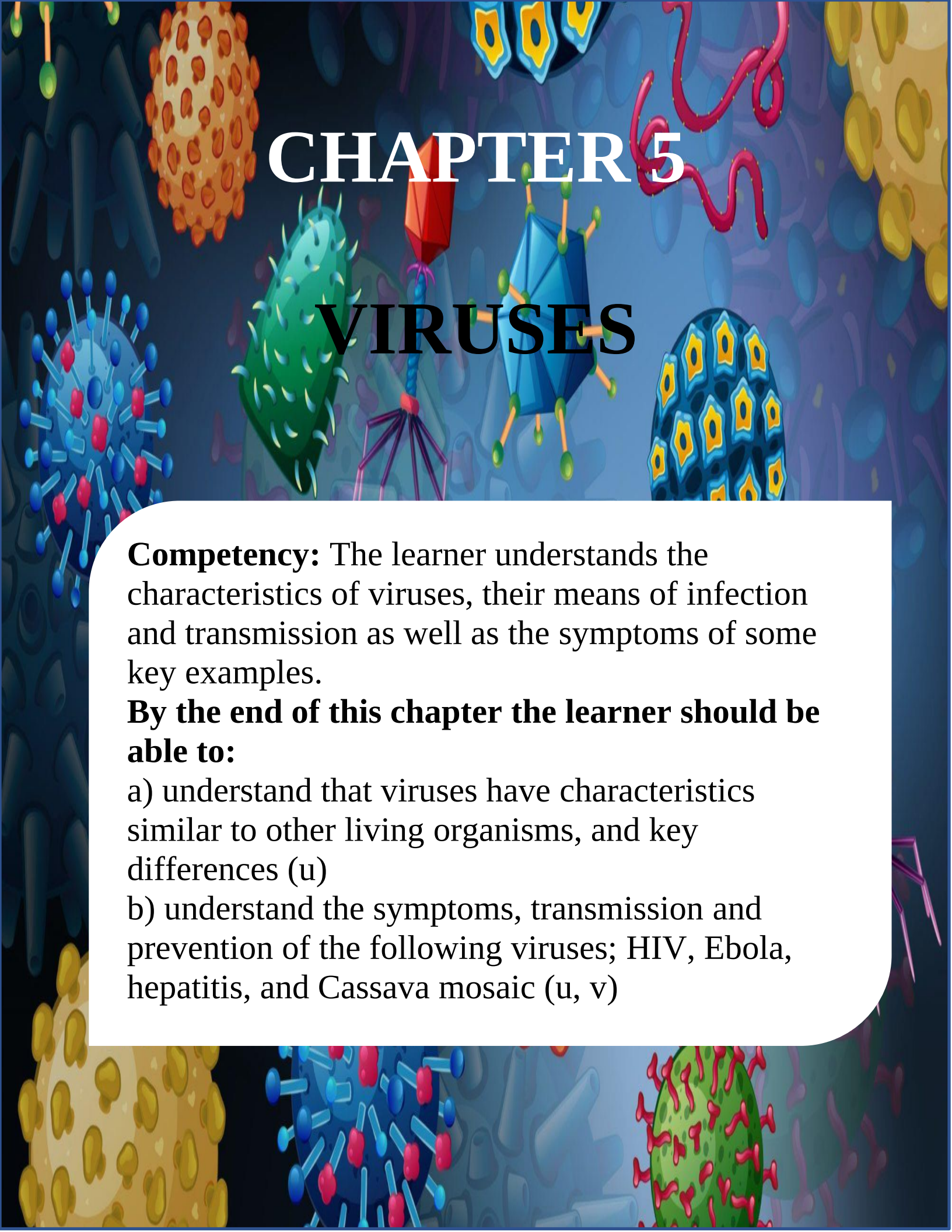


CHAPTER 5

VIRUSES

Competency: The learner understands the characteristics of viruses, their means of infection and transmission as well as the symptoms of some key examples.

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

a) understand that viruses have characteristics similar to other living organisms, and key differences (u)

b) understand the symptoms, transmission and prevention of the following viruses; HIV, Ebola, hepatitis, and Cassava mosaic (u, v)

Introduction to the Topic of Viruses

In the previous chapter, we learned about the five kingdoms of classification—Monera, Protista, Fungi, Plantae, and Animalia. These kingdoms help scientists group living things based on their characteristics, such as how they obtain energy or how their cells are structured. However, there is something interesting: viruses are not included in any of these five kingdoms.

This is because viruses are very different from other living things. They don't fit neatly into the groups we use to classify life. Unlike organisms in the five kingdoms, viruses don't have cells, and they cannot carry out activities like growing or reproducing on their own. Instead, they rely entirely on other living things to survive and multiply.

In this chapter, we will explore what makes viruses unique, how they behave, and why they are important to understand. They may not belong to any kingdom, but they still play a huge role in nature and our lives. From causing diseases to being used in science and medicine, viruses are tiny but powerful entities worth studying.

Meaning of virus and their examples

A virus is a tiny, non-living particle made up of genetic material (DNA or RNA) enclosed in a protein coat. It cannot grow, reproduce, or carry out life processes on its own. Instead, a virus must invade the cells of a living organism (called a host) to replicate. Viruses are much smaller than bacteria and are so tiny that they can only be seen using a powerful microscope.

Viruses are infectious agents with both living and nonliving characteristics. It is therefore paramount to avoid activities, behaviours and habits that lead to acquisition of viral infections.

Common viruses

Viruses can infect various hosts, including humans, animals, plants, and even bacteria. Below are some examples:

-HIV (Human Immunodeficiency Virus) that causes AIDS by attacking the immune system.

-Influenza Virus that causes flu, which leads to fever, cough, and fatigue.

-Coronavirus that causes COVID-19, a respiratory illness.

-Hepatitis B Virus that affects the liver and can cause chronic liver disease.

-Cassava mosaic virus that causes cassava mosaic disease in cassava plants.

Structure of virus

A virus has a simple structure designed for infection and replication. Its core contains genetic material, either DNA or RNA, which carries instructions for making new viruses. This is protected by a protein coat called the capsid, which determines the virus's shape. Some viruses have an additional lipid-based

envelope, derived from the host cell, which contains surface proteins or spikes to help the virus recognize and attach to host cells. Non-enveloped viruses lack this outer layer. Complex viruses, like bacteriophages, may also have tail structures and fibers for injecting genetic material into bacterial cells.

Characteristics of viruses

Viruses are numerous and everywhere, they are microscopic and show characteristics of both living and nonliving things. As such they are considered to be at the border of living things and nonliving things.

-Viruses are tiny particles made up of genetic material (DNA or RNA) wrapped in a protein coat. Unlike living organisms, they don't have cells.
-Viruses contain either DNA or RNA, which holds the instructions for making more viruses.
-Viruses do not feed, grow, or respire like living organisms. They are inactive outside the host cell and only become active when inside a host.
-Viruses depend on host cells to replicate/reproduce. They use the host cell's machinery to make copies of themselves.
-Viruses have specific host cells they can infect. They attach to these cells using proteins on their surface.
-Viruses can change over time due to mutations, which can lead to new strains and affect how they spread and cause disease.
-Viruses are incredibly small, much smaller than bacteria and other microorganisms.

Viruses behave like living things in the following ways:

-Like other living cells, a virus has genetic materials.
-Multiplies when inside living cells.
-Carry out metabolism when inside living cells.
-They can change (mutate) into new strains.

Also, viruses behave like non-living things in the following ways:

-Not made up of cell.
-Do not need to eat in order to live.
-Need a host cell to multiply/reproduce.
-Need a host cell to carry out metabolism.
-Crystalize and become completely inert if isolated from host cell.

Methods of viral infection/disease transmission

- ✓ Direct contact through blood for example HIV, body fluid like sweat, saliva for example covid 19, Ebola.
- ✓ Feeding on contaminated food and using contaminated water for example poliomyelitis.
- ✓ Droplet infection, when we cough, sneeze or merely talk we produce a fine spray of droplets of saliva. If we are carrying infection, these droplets may contain viruses which may remain suspended in air or fall to the ground ending up affecting healthy people especially respiratory infection like influenza, covid 19.

Diseases caused by viruses

Viruses are pathogens that penetrates into the host cells and destroy the cells in which they reproduce leading to infection or diseases. Viruses cause diseases in various hosts, including humans, animals, plants, and bacteria. Some diseases they cause can be mild, while others can be severe or even cause pandemics. The most common viral infections include, AIDs acquire immunodeficiency syndrome cause by HIV virus, hepatitis B, hepatitis E, cassava mosaic, Ebola, influenza among others.

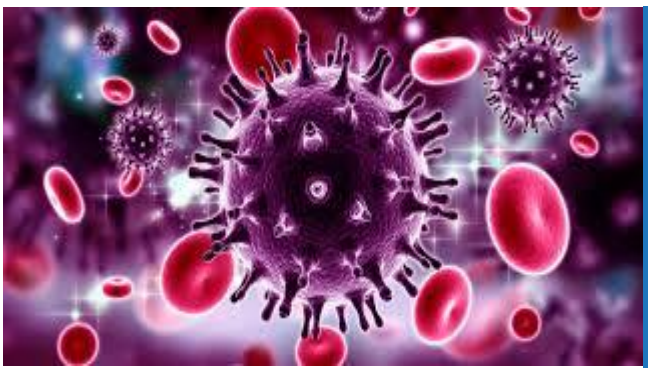
Understanding the Symptoms, transmission and prevention of common viral infections/diseases

1. HIV (Human Immunodeficiency Virus):

Human immunodeficiency virus (HIV) is a virus that attacks the body's immune system causing acquired immunodeficiency syndrome (AIDS) which occurs at the most advanced stage of the infection.

HIV targets the body's white blood cells, weakening the immune system. This makes it easier to get sick with other diseases/infections because the body find it's hard to fight off other infections.

HIV virus is one of the major problems faced by communities. In 2018, 1.4 million people were reported to be living with HIV in Uganda



Did you know?
HIV remains a major global public health issue, having claimed an estimated 42.3 million lives to date. Transmission is ongoing in all countries globally.
There were an estimated 39.9 million people living with HIV at the end of 2023, 65% of whom are in the WHO African Region.
In 2023, an estimated 630 000 people died from HIV-related causes and an estimated 1.3 million people acquired HIV.
There is no cure for HIV infection. However, with access to effective HIV prevention, diagnosis, treatment and care, including for opportunistic infections, HIV infection has become a manageable chronic health condition, enabling people living with HIV to lead long and healthy lives.

Understanding the Signs and symptoms of HIV viruses

The symptoms of HIV vary depending on the stage of infection.
HIV spreads more easily in the first few months after a person is infected, but many are unaware of their status until the later stages. In the first few weeks after being infected people may not experience symptoms.

Others may have an influenza-like illness including:

- fever
- headache
- rash
- sore throat.

The infection progressively weakens the immune system. This can cause other signs and symptoms:

- swollen lymph nodes
- weight loss
- fever
- diarrhoea
- cough.

Note: Without treatment, people living with HIV infection can also develop severe illnesses: such as tuberculosis.

Transmission

HIV can be transmitted via the exchange of body fluids from people living with HIV, including blood, breast milk, semen, and vaginal secretions. HIV can also be transmitted to a child during pregnancy and delivery. People cannot become infected with HIV through ordinary day-to-day contact such as kissing, hugging, shaking hands, or sharing personal objects, food or water.

Risk factors that can lead to infections.

Behaviours and conditions that put people at greater risk of contracting HIV include:

- Having anal or vaginal sex without a condom;

- Having another sexually transmitted infection (STI) such as syphilis, herpes, chlamydia, gonorrhoea and bacterial vaginosis;
- Harmful use of alcohol or drugs in the context of sexual behaviour;
- Sharing contaminated needles, syringes and other injecting equipment, or drug solutions when injecting drugs;
- Receiving unsafe injections, blood transfusions, or tissue transplantation; and
- Medical procedures that involve unsterile cutting or piercing; or accidental needle stick injuries, including among health workers.

Prevention strategies of HIV virus.

HIV is a preventable disease. Reduce the risk of HIV infection by:

- Using a male or female condom during sex,
- Being tested for HIV and sexually transmitted infections, Other STIs can put you at higher risk for an HIV infection.
- Having a voluntary medical male circumcision, this procedure removes tissue in the foreskin that's vulnerable to HIV.
- Doctors may suggest medicines and medical devices to help prevent HIV infection, including:
- antiretroviral drugs (ARVs), including oral Pre-Exposure Prophylaxis (PrEP)
- ARVs can also be used to prevent mothers from passing HIV to their children.

Note

Antiretroviral drugs given to people without HIV can prevent infection.
When given before possible exposures to HIV it is called pre-exposure prophylaxis (PrEP) and when given after an exposure it is called post-exposure prophylaxis (PEP). People can use PrEP or PEP when the risk of contracting HIV is high; people should seek advice from a clinician when thinking about using PrEP or PEP.

Did you know?

People living with HIV who are taking ARVs and have an undetectable viral load will not transmit HIV to their sexual partners. Early access to ARVs and support to remain on treatment is therefore critical not only to improve the health of people living with HIV but also to prevent HIV transmission.

GROUP ACTIVIY

Short drama showing transmission and prevention of HIV/AIDS.

Sample Presentation Outline:

Title: "Breaking the Chain of HIV Transmission."

Scene 1: Unsafe practices leading to infection.

Scene 2: An educational session on safe sex and regular HIV testing.

Scene 3: How using prevention methods reduces risks.

Sample item 1

Uganda has been a global success story in the fight against HIV and AIDS since the first case was discovered along the shores of Lake Victoria in the 1990s. The HIV/AIDS prevalence declined from 30% in 1990s t0 5.1% in 2022, This success is attributed to a well-coordinated multi-sectoral response. Despite the excellent progress, globally Uganda is ranked 5th of those with the highest HIV burden. The table below shows percentage HIV/AIDS prevalence rates as of 2022 in selected region of the country

Region	Percentage HIV/AIDS prevalence rate (%)
Mid-western	4.9
South western	6.0
West Nile	2.3
Mid north	6.7
North east	2.8
South Buganda	8.3

Task

a) Create a bar graph or pie chart to show the rates of HIV/AIDS prevalence in the selected regions of the country.

b) Explain the differences in the rate of HIV/AIDS prevalence in the selected regions of Uganda

c) What measures can be taken to reduce on the number of HIV/AIDS infections in the country.

Sample item 2

Aids is one of the killer diseases (Viral disease) in Uganda, basing on the statistics in Uganda, six people per hour are getting infected with the above disease.

i) As a learner who has studied about viruses, what are the measures of preventing the above disease?

ii) State the ways how an individual can be affected with Aids

2. Ebola Virus:

Ebola virus disease (EVD) is a severe, often fatal, illness. The virus was first discovered in 1976 in the Ebola River region of Congo. This is a rare but deadly virus; it spread throughout the body fluids and damage the immune system causing ebola hemorrhagic fever.

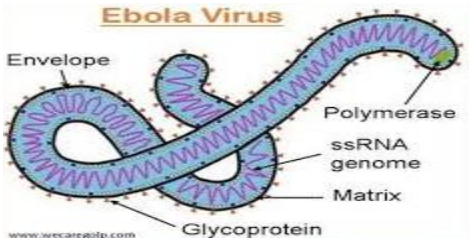


Fig ebola virus

Understanding the sign and symptoms of ebola virus.

Symptoms are similar to those of other infectious diseases such as malaria, typhoid fever and this makes diagnosis difficult. The symptoms appear after 2 to 21 days and include

Fever, fatigue, muscle pain, headache, and sore throat, followed by vomiting, diarrhoea, rashes, symptoms of impaired kidney and liver function, and in some cases internal and external bleeding (e.g., oozing from the gums, blood in the stools). Laboratory findings include low white blood cell and platelet counts and elevated liver enzymes.

Fig. signs and symptoms of ebola.

Transmission of ebola virus

It is believed that ebola was transmitted to humans from wild animals such as bats, porcupines and non-human primates like monkeys, chimpanzees and gorillas, due to close contact with infected wild animals and then transmitted from human to human through direct contact with the blood, secretions, organs or other bodily fluids of an infected person. It can also be transmitted through surfaces and materials for example bedding, clothing, contaminated with these fluids.

Prevention measures and Treatments of ebola virus

-Regularly wash your hands with soap and water
-Avoid contact with blood, and body fluids such as urine, faeces, saliva, sweat, vomit of people who are sick
-Avoid contact with items that may have come in contact with infected person's blood or body fluids such as clothes, bedding, needles, and medical equipment's
-Avoid contact with wild animals such as bats, forest antelopes, monkeys, chimpanzees

Fig. various prevention strategies of ebola virus

Did you know?

In 2016, the world health organization (WHO) approved a vaccine for use against ebola virus. It is believed that effective vaccines are the most infallible tool in eradicating ebola outbreak.

Sample item:

In 2024, a localized Ebola outbreak was reported in four districts of Uganda: Mubende, Kasanda, Kampala, and Wakiso. The Ministry of Health collected data on confirmed Ebola cases and deaths over a two-month period. The table below summarizes the data:

District	Confirmed Cases	Confirmed Deaths
Mubende	200	150
Kasanda	120	90
Kampala	80	40
Wakiso	50	20

Task

a) Draw a **bar graph** or a **pie chart** to represent the number of confirmed cases and confirmed death in each district.
b) Identify which district was affected the most in terms of:
   i) The highest number of confirmed cases.
   ii) The highest percentage of deaths relative to cases.
c) Write a short paragraph explaining the possible impact of the outbreak in the most affected district.
d) Suggest two measures the government or community health organizations can take to prevent further spread of Ebola in the most affected district.

3. Hepatitis Virus:

Hepatitis is an inflammation of the liver that is caused by a variety of infectious viruses and noninfectious agents leading to a range of health problems, some of which can be fatal. There are five main strains of the hepatitis virus, referred to as types A, B, C, D and E. however hepatitis B is the major concern. The prevalence of hepatitis B virus in Uganda is high. According to the ministry of health, this stood at 4.3% by 2016.

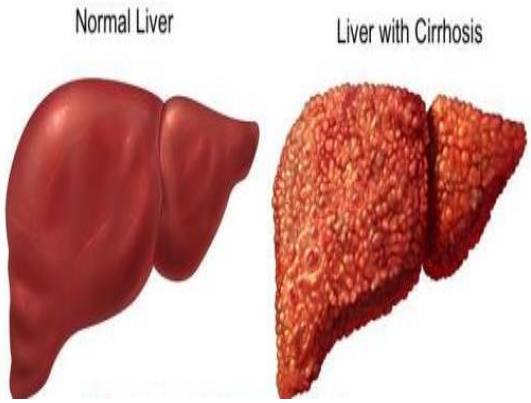


Fig. human liver affected by hepatitis B virus

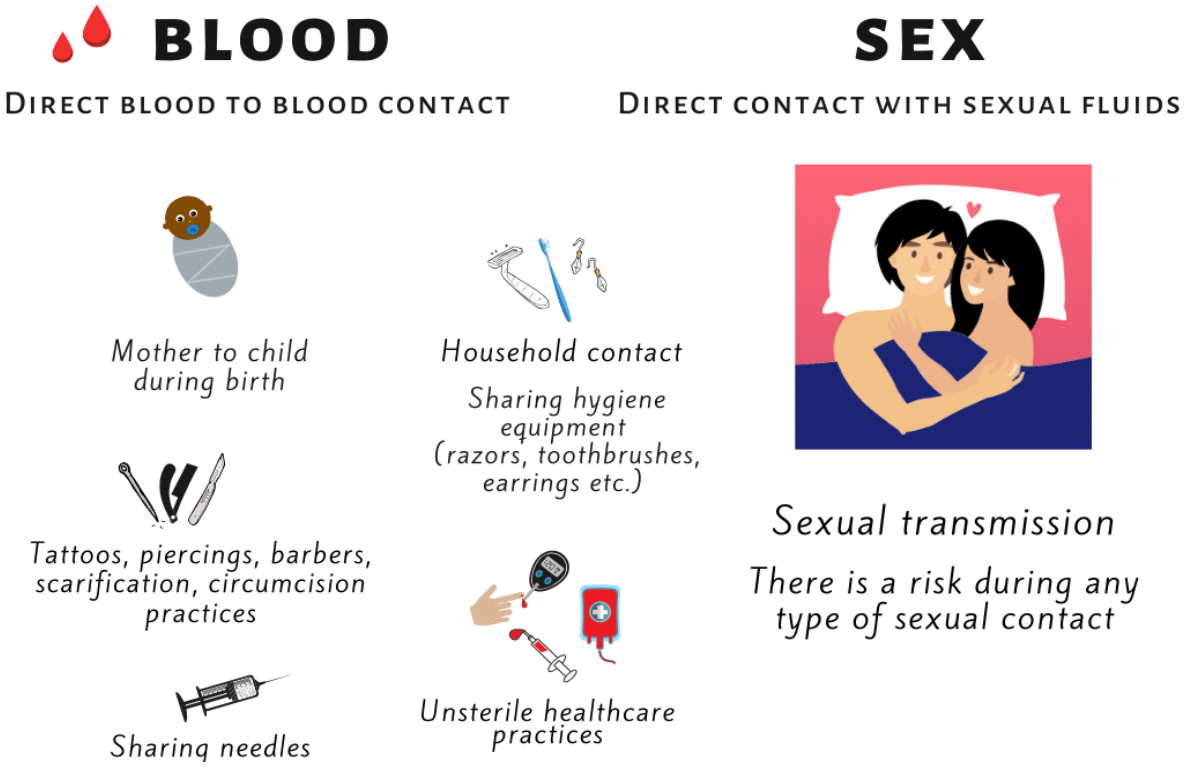
Understanding the symptoms, transmission and prevention of hepatitis B virus

Common symptoms of acute hepatitis B are:

- Abdominal pain, nausea, and/or vomiting.
- Dark urine or clay-colored stools.
- Fatigue.
- Fever.
- Jaundice.
- Joint pain.
- Loss of appetite

Fig. showing sign and symptoms of hepatitis B virus infection.

Transmission of hepatitis B virus.



Did you know?
The hepatitis B virus can survive outside the body for at least 7 days. During this time, the virus can still cause infection if it enters the body of a person who is not protected by the vaccine. The incubation period of the hepatitis B virus ranges from 30 to 180 days. The virus may be detected within 30 to 60 days after infection and can persist and develop into chronic hepatitis B, especially when transmitted in infancy or childhood.

Prevention strategies of hepatitis B virus

Hepatitis B is a vaccine-preventable disease. More than 1 billion doses of the hepatitis B vaccine have been given worldwide, and it is considered to be a very safe and effective vaccine to protect infants, children and adults from hepatitis B. In addition to vaccination, there are other simple ways to help stop the spread of hepatitis B:

- Wash your hands thoroughly with soap and water after any potential exposure to blood
- Use condoms with sexual partners
- Avoid direct contact with blood and bodily fluids
- Clean up blood spills with a fresh diluted bleach solution
- Avoid sharing sharp items such as razors, nail clippers, toothbrushes, and earrings or body rings
- Discard sanitary napkins and tampons into plastic bags
- Make sure new, sterile needles are used for ear or body piercing, tattoos

Note: It is important to remember that hepatitis B is not spread casually! It is not spread by coughing, sneezing, hugging, cooking and sharing food. It is spread through direct contact with infected blood and bodily fluids.

Sample item 1.

In the Northern Uganda district of Gulu, health officials reported a high prevalence of hepatitis B, with infection rates reaching 17% among the adult population. The Ministry of Health, in collaboration with international health organizations, implemented a series of strategies to combat the spread of the virus. These included free vaccination drives for high-risk groups, public awareness campaigns on the importance of vaccination and safe health practices, and the provision of hepatitis B testing and treatment in all public health facilities.
Additionally, schools in the district introduced education programs on the dangers of sharing sharp objects and the importance of regular health check-ups. Local

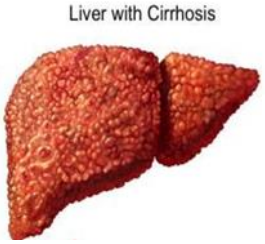
leaders and religious organizations were actively involved in promoting these initiatives to ensure community participation.
Despite these efforts, challenges such as vaccine shortages, myths about the vaccine, and reluctance to seek medical attention hindered progress.

Task:

a) Identify the strategies being used to prevent the spread of hepatitis B in Gulu district as mentioned in the scenario.
b) Explain why each of these strategies is essential for reducing hepatitis B prevalence in the region.

Sample item 2.

Mr. Joseph became ill and was advised to visit a nearby hospital. On his arrival the receptionists directed him to the doctor for consultations. He was then asked by the doctor to describe how the disease makes him feel. He described it that he feels headache, abdominal pain, loss of appetite, fatigue, dark urine, pale stool and jaundice. On analysis. His liver was found infected with a virus as seen below.



(a) Which viral disease do you think the doctor diagnosed.
(b) How do you think the transmission of the disease should be prevented?
(c) Describe the characteristics of the agent causing the disease.

4. cassava mosaic virus.

Cassava is one of the staple foods for Africans in different countries. Cassava plants are usually threatened by a serious disease that affects leaves and stems known as cassava mosaic disease.
Cassava mosaic virus causes cassava mosaic, a disease in cassava plants. The disease has led to great losses to farmers, especially in areas where cassava is the staple food for the community.

Fig A) affected cassava plant

B) Healthy cassava plant

Understanding the symptoms, transmission and prevention of cassava mosaic virus

Common signs and symptoms of cassava mosaic virus.

-Affected leaves show a characteristic mosaic pattern with yellow or pale green patches interspersed with normal green areas. This mottled appearance is the most visible and diagnostic symptom of the disease.
-Infected leaves often become distorted, with curling or twisting at the edges. The leaves may also appear smaller than those on healthy plants, further reducing the plant's ability to photosynthesize effectively.
-Plants affected by cassava mosaic disease experience stunted growth, resulting in shorter stems and reduced overall size. This is due to the compromised ability of the plant to produce energy through photosynthesis.
-Cassava mosaic disease significantly impacts tuber production, leading to smaller or fewer tubers. The poor development of tubers is a direct result of the plant's reduced photosynthetic activity and overall health.
-Chlorosis, or yellowing of the leaves, is another common symptom, often appearing along the veins. This symptom indicates a severe infection that further hampers the plant's growth and productivity.

Fig cassava plants affected by cassava mosaic virus

Transmission of cassava mosaic virus.

-Cassava mosaic virus disease is a viral disease which is carried by insects such as whiteflies. When the whiteflies suck sap from the plant thy pick up the virus, and then transport and inject it while feeding on the next cassava plant.
-The use of cassava stem cuttings from infected plants for propagation is another significant mode of transmission. Since cassava is commonly propagated vegetatively, infected cuttings ensure that the virus persists in new crops.
-Though less common, the virus can also be spread mechanically through tools and equipment used for harvesting or pruning, especially if these tools come into contact with infected plant sap.

Prevention strategies of cassava mosaic virus.

-Growing cassava varieties that are resistant to cassava mosaic disease is one of the most effective prevention strategies. Examples include resistant varieties developed by agricultural research institutions like NARO in Uganda.
-Ensuring that only clean, virus-free cassava stem cuttings are used for planting.
-Managing whitefly populations, the primary vector of cassava mosaic disease, helps limit the virus's spread. Strategies include the use of insecticides, planting whitefly-repellent crops around cassava fields, or using biological control methods such as introducing natural predators.
-Rotating cassava with non-host crops for example legumes or cereals can disrupt the life cycle of the virus and its vectors.
-Educating farmers about cassava mosaic disease symptoms, transmission, and prevention methods is essential. Awareness campaigns can help farmers recognize infected plants and adopt best practices to minimize spread.
-Cleaning tools used for planting, pruning, and harvesting cassava prevents the mechanical transmission of the virus between plants.

Sample item 1

Cassava mosaic disease continues to hinder productivity of cassava among Ugandan farmers with infected crops having mottled and twisted leaves. The virus responsible for causing the disease also results in blockage of phloem vessels. During harvest smaller tubers are uprooted.

Task

a) Mention the affected organs and plant processes affected by the disease leading to poor yields.
b) Explain how the disease contributed to poor productivity at harvest
c) Suggest possible measures by farmers to ensure proper growth and better yields.

Sample item 2

Mr. John is a great farmer in masaka. His cassava plants developed twisted/curled leaves with mosaic patterns and the tubers where deformed. He obtained very low yields last season, but is not certain of the cause.

Support material

Figure 1: shows a representative cassava plant from his garden

Task

(a) Name the plant structures and processes that were affected in the cassava plants.

i)Plant structures

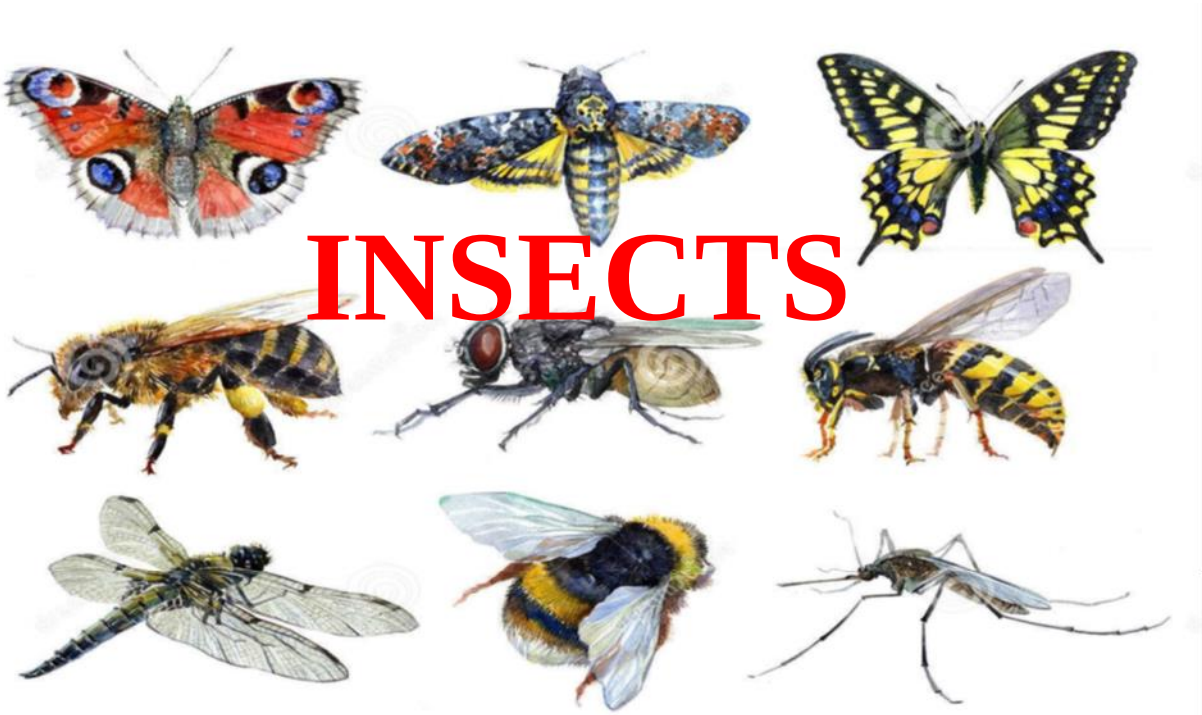
ii)Processes affected

(b) Describe how the symptoms developed on plants affected the normal functioning of the plants.

(c) Describe the cause of the symptoms developed by plants and state how the cause is spread in the garden.

(d) Provide possible solutions on how Mr. Musoke can overcome the symptoms in his garden the following seasons.

CHAPTER 6



INSECTS

Competency: The learner understands the characteristics of insects, relates structures to their functions in some common insects, and appreciates that insects have a direct or indirect effect on the well-being of other organisms.

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

a) identify the observable external features of a housefly, cockroach, mosquito, termite, bee, and butterfly (No details of mouth parts required) (k, s)
b) construct a dichotomous key (s)
c) appreciate the useful and harmful effects of a housefly, cockroach, mosquito, bee, and butterfly (u) (v)
d) know the different methods of controlling the harmful stages of a housefly, cockroach, mosquito, and butterfly (u)

Introduction

Insects, belonging to the class Insecta, are the most diverse group of animals on Earth, comprising over a million described species and accounting for more than half of all known living organisms. These arthropods play crucial roles in various ecosystems, acting as pollinators, decomposers, and a food source for other animals. Insect populations and their variety can tell us significance in the environment that they are worth studying. Their physical features and behaviour give an idea of the role they play in the lives of man, plants and other living organisms. The insects that we interact with regularly are the housefly, cockroach, mosquito, worker bee, and butterfly and soldier termite.

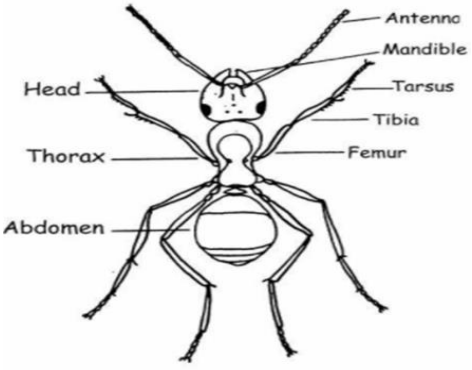
Characteristics of insects.

Insects have specific features common to all of them. Such features distinguish them from other organisms in phylum Arthropoda. However, some features in insects vary from one insect to another.

-Insects have three body parts, namely: the head, thorax, and abdomen.
-They have one pair of antenna.
-They have a pair of compound eyes. In some case, simple eyes are also present.
-They have three pairs of walking legs on the thorax. One pair of walking legs per segment of the thorax.
-Most insects have one or two pairs of wings on the second and/ or the third segment of the thorax. Some insects have no wings.
-They breathe by means of spiracles and carry out gaseous exchange in the tracheal system.
-They undergo complete or incomplete metamorphosis with a larval stage.
-Some insects such as ants are carnivorous while others such as grasshoppers are herbivorous.

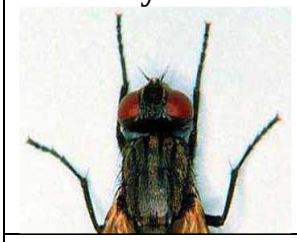
Observable external features of an insect

All insects have three main body parts, that is, the head, thorax and abdomen. These parts bear other structures that enable the insect to function normally and live well in its environment.



Identifying the external structures on the head of an insect

The head forms the first body division/part in all insects and consists of structures such as the mouth parts, antennae, and may or may not have eyes.

Insects	**Description of the features**		
	Type of mouth parts	**Antennae (number, length and shape)**	**Eyes (number, type and shape)**
Cockroach 	biting and chewing.	A pair of long, slender, flexible and segmented antennae.	A pair of large compound eyes. Three simple eyes.
Housefly 	Siphoning	One pair of short hairy antennae.	A pair of compound eyes. Three simple eyes.
Butterfly 	Siphoning and sucking	A pair of short, jointed and clubbed-shaped antennae.	A pair of compound eyes. Three simple eyes.
Termite 	Biting	A pair of short, hairy antennae.	No eyes.
Mosquito 	Piercing and sucking	One pair of short hairy antennae (long in males).	A pair of compound eyes. Two simple eyes.

Bee 	Chewing and lapping	A pair of short, tapered and segmented antennae.	A pair of compound eyes. Three simple eyes.

Functions of the features of on the head of an insect.

1. Eyes

All insects studied (cockroach, housefly, mosquito, worker bee, butterfly and soldier termite) apart from termites have compound eyes
Compound eyes have poor image resolution; however, they possess a very large view angle and the ability to detect fast movement and light.
Insect's eyes are made up of thousands of tiny light detectors packed closely together which allow them to spot very fast movements and see in a wide angle all around their bodies. Hence, avoid sudden attacks from hungry predators.
The compound eyes in bees are specifically useful for pollination because they need to differentiate between a bud, mature flower and dying bloom. Bees have five eyes, two large compound eyes and three small simple eyes/ocelli located between the compound eyes to perceive light.

Antennae/feelers

All insects have a pair of antennae. The shapes and size differ in different insects. For instance, cockroaches have a long pair of flexible and segmented antennae which help them to pick up smells and vibrations. The worker bees have short and segmented antennae. The antennae on each insect play a significant role of smelling, feeling the surface of an object, sensing hot and cold, listening to sounds or detecting any movement around them.

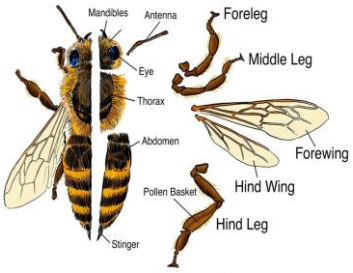
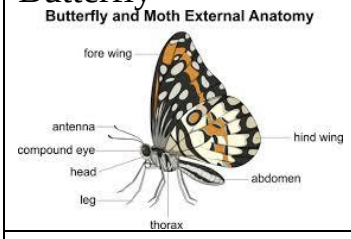
Mouthparts

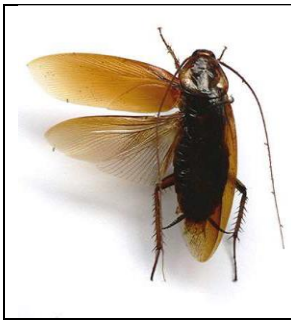
Insects have different types of mouthparts that are adapted for their feeding habits. For example, some insects chew solid food, while others pierce and suck.

THE THORAX OF AN INSECT

The thorax is the mid-section tagma of the insect. This part of the insect is divided into three segments namely: prothorax, mesothorax and metathorax. The thorax of an insect bears structures such as spiracles, legs and may or may not have wings.

FEATURES OF THE THORAX

Insects	Description of the features of the thorax		
	Wings (number and texture)	**Legs (number, length and texture)**	**Number of segments**
Housefly 	A pair of smooth Transparent (membranous) veined wings.	3 pairs of hairy, jointed and segmented legs with glandular pads in between the claws.	Three segments
Bee 	2 pairs of heavy membranous wings.	3 pairs of hairy and segmented legs. Hind legs have pollen brushes and basket.	Three segments
Termite 	No wings	3 pairs of shorter jointed legs.	Three segments
Butterfly 	2 pairs of smooth and powdery wings.	3 pairs of jointed and segmented legs with arolium in between the claws.	Three segments
Mosquito 	One pair of transparent, veined and membranous wings.	3 pairs of long jointed thin legs.	Three segments
Cockroach	Two pairs of wings.	3 pairs of muscular	Three segments.

	• A pair of hard stiff dark-brown outer wings. • A pair of soft, membranous and folded inner wings used for flight.	jointed legs with spines with glandular pads in between the claws.	

WINGS

Wings of mosquitoes and houseflies

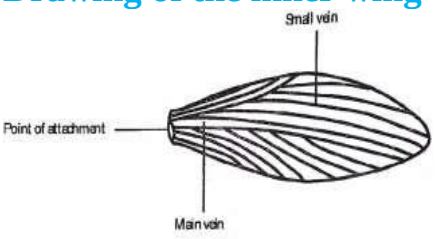
Most of the insects have one pair of wings; on their mesothorax segment and a pair of halters on the metathorax. What would be the hind pair of wings is reduced to small halters that aid insects in flight stability. **Halters** are small balancing organs.

Wings of cockroaches

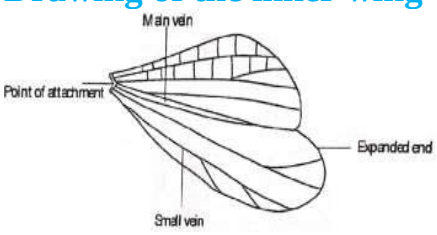
Cockroaches have two pairs of wings. They have the outer wings which are brown, hard and opaque on their mesothorax segment.
The outer wings give protection to the inner wings attached on the metathorax segment which are large, soft and transparent.

Diagram showing structures of wings of cockroaches

Drawing of the inner wing



Drawing of the inner wing



Differences between hind (outer) and inner wings.

Wings of butterfly

A butterfly has four wings, two on each side. They are broken into two fore wings and two lower wings called the **hind wings**. Its wings are very fragile and flexible but strong enough to support the butterfly's body in the air.

Wings of a worker bee

A worker bee has two pairs of wings connected by a row of hooks on the back wing. The fore wings are much larger than the hind wings but they both help the worker bee with flight.

NB: Soldier termites do not bear wings.

LEGS

Insects have three pairs of jointed legs. For example, the cockroaches, worker bees, butterflies, houseflies, soldier termites and mosquitoes.
Cockroaches have enlarged hind femur in its hind leg with powerful muscles and spines.
The worker bee legs possess a hairy pollen basket that is used to transport pollen from flowers to the hive.

Diagram showing structure of hind leg of a cockroach

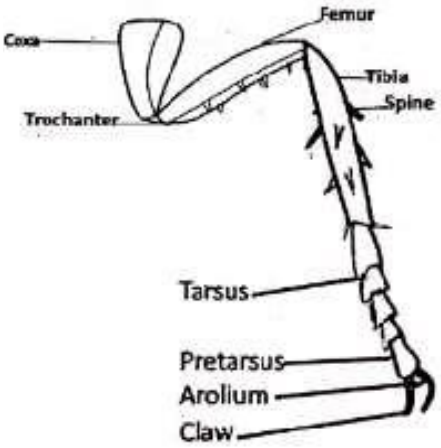
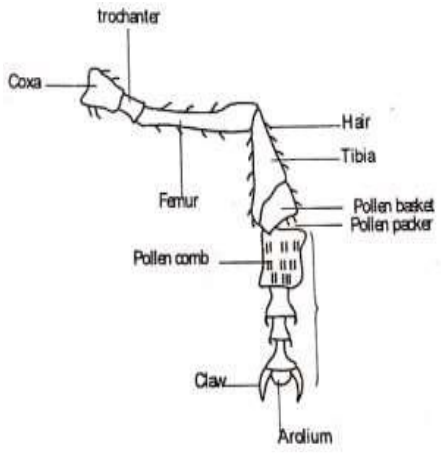


Diagram showing part of the leg of a worker bee



The abdomen part of an insect

An insect's abdomen is their functional tagma of its body. The abdomen is located just behind the thorax. In most insects the junction between thorax and abdomen is broad but in some groups the junction is very (petiolate) giving the appearance of a "wasp-waist".

Insects	Description of the features of the abdomen		
	Shape	**Texture**	**Other features**
Housefly	Blunt ended.	Smooth and hairy.	Expanded organ ovipositor. - Anal cerci on last segment in males.
Mosquito	Elongated and narrow.	Smooth.	Reproductive structures
Bee	Thick and blunt at the end in drones. - Long and pointed in workers and queens.	Rough hairy scales.	Sting in workers only. - Reproductive structures on queen bees.
Butterfly	Narrow	Rough with scales.	Finger-like cerci.
Termite	Blunt ended.	Smooth.	Reproductive structures.
Cockroach	Broad in females. - Narrow in males. - Dorso-ventrally flattened.	Smooth and glossy.	Anal styles and anal cerci in males. Anal cerci and podical plates in females.

IDENTIFICATION OF INSECTS

A dichotomous key is a tool that can be used to identify organisms in the natural world. “Dichotomous” originates from the Greek word meaning “branching in two” and refers to the fact that you have two descriptions to choose from at each step.

Each step of the key provides two choices until there are no more choices to be made and you have identified the organism.

Note. Dichotomous keys may differ depending on the choice of features used during the making of the key.

You are going to construct a dichotomous key to identify different insects using their characteristics discussed before in this chapter.

Construction of a dichotomous key to identify common insects.

Table of characteristic features on the abdomen of insects.

Insects	Features		
	Head	**Thorax**	**Abdomen**
Cockroach	- Long antennae. - Biting and chewing mouth parts. - 3 simple eyes.	- 2 pairs of wings. - Glossy.	- Long abdomen.

Bee	- Short antennae. - Chewing and lapping mouth parts. - 3 simple eyes.	- 2 pairs of wings. - Hairy.	- Short abdomen.
Housefly	- Short antennae. - Siphoning and lapping mouth parts. - 3 simple eyes.	- One pair of wings. - Hairy.	- Short abdomen.
Butterfly	- Short antennae. - Siphoning and lapping mouth parts. - 3 simple eyes.	- 2 pairs of wings. - Scaly.	- Long abdomen.
Mosquito	- Short antennae. - Piercing and sucking mouth parts. - 2 simple eyes.	- One pair of wings. - Hairless.	- Long abdomen.
Termite	- Short antennae. - Biting mouth parts. - No eyes.	- No wings. - Glossy.	- Long abdomen.

Dichotomous key

1. (a) Have short antennae. …….…. go to 2
(b) Has long antennae. …… cockroach
2. (a) Have wings. …….....go to 3
(b) Has no wings. ……. termite
3. (a) Have short abdomen. ……..... go to 4
(b) Have long abdomen. ……...…go to 5
4. (a) Has two pairs of wings……. worker bee
(b) Has one pair of wings……housefly
5. (a) Has piercing and sucking mouth parts……mosquito
(b) Has siphoning and lapping mouth parts……. butterfly

THE BENEFITS AND HARMFUL EFFECTS OF INSECTS

The existence of insects in the environment plays a big role to the existence of the rest of the living organisms. In the next activity, you need to find out how the

insects studied in this chapter are helpful to the existence of other organisms and to the environment as well as how harmful they can be to them.

Benefits of insects to other organisms and their surroundings.

In our environment, insects are important components of the ecosystem. They perform many relevant functions in the environment such as:
Insects are decomposers of organic matter feeding on dead animals and plants such that the recycling of nutrients back into the soil is done.
As decomposers, insects help in the formation of top soil (humus), the nutrient-rich layer of the soil that helps plants to grow.
Maggots feed on organic matter in ***latrines*** preventing it from accumulating.
Burrowing insects dig tunnels that provide channels for water which benefits the plants.
Bees and butterflies are good pollinating agents, hence support the reproduction process of plants.
Butterflies have nice colours that offer great beauty in the environment.
Butterflies are indicators of a healthy environment and healthy ecosystem.
Butterflies produce chemicals that chase away predators and parasites which have been exploited economically.
Bees produce honey which is of good medicinal and nutritional value to man.
Bees provide wax used in industry to make candles, varnish, shoe polish etc.
Some insects help farms to control other harmful insects (pests) such as aphids and caterpillars which feed on new plant growth.
Grasshoppers and ants are food for man and other animals.

HARMFUL EFFECTS OF GIVEN INSECTS

Sometimes insects have harmful or negative effects to the organisms and to the environment in which they are found.
• Caterpillars which is the larva stage of butterflies destroy crops, trees and other useful property thus reduces the productivity.
• Cockroaches bite and destroy important materials such as paper, clothes, wood and food.
• Cockroaches and houseflies contaminate food with faecal material and germs as they leave latrines and walk or land on food in the house.
• The powder from the wings of butterflies, cause alleges in humans
• Some insects are vectors that transmit diseases to human beings, animals and plants. For example, houseflies carry germs that cause diseases like typhoid, trachoma, diarrhoea and dysentery. Mosquitoes spread the following disease-causing germs
.

LIFE CYCLES OF INSECTS

A life cycle refers to the stages of development through which an organism undergoes from eggs to adult. Insects show ***metamorphosis*** in their life cycle. Metamorphosis is the existence of different forms/stages of the same organisms during its life cycle.

ASSIGMENT

1. In groups, research about the lifecycles of the following insects: Butterfly, mosquito, housefly, cockroach, termites and bees.

2. Write a report on your findings. In the report, include the following: number of stages, diagrams of the lifecycles and time taken to complete the cycle.

HARMFUL AND USEFUL STAGES OF INSECTS

Insects have got different adaptations at each stage of development which enables them to perform different functions. Insects use these adaptations to cause harm to other organisms.

At one stage of development in its life cycle, an insect can be important, while at another, it can be dangerous.

Insect	**Useful stages**	**effects**	**Harmful stages**	**effects**
Housefly	Larva	- It reduces the bulk of waste minimizing environmental risks of its disposal. - Feed for animal nutrition.	Adult	- It spread pathogens attached on their hairy bodies from contaminated breeding sites to other organisms.

Mosquito	Larvae	- It is food to fish.	Adults	- Female anopheles mosquitoes are vectors for plasmodium parasites.
	Adults	- It pollinates aquatic plants as they obtain nectar.		
Termite	Adult	- It digs tunnels in soil aerating the soil. - It facilitates decomposition of materials increasing soil fertility. - Queens are fed on by humans.	Adult	- It destroys crops by feeding on them for example cutting stems of trees and maize.
Cockroach	Adult	- It helps in decomposition of materials.	Adult	- Vectors for pathogens. - Destroy property such as papers and clothes.
Bee	Adult	- It produces honey extracted for use by people. - It produces bees wax for use by man.	Adult	- It stings people causing irritation of the skin. - It makes noise disrupting feeding in animals like elephants.
Butterfly	Larvae	- It produces silk (silk worms) used in textile industries.	Larvae	- It destroys crops in fields by feeding on them.
	Adults	- It is a basis for art and design. - It pollinates flowers of plants.		

METHODS OF CONTROLLING THE HARMFUL STAGES OF INSECTS.

Previously we have seen that some stages in the life cycle of insects are dangerous to other living things and property. However, some preventive mechanisms have been designed to overcome their harmful effects without risking extinction. In this

activity you will explore and analyse the different methods of controlling the harmful stages of insects.

CONTROLLING HOUSEFLIES

Improvement of environmental sanitation and hygiene. Four strategies can be employed:

(a) Reduction or elimination of fly breeding sites through: Reduction of sources that attract flies from other areas; and prevention of contact between flies and disease-causing germs.

(b) The measures to eliminate fly breeding sites also reduce contact between flies and germs. The installation and use of proper latrines and toilets where flies cannot contact faeces.

(c) Prevention of contact between flies and sick people, their excreta, soiled baby nappies, open sores, and infected eyes.

(d) The prevention of access of flies to slaughter houses, offal and dead animals.

• Protection of food, eating utensils and people from contact with flies.
• By killing flies directly by either physical or chemical methods.
• Use of fly traps and sticky tapes.
• Introduction of toxic materials to resting sites.
• Attracting of flies with toxic baits.
• Treatment of resting sites with residual insecticides.
• Spraying with pressurized aerosol spray cans, hand-operated sprayers or small portable power sprayers. The principle is to fill a space with a mist of small droplets that are picked up by the insects when they fly.
• Treatment of breeding sites with larvicides: - chemical substances that kill larvae which are mainly used on dung on farms.

CONTROLLING CATERPILLARS

• Hand picking them and killing them.
• Physical prevention by fencing them out using fine mesh netting.
• Repelling them using plant extracts.
• Using decoy/trap crops that attract caterpillars leaving desirable plants free from caterpillars.
• Practicing crop rotation to cut the life cycle of caterpillars short.
• Planting strong scent herbs such as rosemary and lavender that repel caterpillars.
• Introducing biological enemies such as chicken, ladybugs and parasitic wasps that kill the worms.
• Spraying with insecticides.

CONTROLLING TERMITES

• Pouring termicides in termite mounds.

• Placing termite baits, which traps and kills termites in the group.
• Using termite barriers such as termite shields to avoid attack by termites.
• Fumigating items having termites.
• Treating wood with borate which is used to kill termites.

CONTROLLING MOSQUITOES.

• Introduction of mosquito eating fish to feed on the mosquito larvae.
• Pouring oil on stagnant water to suffocate the larvae.
• Draining away stagnant water to prevent mosquitoes from laying eggs.
• Disposing empty containers and plastic bags properly to prevent water from collecting in them.
• Fumigating houses.
• Spraying using suitable and environmentally friendly insecticides.
• Painting the house with bright colours.
• Ensuring that rooms are well lit.
• Clearing bushes and tall grass around homes to reduce mosquito breeding areas.
• Using treated mosquito nets to cover beds at nights. Nets can also be used at doors or windows to prevent mosquitoes from getting into houses.
• Applying mosquito repellents on the body to keep mosquitoes off and thus prevent mosquito bites.

CONTROLLING COCKROACHES

• Proper sanitation to eliminate breeding grounds for cockroaches. This ensures that cockroaches have no dirt to feed on.
• Making sure buildings are in good repair to make it harder for cockroaches to get in and give them fewer places to live and breed in.
• Inspecting areas where we suspect presence of cockroaches and spraying them with insecticides.

Sample items.

Item 1

Mr. Godfrey is a cattle farmer in Nakasongola district. In a bid to reduce destruction of people's crops by his cows, he fenced his land using poles however after a period of 8 month; he observed the poles falling down due to destruction of the poles by certain organisms. He observed the following organisms around the poles but not sure of which organism could have caused the damage.

Support material

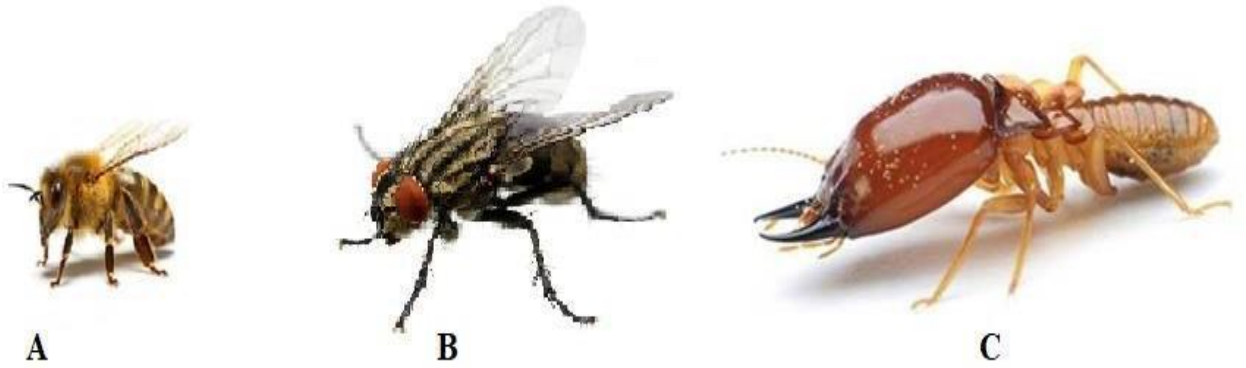


Figure 2: shows organisms obtained around the poles.

Task

(a) Giving two reasons in each case, state any two shared taxonomic levels among the organisms given above.

(b) With a reason, state the organism responsible for the damage of the poles.

(c) In order to overcome the destruction, he has decided to kill the organism responsible for damage by spraying it with insecticides. Explain the likely effects on the environment due to his decision.

(d) Describe how the effects of organism B can be overcome by the farmer in his family.

Item 2

Nathan is a maize farmer in ociba village. The village is experiencing an outbreak of a new pest which has a stage in its lifecycle that feeds on leaves and stems of maize plants. Analysis done on a sample of leaves and stems affected by the pest shows that, organelles for protection, those that are responsible for making food for the plant, among others, were destroyed completely. Naptali is worried that the feeding mode of the pest may cause reduction in both yield and grain quality.

Task:

(a) Identify the cell structures affected basing on the results of the analysis.

(b) How do the actions observed in analysis impact the normal functioning of the cells leading to reduced yield and grain quality?

(c) Name the harmful stage of the pest.

d) Advice Naptali on how he can control the harmful stage of the pest

Item 3

John a prominent farmer in Kamuli District was advised by the district Agricultural officer to reduce or even stop use of herbicides (chemicals used to kill weeds) as they may be partly the cause of his recent poor harvests last season since they kill important insects that are important in plant life.

Figure 2 shows some insects the officer talked about.

Task

a) State two similarities and differences between the above insects

b) Explain the roles the above insects play in plant life.

CHAPTER 7

FLOWERING PLANTS

Competency: The learner understands that different parts of flowering plants carry out different functions, and understands how the parts

The learner should be able to:

a) know the external parts of a typical flowering plant (k, u)
b) understand how the structures of monocotyledonous and dicotyledonous roots, stems, leaves, flowers, and fruits suit their functions (u)
c) Classify leaves (a)

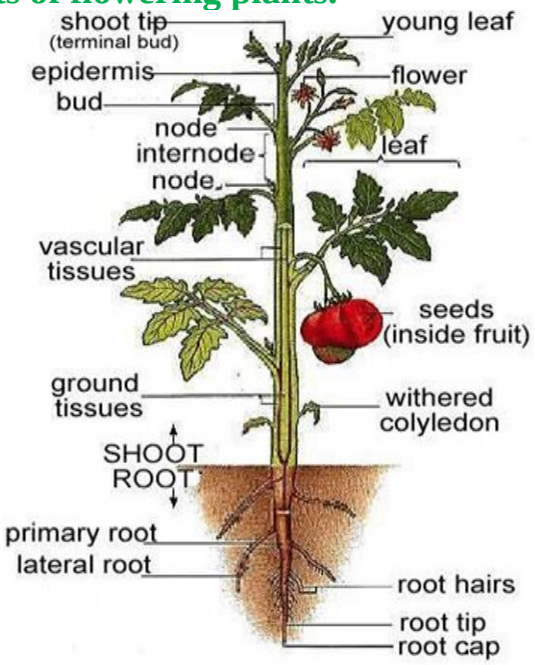
Introduction to flowering plants

Flowering plants, also known as angiosperms, comprise the largest and most diverse group of plants on Earth. They are characterized by the presence of flowers, which are specialized reproductive structures responsible for sexual reproduction. Plants are multicellular organisms that are easily seen by our naked eyes. Their cells have chlorophyll that absorb sunlight energy that is used in the process of making food.

External parts of a flowering plants

Flowering plants has got different parts which have unique features that complement their roles in the plant life. However, these features often make them as well useful to other living things. These parts are divided into two systems.
The root system is the portion below the ground on a plant axis and it penetrates into the soil
The shoot system is the portion above the ground or soil level.

External parts of flowering plants.



Major divisions of flowering plants

Flowering plants are divided into two groups depending on the number of cotyledons their seeds have:

Monocotyledonous plants

Monocotyledonous plants are commonly referred to as monocots, are a major group of flowering plants characterized by special features in their anatomy, growth pattens, and seed structure. They have a single cotyledon which is the embryonic leaf within the seed.

Examples include: Maize, Rice, Wheat, Barley, Sorghum, Sugarcane, and Bamboo


sorghum


maize


rice


wheat


sugarcane


bamboo


barley

characteristics of monocotyledonous plants

- monocots have parallel leaf venation
- the embryo of monocot seeds bears one cotyledon
- monocot leaves are composed of open or closed sheath which encloses the stem
- have scattered vascular bundles in their stems
- they have long and thin leaves
- they have fibrous root system
- they undergo hypogeal types of germination.

Dicotyledonous plants

Dicotyledonous plants are commonly referred to as dicot, are groups of flowering plants characterized by having two cotyledons.
Examples include: beans, orange plant, mango pant, avocado plant, coffee plant, ground nut among others.


beans plant


pawpaw


oranges


mango

characteristics of dicotyledonous plants

- dicot leaves have network venation
- their stems have vascular bundles which appear in a ring form
- they have tap root system
- their seed embryo has two cotyledons
- dicot plants have petioles that support the leaf
- they have short and broader leaves
- they undergo epigeal types of germination

Differences between monocot and dicot plants

Monocotyledonous plant	Dicotyledonous plant
Seeds have only one cotyledon	Seeds have two cotyledons
Leaves has parallel leaf venation	Leaves has network leave venation
Stems vascular bundles are scattered	Stems vascular bundles are in rings
Has fibrous root system	Has tap root system
Has long and thin leaves	Has short and broader leaves
Leaves are attached to the stem by an open or closed sheath	Leaves are attached to the stem by petioles or leaf stalk
Secondary growth absent	Secondary growth present
They undergo hypogeal germination	They undergo epigeal germination

Similarities between monocot and dicot plants

- Both contain specialized vascular tissues arrange in bundles
- Both produce flowers which specialized structure for sexual reproduction
- Both have stems, roots, and leaves though their arrangement and structure differs.

Structures of monocotyledonous and dicotyledonous plants.

Monocotyledonous and dicotyledonous plants have got different parts which have unique features that complement their roles in the plant life. However, these features often make them as well useful to other living things. These parts are divided into two systems.

Root system.

Roots are the essential parts of plants, serving several vital functions. They anchor the plant in the ground, providing stability and absorption of water and nutrients from the soil. The root systems are either fibrous or tap root system.

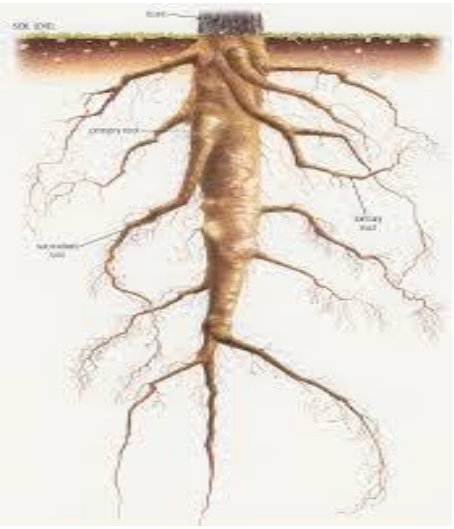
Fibrous root system

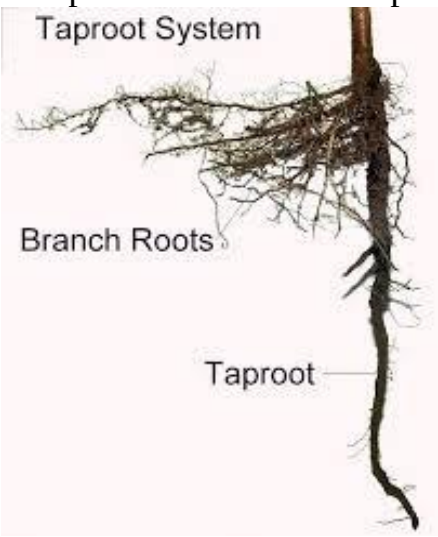
The fibrous root system is characterized by numerous thin highly branched roots that arise from the base of the stem. Its commonly found in monocotyledonous plants such as grasses, rice, wheat. In this system there is no prominent central root and the root grows shallowly and spread horizontally.

Tap root system

Tap root system consists of a single, main root known as the tap root, which grows vertically into the ground. It is found in dicotyledonous plants such as trees, shrubs and many flowering plants. The tap root is generally thick and elongated with smaller lateral roots branching off from it.

It provides strong anchorage to the plant and enable it to penetrate the soil deeply.



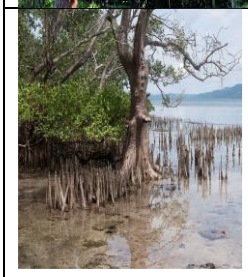


Functions of roots

- They absorb water and mineral salts from the soil for the plant.
- They fix the plant firmly in the soil.
- Transport water and mineral salts to the shoot.

Modified roots

Plant roots are generally meant for anchorage and absorption of water and mineral salts from the soil. However, in certain plants roots perform additional functions. The root structure undergoes certain modifications to perform these additional functions in the plants.

Root	Modification and description	Special function performed
	**Hanging aerial roots**: These roots are aerial, hanging and spongy. They have a porous wall and absorb moisture from the atmosphere.	Absorption of water moisture and nutrients from the air
	**Breathing roots**: are specialized roots that grow above ground to help plants absorb oxygen from the atmosphere. They are found in trees and plants that grow in environments with limited oxygen, such as mangroves.	Trapping oxygen in air for respiration of roots in water logged soil
	**Buttress roots**: are large, wide roots that grow on all sides of a tree at its base. They are a type of aerial root that help stabilize trees, especially in shallow, saturated soils.	Providing extra support to large trees
	**Prop roots**: are modified roots that grow from the stem of a plant and support its branches. They are a type of aerial root, which means they grow above the ground.	Providing extra support to plants with weak stems
	**Swollen fibrous roots**: are modifications of the fibrous root system for the storage of food. They store food prepared by the plant within them, which makes them fleshy and swollen.	Storing dissolved food and water
	**Swollen tap roots**: are fleshy roots that store food in many plants.	Storing water and dissolved food
	**Clasping roots**: They are thinner, more numerous and grow horizontally to girdle the stem of the support.	They provide support to the climbing plant

	**Root nodule**: a knob-like structure on the roots of plants that forms when the plant interacts with nitrogen-fixing bacteria.	Habouring rhizobium bacteria for nitrogen fixation.
	**Stilt roots**: A tree root that arises from the lower trunk and runs obliquely to the ground, providing additional support for the tree.	These roots support the plant above the mud for example, in the red swampy mangrove.

The stem

The stem is part of the shoot that supports the rest of the shoot parts. It has a main growing point at the tip called a terminal bud. The leaves are arranged alternately on the stem and the angle between the leaf and the stem is known as the Axil. A bud develops from the Axil and it is called the Axillary bud. This bud is responsible for formation of flowers and branches. The Axillary bud is also called the lateral bud. On the stem, leaves arise from regions called nodes. The space between two adjacent nodes is called the internode.

Functions of a stem

- It supports the leaves and spaces them out so that they receive enough light.
- It allows conduction of water and mineral salts from the roots to other parts of the plant
- Conduct manufactured food from the leaves to other parts of the plant.
- It supports flowers above the ground to facilitate pollination.

Modified stems

Stems exist in varied forms depending on the other additional functions they perform in plants. These stems have features that are different from the ordinary stems, this makes them to perform additional special functions.

Passion fruit stem

bean stem

cactus shoot

sugarcane stem

Banana sucker

sprouting irish potato

bougainvillea stem

ginger rhizome

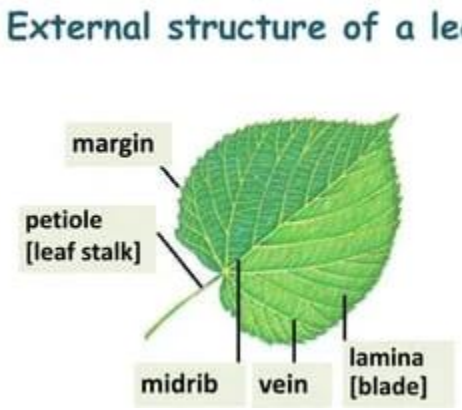
Stem(s)	**Characteristics**	**Special function(s) performed**
Sprouting Irish potato, sugar cane, ginger rhizome	Fleshy/swollen with food materials	Food storage
Sprouting Irish potato, sugar cane, ginger rhizome, banana sucker	They have buds, and are swollen with water and food reserves	Vegetative propagation
Bougainvillea, cactus	They have thorns	Protection
Passion fruit stem, bean,	They have hooks/thorns, tendrils for attachment to other plant	Support
Passion fruit stem, bean, bamboo, banana, cactus	They contain green pigments chlorophyl making them green	Manufacturing of food

Leaves

The leaves make up the largest vegetative part on the shoot. The leaf is made up of the upper and lower epidermis with a mesophyll layer between them. The surface of the leaf is called the lamina and it is supported by a series of veins. The leaf connects to the stem by the petiole (leaf stalk). Some plants (monocots) do not have a petiole; they instead have a leaf sheath.

A typical leaf consists of three main parts

- Leaf base this attaches the leaf to the stem
- Petiole/leaf stalk this holds the leaf blade exposing it to sunlight
- Lamina this is an expanded part of the leaf with veins. The middle prominent vein(midrib) together with other veins, provide rigidity to the leaf blade and provide means of transport for water and food materials.



Leaf venation

This is a description of the arrangement of veins in a leaf of a plant. There are mainly two types of venations.

1. **Network venation**; this is where veins are arranged in a network manner. It is also called reticulate venation. This type of venation is found in dicot. Plants.
2. **Parallel venation**: This is a type of venation where veins are arranged one parallel to the other. It is common in monocot plants.

Parallel venation in commelina leaf

network venation in hibiscus leaf

Phylotaxis/Leaf arrangement

This refers to how leaves are arranged on the stem of a plant. There are three main types of leaf arrangements.

Type of arrangement	Description	Structure
Opposite arrangement	This is where two leaves develop at one node with one leaf opposite the other	
Alternate arrangement	This is where one leaf develops at a node where by the position of each leaf at the node is different from the adjacent leaf on another node.	
Whorled arrangement.	This is where more than two leaves develop at a node	

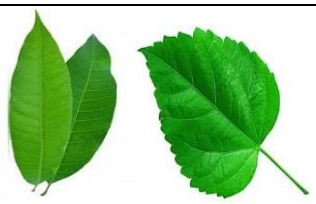
classification of leaves

Leaves are attached on plant stems and their classification is based on their characteristics. The main features used to distinguish leaves include; the nature of their lamina, types of venations, types of leaf margin, description of the leaf stalk and the shape of the leaf apex

There are two major types of leaves.

1. Simple leaves.

A simple leaf is one with undivided or a partially divided lamina. Simple leaves are Grouped into the following types.

Type of simple leaf	**Description**	**structure**
Simple entire	This is a leaf whose lamina is not divided at all for example hibiscus leaves, mango leaves, jack fruit leaves.	

Simple palmate	This is a leaf whose lamina is partially divided into a number of small portions, which look like the palm of the hand for example, the pawpaw leaves	
Simple digitate leaf	A type of leaf in which the leaf blade is divided into multiple lobes or segments (leaflets) that radiate from a single point at the end of the petiole, resembling the fingers of a hand. For example, cassava leaf	

2. Compound leaf.

This is a leaf whose lamina is completely divided into leaflets each with a small stalk. There are different types of compound leaves, which include the following.

Type of compound leaf	Description	Structure
Compound pinnate	This is a leaf whose lamina is divided into leaflets arranged in pairs one opposite the other, for example, cassia leaves	
Compound bipinnate	This is a leaf whose lamina is divided into leaflets and the leaflets further divided into sub leaflets, for example, Jacaranda leaf.	
Compound trifoliate	This is a leaf whose lamina is divided into three leaflets for example, the bean leaf and Soya bean leaf.	

Compound digitate	This is the leaf whose lamina is divided into a number of leaflets which radiate from the end of the stalk like fingers of the hand for example, in silk cotton.	

Functions of leaves.

The primary functions of leaves include.
1. They make food for the plant through photosynthesis.
2. They have stomata, which carry out gaseous exchange.
3. They carry out transpiration, which aids in water and mineral salt absorption. Transpiration also helps in cooling the plant during high temperatures.

Modified leaves.

Modified leaves are leaves that have undergone structural or functional changes to adapt to specific environments or perform specialized roles other than its primary functions. These modifications enable plants to survive in diverse conditions or fulfill unique roles in reproduction, protection, or nutrient acquisition.

Cow pea

Onion

Venus fly trap

Cactus leaves

Pitcher leaf

Solanum leaf

Bryophyllum

Modified leaf	Modification	Special function
Cactus leaves	Thorns, fleshy and swollen	Protection and storage of water
Venus fly trap	Has short, stiff trigger hairs	Trapping insects and digesting them to obtain nitrogen
Solanum leaf	Has thorns	Protection from browsers and grazers
Cow pea	Has leaf tendrils	Providing extra support
Bryophyllum	Freshy, swollen and contains buds	Vegetative propagation and storage of water
Pitcher leaf	Pouch with digestive enzymes	Capturing and digesting organisms
Onion	Has scaly leaf, swollen and freshy	Protection from drying and storage of materials

Constructing a dichotomous key using leaves

As discuss in the previous chapter, dichotomous key is a tool used to identify organisms in the natural world.and its construction is based on division of specimens into two distinct groups using key observable features. Its applied in identification of the different classes of leaves.

Construction of a dichotomous key to identify common leaves.

Use a table of observable features to construct an identification key using a collection of leaves shown below

Table of features of leaves

Features	Specimen			
	A	B	C	D
Venation	Parallel	Network	Network	Network
Leaf margin	Smooth/entire	Serrated/rough	Smooth/entire	Smooth/entire
Type of leaf	Simple	Simple	Compound trifoliate	Compound bipinnate
Leaf stalk	Leaf sheath	Has pulvinus	Has pulvinus	Has pulvinus
lamina	Undivide	Undivided	Divided	Divided

1. (a) simple leaf. ……. go to 2
(b) compound leaf. …….. go to 3
2. (a) parallel leaf venation. ……..... A
(b) network venation. ……..…. B
3. (a) compound trifoliate. ……...C
(b) compound bipinnate. …… D

Sample item

During the study of flowering plant structures, S.1 students collected the different plant structures in their school compound for study but were unable to identify the structures collected and how to classify them. You are provided with plant structures A, B, C, D and E that were collected.

Task

(a) Critically observe and identify the specimens giving reasons for your response.

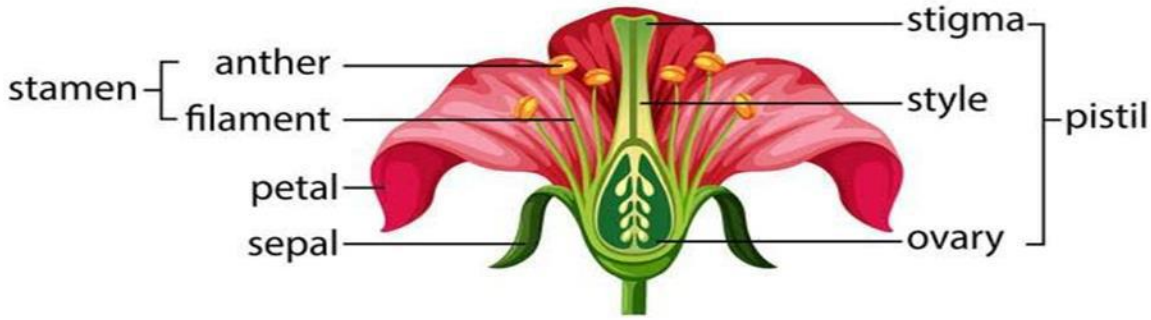
b) Describe how the plant structures are adapted to perform their functions.

c)Usingobservable features, show how the provided specimens can be identified using a dichotomous key.

Flowers

The use of the term 'flowering plants' is a reference to the uniqueness of this group in producing flowers. The flower is the reproductive structure in angiosperms (flowering plants) and is responsible for sexual reproduction. It contains the organs for both male and female gamete production and is adapted for the process of pollination.

Identifying parts of a flower



Finding out functions of parts of flower

Sepals (Calyx): The sepals collectively form the calyx, which is the outermost whorl of the flower.

Function: Protect the flower bud before it opens. Sepals are usually green and leaf-like.

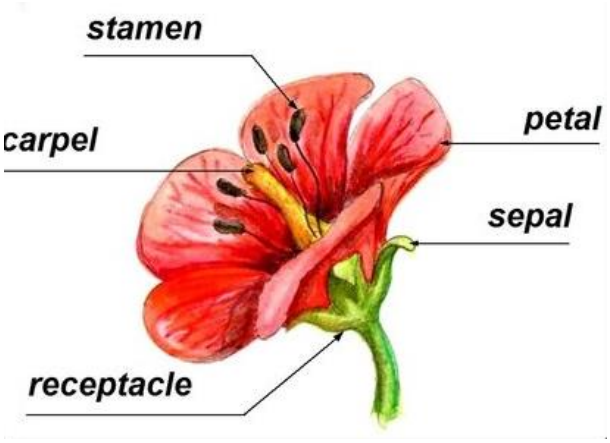
Petals (Corolla): The petals collectively form the corolla. Petals vary greatly in size, shape, and color depending on the plant species.

Function: Attract pollinators such as insects, birds, and bats. Petals are often brightly colored and may have distinct patterns or scents.

Stamens (Androecium): The male reproductive organs. Multiple stamens surround the central part of the flower and form the androecium.
Anther: Produces and releases pollen grains, which contain the male gametes (sperm cells).
Filament: A slender stalk that supports the anther and positions it for effective pollination.
Carpels (Gynoecium): The female reproductive organs. The carpels may be free (apocarpous) or fused (syncarpous) to form a single pistil.
Stigma: The sticky top part of the carpel that captures and holds pollen grains.
Style: A slender stalk that connects the stigma to the ovary and facilitates the growth of the pollen tube.
Ovary: The swollen base of the carpel that contains one or more ovules. After fertilization, the ovary develops into a fruit.
Ovule: The structure within the ovary that contains the female gamete (egg cell) and where fertilization occurs.

Description of the structure of a flower

Basically, each flower consists of a floral axis upon which are borne the essential organs of reproduction stamens and pistils and usually accessory organs, sepals and petals; which may serve to both attract pollinating insects and also protect the essential organs. The floral axis is a greatly modified stem; it is usually contracted, so that the parts of the flower are crowded together on the stem tip, called the receptacle. The flower parts are usually arrayed in whorls (or cycles) but may also be disposed spirally, especially if the axis is elongate. There are commonly four distinct whorls of flower parts and these include: an outer calyx consisting of sepals; within it lies the corolla, consisting of petals; the androecium, or group of stamens; and in the centre is the gynoecium, consisting of the pistils.



The sepals and petals together make up the perianth, or floral envelope. The sepals are usually greenish and often resemble reduced leaves, while the petals are usually colourful

The androecium, or male parts of the flower, comprise the stamens, each of which consists of a supporting filament and an anther, in which pollen is produced.

The gynoecium, or female parts of the flower, comprises one or more pistils, each of which consists of an ovary, with an upright extension, the style, on the top of which rests the stigma, the pollen-receptive surface. The ovary encloses the ovules, or potential seeds.

Fig the four floral whorl, corolla, calyx, stamens and pistil

Common flowers of biological importance

Hibiscus flower

morning glory flower

crotalaria flower

Maize flower

sweet potato flower

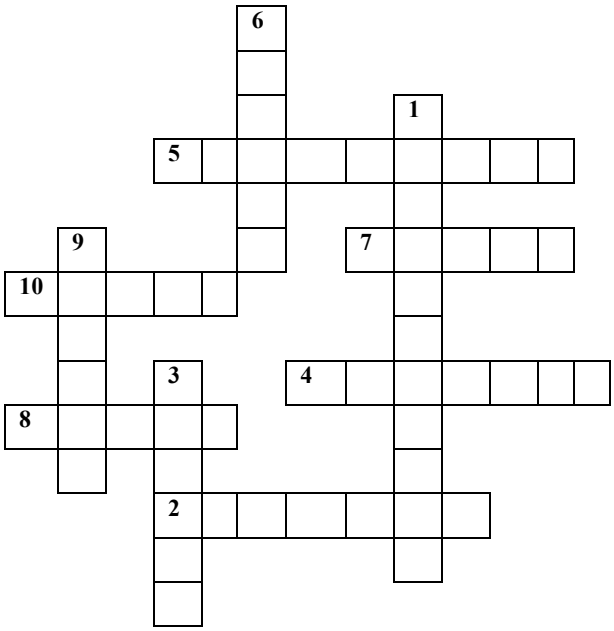
bean flower

Differences between dicotyledonous flower and monocotyledonous flower

- Foral parts of monocots are arrange in multiples of three while those of dicots are arranged in multiples of four or fives
- Dicots flowers are brightly coloured while monocot flowers are dull coloured

Exercise

Complete the crossword puzzle below



Across

2. the stalk of the flower
4. form the male reproductive organs of a flower
5. threadlike structures that hold up the anther
7. the portion of the flower used to visually attract insects
8. leaf like structure outside the petals
10. where fertilisation takes place

Down

1. expanded structures on which flower structures are attached
3. a combination of ovary, style and stigma
6. tube like structures that hold the stigma
9. when fertilised, these become the seeds

Sample item 1

Many people in rural area of Uganda grow some crops near their homes. However, due to ignorance, their children always remove floral parts of the plants resulting into poor yields.

Task:

Using external observable features, explain how are the children's actions likely to affect the plant growth and species survival?

Sample item 2

Mr. Pius is a garden designer and decorator for parties. He grows flowers like hibiscus and morning glory in his garden, which is always visited by many insects such as bees and butterflies. These insects are attracted by the flowers.

One day, Mr. Pius wanted to spray insecticides to get rid of the insects, thinking it would make the garden cleaner. However, his son, a Senior Two student, stopped him. He explained that insects are important because they help flowers in plant reproduction. Mr. Pius became curious and wanted to learn more about how flowers and insects are useful to plants and the community.

Task

a) Explain how the structural features of the hibiscus and morning glory flowers are adapted for attracting pollinators.
b) Why are pollinators important for these flowers, and what would happen if pollinators were absent?

Seeds and fruits

Seeds and fruits are essential parts of flowering plants that play a critical role in plant reproduction and survival. After fertilization in a flower, the ovule develops into a seed, while the ovary matures into a fruit. Both seeds and fruits have specific structures that help protect, nourish, and spread new plants in the environment.

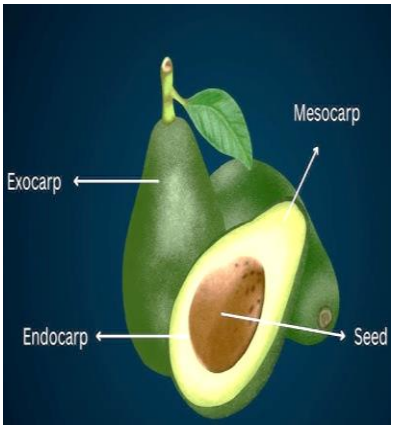
A seed is a fertilized mature ovule.

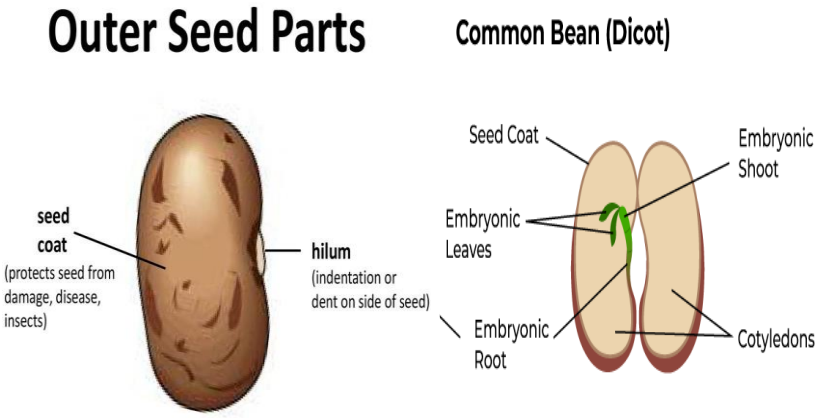
It has one scar called hilum which is a spot where it was attached to the pod inside a fruit.

A fruit is a fully grown fertilized ovary containing one or more seeds.
A fruit has 2 scars, one where it was attached to the receptacle and the other, the remains of the style or stigma.
During a fruit formation, the wall of the ovary becomes a fruit wall called pericarp.

Understanding the external and internal structures of seeds and fruits

The external and internal structures of seeds and fruits are carefully designed by nature to perform important functions such as safeguarding the embryo, storing food, and facilitating seed dispersal. Understanding these structures not only helps in learning about plant reproduction but also highlights their significance in agriculture, biodiversity, and human nutrition.





Understanding how structures of fruits and seeds relate to their functions

Friut

Part	Description	Adaptations
Epicarp	Brightly coloured	Attract animals that eat the fruit and disperse the seeds
Endocarp	Fleshy, juicy	The only part of the fruit that is eaten and the rest containing the seeds is thrown away
seed	Small and hard	To resist digestion along the alimentary canal of animals dor their dispersal

Seeds

Part	Description	Adaptations
Seed coat	Dry and hard	Protect the inner parts from machanical injury
Embryo	Plumule	Grows into shoot system
	Radicle	Grows into root system
Cotyledon	Large, thicked sack like structure	Storage of food for developing embryo and protection of the delicate embryo

Functions of seeds and fruits to plant

1. Functions of Seeds

Seeds play a crucial role in the reproduction and survival of plants. Their functions include:

- Seeds contain the embryo that grows into a new plant, ensuring the continuation of the plant species.
- The seed coat protects the embryo from physical damage, drying out, and diseases.
- Seeds store nutrients (in cotyledons or the endosperm) to support the growth of the seedling during germination.
- Seeds can remain dormant during unfavorable conditions and germinate when the environment becomes suitable for growth.
- Seeds are adapted for dispersal by wind, water, animals, or self-explosion, allowing plants to spread to new areas.

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2. Functions of Fruits

Fruits also play a vital role in plant reproduction and seed protection. Their functions include:

- Fruits enclose and safeguard the seeds from environmental stress and predators.
- Fruits attract animals that eat them and disperse the seeds, or they may be adapted for dispersal by wind, water, or mechanical means.
- Fleshy fruits store nutrients that may nourish developing seeds or attract dispersers.
- Fruits ensure that seeds are released in a way that maximizes their chances of survival and germination.

Comparing seeds and fruits

Similarities between a seed and fruit

- ✓ Both have scar for attachment to the parent plant

- ✓ Both are covered with an outer covering, epicarp in fruits and seed coat/testa in seeds

Differences between seeds and fruits

Seed	Fruit
Its outer layer is testa	Its outer layer is epicarp
It consists of an embryo	It consists of seeds
It has one scar for attachment	It has two scars for attachment
It is dry therefore contains low moisture content	It is succulent, therefore contains high moisture content
Its wall is undivided	It is divided into three layers, epicarp, endocarp and mesocarp

Sample items

Item 1

Mrs. Ndagire is a qualified herbalist in Masaka district. She obtains herbal medicine from different plant structures either by plucking off leaves, digging out roots, removing of barks of trees or uprooting out the plants. The population of medicinal plants has reduced due to her poor harvesting methods, which has made her medicine expensive on the market.

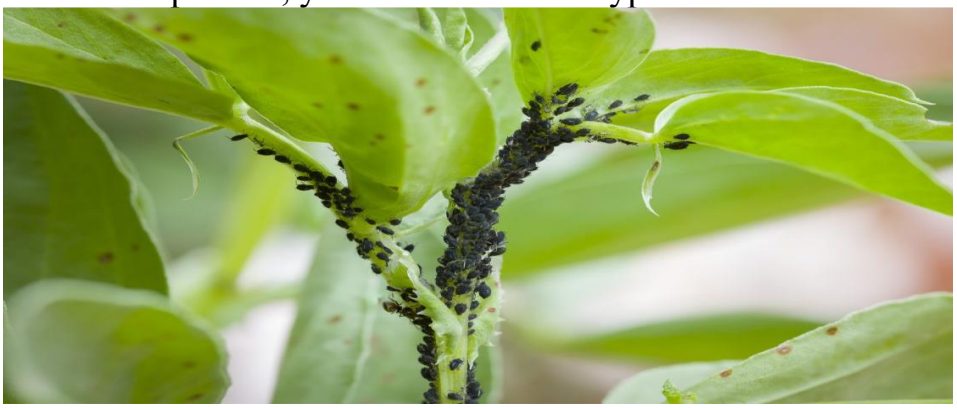
Task

(a) Identify the plant processes affected by her poor harvesting methods.

(b) Explain how her poor harvesting methods affected the normal functioning of medicinal plants?

Item 2

In a local garden, the plants have recently been showing signs of damage. The leaves have holes, the stems are chewed, and some plants are even uprooted. Upon a closer inspection, you noticed several types of animals around the garden.



Task.

(a) Describe the types of damage insects, Herbivores and burrowing animals can cause to plant leaves.

(b) Explain how this damage affects the plant's ability to perform photosynthesis.

Item 3

Mrs. Akello has a maize garden surrounded by some anthills. On a Monday morning, she woke up to check on her maize and found out that many plants were laid down by termites.

Fig. 1 shows Mrs. Akello's maize garden damaged by termites.

Task

a) Identify the maize structures affected by termites.

b) Explain how termites affected vital processes in maize plants.

c) Suggest to Mrs. Akello, ways she can control termites in order to avoid similar damages next time.