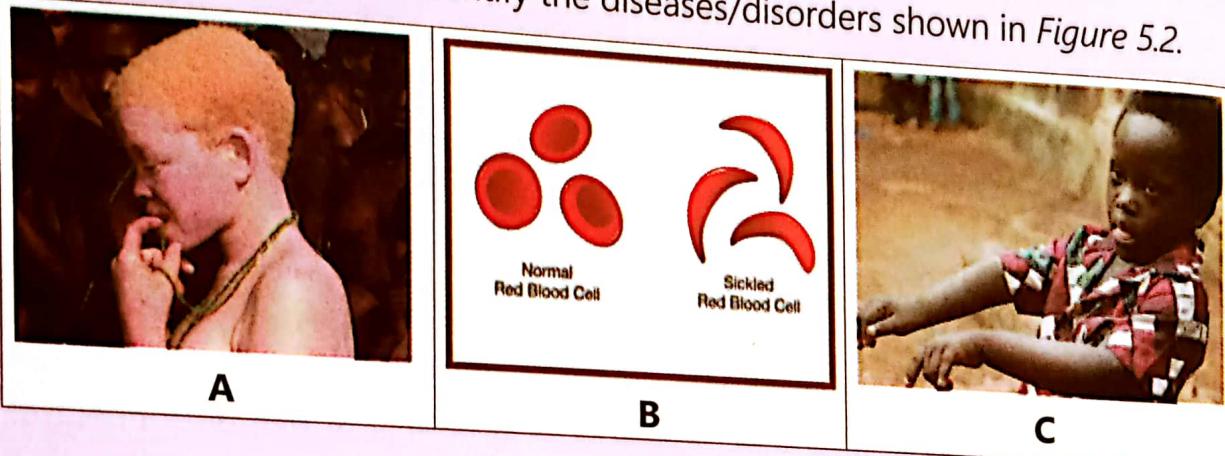


Figure 5.2: Genetic disorders

2. Discuss the visible phenotypic signs exhibited as well as the genetic causes of each disorder as well as the visible phenotypic signs exhibited.
3. Identify the risks faced by people with such genetic disorders.
4. State the attitudes of the people in your community towards those with genetic disorders.
5. Describe how you can raise awareness and tolerance for people living with genetic disorders in your community.
6. State how the knowledge of inheritance be used to prevent genetic disorders.
7. Write a report from your findings, and share with the class.



Career: A GENETICIST

A geneticist is a scientist who studies genes, including how they are inherited, mutated, activated, or inactivated. They often study the role that genes play in disease and health. Environmental geneticists specialise in studying the interactions between genes and environmental factors that lead to adverse health effects, disease, and aging. Geneticists study the inheritance of traits. They may focus on these events at the molecular, organism, or population level. Some treat people with genetic disorders. Many environmental geneticists try to understand how environmental factors or exposures interact with genes to cause disease.

5.3 Natural Selection as a Mechanism of Evolution

Compared to how you looked ten years back and now, you realise that there have been changes in your physical appearance and behaviour that have occurred gradually over time. Similarly, evolution is a change in the characteristics of a species over several generations, and it relies on the process of **natural selection**. Natural selection is best explained by the phrase “survival for the fittest”. The phrase was made famous in the fifth edition (published in 1859) *On the Origin of Species* by British naturalist **Charles Darwin**. He suggested that organisms best adapted to their environment are the most successful in surviving and reproducing as compared to organisms that are not well adapted to their environment. A species can become extinct if environmental changes no longer support its survival. Individuals that are suited to the new environment survive and pass on their characteristics to their offsprings.

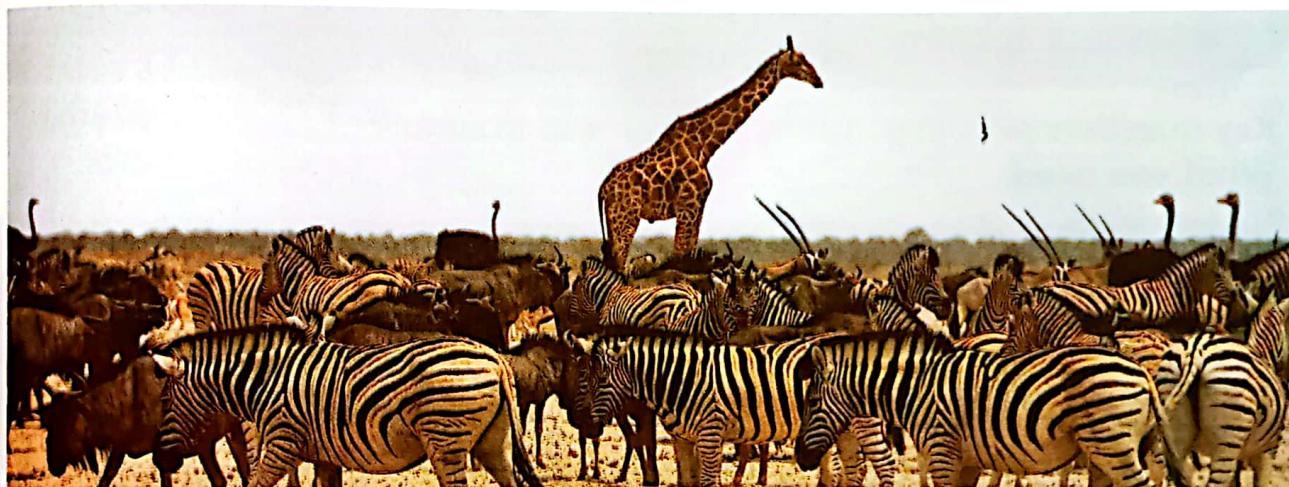


Figure 5.3: A population of wild animals

When a large population of organisms, such as those in *Figure 5.3* live together, there is competition for food, and the weaker ones are likely to be killed by predators. Individuals best adapted to their environment survive and reproduce. In *Activity 5.3 (a)* below, you will find out the meaning of natural selection.



Activity 5.3(a): Examining the concept of natural selection

Key question: What is natural selection?

What you need:

- Pen
- Notebook
- 2 plain papers
- Computer with Internet/biology textbooks

What to do:

In groups,

1. Obtain two sheets of paper and place them on the table. On one paper, write a word “organisms”, and on the other write the word “dead zone”.

2. Collect pens from the group members and put them on the paper labeled "organisms". These represent organisms in the environment.
3. Choose the characteristics you will use to eliminate some pens from the "organisms" paper. The characteristics can be for example: pens without a cork/cover.
4. Pick the pens without a cork and place them on the paper labeled "dead zone". This represents organisms that have died (extinct).
5. Count the number of pens remaining on the paper labelled organisms. These are organisms with good characteristics that are fit for survival.
6. Relate the activity to natural selection and explain the meaning of natural selection.
7. Share your findings with the class.



Activity 5.3(b): Analysing natural selection as a mechanism of evolution

Key question: How does natural selection lead to evolution?

What you need:

- Notebook
- Pen
- Computer with Internet/ biology resource materials

What to do:

In groups,

1. Research how animals, plants and bacteria have evolved over time by natural selection.
2. Write a report on natural selection. Use any organism of your choice. Consider changes in skeletal adaptations, colouration, resistance and physiology.
3. Include an explanation of how natural selection has led to evolution of the organism.
4. Present your findings to the class.

5.4 Artificial Selection

For a very long period of time, people have been improving crop and animal breeds by cultivating and breeding individuals with desirable traits. These traits may include: disease resistance, high yields, drought resistance and faster growth. This type of breeding where individuals with desirable traits are selected for mating is called **selective breeding**. The selected individuals pass on their genes to the next generation and through this process individuals with better characteristics are present in the subsequent population. See *Figure 5.4(a)*. This type of selection is called **artificial selection** because the identification of plants and animals with desirable traits and the steps taken to continue those traits in future generations are carried out by humans.

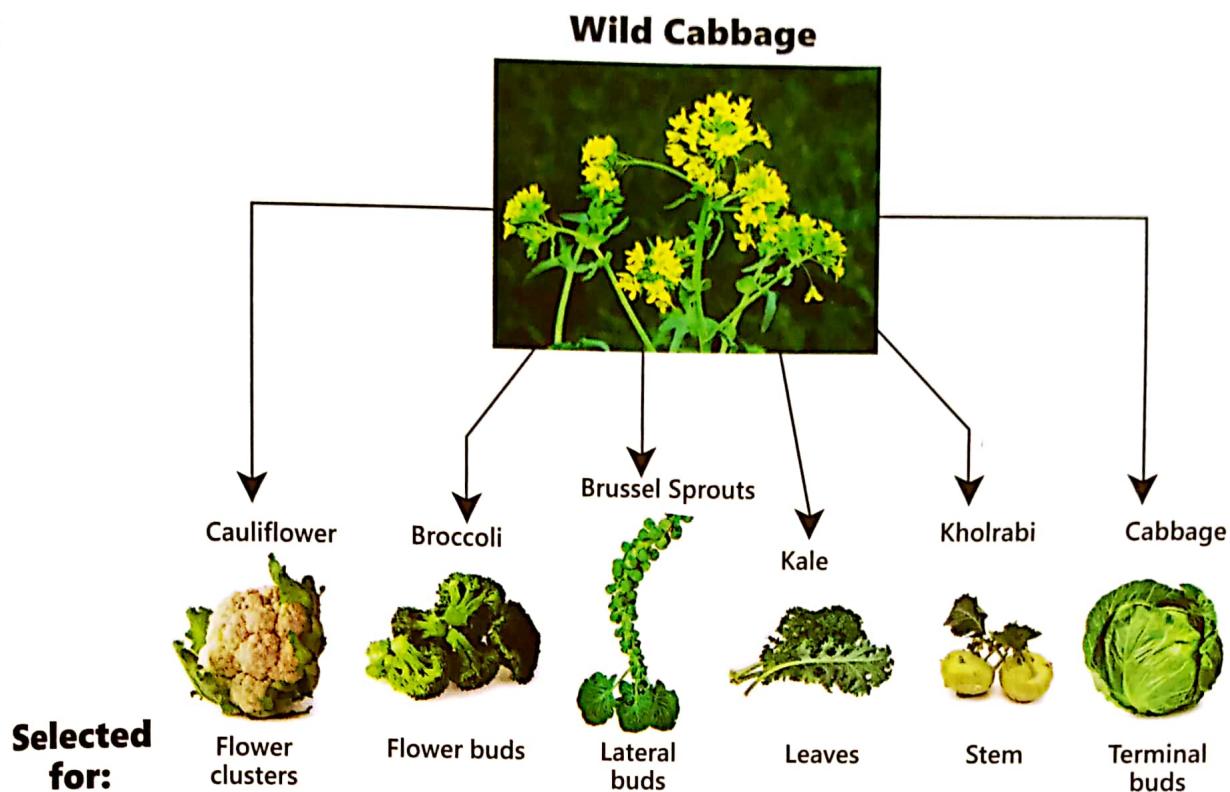


Figure 5.4 (a): Artificial selection

In Figure 5.4 (a) above, parts of wild cabbage were enhanced by artificial selection to give rise to food crops we know today.

When selection involves mating of two different breeds of organisms of the same species, it is called **cross breeding**. Cross breeds are often stronger and healthier than either of the pure breeds from which they came from. For example, a Girolando breed of cattle (see Figure 5.4(b)), arose in the 1940s in Brazil when farmers crossed Gir with Holstein cattle. Girolando has characteristics such as improved udder capacity, reproductive efficiency, and high forage conversion.

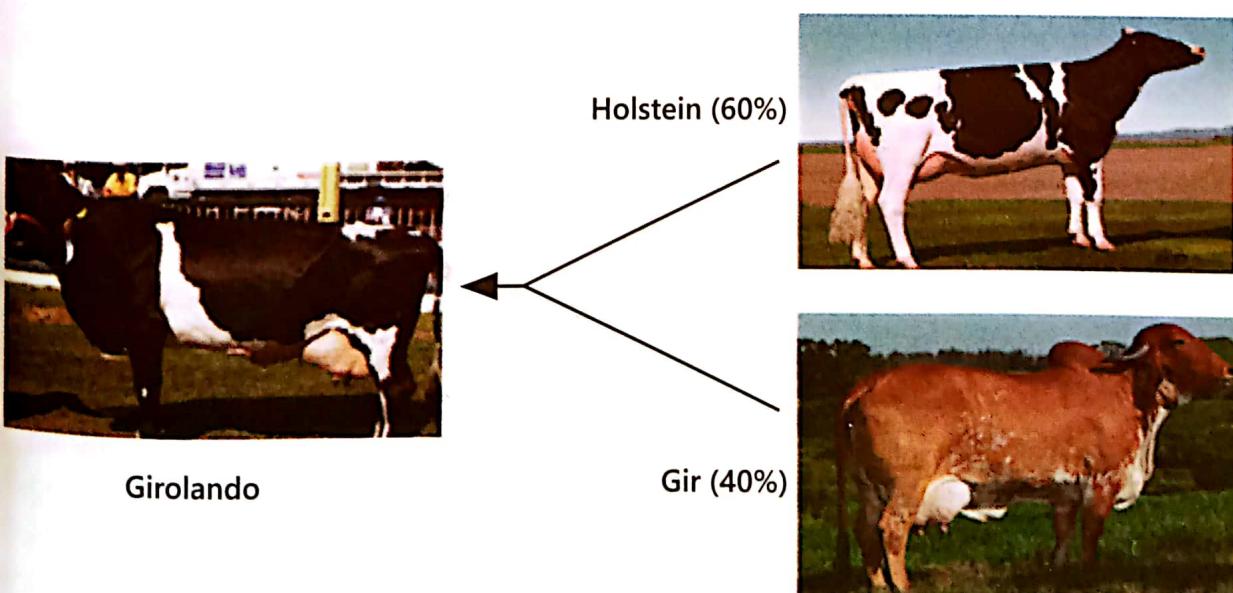


Figure 5.4 (b): Cross breeding



Activity 5.4: Examining the use of artificial selection in selective breeding

Key question: Of what use is artificial selection in selective breeding?

What you need:

- Notebook
- Pen
- Interview guide

What to do:

In groups,

1. Discuss the questions you will ask the Agriculture Officer and come up with an interview guide.
2. Visit an agricultural facility or listen to a visiting Agriculture Officer.
3. Interview the Agriculture Officer about what genetic advances have been achieved through artificial selection and selective breeding in Uganda.
4. Make a report on the lessons that you have learnt from the talk, and carry out additional research on genetic engineering, artificial selection and selective breeding.
5. Prepare a presentation and discuss it with the class.



Career: A GENETIC ENGINEER

A Genetic engineer is a highly trained expert who uses a variety of molecular tools and technologies to rearrange fragments of DNA. The overall goal in doing so is to add or remove an organism's genetic makeup for the better, or to transfer DNA code from one species to another. The overall goal of this is to enhance organisms so that they are better able to thrive in certain environments. An example is when a plant is modified to thrive better in drought conditions or when a bacteria is adapted in such a way that it helps improve drug treatment.



Information Box: Developing genetically engineered banana with high levels of B-carotene in Uganda

There is an increase in vitamin A deficiency particularly in developing countries including Uganda. To address this problem, Scientists at National Agricultural research institute in Kawanda have developed banana varieties with the B carotene gene. B carotene is a pro-vitamin A carotenoid that the body readily converts into Vitamin A. Eating carotenoid rich diet prevents eye diseases. The B carotene gene was retrieved from non-edible banana varieties from South East Asia.



Sample Activity of Integration

Operation Wealth Creation (OWC) gave out white maize seeds to farmers in Kiryandongo District. This maize was planted on large farms. At harvest, some farmers noticed that some of their maize cobs had coloured kernels. They kept some seeds for the next planting season. During the harvest, the farmers found that more maize cobs had coloured seeds.

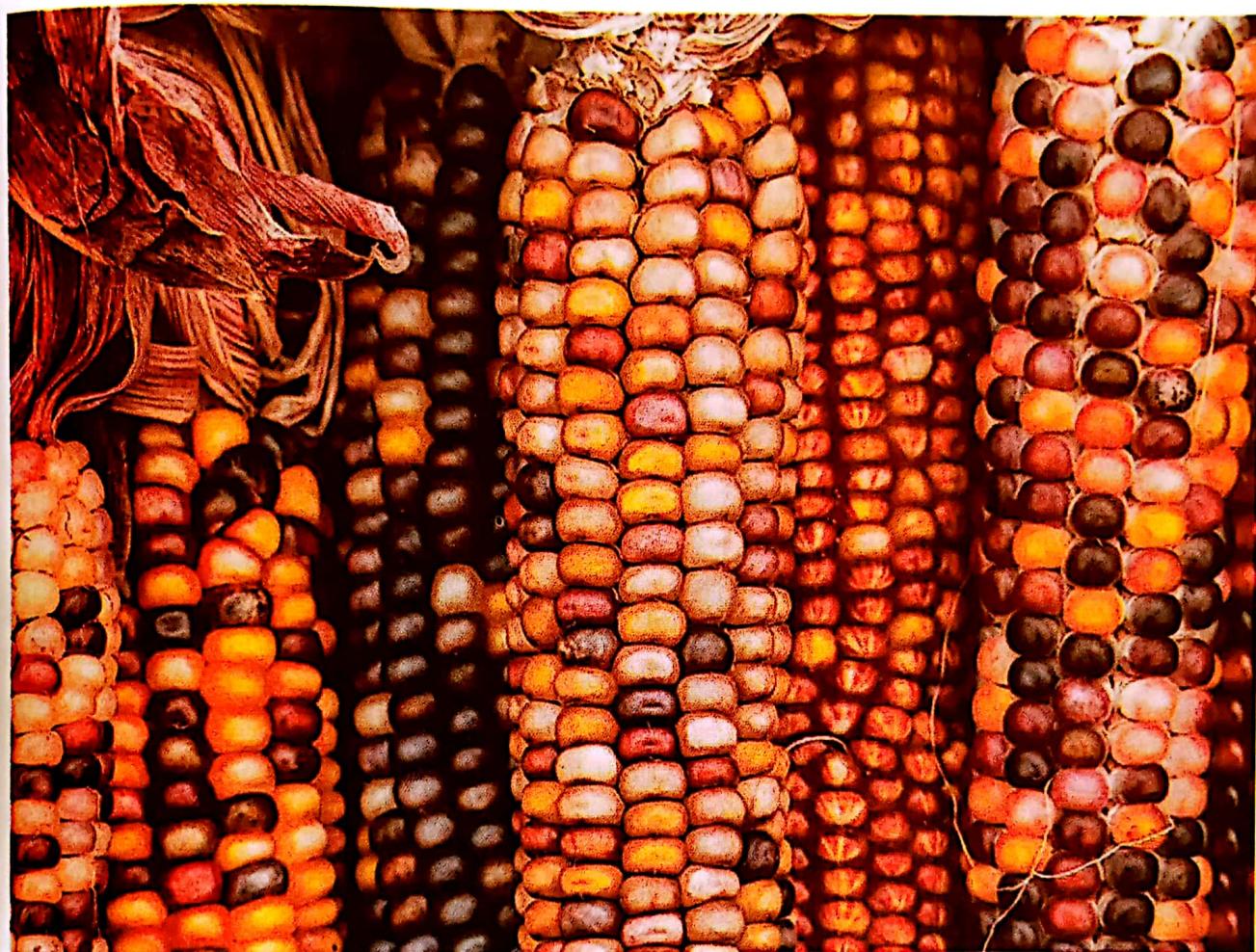


Figure 5.5: Coloured kernels

This troubled the farmers since they knew that their produce would be rejected by the millers due to the increasing number of coloured maize seeds they were producing. These farmers intend on raising complaints to OWC and possibly rejecting future help from them.



Task:

Prepare a presentation of at least 300 words explaining what could have happened to the maize plants before the farmers ruin their chances of future wealth creation opportunities.

Chapter Summary

In this chapter, you have learnt about:

- Variations are differences in appearance among individuals of the same species or different species.
- Variations can be continuous or discontinuous
- A mutation is a change in the structure or amount of DNA of an organism
- A mutation can be beneficial, harmful, or neutral
- Genetic disorders are defects in genes of an organism and can be inherited
- Evolution is a gradual process that involves change in the genetic make-up of populations
- Natural selection is a mechanism of evolution
- Selective breeding is the selection of individuals with desirable traits for mating and this type of selection is called artificial selection.



Keywords

- ecology
- ecosystem
- population
- habitat
- community

By the end of this chapter, you should be able to:

- a) know the meaning of the term ecology
- b) understand the concept of communities, habitats and ecosystems

6.0 Introduction

Our planet consists of life forms that interact with each other and with the environment for their existence. The study of these interactions with the environment is known as **ecology**.

In this chapter, you will understand the various ways in which the interrelationships among living organisms with their environment benefits the wellbeing of humans; the earth system as a whole. You will also understand the concepts of community, habitats and ecosystem.

6.1 Meaning of the Terms Used in Ecology

Different terminologies are used in ecology. In Activity 6.1 below, you will explore the meanings of these terminologies.



Activity 6.1: Finding out the meaning of the terms used in Ecology

Key question: What is the meaning of the different words used in ecology?

What you need:

- Pen
- Pencil
- Notebook
- Computer with internet/biology textbook

What to do:

In groups,

1. Research and prepare a report on the meaning of the following terms.

a) Habitat	d) Communities	g) Ecosystem
b) Population	e) Territory	
c) Species	f) Ecological niche	
2. Include an illustrative example where applicable.
3. Present your findings to the class.

6.2 Meaning of an Ecosystem

In order for a school to function well, an interaction among cooks, learners, teachers, buildings, desks and other components is required. Without the cooks, the learners, administrators, as well as teachers will spend the day hungry. Eliminate learners and the teachers will have no one to teach. Remove buildings, and you will have no school. Each of the different components of the school is important in creating a functioning school system. Similarly, interactions among living organisms with the environment results into a self-sustaining unit known as an **ecosystem**. In Activity 6.2 (a), you will analyse different ecosystems in Uganda. Figures 6.2 (a) and 6.2 (b), show some of the interactions that make an ecosystem self-sustaining. In Activity 6.2 (a), you will identify interactions among living organisms and between living organisms and their environment.



Figure 6.2 (a): Organisms in a community depend on their environment



Figure 6.2 (b): Organisms in a community depend on each other



Activity 6.2(a): Identifying interactions among living organisms and between living organisms and their environment

Key question: Which interactions exist among living organisms and between living organisms and their environment in your area?

What you need

- Pen
- Notebook
- Biology textbook

What to do

1. Move around the school farm, compound, or community.
2. Identify the living organisms present in the school farm, compound or community.
3. Identify the non-living things present in the farm, compound, or community.
4. Observe and identify the interactions among living organisms and between living organisms with their environment.
5. Describe how these interactions ensure the existence of a self-sustaining ecosystem.



Activity 6.2(b): Analysing different ecosystems in Uganda

Key question: Which ecosystems exist in Uganda?

What you need

- Pen
- Notebook
- Biology resource textbooks/internet
- Map of Uganda showing physical features

What to do

In groups,

1. Study a map showing the main physical features of Uganda and identify at least 5 ecosystems and their distinguishing features.
2. Prepare a report on your findings.
3. Present your report to the class.



Career: AN ECOLOGIST

Ecologists are scientists who survey ecosystems and assess the diversity, abundance and behaviour of the different organisms. They usually work for government agencies, environmental trusts, conservation charities or research institutes.

6.3 Components of an Ecosystem

An ecosystem is made up of biotic and abiotic factors. Biotic factors are living components within an ecosystem such as plants, animals, microorganisms etc. Abiotic factors are non-living components such as water, soil and atmosphere etc. In Activities 6.3 (a) and 6.3 (b), you will explore different categories of components in an ecosystem, and analyse different ecosystems in Uganda.

DID YOU KNOW?

The term ecosystem was coined by the Oxford ecologist Arthur Tansley to encompass the interactions among biotic and abiotic components of an ecosystem.



Activity 6.3(a): Exploring different categories of components of an ecosystem

Key question: What are the different categories of components in an ecosystem?

What you need:

- Pen
- Notebook
- Biology textbook/Internet

What to do:

In groups,

1. Research about the different categories of components in an ecosystem.
2. Describe each of the categories and give examples where necessary.
3. State the significance of the various components of an ecosystem.
4. Make a write-up of your findings.
5. Present your findings to the class.



Activity 6.3(b): Analysing the concept of an ecosystem, community and habitats

Key question: What makes up an ecosystem, community and habitats?

What you need:

- A note book
- Camera / pairs of binoculars
- Computer with Internet/biology textbook
- Pen
- Pencil



Career: AN ECOLOGIST

Ecologists are scientists who survey ecosystems and assess the diversity, abundance and behaviour of the different organisms. They usually work for government agencies, environmental trusts, conservation charities and research institutes.

6.3 Components of an Ecosystem

An ecosystem is made up of biotic and abiotic factors. Biotic factors are living components within an ecosystem such as plants, animals, microorganisms while abiotic factors are non-living components such as water, soil and atmosphere. In Activities 6.3 (a) and 6.3 (b), you will explore different categories of components of an ecosystem, and analyse different ecosystems in Uganda.



The term ecosystem was coined by the Oxford ecologist Arthur Tansley to encompass the interactions among biotic and abiotic components of an ecosystem.



Activity 6.3(a): Exploring different categories of components of an ecosystem

Key question: What are the different categories of components in an ecosystem?

What you need:

- Pen
- Notebook
- Biology textbook/Internet

What to do:

In groups,

1. Research about the different categories of components in an ecosystem.
2. Describe each of the categories and give examples where necessary.
3. State the significance of the various components of an ecosystem.
4. Make a write-up of your findings.
5. Present your findings to the class.



Activity 6.3(b): Analysing the concept of an ecosystem, community and habitats

Key question: What makes up an ecosystem, community and habitats?

What you need:

- A note book
- Pen
- Pencil
- Camera / pairs of binoculars
- Computer with Internet/biology textbook

What to do:**In groups,**

1. Study a local ecosystem and:
 - a) Classify the living and non-living components.
 - b) Evaluate and determine a dominant species (an organism which determines the other organisms found there).
 - c) Identify the communities and habitats within the ecosystem.
2. Share ideas and discuss the ecosystem's components, communities and dominant species.
3. Prepare a power point presentation or book presentation and share your findings with the class.

**Assignment 6.1**

Residents of Kabata Village in Kibaale District woke up to a big shock one Saturday morning. Elephants living in the nearby Kibaale Forest had destroyed their plantations of matooke.

Filled with anger, the villagers stormed their village chairperson's home demanding for the immediate slaughter of all elephants in the park.

**Questions**

1. As a Biology student, prepare a speech to enlighten the villagers on the consequences of their proposed action to the environment.
2. Why is there an increasing number of animal invasions on human farmlands and homesteads?
3. Suggest possible solutions to this problem.



Sample Activity of Integration

Gross deforestation, bush burning, charcoal burning, hunting as well as washing clothes, bicycles and motocycles from the river are common activities in Abito village. Despite advice from community leaders to the inhabitants of the village to end such activities, there has been no response.



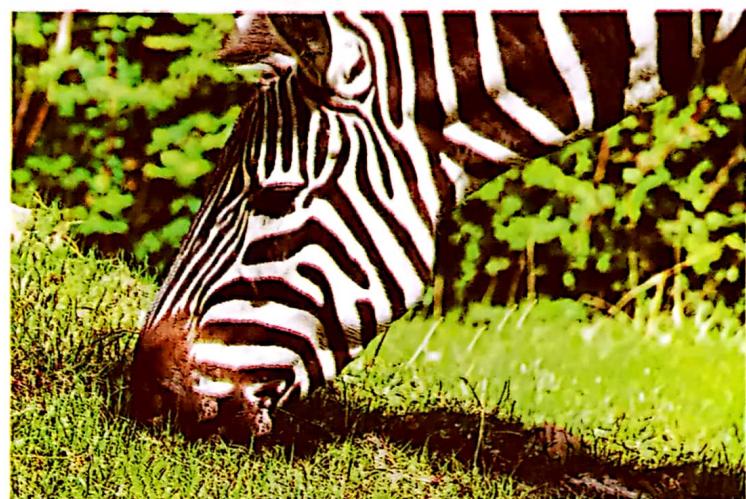
Task:

Design a poster to enable the community understand the importance of maintaining the ecosystem and the impact of their activities to it.

Chapter Summary

In this chapter, you have learnt that:

- Ecology is the study of the interaction between organisms in relation to their environment.
- Ecosystem is a unit of the environment consisting of both living (biotic) and non-living (abiotic) components interacting to form a self-sustaining unit.
- The total group of organisms of the same species living in a particular place at a given time is called a population.
- A collection of populations living and interacting together is called a community.
- A habitat is a place where an organism lives, obtains water, shelter and reproduces from.
- The biotic components of an ecosystem are categorised into: producers, consumers and decomposers.



Keywords

- ecological pyramid
- food chain
- food web
- producer
- consumer
- prey
- predator
- pyramid of numbers
- carbon cycle

By the end of this chapter, you should be able to:

- a) understand the feeding relationships in an ecosystem, and express them using food chains, webs, and pyramids
- b) appreciate the organisms and processes involved in the carbon cycle and its role in maintaining the carbon dioxide balance in the atmosphere

7.0 Introduction

One of the most eye-catching interactions in an ecosystem are feeding relationships among organisms. It is through these feeding relationships that living things get energy to support life's metabolic requirements. The energy is obtained through feeding on food which some organisms manufacture for themselves while others obtain it from other organisms. The latter informs us that organisms in an ecosystem cannot exist without depending on other organisms.

In this chapter, you will appreciate this interdependence of organisms in a given ecosystem.

7.1 Feeding Relationships in an Ecosystem

In physics, the Law of Conservation of Energy, states that energy can neither be created nor destroyed; energy can only be transferred or changed from one form to another. This principle is seen in nature through the feeding relationships in an ecosystem, which are represented through food chains, food webs, and pyramids.

Food chains

You have seen rings of metal like the one in *Figure 7.1 (a)*, and you can probably identify it as a chain because each ring is linked to the next one. Likewise, a food chain shows links between organisms in an ecosystem in terms of feeding relationships. A food chain is a descriptive illustration showing who eats who in an ecosystem. The food chain consists of arrows, each pointing from the food source to the dependent organism. This also depicts energy flow from one organism to another in the ecosystem (see *Figure 7.1 (b)*).



Figure 7.1(a): Metal chains

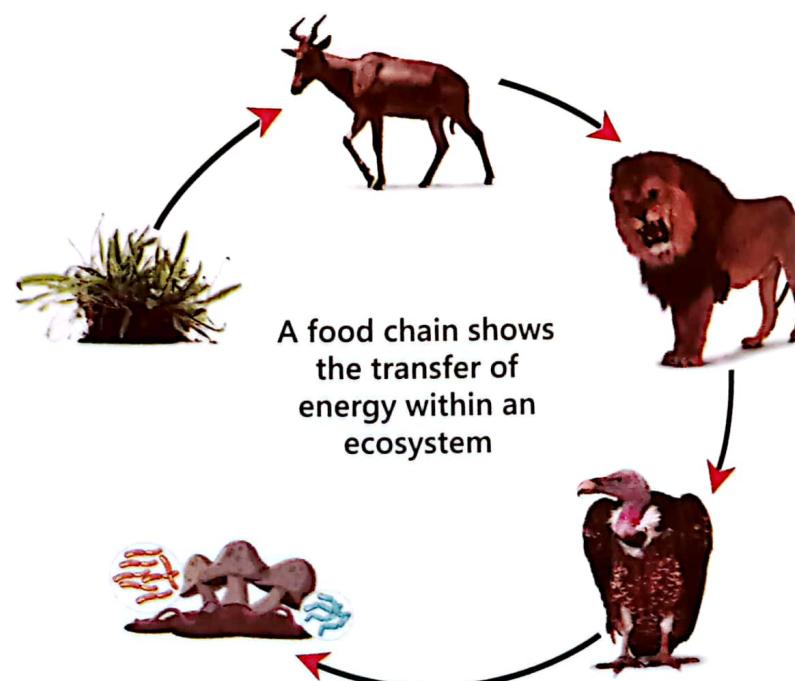


Figure 7.1(b): A food chain

Food webs

You have seen a spider web before; It is made up of silk 'threads' forming a net-like structure called a web. (See *Figure 7.2(a)*). It is the same as a **food web** which is made up of a network of feeding relationships formed by numerous food chains meshed together as shown in *Figure 7.2(b)*. Therefore, a food web is a network of many interconnecting food chains. Why do we have food webs in an ecosystem? Food webs exist in an ecosystem because many organisms depend on more than one species as their source of food. How many species do you depend on for food?

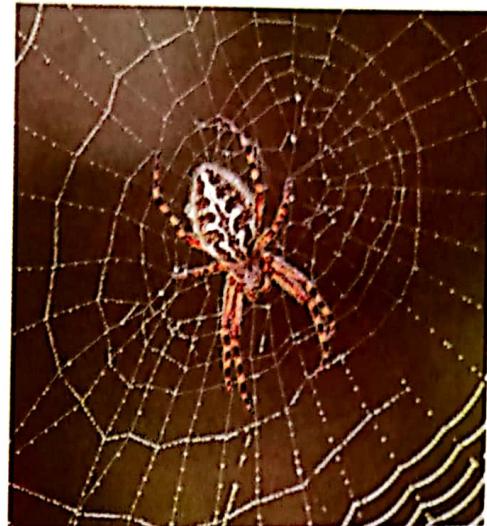


Figure 7.2 (a): Spider web

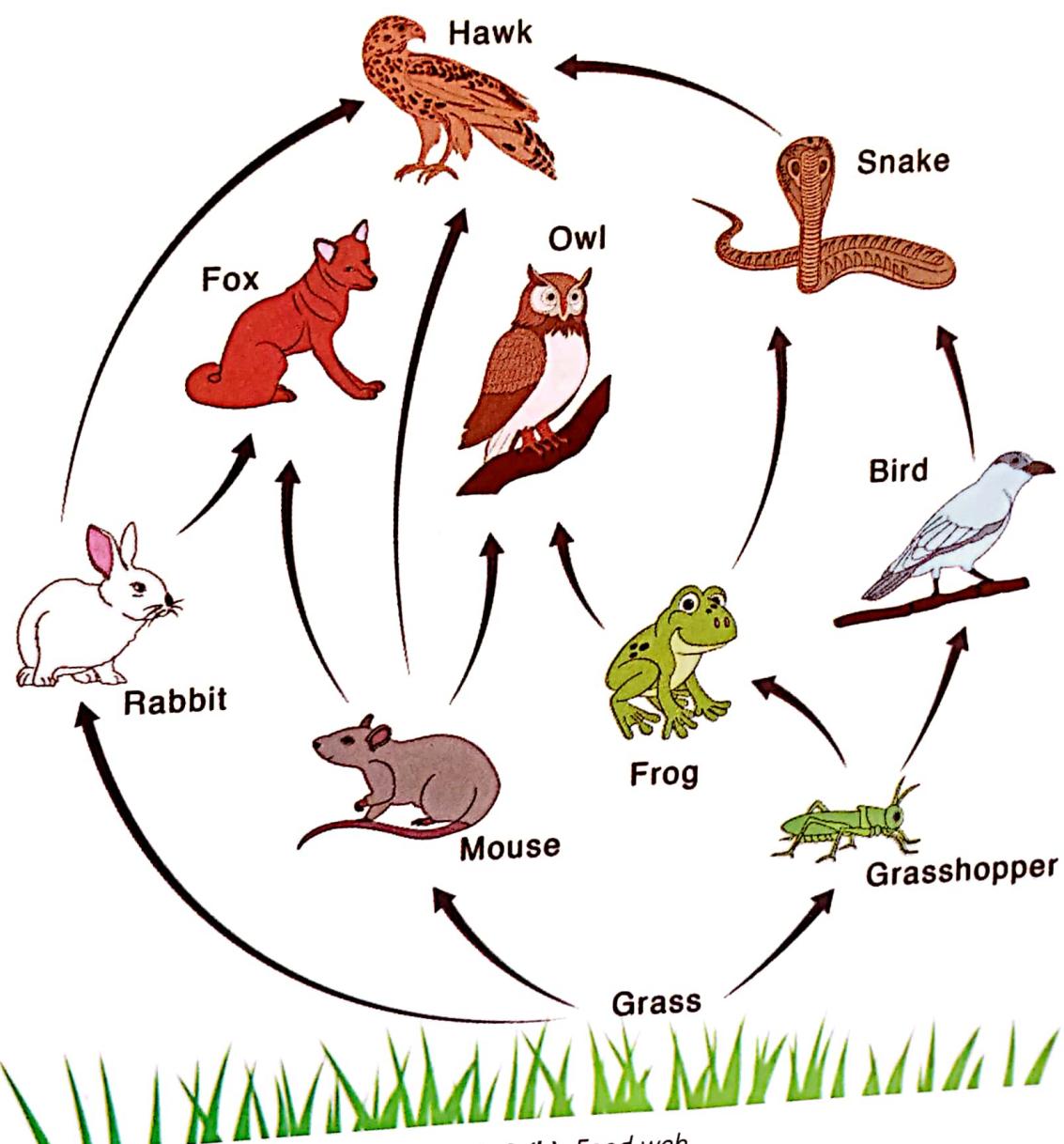


Figure 7.2 (b): Food web



Project work: Identifying feeding relationships in a local ecosystem

Aim: To find out the feeding relationships between living organisms in your environment?

What you need:

- Papers • Pen • Pencil • Hand lens • Field guide

What to do

1. Choose a natural community near your school to be your ecosystem for study. You may choose a pond, a forest, or bush, a rotten log.
2. Decide the boundaries of the ecosystem you want to study.
3. Observe the organisms that live in the ecosystem. Use a hand lens to observe small creatures. Look for evidence such as tracks, feathers, droppings, etc. of organisms you cannot see. Use field guides to identify the organisms.
4. Visit the ecosystem as many times as you can and at different times of the day for two weeks.
5. Observe the interactions and relationships among organisms and how organisms interact with non-living components of the ecosystem.
6. Record your observations in the table like one shown below.

Organism	Number of individuals	Food source	Trophic level
1.			
2.			
3.			
4.			



Discussion Questions

1. Name the ecosystem that you chose.
2. State the number of populations counted.
3. Categorise the organisms in the ecosystem as producers, consumers or decomposers.
4. Construct possible food chains and a food web for that ecosystem.
5. Describe what would happen if a population of producers was removed from the community.
6. Explain how the non-living components of the environment are important in the ecosystem.

Trophic levels

In an ecosystem, each organism occupies a specific feeding level depending on what it feeds on. Such feeding levels are known as trophic levels. Trophic levels

include producers, consumers, detritivores and decomposers. These trophic levels show how energy is transferred through the ecosystem. The energy from the sun is captured by the producers, transferred to the consumers and then from consumers back to producers by the decomposers.

As energy flows from one trophic level to another, some of it is lost. This energy loss limits the length of food chains in an ecosystem. In what ways is energy lost in an ecosystem as it flows from one trophic level to another?

Ecological pyramids

An ecological pyramid is a graphical representation showing the relationship between different organisms in an ecosystem. It shows the flow of energy at different trophic levels in an ecosystem. Ecological pyramids are of three types: pyramid of numbers, pyramid of biomass, and pyramid of energy. In this chapter, you will focus on understanding the pyramid of numbers.

Pyramid of numbers

Pyramid of numbers shows the number of organisms at each trophic level. For example, *Figure 7.3*, shows a pyramid of numbers using a simple food chain scenario in a grassland ecosystem.

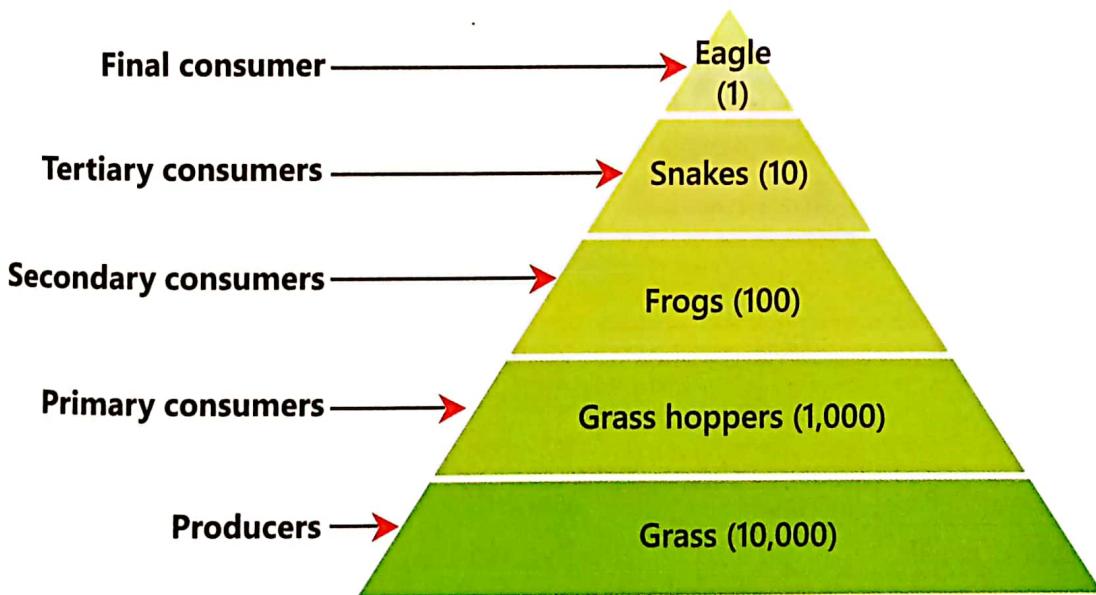


Figure 7.3: Pyramid of numbers in a grassland ecosystem

At the top of the pyramid, we have the apex predator, which is an eagle. Since the eagle is at the highest trophic level, there are relatively fewer individuals in the population.

Below the eagle, we have the tertiary consumer, the snake. There are fewer snakes compared to frogs, for snakes occupy a higher trophic level.

Next, we have the secondary consumer, the frog. There are more frogs than snakes because the frog's primary food source is grasshoppers, which are more abundant.

Below the frog, we have the primary consumer, the grasshopper. Grasshoppers feed on grass, and their population is larger than that of frogs because a large base of producers supports them.

At the base of the pyramid, there are producers, which are the grass. Grass forms the foundation of the food chain and supports the largest population, for it provides the primary source of energy for all the organisms above it.

The pyramid of numbers is usually upright because most ecosystems have producer more in number than other trophic levels. In some situations, the pyramid of numbers can be inverted; for example, a detritus food chain where many organisms feed on one dead plant. Give an example of a detritus food chain. In *Activity 7.1* below, you will construct a pyramid of numbers.



Activity 7.1: Constructing a pyramid of numbers

Key question: What steps are involved in constructing a pyramid of numbers?

What you need:

- Notebook
- Pen and pencil
- Computer spreadsheet program
- Internet/textbooks
- Scientific calculator

What to do:

In groups,

1. Research about the steps taken to construct a pyramid of numbers.
2. Study the given data of certain communities of living organisms, and use it to answer the questions that follow.

Organisms	Population Estimates
Elephants	500
Buffaloes	900
Birds	1,500
Crocodiles	20
Lions	50
Hippos	100

Organisms	Population Estimates
Grasshoppers	7,200
Shrubs	9,500
Grass	55,000
Warthogs	800
Waterbucks	700
Pythons	50

3. Place the organisms in their respective trophic levels (that is; producers, primary consumers, secondary consumers and tertiary consumers) according to their feeding relationships in an ecosystem. Give a reason why you have placed each organism in that specific trophic level.
4. Calculate the number of organisms in each trophic level.
5. Use the total number of organisms in each trophic level obtained to construct a pyramid of numbers.
6. Explain the appearance of the pyramid of numbers you have obtained to the class.

7.2 The Carbon Cycle

Carbon is a very important component of the environment and all living organisms because it is the foundation of all life on earth. Carbon is the main component of biological compounds such as carbohydrates, fats, and proteins. The carbon cycle describes the process through which carbon atoms continually move from the atmosphere to the earth and then back into the atmosphere. (See Figure 7.4).

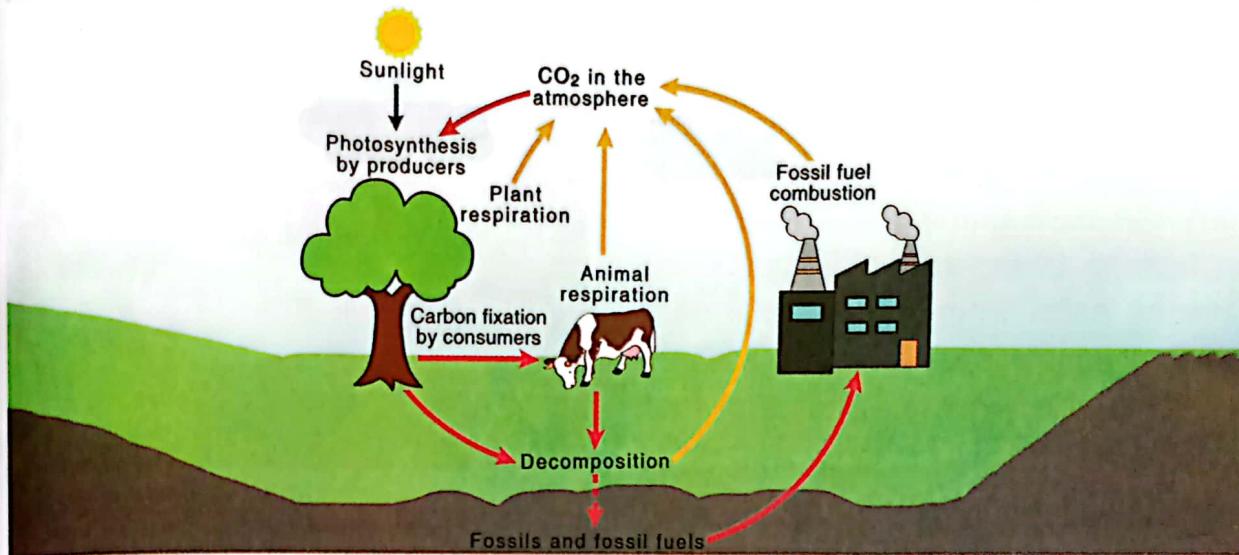


Figure 7.4: Carbon cycle diagram

DID YOU KNOW?

The amount of carbon we currently have on earth is the same amount we have always had. The amount of carbon dioxide in the atmosphere is rapidly rising; it is already considerably greater than at any time in the last 800,000 years.



Activity 7.2: Analysing the carbon cycle

Key question: How do the processes of carbon cycle contribute to its sustainability?

What you need:

- Notebook
- Markers
- Pen
- Biology textbook
- Manilla Paper
- Internet

What to do:

In groups,

1. Make research about the carbon cycle.
2. Identify the different processes involved in the carbon cycle, and how each process contributes to it.
3. State the processes that increase the amount of carbon dioxide in the atmosphere.
4. State the processes that reduce the amount of carbon dioxide in the atmosphere.
5. Describe the effects of having too much carbon dioxide in the atmosphere.
6. Design a chart of the carbon cycle.
7. Present your answers to the class.

Exercise 7.1



1. Why do living organisms need carbon?
2. Explain how carbon atoms become part of a plant.
3. What happens to some of these carbon atoms when a plants respire?
4. Explain the role of decomposers in the carbon cycle.



Sample Activity of Integration

The Tawa community lives near Queen Elizabeth National Park in Uganda. They carry out bush burning to create space for farming as well as hunting and killing savanna hares from the national park, which are a delicacy to them. Savanna hares are also a primary source of food for leopards.



The Uganda Wildlife Authority and National Environmental Management Authority recently became aware of these activities, and they are planning to take measures against the people carrying out these activities.



Task:

Prepare a speech to explain to the Tawa community why their activities have drawn the attention of UWA and NEMA.

Chapter Summary

In this chapter, you have learnt that:

- All living organisms need energy in the form of food to survive in the ecosystem.
- The sun is the ultimate source of energy for all ecosystems on the earth.
- Energy is transferred from one organism to another through the feeding relationships between organisms in an ecosystem.
- Some organisms namely, producers are able to make their own food through photosynthesis; they use light energy which they trap from the sun.
- Other organisms, namely consumers, do not have chlorophyll; therefore, they cannot trap light energy from the sun to make their own food. They obtain energy by consuming producers.
- The amount of carbon atoms we have on the earth is the same as we have always had.
- Carbon atoms continually move from the atmosphere to the earth and from the earth back to the atmosphere.
- The carbon cycle explains the way carbon atoms are reused in nature.



Keywords

- commensalism
- competition
- mutualism
- parasitism
- predator
- prey
- symbiosis

By the end of this chapter you should be able to:

- a) know what competition is and describe how organisms compete in nature
- b) differentiate prey from predators and describe a predator-prey relationship
- c) understand symbiosis, commensalism, mutualism and parasitism and appreciate their role in the ecosystem
- d) recognise the role of parasites and vectors in the transmission of common diseases like malaria, bilharzia, nagana and sleeping sickness
- e) know adaptations of parasites to their mode of life

8.0 Introduction

An English poet, John Donne once said, "No man is an island". This figure of speech applies to living organisms and their communities. There is no living organism that is self-sufficient. They all need each other and collaborate through relationships of different kinds. In this chapter, you will appreciate that organisms naturally interact in different ways with one another in a given habitat.

8.1 Competition

What do you understand by the term competition? You compete with your friends for good positions in class and in sports. What things do people in your community compete for? Organisms too compete in nature **especially when resources required for survival are limited**. There are two main forms of competition among organisms: **intraspecific competition** where organisms compete among members of the same species, and **interspecific competition** which occurs between members of different species, see images in *Figure 8.1*. Interspecific competition can lead to extinction of a given species in case it is out competed by other species. Do you know of any extinct species in Uganda?

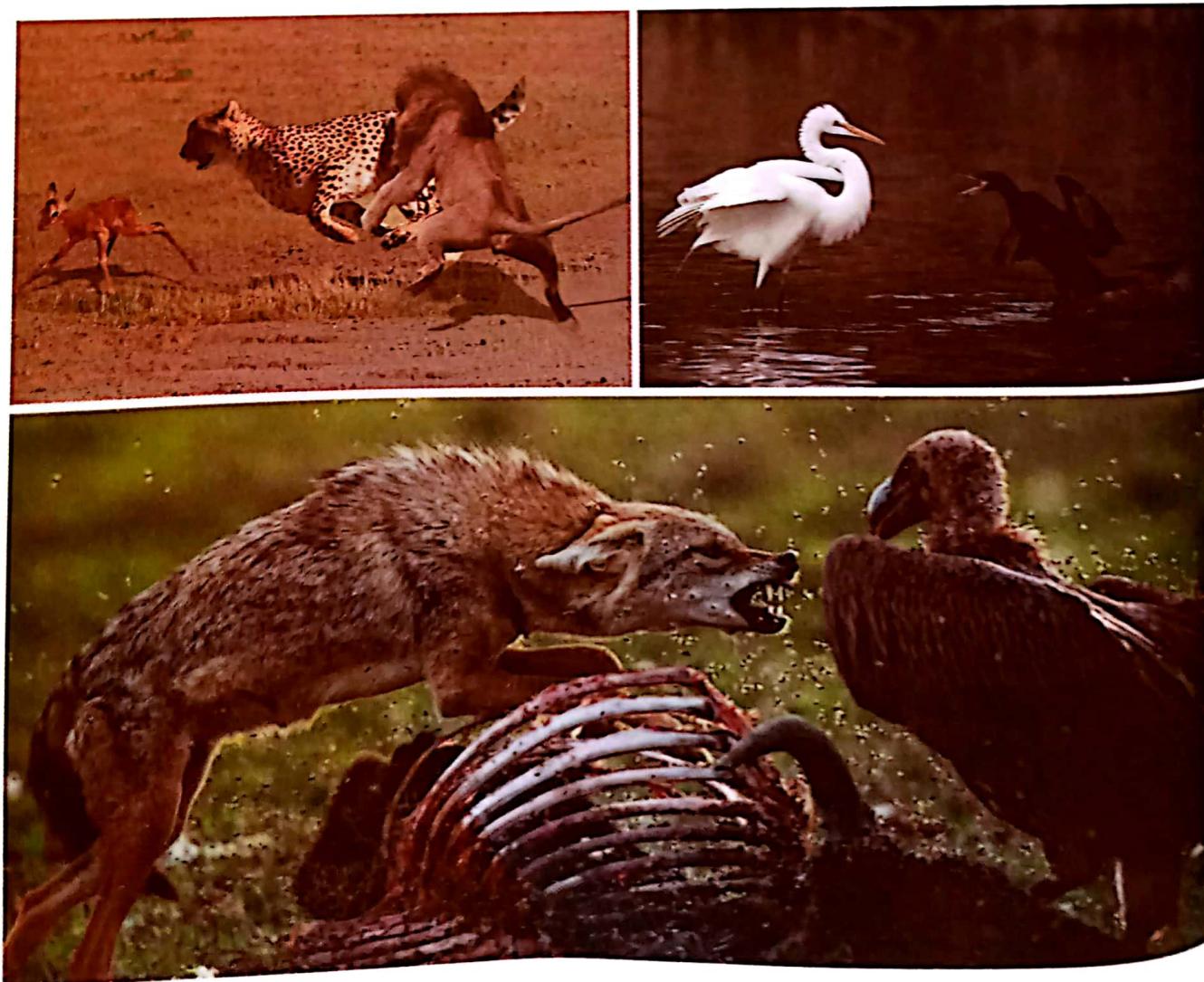


Figure 8.1: Interspecific competition for food



Activity 8.1: Analysing competition among organisms in a given ecosystem

Key question: Which examples of organisms fall under each form of competition in the ecosystem?

What you need:

- Pen
- Notebook
- Binoculars

What to do:

1. Choose a natural community with many organisms of different species near your school to be your ecosystem for study about competition.
2. Visit the area several times to observe the effects of competition among the organisms.
3. Identify the resources competed for among members of the same, and of different species.
4. Mention examples of organisms under the following forms of competition:
 - a) Intraspecific competition
 - b) Interspecific competition
5. State the characteristics that make an organism a good competitor.
6. Describe the significance of competition in the ecosystem.

8.2 Predator-prey Relationships

Many organisms get their food by eating other organisms. The act of one organism pursuing and consuming another organism for food is called **predation**. The organism that pursues another is the **predator** and that which is pursued is known as the **prey**. If you have watched a cat catch a bird or mouse, then you have witnessed a predator catch its prey. (See Figure 8.2.) Which other organisms exhibit a predator-prey relationship in the environment? In Activity 8.2 below, you will analyse predator-prey relationships in different ecosystems.



Figure 8.2: A cat eating a mouse



Activity 8.2: Analysing predator-prey relationships in different ecosystems

Key question: What is the effect of predator-prey relationships in an ecosystem?

What you need:

- Pen
- Notebook
- Computer/graph paper
- Access to numerical data on predator-prey relationships (internet or biology textbook)

What to do:

In groups,

1. Examine the provided numerical data related to a prey-predator relationship and plot a predator-prey curve. Use MS Excel or a graph paper.
2. Describe the predator-prey relationship illustrated by the curve, explaining each phase.
3. Make a written report of your findings.
4. Share your findings with the class.

8.3 Symbiotic Relationships

Some species survive because of the relationships they have developed with other species. The inter relationship that exists when two or more species live together is known as **symbiosis**. There are three kinds of symbiotic relationships: mutualism, commensalism, and parasitism. In *Activity 8.3*, you will examine the different symbiotic relationships.



Activity 8.3: Examining different symbiotic relationships

Key question: What are the different types of symbiotic relationships?

What you need:

- Notebook
- Pen
- Biology textbooks/ Internet

What to do:

In groups,

1. Research about each kind of symbiotic relationship, and describe it (use suitable examples in your descriptions).
2. Produce a poster using graphic images illustrating each type of symbiotic relationship.
3. Present your findings to the class.

8.4 The Role of Parasites and Vectors in the Transmission of Common Diseases

As described in Activity 8.3, **parasitism** is a symbiotic relationship in which one organism benefits at the expense of another. Parasites can be either external or internal. A living organism that transmits parasites from an infected animal to humans or other animals is known as a **vector**. Figure 8.4 is an example of how a vector can transmit disease causing germs into another organisms. In Activity 8.4, you will research about common parasitic diseases.



Figure 8.4: A mosquito sucking blood from a person



Activity 8.4: Researching about common parasitic diseases

Key question: What are the common parasitic diseases of humans, animals and plants?

What you need:

- Note book
- Pen

What to do:

In groups,

1. Visit a nearby health/agricultural facility, or listen to a visiting health/agriculture officer.
2. Carry out research and then report on:
 - a) common parasitic diseases of humans, animals, and plants.
 - b) how these diseases are transmitted.
 - c) ways through which they can be prevented and controlled.
3. Share your findings with the class.

8.5 Adaptations of Parasites to Their Mode of Life

Different parasites have different characteristics that aid their mode of life and survival. You will research about these characteristics in *Activity 8.5*.

DID YOU KNOW?

Studying viruses and the life cycle of vectors is important because it reveals the stage at which the organisms are most vulnerable and therefore can easily be destroyed.



Activity 8.5: Researching about adaptations of different parasites to their mode of life

Key question: How are different parasites adapted to their mode of life?

What you need

- Pen
- Notebook
- Computer with Internet/biology textbook
- Manilla paper/large paper

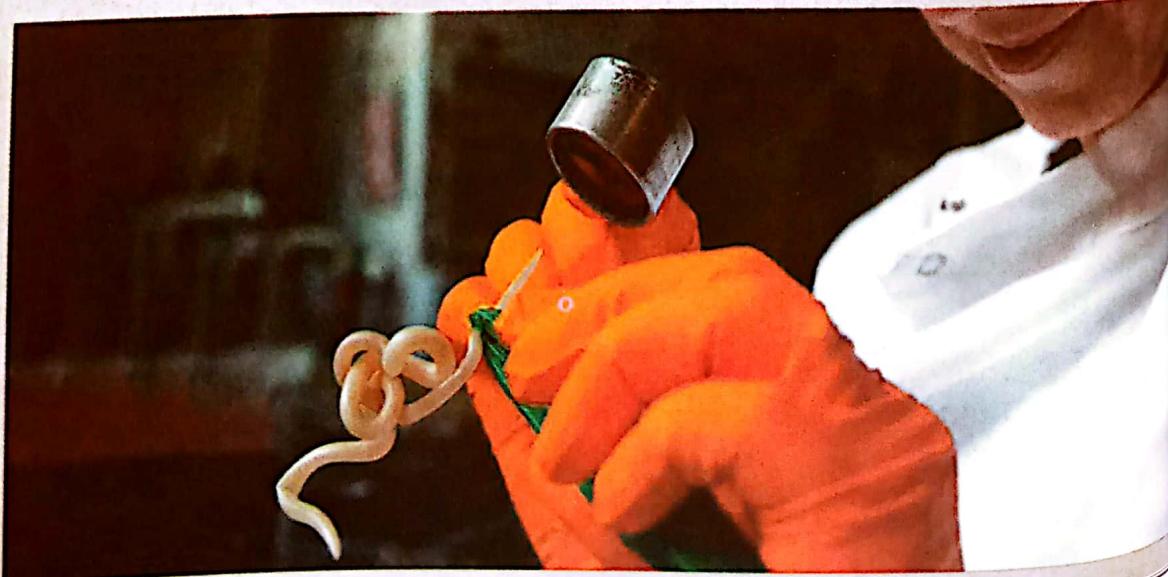
What to do

1. Research about the following parasites; plasmodium, tape worms, schistosomes, trypanosomes and ticks.
2. Find out and note down adaptations of each organism to its mode of life.
3. Present your findings to the class.
4. Hand in a written report to your teacher for assessment.



Career: A PARASITOLOGIST

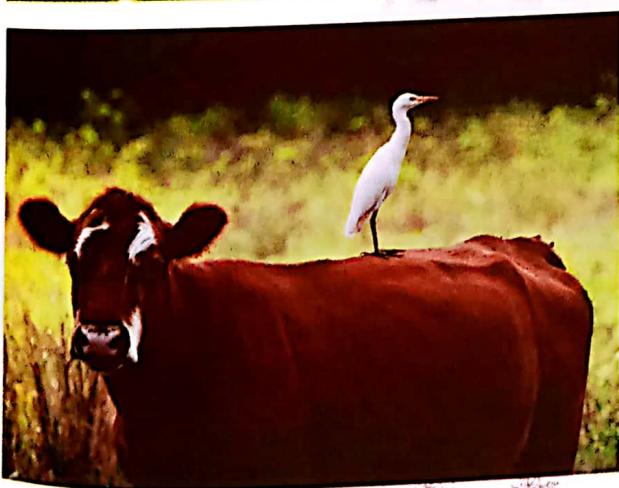
Parasitologists study the life cycle of parasites, the parasite-host relationship and how parasites adapt to different environments. They may investigate the outbreak and control of parasitic diseases such as malaria.





Sample Activity of Integration

Mr. Xavier started a farm a year ago. He rears cattle on one plot and cultivates crops on the other plot. He has started to recognise strange interactions between organisms on his farm. For example, birds and insects flying in his crops mostly at the flowering stage. Some caterpillars are attached to the leaves in his farm crops, ticks are attached to the hides of his cattle, and birds like egrets moving with cattle in the farm. He is confused about which interactions are useful or harmful to his crops and cattle and how to control harmful organisms. Mr. Xavier has contacted you for advice.



Task:

Write a speech you will deliver to Mr. Xavier to help him differentiate useful interaction from harmful interaction on his farm, and explain how he can control the harmful interactions.

Chapter Summary

In this chapter, you have learnt that:

- Competition can occur among organisms of the same species, intraspecific competition or organisms of different species, interspecific competition.
- Predator-prey relationships are typical of ecosystems where an organism (predator) feeds on another organism (prey).
- Symbiosis has three forms: mutualism, commensalism, and parasitism.
- Some of the most prevalent diseases such as malaria are caused by parasites which are transmitted by common vectors like mosquitoes.
- Parasites can be either microscopic or macroscopic, internal or external, but they are highly adapted to their mode of life.



Keywords

- natural resources
- sustainability
- degradation
- extinction
- natural environment
- human-induced activities
- climate change
- pollution

By the end of this chapter, you should be able to:

- a) understand there is a world-wide focus on sustainability and its importance
- b) know and give examples of natural resources found in uganda
- c) appreciate and describe natural factors and human influences that may have an impact on ecosystems, and make suggestion about how to preserve natural environment for all living things
- d) understand the sources, effects and control of air, land and water pollution

9.0 Introduction

The environment is the most important resource that humans have. It is therefore everyone's responsibility regardless of occupation to ensure that their actions do not endanger the future use of this resource. Environmental awareness in local communities is key to ensuring that the environment is protected and properly used. When you critically observe your surroundings, do you realise how humans have modified the environment to serve their needs? In pursuit for various needs, humans have negatively impacted the environment through disastrous activities that strain the earth and its resources beyond self-recovery. Although the emergence of advanced technologies has improved man's way of living, environmental problems have continued to increase.

In this chapter, you will appreciate that Uganda has various natural resources, which human activities impact, and you will also recognise the reasons why countries have committed to Global Sustainable Development Goals.

9.1 Worldwide Focus on Sustainability

In 2015, the United Nations adopted Sustainable Development Goals (SDGs) as a universal call to end poverty, protect the planet, and ensure that by 2030, all people enjoy peace and prosperity. We shall focus on those goals and focus on environmental protection and sustainable use of resources. Sustainability involves satisfying the needs of the current generations with the available resources without compromising the needs of future generations. There are two types of natural resources: **renewable and non-renewable resources**.

Natural processes can easily replace renewable resources as quickly as humans use them; for example, sunlight and wind whereas non-renewable resources such as fossil fuels cannot be replaced easily by natural means at the pace quick enough to keep up their consumption. A resource is sustainable if it does not run out even under continued use. For example, wood from the forest can be a sustainable resource if we always plant new trees to replace those cut down and also make sure that plenty of young trees are allowed to naturally grow. How can you make fish from the lake or river a sustainable resource? (See Figure 9.1).



Figure 9.1: Use of right size fishing nets



Activity 9.1: Analysing the importance of sustainability focus on worldwide

Humans and the Natural Environment

Key question: What is the importance of sustainability?

What you need:

- Pen and pencil
- Notebook
- Computer with Internet

What to do:

1. In groups, carry out research on the origin of the 2030 Sustainable Development Goals, their pillars, importance, and scope. Focus only on the 6th, 7th, 11th, 12th, 14th and 15th goals.
2. Prepare a report on your findings and make a chart to illustrate the Sustainable Development Goals.
3. The report should include:
 - a) what would happen to both man and the earth without sustainable development.
 - b) how international cooperation is essential to the achievement of the Sustainable Development Goals.
 - c) how observing the pillars of sustainability is an important aspect for you and your community.
4. Write a poem on the theme, "Sustainable Development Goals".
5. Share your report with the class and recite your poem.

9.2 Natural Resources in Uganda

Natural resources are any materials from nature with potential economic value or the ability to sustain life. These resources exist entirely without any human intervention. Uganda is highly endowed with natural resources such as fresh water, fertile soils, and minerals among others (See Figure 9.2(a) and (b)). What are the other examples of natural resources found in Uganda? People living in Uganda use natural resources every day for different purposes. In Activity 9.2, you will explore different natural resources in Uganda. Natural resources can be consumed directly, for example, using water for washing or consumed indirectly by modifying them to meet people's specific needs; for example, using wood from trees to make pencils and building materials.



Figure 9.2 (a): Lake Nyinambuga



Figure 9.2 (b): River Nile



Activity 9.2: Classifying natural resources in Uganda

Key question: What are the different natural resources in Uganda?

What you need:

- Notebook
- Pen
- Computer with internet
- Newspapers
- Camera

What to do:

In groups,

1. Brainstorm and carry out research on the different natural resources in Uganda.
2. Classify the resources as renewable or non-renewable.
3. State the importance of these natural resources.
4. Identify the human activities that have affected the natural resources both positively and negatively.
5. Suggest ways of conserving Uganda's natural resources for future generations.
6. Write a report and present it to the class.

9.3 The Impact of Natural Factors and Human Influences on Ecosystems

Every organism has an impact on the ecosystem and humans are not an exception. Since time immemorial, we have continuously altered the environment to meet our desires and needs. Apart from deforestation as illustrated in *Figure 9.3 (a)*, which other human activities negatively affect ecosystems? In addition to human activities, there are natural factors whose occurrence negatively affects the environment. What are some of these activities? (*See Figure 9.3 (b)*). In *Activity 9.3*, you will explore the impact of natural factors and human activities on ecosystems.



Figure 9.3 (a): Deforestation



Figure 9.3 (b): Wild fires



Activity 9.3: Exploring the impact of natural factors and human activities on ecosystems

Key question: What is the impact of natural factors and human activities on the environment?

What you need:

- Pen
 - Notebook
 - Computer with Internet/ Biology textbooks

What to do:

In groups,

1. Discuss the impact of natural factors and human activities on the environment.
 2. Suggest ways how the natural environment can be preserved for all living things.
 3. Between the natural processes and human induced ecosystem impacts, which ones are;
 - a) more frequent and why? b) more preventable and why?
 4. Write a report from your findings.
 5. Based on your report in (4) above, prepare a skit and present it to the class.

9.4 Pollution

Pollution is a process by which harmful substances are added to the environment. Such substances are known as pollutants. Mention examples of pollutants in your environment. Pollution can either be caused by natural factors such as volcanic eruptions and windblown dust or by human interventions such as burning of fossil fuels. Pollution results into degradation of the quality of our environment (see Figure 9.4).



Figure 9.4: Water pollution by humans

There are various forms of pollution, and they include air pollution, water pollution, and land pollution. In Activities 9.4 (a) to 9.4 (d), you will explore the causes and effects of the various forms of pollution and how each can be addressed.



Activity 9.4(a): Finding out the need for the air we breath

Key question: Of what importance is air to humans?

What you need:

- Notebook
- Pen
- Stop clock

What to do:

In groups,

1. Hold your breath, and note how long you can survive without breathing.
2. Calculate the average time your group member could hold his/her breath.

From Activity 9.4(a), you have learnt that air is a critical part for your survival and that of other life forms. We need over twice the amount of air daily compared to water. The quality of air you breathe is just as important as the air itself. However, the quality of air has been on the decline since the dawn of the industrial revolution. Why is this so? In Activity 9.4 (b), you will explore air pollution to find out its sources, effects and how it can be addressed.



Activity 9.4(b): Exploring air pollution

Key question:

What are the sources, effects and ways of addressing air pollution?

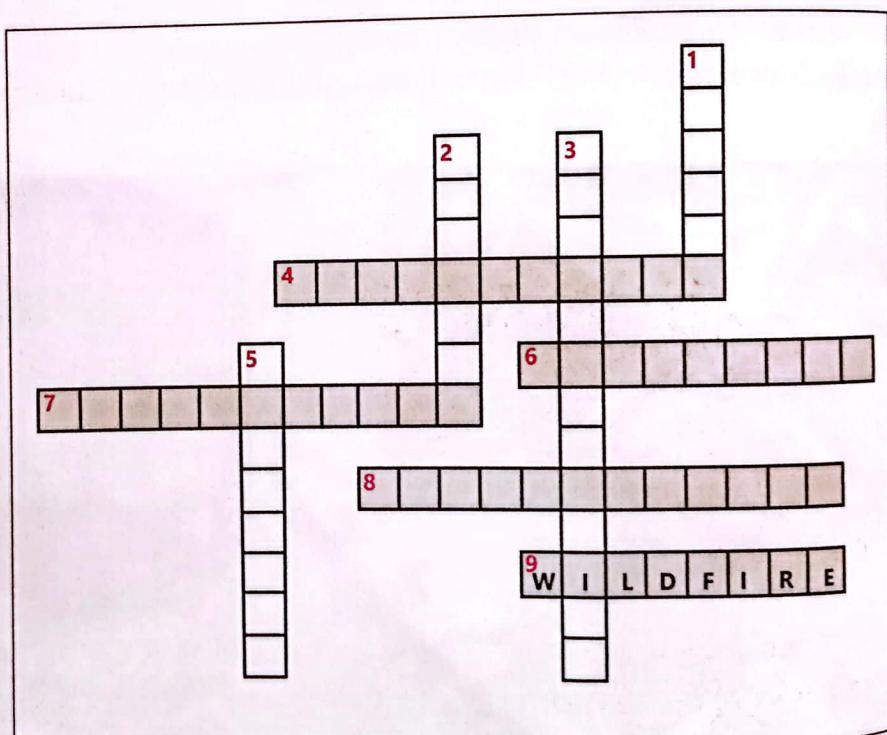
What you need:

- Notebook
- Pen
- Dictionary

What to do:

In groups,

1. Complete the puzzle.



ACROSS

4. Four wheels, and usually propelled by an internal combustion engine (11)
7. Volcanic activity (11)
9. Destructive fire that spreads quickly over woodland and brush (8)
6. Wind carrying clouds of sand with it in a desert (9)
8. Making an area urban (12)

DOWN

5. Activity concerned with the processing and manufacturing of goods and services (8)
3. Emission of ionising particles caused by the spontaneous disintegration of atomic nuclei (13)
1. Can produce microscopic airborne particles some containing allergies and chemicals (6)
2. Vertical channel or pipe which conducts smoke from a fire or furnace (7)

2. State the sources of air pollution according to the puzzle.
3. Describe the effects of air pollution to both the natural environment and humans.
4. Suggest measures that can be put in place to mitigate air pollution.
5. Write a report of your findings.
6. Share your findings with the class.

Water pollution

Water pollution occurs when water sources such as lakes and rivers are contaminated with substances such as chemicals, solid wastes, wastewater, and parasites. In *Activity 9.4(c)*, you will explore the sources, effects and ways to address water pollution.



Activity 9.4(c): Exploring water pollution

Key question: What are the sources, effects and ways of addressing water pollution?

What you need

- Notebook
- Pen
- Camera
- Biology textbooks
- Personal Protective wear like gumboots, overalls

What to do

In groups,

1. Visit a water source of your choice anywhere in your community, or watch a documentary video showing water pollution in Uganda.
2. Assess the sources of water pollution for the water source being studied.
3. Note down the impacts of water pollution on this water source.
4. Discuss the ways through which the water pollution problem can be solved.
5. Write a report on the field activity or a video presentation to share in class.

Land pollution

Land pollution occurs when solid or liquid waste materials are dumped on land or underground, thus reducing the quality of soil. Materials that lead to land pollution are usually referred to as **non-biodegradable materials**; for example, plastic waste. Define a non-biodegradable material. In Activity 9.4 (d), you will explore the sources, effects and ways of addressing land pollution.



Activity 9.4(d): Exploring land pollution

Key question: What are the sources, effects and ways of addressing land pollution?

What you need:

- Notebook
- Pen
- Biology textbooks

What to do:

In groups,

1. Carry out a field study in your community or watch a video on land pollution in Uganda and identify the numerous sources of land pollution in your community.
2. Describe the effects of land pollution on the environment.
3. What measures are being taken to reduce these effects?
4. Write a report on your findings and share with your class.

9.5 Solid Waste Management in Uganda

Solid waste is one of the greatest challenges faced by most urban areas in Uganda. The amount of wastes generated exceeds both financial and technical capacities to collect and dispose it off, and this has negatively affected the environment.

In Kampala and other urban areas, poor waste management is largely associated with overcrowding and development of slums. Identify the most generated solid wastes in your community and the different methods used to dispose off this waste. One of the ways to manage solid waste is through recycling and reusing. In Activity 9.5, you will explore the recycle and reuse of solid waste in Uganda.



Activity 9.5: Exploring recycling and re-use of solid waste in Uganda

Key question: In what ways are solid waste materials recycled and reused in Uganda?

What you need:

- Pen
- Notebook
- Newspapers
- Computer with Internet/ Biology textbooks

What to do:

1. Visit any school neighbouring community and take note of the solid waste materials being recycled and reused.
2. Write individual essays on how recycling and reuse of solid waste materials is being carried out in your community.
3. Suggest what could be done to improve the recycling and reuse of solid waste materials.
4. Share your essay with the class and submit your work to the teacher for assessment.

**Project work:** Recycling and re-using some of your individual waste

AIM: To recycle and re-use materials in the community

What you need

- A note book
- Pen
- Waste materials

What to do:

1. In pairs, every evening for the next 7 days, note the various solid wastes that you generate daily.
2. At the end of the 7 days, create a mind map on how you can re-use or recycle some of the solid waste you noted.
3. Design a green model concept for your school to reduce its negative environmental impacts.
4. Describe how nature recycles and reuses its waste. Why is this important?
5. Write a report on this and submit it to your teacher for review.

**Sample Activity of Integration**

Temin is a small town that is close to a seasonal river. A forest that once surrounded this town has almost been fully cleared. The streets of the town have plastic bottles and polyethene all over. The monkeys that used to live in the forest migrated and some of them died. The amount of rainfall has greatly reduced over the past years, and the river, drying up.

**Task:**

Design a poster sensitising the leaders and community members in Temin of the events taking place, their effects, and how they can be addressed.

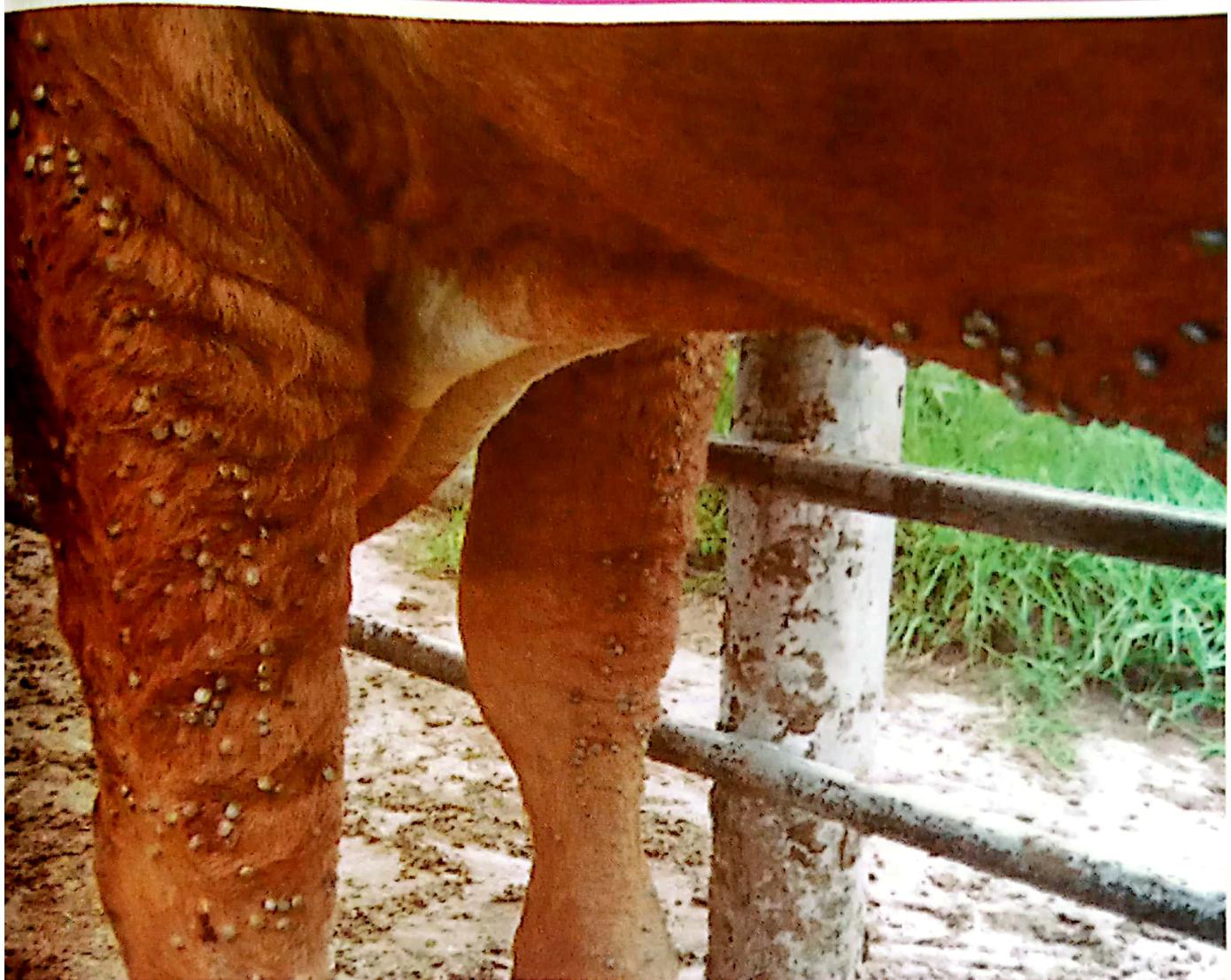


Chapter Summary

In this chapter, you have learnt that:

- The seventeen sustainable development goals were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet and ensure that by 2030 all people enjoy peace and prosperity
- Uganda is highly endowed with natural resources that range from lakes, rivers, mountains, forests, swamps, and wildlife
- Human activities have greatly affected the ecosystems; it has resulted into climate change and global warming
- The environment has a limit on how much pollutants it can assimilate and continued addition of wastes to the environment has resulted into air, water and land pollution
- Some of the wastes can be recycled and reused, and this is one of the most important ways of conserving the environment.

Sample Assessment Items



Rationale

These items serve to expose you to the structure of assessment in the new secondary curriculum. They are sample practice tools to help you develop the skill of problem solving and critical thinking, as you evaluate yourself and familiarise with the content of actual assessments.

- When the Parish Development Model was rolled out, a group of smallholder farmers in a certain parish embraced it and got some funds to expand their farm. Currently, they mainly grow bananas and cassava, which cover the largest part of the farm. However, they have continuously faced a problem of Wandering Jew, a weed that lowers the agricultural productivity of their farm. Despite their efforts to uproot it, the weed has always resurfaced in a few days.

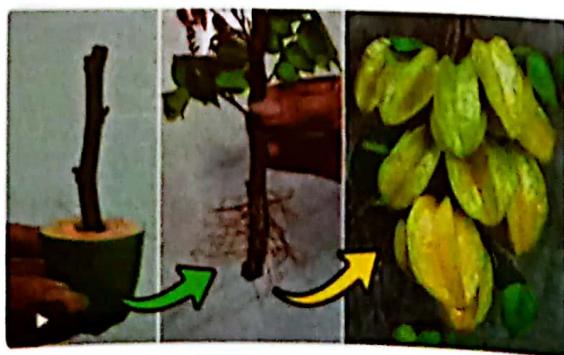
Support



Task Advise the farmers on how best they can control the weed and expand their farm using the already available banana and cassava plants.

- A community of fruit growers in a particular district relies on seeds to plant new crops for each new fruit-growing project. Recently, the community's representatives had an opportunity to visit a large village leaders' fruit farm in one of their neighbouring districts and they were surprised to find out that the growing techniques used on the leaders' farm were different from theirs. Farmers on the leaders' farm grow new fruit plants from stems of already existing plants and they improve the variety of given fruit plants by fixing stems of better varieties into the stumps of those of poor variety. On the contrary, the fruit growers in the community usually just cut down the fruits of poor variety and replace them with better ones.

Support



Task With justification, conclude on which of the leaders' and community techniques are better, and highlight how best the better technique can be adopted.

3. A few years after their graduation, a group of former university students pooled resources and bought an orange farm, from which they obtain the oranges they sell in markets. The oranges are of different sizes and according to the customers' feedback, the smaller oranges are sweeter than the bigger ones. The group has realised that most of their customers prefer to buy oranges that are both sweet and big in size, but they do not have sufficient understanding of how to achieve this.

**Task**

Evaluate the group's idea of growing oranges that will have the desired characteristics and explain how they can achieve this in large quantities.

Support

4. A family is organising a give-away ceremony for their first daughter and there are about 4 months left to the function. However, their compound is not as appealing to host the in-laws as compared to their neighbour's. Additionally, due to financial constraints, the family is not able to buy seedlings to improve on the appearance of his compound before the date of the ceremony.

**Task**

Advise the family on how they can beautify their compound in the shortest time possible, without incurring many costs.

Support

Part of the neighbour's compound

5. A national park in Uganda is experiencing changes in the blooming patterns of its flowers. Over the past few years, some flowers have been blooming earlier than usual while others have been blooming later than the usual time. The park management is concerned about these changes because they have resulted into a decline in plant growth, which is essential for sustaining the park ecosystem.

**Task**

Analyse the causes of the trend in the blooming patterns of the park's flowers and propose solutions to the park management.

Support

6. A farming community has for long tried to artificially select for maize plants with thicker cobs, because of the greater yields they provide and high market demand they carry. They have been doing this by planting seeds of maize cobs with only thick cobs. However, even to their surprise, they have been harvesting a mixture of thick and thin maize cobs—and sometimes, more of the latter. This has not only affected their financial returns but also the capacity of the community to significantly transition from subsistence to commercial farming.

Support



Task

Prepare a speech that you would deliver to the community during a sensitisation session, on what causes the disparity in their harvests and how they can sustainably improve their maize production.

7. The management of a local secondary school decided to create a garden on the school's land. As part of the project, they planted a variety of trees, including the non-native *Lantana camara*, an attractive ornamental shrub. The project also produces fruits for birds in the area. Over time, the residents in the area have noticed that the *Lantana camara* trees are growing rapidly in people's backyards, roadsides and almost everywhere they can, where they often outcompete the native plant species in the area.

Support



Task

In a write-up to the school management, assess the growth of the trees and propose a solution to the challenge associated with *Lantana camara* trees in the area.

8. Farmers in a particular region face a challenge of widespread and fast-growing weeds in their gardens, which have greatly affected their agricultural productivity. Having tried some approaches but without much success, they recently adopted the use of pesticides to control the weeds. However, despite achieving considerable

success, the farmers have observed a decline in the populations of bees on their farmlands, which were not only providing honey but also pollinating their crops and sustaining their growth.



Task Prepare a comprehensive report in which you analyse the impact of the use of pesticides, and propose environmentally friendly approaches to control weeds.

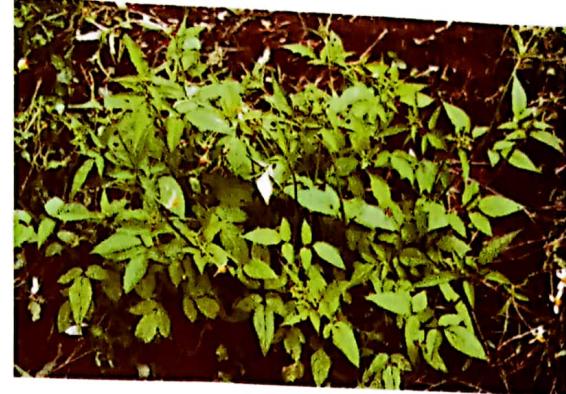
9. In a rural island community along the shores of a certain lake, a local health centre has started offering free HIV testing and counselling services. Despite the prevalence of HIV in the community and wide mobilisation by the health centre, the turn-up at the centre has been low. This has been mainly attributed to fear, misconceptions and stigma associated with HIV and HIV-affected people in the community.



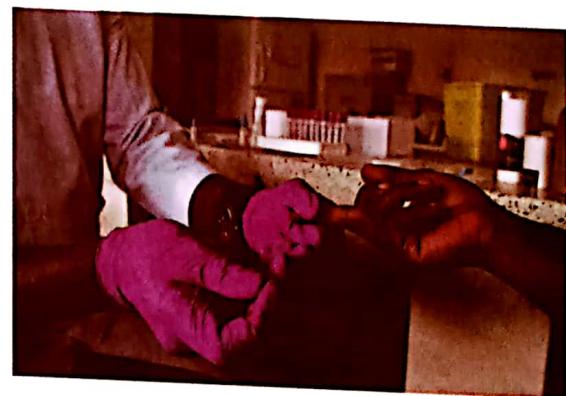
Task As a Village Health Officer, design appropriate community-wide strategies to address the factors that contribute to the continued spread of HIV.

10. In a certain school, a learner got pregnant, with one of her classmates being responsible for the pregnancy. The news spread quickly within the school, which led to her expulsion. Outside school, many people in the community viewed her with considerable disdain, to the extent that she almost considered aborting. Fortunately, she eventually opened up to you and you helped her to manage the situation and even return to school.

Support



Support



Support





Task

Develop a presentation that you would deliver to the school which has invited you as a community role model to evaluate the solutions to the challenges of teenage pregnancies.

11. According a recent report by the **Support**

Uganda National Institute of Public Health, Mubende has registered one of the highest numbers of birth complications in the country in the past 5 years. This has greatly affected economic productivity levels of women after giving birth and led to increased maternal mortality rate in the area.



The report highlights the high level of reluctance among expectant mothers to attend antenatal care because of low levels of awareness and other barriers, as well as limited accessibility to the required services.

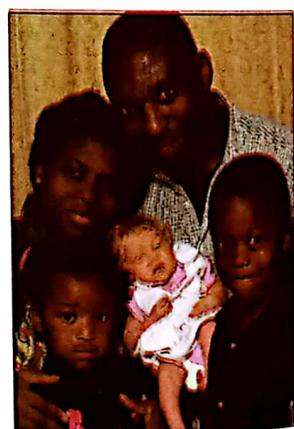


Task

Develop a proposal to address the challenges highlighted in the report and improve the productivity of birth-giving women in Mubende.

12. A man recently recorded a police **Support**

statement alleging an affair between his wife and their gateman. He is suspicious that their baby, who has a much lighter skin as compared with the rest of the family members, might be the result of his wife's alleged involvement in an affair with their dark-skinned gateman, but the wife has been fully faithful to her husband.



Task

Assess the conflict between the man and his wife, and explain how a light-skinned baby may have arose in the family, despite both its parents being dark-skinned.

13. For more than a decade now, farmers in a certain region have been facing a challenge of tick-borne diseases, which have been killing their animals especially cattle. This has not only led to a reduction in milk production but also limited reproduction among the animals. Some years back, the farmers started using a particular acaricide to control the ticks. However, they have recently noticed that it has lost its effectiveness in killing the ticks, despite its earlier considerable effectiveness.

Support

Task Investigate what could have caused the loss in the effectiveness of the acaricide and propose a better solution to fight the tick-borne diseases.

14. A group of farmers in Southwestern Uganda paid a visit to their friend in Central Uganda. They were served well-prepared hot meals, part of which were wonderfully delicious avocado fruits from the friend's garden. Impressed by their taste, they decided to take some avocado seeds and plant them on their own farm. After patiently nurturing them for years, they eagerly awaited an opportunity to consume the fruits on these avocado trees. However, they were disappointed by their flavour, which was not any close to that of the avocado fruits they had relished at their friend's place.



Task Analyse the group's experience in relation to the principles of variation and selection, and advise them on what they can do to have their avocado fruits achieving the desired flavour.

15. The stocks of fish in a certain river have significantly reduced, which has affected the livelihoods of many people who rely on the fish and associated activities to make a living. The use of undersized fishing nets has often led to the capture of pre-mature fish, greatly affecting the fish replenishment rates in the river. A recent survey has indicated that over 10,000 people will lose their jobs in the next 5 years, if the situation of the fish in the river is not addressed immediately and effectively.

Support**Support**

**Task**

Write an article to be published in a newspaper, in which you develop a strategic plan to revamp the stocks of fish in the river.

16. Due to an increase in the number of people living in a particular sub-county over the past decades, there has been increased encroachment on the forested slopes of a mountain in the area. Consequentially, the area has begun to register a rise in the frequency of landslides and increase in the instances of soil erosion in the area. Among other effects, these have destroyed many housing facilities and hindered agricultural practices in the community.

**Task**

Write a letter to the sub-county leaders, in which you analyse this situation and suggest ways to sustainably address it.

Support

17. The settlers around a certain landfill are faced with a significant challenge of land pollution. The area was designated as a landfill but within close proximity to human settlements, and its users have expanded it to collect wastes from far districts. This has created many health challenges for the settlers and affected the quality of their land, especially from the poor disposal of polyethene bags at the landfill and its neighbourhood.

**Task**

Prepare a speech that you would deliver on a talk show, during which you will highlight the state of the landfill and propose solutions to its associated challenges.

Support

18. A lead battery-recycling factory was established in a certain village along the shores of a lake. The local people celebrated the establishment because of the jobs that were created and the development it brought to the community. Over the years, however, employees of factory started suffering from lead poisoning. In addition, the water stream near the factory was significantly contaminated — causing a range of illnesses for the residents whose source of water was the lake — and many aquatic organisms were affected.

Support

**Task**

Prepare a report on the effects of the establishment of the factory in this village and propose strategies to promote sustainable and environmentally friendly existence of the factory.

19. A mining company wants to establish a mining operation in a national park. The operation will provide raw materials, such as copper and gold, to various industries, including those making electric cables and jewellery. However, there is a concern about the impact that the mining operation will have on the ecosystem of the national park, and the management of the park has suspended the establishment of the operation.

Support**Task**

Evaluate the impact of establishing the mining operation in the national park and help the management to reach a consensus with the company.

20. A group of food enthusiasts seeks to introduce shrimp fish to the Lake Albert ecosystem. They want to be able to get shrimp fish in their diet, both for aesthetic and nutritional purposes. They argue that this will also create an additional livelihood for the fish-farming communities around the lake, as well as expanding its domain of fish species.

Support**Task**

Analyse the intended action of the food enthusiasts and report your findings to the relevant regulatory bodies, so that the group is allowed to proceed.

Glossary

A

Abortion: the deliberate termination of a human pregnancy, most often performed during the first 28 weeks of pregnancy.

Abstinence: the decision not to have sexual intercourse.

Allele: one of two or more versions of the same gene at the same place on a chromosome.

Antenatal: a period of time before birth, during, or relating to pregnancy.

Asexual: reproduction not involving the fusion of gametes

B

Biosphere: a global ecosystem composed of living organisms (biota) and the abiotic (non-living) factors from which they derive energy and nutrients.

C

Carbon cycle: biogeochemical cycle by which carbon is exchanged among the biosphere, geosphere, hydrosphere, and atmosphere of the earth.

Chromosomes: thread-like molecules that carry hereditary information for everything.

Climate change: the global phenomenon of climate transformation characterised by the changes in the usual climate of the planet (regarding temperature, precipitation, and wind) that are especially caused by human activities.

Commercialism: an association between two organisms in which one benefits and the other derives neither benefit nor harm.

Community: an interacting group of various species in a common location.

Competition: a relationship between organisms in which one is harmed when

both are trying to use the same resource related to growth, reproduction, or survivability.

Consumer: an organism that generally obtains food by feeding on other organisms or organic matter due to lack of the ability to manufacture own food from inorganic sources.

Contraception: the deliberate use of artificial methods or other techniques to prevent pregnancy as a consequence of sexual intercourse.

Cultivar: a cultivar is a plant variety that has been produced in cultivation by selective breeding.

D

Degradation: the process by which something is made worse, especially the quality of land.

Dominant allele: show their effect even if the individual only has one copy of the allele.

E

Ecosystem: a biological community of interacting organisms and their physical environment

Erectile dysfunction: inability to get and keep an erection firm enough for sex.

Evolution: the change in the characteristics of a species over several generations, and it relies on the process of natural selection.

Extinction: the termination of a kind of organism or of a group of kinds (taxon), usually a species.

F

Fertilisation: the fusion of the nucleus of a male gamete with the nucleus of a female gamete, producing a new cell called a zygote.

Food chain: a linear sequence of organisms where nutrients and energy is transferred from one organism to the other.

Food web: a natural interconnection of food chains and a graphical representation (usually an image) of what-eats-what in an ecological community.

Fruit: a mature, ripened ovary, along with the contents of the ovary.

G

Gametes: an organism's reproductive cells.

Genes: the basic physical and functional units of heredity.

Genetic disorders: A genetic disorder is a disease that is caused by a change, or mutation in an individual's DNA sequence.

Genitalia: the male or female reproductive organs.

Genotype: the genetic constitution of an organism.

H

Habitat: the natural home or environment of an animal, plant, or other organism

Heterozygous: a diploid organism with two alleles, each of a different type.

Homozygous: a diploid organism with two identical alleles.

Implantation: the stage of pregnancy at which the embryo adheres to the wall of the uterus.

Inheritance: the process by which genetic information is passed on from parent to child.

I

Meiosis: a process where a single cell divides twice to produce four cells containing half the original amount of genetic information.

Menstrual cycle: the monthly series of changes a woman's body goes through in

preparation for the possibility of pregnancy which one cell divides into two genetically identical daughter cells.

Mutation: a change in a DNA sequence.

Mutualism: an interaction between organisms of two different species, in which each organism benefits from the interaction in some way.

N

Natural Resources: materials created in nature that are used and usable by humans.

Natural selection: a process in which an organism adapts to its environment through selectively reproducing changes in its genotype.

O

Oestrogen: any of a group of steroid hormones which promote the development and maintenance of female characteristics of the body.

Ovum: a mature female reproductive cell, especially of a human or other animal, which can divide to give rise to an embryo usually only after fertilisation by a male cell.

P

Parasitism: a type of symbiotic relationship, or long-term relationship between two species, where one member, the parasite, gains benefit that come at the expense of the host member.

Phenotype: the set of observable characteristics or traits of an organism.

Pollination: the transfer of pollen grains from the male anther of a flower to the female stigma.

Pollution: the introduction of harmful materials into the environment.

Population: a group of interbreeding individuals of the same species, which is

isolated from other groups.

Predator: an organism that consumes all or part of the body of another living or recently killed organism.

Prey: animals eaten by other animals.

Producer: organisms that create food from inorganic matter.

Progesterone: a hormone released by the corpus luteum in the ovary.

Propagation: the process by which new plants grow from a variety of sources: seeds, cuttings and other plant parts.

Pyramid of numbers: shows the total number of individual organisms at each level in the food chain of an ecosystem.

R

Recessive allele: a type of allele that when present on its own will not affect the individual.

S

Sexually transmitted infection: an infection that is transferred from one person to another through sexual contact.

Sperm: sperm is the male reproductive cell.

Sustainability: the responsibility to conserve natural resources and protect global ecosystems to support health and wellbeing, now and in the future.

Symbiosis: interaction between two different organisms living in close physical association, typically to the advantage of both.

T

Testosterone: a steroid hormone that stimulates development of male secondary sexual characteristics, produced mainly in the testes, but also in the ovaries and adrenal cortex.

V

Variation: any difference between cells, individual organisms, or groups of organisms of any species caused either by genetic differences (genotypic variation) or by the effect of environmental factors on the expression of the genetic potentials (phenotypic variation).

Vegetative: relating to or denoting reproduction or propagation achieved by asexual means, either naturally (budding, rhizomes).

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Baroque Senior Four Biology Learner's Book has been developed in conformity with the requirements of the **National Curriculum Development Centre (NCDC)** following the New Competence-based Lower Secondary School Curriculum that came into use in 2020.

The Learner's Book has been designed to enable learners to use advanced principles of scientific methods/processes and apply experimental techniques to solve scientific problems. The Book will enable the learners to understand the biological processes involved in reproduction within plants and humans, develop an intrinsic appreciation for inheritance, variation and selection as well as the vital life-sustaining inter-relationships in the environment and the urgent need for sustainability to secure the future of mankind.

The purpose of the Book is to develop the understanding and skills of learners through scientific inquiry and rational thinking. The nine chapters of the Book are structured in a way that will enable the learners to develop a deep understanding of how new offsprings are created within the plant kingdom & within the human population, and a keen outlook on the interconnectedness of life and the current efforts to protect this web of life from the threat of collapse.

In the structuring of this Book, efforts have been made to address the following aspects:

- respect for human life
- awareness of the importance of living in harmony with the environment
- independent and critical thinking
- innovative application of technology in solving problems

Upon completion of this course, the learners should be able to:

- understand asexual reproduction processes in plants
- explain the process of sexual reproduction in plants
- appreciate the process of sexual reproduction in humans
- understand the concept of inheritance using genetic diagrams
- understand the concepts of communities, habitats and ecosystems
- appreciate the interdependence of organisms in a given ecosystem
- understand how organisms naturally interact with one another in their respective habitats
- understand the need for a worldwide concern and focus on sustainability

ISBN 978-9913-671-01-9



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