Biology

LEARNER'S BOOK 4

With Biblical Integration

edify

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Kisubi Associated Writers' Agency

Tel: 0414670167

E-mail: kawaagency@gmail.com

Website: www.kawa.ac.ug

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TERM 1

Theme: Reproduction and organisms.

1. Chapter 1: Asexual Reproduction in Plants

Key words

- Reproduction
- Vegetative/Asexual
- Propagation

Learning outcomes

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.

BIBLICAL INTEGRATION

"Let the land produce vegetation: seed-bearing plants and trees on the land that bear fruit with seed in it, according to their various kinds." - Genesis 1:11. Just as God created plants to reproduce and fill the earth, asexual reproduction in plants reflects His design by enabling efficient and reliable propagation, ensuring the continuity and abundance of plant life.

Understanding asexual reproduction in plants is crucial for appreciating how plants propagate and thrive, aligning with the biblical principle in Genesis 1:11 of vegetation multiplying and sustaining life on earth. This knowledge equips us with the skills to enhance agricultural productivity and conservation efforts.

Introduction

Have you noticed that plants often increase in number? How do you think this happens? In primary science, you learned about the different modes of reproduction in plants.

In this chapter, you will understand how some plants use some of their parts to develop new independent plants. See Figure 1.1. You will acquire skills and knowledge on how to grow plants without seeds. This information will enable you understand the methods used in growing some crops on commercial scale.

1.1Modes of Asexual Reproduction

figure 1. 1 modes of asexual reproduction

Some plants use different vegetative structures of either their leaves, stem shoot or root system to give rise to new plants. This type of reproduction is known as Asexual reproduction. The organisms arising from asexual reproduction have the same genetic constitution as the parent.

Vegetative reproduction in plants does not involve the use of seeds. This method is advantageous for maintaining the genetic characteristics of the parent plant. Here are some common plant parts used for vegetative reproduction:

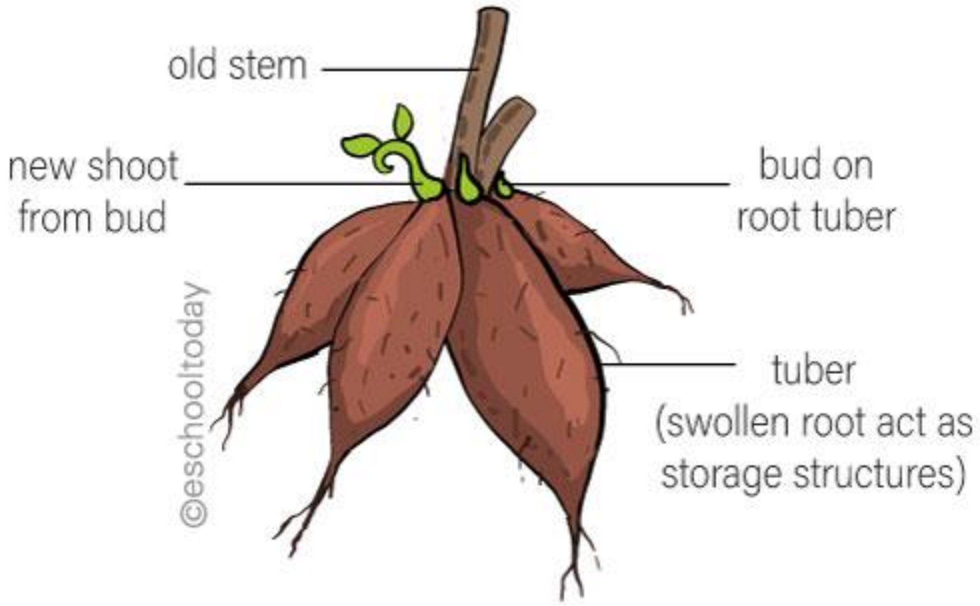


figure 1. 2: vegetative reproduction

1. **Stems:**
   - **Runners (Stolons):** Horizontal stems that grow above the ground and produce new plants at nodes.
   - **Rhizomes:** Underground stems that can give rise to new shoots and roots.
2. **Roots:**
   - **Tubers:** Swollen, underground storage structures that can give rise to new plants (e.g., potatoes).
   - **Adventitious Roots:** Roots that develop from non-root tissues, contributing to new plant formation.

3. **Leaves**
    - **Leaf Cuttings:** Portions of leaves can be used to propagate new plants (e.g., succulents like jade plants).
    - **Leaf-bud Cuttings:** A leaf with a portion of the stem attached, including a bud, can develop into a new plant (e.g., African violets).
4. **Bulbs**
    - **Offset Bulbs:** Bulbs that produce small bulbs around the main bulb (e.g., garlic and daffodils) can be separated and planted.
    - **Corms:** Similar to bulbs, corms (e.g., gladiolus) can be divided for propagation.
5. **Specialized Reproductive Structures**
    - **Suckers or Adventitious Shoots:** New shoots that arise from the base of the plant, forming genetically identical individuals (e.g., raspberry plants).
    - **Bulbils:** Small bulbs produced in the flower head or on the stem (e.g., tiger lilies).
6. **Buds:**
    - **Vegetative Buds:** Buds that develop into new shoots and roots when detached and planted (e.g., fig tree cuttings).

Advantages of Vegetative Reproduction:

- **Genetic Uniformity:** Offspring are genetically identical to the parent, ensuring the preservation of favourable traits.
- **Faster Growth:** Vegetative reproduction often results in quicker establishment and growth compared to growing from seeds.
- **Preservation of Desirable Traits:** Useful for maintaining specific characteristics in crops or ornamental plants.
- **Propagation of Clones:** Certain crops, such as fruit trees, are commonly propagated through vegetative means to ensure consistent fruit quality.

Applications:

- **Agriculture:** Farmers use vegetative reproduction to propagate crops with desirable traits.
- **Horticulture:** Gardeners use vegetative propagation for ornamental plants.
- **Forestry:** Certain trees are propagated vegetatively to maintain specific timber or fruiting characteristics.

Understanding these methods of vegetative reproduction is important not only for agricultural practices but also for conservation efforts and the preservation of unique and valuable plant varieties.

Common modes of asexual reproduction

1. **Binary Fission**

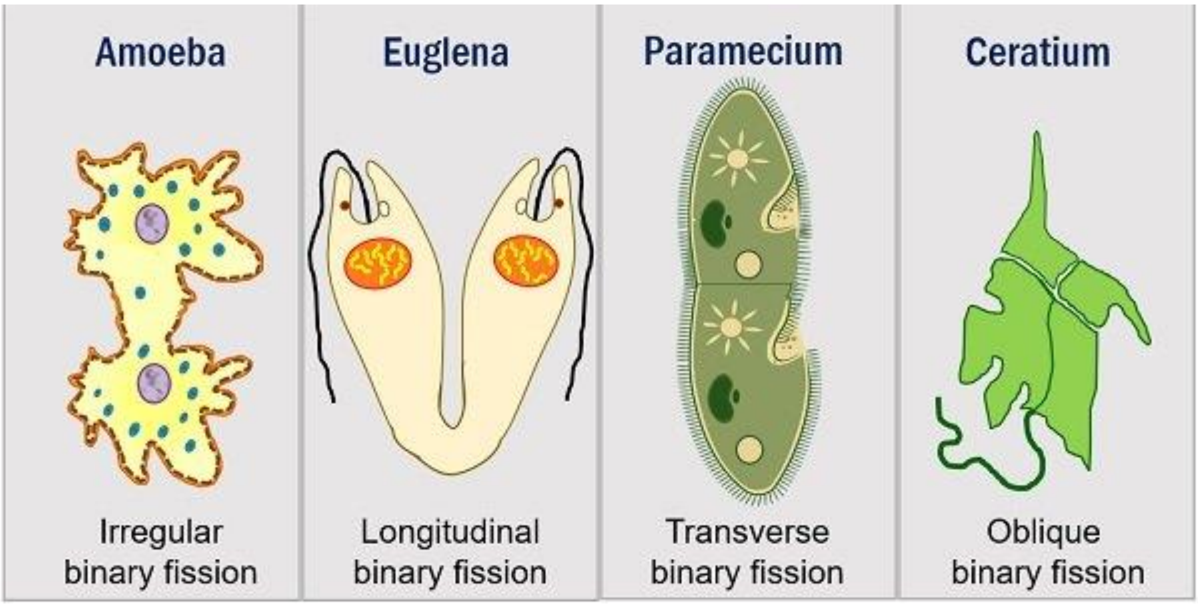


figure 1. 3: Binary fission

- Common in single-celled organisms like bacteria.
- The parent cell divides into two equal and identical daughter cells.

2. **Budding**

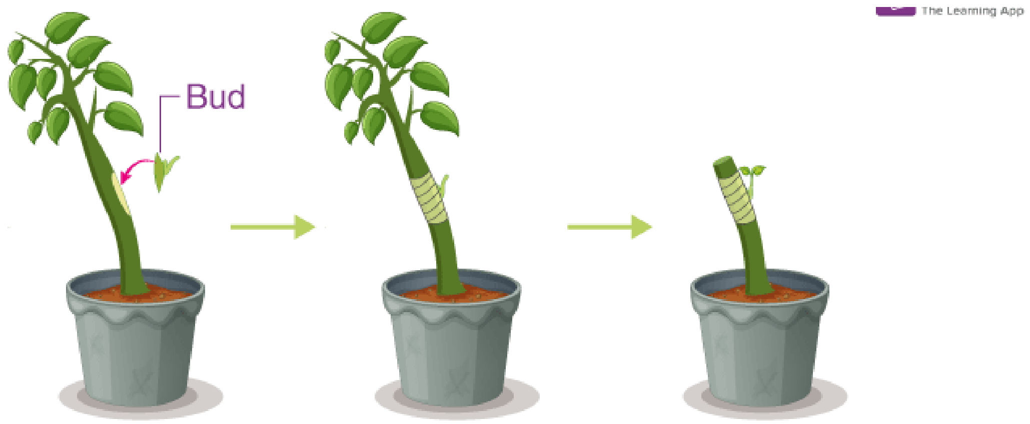


figure 1. 4: Budding

- Common in organisms like yeast and hydra.
- A small outgrowth (bud) forms on the parent organism, eventually detaching and becoming an independent organism.

3. **Fragmentation**

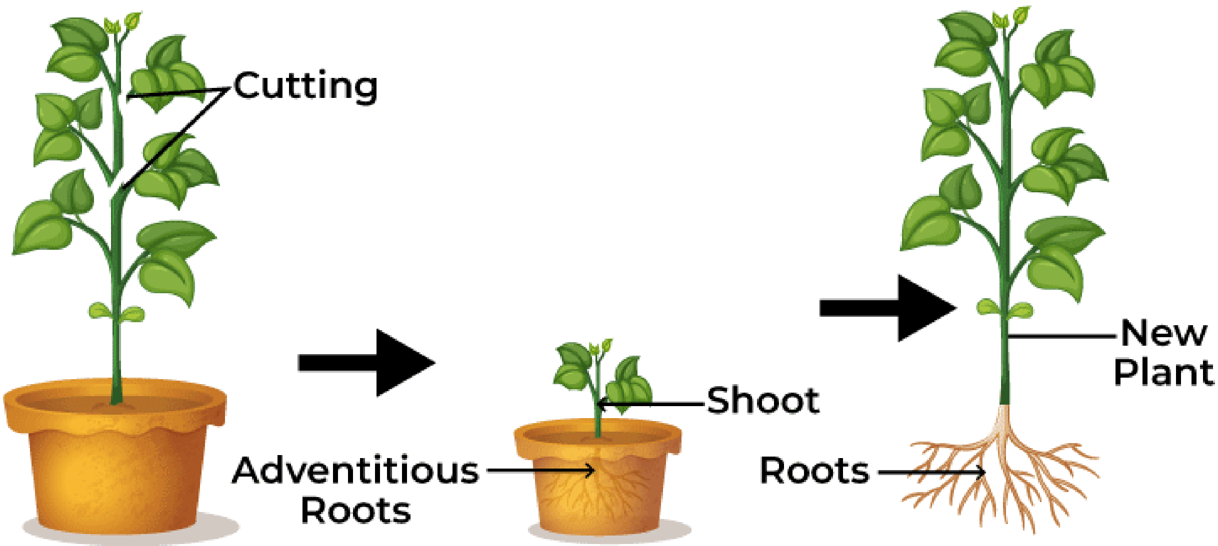


figure 1. 5: Fragmentation in plants

- Common in organisms like starfish and flatworms.
- The parent organism breaks into fragments, and each fragment can grow into a new, genetically identical organism.

4. **Vegetative Propagation**

- Common in plants, including examples like potatoes and strawberries.
- New plants arise from the vegetative parts (roots, stems, or leaves) of the parent plant.

5. **Spore Formation**

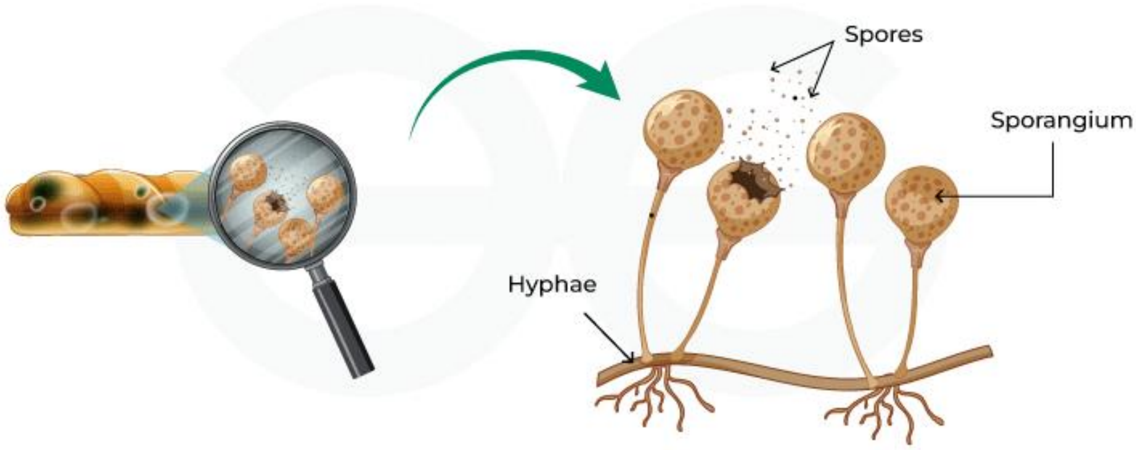


Figure 1: Spore formation

- Common in fungi, algae, and some plants.
- Specialized cells (spores) are produced and can develop into new organisms under suitable conditions.

6. **Parthenogenesis**

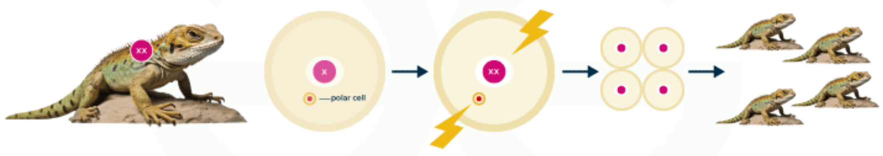


Figure 2: Parthenogenesis

- Common in some insects, reptiles, and fish.
- Development of an egg into a new individual without fertilization by a male gamete.

In Activity 1.1, you will identify the plants that reproduce asexually and the parts they use.

Activity 1.1: Identity plants that reproduce asexually

Key question: Which plant parts are used for vegetative reproduction?

What you need: A note book, a pen

What to do:

1. Move around the school or the community, identify and observe plants that reproduce asexually. Note the parts that have been or could be used to get new plants of the same kind. Present your findings in the table below.

Plant	Part

Although different varieties of plants reproduce asexually/vegetatively, some plants are naturally adapted to this mode of reproduction while others are artificially induced. Therefore, there are two types of asexual reproduction; Natural asexual reproduction and artificial asexual reproduction.

Project 1.1: Growing plants in school using artificial vegetative propagation

1. In groups, choose one crop from each of categories below:

Category 1: Passion fruit/Orange/Mango

Category 2: Cassava/Sugarcane/Coffee

Category 3: Gooseberry/Strawberry

2.Prepare and write a plan of how you will grow the selected crop clearly explaining the choice of method of artificial vegetative propagation for each selected crop.

3. Identify, prepare a garden and grow the selected crops.

4. Observe the crop growth for a period of one month. Record all observations and maintenance procedures during this time.

5.Write a detailed report for each crop including; steps followed, observations, successes and challenges.

Share your findings with the rest of the class.

1.2 Commercial Applications of Vegetative Propagation

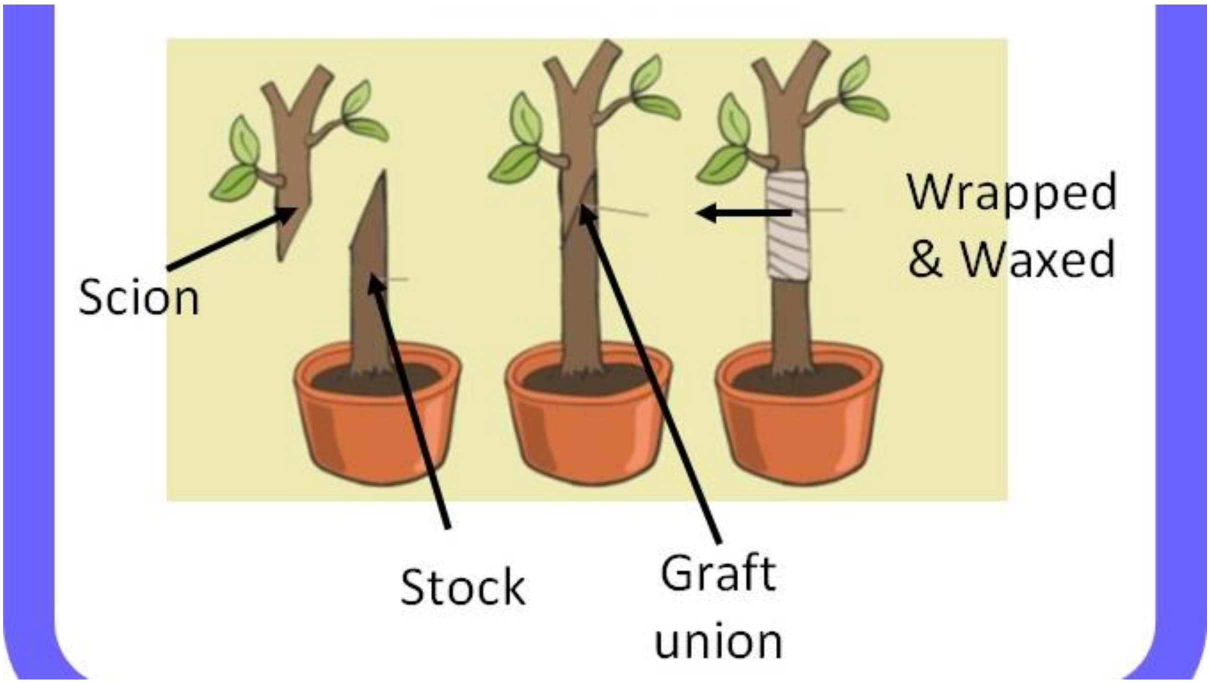


Figure 3: Vegetative Propagation

Humans have made use of the knowledge of asexual reproduction to produce high quality plants which give high quantity and quality yields in a short period of time.

In Uganda, vegetative propagation has several commercial applications across various sectors.

Some specific examples

1. **Banana Plantations:**

- **Type:** Suckers or Offsets
- **Application:** Banana is a staple crop in Uganda, and commercial banana plantations often use vegetative propagation through suckers to ensure the cultivation of disease-resistant and high-yielding banana varieties.

2. **Coffee Cultivation:**
   - **Type:** Cuttings
   - **Application:** Uganda is a major coffee-producing country. The commercial coffee industry uses vegetative propagation through cuttings to maintain specific coffee varieties that are well-adapted to local growing conditions and produce high-quality beans.
3. **Fruit Orchards:**
   - **Type:** Grafting and Budding
   - **Application:** Commercial fruit orchards, including those growing apples, oranges, and mangoes, use vegetative propagation techniques such as grafting and budding to reproduce fruit trees with desired characteristics, including fruit quality, taste, and disease resistance.
4. **Rose Farms:**
   - **Type:** Cuttings

- **Application:** The commercial flower industry, particularly rose farms, uses vegetative propagation through cuttings to produce consistent and high-quality roses for both local and international markets.

5. **Tea Plantations:**
    - **Type:** Cuttings
    - **Application:** Uganda is known for its tea production. Tea estates use vegetative propagation through cuttings to maintain tea plant varieties that are well-suited for tea production in the country's climate and altitude.
6. **Vegetable Farms:**
    - **Type:** Cuttings, Tuber Division
    - **Application:** Vegetables like sweet potatoes and Irish potatoes are commercially propagated using vegetative methods to ensure the uniformity of crops, especially in terms of size, taste, and disease resistance.
7. **Agricultural Demonstration Farms:**

    Type: Various (Cuttings, Runners, Tubers)

    - **Application:** Government and private agricultural extension services may establish demonstration farms to showcase best practices in agriculture. Vegetative propagation methods are employed to ensure the success of these demonstration farms.

8. **Nurseries and Landscaping:**

   Type: Cuttings, Grafting

   - **Application:** Commercial plant nurseries use vegetative propagation to produce a variety of plants for landscaping purposes, including ornamental trees, shrubs, and flowers.

9. **Oil Palm Plantations:**

   Type: Offshoots or Suckers

   - **Application:** Uganda has started to venture into oil palm cultivation. Commercial plantations use vegetative propagation through offshoots or suckers to establish oil palm plantations for oil production.

10. **Forestry and Timber Production:**

    Type: Cuttings, Grafting

    - **Application:** In the forestry sector, vegetative propagation is used to produce timber trees with desirable traits such as straight trunk growth, disease resistance, and high-quality wood for commercial timber production.

These examples highlight how vegetative propagation is a valuable practice in Uganda's agriculture and horticulture, contributing to the commercial success of various crops and industries.

In Activity 1.3, you will identify the crops that are commercially grown by vegetative propagation.

Activity 1.3: Carrying out research on crops that are commercially grown by vegetative reproduction in Uganda

Key question: Which crops are commercially grown by vegetative reproduction in Uganda?

What you need: A resource person, the Internet, a pen and notebook

1. Invite a resource person or visit a Zonal Agricultural Research and Development Institute near your school and listen to a talk about commercial vegetative reproduction in Uganda. Alternatively, you can read newspaper articles or research on the Internet about commercial vegetative reproduction in Uganda. Find out the crops grown, methods used and the reasons why the methods are used in the following regions of Uganda.

i) Central region

ii) Eastern region

iii) Northern region

iv) Western region

2. Design a digital presentation or develop a brochure using the information you have gathered.

Present your work to the rest of the class.

Sample Activity of Integration

The farmers in a community bought seeds for cassava, coffee and passion fruits and planted them. The plants took too long to mature even when all conditions were favorable. They talked to other farmers in the community who were growing onions, Irish potatoes, strawberries, bananas and ginger and they were facing the same problem. The farmers were frustrated and wanted an alternative way to grow these crops.

Task: Write a speech you would give to the farmers to resolve their frustration.

Chapter summary

In this chapter, you have learnt that:

1. Asexual reproduction is a mode of reproduction where plants use their structures like roots, stems and leaves to reproduce.

2. There are two forms of asexual reproduction which are natural and artificial asexual reproduction.

3. Asexual reproduction has been used by farmers to produces high quality and quantity yields.

2. Chapter 2: Sexual Reproduction in Plants

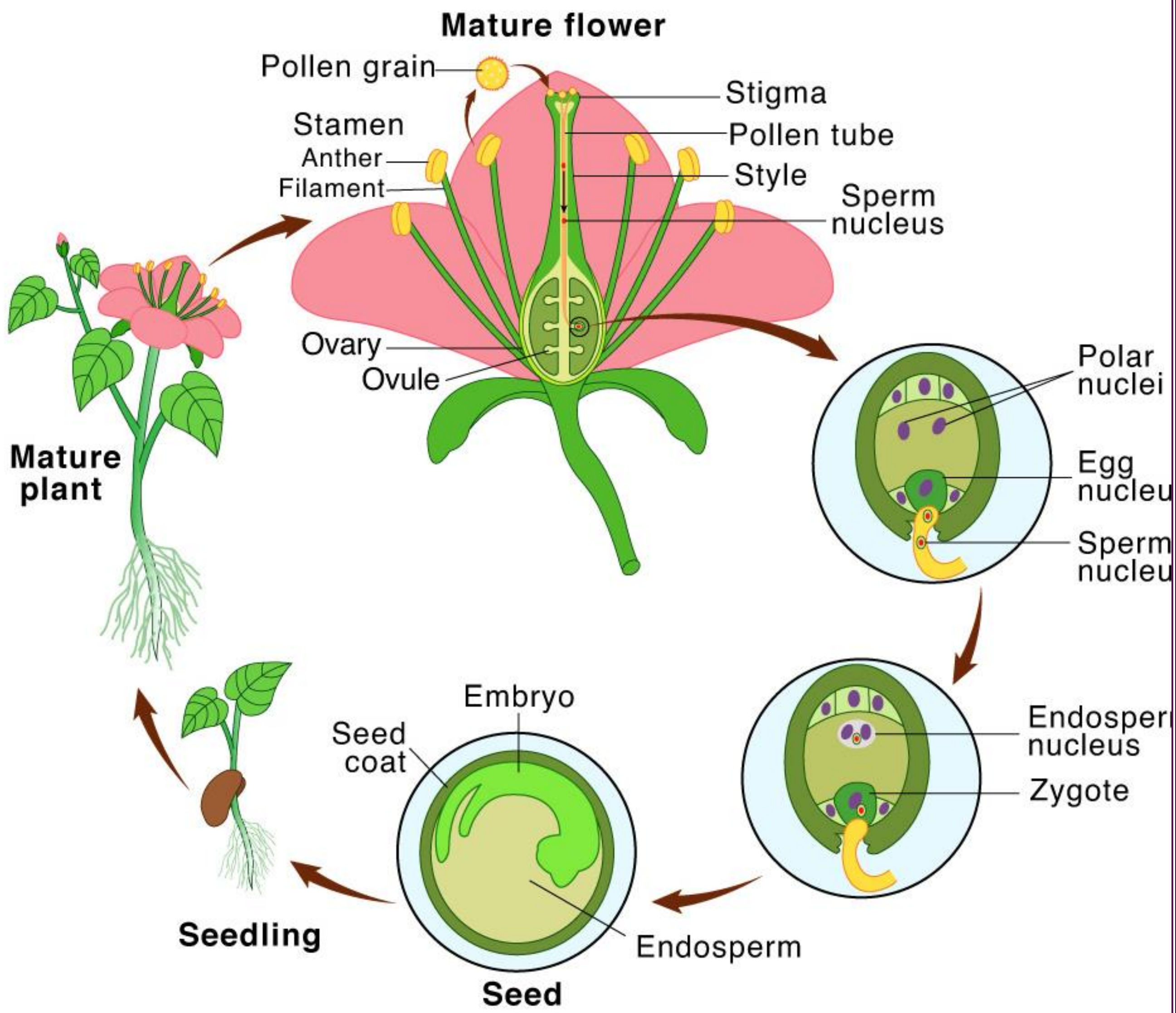


figure 2. 1

Figure 4: Sexual reproduction in plants

Key Words

- Reproduction
- Sexual reproduction

- Pollination
- Fertilization
- Fruits
- Seeds
- Dispersal

Learning outcomes

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

a) Recognize the flower structures that are involved in the processes of pollination, fertilization, fruit and seed development and outline their functions.

b) Know the processes of pollination, fertilization and fruit formation.

c) Understand the difference between cross and self-fertilization, and the advantages of each method.

d) Differentiate between seeds and fruits structurally and functionally.

e) Understand the importance of dispersal

f) Recognize the structures and types of fruits and relate their structures to their methods of dispersal.

BIBLICAL INTEGRATION

"Consider the lilies, how they grow: they neither toil nor spin; yet I tell you, even Solomon in all his glory was not arrayed like one of these." - Luke 12:27. Just as the lilies grow beautifully through the natural processes God designed, studying sexual reproduction in plants helps us marvel at the intricate ways plants reproduce and thrive. In this chapter, you will learn about the crucial processes and structures involved in plant reproduction, aligning with the biblical principle in Luke 12:27 that highlights the beauty and complexity of nature. This knowledge enhances our understanding of plant life and its importance in sustaining ecosystems and human agriculture.

Introduction

In chapter 1, you looked at asexual reproduction in plants. However, you should note that not all plants reproduce asexually. Many plants reproduce sexually which involves fusion of male and female gametes. In this chapter, you will understand that a flower is the specialized organ in which all events of a plant's sexual reproduction occurs, leading to the formation of an embryo located in the seed.

2.1: The Flower

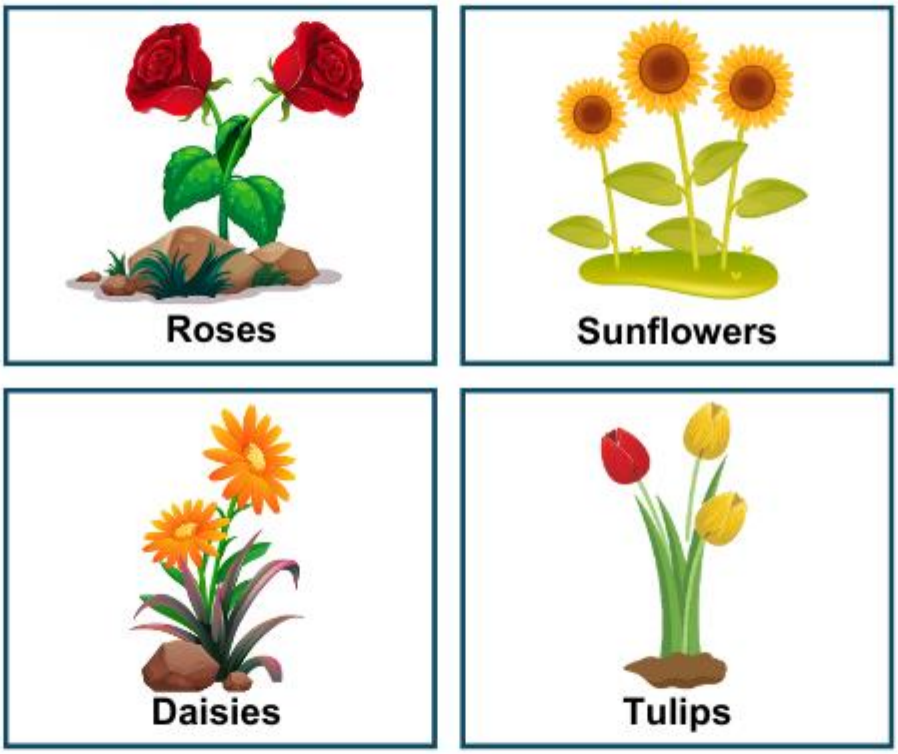


figure 2. 2

Figure 5: Flowers

Using your primary school science knowledge. What do you think is the importance of a flower to a plant? The flower has different structures some of which directly take part in the process of sexual reproduction. These are referred to as essential parts. The other parts which are not directly involved in the reproduction process are called non-essential parts.

Introduction: A flower is a reproductive structure found in flowering plants. It plays a crucial role in the plant's life cycle by facilitating the process of pollination and fertilization, which leads to the formation of seeds and the next generation of plants.

Main Components of a Flower

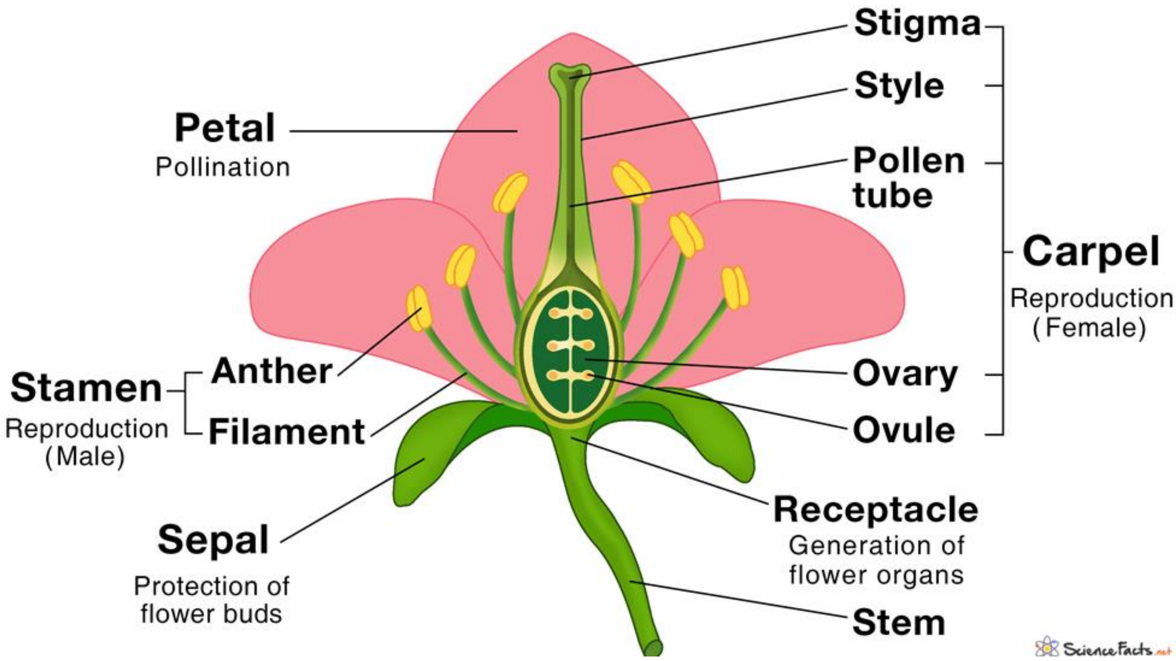


Figure 6: Parts of a Flower

1. **Petals:**

- **Description:** Petals are the colorful, often delicate, outer parts of the flower.
- **Function:** They attract pollinators like bees, butterflies, and birds with their colors and fragrances.

2. **Sepals:**

- **Description:** Sepals are the small, usually green structures located at the base of the flower.
- **Function:** They protect the developing flower bud.

3. **Stamens:**

- **Description:** Stamens are the male reproductive parts of the flower.

  Components

- **Anther:** The part of the stamen that produces pollen.
- **Filament:** The stalk that holds up the anther.
  - **Function:** Stamens produce pollen, which contains male reproductive cells.

4. **Pistil (or Carpels):**

- **Description:** The pistil is the female reproductive part of the flower.

  Components:

- **Stigma:** The sticky top part that captures pollen.
- **Style:** The tube-like structure that connects the stigma to the ovary.
- **Ovary:** The enlarged base of the pistil that contains ovules.
- **Function:** The pistil receives pollen, and if fertilization occurs, it develops into a fruit.

5. **Ovules:**

- **Description:** Ovules are small structures within the ovary.
- **Function:** Ovules contain female reproductive cells, and when fertilized, they develop into seeds.

In Activity 2.1, you will examine the structure of the flower and identify the functions of its different parts. This will help you to appreciate that each part of a flower is vital in one way or another.

Activity 2.1: Examining the flower structures and identifying the functions of the parts

Do this activity in a group.

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

What you need: Fresh complete flowers e.g. hibiscus, morning glory, reference materials, notebook, a sharp blade

What to do:

1. Hold the flower by its stalk and examine its external structures.
2. Carefully cut it longitudinally using a sharp blade and examine the internal structures.
3. Using your primary school science knowledge, write down the names of the parts/structures that you identified and state the functions(s) of each in the table below.

Flower part	Function(s)

4. Which of the structures identified form the;

i) Male part of the flower?

ii) Female part of the flower?

5. What name is given to the:

i) Male part of the flower?

ii) Female part of the flower?

6. Which of the structure identified are essential or non-essential?

7. Make a labelled drawing of the longitudinal section of the flower.

Share your findings with the whole class

2.2: Pollination

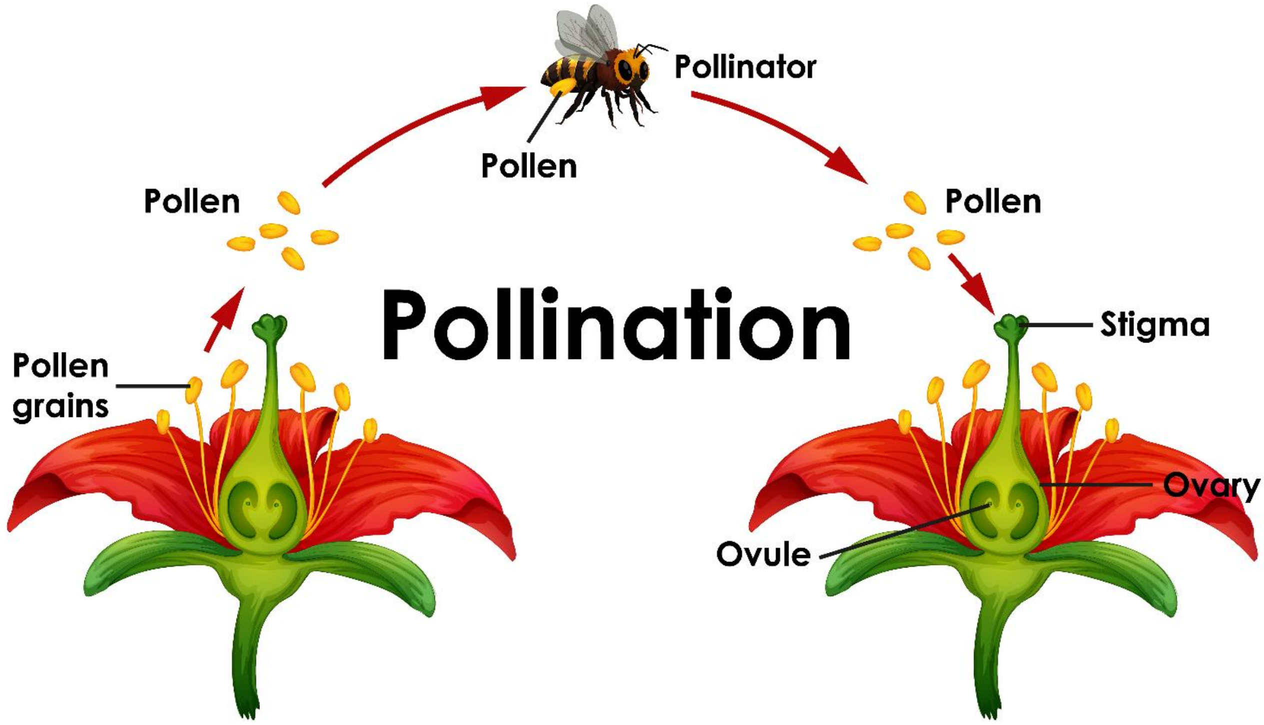


Figure 7: pollination

Pollination is a crucial process in the reproduction of flowering plants, where pollen from the male reproductive organ (anther) is transferred to the female reproductive organ (stigma) of the same or a different flower, leading to the formation of seeds. This process is essential for the continuation of plant species and the production of fruits and seeds.

Process of Pollination

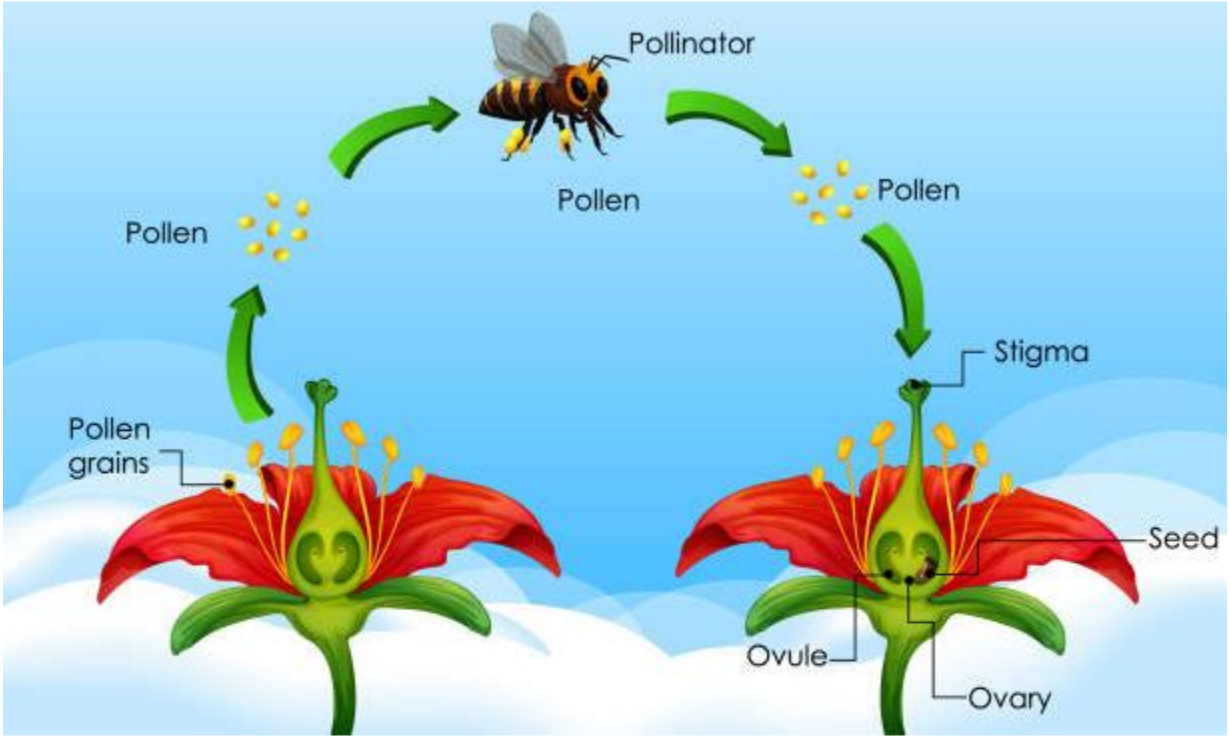


Figure 8: Process of Pollination

1. **Production of Pollen:** The anthers, located in the male parts of the flower (stamen), produce pollen. Pollen is a powdery substance that contains male gametes.

2. **Transfer of Pollen:** Pollen can be transferred from the anther to the stigma through various methods:

   - **Wind:** Some plants, like grasses and many trees, rely on the wind to carry their lightweight pollen to other flowers.

   - **Animals:** Many plants depend on animals, such as bees, butterflies, birds, and beetles, to transfer pollen between flowers as they forage for nectar.

3. **Stigma Receptivity:** The stigma, located in the female part of the flower (pistil), must be receptive to pollen. If the stigma is not ready, it will not accept the pollen.
4. **Pollen Tube Formation:** Once pollen lands on a compatible stigma, it germinates, and a pollen tube begins to grow down through the style, the tube connecting the stigma to the ovary. This tube allows the male gametes to reach the ovule.
5. **Fertilization:** The male gametes travel through the pollen tube to reach the ovule within the ovary. Fertilization occurs when the male gametes combine with the female gamete in the ovule, forming a zygote. This zygote develops into a seed.
6. **Seed Development:** The fertilized ovule develops into a seed, and the ovary develops into a fruit, protecting the developing seeds.

Types of Pollination

1. **Self-Pollination:**

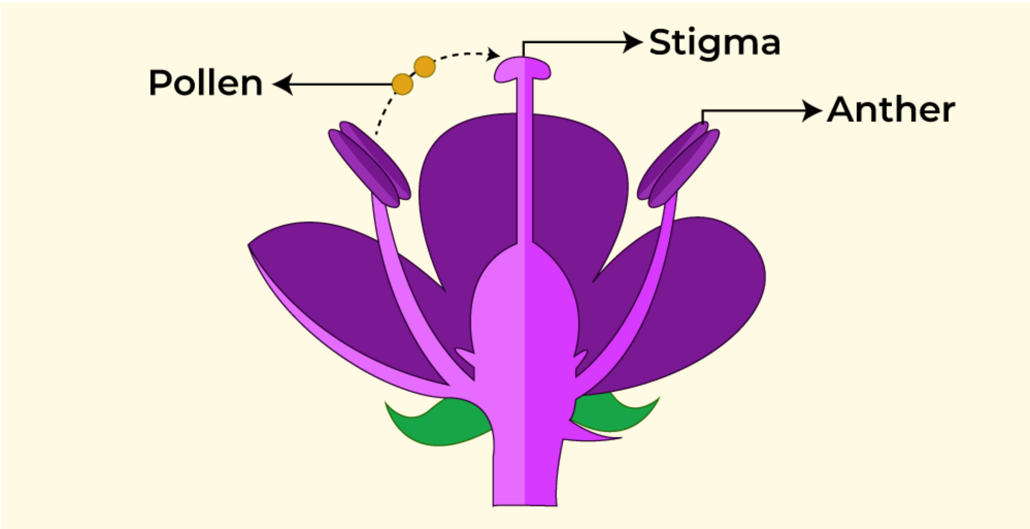


Figure 9: Self pollination

- Pollen is transferred from the anther to the stigma of the same flower or another flower on the same plant.

Advantages:

Ensures reproduction when pollinators are scarce.

Disadvantages:

Limits genetic diversity.

2. **Cross-Pollination**

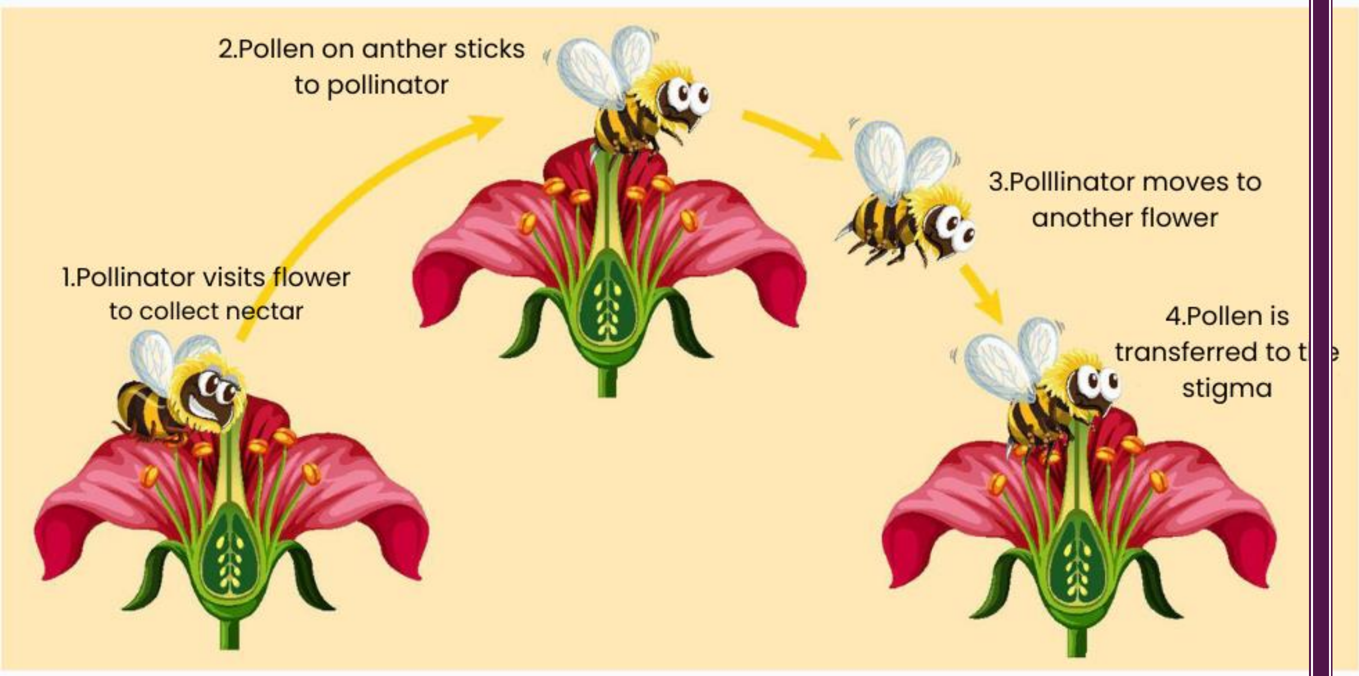


Figure 10: Cross-Pollination

- Pollen is transferred from the anther of one flower to the stigma of a different flower, often on a different plant.

Advantages:

Promotes genetic diversity, and it requires external agents like wind or animals.

Disadvantages:

Requires the presence of pollinators and may be less reliable than self-pollination.

In Activity 2.2, you will discover the meaning and process of pollination and understand the different types of pollination.

Activity 2.2: Exploring the process of pollination

Do this activity in a pair?

Key Question: How does pollination take place?

What do we need: A chart showing the process of pollination, reference materials about pollination, the internet?

What to do:

1. Study the images below or the chart showing the process of pollination provided by the teacher and discuss the detail of process taking place.

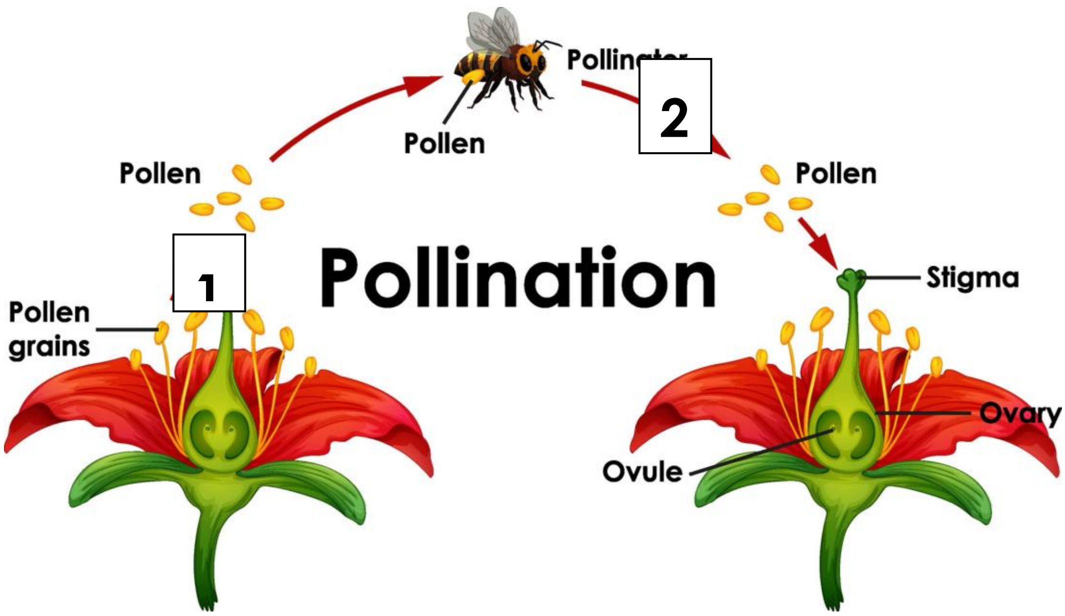


Figure 11: The process of pollination

i) From your discussion, derive the meaning of pollination.

ii) Identify and describe the type of pollination presented by each of the movements 1 and 2.

iii) Using a suitable table, compare the two types of pollination.

Present your work to the whole class.

Self-study:

Of what economic value is pollination to a horticulturist?

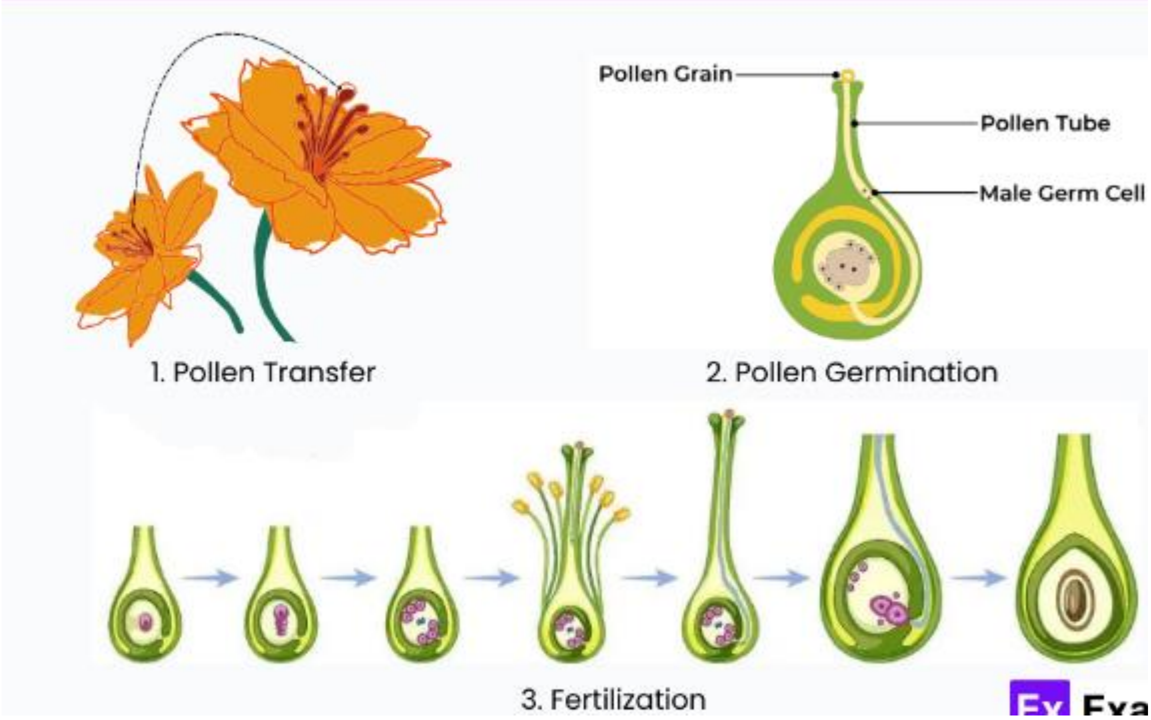


Figure 12: Features Favoring Self-Pollination

1. **Stable Environments:**

- Self-pollination is favoured in stable and consistent environments where external factors, such as wind or pollinators, may not be reliable.

2. **Isolation or Lack of Pollinators:**

- Plants that grow in isolation or in areas with a scarcity of pollinators may favor self-pollination to ensure reproductive success.

3. **Small, Inconspicuous Flowers:**

- Self-pollinating plants often have small, inconspicuous flowers that do not rely on attracting pollinators through visual or olfactory cues (refer to signals or stimuli that are related to the sense of smell).

4. **Non-Motile Pollen:**

- Pollen grains of self-pollinating plants are often non-motile and less likely to be dispersed by external factors like wind or insects.

5. **High Flower and Pollen Production:**

- Self-pollinating plants may produce a high number of flowers and pollen to increase the chances of successful pollination without external assistance.

6. **Reliable Seed Production:**

- Self-pollination ensures a consistent and reliable seed production, especially in conditions where cross-pollination may be challenging.

7. **Reduced Genetic Variability:**

- While this is not necessarily a feature of the plant itself, self-pollination results in reduced genetic variability within a population, allowing for the preservation of favorable traits.

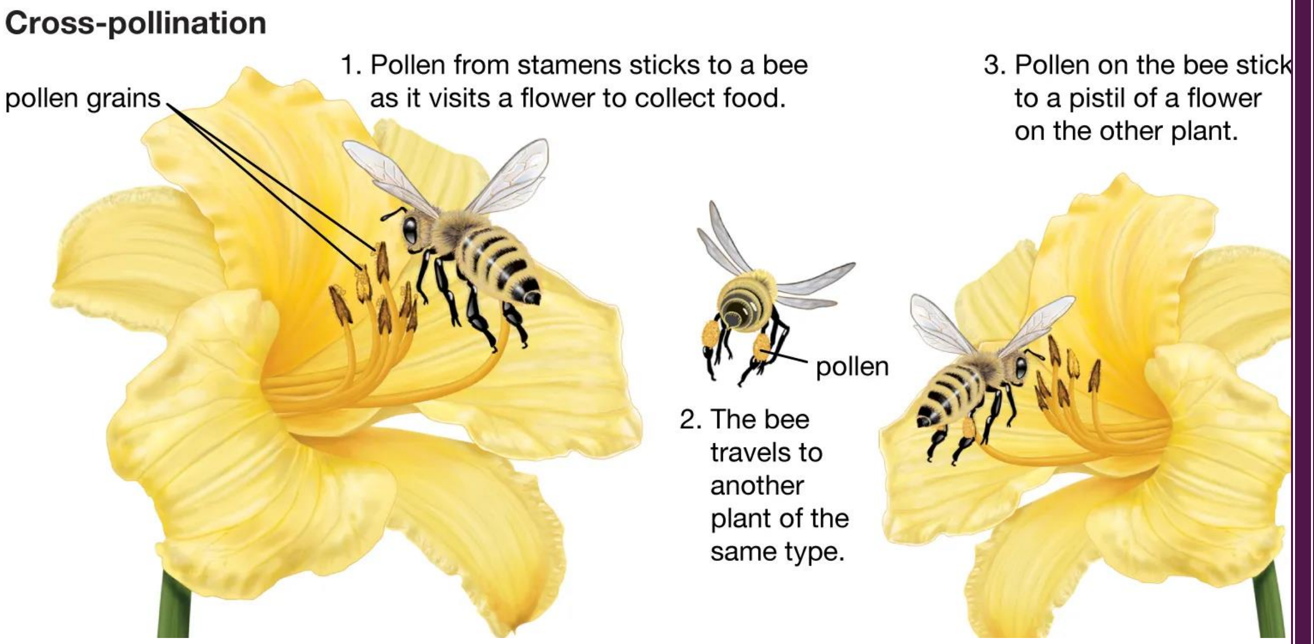


Figure 13: Features Favoring Cross- Pollination

1. **Dichogamy:**

- Male and female organs mature at different times in the same flower, preventing self-pollination. Examples: corn, lilies

2. **Showy and Fragrant Flowers:**

   - Plants that rely on cross-pollination often have large, showy, and fragrant flowers to attract pollinators, such as bees, butterflies, or birds.

3. **Temporal Separation of Male and Female Organs:**

   - Some plants have mechanisms that promote temporal separation of male and female reproductive organs, reducing the likelihood of self-pollination.

4. **Dioecious Plant**
    - Dioecious plants have separate male and female individuals, necessitating cross-pollination for reproduction. Examples include kiwi plants.
5. **Incompatible Gametes or Self-Incompatibility**
    - Some plants have mechanisms to prevent self-pollination, such as incompatible gametes or self-incompatibility systems that reject pollen from the same plant.
6. **Specialized Pollinators**
    - Cross-pollinating plants often rely on specialized pollinators, like certain insects or birds, which ensure efficient transfer of pollen between different flowers.
7. **Pollen Adaptations**
    - Pollen grains of cross-pollinating plants may be adapted for specific modes of transportation, such as being sticky for attachment to insects or having structures that facilitate wind dispersal.

Understanding these features helps elucidate the evolutionary strategies that plants employ to achieve successful pollination in various environmental conditions. Both self-pollination and cross-pollination have advantages depending on the ecological context and selective pressures within a plant population.

Activity 2.3: Exploring the features that favor self and cross pollination

Do this activity in a pair

Key Question: Which feature of flower favor self or cross pollination?

What do you need: Hibiscus flower, pawpaw flower, the male maize floret, the internet?

What to do:

1. Hold each of the flowers provided one at a time and examine it carefully.
   i) Note the absence or presence of both the stamens and pistils.
   ii) Examine the location of the anthers in comparison to the stigma. What do you conclude?
   iii) Examine the location of the anthers in relation to the petals. What does the position of the anthers for each flower imply?
2. For each of the flowers provided, state the type of pollination which takes place. Give observable features to support your answer.
3. Of what advantage is the type of pollination identified for each flower in 2 above to the plant

Share your findings with the class.

2.3: Mode of Pollination

Figure 14: Modes of pollination

The structure of the flower is closely related to the way it is pollinated. That is, flowers are adapted to specific mode or agents of pollination. Do you recall the common agents of pollination?

The mode of pollination refers to the specific mechanisms and agents involved in the transfer of pollen, which can vary among different plant species. Understanding the mode of pollination is crucial for insights into a plant's reproductive strategies and its interactions with the surrounding environment.

Characteristics of Insect-Pollinated Flowers

Figure 15: Insect-Pollinated Flowers

1. **Colourful and Showy Petals:**
    - Insect-pollinated flowers often have bright and vibrant colors, including shades of red, purple, and blue, which are attractive to insects.

2. **Nectar Production**

Figure 16: Nectar

- Many insect-pollinated flowers produce nectar as a reward for visiting pollinators. Nectar serves as an energy source for insects.

3. **Fragrance:**

- Insect-pollinated flowers often emit pleasant fragrances to attract insects. The scent acts as an olfactory cue to guide the pollinators to the flowers.

4. **Specialized Landing Platforms:**

- Some flowers have specialized structures, such as landing platforms or markings, that provide a convenient landing space for insects.

5. **Tubular or Deep Flowers**

Figure 17: Tubular Flowers

- Insect-pollinated flowers may have tubular or deep shapes, making it easier for insects with long mouthparts (like butterflies and hummingbirds) to access the nectar.

6. **Sticky Pollen**

Figure 18: Sticky Pollen

- The pollen of insect-pollinated flowers is often sticky or clumped, making it more likely to adhere to the bodies of visiting insects for effective transport.

7. **Pollen Placement**

Figure 19: Pollen Placement

- In some cases, the anthers and stigmas of insect-pollinated flowers are positioned in a way that ensures contact with specific body parts of the visiting insects.

8. **Daytime Blooming**

Figure 20: Daytime Blooming

- Many insect-pollinated flowers open during the daytime when most pollinators are active.

9. **Visible Ultraviolet Patterns:**

- Some flowers have patterns visible in ultraviolet light, which is perceivable by insects but not by humans, helping guide them to the reproductive structures of the flower.

Characteristics of Wind-Pollinated Flowers

Figure 21: Wind-Pollinated Flowers

1. **Reduced Petal Size and Color:**

- Wind-pollinated flowers often have reduced or inconspicuous petals. They may lack vibrant colors since they do not rely on visual signals to attract pollinators.

2. **Large Quantities of Pollen:**

- Wind-pollinated plants produce large quantities of lightweight, small-grained pollen that can be easily carried by the wind.

3. **Lack of Nectar:**

- Wind-pollinated flowers generally do not produce nectar, as they do not require a reward to attract pollinators.

4. **Feathery Stigmas**

Figure 22: Feathery Stigmas

- The stigmas of wind-pollinated flowers are often feathery or branched, providing a large surface area to capture airborne pollen.

5. **Stamen Exposed**

Figure 23: Stamen Exposed

- The male reproductive structures (stamens) are often exposed to facilitate the release of pollen into the air.

6. **No Fragrance**

- Wind-pollinated flowers typically lack fragrance since there is no need to attract insects with scent.

7. **Small and Inconspicuous Flowers**

Figure 24: Small and Inconspicuous Flowers

- Wind-pollinated flowers are often small and inconspicuous, as they don't need to attract pollinators from a distance.

8. **Production of Many Flowers**

- Wind-pollinated plants may produce a large number of flowers to increase the chances of pollen reaching neighboring plants.

9. **Produce Pollen in Large Amounts**

- Wind-pollinated plants produce copious amounts of pollen to increase the likelihood of successful pollination.

10. **No Specific Pollination Timing:**

- Wind-pollinated plants do not need to synchronize their flowering with the activity patterns of specific pollinators, as the wind can disperse pollen at any time.

In Activity 2.4, you will understand the characteristics of insect pollinated and wind pollinated flowers and make a comparison of the two. You will therefore appreciate why flowers of different plants are different in structure as well as other characteristics.

Activity 2.4: Identifying and comparing the characteristics of insect and wind pollination

Do this activity in a pair?

Key question: What are the characteristics of insect and wind pollinated flowers?

What you need: Fresh flowers of morning glory or hibiscus, a male maize inflorescence, hand lens, microscope, prepared slides of pollen grains

What to do:

1. Hold the specimen provided one at a time and examine it.

i) Look at the sepals and examine them carefully. Note their color.

ii) Look at the petals and carefully examine them. Note their color and then count them and note their number?

iii) Examine the stamens and the stigma to identify their position in relation to the petals.

iv) Using hand lens carefully examine the structure of both the stamens and the stigma. Describe the structure of each.

v) Slightly touch the anther and then the stigma. What happens?

vi) Bring the flower close to your nose and smell. Does the flower have a scent?

vii) Observe slides of pollen grains from hibiscus or morning glory flowers and male maize inflorescence prepared by the teacher. View under low power and then medium power objective lens.

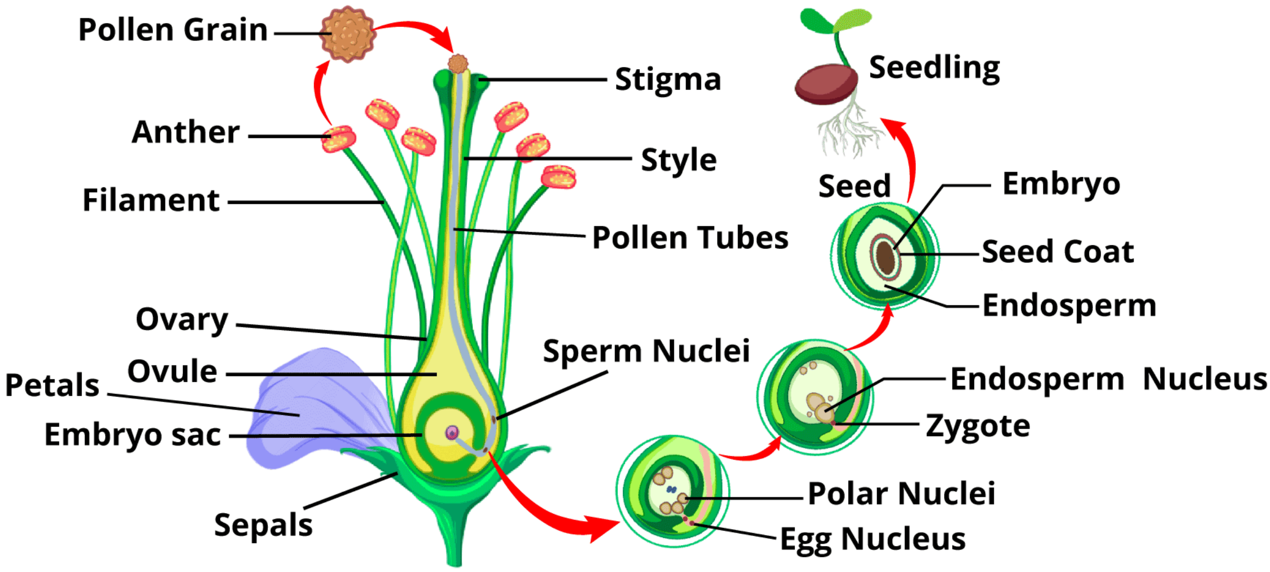
2. Make a comparison betwe~1l morning glory or hibiscus flower and the male maize inflorescence relating structure to the function(s), Present your work in a suitable table.

3. From the table in 2, identify which of the flowers is insect or wind pollinated.

4. Which other examples of Wind and insect pollinated flowers can you identify from your locality?

Present your findings to the whole class

2.4: The Process of Fertilization in Flowering Plants



Fertilization in flowering plants involves the fusion of the male and female gametes to form a zygote which then develops into an embryo and this occurs after the process of pollination. However, a number of events take place in the pistil before the actual fertilization as follows;

1. **Pollination:** Pollination is the transfer of pollen grains from the male reproductive organ (anther) to the female reproductive organ (stigma) of a flower.

This can occur through various agents such as wind, water, insects, birds, or other animals. Once a pollen grain reaches the stigma of a compatible flower, it germinates, forming a pollen tube.

2. **Pollen Tube Formation:** The pollen tube grows down the style (the tube connecting the stigma to the ovary) towards the ovule. This tube provides a pathway for the male gametes (sperm cells) to reach the ovule.

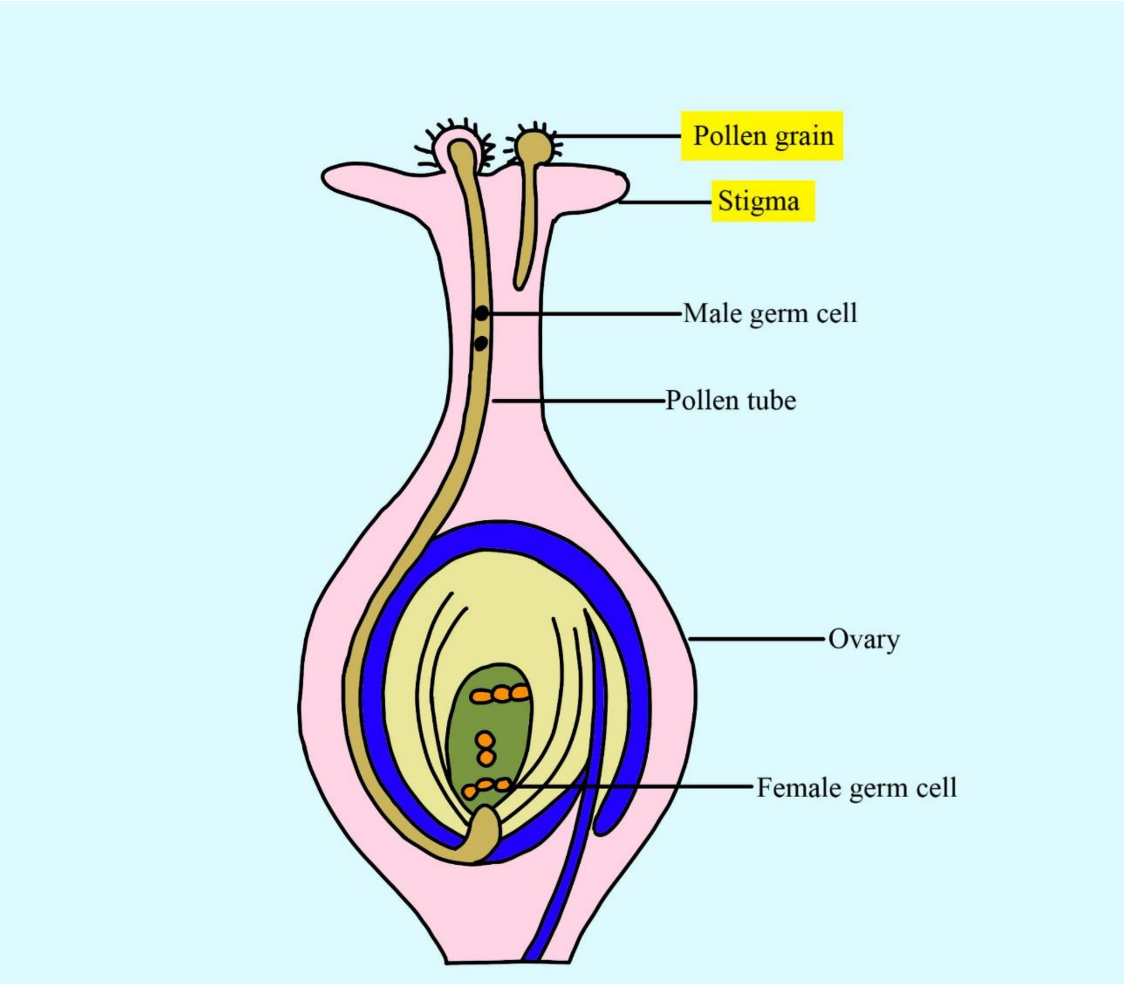


Figure 25: Pollen Tube Formation

3. **Double Fertilization:** In the ovule, there is an egg cell (female gamete) and two polar nuclei. One of the sperm cells fuses with the egg cell, forming a zygote.

This process is the actual fertilization event. The other sperm cell fuses with the two polar nuclei, resulting in the formation of a triploid cell. This triploid cell develops into the endosperm, a tissue that provides nourishment to the developing embryo.

4. **Seed Development:** The fertilized ovule transforms into a seed, and the ovary develops into a fruit. The seed contains the embryo, which will eventually grow into a new plant. The surrounding fruit serves as protection and a means for seed dispersal.

In Activity 2.5, you will understand how the process of fertilization in flowering plants takes place. This will help you appreciate that from the time of pollination to fruit formation there are other complex stages which cannot be seen.

Activity 2.5: Describing the process of fertilization in flowering plants

Do this Activity in a group

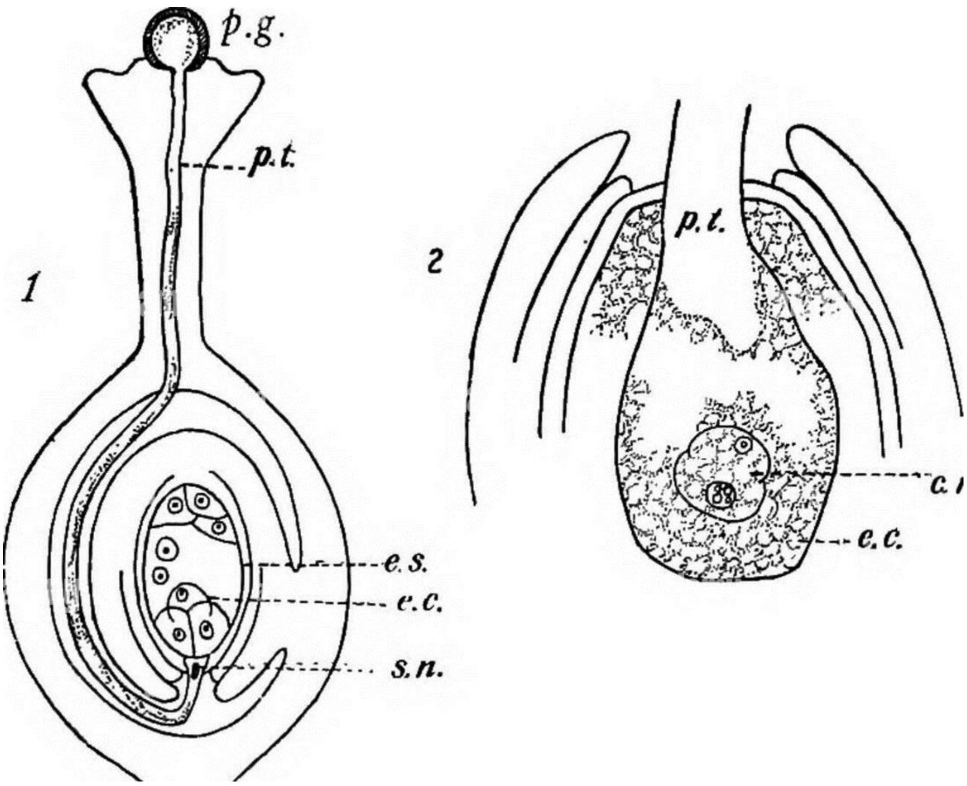
Key question: How does fertilization occur in flowering plants?

What you need: Drawing of structure of an embryo sac showing growth of a pollen grain to form a pollen tube and the process of fertilization, reference materials, the Internet

What to do:

1. Study the drawing below or the chart provided and research about

fertilization process in flowering plants. The visually impaired are encouraged to use the chart since it has bigger letters.



i) Draw and label the figure above

ii) Describe the steps involved in the process of fertilization.

iii) Why is this type of fertilization referred to as double fertilization?

Present your responses to the whole class

2.5: Formation of Fruits and Seeds

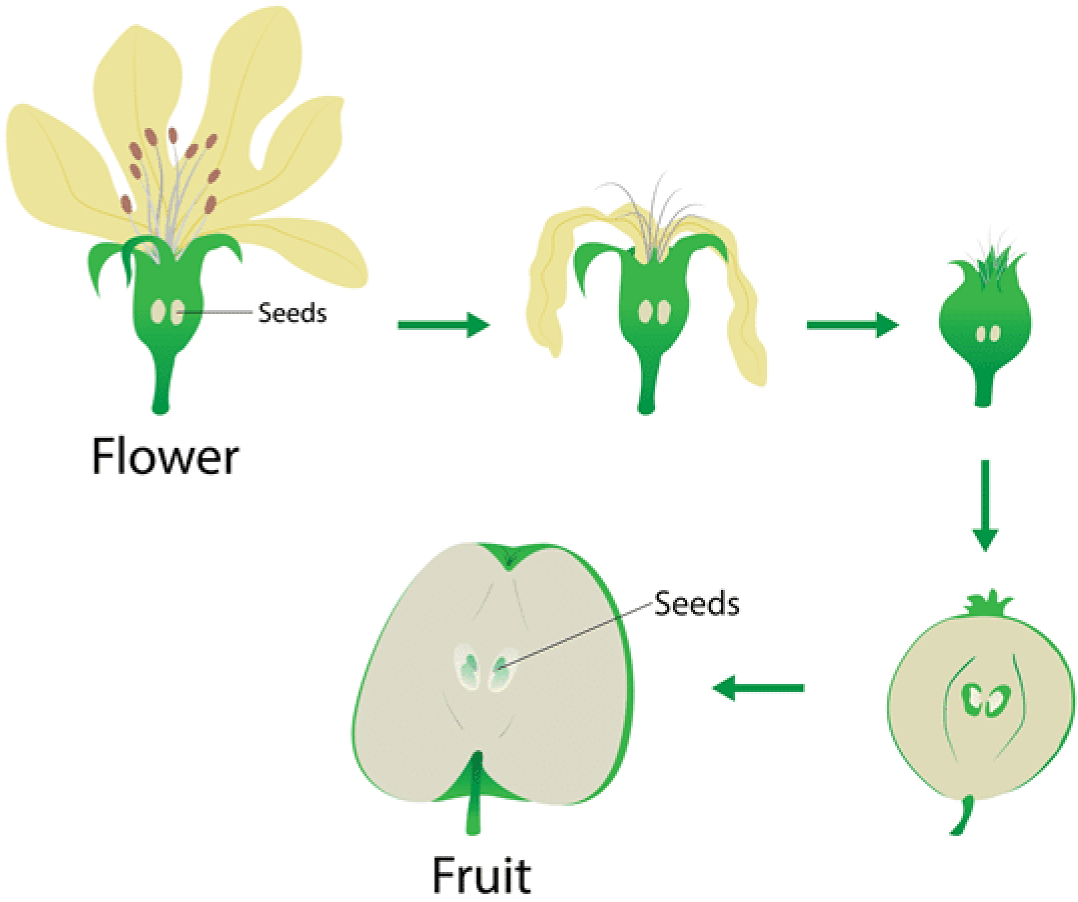


Figure 26: Formation of Fruits and Seeds

Immediately after fertilization, several processes occur leading to formation of fruits and seeds. How does formation of fruits and seeds take place? Some flower parts dry off or wither while others develop into seeds and fruits. Which flower parts wither after fertilization? Development of the fruit is immediate while that of the seed(s) takes some time.

Processes After Fertilization Leading to the Formation of Seeds and Fruits:

1. **Embryo Development**

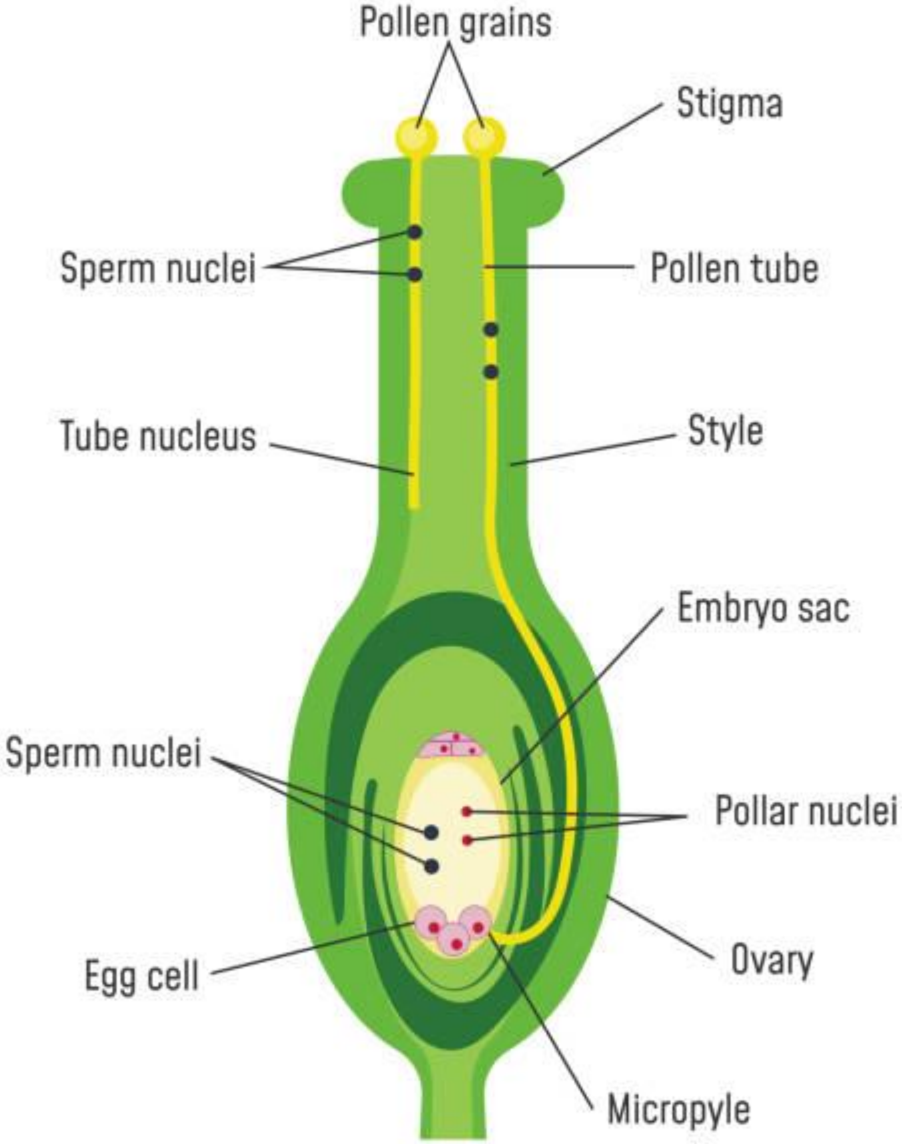


Figure 27: Embryo Development

- Following fertilization, the fertilized ovule develops into an embryo within the ovary of the flower. The zygote, resulting from the fusion of male and female gametes, undergoes multiple divisions to form a multicellular embryo.

2. **Seed Coat Formation**

- The outer layers of the ovule, including the integuments, develop into a protective seed coat that surrounds the developing embryo. The seed coat provides protection to the embryo and the seed contents.

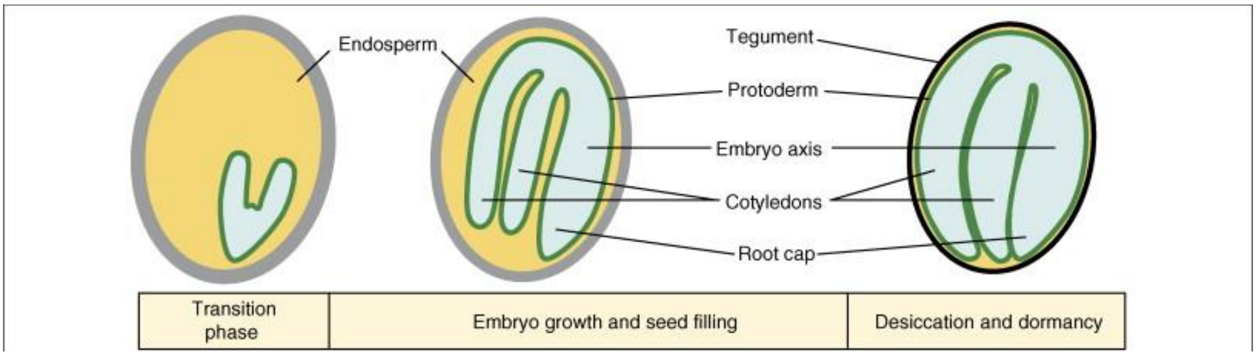
3. **Endosperm Development (In Certain Species):**

- In some plant species, a triploid cell resulting from the fusion of two polar nuclei with a sperm cell during fertilization develops into endosperm. The endosperm serves as a nutrient-rich tissue that nourishes the developing embryo in the seed.

4. **Fruit Formation:**

- The ovary of the flower, which housed the ovules, develops into a fruit. The fruit surrounds and protects the seeds, providing a means for their dispersal. Fruits come in various forms, such as fleshy fruits (e.g., apples, berries) or dry fruits (e.g., nuts, capsules).

5. **Maturation of Seeds**

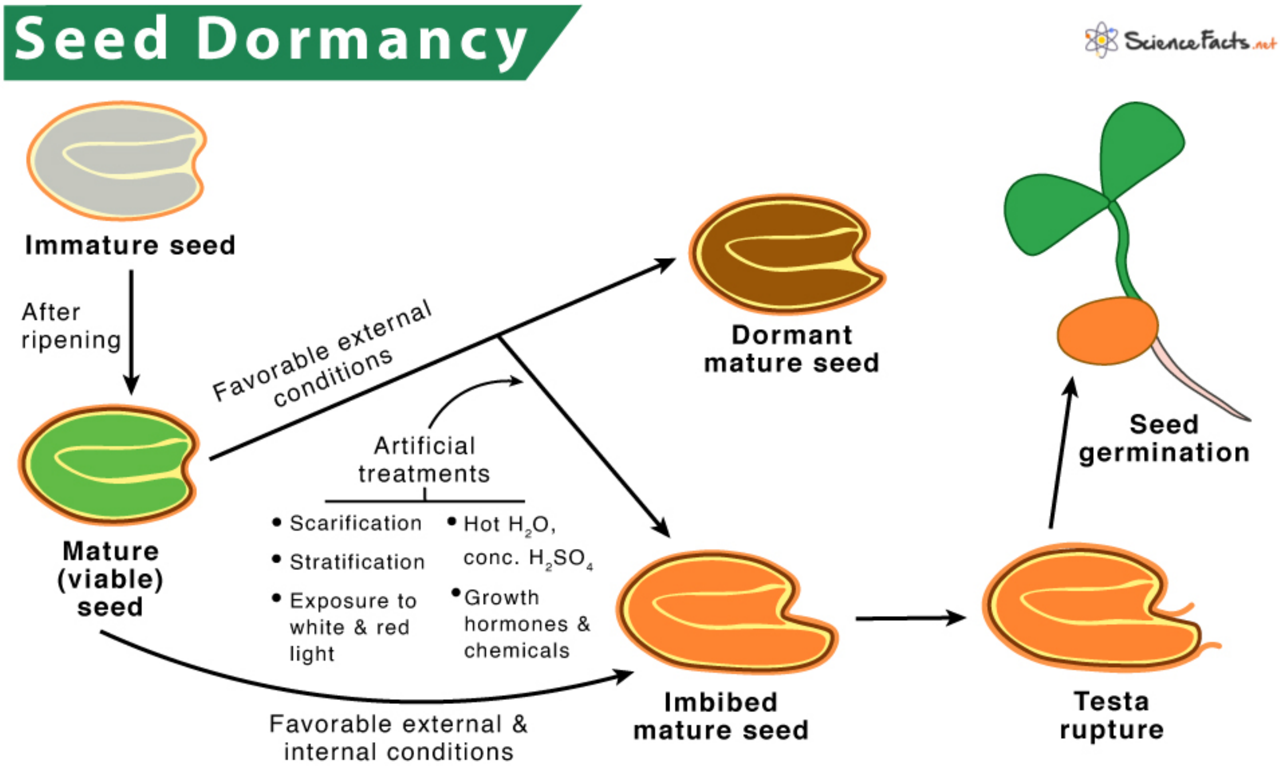


- The developing seeds undergo maturation, during which they accumulate nutrients, water, and storage compounds. This process prepares the seeds for eventual dispersal and germination.

6. **Seed Dispersal:**

- Seeds are dispersed from the parent plant to new locations, ensuring the establishment of new individuals. Dispersal mechanisms vary widely and can include wind dispersal, animal dispersal (by attachment to fur or ingestion and subsequent excretion), or water dispersal.

7. **Dormancy**



- Many seeds enter a state of dormancy, a period of inactivity during which the seed does not germinate even under favorable conditions. Dormancy allows seeds to survive adverse environmental conditions and ensures that germination occurs at a suitable time for the plant's success.

8. **Germination**

- Germination marks the beginning of seedling development. Under favorable environmental conditions, such as adequate moisture, oxygen, and suitable temperatures, the dormant seed absorbs water and begins metabolic activities, leading to the emergence of a radicle (embryonic root) and shoot.

9. **Seedling Growth**

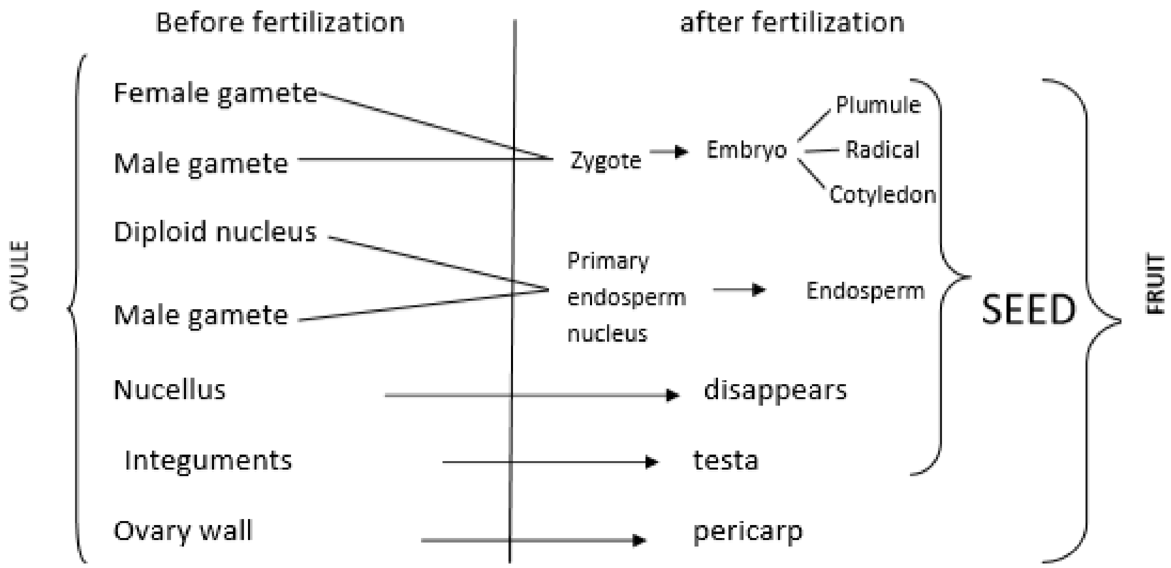
Figure 28: Seedling Growth

- As germination progresses, the seedling grows, and the stored nutrients within the seed support initial growth until the seedling can photosynthesize and produce its own energy.

10. **Establishment of the New Plant**

- The seedling continues to grow into a mature plant, and the cycle repeats as the plant reaches reproductive maturity and produces flowers for pollination and seed formation.

Summary of changes that occur after fertilization in flowering plants



In Activity 2.6, you will understand the processes which occur after fertilization leading to the formation of seeds and fruits and this will help you to appreciate that seeds and fruits we eat come from the flowers.

Activity 2.6: Exploring the process of fruit formation in flowering plants

Do this Activity in a group

Key question: How are fruits formed in flowering plants?

What you need: Mature tomato plant (or photo of the plant), textbook or the internet, pen/pencil, notebook

What to do

1. Observe the tomato plant or the picture shown and note any difference in the flower structure at the different stages (1 to 4) of fruit formation/development.

2. Identify what is taking place at each stage 1 to 4.
3. Research and discuss the processes which occur after fertilization in a flower.

Present your work to the whole class.

Self-study: Some fruits like pineapples are seedless and their formation does not require fertilization. How are these fruits formed?

Fruits

Usually a fruit is considered to be a fertilized ovary since it develops from an ovary of a flower after fertilization. This usually involves hormones which cause the fertilized ovary to grow and increase in size until it becomes a fully grown fruit.

Main parts of a fruit

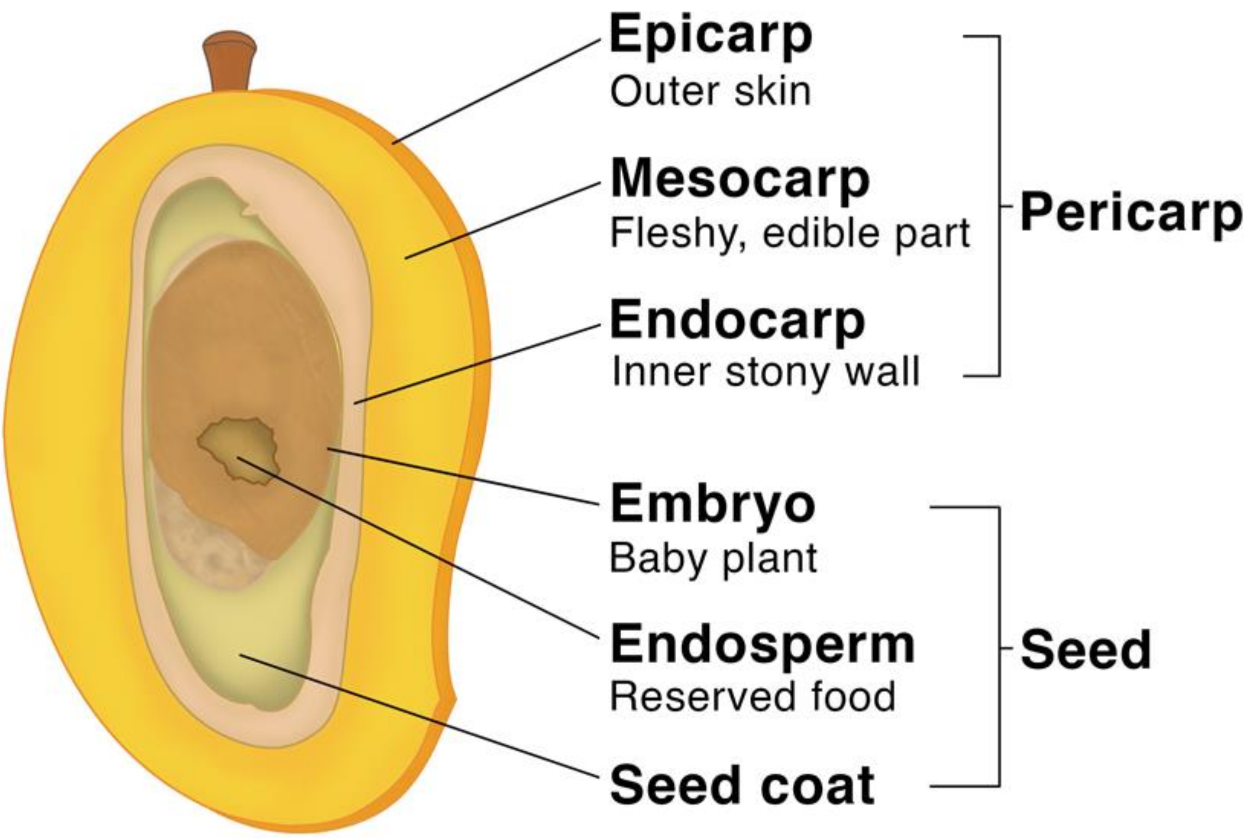


Figure 29: Parts of a fruits

1. **Pericarp:** The pericarp is the entire wall of the fruit. It is composed of three layers:

- **Exocarp:** The outermost layer, often referred to as the skin or peel.
- **Mesocarp:** The middle layer, which is usually fleshy in fruits like peaches or apples, or fibrous in fruits like coconuts.
- **Endocarp:** The innermost layer surrounding the seeds. It can be hard or stony, as in the case of a peach pit or cherry stone, or soft and thin, as in tomatoes.

- **Seed(s):** Seeds are mature fertilized ovules. They are typically found within the ovary of the flower and are surrounded by the endocarp. Seeds are essential for the plant's reproduction.

2. **Reproductive Structures**

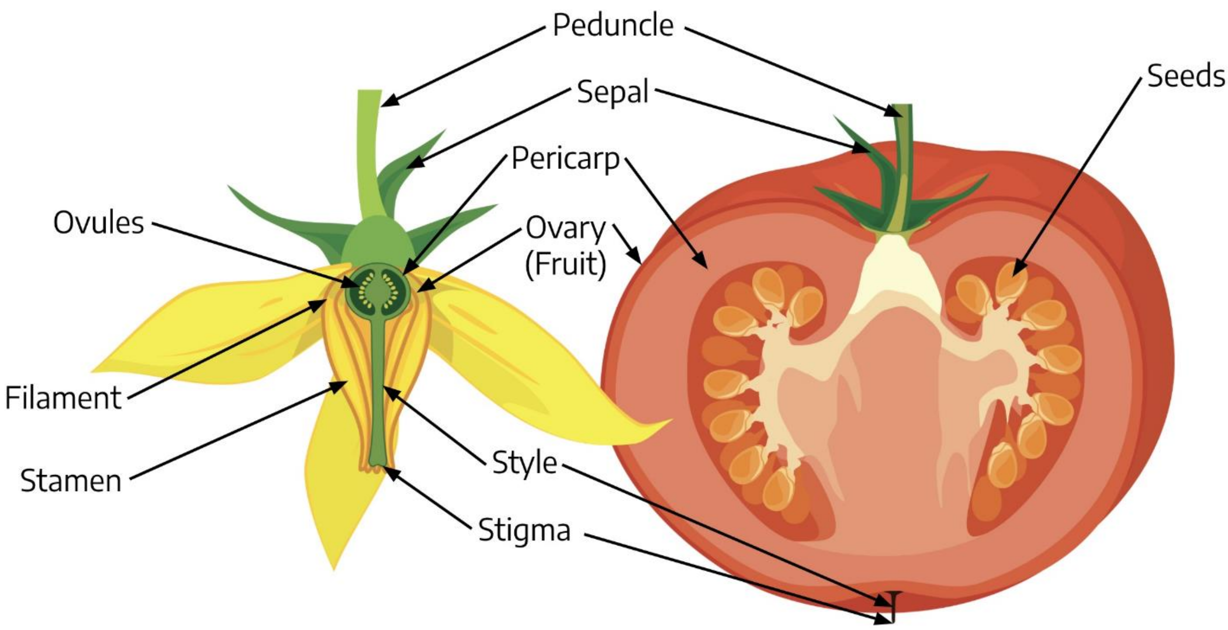


Figure 30: Reproductive Structures

- **Ovary:** The ovary is the part of the flower that develops into the fruit after fertilization. It contains the ovules, which become seeds when fertilized.

- **Stigma, Style, and Ovary:** In some fruits, remnants of the female reproductive structures may persist. For example, the remains of the stigma, style, and ovary may still be visible at the top of the fruit, depending on the type.

3. **Accessory Structures (optional):**

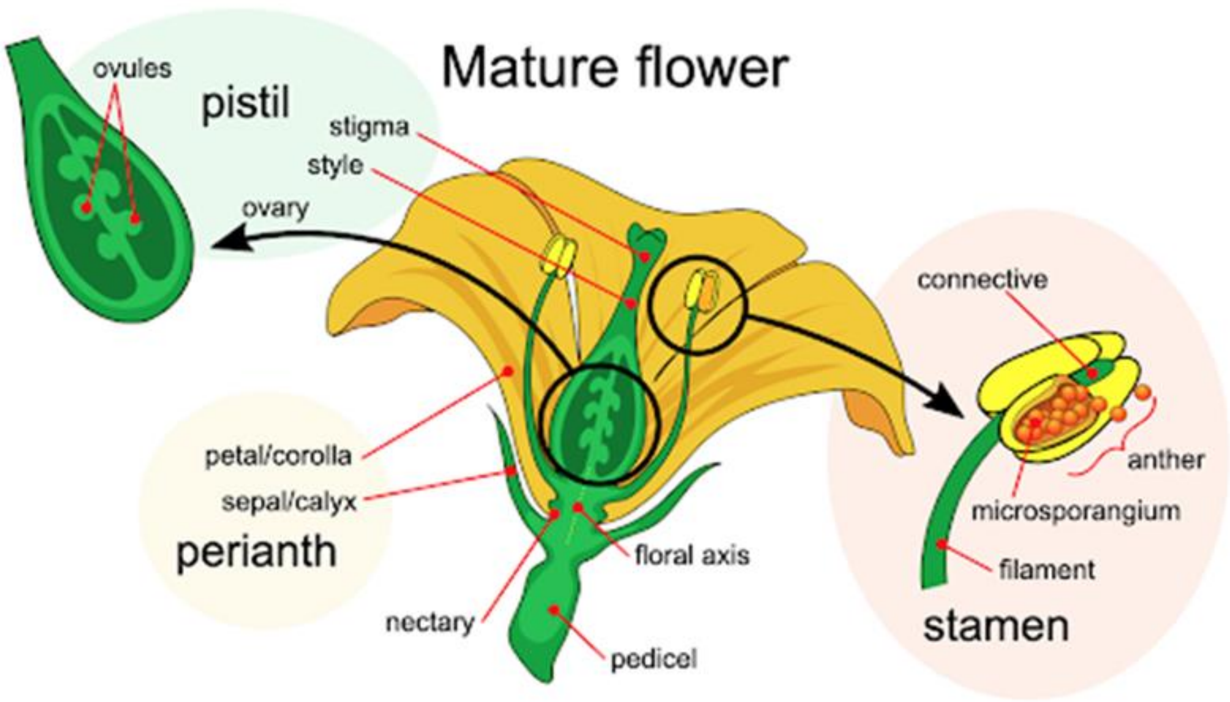


Figure 31: structure of a mature flower

- **Sepals and Petals:** In some fruits, sepals and petals may persist. Sepals are the outermost floral structures, and petals are the colorful, inner structures. They may remain attached to the fruit, particularly in fruits like apples and strawberries.

In Activity 2.7, you shall examine the parts of a fruit and compare different fruits. This will give you a better understanding of the fruits we always eat and appreciate that though fruits are formed by the same process and have a similar basic plan, they differ in some ways.

Activity 2.7: Examining the parts of a fruit

Key question. What are the major parts of a fruit?

What you need: Tomato fruit, orange fruit, raw mango fruit, avocado fruit, knife and, razorblade, pencil, the Internet

What to do:

1. Carefully study each of the fruits provided one at a time and observe the external features. What do you note on each?
2. Using a knife or razor blade, carefully cut each of the fruits longitudinally into two halves.
3. Use labeled drawing of a longitudinal section of a fruit from the internet to help you identify all the feature of the fruits you cut.
4. Using a sharp pencil, make a well labelled drawing of one of the halves from each fruit.
5. Which similarities do you note from the different fruits studied?

Present your findings to the whole class

Classes of Fruits

Figure 32: Fruits

Basing on the number of carpels in a flower and number of flowers involved in fruit formation, fruits can be classified into three main classes. In Activity 2.8, you will discover the different classes of fruits.

Fruits can be classified into three main classes based on their Characteristics and structure

1. **Simple Fruits**

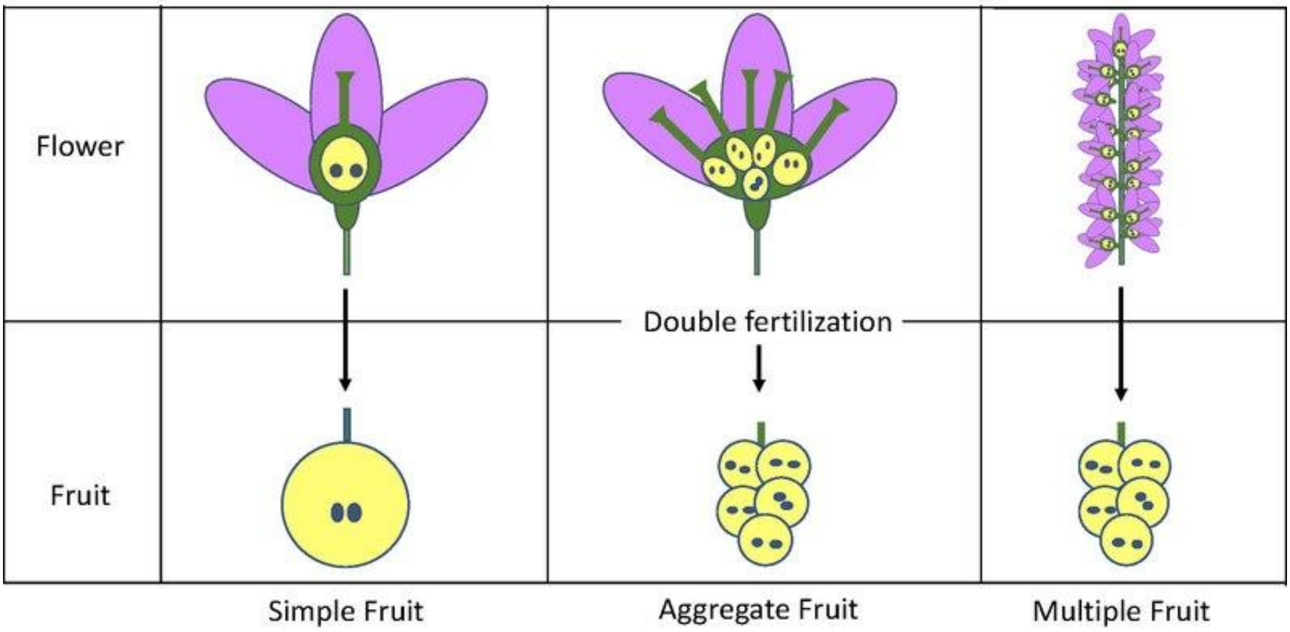


Figure 33: simple fruit development

- Simple fruits develop from a single ovary of a single flower. They may contain one or more seeds, but all seeds originate from a single carpel. Simple fruits can be further categorized based on their structure:
- **Fleshy Fruits:** The ovary wall becomes fleshy at maturity. Examples include tomatoes, cherries, and peaches.
- **Dry Fruits:** The ovary wall dries out and hardens at maturity.
- **Dehiscent Dry Fruits:** Split open at maturity to release seeds (e.g., peas, beans).
- **Indehiscent Dry Fruits:** Do not split open; seeds remain enclosed (e.g., acorns, sunflower seeds).

2. **Aggregate Fruits:**

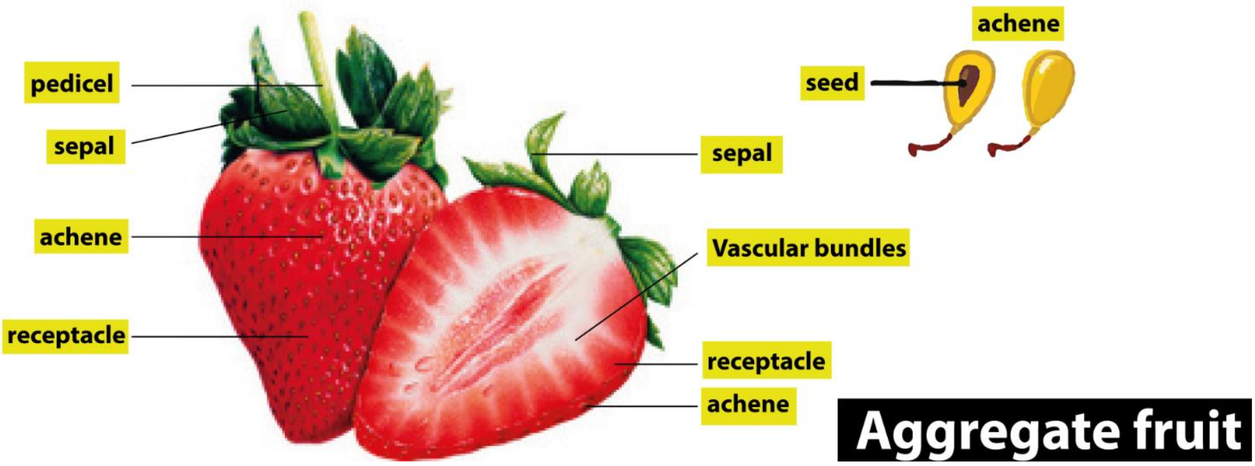


Figure 34: Aggregate fruits

- Aggregate fruits develop from the ovaries of multiple, separate flowers that are closely packed together in a single, compound flower. Each ovary contributes to the formation of a cluster of small, seed-like structures, often called "drupelets." Examples include strawberries, raspberries, and blackberries.

3. **Multiple (or Composite) Fruits:**

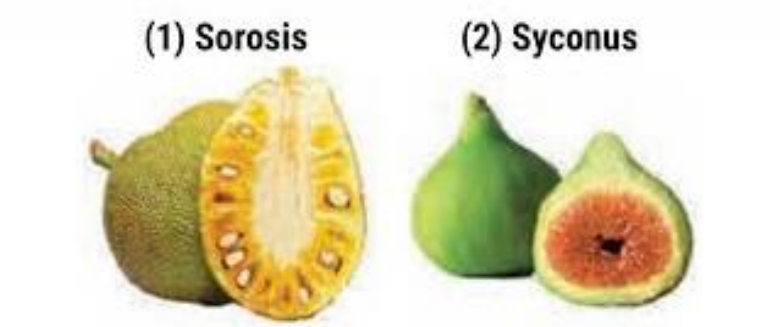


Figure 35: composite fruits

- Multiple fruits form from the ovaries of multiple flowers that are closely packed together. The entire inflorescence, or cluster of flowers, develops into a single, larger fruit. The individual fruitlets fuse together during development. Examples include pineapples and figs.

Understanding the classification of fruits is essential in botanical studies, horticulture, and agriculture, as it provides insights into the diversity of fruit structures and aids in the identification of plant species.

Activity 2.8: Finding out the three classes of fruit

Key question: What are the different classes of fruits?

What to do: Use the Internet or reference materials to read about the classes of fruits. Use the information you have got to fill in the blank spaces in the paragraph below.

Note: For the visually imparted teacher will print the text in a bigger font. For each of the classes mentioned, give an example of a common fruit that lies in that class.

1. ....fruits: These are fruits formed from one flower. These fruits can either be monocarpous if the pistil consists of .... carpel or .... if the pistil consists of several fused carpels. Examples.....................

2. .... fruits: These are fruits formed from one flower with a pistil consisting of many free carpels that is an .... pistil. Such fruits are therefore a collection of many .... fruits. Example................

3. …………………………. fruits. This kind of fruit is not formed from one flower but from a ……………………. of flower. Examples ………………………

a) Simple fruits

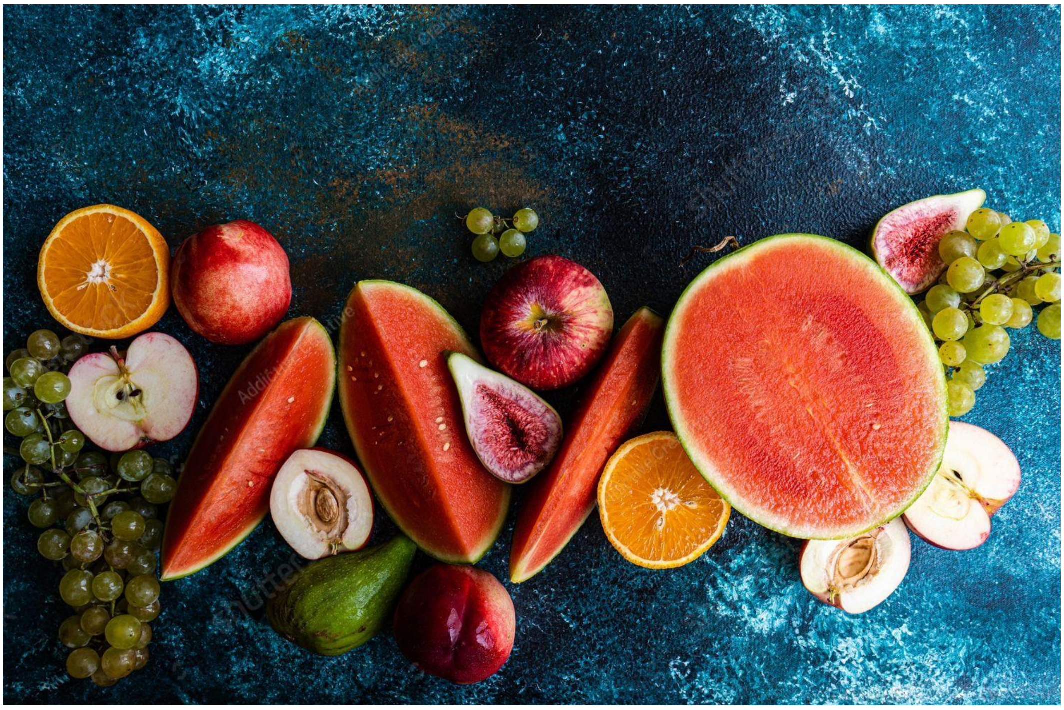


Figure 36: Simple fruits

Most of the common fruits in Uganda are simple fruits. These fruits are fleshy and juicy while some are not fleshy at all. This therefore forms a basis of classifying simple fruits into two namely, succulent fruits and dry fruits.

Simple fruits, which develop from a single ovary of a single flower, can be classified based on various characteristics such as the structure of the fruit and its mode of dehiscence (if any).

Classifications of simple fruits

Figure 37: simple fruits

1. **Fleshy Fruits**

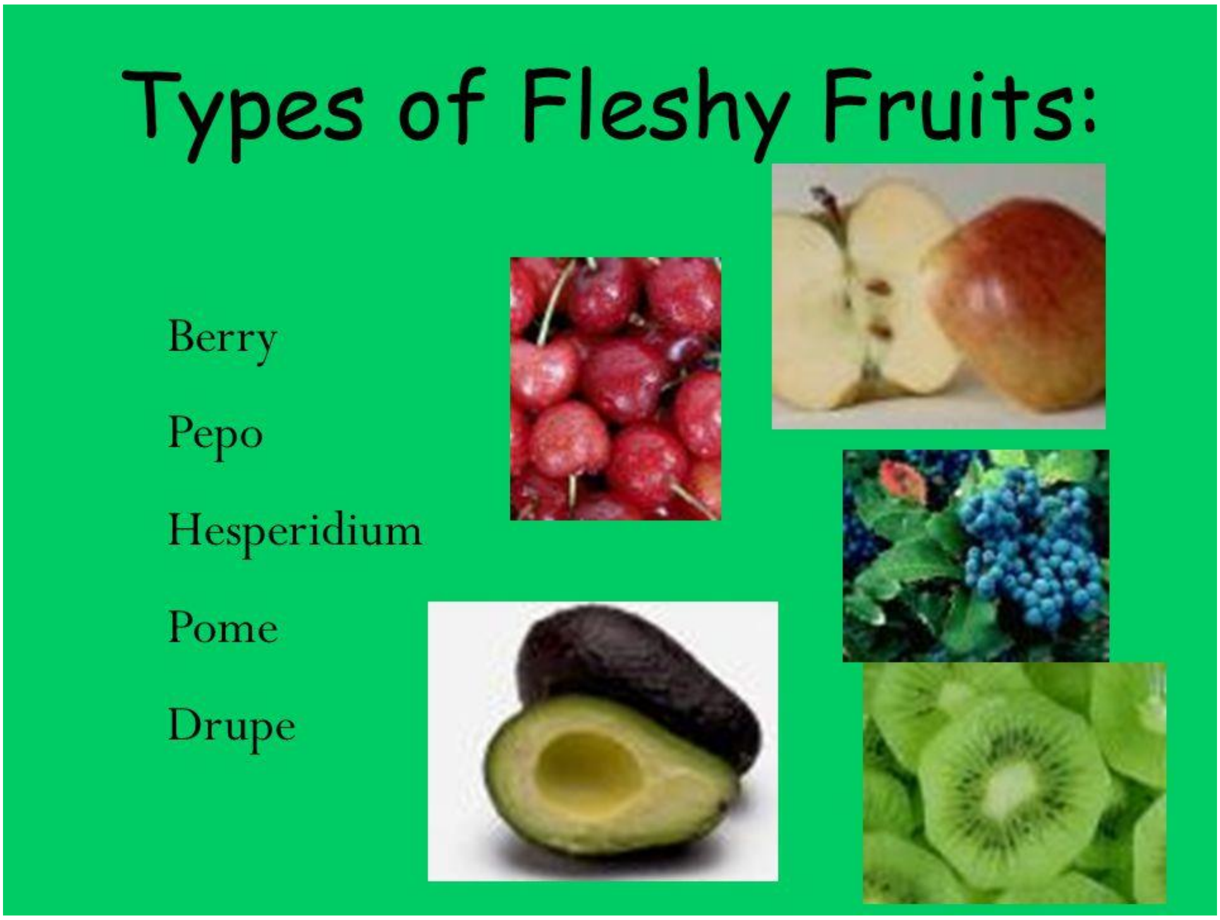


Figure 38: Fleshy Fruits

- **Berry:** A fleshy fruit with a soft, thin skin and a relatively large amount of flesh surrounding the seeds. Examples include tomatoes, grapes, and bananas.
- **Drupe:** A fleshy fruit with a single seed enclosed in a hard, woody endocarp or stone. The mesocarp is typically fleshy. Examples include peaches, plums, and cherries.
- **Pome:** A fleshy fruit derived from the enlargement of the floral tube surrounding the ovary. The true fruit is the seed-bearing core (endocarp), while the fleshy part is derived from the floral tube. Examples include apples and pears.

2. **Dry Fruits**

Figure 39: Dry Fruits

Dehiscent Dry Fruits

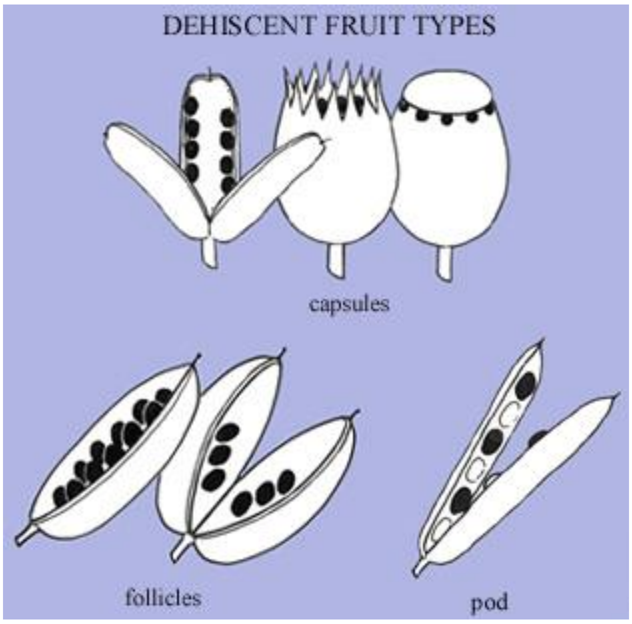


Figure 40: Dehiscent Fruits

- **Capsule:** A dry fruit that splits open at maturity to release seeds. The split can occur along various lines (valves) or through pores. Examples include poppies and iris.

- **Follicle:** A dry fruit that splits along one side to release seeds. Examples include milkweed and columbine.
- **Legume:** A type of follicle that splits along two sides. Examples include peas, beans, and peanuts.
- **Silique and Silicle:** Variations of capsules found in the mustard family (Brassicaceae) with two fused carpels. Silique is long and slender, while silicle is short and broad. Examples include radishes and mustards.

Indehiscent Dry Fruits

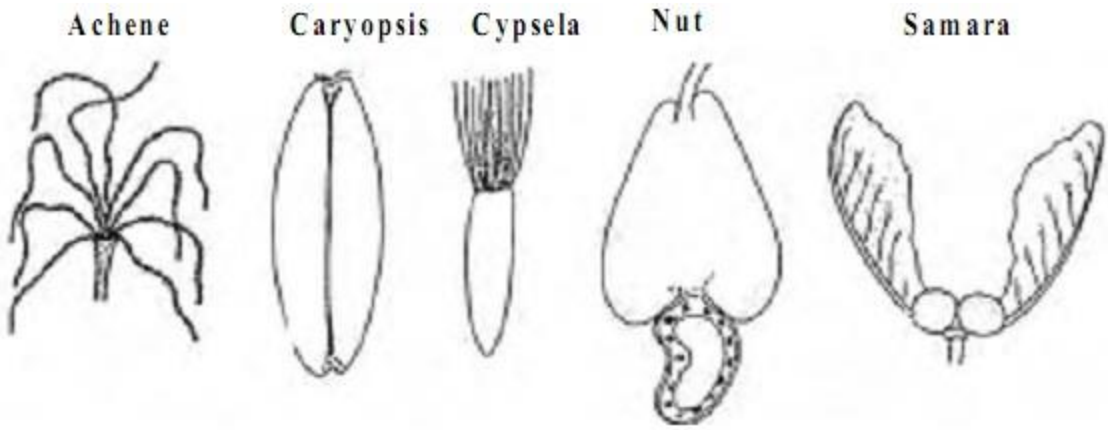


Figure 41: Indehiscent Dry Fruits

- **Achene:** A small, dry fruit with a single seed attached to the ovary wall at one point. Examples include sunflower seeds and buttercups.
- **Nut:** jSimilar to an achene but larger, often with a hard shell or woody pericarp. Examples include acorns and chestnuts.
- **Samara:** A winged achene that aids in wind dispersal. Examples include maple seeds.

- **Grain/Caryopsis:** A one-seeded fruit where the seed coat is fused to the ovary wall. Examples include wheat, rice, and corn.

In Activity 2.10, you will classify fruits as either dry or succulent. This will give you a clear understanding of fruits and will help you to appreciate the differences amongst them.

Activity 2.9: Classifying simple fruits

Key question: How can simple fruits be classified?

What you need: Razorblades, knife, pencil, hand tens, fruits of different types, that is mangoes or avocado, tomatoes or oranges, desmodium, beans or crotalaria, maize grains, tridax, blackjack

What to do:

1. Collect the different fruits or receive them from the teacher. (The less able learners should receive the fruits from the teacher in class)
2. Study each of the fruits carefully paying attention to all the external features
3. Using a knife and/or a razorblade, cut each of the fruits longitudinally into two halves and.

i) Identify and study the internal features of each fruit.

ii) What do you say about the pericarp for each? Is it dry or succulent? Is it clearly differentiated into the epicarp, mesocarp and endocarp?

iii) Carefully study the endocarp. Is it woody or fleshy and juicy?

iv) Observe the seeds. Are they many or just one?

4. Using a suitable table, show the features observed on each fruit paying attention on whether the pericarp is dry or succulent, endocarp is woody or fleshy and number of seeds where applicable.

5. From your table, classify the fruits as dry or succulent and drupe fruits or berry fruits.

Present your work to the whole class

b) Dry Fruits

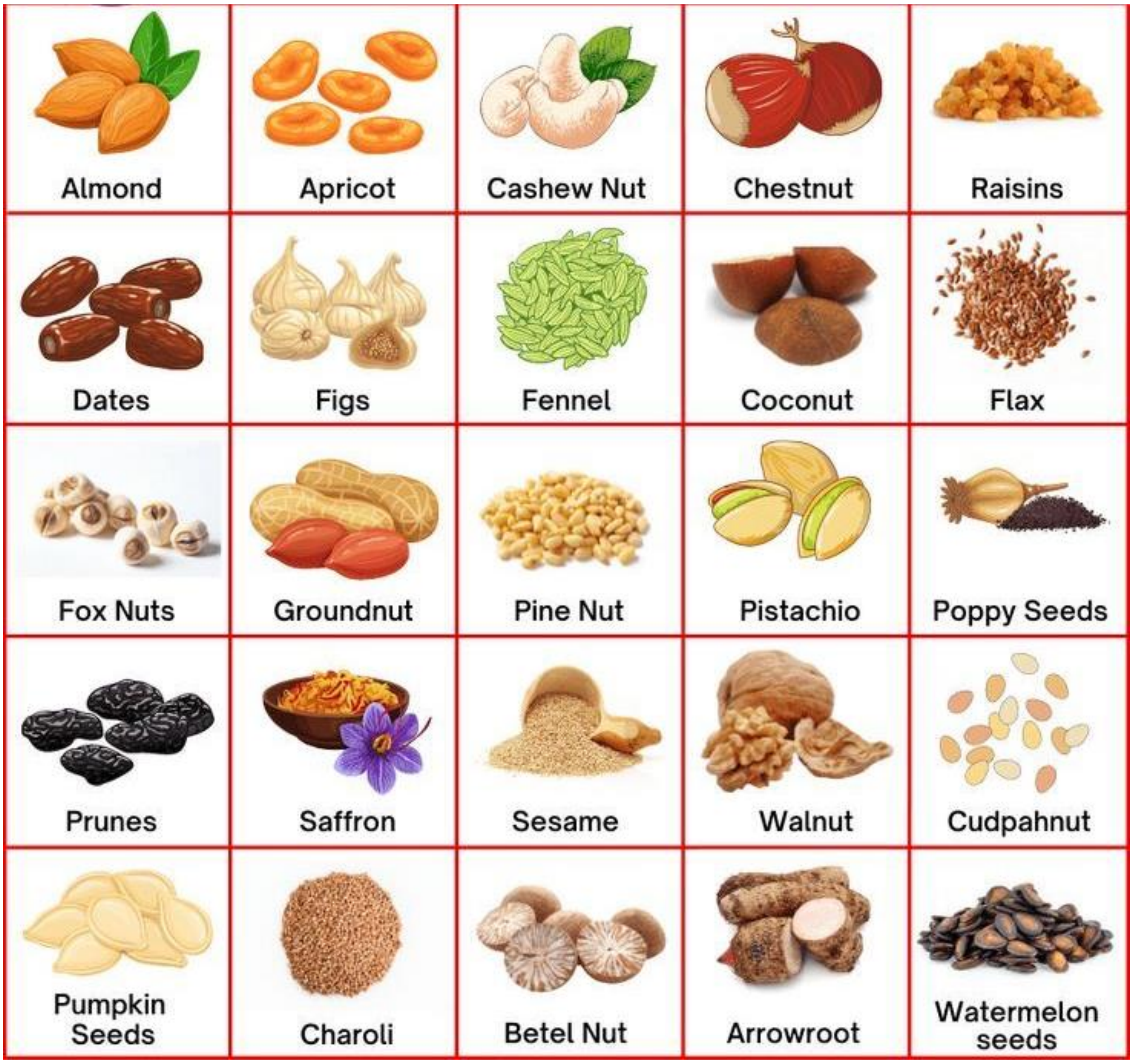


Figure 42: Dry Fruits

What are dry fruits? From Activity 2.9, you identified some examples of dry fruits. However, you should have noticed that the dry fruits do not have exact similar features and based on their differences, they are subdivided into dry dehiscent and dry indehiscent fruits. What does the term dehiscence mean?

Dry dehiscent fruits split open when dry while dry indehiscent fruits do not split open. The dry dehiscent fruits are further subdivided into follicles, legumes, capsule and schizocarp while the dry indehiscent are subdivided into achene, cypsela, nut, samara and caryopsis.

Dry fruits are a category of fruits that have a dry pericarp (fruit wall) at maturity. They can be further classified into dehiscent and indehiscent types based on whether or not they split open to release their seeds.

1. Dehiscent Dry Fruits

Capsule:

- *Characteristics:* A dry fruit that splits open at maturity to release seeds. The split can occur along various lines (valves) or through pores.
- *Examples:* Poppy, lily, iris.

Follicle

- *Characteristics:* A dry fruit that splits along one side to release seeds.
- *Examples:* Milkweed, columbine.

Legume:

- *Characteristics:* A type of follicle that splits along two sides.
- *Examples:* Peas, beans, peanuts.

Silique and Silicle:

- *Characteristics:* Variations of capsules found in the mustard family (Brassicaceae) with two fused carpels. Silique is long and slender, while silicle is short and broad.

- *Examples:* Radishes, mustards.

2. Indehiscent Dry Fruits:

Achene:

- Characteristics: A small, dry fruit with a single seed attached to the ovary wall at one point.
- Examples: Sunflower seeds, buttercups.

Nut:

- Characteristics: Similar to an achene but larger, often with a hard shell or woody pericarp.
- Examples: Acorns, chestnuts.

Samara:

- Characteristics: A winged achene that aids in wind dispersal.
- Examples: Maple seeds.
- **Grain/Caryopsis:**

- *Characteristics:* A one-seeded fruit where the seed coat is fused to the ovary wall.
- ***Examples:*** Wheat, rice, corn.

In Activity 2.10, you will classify dry fruits under different types of dry dehiscent and dry indehiscent fruits. This. will give you a detailed understanding of the characteristics of different dry fruits.

Activity 2.10: Classifying dry fruits

Key question: How can dry fruits be classified?

What you need: Reference material about dry fruits, the internet, knife, various fruits like blackjack, cashew nut, maize, cassia, beans, tridax, desmodium, cotton or Datura.

What to do:

1. Examine the fruits provided, identify their different characteristics and use the information to complete the table below.

Fruit	Pericarp can split open or not	Pericarp very hard or not	Number of lines of weakness	Persistent calyx present or absent

2. From the task above, identify fruits which are dry dehiscent and those that are dry indehiscent.

3. Using reference materials and or internet, read about the characteristics of the different types of both the dry dehiscent

fruits. Use the characteristics and the table above to identify which dry dehiscent fruits are follicle fruits, legume fruits, capsule fruits and schizocarp fruits and which dry indehiscent fruits are achene, samara, cypsela, caryopsis, achene and nut

Seeds

Figure 43: Seeds

A seed is a fertilized ovule. How is a seed different from a fruit? A seed has an endosperm and cotyledon which serve as a good food reserve for the embryo usually during germination.

It is important to note that after formation of the zygote, it undergoes mitotic division and it becomes differentiated into the plumule, radicle and cotyledons and the growing embryo gets nutrients from the parent plant through the stalk.

2.6: Differences between Seeds and Fruits

Figure 44: Seeds and Fruits

Fruits and seeds tend to show marked differences both structurally and functionally.

Feature	Seed	Fruit
Definition	Mature ovule containing embryo, nutrients, and protective seed coat	Mature ovary of a flower, often containing seeds
Origin	Develops from fertilized ovule within the ovary	Develops from fertilized ovary after pollination
Components	Embryo, endosperm (in some cases), seed coat	Pericarp (exocarp, mesocarp, endocarp)

Function	Primary function is to germinate and give rise to a new plant	Primary function is to protect and aid in seed dispersal
Development	Develops from the fertilized ovule after fertilization	Develops from the fertilized ovary after pollination
Size and Structure	Usually smaller; has a protective seed coat	Varies widely in size, shape, and structure; pericarp provides protection
Dispersal	Dispersed by various means (wind, water, animals	Often aids in seed dispersal (wind, animals, etc.)
Germination	Undergoes germination to become a seedling	Does not undergo germination; facilitates seed dispersal

Consumption	While some seeds are edible, like nuts and beans, most are not palatable or contain toxins. Their primary purpose is to develop into new plants, not to be consumed.	Fruits are often a source of food for humans and animals due to their sugars and other nutrients. Some fruits, like berries, are eaten whole, while others are processed into juices, jams, or other products.

Seeds are the reproductive structures containing the plant embryo and nutrients, while fruits are the mature ovaries of flowers that typically contain seeds and aid in their dispersal. Together, they play essential roles in the life cycle and reproductive success of flowering plants.

In Activity 2.11, you will examine the key differences between fruits and seeds. This will help you to know whether the different plant structures we eat are either seeds or fruits.

Activity 2.11: Exploring the difference between fruits and seeds

Do this activity in a pair?

Key question: How are seeds different from fruits?

What you need: A knife or sharp blade, orange fruit and bean seeds, pencil

What to do:

1. Carefully study the fruits and seeds provided and observe the external structure of each. Do you observe any scars? How many scars do you observe on each?
2. Using a knife or sharp blade, carefully cut each of the specimens longitudinally

i) What do you see inside the fruit and inside the seed?

ii) From which part of the flower does each develop?

iii) State the differences between seeds and fruits using the observations made above in a suitable table.

Share your observations with another pair.

2.7: Fruit and Seed Dispersal

Figure 45: Fruit and Seed Dispersal

You have at least at one point picked a mango or orange fruit from its parent plant and moved away with it. Which part did you eat? Which parts did you throw away? Which process did you aid by throwing the seed away?

When you walk through a bush around your home, you at times notice some blackjack attached onto your clothes. What do you do to them? Which process do you think you aid by doing that? There are many other ways in which fruits and seeds are moved from their parent plant to other places, a process known as dispersal.

Methods/Agents of Dispersal, Mode of Dispersal, and Structures Aiding Dispersal for Different Fruits and Seeds:

1. **Wind Dispersal**

Figure 46: Wind Dispersal

- **Methods/Agents:** Wind carries seeds away from the parent plant.
- **Mode of Dispersal:** Seeds are often equipped with structures that enhance wind dispersal.
- **Wings or Pappus:** Structures like wings or a pappus (parachute-like appendage) assist in wind dispersal. Examples include dandelion seeds.

- **Feathery Appendages:** Feathery structures on seeds increase surface area, enhancing wind dispersal. Examples include maple seeds.

2. **Water Dispersal**

Figure 47: Water Dispersal

- **Methods/Agents:** Seeds are transported by water.
- **Mode of Dispersal:** Seeds are adapted to float and withstand water currents.
- **Buoyant Structures** Seeds with air-filled structures or waterproof coverings float on water. Examples include coconuts, water lilies.

3. **Animal Dispersal**

Figure 48: Animal Dispersal

- **Methods/Agents:** Animals, including mammals, birds, and insects, carry seeds.
- **Mode of Dispersal:** Seeds may be attached to animals' fur, feathers, or ingested and later excreted.
  - **Hooks or Velcro-like Structures:** Seeds with hooks attach to fur or feathers. Examples include burdock.
  - **Edible Fruits:** Fruits with fleshy, nutritious pulp attract

    animals to eat and disperse seeds. Examples include berries, cherries.

4. **Explosive Mechanisms (Explosive Dehiscence)**

Figure 49: Explosive Dehiscence

- **Methods/Agents:** Mechanical ejection of seeds from the parent plant.
- **Mode of Dispersal:** Seeds are forcefully expelled.

- **Seed Pods:** Pods that split open explosively, propelling seeds. Examples include peas, touch-me-not plants.

Seeds and fruits have evolved various adaptations to enhance their modes of dispersal, increasing the chances of successful establishment in new locations. These adaptations are often the result of natural selection and are shaped by the environmental conditions and available dispersal agents.

Some common adaptations

1. **Wind Dispersal**

   Adaptations in Seeds:

- **Wings or Pappus:** Some seeds have wing-like structures (samara) or a pappus (parachute-like appendage) that increases surface area and allows them to be carried by the wind.
- **Feathery Appendages:** Seeds may have feathery structures that increase drag, enabling them to be carried by the wind. Examples include dandelion seeds.

2. **Water Dispersal:**

   Adaptations in Seeds:

- **Buoyant Structures:** Seeds are adapted to float on water, often by having air-filled structures or waterproof coverings. Coconuts and water lilies are examples,

3. **Animal Dispersal:**

   Adaptations in Fruits:

- **Edible Flesh:** Fruits may have a fleshy and nutritious pulp that attracts animals. Animals eat the fruit, and the seeds are later dispersed through their droppings.
- **Hooks or Velcro-like Structures:** Seeds may have hooks or structures that attach to the fur or feathers of animals, promoting dispersal. Burdock is an example.

4. **Explosive Mechanisms (Explosive Dehiscence):**

   Adaptations in Seed Pods:

- **Mechanical Ejection:** Seeds in explosive seed pods are adapted to be forcefully expelled, often due to tension created during drying. Peas and touch-me-not plants exhibit this adaptation.

In Activity 2.12, you will discover the methods/ agents of dispersal, the mode of dispersal and the structures which aid dispersal of the different fruits and seeds. This will help you appreciate that the different structures seeds and fruits possess are suited for some particular modes of dispersal.

Activity 2.12: Understanding the process of fruit and seed dispersal

Key question: How are seeds and fruits adapted to their mode of dispersal above.

What you need: A knife or sharp blade, various fruits and seeds like tridax, blackjack, tomato, orange, ripe mango, jacaranda, desmodium, guavas, bean pods

What to do:

1. Carefully examine the fruits provided and identify the externa structures and appearance.

i) Copy the table below in your notebook and record your observations.

Fruit	Feature/ structure	Agent of dispersal	Way/ mode of dispersal

ii) Apart from the observable characteristics, research and find out other adaptations which seeds and fruits have for their mode of dispersal.

Present your work to the rest class.

Sample Activity of integration

A school grows maize in their garden. One day the biology teacher told the learners to go and collect flowers. The learners went to the garden and removed all the inflorescence from the maize plants. That season the school did not get any harvest.

Task: Write a report to the head teacher to explain why they did not get any yields that season.

Chapter summery

In this chapter, you have learnt that:

1. Essential parts of the flower directly take part in the process of sexual reproduction while non-essential part do not.
2. Without pollination, fertilization and seed and fruit pollination cannot take place
3. Flowers are adapted to specific modes or agents of pollination
4. The process of fertilization in flowering plants involves fusion of the male and female gametes

5. Immediately after fertilization, different processes occur that lead to fruit and seed formation.

Chapter 3: Sexual Reproduction in Humans.

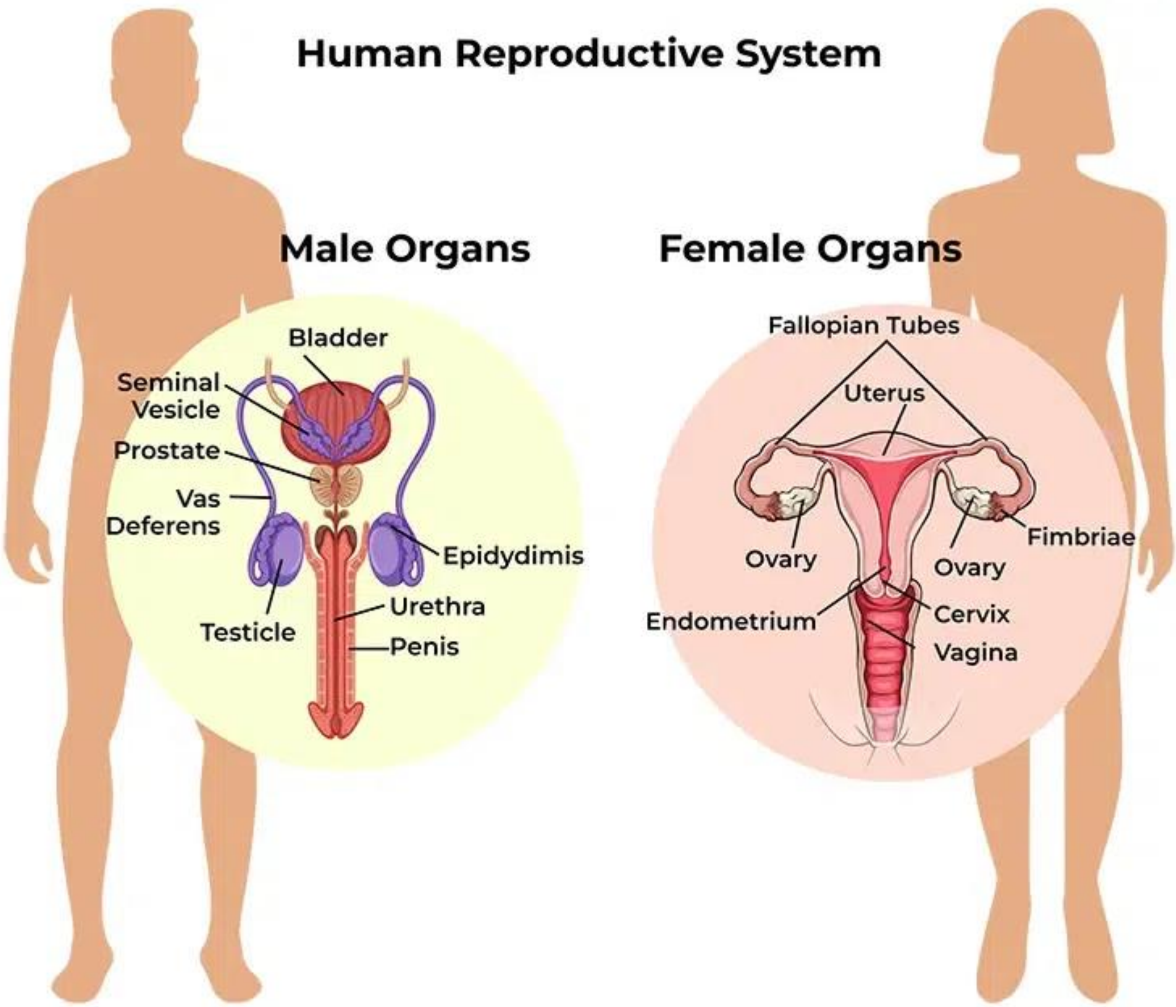


figure 3. 1

Key words:

- Gametes
- Penis
- Vagina

- Semen
- Ovary
- Uterus
- Menstrual cycle
- Zygote
- Embryo
- Fetus
- Oviduct
- Ovulation
- Testes

Learning outcomes

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

a) Understand the structure and functions of male and female reproductive system in humans.

b) Understand the changes that take place during the menstrual cycle.

c) Relate male and female gametes.

d) Appreciate the process of fertilization of an ovum and the development of the zygote up to birth.

e) Know the role of the placenta during pregnancy.

f) Understand the importance of antenatal medical care.

g) Understand aspects of care for the baby after birth (breast feeding, balanced diet, immunization and hygiene).

h) Recognize the health risks/complications associated with early/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 symptoms and understand the mode of transmission of syphilis, gonorrhea, candida, Human Papilloma Virus (HPV), hepatitis Band HIV/AIDS. Appreciate the preventive measures for STIs. Note. The: only Preventive method recommended for young people is abstinence.

l) Identify the challenges faced by people living with HIV/AIDS and how to overcome.

BIBLICAL INTEGRATION

"For you created my inmost being; you knit me together in my mother's womb." - Psalm 139:13. This verse underscores the wonder and intricacy of human life from conception, reminding us of the care and intentionality involved in our creation. As we study human reproduction, we appreciate

the divine design and the importance of respecting and caring for life at all stages.

By understanding the processes and structures involved in human reproduction, we can better appreciate the complexity and sanctity of life as reflected in Psalm 139:13. This knowledge empowers us to make informed decisions about our health and the well-being of future generations.

Introduction

Sexual reproduction is a type of reproduction that involves gametes from a male and female organisms.

In this chapter, you will be able to understand that for sexual reproduction to occur, there must be two parents producing specialized reproductive cells. In males, the specialized cells are sperm cells produced in the testis of the male reproductive system. In females, the specialized cells are the ova which are found in the ovaries of the female reproductive system.

3.1: The Male Reproductive System

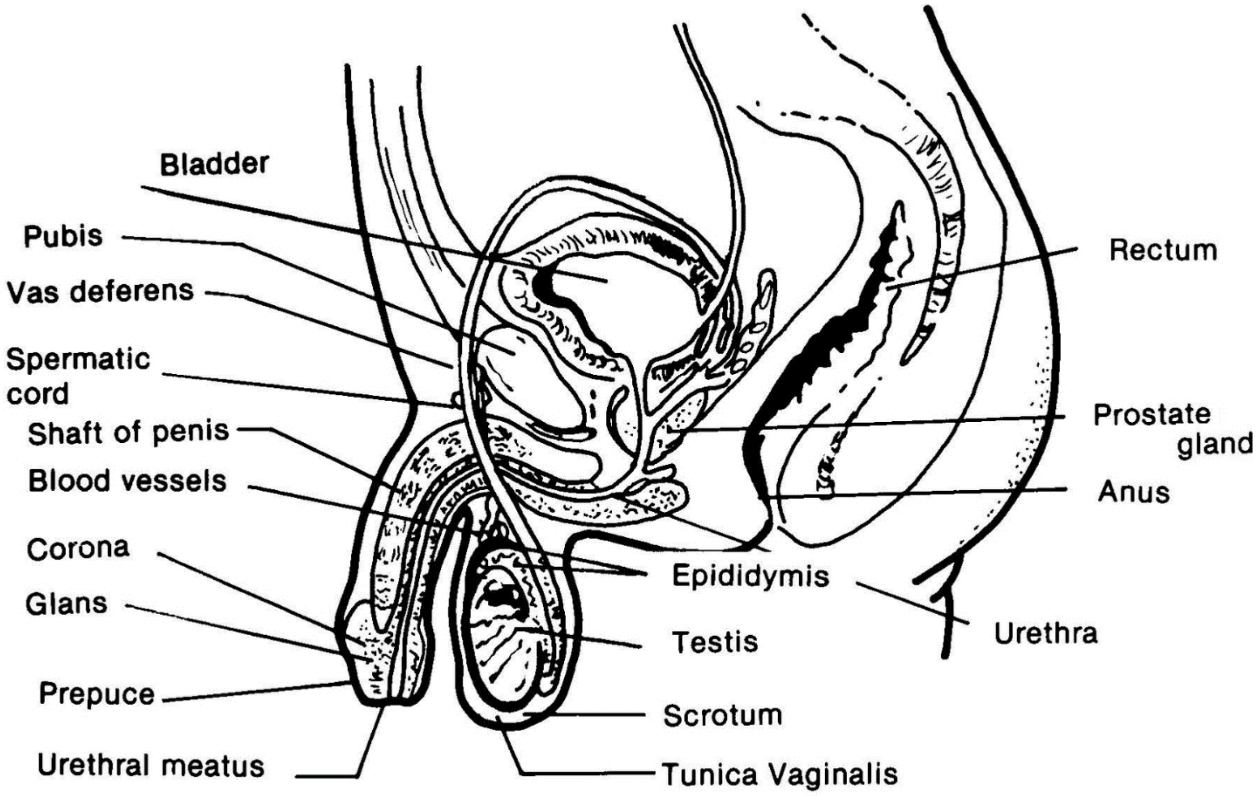


figure 3. 2

The human male reproductive system produces sperms which it delivers into the female reproductive system during sexual intercourse. Usually what is seen as the male reproductive system is the penis and the testes since they are visible. However, it is important to know that this system is comprised of many other organs.

The male reproductive system in humans consists of several organs and structures that work together to produce, transport, and deliver sperm for fertilization. The main components of the male reproductive system include the testes, epididymis, vas deferens, prostate gland, seminal vesicles, and penis.

1. **Testes**

- The testes are the primary male reproductive organs responsible to produce sperm and testosterone, the male sex hormone.
- Sperm production occurs within structures called seminiferous tubules.

2. **Epididymis**

- The epididymis is a coiled tube located on the surface of each testis.
- It serves as a storage and maturation site for sperm produced in the testes.
- Sperms that leave the testes are not fully mature and must pass through the epididymis to acquire motility and the ability to fertilize an egg.

3. **Vas Deferens**

- The vas deferens is a muscular tube that transports mature sperm from the epididymis to the ejaculatory duct.
- During ejaculation, the vas deferens contracts, propelling sperm forward.

4. **Seminal Vesicles**

- The seminal vesicles are two small glands located near the base of the bladder.
- They secrete a fluid rich in fructose and other substances that nourish and activate sperm.
- The fluid from the seminal vesicles, combined with sperm from the vas deferens, forms semen.

5. **Prostate Gland**

- The prostate gland is a small, walnut-sized gland located just below the bladder.
- It produces a milky fluid that contributes to the composition of semen.
- The fluid from the prostate contains enzymes and other substances that enhance sperm motility and viability.

6. **Bulbourethral Glands**

- Also known as Cowper's glands, these small glands secrete a clear, lubricating fluid into the urethra during sexual arousal.
- The fluid helps neutralize acidity in the urethra and provides a lubricating medium for sperm.

7. **Penis**

- The penis is the external organ that delivers sperm to the female reproductive system during sexual intercourse.

- The urethra, which runs through the penis, serves as a duct for both urine and semen.

During sexual arousal, the male reproductive system works together to produce and deliver sperm to the female reproductive system for fertilization. The release of sperm from the penis is known as ejaculation. The process is regulated by a complex interplay of hormones, and the male reproductive system plays a crucial role in the perpetuation of the human species through the production of offspring.

In Activity 3.1, you will explore the structure and functions of the male reproductive system. This will help you to understand its components and their functions.

Activity 3.1: Exploring the structure of the male reproductive organ and its functions

Key question: Explain the structure and functions of the male reproductive system.

What you need: A chart showing the male reproductive system, reference materials, the Internet

What to do:

1. Carefully study the diagram in the chart provided by the teacher and;

I) Draw and label the structure of the male reproductive system.

ii) Discuss the functions of each of the parts and present your conclusions in a suitable table.

Compare your work with that of other groups.

3.2: The Female Reproductive System

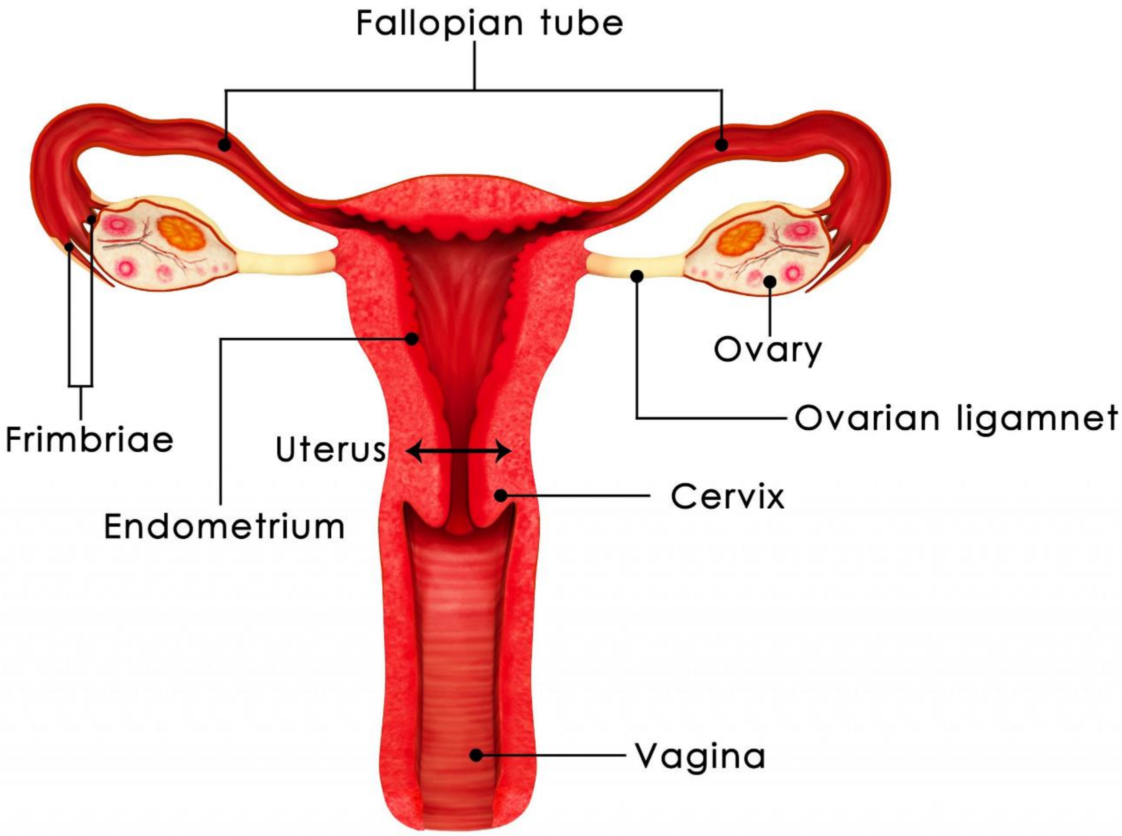


figure 3. 3 Female Reproductive System

The female reproductive system in humans is a complex system of organs and structures involved in the production of eggs (ova), fertilization, pregnancy, and childbirth. The main components of the female reproductive system include the ovaries, fallopian tubes, uterus, cervix, and vagina.

1. **Ovaries**

- The ovaries are a pair of small, almond-shaped organs located on either side of the uterus.
- They are responsible for producing eggs (ova) and female sex hormones, including estrogen and progesterone.
- Ovaries release mature eggs during the menstrual cycle in a process called ovulation.

2. **Fallopian Tubes**

- The fallopian tubes are two slender tubes that extend from the ovaries to the uterus.
- After ovulation, the fallopian tubes capture the released egg and provide a site for fertilization by sperm.
- Fertilized eggs (zygotes) then travel down the fallopian tubes toward the uterus.

3. **Uterus**

- The uterus, or womb, is a muscular organ where a fertilized egg implants and develops into a fetus during pregnancy.
- The uterus is lined with the endometrium, which thickens during the menstrual cycle to prepare for a potential pregnancy.
- If fertilization does not occur, the uterine lining is shed during menstruation.

4. **Cervix**

- The cervix is the lower, narrow part of the uterus that connects to the vagina.
- It acts as a passage way between the uterus and the vagina.
- The cervix produces cervical mucus that changes in consistency during the menstrual cycle, influencing sperm movement and allowing or preventing the passage of sperm into the uterus.

5. **Vagina**

- The vagina is the muscular tube that connects the cervix to the external genitals.
- It serves as a passageway for menstrual flow, receives the penis during sexual intercourse, and acts as the birth canal during childbirth.

6. **Vulva**

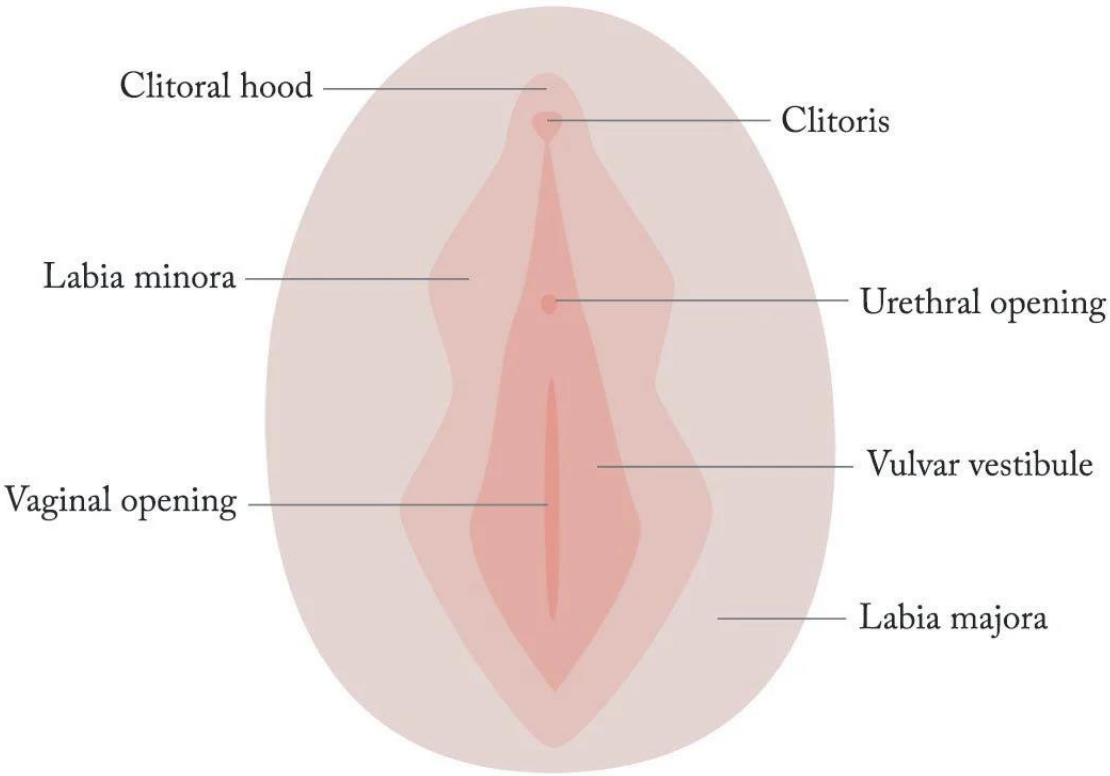


figure 3. 4 vuva

figure 3. 5

- The vulva is the external genitalia that includes the labia majora, labia minora, clitoris, and other structures.
- The labia protect the openings of the vagina and urethra, while the clitoris is a sensitive organ associated with sexual arousal.

The female reproductive system undergoes cyclical changes during the menstrual cycle, which typically lasts about 28 days. This cycle is regulated by hormones, including oestrogen and progesterone, produced by the ovaries. Menstruation, ovulation, and the preparation of the uterus for potential pregnancy are key events in the menstrual cycle.

The female reproductive system plays a crucial role in human reproduction, supporting the development and birth of offspring. It is also involved in the regulation of hormonal and physiological processes throughout a woman's life.

In Activity 3.2, you will explore the structure and functions of the parts of the female reproductive system.

Activity 3.2: Exploring the structure and functions of the female reproductive system.

Key question: Explain the structure and functions of the female reproductive system.

What you need: A chart showing the female reproductive organ, reference materials, the Internet, a pencil, a pen, a notebook

What to do:

Carefully study the diagram in the chart provided by the teacher and:

i) Draw and label the structure of the female reproductive system.

ii) Discuss the functions of each of the parts and present your conclusions in a suitable table.

Compare your work with that of other groups.

3.3 Male and Female Gametes

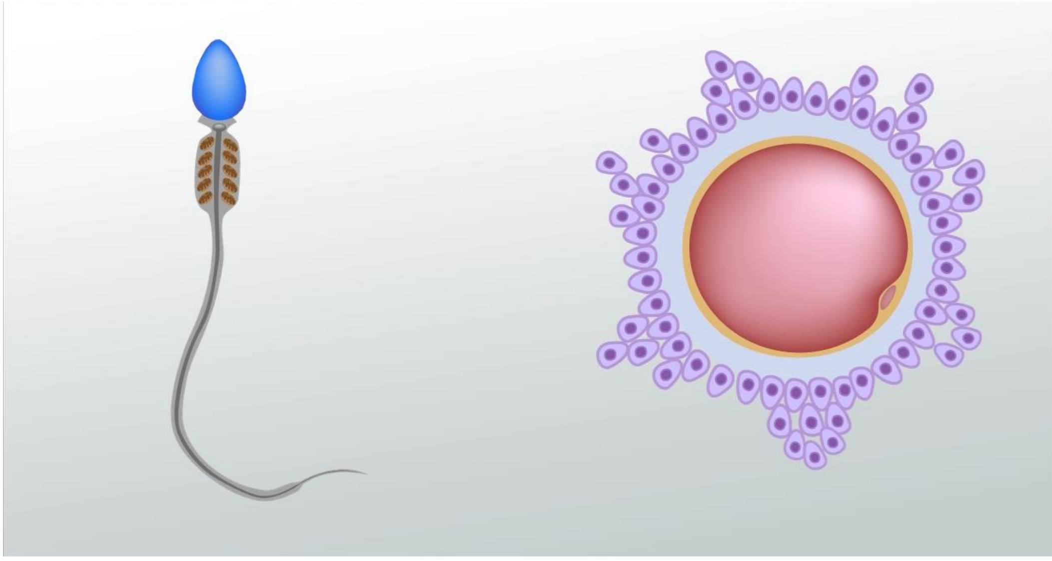


figure 3. 6

Figure 51: Male and Female Gametes

Human reproduction process includes the meeting of the male and female gametes i.e. the sperm from the male and ovum from the female. See Figure 3.1 and Figure 3.2.

Structure of Sperm

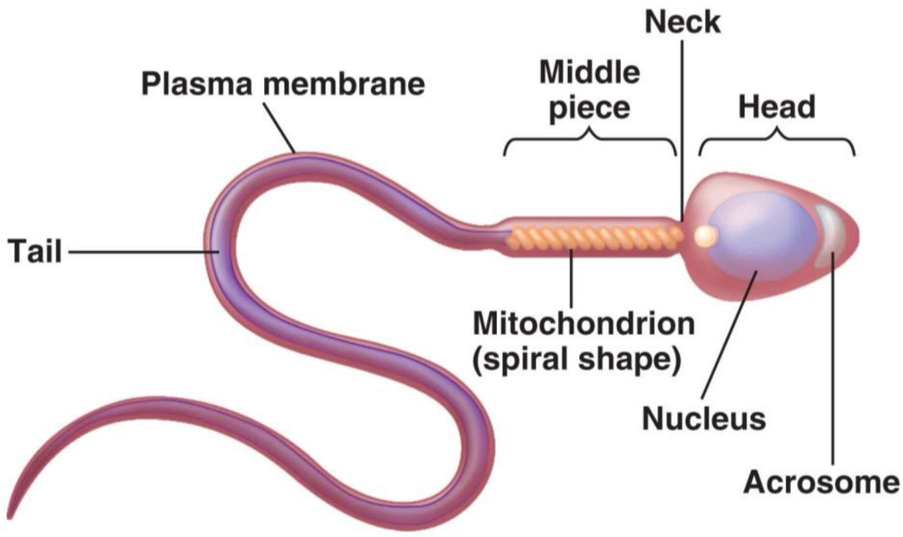


Figure 52: Structure of Sperm

Sperm cells, or spermatozoa, are the male reproductive cells responsible for fertilizing the female egg. The structure of a sperm cell is highly specialized for its function of reaching and penetrating the egg. The main parts of a sperm cell include:

1. **Head**

- The head of the sperm contains the genetic material (chromosomes) necessary for fertilization.
- The tip of the head is covered by a cap called the acrosome, which contains enzymes that help the sperm penetrate the protective layers of the egg during fertilization.

2. **Midpiece**

- The midpiece is a narrow, elongated region behind the head.
- It contains numerous mitochondria that provide the energy (in the form of ATP) needed for the sperm to swim toward the egg.

3. **Tail (Flagellum)**

- The tail is a long, whip-like structure that propels the sperm forward.
- The movement of the tail is driven by energy generated in the midpiece.

Structure of the ovum

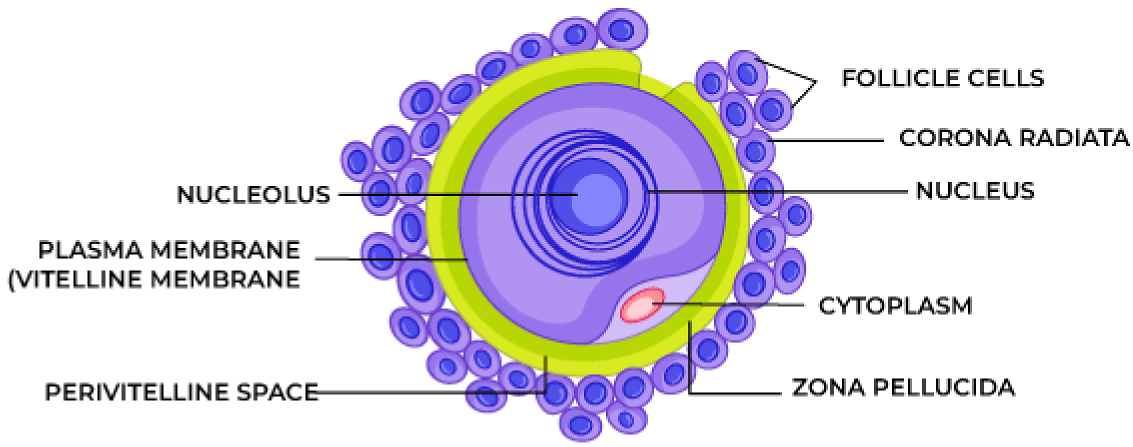


Figure 53: Ovum Structure

The term "ovum" generally refers to a mature egg cell, or oocyte, in the context of female reproduction. The structure of an ovum is designed to facilitate fertilization and support the early stages of embryonic development. Here are the main components of an ovum:

1. **Cell Membrane (Zona Pellucida)**

- The outer layer of the ovum is surrounded by a glycoprotein-rich layer called the zona pellucida.
- The zona pellucida plays a crucial role in protecting the egg and facilitating sperm binding during fertilization.

2. **Cytoplasm**

- The cytoplasm of the ovum contains organelles, including mitochondria, which provide energy for the developing embryo.
- Various structures within the cytoplasm contribute to the development and nourishment of the early embryo.

3. **Nucleus**

- The nucleus of the ovum contains the genetic material, including chromosomes carrying the DNA.
- The nucleus combines with the sperm nucleus during fertilization to form a diploid zygote with a complete set of chromosomes.

4. **Polar Body (Optional)**

- During the process of oogenesis (egg cell development), polar bodies may be produced.

- Polar bodies are smaller cells that do not develop into mature eggs; they contain a portion of the genetic material discarded during egg maturation. Polar bodies are a byproduct of the unequal division of the oocyte's cytoplasm.

5. **Corona Radiata**

- The corona radiata is a layer of cells surrounding the ovum, which are closely associated with the zona pellucida.
- These cells help protect the ovum and assist in interactions with sperm.

The structure of the ovum is designed to support fertilization and the early stages of embryonic development. Once released from the ovary, the ovum travels through the fallopian tube, where it may encounter sperm. If fertilization occurs, the genetic material from the sperm combines with that of the ovum, forming a zygote. The zygote undergoes subsequent divisions, leading to the development of the embryo and, eventually, a fetus during pregnancy.

In Activity 3.3, you will understand the structures of the sperm and ovum.

Activity 3.3;

Key question: What is the structure of the sperm and the ovum?

What you need: Reference materials and or Internet, a pencil, a notebook

I. Draw and label both the sperm and ovum in your notebook
II. Using reference materials or the Internet, find out the importance of each labeled part.
III. Compare a sperm and an ovum. Present your responses in a suitable table.
IV. Make any other important notes about the sperm and the ovum.

Compare your work with that of other groups.

3.4: The Menstrual cycle

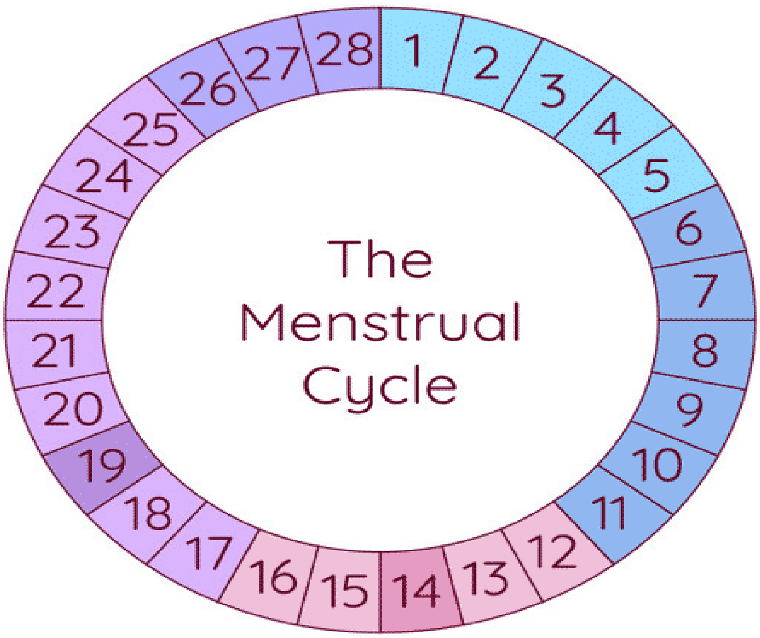


Figure 54: The Menstrual cycle

The menstrual cycle is a natural, monthly process that occurs in the female reproductive system and involves a series of hormonal and physiological changes. The menstrual cycle has an average length of about 28 days, although variations are common. It is usually controlled by a number of hormones. How important is the menstrual cycle? In Activity 3.4, you will understand the changes that take place during the menstrual cycle.

It is divided into several phases, each with distinct events and hormonal patterns. The menstrual cycle is regulated by interactions between the hypothalamus, pituitary gland, ovaries, and uterus. Here are the main phases of the menstrual cycle:

1. **Menstrual Phase (Days 1-5):**

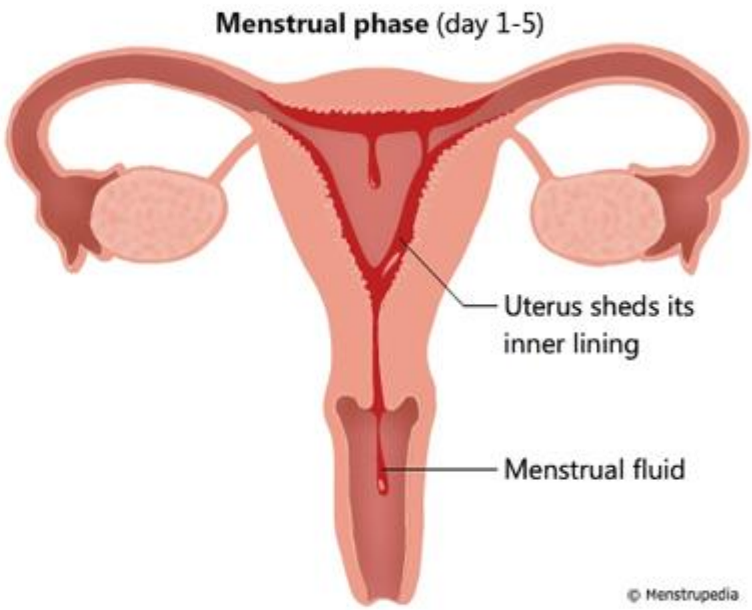


Figure 55: Menstrual Phase

- The menstrual cycle begins with menstruation, the shedding of the uterine lining (endometrium) that was prepared in the previous cycle.
- Menstruation occurs if fertilization did not take place in the previous cycle.
- Hormone levels, including estrogen and progesterone, are low during this phase.

2. **Follicular Phase (Days 1-13):**

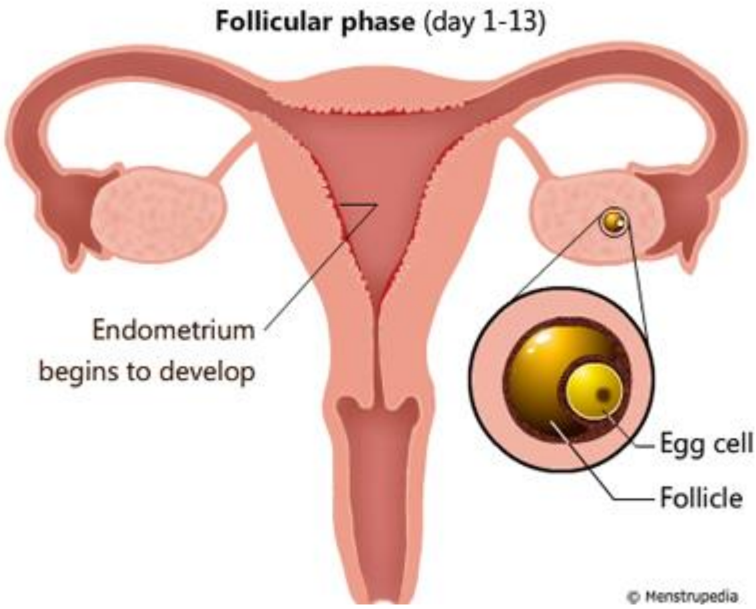


Figure 56: Follicular Phase

- The follicular phase coincides with the development of ovarian follicles in the ovaries.
- Follicle-stimulating hormone (FSH) from the pituitary gland stimulates the growth of several ovarian follicles, each containing an immature egg (oocyte).

- As the follicles grow, they produce increasing amounts of oestrogen, which stimulates the thickening of the uterine lining.

3. **Ovulatory Phase (Day 14):**

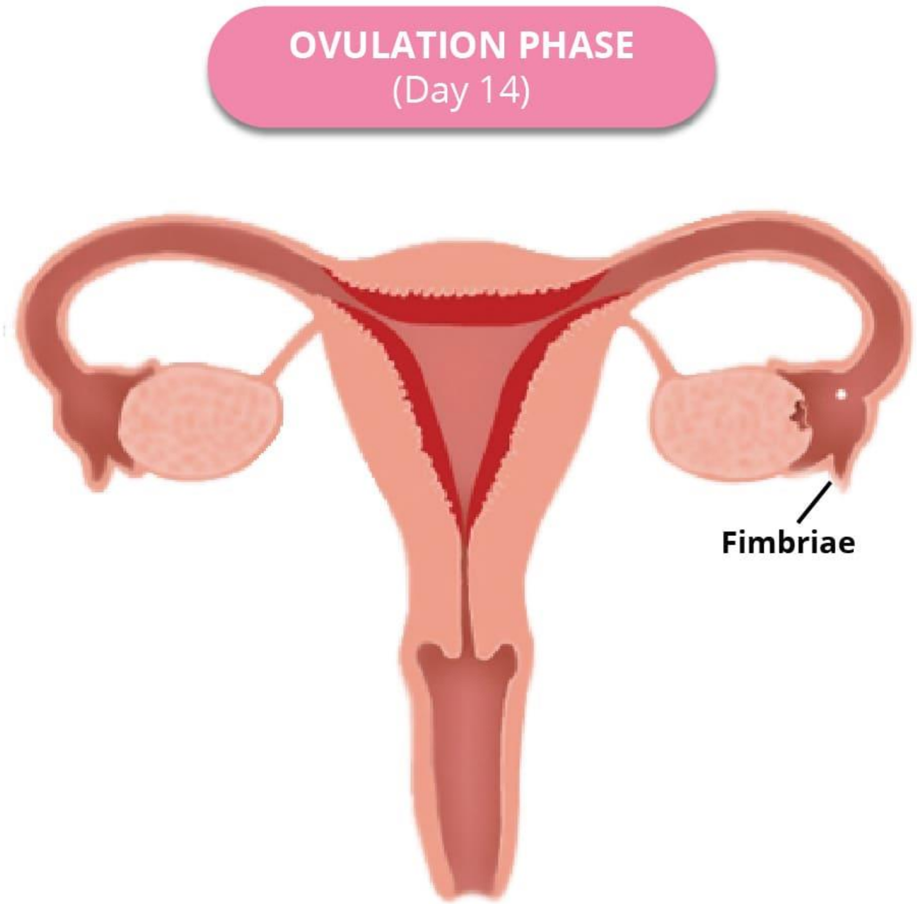


Figure 57: Ovulatory Phase

- Ovulation is the release of a mature egg from the ovary into the fallopian tube.
- High levels of luteinizing hormone (LH) trigger ovulation, usually around the middle of the menstrual cycle.
- The surge in LH also causes the mature follicle to release the egg.
- The egg is then available for fertilization by sperm.

4. **Luteal Phase (Days 15-28)**

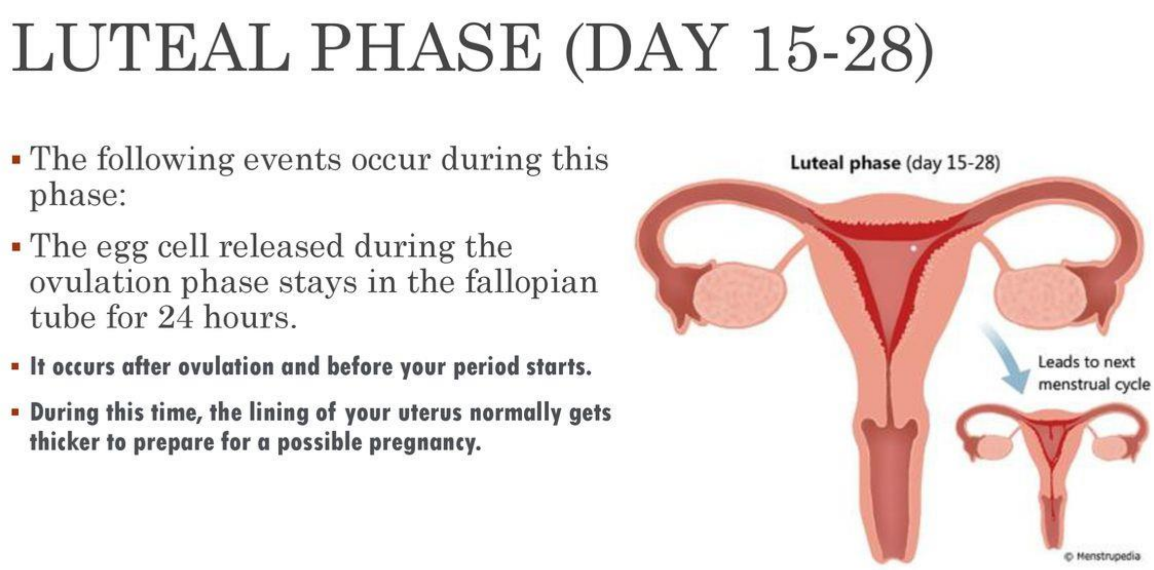


Figure 58: Luteal Phase

- After ovulation, the ruptured follicle transforms into a structure called the corpus luteum.
- The corpus luteum produces progesterone and some oestrogen, which prepare the uterine lining for a potential pregnancy.

- If fertilization occurs, the developing embryo signals the corpus luteum to continue producing hormones.
- If fertilization does not occur, the corpus luteum degenerates, leading to a decline in hormone levels and the eventual onset of menstruation.

Throughout the menstrual cycle, the levels of oestrogen and progesterone fluctuate, influencing changes in the uterine lining and cervical mucus.

These hormonal changes also affect the menstrual symptoms experienced by many women, such as mood swings, breast tenderness, and changes in libido.

It's important to note that individual variations in cycle length and hormonal patterns are common, and factors such as stress, illness, and lifestyle can influence the menstrual cycle. Monitoring the menstrual cycle can be valuable for women trying to conceive or those seeking to understand their reproductive health.

Activity 3.4: Exploring the menstrual cycle

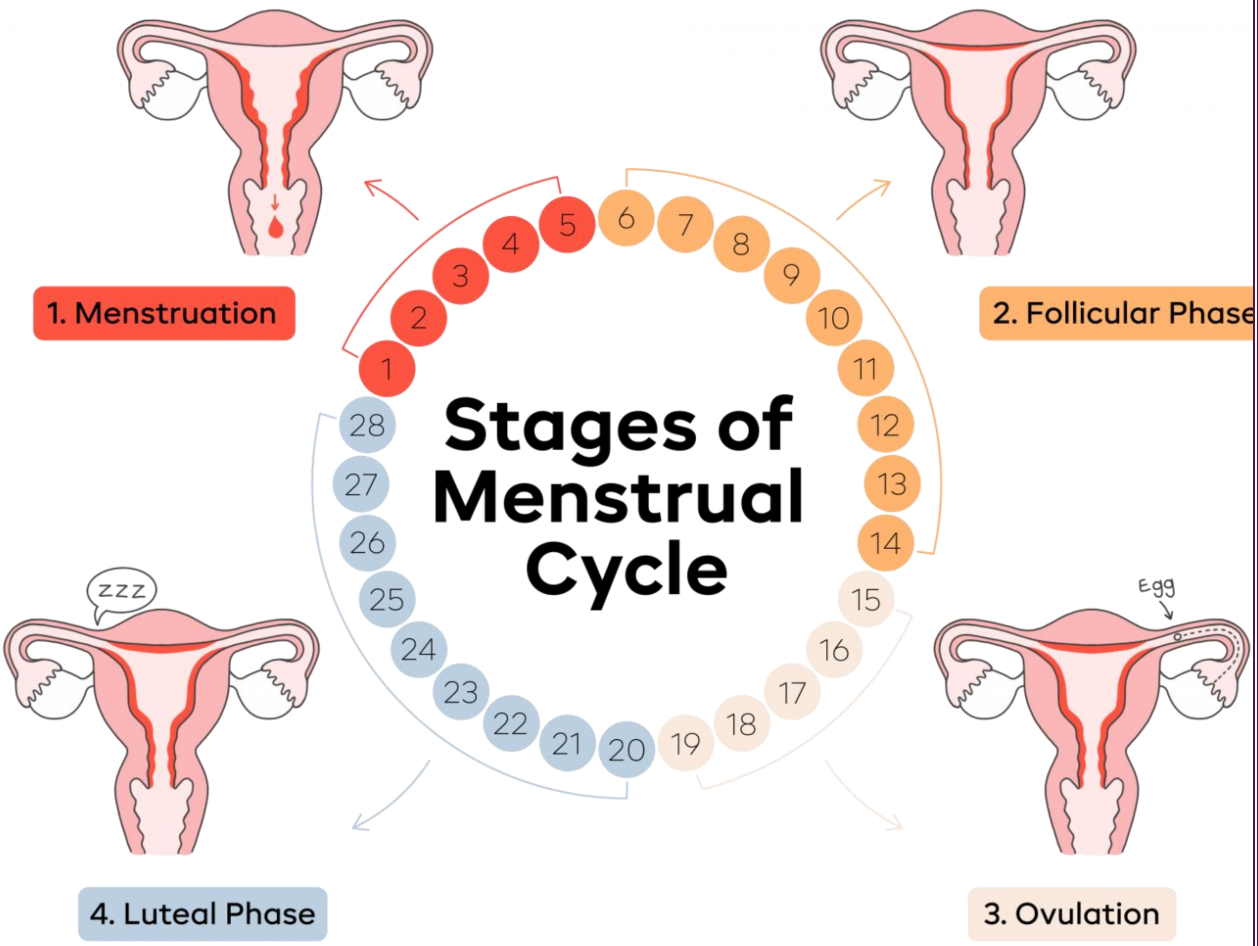


Figure 59: Menstrual cycle

Key question: Explain the menstrual cycle.

What you need: Pencil, pen, notebook, reference materials and/or the internet

What to do

1. Figure 65: represents the stages of a menstrual cycle. Carefully study it and identify the different changes taking place at different stages. Present your answers in a table below.

Stage	Changes
A	
B	
C	
D	

2. Identify the different hormones involved in the menstrual cycle.

Research and find out why these hormones are important and what role they play in the cycle.

Compare your responses with those of another pair.

3.5: Common Issues Associated with Reproductive Systems

Some females usually experience menstrual disorders and some males experience erectile abnormalities. In Activity 3.5, you will find out these orders.

There are various abnormalities and disorders associated with human reproduction that can affect both males and females. Here are some common abnormalities related to reproduction:

In Females:

Polycystic Ovary Syndrome

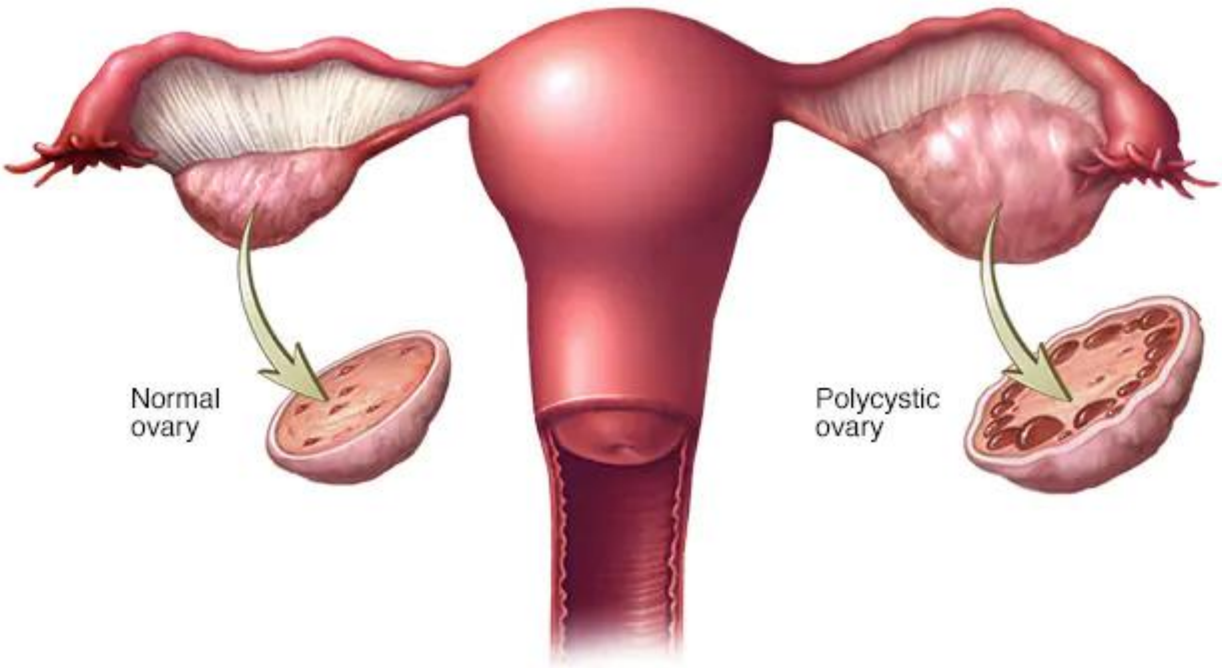


Figure 60: Polycystic Ovary Syndrome

- A hormonal disorder where the ovaries may develop cysts, leading to irregular periods, fertility issues, and hormonal imbalances.

1. **Endometriosis**

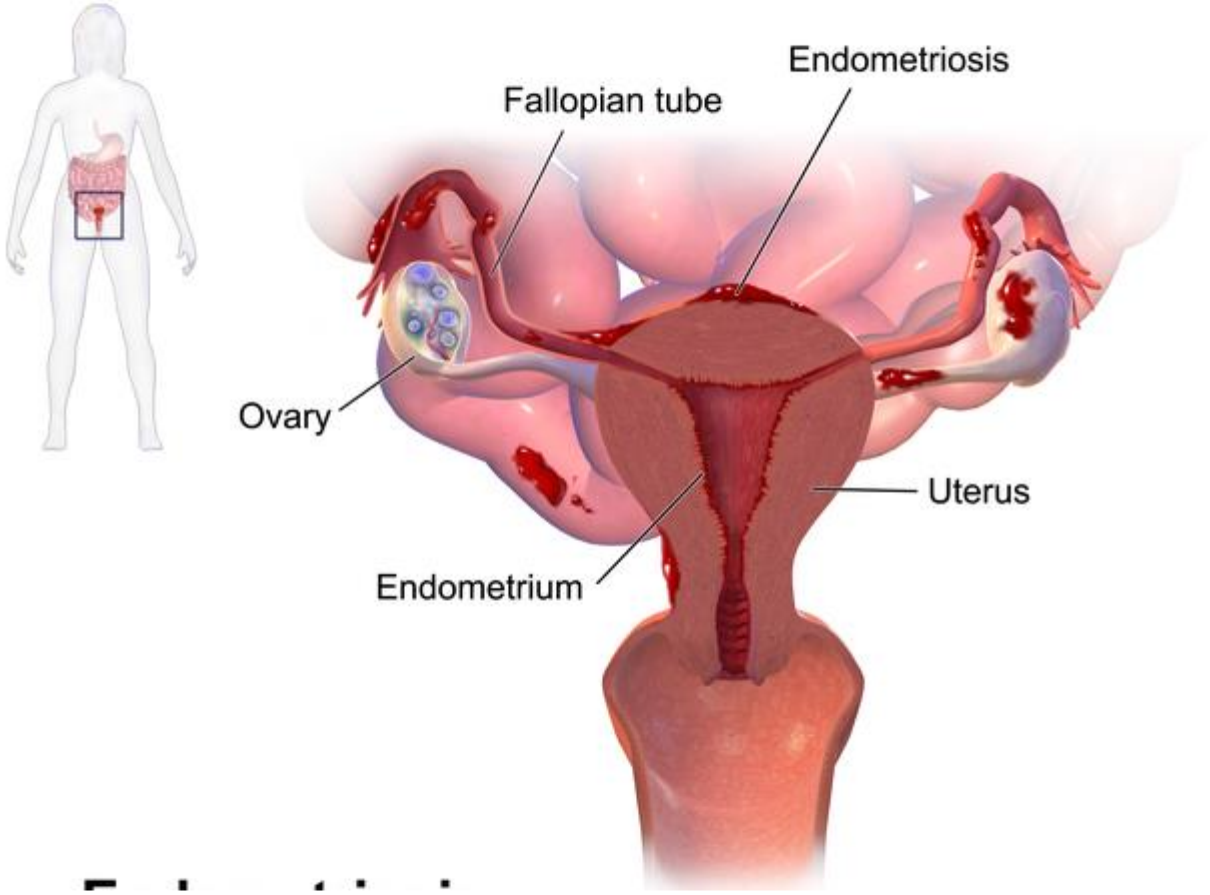


Figure 61: Endometriosis

- A condition where tissue similar to the lining of the uterus grows outside the uterus, causing pain, menstrual irregularities, and fertility problems.

2. **Uterine Fibroids**

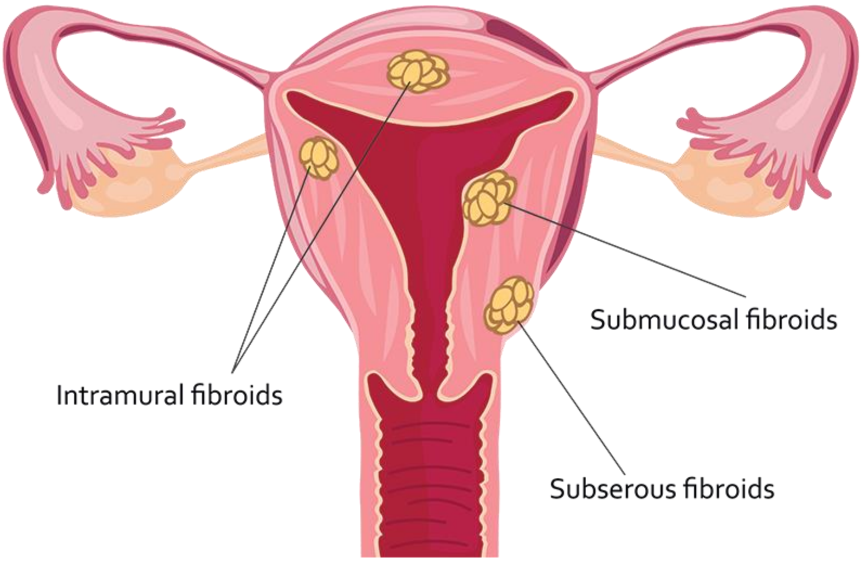


Figure 62: Uterine Fibroids

- Non-cancerous growths in the uterus that can cause heavy menstrual bleeding, pelvic pain, and fertility issues.

3. **Premature Ovarian Insufficiency**

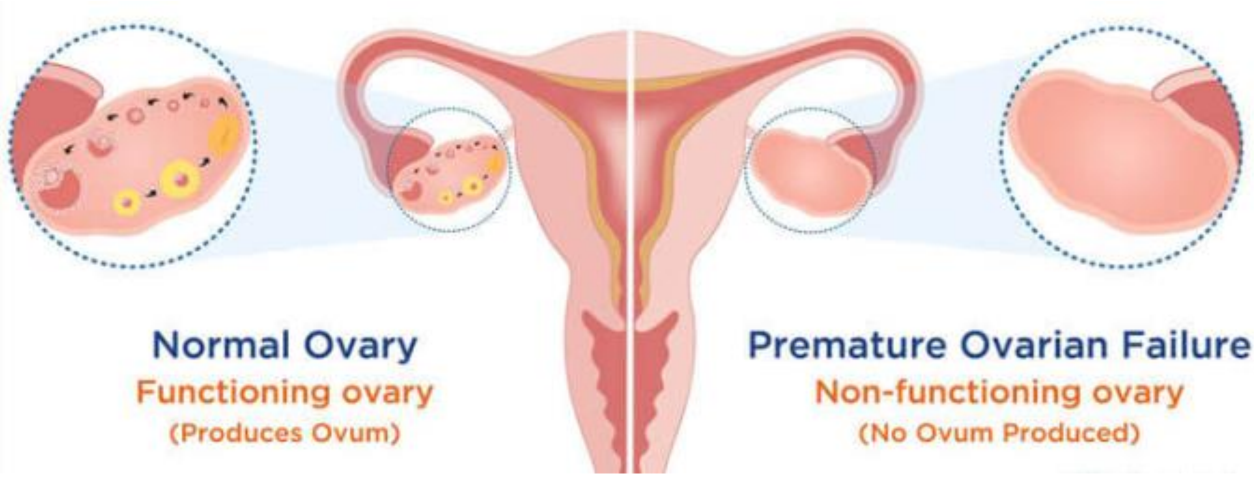


Figure 63: Premature Ovarian failure

- The ovaries stop functioning before the age of 40, leading to irregular periods, infertility, and hormonal imbalances.

4. **Pelvic Inflammatory Disease**

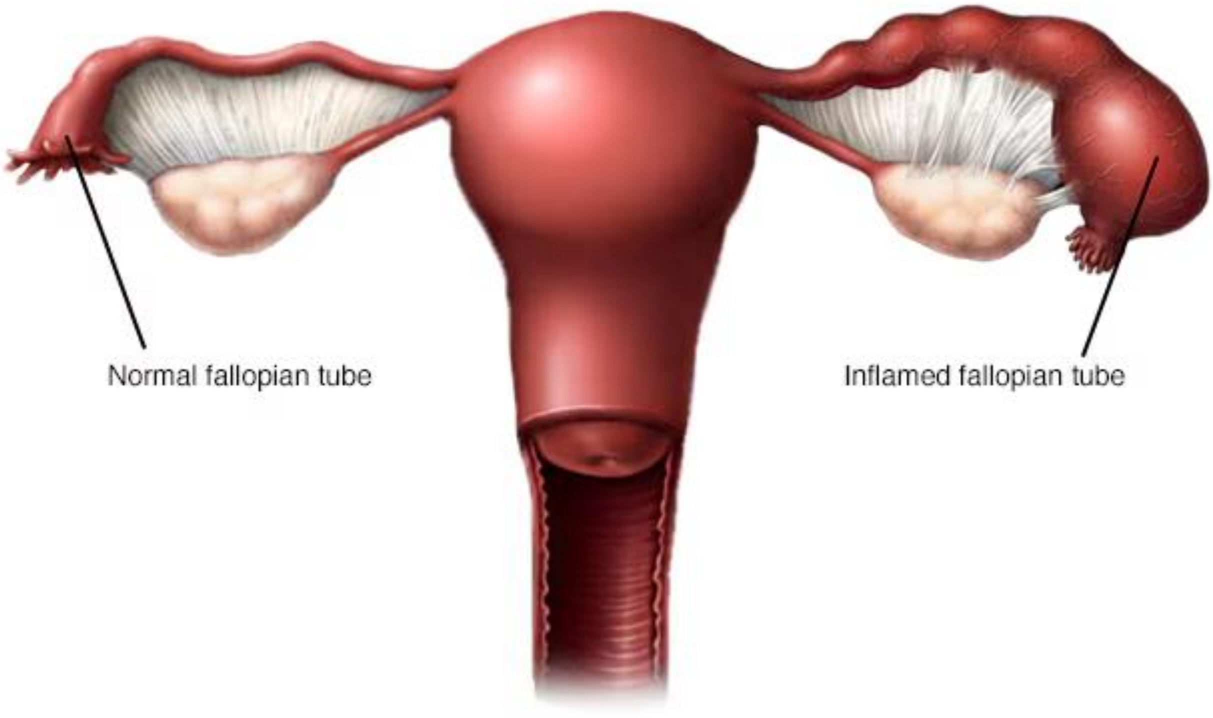


Figure 64: Pelvic Inflammatory Disease

- An infection of the female reproductive organs, often caused by sexually transmitted infections (STIs), which can lead to infertility if left untreated.

5. **Blocked Fallopian Tubes**

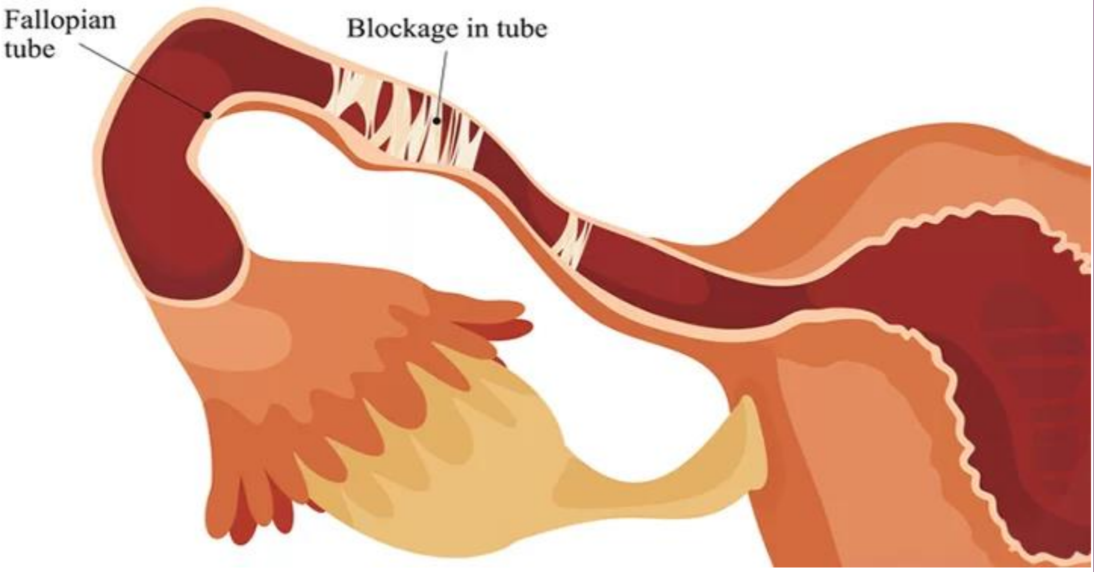


Figure 65: Blocked Fallopian Tubes

- Obstruction of the fallopian tubes can prevent the egg from meeting sperm, leading to infertility.

6. **Amenorrhea**

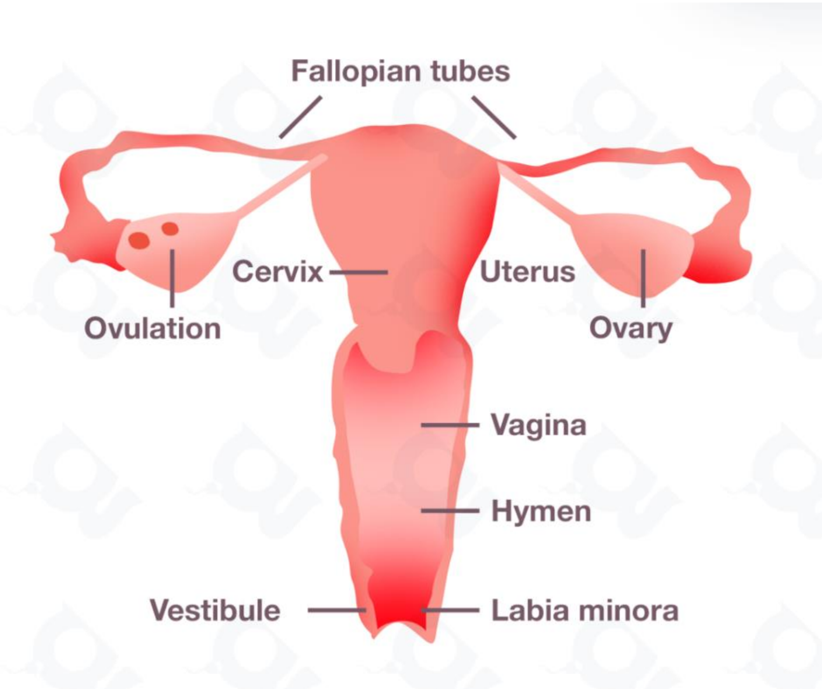


Figure 66: Amenorrhea

- The absence of menstrual periods, which can be caused by various factors, including hormonal imbalances, excessive exercise, or certain medical conditions.

7. **Menstrual Disorders**

Figure 67: Menstrual Disorders

- Conditions like menorrhagia (heavy menstrual bleeding), oligomenorrhea (infrequent periods), and dysmenorrhea (painful periods) can impact reproductive health.

In Males:

1. **Erectile Dysfunction**

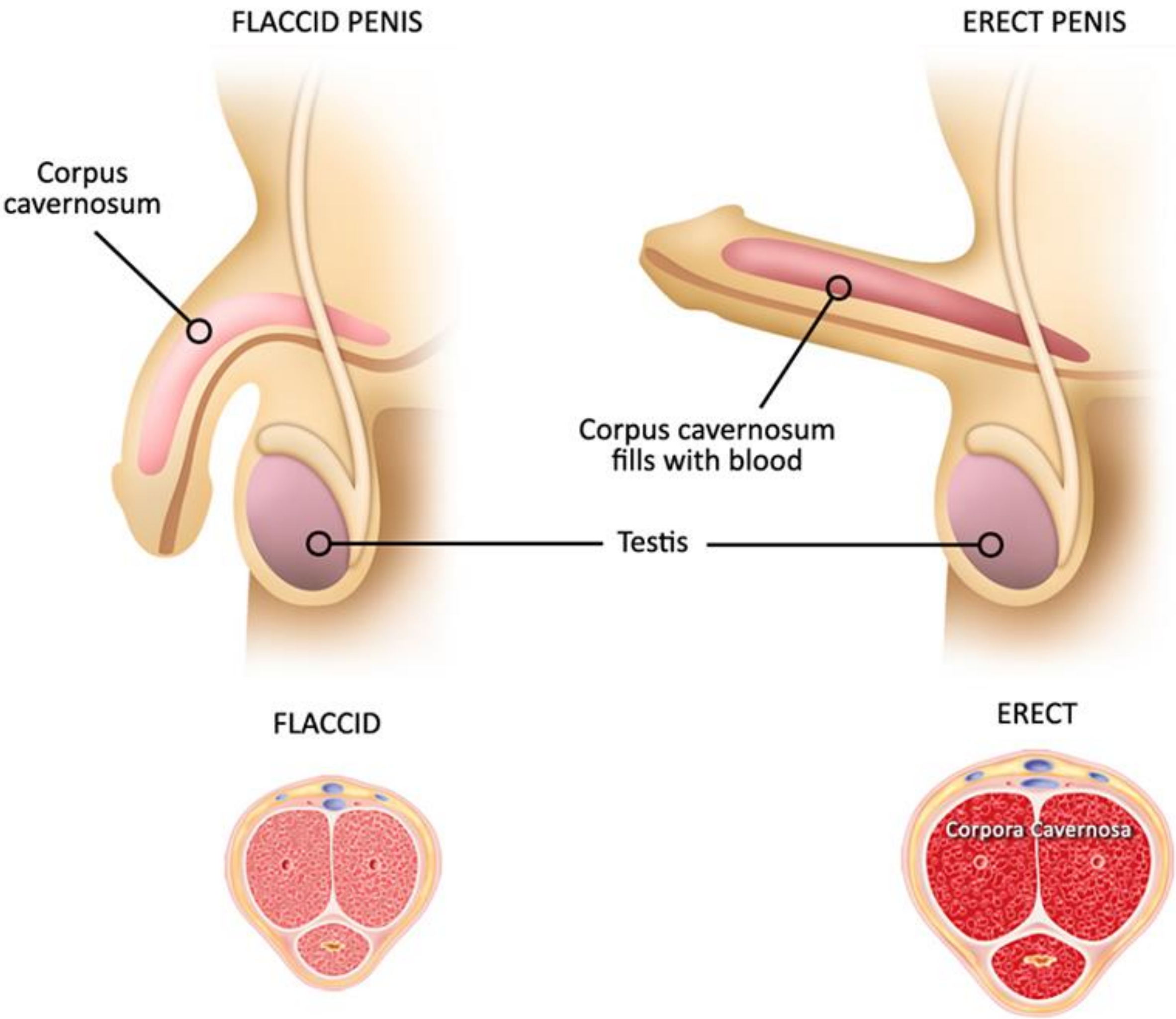


Figure 68: Erectile Dysfunction

- The inability to achieve or maintain an erection sufficient for sexual activity, which can affect fertility.

2. **Varicocele**

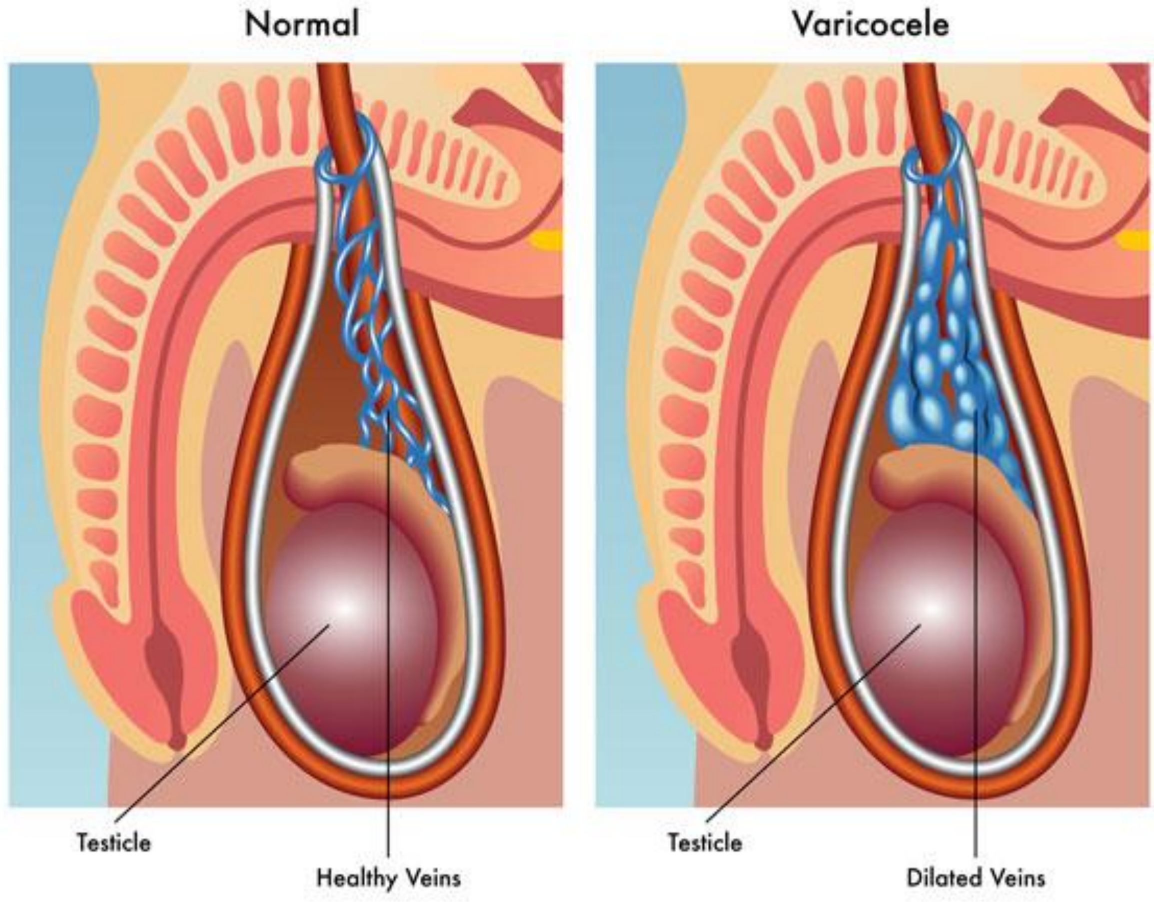


Figure 69: Varicocele

- Enlarged veins within the scrotum that can impact sperm production and quality.

3. **Low Sperm Count (Oligospermia) and Poor Sperm Motility:**

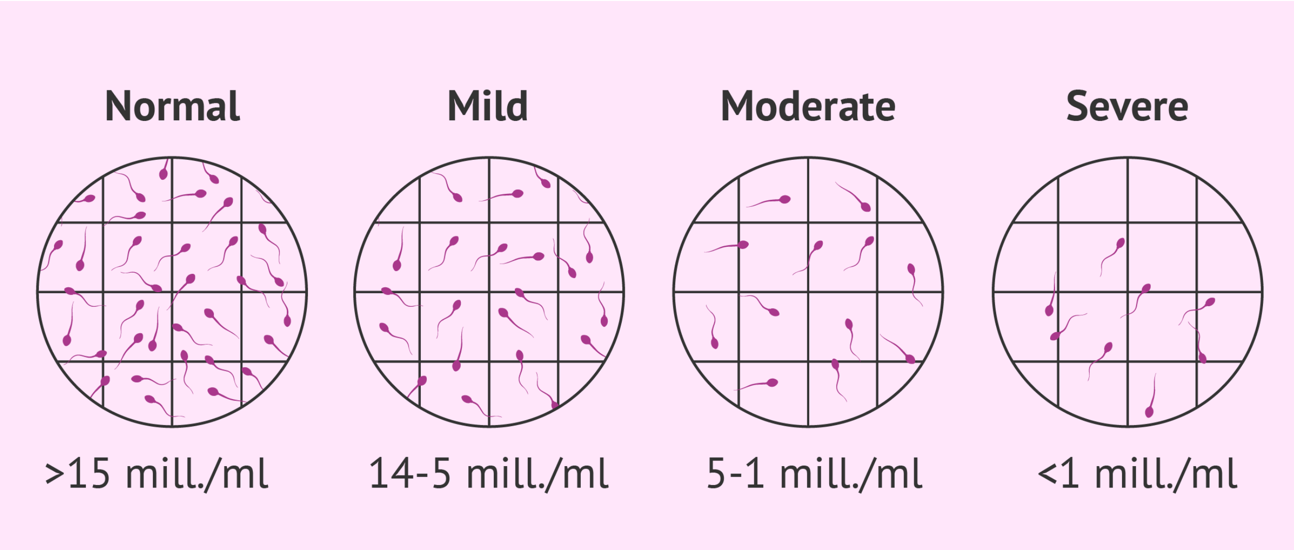


Figure 70: Low Sperm Count

- Conditions that can affect male fertility and reduce the likelihood of successful fertilization.

4. **Testicular Disorders**

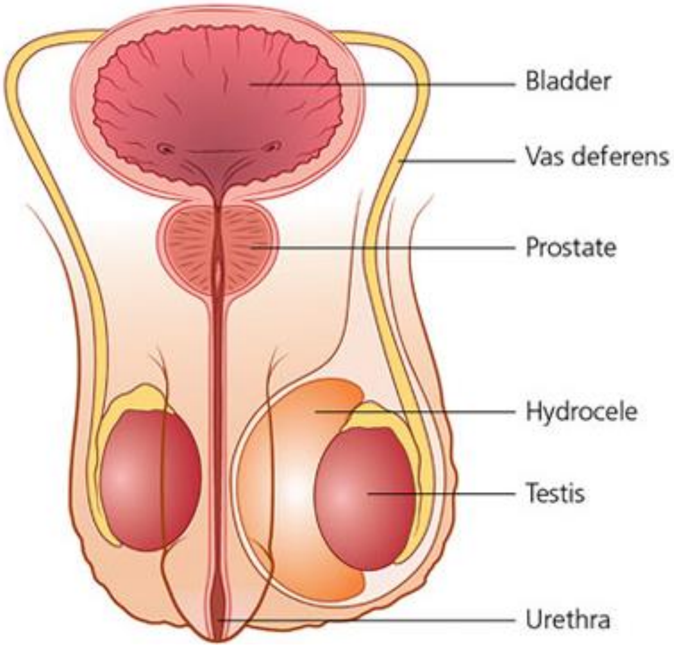


Figure 71: Testicular Disorders

- Conditions such as cryptorchidism (undescended testicles), testicular cancer, and testicular atrophy can impact reproductive function.

5. **Genetic Disorders**

- Conditions caused by genetic abnormalities, such as Klinefelter syndrome or Y chromosome deletions, that can affect male reproductive development and fertility.

6. **Obstructive and Non-obstructive Azoospermia**

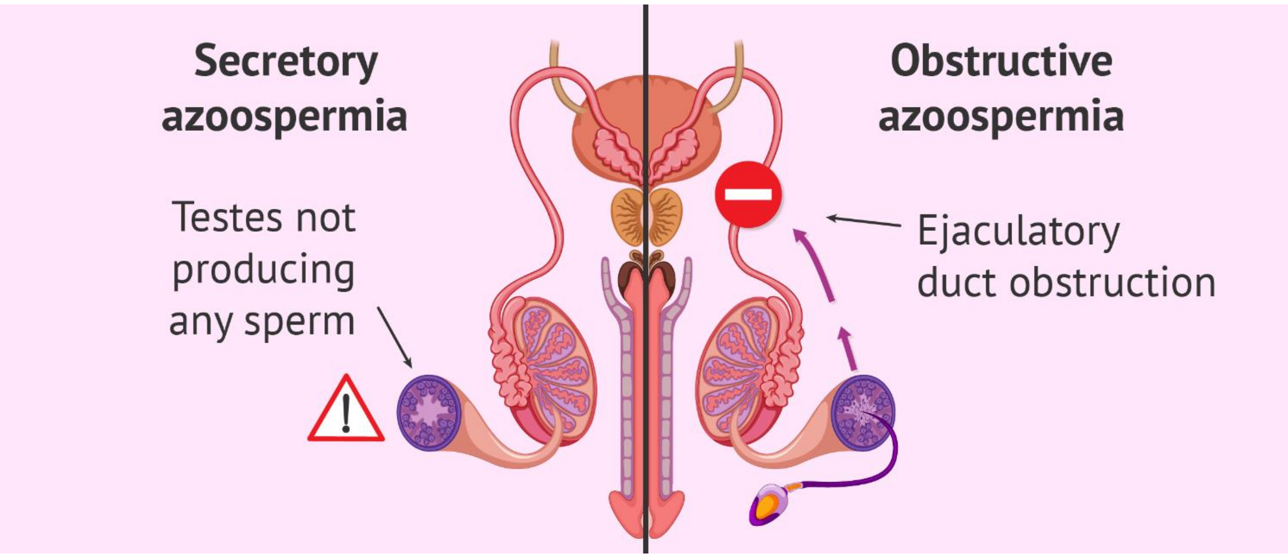


Figure 72: Obstructive and Non-obstructive Azoospermia

- Conditions where there is an absence of sperm in the ejaculate, either due to obstruction or insufficient sperm production.

7. **Hormonal Imbalances**

- Disorders that affect the production or regulation of hormones involved in sperm production, such as testosterone and follicle-stimulating hormone (FSH).

It's important to note that many reproductive abnormalities are treatable with medical interventions, lifestyle modifications, or assisted reproductive technologies. Individuals experiencing difficulties with reproduction should seek guidance from healthcare professionals, including reproductive endocrinologists or fertility specialists, to explore diagnostic and treatment options based on their specific circumstances

Activity 3.5: Finding out common human reproductive disorders

Key question: What are the common abnormalities associated with reproduction in humans?

What you need: A resource person, questionnaire, a notebook and a pen

What to do.

1. Interview a resource person and find out menstrual and erectile abnormalities in young people. Find out their causes and possible medical remedies. Report your findings in a suitable table.

3.6: Process of Fertilization and Development of a Zygote

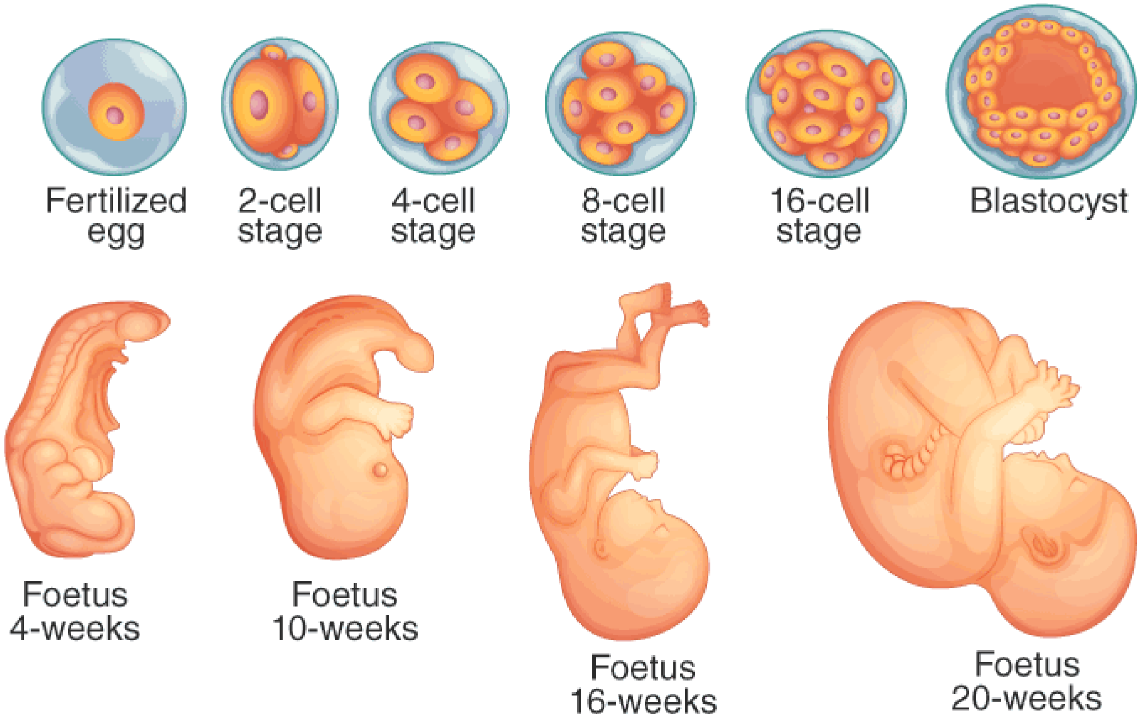


Figure 73: Process of Fertilization and Development of a Zygote

In the previous sections, you learnt that fertilization takes place when male and female gametes meet and fuse to form a zygote.

In Activity 3.6, You will understand the process of fertilization in humans.

Fertilization is the process by which a sperm cell and an egg cell (ovum) fuse to form a zygote, marking the beginning of a new organism. In humans, fertilization typically occurs in the fallopian tubes.

The process of fertilization in humans

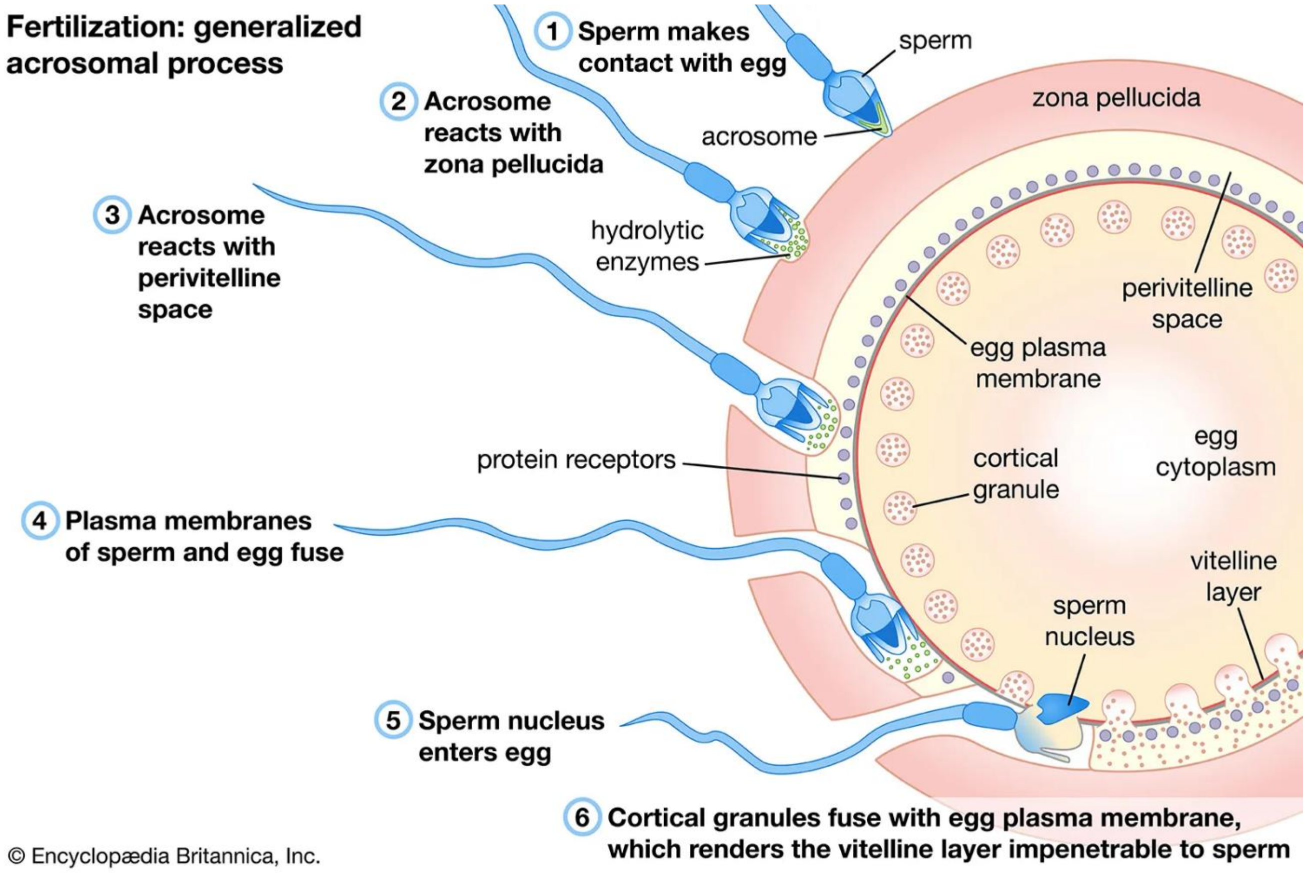


Figure 74: process of fertilization in humans

1. **Ovulation**

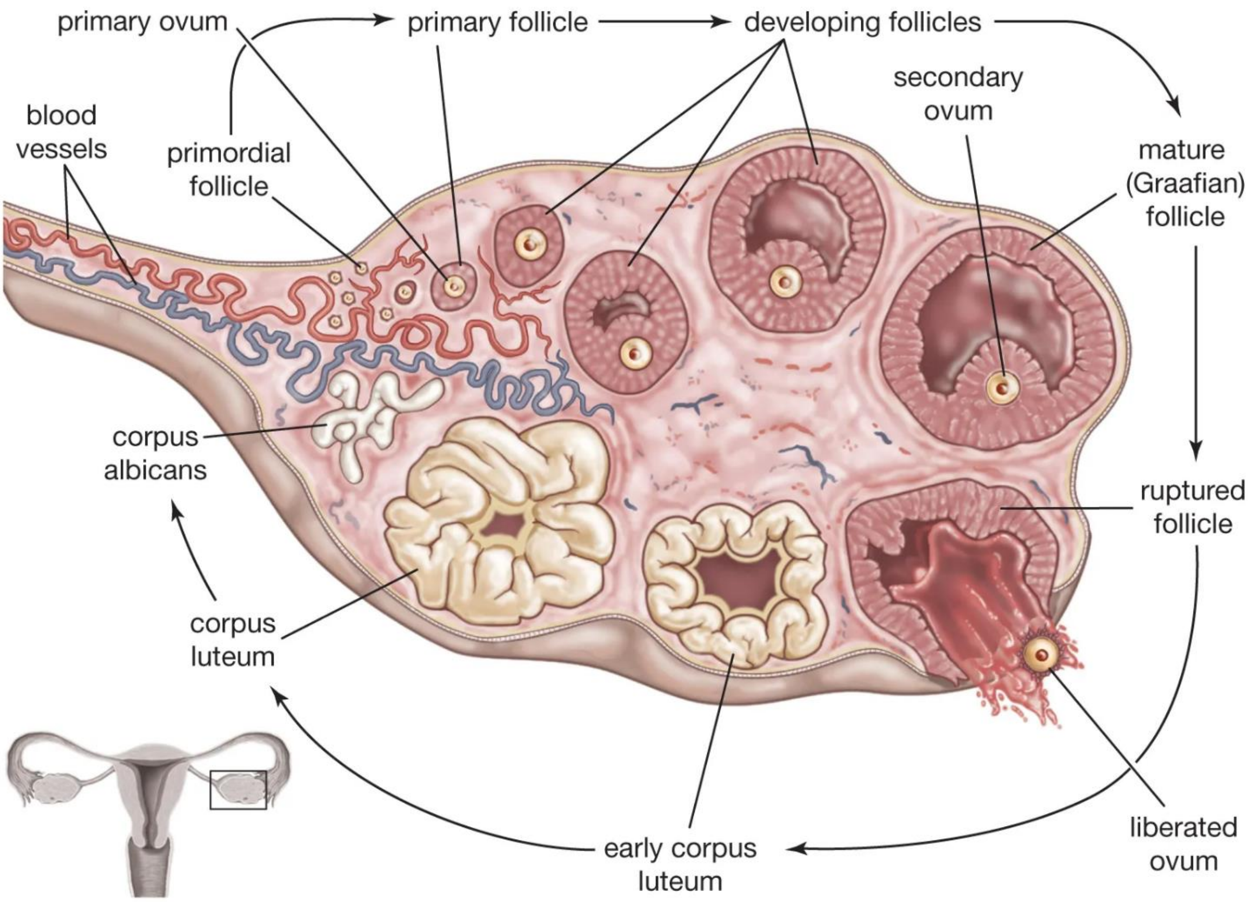


Figure 75: Ovulation process

- Ovulation is the release of a mature egg from one of the ovaries. This usually occurs around the middle of the menstrual cycle, approximately 14 days before the start of the next menstrual period.

2. **Egg Transport:**

- The released egg is swept into the fallopian tube by the fimbriae, finger-like projections at the end of the fallopian tube.

3. **Sperm Transport:**

- Sperm are deposited into the vagina during sexual intercourse.
- Motile sperm navigate through the cervix and into the uterus, and then continue their journey into the fallopian tube where fertilization takes place.

4. **Acrosome Reaction:**

- The acrosome is a cap-like structure at the head of the sperm containing enzymes. As the sperm reaches the egg, the acrosome undergoes a reaction, releasing enzymes that help the sperm penetrate the protective layers surrounding the egg.

5. **Sperm Penetration:**

- The sperm penetrates the corona radiata (layer of cells surrounding the egg) and the zona pellucida (glycoprotein layer covering the egg).
- Upon reaching the egg's cell membrane, the sperm fuses with the egg in a process known as fertilization.

6. **Completion of Meiosis:**

- Fertilization triggers the completion of the second meiotic division in the egg, resulting in the formation of a mature ovum and a polar body.
- The sperm contributes its nucleus, containing genetic material, to form a diploid zygote.

7. **Zygote Formation**

- The fusion of the sperm and egg nuclei results in the formation of a zygote. The zygote now has a complete set of chromosomes, half from the mother and half from the father.

8. **Cell Division**

- The zygote undergoes rapid cell divisions through mitosis, forming a blastocyst.
- As the blastocyst travels down the fallopian tube, it undergoes several divisions and differentiates into cells that will contribute to the development of various tissues and structures.

9. **Implantation**

- The blastocyst reaches the uterus and undergoes implantation, where it attaches to the uterine lining.
- Implantation initiates the early stages of pregnancy, and the developing structure is now called an embryo.

10. **Embryonic Development**

- The embryo undergoes further development, with cells differentiating into various tissues and organs.
- The placenta and umbilical cord form to support the growing embryo/fetus.

The entire process from fertilization to the formation of a blastocyst and implantation takes about 6-10 days. The developing structure is referred to as an embryo until about the eighth week of gestation, after which it is called a fetus.

Activity 3.6: Describing the process of fertilization in humans

Do this activity a pair.

Key question. How does fertilization take place in humans?

What you need: Reference materials about fertilization in humans, the Internet, a video on fertilization

What to do:

1. Use the Internet or reference materials and research about the process of fertilization in humans and describe the stages involved.

2. Find out the meaning of in-vitro fertilization.

Compare your work with that of another pair.

3.7: Development of a Zygote

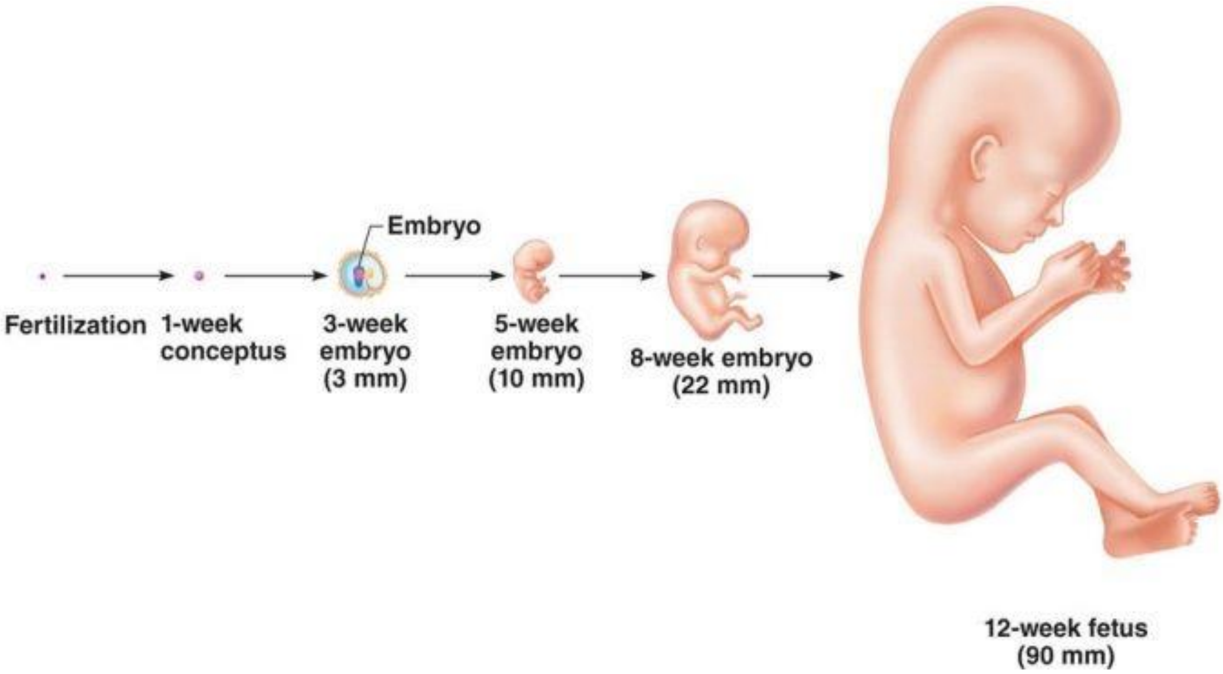


Figure 76: ***Zygote development stages***

What do you observe in Figure 3.5?

After fertilization has taken place, the zygote formed undergoes a series of cell divisions to form a blastocyst which then develops into an embryo and later into the foetus. The foetus also undergoes a series of changes until it fully develops into a baby at nine months. The period between conception and birth is known as gestation period and it is nine months in humans.

The development of a zygote involves a series of stages, each marked by specific events and changes as the zygote transforms into a multicellular organism.

Stages of human embryonic development

1. **Zygote Formation**

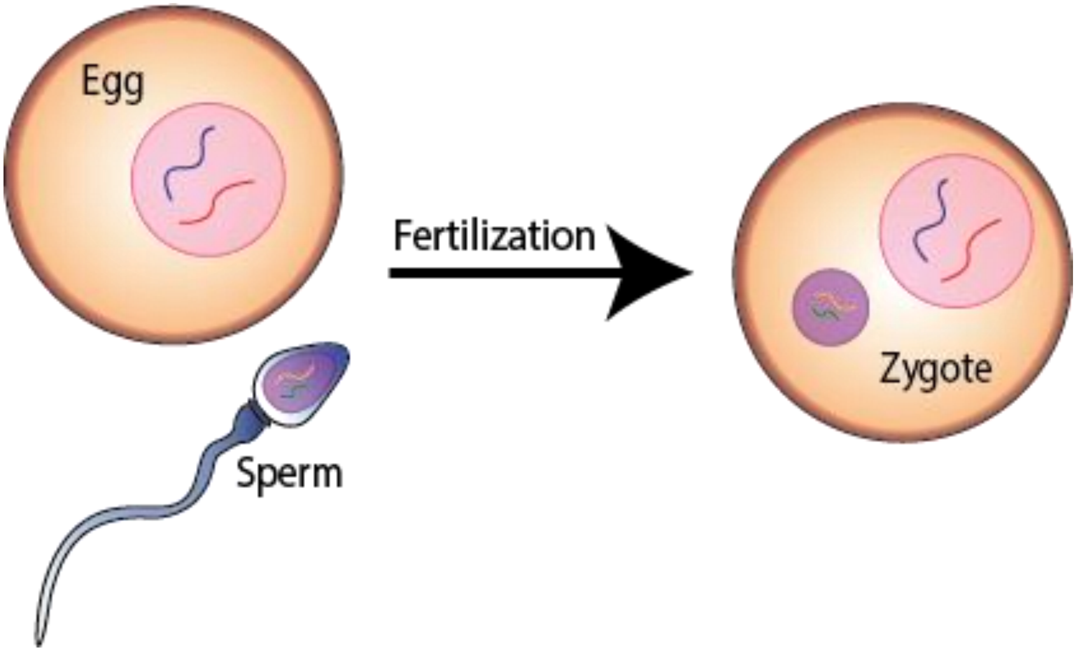


Figure 77: Zygote Formation

- The zygote is formed through the fusion of a sperm cell and an egg cell during fertilization.
- The zygote contains a complete set of chromosomes, half from the mother and half from the father.

2. **Cleavage**

- The zygote undergoes a series of rapid cell divisions called cleavage.
- These divisions result in the formation of a multicellular structure called a morula, composed of a cluster of cells.

3. **Blastula Formation**

- Cleavage continues, forming a hollow ball of cells called a blastula.
- The blastula has an outer layer of cells (trophoblast) and an inner cell mass.

4. **Blastocyst Formation**

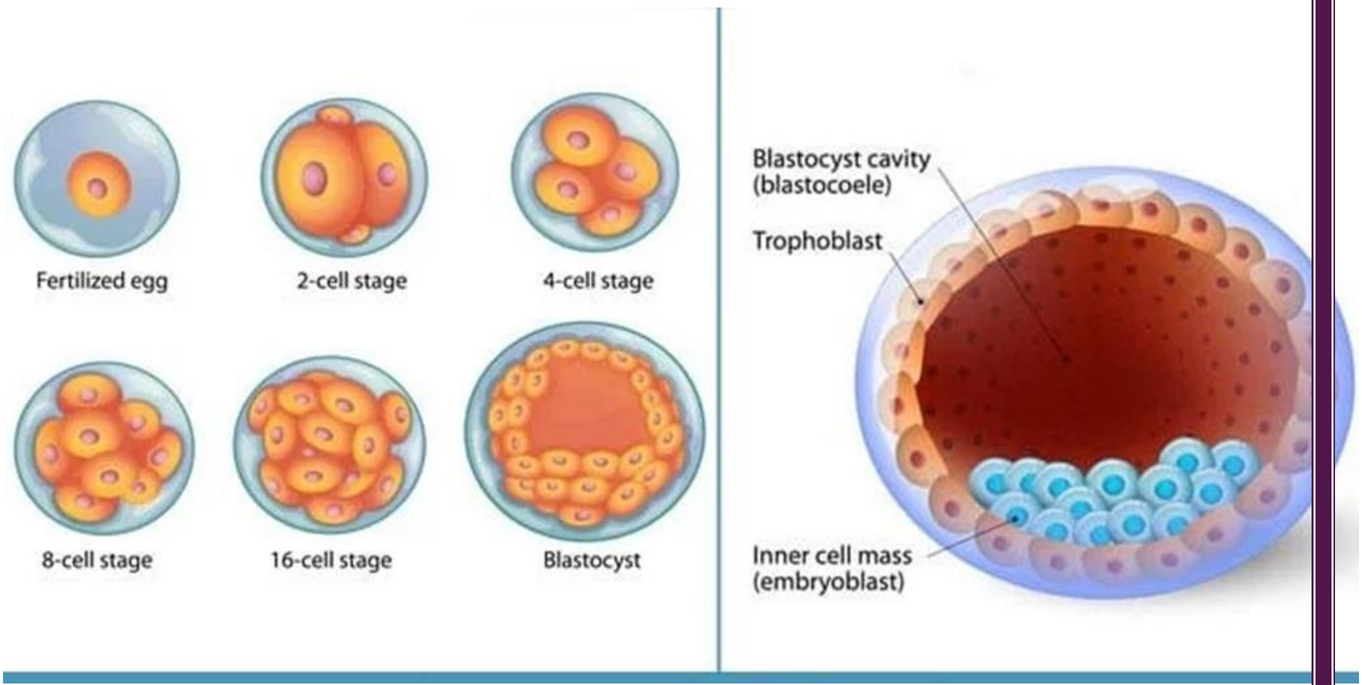


Figure 78: Blastocyst Formation

- The blastula undergoes further differentiation to become a blastocyst.
- The blastocyst has a fluid-filled cavity called the blastocoel, an outer layer of trophoblast cells, and an inner cell mass that will give rise to the embryo.

5. **Implantation**

- The blastocyst travels down the fallopian tube to the uterus.
- Implantation occurs when the blastocyst attaches to the uterine lining.
- The trophoblast cells play a crucial role in forming the placenta.

6. **Gastrulation**

- Gastrulation is the process during which the three germ layers (ectoderm, mesoderm, and endoderm) form.
- Cells migrate and differentiate to give rise to tissues and organs.

7. **Neurulation**

- The notochord forms, signaling the beginning of neurulation.
- The neural tube develops from the ectoderm, giving rise to the nervous system.

8. **Organogenesis**

- Organogenesis involves the development of major organ systems from the three germ layers.
- Differentiation and morphogenesis occur as cells organize into tissues and structures.

9. **Foetal Period**

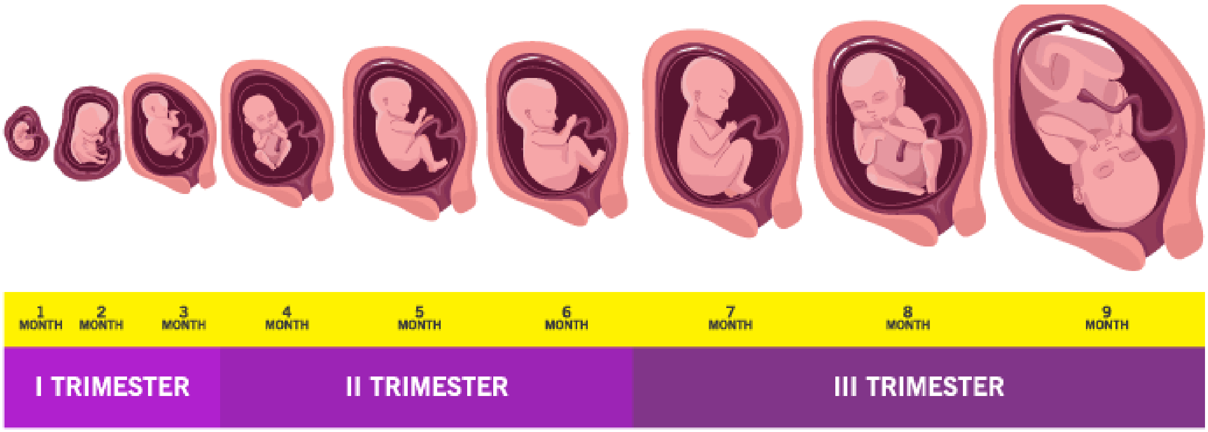


Figure 79: Fetal growth

- By the end of the embryonic period (around the eighth week), the developing structure is called a fetus.
- During the fetal period, growth and maturation continue, with the formation and development of organs, limbs, and features.

Throughout these stages, the developing organism is vulnerable to external influences, and disruptions during critical periods can lead to congenital anomalies. The development of a zygote into a mature organism is a highly regulated and intricate process that relies on precise genetic and environmental cues. The process is completed with the birth of a fully formed infant, and postnatal development continues as the individual grows and matures.

In **Activity 3.7,** you will understand the development stages of a zygote up to birth.

Activity 3.7: Describing the development stages of a zygote

Key question: What happens at every stage of development of a zygote?

What you need: The Internet, a chart with pictures showing the developments of a zygote up to birth

1. Carefully study the picture of the development stages of a zygote provided on the chart, analyses and write down the changes taking place up at every stage of zygote development.

Present your work to the whole class for discussion

3.8 The Role of the Placenta During Pregnancy

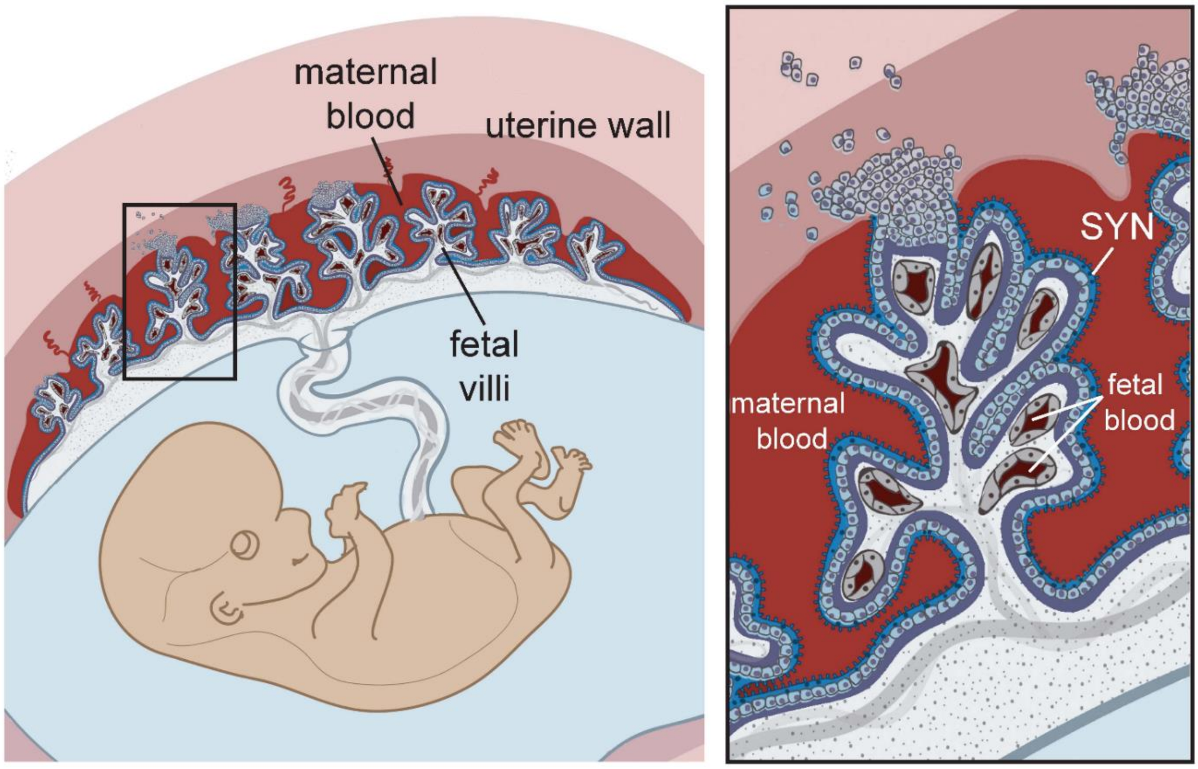


Figure 80: The placenta

As you can see in **Figure 3.6** The placenta serves as a major connection between the mother and foetus. A placenta develops from both embryonic and maternal tissues.

The placenta plays a crucial role during pregnancy, serving as a lifeline between the mother and the developing foetus. It is a temporary organ that forms during early pregnancy and is essential for the growth, development, and well-being of the fetus.

Roles of the placenta during pregnancy

1. **Nutrient and Oxygen Exchange**

- The placenta acts as a conduit for the exchange of nutrients, oxygen, and waste products between the mother and the fetus. Nutrients and oxygen from the mother's blood pass through the placenta to nourish and support the developing fetus.

2. **Waste Elimination**

- The placenta facilitates the removal of waste products, including carbon dioxide and other metabolic byproducts, from the fetal bloodstream. These waste products are then carried away in the mother's blood.

3. **Hormone Production**

- The placenta produces hormones that are crucial for maintaining a healthy pregnancy. These hormones include human chorionic gonadotropin (hCG), which is responsible for supporting the corpus luteum during early pregnancy and sustaining the production of progesterone.

4. **Protection from Maternal Immune System**

- The placenta acts as a barrier between the mother's immune system and the developing fetus. It helps prevent the mother's immune system from attacking the fetus, which is a unique entity with its own set of genetic material.

5. **Endocrine Function**

- In addition to hCG, the placenta produces hormones such as progesterone, oestrogen, and human placental lactogen (hPL). These hormones play vital roles in maintaining the pregnancy, supporting foetal development, and preparing the mother's body for labor and breastfeeding.

6. **Blood Supply and Circulation**

- The placenta is richly vascularized, with blood vessels from both the mother and the fetus. It facilitates the exchange of substances while preventing the mixing of the two blood supplies.

7. **Immunological Functions**

- The placenta contributes to the immunological protection of the developing fetus. While allowing the necessary exchange of substances, it also provides a barrier against certain infections and pathogens.

8. **Amniotic Fluid Production**

- The placenta contributes to the production and maintenance of amniotic fluid, which surrounds and protects the developing fetus within the amniotic sac.

9. **Temperature Regulation**

- The placenta helps regulate the temperature of the developing fetus, providing an environment conducive to proper growth and development.

Hormones responsible for maintenance of pregnancy

The maintenance of pregnancy involves a complex interplay of hormones that are produced by both the mother and the developing placenta. These hormones play crucial roles in supporting the various stages of pregnancy, from implantation to childbirth. Here are the key hormones and their roles in the maintenance of pregnancy:

1. **Human Chorionic Gonadotropin (hCG)**

- **Source:** Produced by the cells surrounding the developing embryo and later by the placenta.
- **Role:** hCG is the hormone detected in pregnancy tests. It supports the corpus luteum in the early weeks of pregnancy, ensuring the continued production of progesterone. Later in pregnancy, the placenta takes over the role of producing progesterone.

2. **Progesterone**

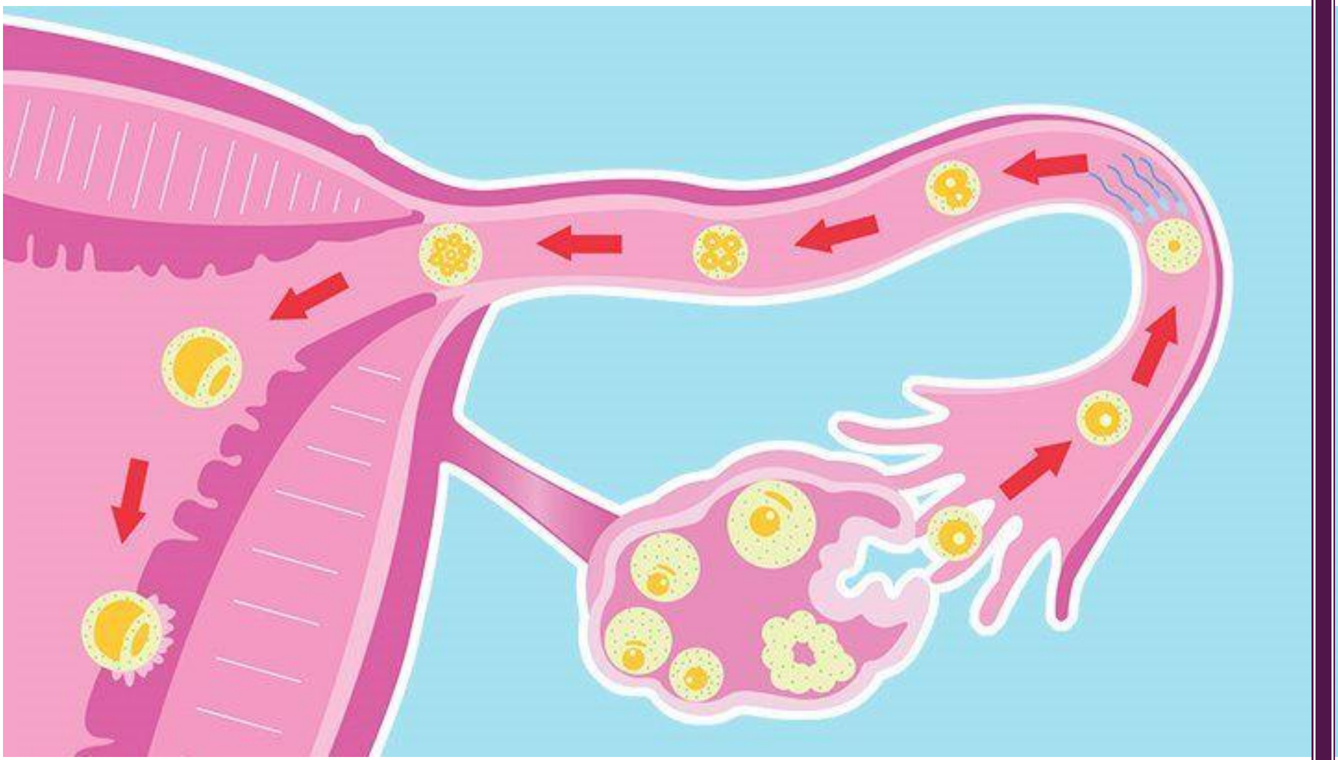


Figure 81: Progesterone

- **Source:** Initially produced by the corpus luteum and later by the placenta.
- **Role:** Progesterone helps maintain the uterine lining, preventing it from shedding and supporting the early stages of pregnancy. It also inhibits uterine contractions, preventing premature labour. Additionally, progesterone supports the growth of blood vessels in the uterus and prepares the mammary glands for breastfeeding.

3. **Oestrogen**

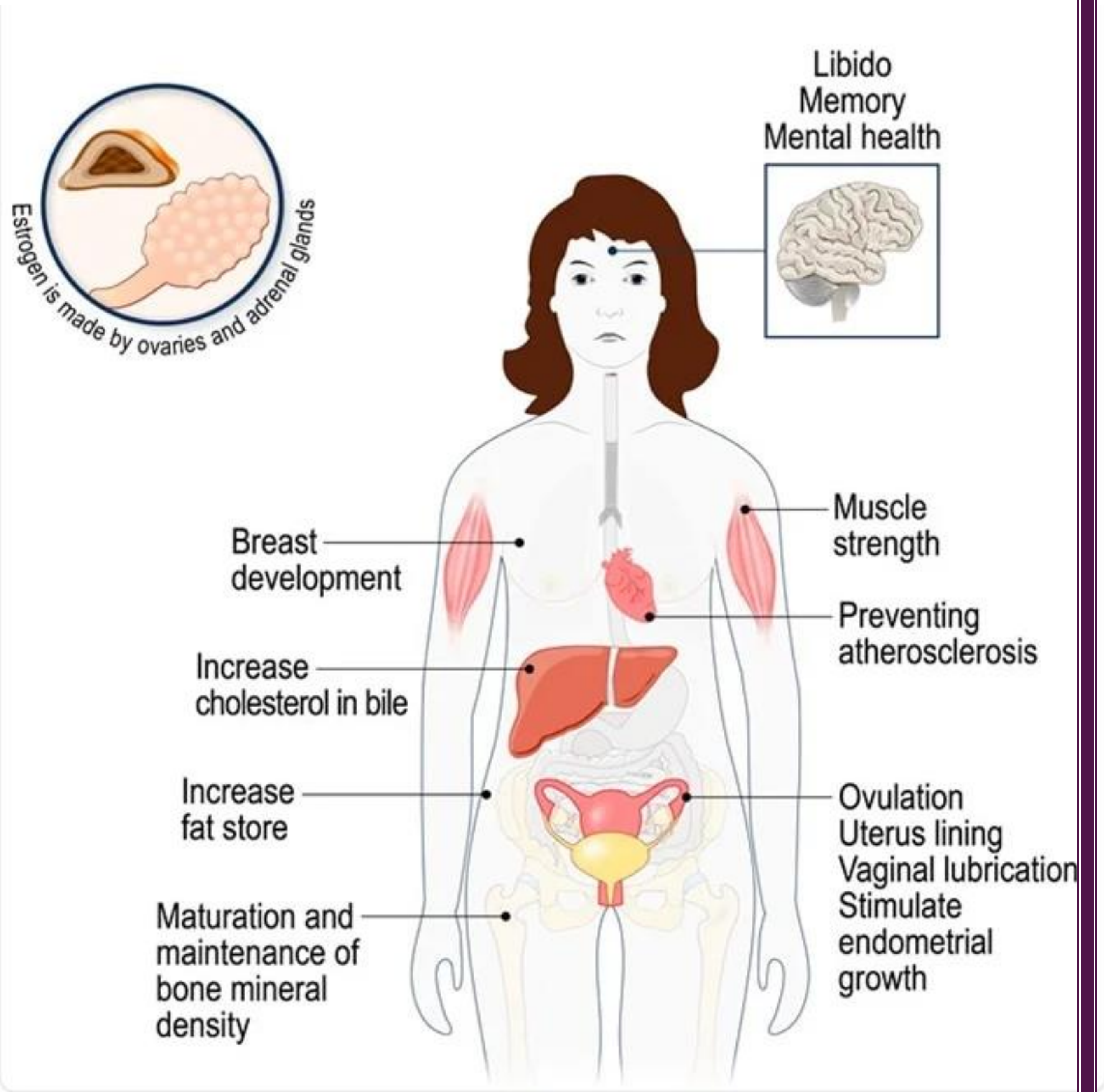


Figure 82: Estrogen action

- **Source:** Produced by the ovaries, placenta, and fetal adrenal glands.
- **Role:** Oestrogen plays a role in maintaining the uterine lining, supporting foetal development, and promoting

the growth of the placenta. Oestrogen also contributes to the development of the mammary glands in preparation for lactation.

4. **Human Placental Lactogen (hPL)**

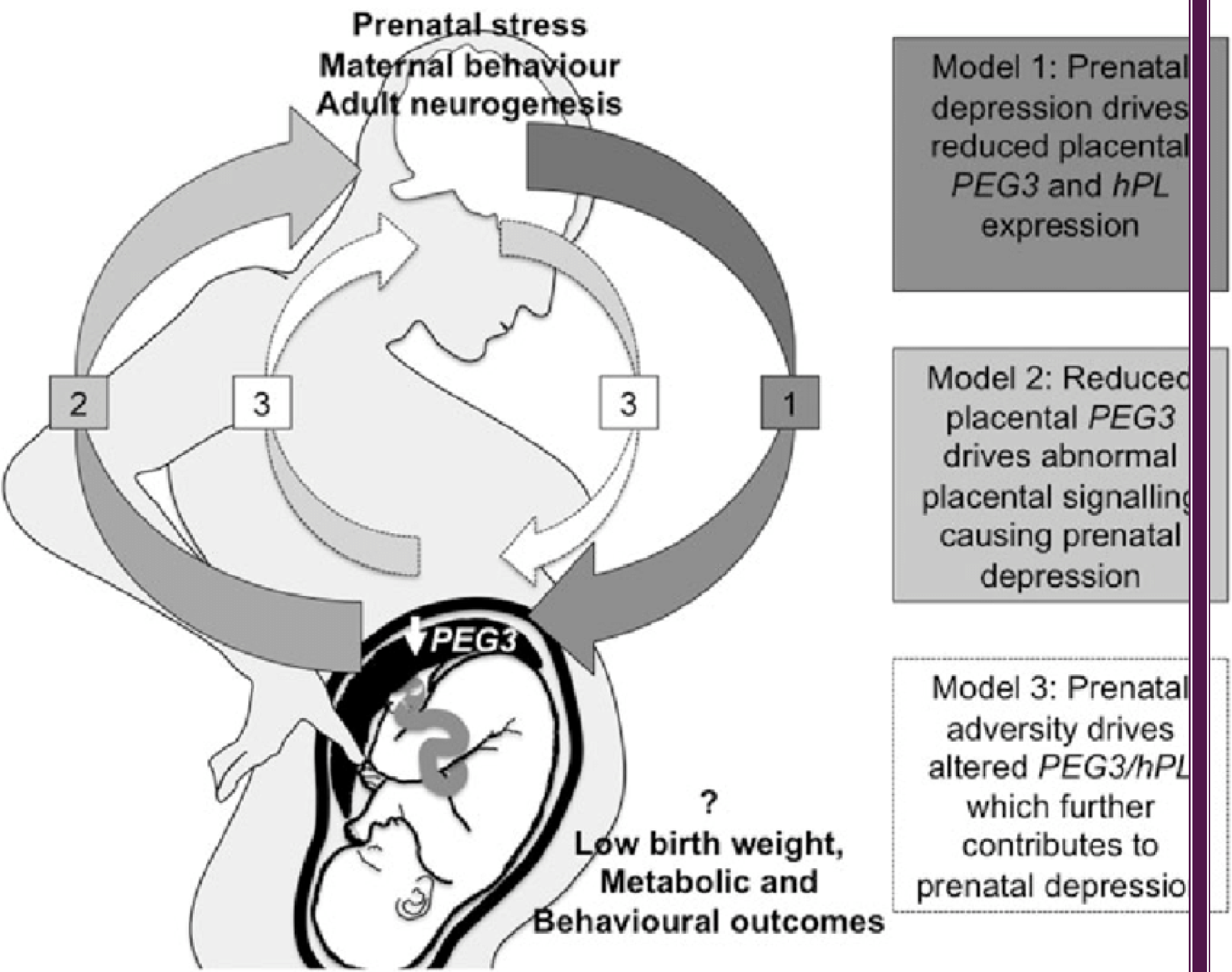


Figure 83:Human Placental Lactogen

- **Source:** Produced by the placenta.
- **Role:** hPL is involved in regulating maternal metabolism, increasing the availability of glucose and nutrients for the developing fetus. It also contributes to the development of mammary glands in preparation for breastfeeding.

5. **Prolactin**

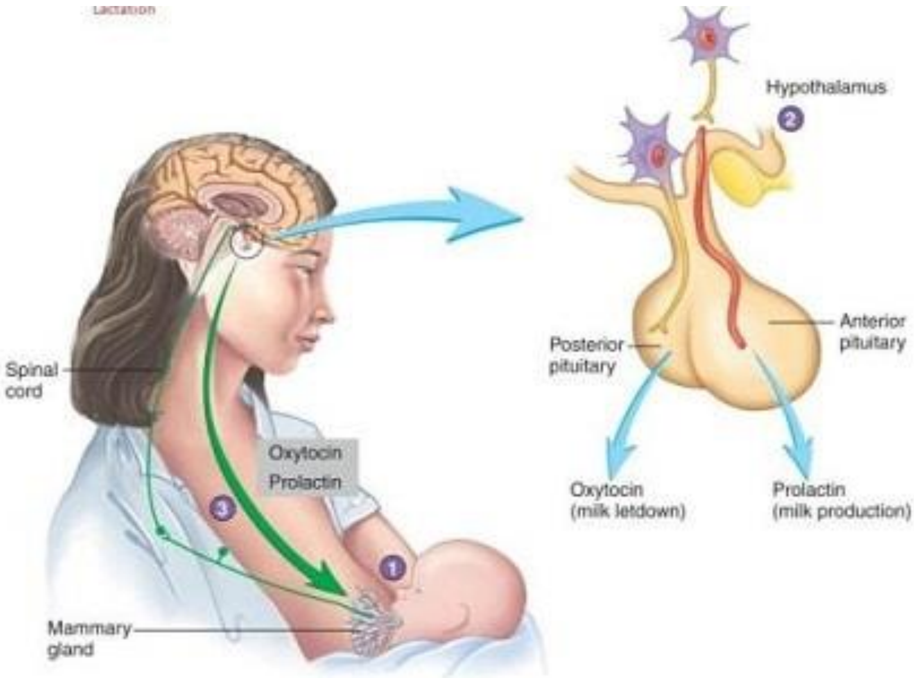


Figure 84: Prolactin archive

- **Source:** Produced by the pituitary gland and later by the placenta.
- **Role:** Prolactin stimulates the development of mammary glands and prepares the breasts for lactation. While its levels rise during pregnancy, high levels are mainly associated with breastfeeding after childbirth.

6. **Oxytocin**

- **Source:** Produced by the hypothalamus and released by the pituitary gland.
- **Role:** Oxytocin plays a key role in uterine contractions during labour and childbirth. It also stimulates milk ejection (letdown reflex) during breastfeeding.

7. **Corticotropin-Releasing Hormone (CRH)**

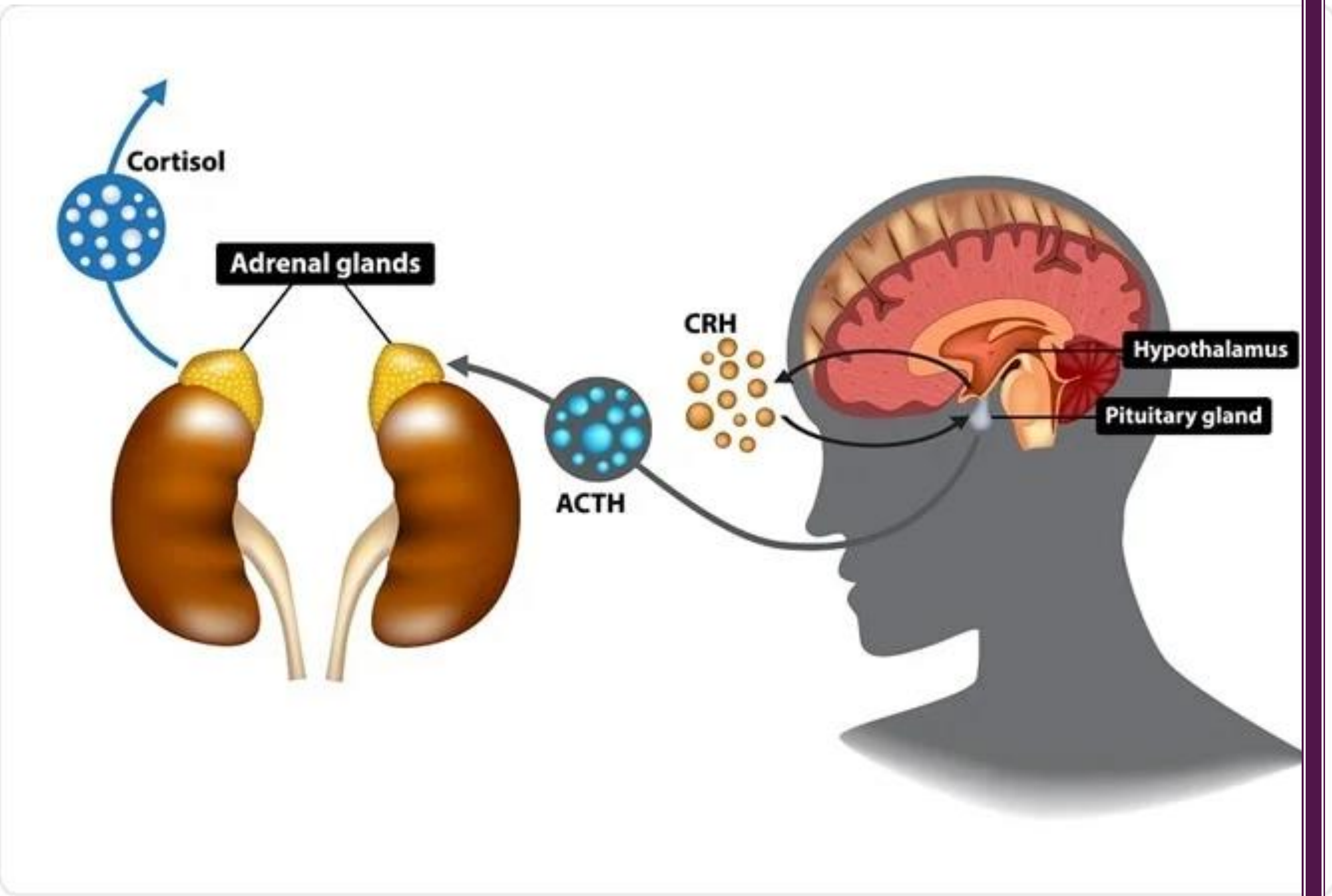


Figure 85: Corticotropin-Releasing Hormone

- **Source:** Produced by the placenta.
- **Role:** CRH contributes to the regulation of the fetal adrenal gland and is involved in the timing of labor. It also plays a role in maternal adaptation to stress during pregnancy.

In Activity 3.8, you will understand the importance of the placenta during pregnancy.

Activity 3.8: Discovering the role of the placenta during pregnancy

Key question: What is the importance of a placenta during pregnancy?

What you need: Reference materials about the role of placenta, the Internet

What to do:

1. What are the different structures you identify from Figure 3.6?

2. Discuss and agree on what would be the importance of each of the structures identified.

3. Observe how the foetus is connected to the placenta. Why do you think this connection is important?

4. From your general observation, what do you think are the roles of the placenta during pregnancy?

5. Using the available reference materials and/ or Internet, research about the role of the placenta during pregnancy

Present your work to the whole class for discussion.

Self-study:

Research about the different hormones and the roles they play in maintenance of pregnancy

3.9: Antenatal Medical Care

Figure 86: Antenatal Medical Care

A number of campaigns are done by reproductive health organizations calling on and encouraging pregnant women to attend medical antenatal care. What do you understand by the term antenatal medical care? How is it important?

Mothers who regularly go for antenatal medical care are more likely to have less complications during giving birth compared to those who don't get such medical attention. This is because any outstanding issues or problems may be detected earlier and be dealt with accordingly before time for giving birth.

Antenatal care, also known as prenatal care, is critically important during pregnancy. It involves medical supervision, support, and education provided to pregnant women to ensure the well-being of both the mother and the developing fetus.

The significance of antenatal care lies in its potential to:

1. **Monitor Pregnancy Health:**

- Regular antenatal check-ups allow healthcare professionals to monitor the health of both the mother and the fetus throughout the pregnancy.
- Monitoring includes tracking fetal growth, assessing maternal vital signs, and identifying any potential complications early.

2. **Detect and Manage High-Risk Conditions:**

- Antenatal care helps identify and manage risk factors and complications that may arise during pregnancy. This includes conditions such as gestational diabetes, preeclampsia, and infections.

- Early detection and management of high-risk conditions contribute to better outcomes for both the mother and the baby.

3. **Promote Healthy Pregnancy:**

Figure 87: feeding on fruits

- Antenatal care provides an opportunity to educate pregnant women about healthy lifestyle choices, proper nutrition, and appropriate exercise during pregnancy.
- Guidance on maintaining a healthy lifestyle helps reduce the risk of complications and supports optimal fetal development.

4. **Prevent and Manage Anaemia:**

- Anaemia is a common concern during pregnancy. Antenatal care includes monitoring maternal hemoglobin levels and providing iron supplements if necessary to prevent and manage anemia.

5. **Address Mental Health and Emotional Well-being:**

- Pregnancy can bring about emotional and psychological changes. Antenatal care includes addressing mental health concerns, providing emotional support, and offering resources for coping with stress and anxiety.

6. **Prepare for Labour and Childbirth:**

- Antenatal classes are often part of prenatal care, providing education on labor, childbirth, and breastfeeding.
- These classes help prepare expectant parents for the physical and emotional aspects of labor and delivery.

7. **Screen for and Manage Infections:**

- Antenatal care includes screening for infections that may affect the health of the mother or the baby, such as sexually transmitted infections (STIs).
- Early detection and treatment of infections help prevent complications during pregnancy.

8. **Plan for Safe Delivery:**

- Antenatal care involves creating a birth plan and discussing options for labor and delivery. This includes considering preferences for pain management, delivery location, and the involvement of birthing partners.

9. **Monitor Fetal Development:**

- Regular ultrasounds and other diagnostic tests during antenatal care help monitor fetal development, identify any abnormalities, and assess the overall health of the baby.

10. **Facilitate Timely Interventions:**

- If complications arise, antenatal care allows for timely interventions, medical treatments, or modifications to the birthing plan to address emerging issues and ensure the safety of both mother and baby.

In summary, antenatal care is crucial for promoting a healthy pregnancy, preventing and managing potential complications, and ensuring a safe and positive childbirth experience. Regular monitoring and early intervention contribute to better outcomes for both the mother and the baby.

Pregnant individuals are encouraged to attend all scheduled antenatal appointments and communicate openly with their healthcare providers about any concerns or questions.

In Activity 3.9, you will appreciate the importance of antenatal health care to pregnant women and to unborn babies. This will put you in a better position to advise the pregnant mothers on why they should go for antenatal medical care.

Activity 3.9: Discovering the importance of antenatal care during pregnancy

Key question: How important is antenatal care during pregnancy?

What you need: Reference materials about antenatal care, notebook, a pen

1. Using reference materials research about the importance of good antenatal medical care to the mother and baby.

2. Interview any mother to find out if she went for antenatal medical care during pregnancy and what benefits she got.

Find out why it is important for fathers to attend antenatal care with their wives.

Make general class Notes

3.10 : Baby Care after Birth

Figure 88: Baby Care after Birth

Do you have baby siblings? Have you observed how mothers take care of babies in infancy?

It is important to take good care of the baby so that it grows in good condition. How important do you think the care is in Figure 3.77 .

This is commonly done by females in most mammals though in humans both sexes participate.

In Activity 3.10, you will understand the different aspects of care for the baby after birth. This will put you in a good position to be a caring parent in future and be able to advise other people on why and how to take care for the babies.

Figure 89: A mother breastfeeding

Newly born babies require special care and attention due to their vulnerability and unique needs during the early stages of life. Providing proper care for newborns is essential for their health, well-being, and overall development.

Reasons why newly born babies need special care

1. **Transition to Extrauterine Life:**

- Newborns undergo a significant transition from the protected environment of the womb to the outside world. They need support to adapt to changes in temperature, breathing, and feeding.

2. **Thermoregulation:**

- Newborns have limited ability to regulate their body temperature. They are more susceptible to heat loss and hypothermia. Keeping them warm through appropriate clothing, swaddling, and maintaining a warm environment is crucial.

3. **Feeding and Nutrition:**

- Proper feeding is essential for newborns to receive adequate nutrition for growth and development. Whether breastfeeding or formula feeding, establishing a feeding routine and ensuring proper latch and suck reflexes are important.

4. **Hydration:**

- Newborns are at risk of dehydration and monitoring their fluid intake is crucial. Ensuring proper breastfeeding or formula feeding and recognizing signs of dehydration are important aspects of newborn care.

5. **Bonding and Attachment:**

- Establishing a strong bond between the newborn and caregivers is vital for emotional well-being. Skin-to-skin contact, cuddling, and responsive caregiving contribute to the development of a secure attachment.

6. **Monitoring Health and Vital Signs:**

- Regular monitoring of vital signs, such as heart rate, respiratory rate, and temperature, helps identify any potential health issues early. Newborns may require screening tests and routine check-ups to ensure they are healthy.

7. **Immunization and Preventive Care:**

- Immunizations and preventive care, such as vitamin supplementation, are essential to protect newborns from common infections and diseases. Following recommended vaccination schedules is crucial for building immunity.

8. **Sleep and Wake Patterns:**

- Newborns have irregular sleep and wake patterns, and caregivers need to establish a safe sleep environment. Providing a consistent sleep routine helps newborns develop healthy sleep habits.

9. **Diapering and Hygiene:**

- Maintaining proper diapering practices and ensuring good hygiene are important for preventing diaper rash and infections. Keeping the umbilical cord stump clean and dry is also essential.

10. **Cognitive Stimulation:**

- Engaging with newborns through gentle talking, singing, and visual stimulation contributes to their cognitive development. However, stimulation should be provided in a way that is appropriate for their sensory abilities.

11. **Recognizing and Responding to Distress:**

- Newborns communicate through crying and non-verbal cues. Caregivers need to learn to recognize signs of distress, hunger, discomfort, or illness and respond promptly and appropriately.

12. **Screening for Developmental Milestones:**

- Monitoring developmental milestones, such as motor skills, social interactions, and communication, helps identify any potential developmental delays. Early intervention can be crucial for addressing developmental concerns.

Caring for newly born babies requires attention to their unique needs and a commitment to providing a safe, nurturing environment.

Essential tips on how to best care for newly born babies

1. **Feeding:**

- **Breastfeeding:** Encourage breastfeeding as it provides essential nutrients and promotes bonding. Follow a feeding schedule and ensure proper latching and positioning.
- **Formula Feeding:** If formula feeding, use the appropriate formula, sterilize bottles, and feed on a regular schedule.

2. **Diapering and Hygiene:**

- Change diapers regularly to prevent diaper rash. Use gentle wipes or warm water and pat the baby dry.
- Keep the umbilical cord stump clean and dry until it falls off.

3. **Thermoregulation:**

- Dress the baby in layers to maintain body temperature.
- Ensure the room is comfortably warm and avoid exposing the baby to drafts.

4. **Sleep Position and Safe Sleep Environment:**

- Place the baby on their back to sleep to reduce the risk of sudden infant death syndrome (SIDS).
- Use a firm mattress in a crib with no loose bedding, toys, or pillows.

5. **Bonding and Cuddling:**

- Engage in skin-to-skin contact, cuddling, and gentle rocking to build a strong bond.
- Talk or sing to the baby to provide comfort and stimulate their senses.

6. **Monitoring Health and Vital Signs:**

- Keep an eye on the baby's vital signs, including body temperature, heart rate, and respiratory rate.
- Schedule regular check-ups with a pediatrician and follow recommended vaccination schedules.

7. **Crying and Comforting:**

- Respond promptly to the baby's cries to meet their needs for feeding, changing, or comfort.
- Use calming techniques such as gentle rocking, swaying, or offering a pacifier.

8. **Hydration and Nutrition:**

- Ensure the baby is adequately hydrated and gaining weight.
- Follow a feeding schedule and consult with a healthcare provider if there are concerns about feeding or weight gain.

9. **Cord Care:**

- Keep the umbilical cord stump clean and dry. Use rubbing alcohol or as recommended by the healthcare provider.
- Avoid submerging the baby in water until the cord stump falls off.

10. **Immunizations and Preventive Care:**

- Follow the recommended vaccination schedule to protect the baby from common infections.
- Provide any recommended vitamin supplements as advised by the pediatrician.

11. **Stimulation and Interaction:**

- Engage in age-appropriate activities to stimulate the baby's senses.
- Talk, sing, and make eye contact to foster communication and social development.

12. **Care for the Caregiver:**

- Ensure the well-being of the caregiver. Adequate rest, a healthy diet, and emotional support are essential for providing quality care to the baby.

13. **Seek Professional Guidance:**

- Consult with healthcare providers for guidance on any concerns or questions related to the baby's health, development, or behavior.

Remember, every baby is unique, and what works for one may not work for another. Pay attention to the baby's cues, trust your instincts, and seek support when needed. Establishing a routine, creating a nurturing environment, and offering love and care contribute to the overall well-being of the newly born baby.

Activity 8.10: Brain storming on different care for the baby

Key question: How do you care for a new born baby?

What you need: Reference materials, the Internet, resource person

What to do:

1. Explain why newly born babies need to be cared for.
2. How best can newly born babies be cared for?
3. You have seen mothers take babies to medical facilities after some time even when not sick. Why do you think this is done?
4. Which kind of food do you see being given to the babies?

At what age are babies' diet changed to hard foods?

Compare your responses with those of another group.

Self-study:

Identify the different diseases which babies need to be immunized against. At which age is each immunized and what health complications may result from such a disease if not immunized.

3.11 : Teenage pregnancy and abortion

Figure 90: Teenage pregnancy

Who is a teenager? Teenage pregnancy also known as adolescent pregnancy, is pregnancy in a female under the age of twenty.

According to the 2018 study on prevalence and determinants of Adolescent pregnancy in Africa, it was found out that the overall prevalence in Africa was 18.8% with the prevalence being highest in East Africa (21.5%) and lowest in Northern Africa (19.2%). The factors associated with teenage pregnancies included rural residence, not attending school, lack of parent to adolescent communication on sexual and reproductive issues, no parents' education among others (reproductive health-journal bio medcentral.com)

Increased teenage pregnancies can result from a combination of complex and interconnected factors that vary across different regions and communities. Understanding these causes is essential for developing effective strategies to prevent and address teenage pregnancies.

Common factors associated with the increased prevalence of teenage pregnancies

1. **Lack of Comprehensive Sex Education**

- Inadequate or absent sex education programs in schools and communities may leave teenagers uninformed about safe sex practices, contraception, and the consequences of early pregnancy.

2. **Limited Access to Contraception**

- Barriers to accessing contraceptives, such as cost, stigma, and lack of availability, can contribute to unprotected sexual activity among teenagers.

3. **Socio-cultural Norms**

- Societal norms and cultural influences may play a role in shaping attitudes toward sex, contraception, and early childbearing. In some communities, early marriage and childbearing may be more socially accepted.

4. **Peer Pressure**

- Influence from peers and social pressure to conform to certain behaviors, including early sexual activity, can contribute to an increased risk of teenage pregnancies.

5. **Poverty and Socioeconomic Disparities**

- Adolescents from economically disadvantaged backgrounds may face limited educational and employment opportunities. The lack of resources and support systems can contribute to early parenthood as an alternative life path.

6. **Media Influence**

- Exposure to media content that glamorizes teenage pregnancy or presents unrealistic portrayals of relationships and parenthood can influence teenagers' perceptions and behaviors.

7. **Family Structure and Dynamics**

- The family environment, including parenting styles, communication patterns, and the level of parental involvement, can impact teenagers' decisions about sexual activity and contraceptive use.

8. **Lack of Future Orientation**

- Some teenagers may lack a sense of future orientation or have limited awareness of the long-term consequences of early parenthood. Factors such as low educational aspirations and limited career goals may contribute to this lack of future planning.

9. **Early Sexual Activity**

- Engaging in sexual activity at an early age increases the risk of unintended pregnancies. Lack of awareness, curiosity, and experimentation can contribute to early sexual initiation.

10. **Absenteeism of Positive Role Models**

- The absence of positive role models or mentors who can provide guidance and support may leave teenagers without the necessary guidance to make informed decisions about relationships and sexual health.

11. **Stigma and Discrimination**

- Stigma and discrimination against contraceptive use or seeking reproductive health services may deter teenagers from accessing the information and resources they need.

12. **Mental Health Factors:**

- Mental health issues, such as low self-esteem, depression, or a desire for affection and acceptance, can influence teenagers' decisions related to sexual activity and relationships.

From your interaction with the community members, which view do you have about teenage pregnancy? Many of the teenage pregnancies are usually prematurely ended by removal or expulsion of the embryo or foetus either through deliberate steps a condition known as induced abortion or without intervention a condition known as miscarriage.

There are however very many health risks and complications associated with teenage pregnancies and abortion some of which result into death of the foetus and/ or the mother.

In order to avoid the health risks associated with these teenage pregnancies, teenagers are advised to abstain from sex.

Both teenage pregnancy and abortion can pose various risks and challenges to the health and well-being of young individuals. It's important to note that the outcomes can vary based on factors such as access to healthcare, support systems, and individual circumstances. Here are some of the dangers associated with teenage pregnancy and abortion:

Dangers Associated with Teenage Pregnancy

Figure 91: Teenage Pregnancy

1. **Maternal Health Risks**

- Teenage mothers are at an increased risk of complications during pregnancy and childbirth, including preterm birth, low birth weight, and pregnancy-induced hypertension.

2. **Limited Prenatal Care**

- Teenagers may be less likely to seek early and regular prenatal care, leading to missed opportunities for monitoring and addressing potential health issues.

3. **Educational Disruption**

- Teenage pregnancy can disrupt a young woman's education, limiting her future opportunities and potentially contributing to long-term economic challenges.

4. **Social Stigma and Isolation:**

- Teenage mothers may face social stigma and isolation, which can contribute to stress, anxiety, and feelings of inadequacy.

5. **Financial Strain:**

- Young parents, often with limited financial resources, may struggle to provide for the financial needs of the child, potentially leading to economic hardship.

6. **Impact on Mental Health:**

- Teenage pregnancy can contribute to mental health challenges, including increased risk of depression and anxiety, as young mothers navigate the responsibilities of parenthood.

7. **Relationship Strain:**

- Relationships between teenage parents may face challenges due to the demands of parenting at a young age, potentially leading to increased stress and relationship strain.

Dangers Associated with Abortion

1. **Health Risks of Unsafe Abortion**

- In regions where safe and legal abortion services are limited, some individuals may resort to unsafe abortion methods, leading to severe health complications, infections, and, in extreme cases, death.

2. **Psychological Impact**

- Some individuals may experience psychological and emotional distress following an abortion, including feelings of guilt, sadness, or anxiety. However, these reactions vary widely among individuals.

3. **Incomplete Abortion**

- Incomplete abortion occurs when not all pregnancy tissue is expelled from the uterus. This can lead to complications such as infection and excessive bleeding.

4. **Impact on Future Pregnancies**

- Complications from an abortion, especially if performed unsafely, can affect future pregnancies, potentially increasing the risk of complications.

5. **Legal and Social Stigma:**

- In places where abortion is legally restricted or socially stigmatized, individuals may face legal consequences, social judgment, and discrimination, leading to additional stress and challenges.

6. **Lack of Access to Post-Abortion Care:**

- Limited access to post-abortion care, including counseling and reproductive health services, may impact individuals' overall well-being after an abortion.

It's crucial to emphasize that both teenage pregnancy and abortion should be approached with sensitivity, recognizing that individual experiences and circumstances vary widely. Access to comprehensive reproductive healthcare, including family planning, prenatal care, and safe abortion services, is essential to mitigate the potential dangers associated with these reproductive health challenges. Supportive environments, education, and open communication can contribute to better outcomes for young individuals facing these complex situations.

Activity 3.11: Finding out dangers associated with teenage pregnancy and abortion

Key question: What are the dangers associated with teenage pregnancy and abortion?

What you need: A notebook, a pen

1. After the covid 19 lock-down in Uganda, many cases of teenage pregnancies were reported.
    i) Brainstorm and note down the causes of increased teenage pregnancies.
    ii) Discuss the dangers associated with the teenage pregnancy
    iii) What advice would you give to teenagers that got pregnant during the covid lock-down
2. Abortion is not acceptable in Uganda. Discuss and give reasons why.

Share your response with another group and make general conclusions in each case.

Present your work to the class

3.12 : Birth Control Methods

Figure 92: Birth Control Methods

Usually, a family would wish to have children in a given organized pattern where there is enough child spacing so that each child is given the necessary parental care before another child is born. It is also meant to regulate the number of children so as to have a manageable family size.

The need to regulate the number of children and/or have them in a given pattern may require use of various birth control methods. Note: The birth control methods need to be used carefully and effectively.

In Activity 3.12, you will explore the different birth control methods commonly used, the biological principle they employ and their effectiveness.

In Uganda, various birth control methods are available to individuals seeking to prevent unintended pregnancies. The accessibility and utilization of these methods can vary based on factors such as geography, education, and socioeconomic status. Common birth control methods in Uganda include:

1. **Condoms**

Figure 93: Condom

- Male condoms and female condoms are readily available and provide dual protection against unintended pregnancies and sexually transmitted infections (STIs).

2. **Oral Contraceptives (Birth Control Pills)**

Figure 94: Birth Control Pills

- Birth control pills are hormonal contraceptives taken orally to prevent pregnancy. They are available through healthcare providers and require a prescription.

3. **Injectable Contraceptives**

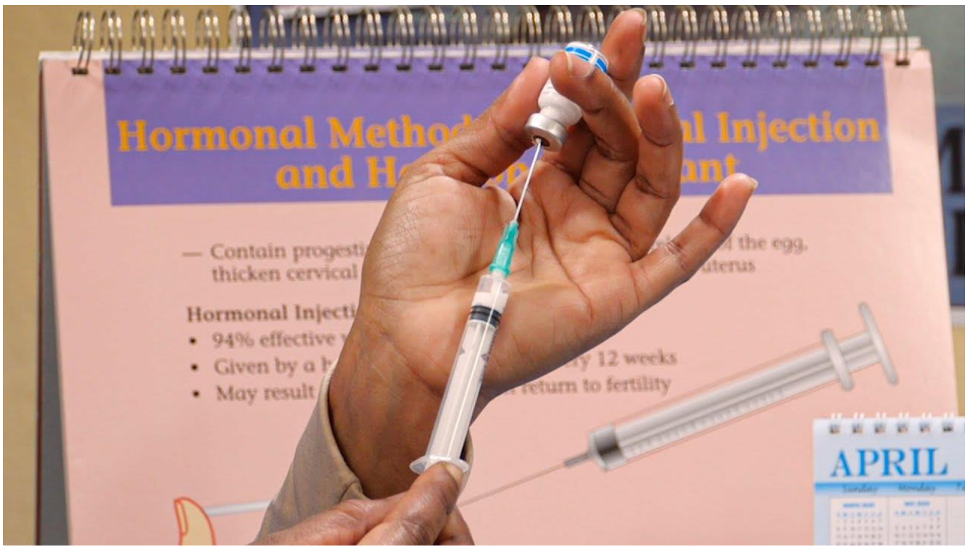
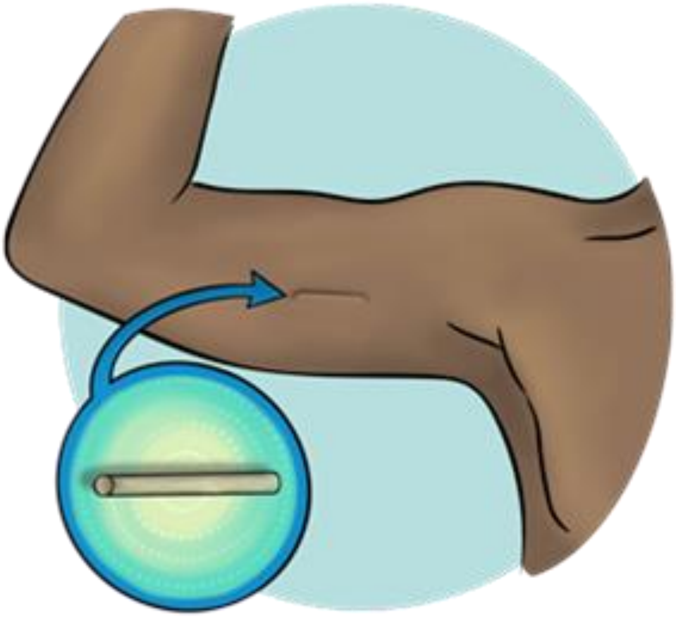


Figure 95: Injectable Contraceptives

- Injectable contraceptives, such as Depo-Provera, are hormonal methods administered through an injection. They provide protection against pregnancy for a specified duration.

4. **Implants**



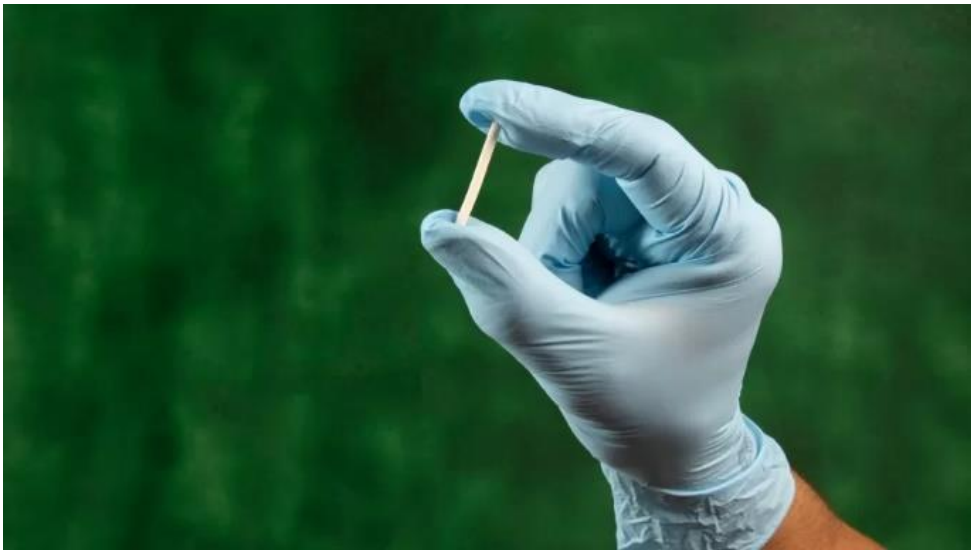


Figure 96: Implants

- Subdermal contraceptive implants, such as Implanon, are small, flexible rods inserted under the skin to release hormones and prevent pregnancy for an extended period.

5. **Intrauterine Device (IUD)**

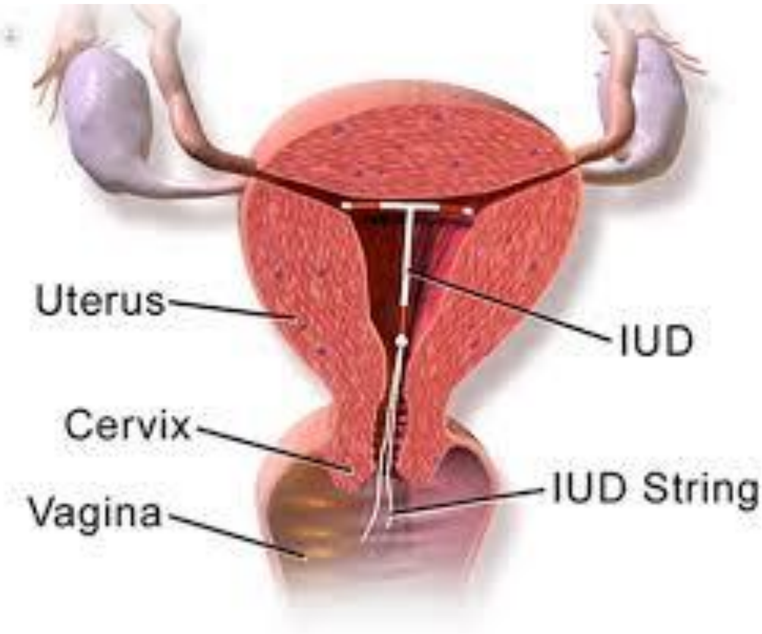


Figure 97: Intrauterine Device

- IUDs are small, T-shaped devices inserted into the uterus to prevent pregnancy. They can be hormonal or non-hormonal and provide long-term contraception.

6. **Emergency Contraception**

Figure 98: Emergency Contraception

- Emergency contraception, also known as the "morning-after pill," can be taken after unprotected intercourse to reduce the risk of pregnancy. It is available over the counter in some settings.

7. **Fertility Awareness Methods**

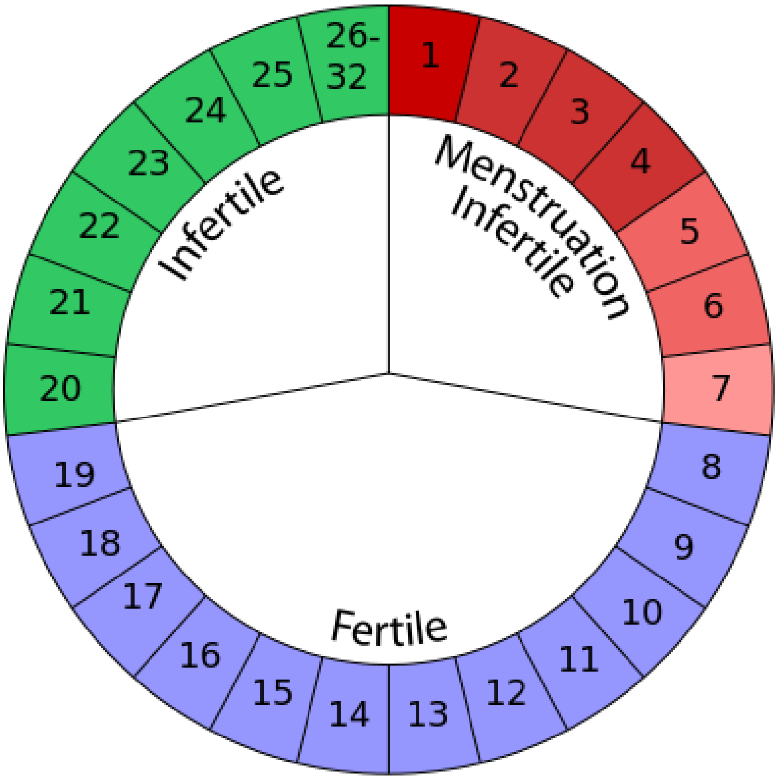


Figure 99: Fertility Awareness Methods

- Fertility awareness methods involve tracking menstrual cycles and identifying fertile days to avoid intercourse during the fertile window. This method requires education and consistency.

8. **Permanent Methods (Sterilization)**

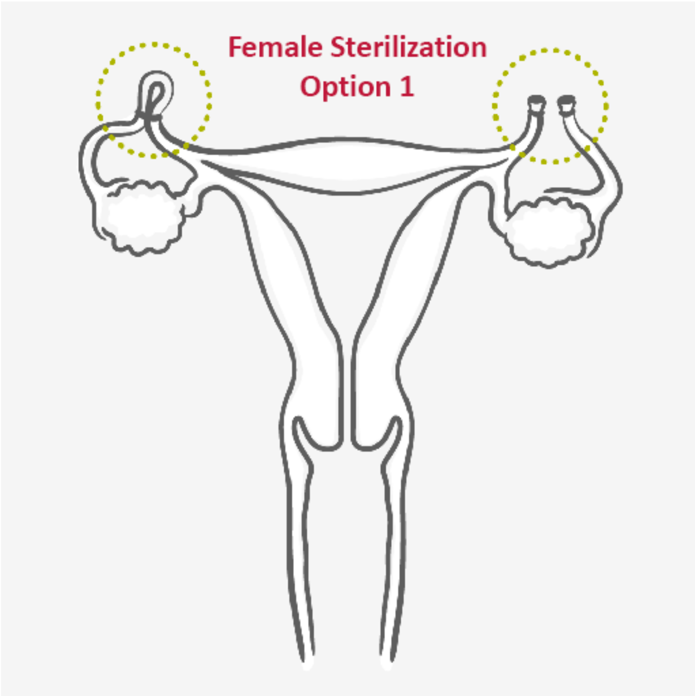


Figure 100: Permanent Methods

- Sterilization procedures, such as tubal ligation (for women) or vasectomy (for men), provide permanent contraception. These procedures are typically considered when individuals or couples have decided not to have more children.

9. **Lactational Amenorrhea Method (LAM):**

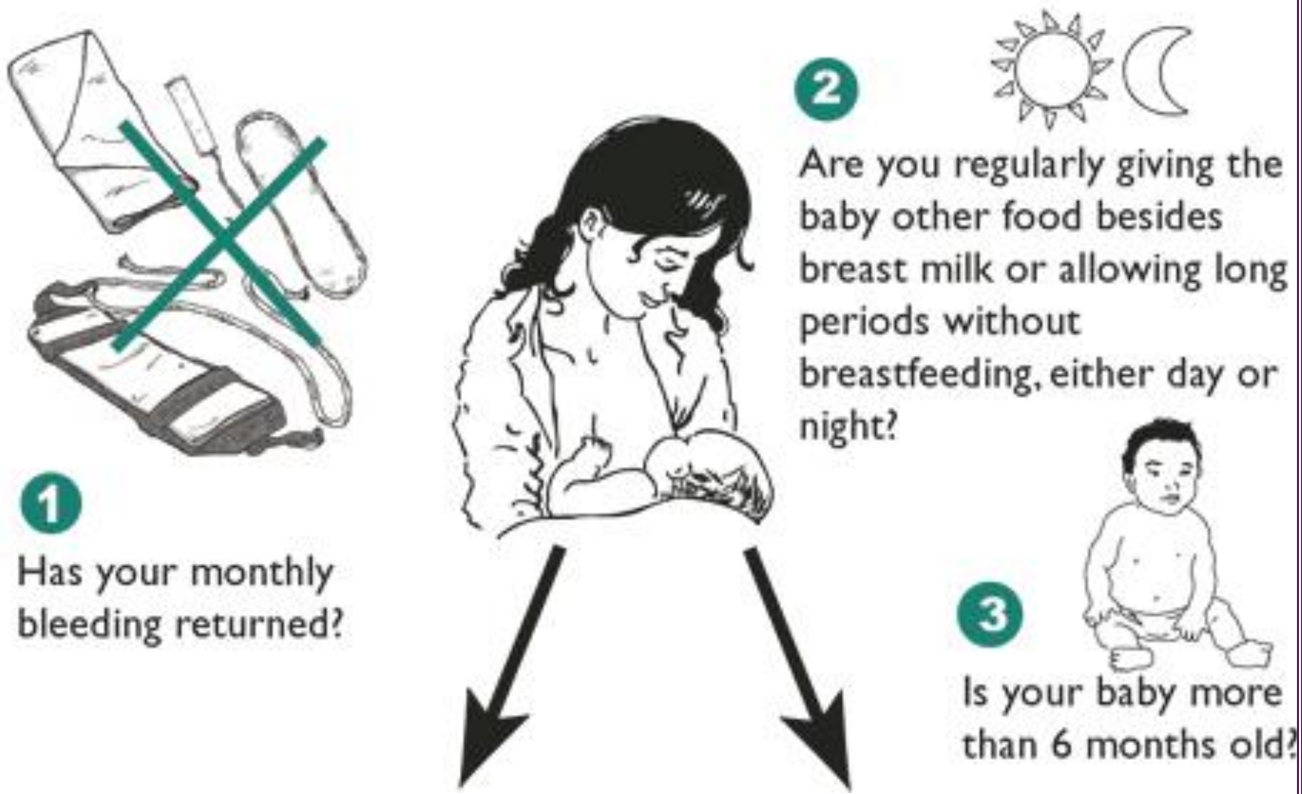


Figure 101: Lactational Amenorrhea Method

- LAM is a natural family planning method that relies on breastfeeding to delay the return of fertility in the postpartum period.

10. Standard Days Method

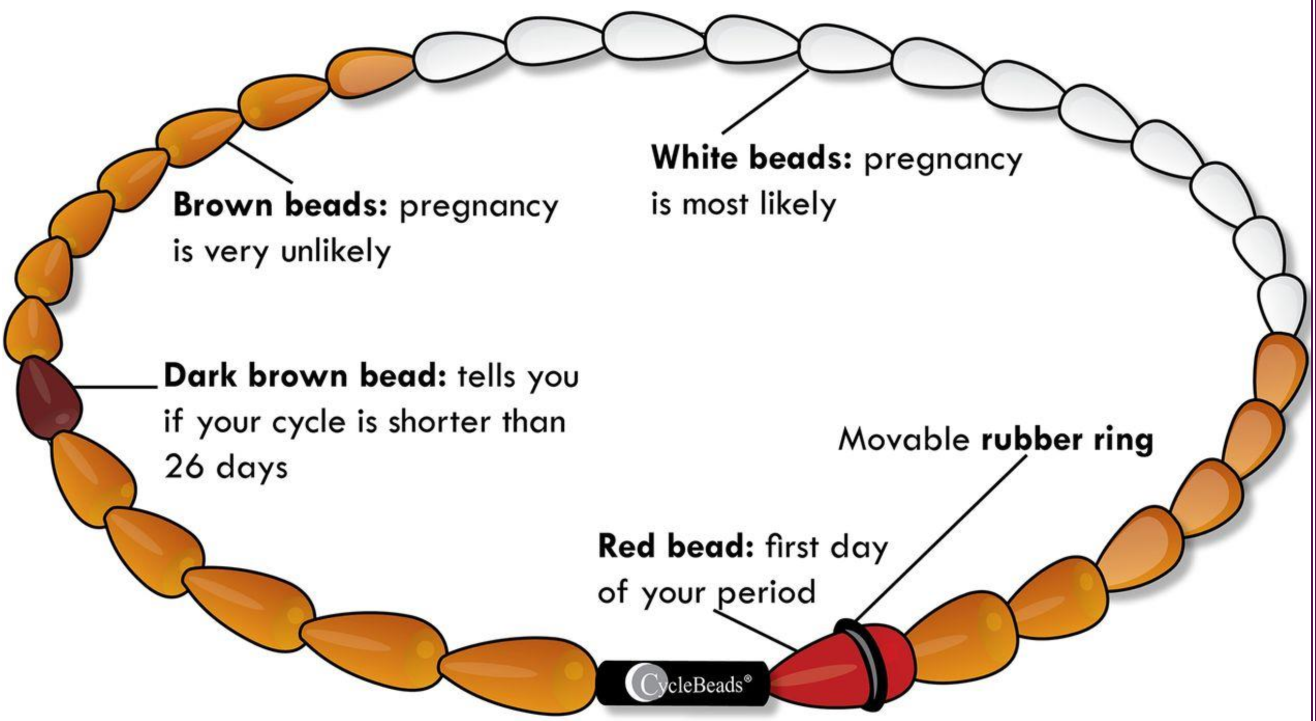


Figure 102: Standard Days Method

- The Standard Days Method involves avoiding intercourse on specific days of the menstrual cycle when conception is more likely.

11. **Cervical Cap and Diaphragm**

Figure 103: Cervical Cap and Diaphragm

- These barrier methods involve using a cervical cap or diaphragm with spermicide to prevent sperm from reaching the cervix.

12. Vasectomy and Tubal Ligation Services

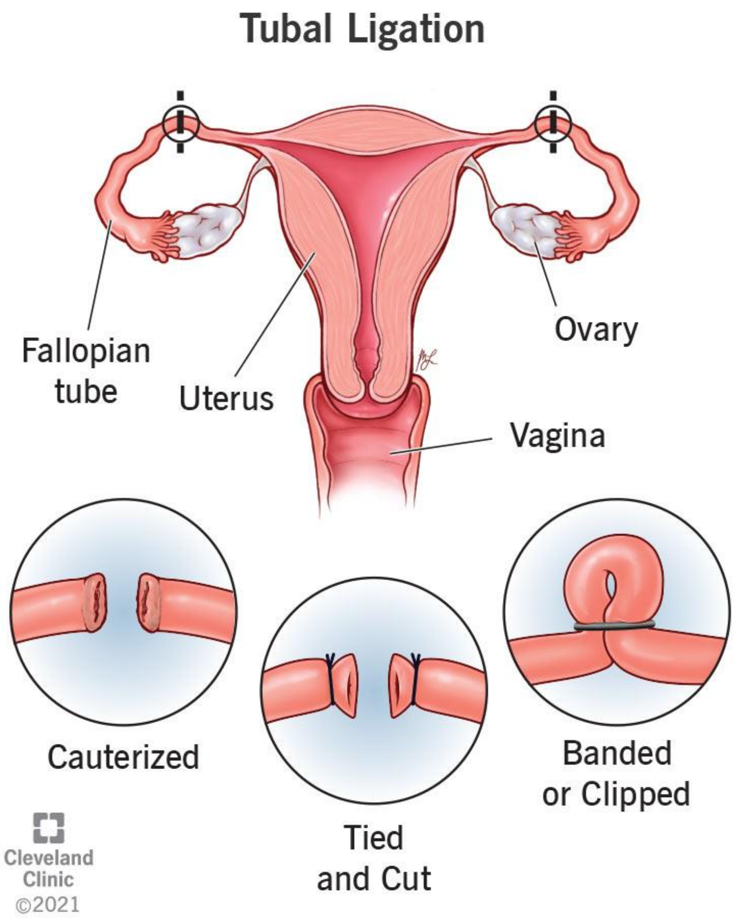


Figure 104: Vasectomy and Tubal Ligation Services

- Permanent contraception methods, such as vasectomy for men and tubal ligation for women, are available for individuals or couples who have completed their desired family size.

Access to birth control methods and family planning services is an essential component of reproductive health programs in Uganda. Healthcare providers, community health workers, and family planning clinics play a crucial role in educating individuals about their contraceptive options and providing access to the method that best suits their needs and preferences.

Activity 3.12: Exploring birth control methods

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

What you need: A resource person, a questionnaire or recorded talk on birth control methods

What to do:

1. With the help of your teacher, invite a health professional to your class and interview him or her about birth control methods, the biological principal they employ, their effectiveness and the dangers associated with them.

2. What discoveries have you made from the interview/the talk?

3. Which of the methods would you consider to be most effective and why?

4. What is your general view about the use of birth control among the youth,

Make general notes about birth control methods

3.13 : Sexually Transmitted Infections (STIs)

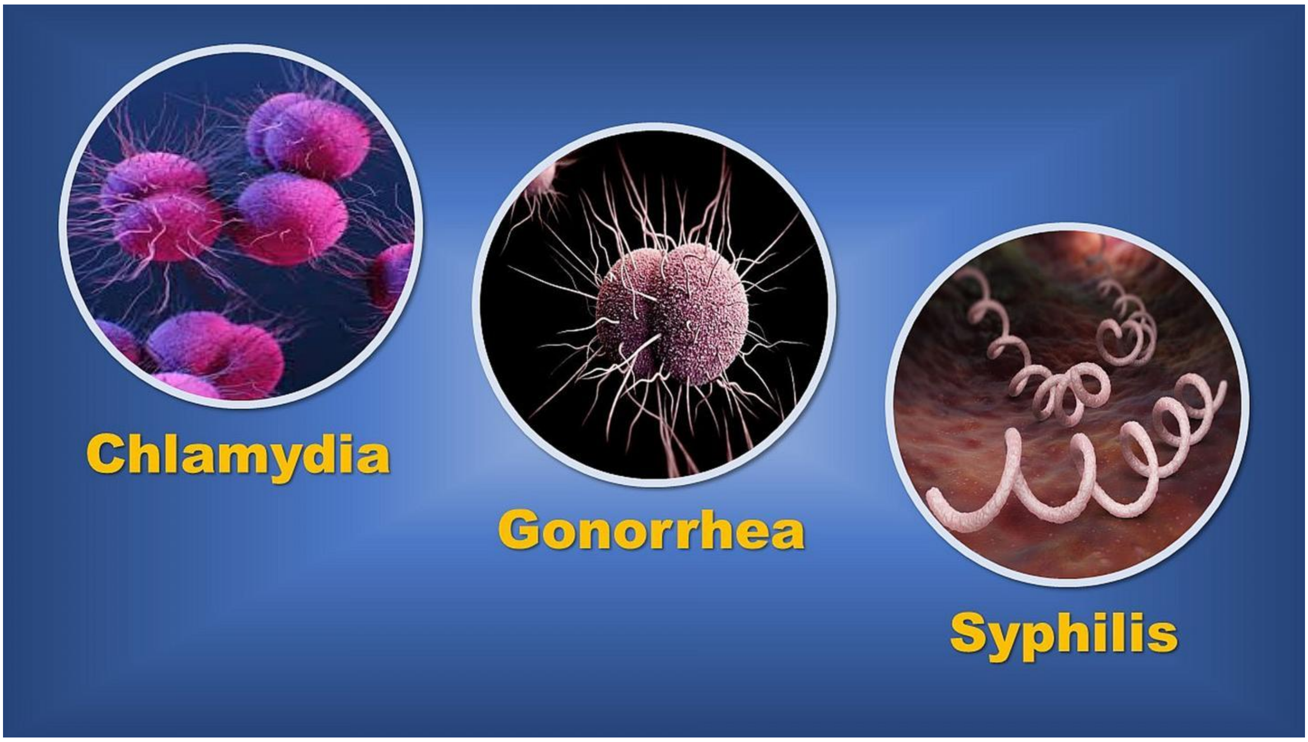


Figure 105: Sexually Transmitted Infections

Sexual reproduction in humans involves sexual intercourse. However, during sexual intercourse, diseases or infections may be transmitted from an infected person to another.

Sexually transmitted infections are therefore Infections which can be passed on from one infected person to another during sexual intercourse.

Do you know the common STIs and STDs?

Different STIs are caused by various bacteria, viruses, parasites, and fungi. The causes, symptoms, and severity of STIs can vary.

A general overview

1. Gonorrhea

Causes:

- **Bacterium:** *Neisseria gonorrhoeae*.

Signs and Symptoms

- Men: Discharge from the penis, painful urination, and testicular pain.
- Women: Vaginal discharge, pelvic pain, and painful urination.
- Both: Rectal and throat infections are possible.

Mode of Transmission:

- Unprotected vaginal, anal, or oral sex with an infected person.

Preventive Measures:

- Consistent and correct use of condoms.
- Regular STI testing, especially for those with multiple sexual partners.
- Treatment with antibiotics if diagnosed.

2. Syphilis:

Causes:

- **Bacterium:** *Treponema pallidum*.

Signs and Symptoms:

- Primary Stage: Painless sores (chancres) at the site of infection.
- Secondary Stage: Skin rash, mucous membrane lesions, and flu-like symptoms.
- Tertiary Stage: Organ damage, including the heart and brain.

Mode of Transmission:

- Direct contact with syphilis sores during sexual activity.

Preventive Measures

- Consistent and correct use of condoms.
- Regular STI testing.
- Treatment with antibiotics if diagnosed.

3. Hepatitis B

Causes:

- Virus: Hepatitis B virus (HBV).

Signs and Symptoms

- Initial symptoms may be mild or absent.
- Jaundice, fatigue, abdominal pain, and nausea in severe cases.

Mode of Transmission

- Contact with infected blood, semen, or other body fluids.
- Unprotected sexual contact.
- Mother-to-child transmission during childbirth.

Preventive Measures

- Hepatitis B vaccination.
- Use of barrier methods (condoms) during sexual activity.
- Avoiding sharing of needles and personal items.

3. Human Papillomavirus (HPV)

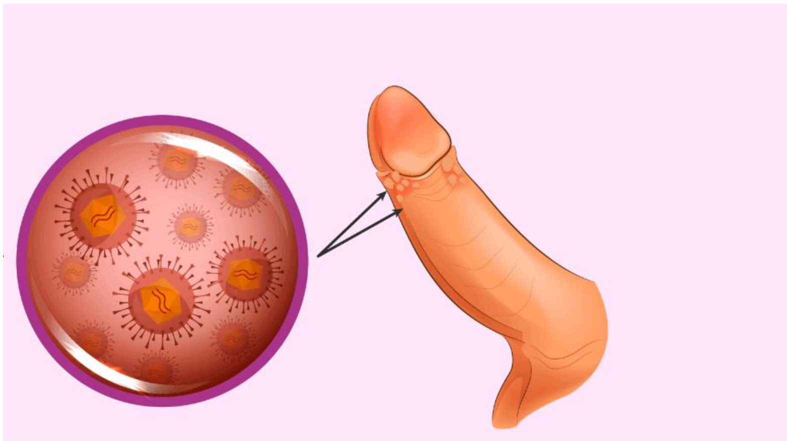


Figure 106: Human Papillomavirus.

Causes:

- Virus: Human Papillomavirus.

Signs and Symptoms

- Most cases are asymptomatic.
- Genital warts (some strains).

- Increased risk of cervical and other cancers.

Mode of Transmission:

- Direct skin-to-skin contact, including sexual activity.
- Can be spread through genital, anal, and oral sex.

Preventive Measures

- HPV vaccination.
- Consistent and correct use of condoms.
- Regular Pap smears and HPV testing for early detection.

5. Candida (Yeast Infection)

Causes:

- **Fungus:** Candida species (usually *Candida albicans*).

Signs and Symptoms

- Itching, burning, and redness in the genital area.
- Cottage cheese-like vaginal discharge.
- Pain during sexual intercourse and urination.

Mode of Transmission

- Imbalance in the normal vaginal flora, often triggered by factors like antibiotics, hormonal changes, or a weakened immune system.

Preventive Measures

- Maintaining good genital hygiene.
- Avoiding unnecessary use of antibiotics.
- Wearing breathable underwear.

6. HIV/AIDS

Causes:

- Virus: Human Immunodeficiency Virus (HIV).

Signs and Symptoms

- Flu-like symptoms in the early stage.
- Long asymptomatic period.
- Advanced stage: Opportunistic infections, weight loss, fatigue.

Mode of Transmission

- Unprotected sexual contact.
- Sharing of needles.
- Mother-to-child transmission during childbirth or breastfeeding.

Preventive Measures

- Consistent and correct use of condoms.
- Pre-exposure prophylaxis (PrEP) for high-risk individuals.
- Antiretroviral therapy (ART) for those living with HIV.

In Activity 3.13, you will explore the causes, signs and symptoms, mode of transmission and preventive measures of gonorrhea, syphilis, hepatitis B, Human Papilloma Virus (HPV), candida and HIV/AIDS.

This will equip you with enough knowledge to be able to avoid these STDs and give adequate information to the community majorly about the mode of transmission and preventive measures.

Activity 3.13: Exploring the common STIs

Key question: What are causes, symptoms of STIs?

What you need: A resource person or a recorded talk about STIs a pen, notebook,

1. Listen to the talk from the health worker about sexually transmitted diseases.

i) Note down STIs mentioned

ii) Use the information from the talk to fill the table below.

Disease	**Symptoms**	**Prevention**

2. Which lessons do you learn from the-discoveries made above

3.14 Challenges faced by people living with HIV/AIDS

People living with HIV/AIDS are faced with many challenges ranging from physical, physiological, social to psychological problems among others. Due to the many challenges experienced by these people, they need a lot of support and it is therefore important that you get acquainted with the necessary information on how to support them.

In Activity 3.14, you will discuss the challenges faced by people living with HIV/AIDS and how they can be overcome. This will put you in a better position to help and support the HIV/AIDS victims.

People living with HIV/AIDS in Uganda, as in many other parts of the world, face a range of challenges that can impact their overall well-being and quality of life. These challenges are often interconnected and can vary based on factors such as geographic location, socioeconomic status, and access to healthcare.

Challenges faced by people living with HIV/AIDS in Uganda include

1. **Stigma and Discrimination:**

- Stigma and discrimination against individuals with HIV/AIDS persist in Uganda, leading to social isolation, loss of employment opportunities, and strained relationships.

2. **Limited Access to Healthcare:**

- Some individuals may face barriers in accessing healthcare services, including antiretroviral therapy (ART) and other necessary medical care. Factors such as distance to health facilities, transportation costs, and healthcare provider attitudes can contribute to limited access.

3. **Medication Adherence:**

- Adhering to a lifelong regimen of antiretroviral medications is crucial for managing HIV/AIDS. Challenges such as medication side effects, stigma, and difficulties in maintaining a consistent treatment schedule can affect adherence.

4. **Disclosure Dilemmas:**

- Deciding whether to disclose one's HIV status can be challenging due to fear of stigma, discrimination, and potential negative consequences in personal and professional relationships.

5. **Economic Insecurity:**

- Individuals living with HIV/AIDS may face economic challenges, including job loss, reduced income, and increased healthcare expenses. Economic instability can impact access to basic needs and healthcare services.

6. **Food Insecurity:**

- Adequate nutrition is essential for individuals with HIV/AIDS. However, food insecurity may be a concern, affecting the ability to maintain a healthy diet and adhere to treatment.

7. **Gender-Based Challenges:**

- Gender-based disparities can affect individuals differently. Women, in particular, may face challenges related to reproductive health, access to resources, and gender-based violence.

8. **Limited Support Systems:**

- Some individuals may lack adequate social support networks, contributing to feelings of isolation and affecting mental health.

9. **Co-Infections and Comorbidities:**

- HIV/AIDS is often accompanied by increased susceptibility to opportunistic infections and other health conditions. Managing co-infections and comorbidities can be challenging.

10. **Mental Health Issues:**

- Stigma, the chronic nature of the condition, and other factors can contribute to mental health challenges, including depression and anxiety.

11. **Access to Prevention and Support Services:**

- Despite efforts to expand access, there may be challenges in reaching certain populations with prevention, testing, and support services.

12. **Legal and Human Rights Issues:**

- Discriminatory laws and policies may impact the rights of people living with HIV/AIDS, affecting areas such as healthcare access, employment, and confidentiality.

Activity 3.14: Exploring the Challenges faced by people living with HIV/AIDS

Key question: What are the challenges faced with people living with HIV/AIDS

What you need: notebook, pen

1. Read the poem What a Malady! by Mercy Timbitwire

What A Malady!

What a malady you are HIV/AIDS!

Anxiety, depression, frustration you bring

Family conflicts you cause

Marriages you break

Suffering you bring

Finances you take

To the grave you send humans

I wish people could see

We are not walking corpses

We are not careless

We are not dangerous

We are harmless

Do not discriminate us

Stand with us instead. Hope is all we need.

Against you we stand resolved.

Despite many visits to heath facilities,

Long medicine cues some times

Severe drug side effects, we will survive.

Several infections we shall survive

Despite no cure We stand against you.

We shall survive

i) What do you think is the theme of the poem?

ii) What name is given to HIV/AIDS in your local language and what does it mean?

iii) According to the poem, what challenges do people living with HIV/AIDS face?

2. What other challenges do you think people living with HIV/AIDS face?

3. Discuss ways through which the challenges identified in I) and 2) above can be managed.

4. What roles have the performing arts (Music, Dance and Drama) played in HIV/AIDS awareness?

Sample Activity of Integration

For many years Uganda uses the campaign slogan "ABSTAIN FROM SEX". This slogan targets young people. However, records show that several teenagers continue to engage in sexual activities and don't seem to understand the meaning of the campaign.

You have been asked by the chairperson of the teen's club to talk to the club members about abstinence from sex.

Task: Write a talk that you would give.

Chapter summary

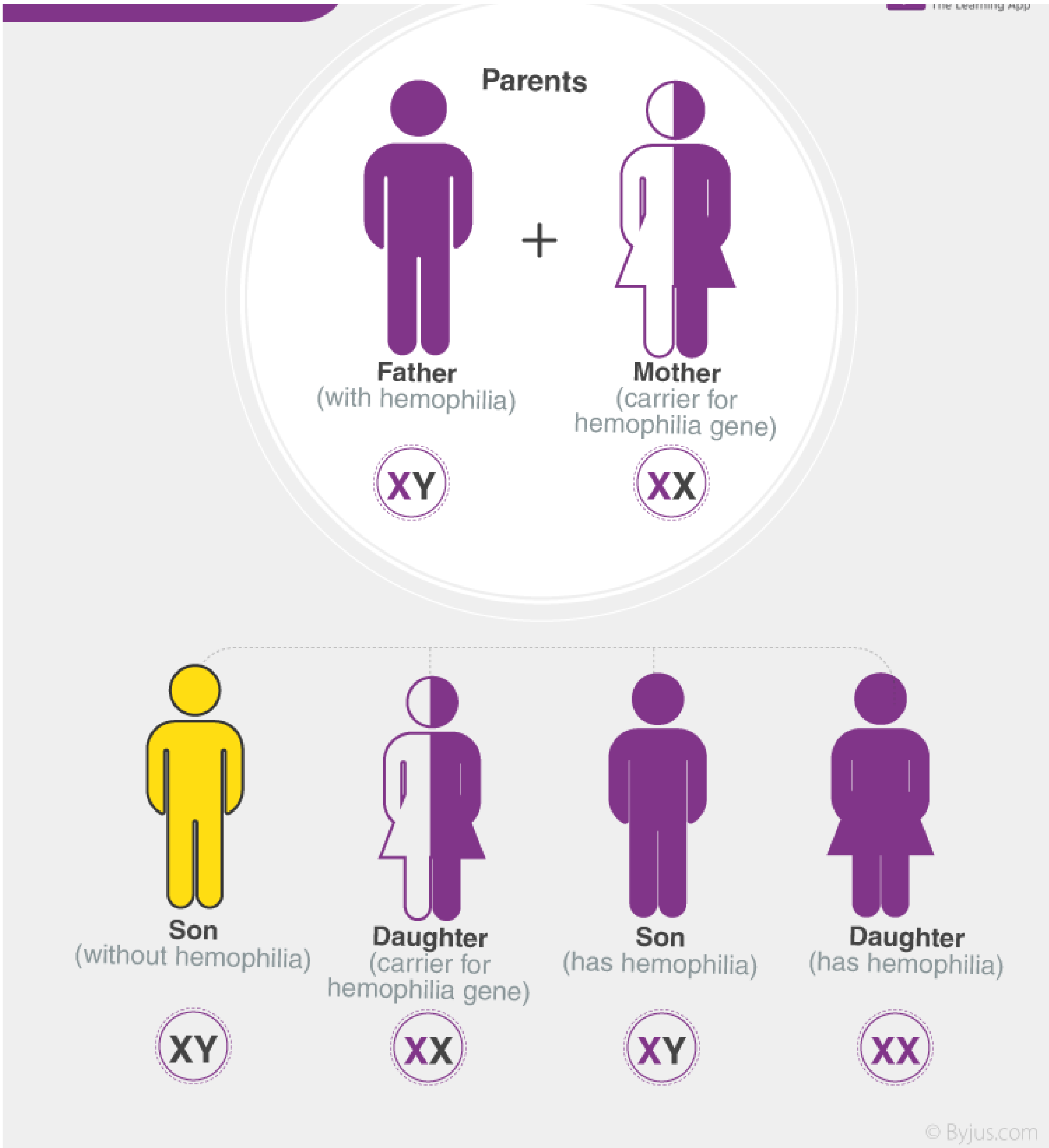
In this chapter, you have learnt about:

- The human male reproductive system produces sperms which it delivers into the female reproductive system during sexual intercourse.
- The female reproductive system is made up of a number of structures each playing a particular role.
- A male gamete is called a sperm whereas the female gamete is called an ovum.
- The menstrual cycle is a series of natural changes in the uterus, ovaries and the hormones of the female reproductive system.
- Some females have issues associated with their reproductive systems
- The placenta serves as the major connection between the mother and the foetus
- Antenatal medical care is very important during pregnancy
- It is very important to care for the baby during infancy
- Teenage pregnancy and abortion
- Teenage pregnancy is pregnancy in a female under the age of twenty.
- Birth control methods are used to enable child spacing
- Sexually transmitted infections are contracted through sexual intercourse
- People living with HIV/Aids are faced with many challenges ranging from physical, physiological; social to psychological problems

TERM TWO

THEME: GENETICS

Chapter 4: Inheritance



Key words

- Inheritance
- Meiosis
- Mitosis
- Genes
- Chromosomes
- Traits
- Sex Linkage
- Co-dominance
- Sax linkage

Learning outcomes

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.

BIBLICAL INTEGRATION

"For you created my inmost being; you knit me together in my mother's womb." - Psalm 139:13. This verse highlights the intricate and purposeful design of our genetic makeup, affirming the wonder of inheritance and the continuity of life as part of God's creation.

By understanding genetics and inheritance, we gain insights into how traits are passed down and the role of heredity in the diversity and unity of life. Psalm 139:13 reminds us to appreciate the marvel of our genetic inheritance as part of God's intentional creation.

Introduction

Have you observed that some people especially family members resemble? Why is this so? Do you resemble any of your parents or siblings? The similarities between parents and children clearly indicate that characteristics are passed on or inherited from parents to the offspring. This process is known as inheritance. The inherited characteristics are known as traits.

In this chapter, you will appreciate how characteristics are passed on from parents to their offspring in a process known as heredity. You will appreciate the role of heredity in continuity of life.

In senior one, you discussed about a cell as a basic unit of life in living organisms. Cells carry the information that is passed on from parents to offspring. In which part of the cell do you think this information is carried? In order for this information to be passed on, the cells have to divide.

4.1: Cell Division

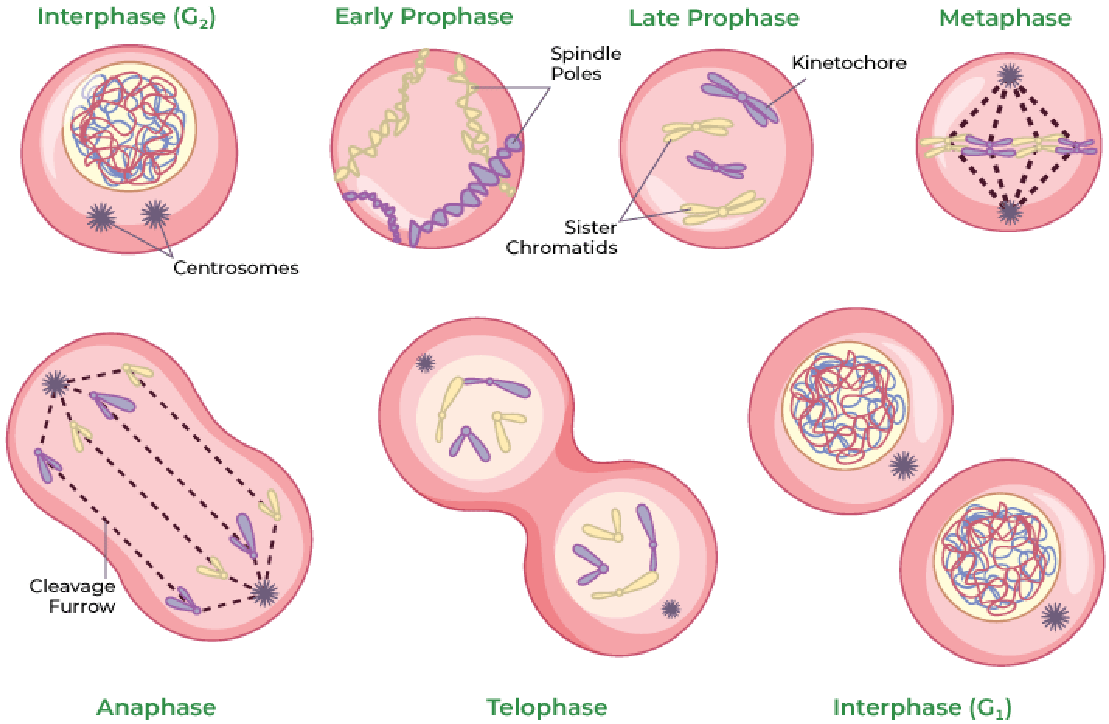


Figure 107: Cell division

The process through which the number of cells in an organism increase is known as cell division. The process of cell division differs in reproductive and non-reproductive cells as illustrated in Figure 4.1 using buns on a plate.

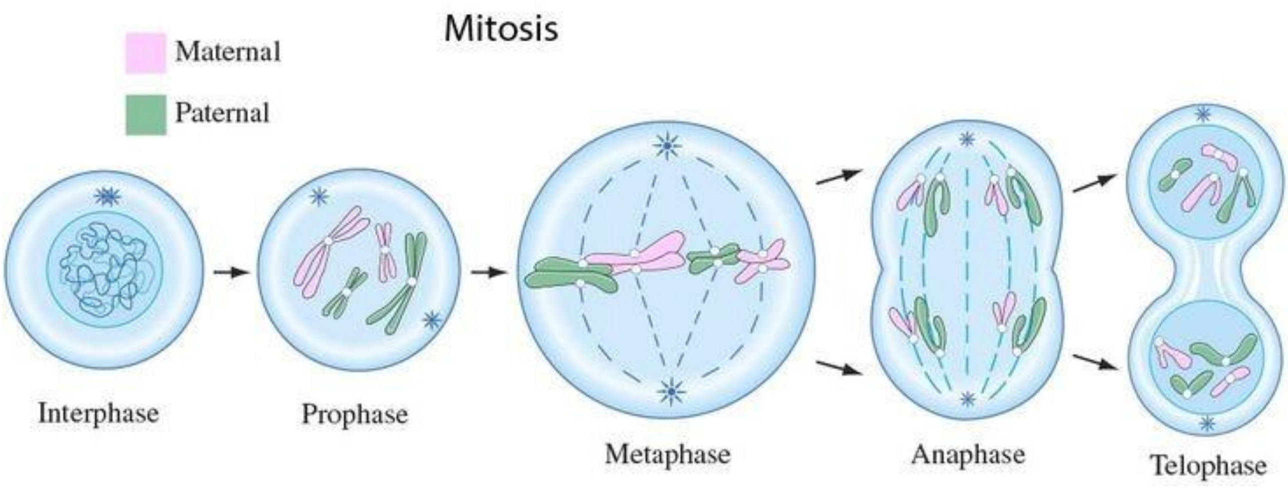


Figure 108: Process of cell division in somatic cells

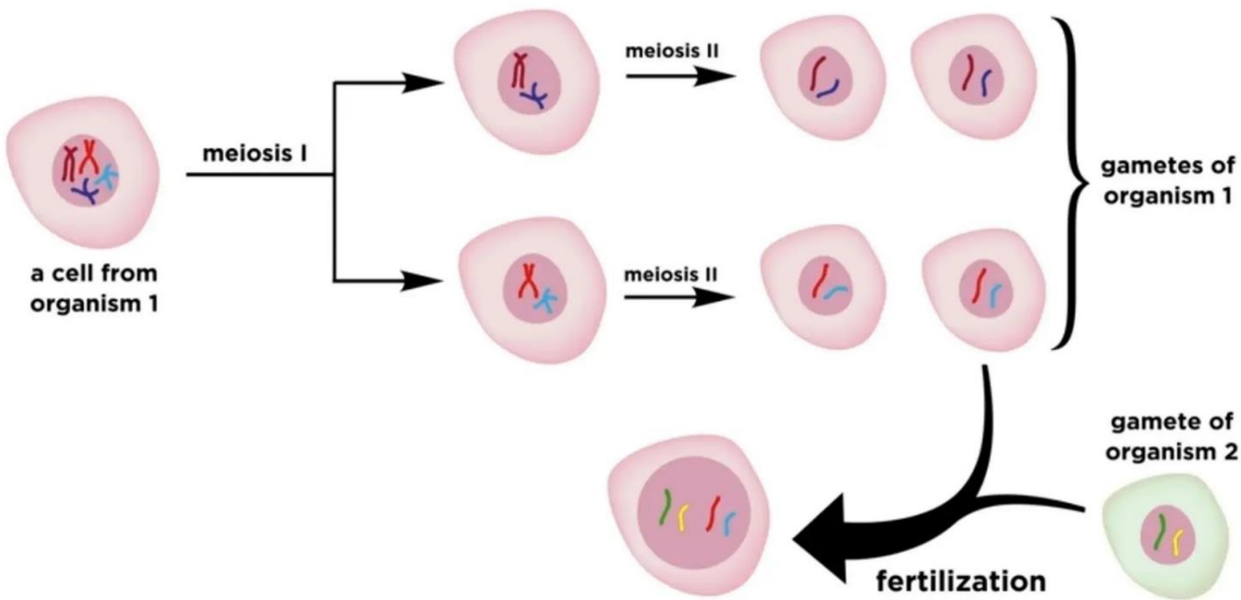


Figure 109: Process of cell division in germ cells

Cell division is the process by which a parent cell divides into two or more daughter cells. There are two main types of cell division: mitosis and meiosis.

Mitosis:

- Purpose: Mitosis is a form of cell division that occurs in somatic cells (non-reproductive cells) and is responsible for growth, development, and tissue repair. The resulting daughter cells are genetically identical to the parent cell ie have the same chromosome number as the parent cell.
- Phases:
- Interphase: The cell prepares for division by growing, carrying out normal cellular functions, and duplicating its DNA.
- Prophase: Chromosomes condense, and the nuclear envelope breaks down. Spindle fibers begin to form.
- Metaphase: Chromosomes align at the cell's equator, known as the metaphase plate.
- Anaphase: Sister chromatids separate and move toward opposite poles of the cell.
- Telophase: Chromatids reach the poles and de-condense into chromatin. The nuclear envelope reforms around each set of chromosomes.
- Cytokinesis: The cell's cytoplasm divides, forming two separate daughter cells, each with its own nucleus.

Mitosis is a crucial process with several important functions in multicellular organisms.

Key aspects of the importance of mitosis

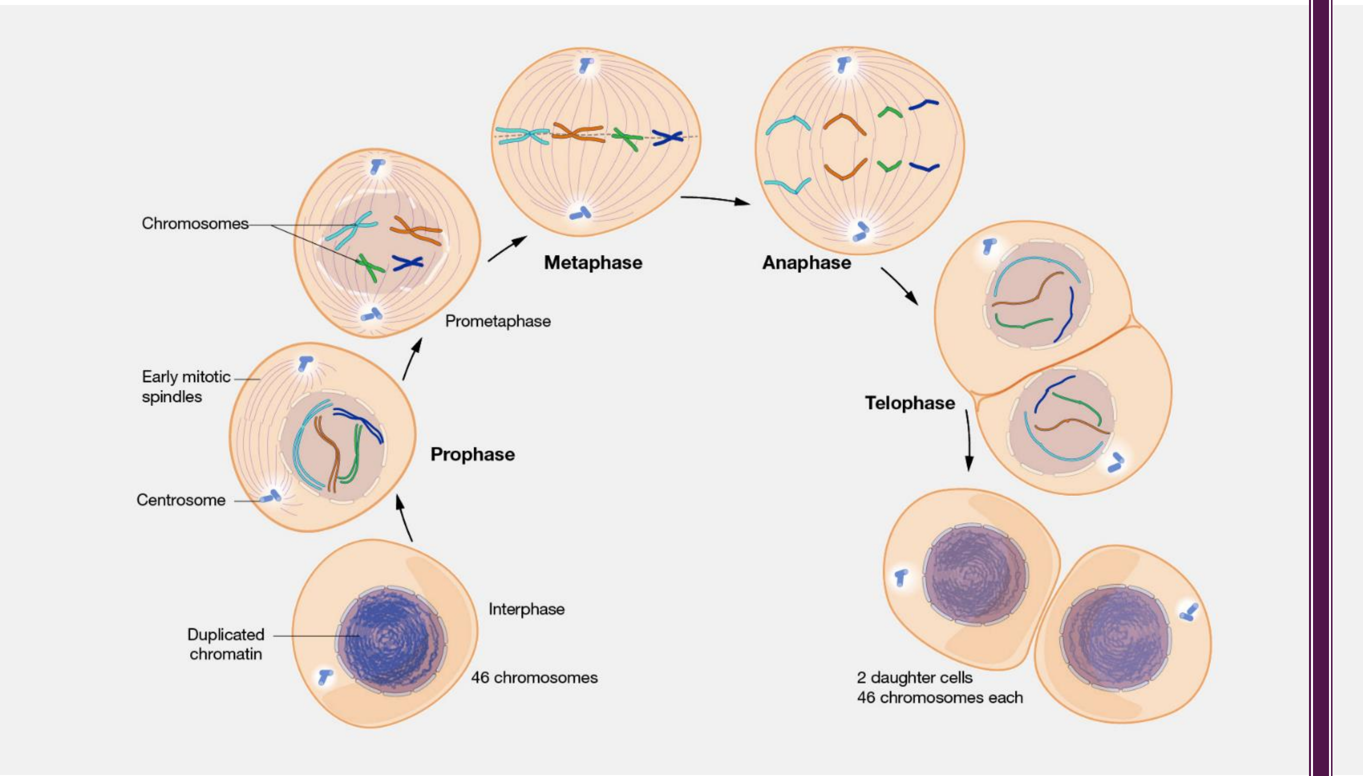


Figure 110: mitosis

Growth and Development

Mitosis plays a fundamental role in the growth and development of multicellular organisms. As an organism grows, cells divide through mitosis to produce more cells, increasing the overall size and complexity of the organism.

Tissue Repair and Maintenance

Mitosis is essential for the repair and maintenance of tissues in the body. When cells are damaged or die, mitosis allows for the replacement of these cells, ensuring the proper functioning of tissues and organs.

Cell Replacement

In tissues with a high turnover rate, such as the skin, blood, and lining of the digestive tract, mitosis is responsible for replacing old or damaged cells with new, identical ones. This continuous renewal is vital for the organism's overall health.

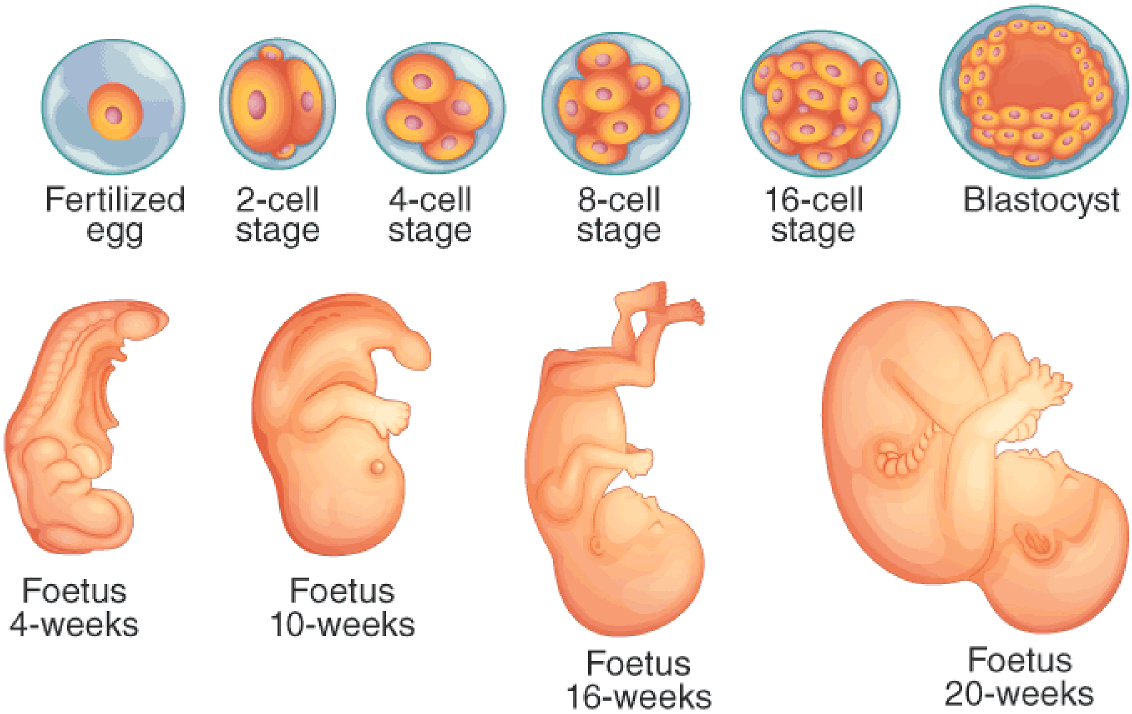
Asexual Reproduction

In some organisms, mitosis is the primary mechanism for asexual reproduction. Single-celled organisms, as well as certain multicellular organisms, can reproduce by mitotic division, producing genetically identical offspring.

Genetic Stability

Mitosis ensures that the genetic information in the parent cell is faithfully replicated and distributed to the daughter cells. This process maintains the stability of the organism's genetic makeup from one generation of cells to the next.

Embryonic Development



During embryonic development, mitosis is responsible for the rapid cell division that gives rise to the different cell types and tissues in the developing embryo. This process establishes the foundation for the body plan and structure of the organism.

Cellular Homeostasis

Mitosis helps maintain a balance or homeostasis within tissues and organs. It ensures that the number of cells in a particular tissue remains relatively constant, preventing abnormal growth or depletion of cell populations.

In summary, mitosis is crucial for the growth, development, maintenance, and repair of multicellular organisms. It plays a central role in various biological processes that contribute to the overall health and functioning of living organisms.

1. **Meiosis**

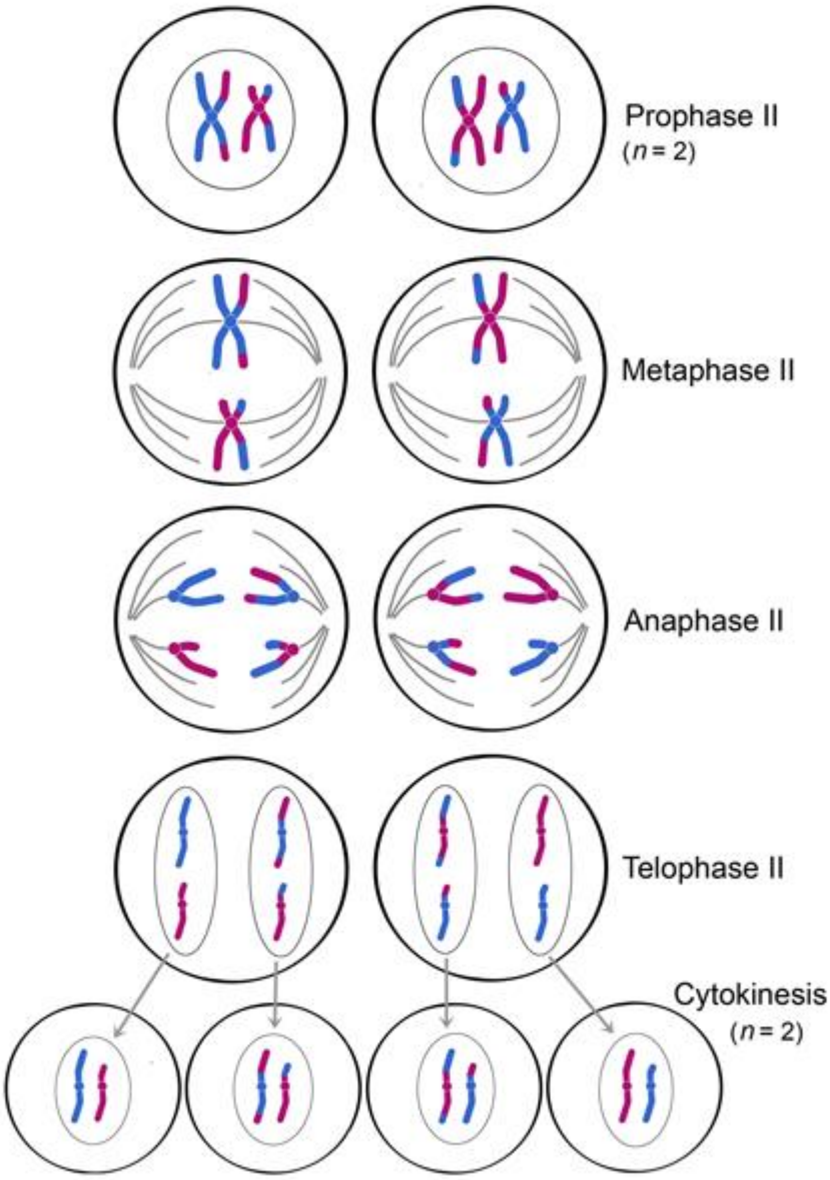


Figure 111: Meiosis

- Purpose: Meiosis is a specialized form of cell division that occurs in germ cells (reproductive cells) and is involved in the formation of gametes (sperm and egg cells). The resulting cells have half the number of chromosomes as the parent cell.

- **Phases:**

Meiosis I

- Prophase I: Chromosomes condense, homologous chromosomes pair up in a process called synapsis, and genetic recombination (crossing over) occurs.
- Metaphase I: Homologous chromosome pairs align at the metaphase plate.
- Anaphase I: Homologous chromosomes separate and move to opposite poles of the cell.
- Telophase I: The cell divides, forming two cells, each with a haploid set of chromosomes.

Meiosis II

- Prophase II: Chromosomes condense again.
- Metaphase II: Chromosomes align at the metaphase plate.
- Anaphase II: Sister chromatids separate and move to opposite poles.
- Telophase II: The cell divides again, resulting in four haploid daughter cells, each with a unique combination of genetic material.

Mitosis ensures that each new cell receives an identical set of chromosomes, while meiosis reduces the chromosome number by half, leading to genetic diversity in offspring.

In Activity 4.1, you will explore the process of cell division

Activity 4.1: Exploring the process of cell division

Key question: How does cell division occur?

What you need: a note book, a pen

What to do

1. Figure 4.1 and Figure 4.2 illustrate two processes. Use them to complete the table below.

		Process A	**Process B**
Stage I	Number of plates		
	Number of buns		
Stage II	Number of plates		
	Number of buns		
Stage III	Number of plates		
	Number of buns		

Stage IV	Number of plates		
	Number of buns		

2. Between stages I and II, describe what happens to the

I). The plate

ii). The buns

3. Between stage II and III, describe what happens to the

I). The plate

ii). The buns

4. What is the difference between the number of plates in the final stage of processes A and B.

5. Compare the number of buns per plate in the first and last stages of processes A and B.

6. Use the textbook/internet to find out what the buns and the plate represent.

7. What name is given to processes A and B.

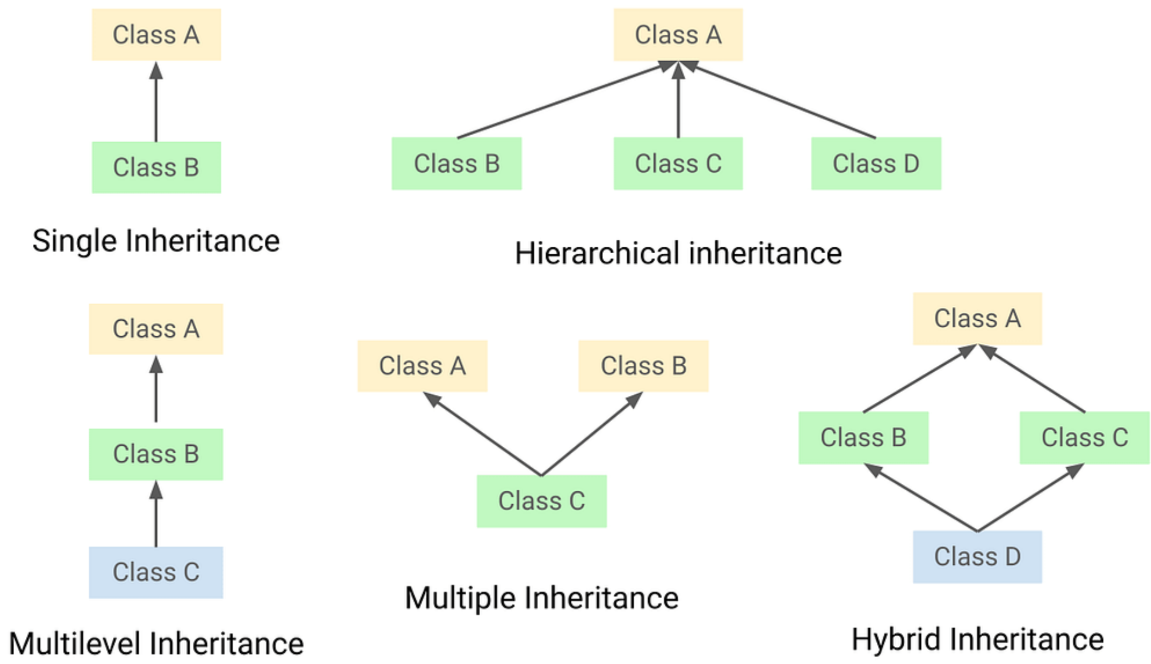
8. Write short notes describing processes A and B.

Share your work with the rest of the class.

From Activity 4.1, you have discovered that cell division involves production

of new cells from the existing cells. Mitosis is cell division that takes place in somatic cells. What is the importance of mitosis? Meiosis is cell division that takes place in germ cells.

4.2: Inheritance



As earlier said, characteristics (traits), are passed on from parents to off springs and this is known as inheritance. The study of how these characteristics or traits are passed on from one generation to the next is called heredity. The scientific study of heredity is called genetics.

Characteristics are passed on from parents to offspring through the transmission of genetic information, which is stored in the form of DNA (deoxyribonucleic acid).

The process by which genetic information is passed from one generation to the next is known as inheritance. The key mechanisms involved in this process are sexual reproduction and the role of genes.

A brief overview of how characteristics are inherited:

1. **Genes and DNA:**

- Genes are segments of DNA that contain instructions for building and maintaining an organism. They determine various traits or characteristics, such as eye color, height, and susceptibility to certain diseases.

2. **Chromosomes:**

- DNA is organized into structures called chromosomes. In humans, each cell typically has 46 chromosomes (23 pairs), with one set inherited from each parent. These chromosomes carry the genetic information that determines an individual's traits.

3. **Sexual Reproduction:**

- In sexually reproducing organisms, such as humans, the process of inheritance involves the combination of genetic material from two parents—male and female.

4. **Gametes (Egg and Sperm):**

- Specialized cells called gametes are involved in sexual reproduction. In humans, the male produces sperm cells, and the female produces egg cells. Each gamete contains half the usual number of chromosomes, or one set.

5. **Fertilization:**

- During fertilization, a sperm cell from the father fuses with an egg cell from the mother. This union forms a zygote, which contains the full complement of chromosomes (46 in humans) with genetic material from both parents.

6. **Genetic Diversity:**

- The combination of genetic material from both parents during fertilization results in genetic diversity among offspring. While offspring inherit genetic material from their parents, the specific combination of genes may lead to unique combinations of traits.

7. **Dominance and Recessiveness**

- Some traits are determined by dominant and recessive alleles of genes. Dominant alleles mask the effects of recessive alleles. The combination of alleles inherited from both parents determines the expression of specific traits in the offspring.

8. **Mendelian Inheritance:**

- The principles of inheritance were first described by Gregor Mendel and are known as Mendelian inheritance. These principles include the segregation of alleles during gamete formation and the independent assortment of genes on different chromosomes.

In summary, the transmission of characteristics from parents to offspring occurs through the inheritance of genetic material. This process involves the combination of genes from both parents during sexual reproduction, leading to the genetic diversity observed in populations. The principles of genetics, including Mendelian inheritance, help explain how specific traits are passed from one generation to the next.

In Activity 4.3, you will discover how characteristics are inherited.

Did you know? This knowledge of genetics was first studied by a scientist called **Gregory Mendel** 1822-1884.

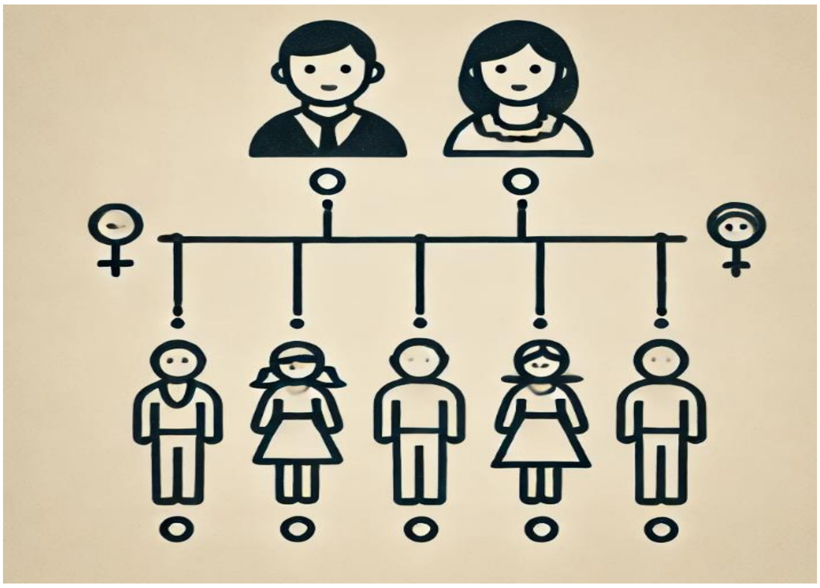
Activity 4.3: Exploring how characteristics are inherited

Key question: How are characteristics passed on from parents to off springs?

What you need: Reference materials, a notebook and a pen.

What to do:

1. The figure below shows how characteristics are inherited. Study it and;



I) Identify the similarities between the parents and the children?

ii) Identify the differences between the parents and children?

iii) From your finding, explain how offspring acquire particular characteristics

Share your work with other groups

Genetic Diagrams

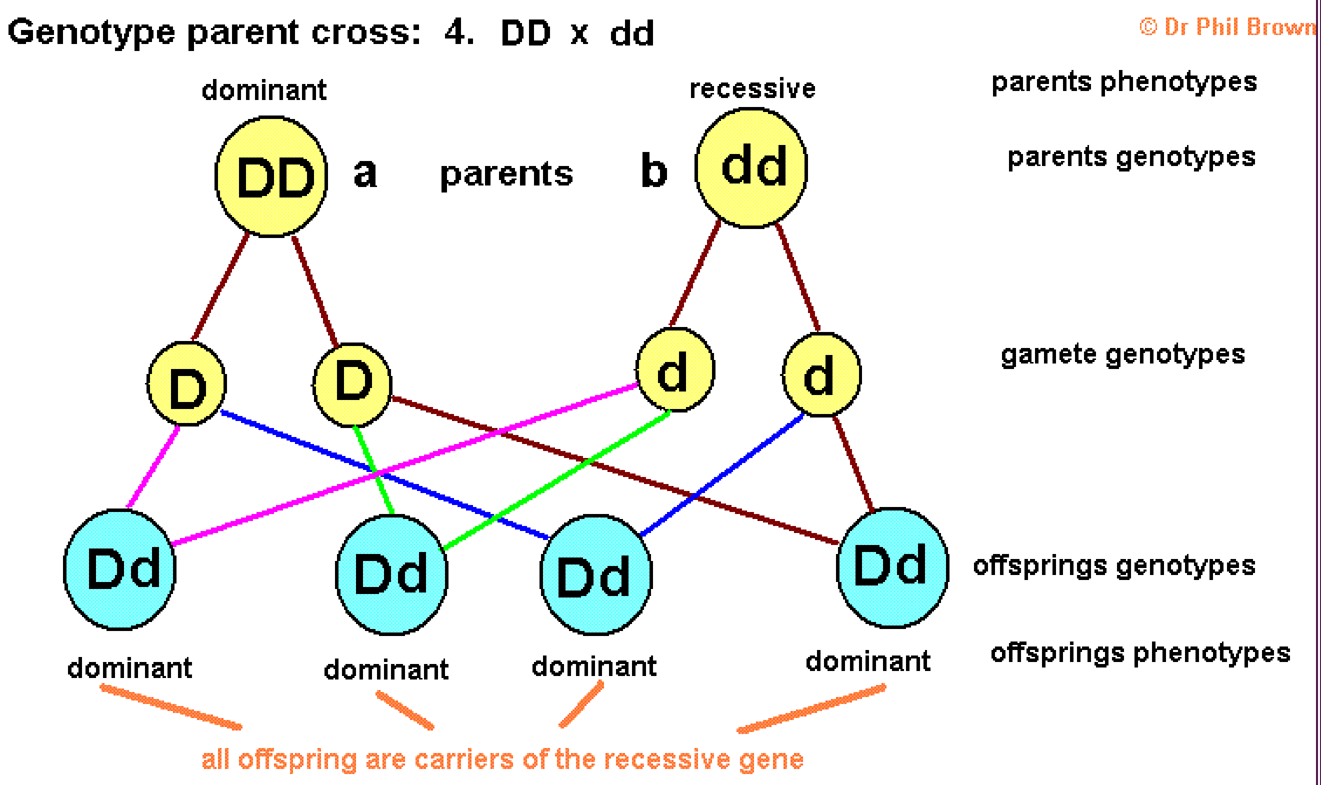


Figure 112: Genetic Diagram

It is important that you understand how characteristics are passed on from one generation to another.

In Activity 4.4, you will discover how this can be easily illustrated using genetic crosses or diagrams. This will help you to get a clear understanding of how these traits are passed on from one generation to another and be able to explain why off springs have similarities to their parents.

Genetics is the branch of biology that studies heredity, the passing of traits from parents to offspring. It encompasses the study of genes, which are segments of DNA that encode the instructions for building and maintaining living organisms.

The field of genetics explores the mechanisms by which traits are inherited, the variation that occurs in populations, and the role of genes in shaping the characteristics of organisms.

Key concepts and terms related to genetics include

1. **DNA (Deoxyribonucleic Acid)**

- DNA is the molecule that carries genetic information in cells. It is composed of two long strands forming a double helix and contains the genetic code in the form of nucleotide sequences.

2. **Genes:**

- Genes are functional units of DNA that provide instructions for the synthesis of proteins or, in some cases, functional RNA molecules. Genes determine the traits and characteristics of an organism.

3. **Chromosomes:**

- Chromosomes are structures made up of DNA and proteins. They are located in the cell nucleus and carry the genetic information. Humans typically have 46 chromosomes (23 pairs).

4. **Genome:**

- The genome refers to the complete set of genetic material (DNA) in an organism. It includes all the genes and non-coding regions of DNA.

5. Allele:

- An allele is one of the alternative forms of a gene that occupies a specific position on a chromosome. Alleles can be different versions of a gene, and individuals inherit two alleles for each gene (one from each parent).

6. Phenotype:

- Phenotype refers to the observable physical or biochemical characteristics of an organism, resulting from the interaction of its genotype with the environment. It is what you can see or measure, such as eye color, height.

7. Genotype:

- Genotype is the genetic makeup of an organism, representing the combination of alleles at specific gene loci. It provides the instructions for the development and functioning of an organism.

8. Dominant allele

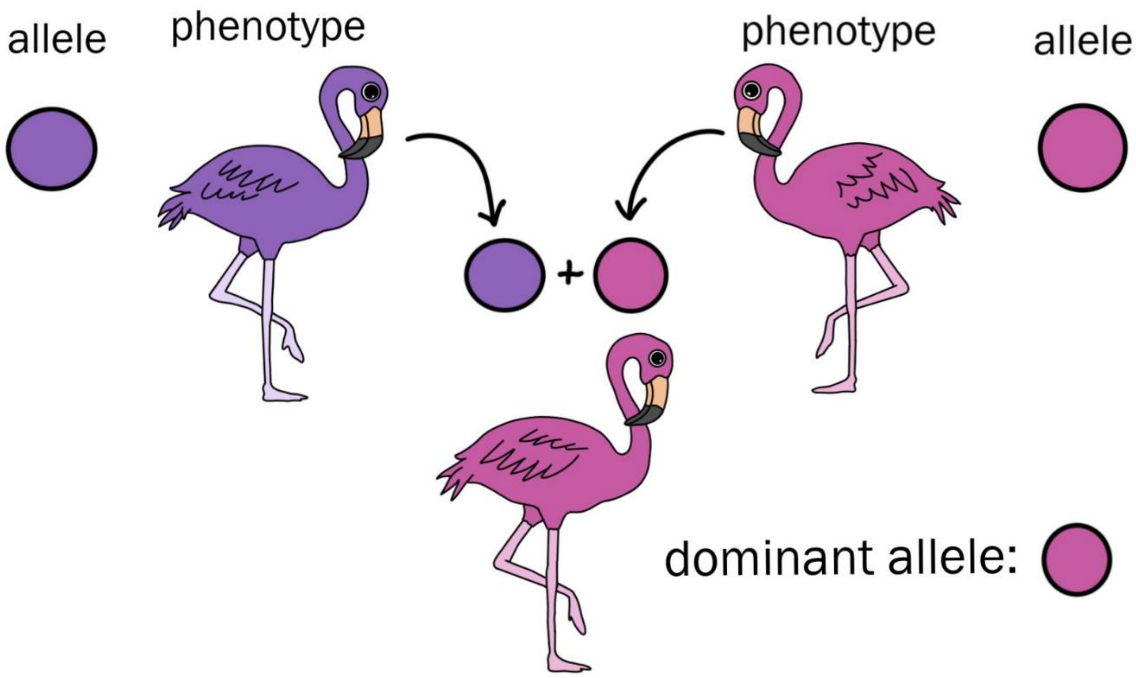


Figure 113: Structure of dominant allele

- Dominant refers to an allele that, when present, is expressed in the phenotype, masking the effect of the corresponding recessive allele. In genetic notation, dominant alleles are often represented by uppercase letters (e.g., B).

9. Recessive allele:

- Recessive refers to an allele whose phenotypic expression is masked by the presence of a dominant allele. Recessive traits are only expressed when an individual is homozygous recessive. Recessive alleles are often represented by lowercase letters (e.g., b).

10. **Mendelian Inheritance**

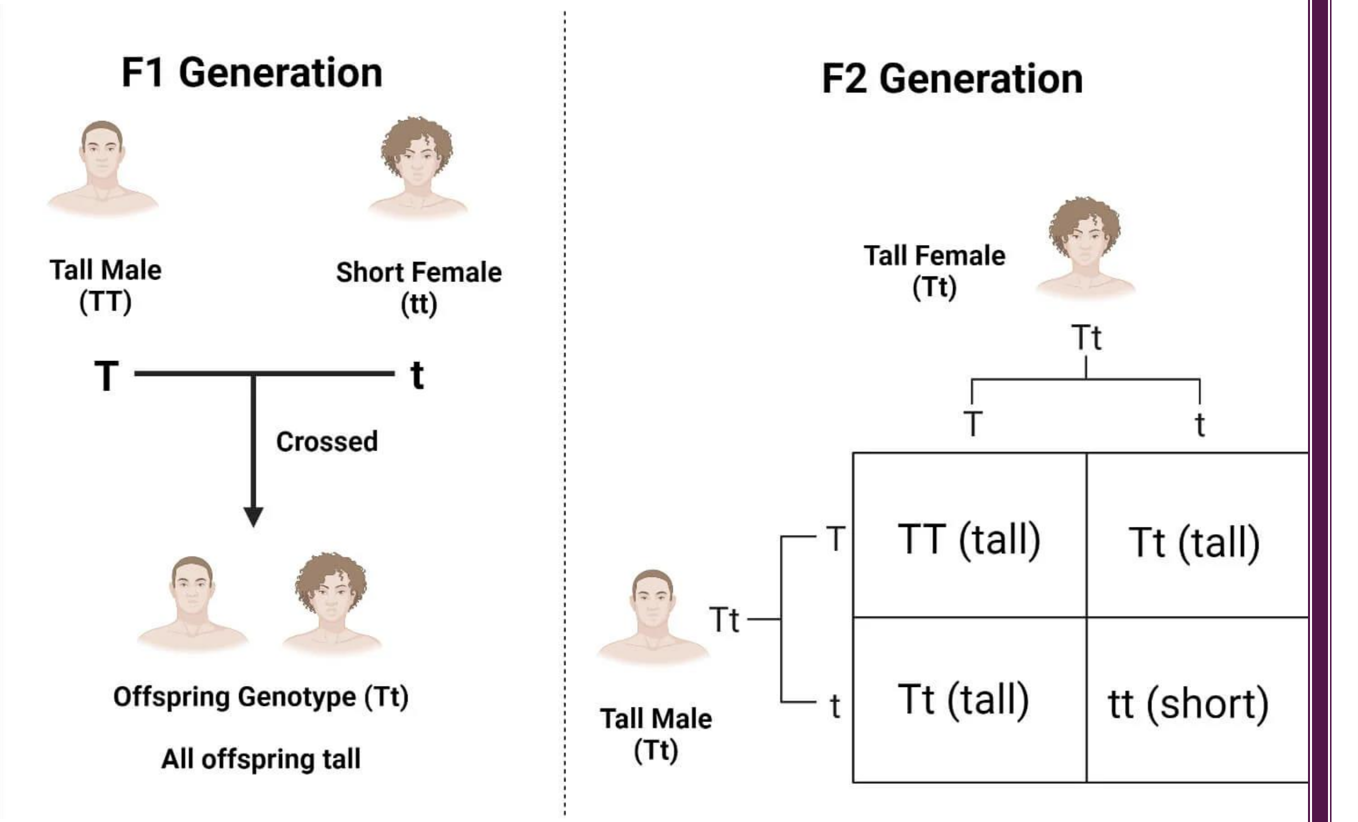


Figure 114: Mendelian Inheritance

- Gregor Mendel's laws of inheritance describe the principles governing the transmission of traits from one generation to the next. These include the law of segregation and the law of independent assortment.

11. **Genetic Variation**

- Genetic variation arises from mutations, genetic recombination during sexual reproduction, and other mechanisms. It is the basis for diversity within populations.

12. **Genetic Disorders**

- Genetic disorders result from abnormalities in an individual's genetic material. They can be caused by mutations, chromosomal abnormalities, or a combination of genetic and environmental factors.

13. **Homozygous**

- Homozygous refers to an individual that has identical alleles for a particular gene on both homologous chromosomes.
- Example: If an individual has two identical alleles for the gene determining eye color (e.g., two alleles for brown eyes), that individual is said to be homozygous for that trait. Homozygous genotypes are represented by identical letters, such as "BB" for two dominant alleles or "bb" for two recessive alleles.

14. Heterozygous

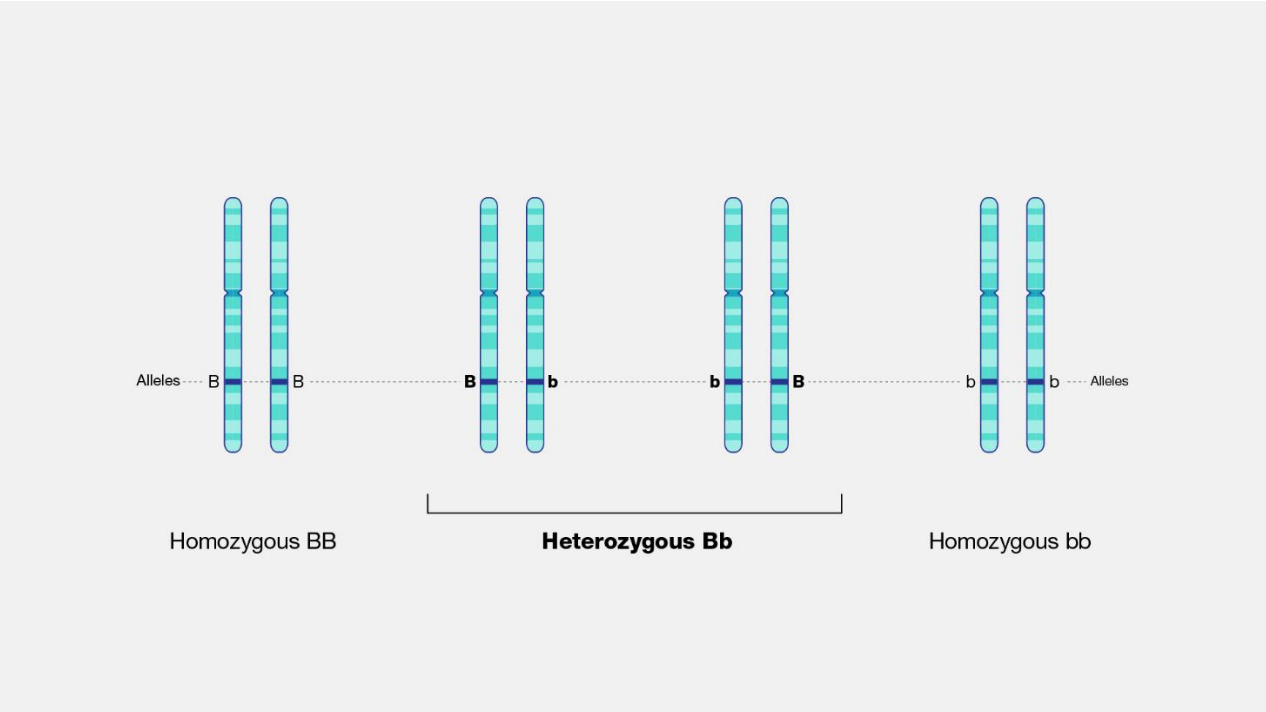


Figure 115: Heterozygous

- Heterozygous refers to an individual that has different alleles for a particular gene on the homologous chromosomes.
- Example: If an individual has one allele for brown eyes and one allele for blue eyes at the gene determining eye color, that individual is said to be heterozygous for that trait. Heterozygous genotypes are represented by different letters, such as "Bb."

In terms of genetic notation, uppercase letters often represent dominant alleles, and lowercase letters represent recessive alleles. For example, if "B" represents the allele for brown eyes (dominant) and "b" represents the allele for blue eyes (recessive), then:

- "BB" would be a homozygous dominant genotype.
- "bb" would be a homozygous recessive genotype.
- "Bb" would be a heterozygous genotype.

The distinction between homozygous and heterozygous is important in understanding how traits are inherited. In cases where a dominant allele masks the expression of a recessive allele, the presence of at least one dominant allele (homozygous dominant or heterozygous) results in the dominant phenotype. The recessive phenotype is only expressed when an individual is homozygous recessive. This concept is known as Mendelian inheritance, named after Gregor Mendel, who laid the foundation for the understanding of genetic principles.

In a nutshell:

- Alleles are gene variants.
- Genotype is the genetic makeup.
- Phenotype is the observable trait.
- Homozygous has identical alleles.
- Heterozygous has different alleles.

- Dominant alleles determine the phenotype in the presence of a recessive allele.
- Recessive alleles are expressed only in the absence of a dominant allele.

Genetic diagrams, also known as Punnett squares, are a useful tool for illustrating the process of inheritance and predicting the potential outcomes of crosses between individuals with known genotypes. Let's use a simple example of eye color inheritance to create Punnett squares for different scenarios.

Example: Eye Color Inheritance

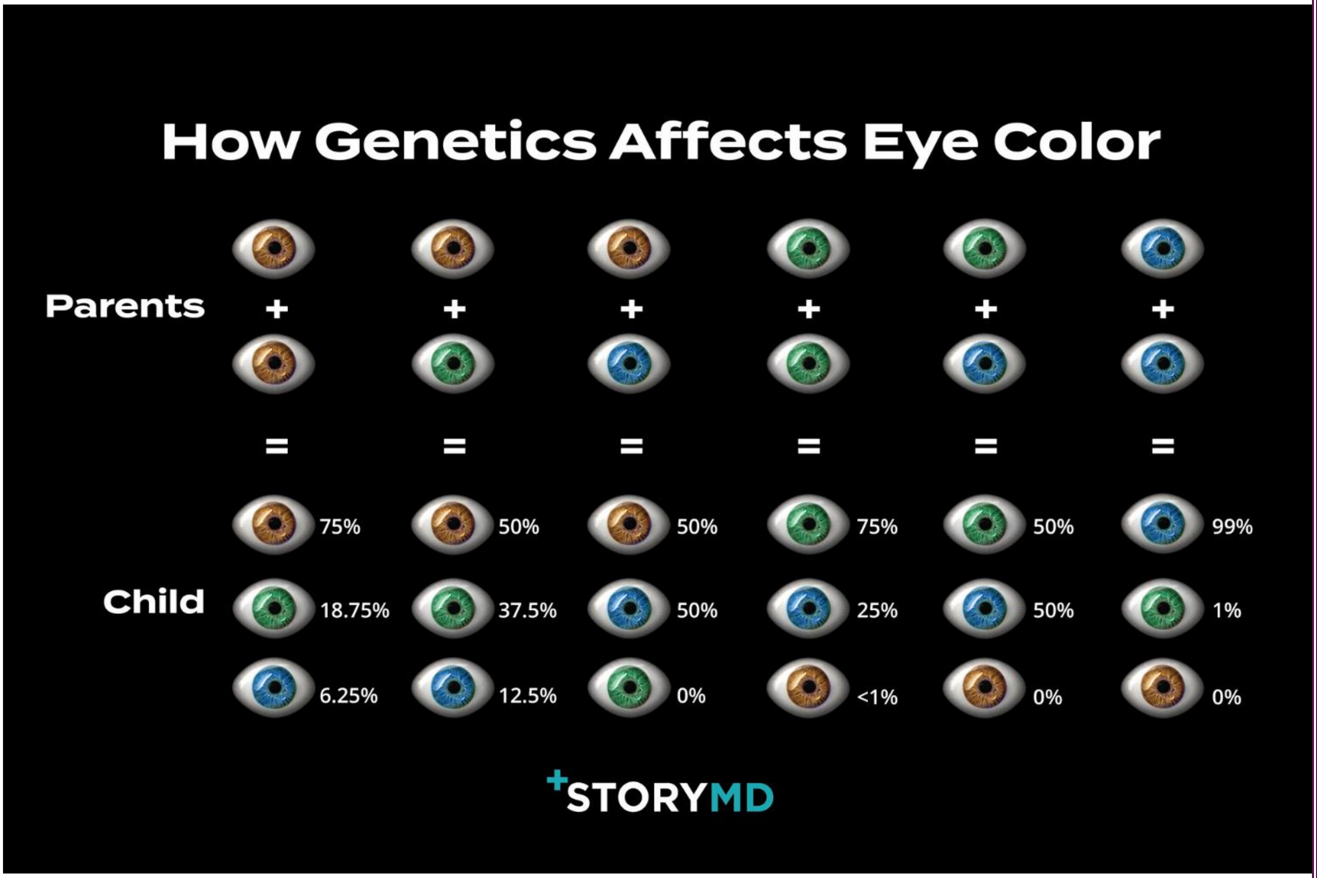


Figure 116: Eye Color Inheritance

Let B represent the allele for brown eyes

Let b represent the allele for blue eyes

1. **Scenario 1: Homozygous Dominant x Homozygous Recessive Cross**

- Parent 1 (Father): Homozygous Dominant (BB)
- Parent 2 (Mother): Homozygous Recessive (bb)

	B	**B**
b	Bb	Bb

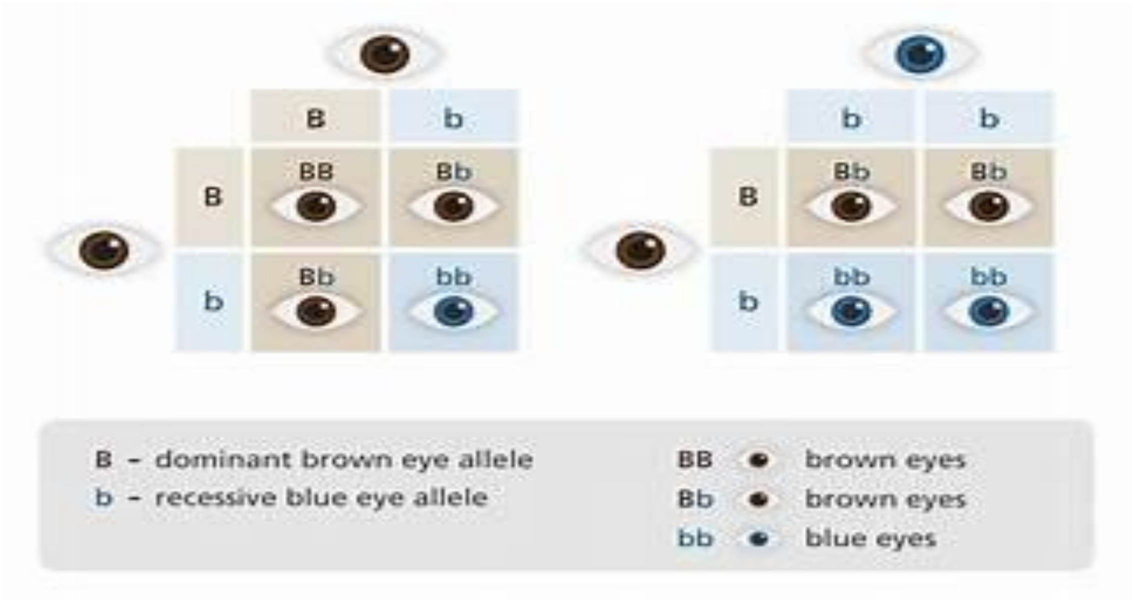
All offspring (100%) in this scenario will have the heterozygous genotype (Bb) and will express the dominant trait (brown eyes).

2. **Scenario 2: Heterozygous x Heterozygous Cross**

- Parent 1: Heterozygous (Bb)
- Parent 2: Heterozygous (Bb)

	B	**b**
B	BB	Bb
b	Bb	bb

In this scenario, there is a 25% chance of homozygous dominant (BB), a 50% chance of heterozygous (Bb), and a 25% chance of homozygous recessive (bb). The phenotypic ratio is 3:1 for brown eyes to blue eyes.



3. **Scenario 3: Heterozygous x Homozygous Recessive Cross**

- Parent 1: Heterozygous (Bb)
- Parent 2: Homozygous Recessive (bb)

	B	**b**
b	Bb	bb
b	Bb	bb

In this scenario, there is 50% chance of Heterozygous (Bb) and a 50% chance of Homozygous recessive (bb)

These examples demonstrate how Punnett squares can be used to predict the possible genotypes and phenotypes of offspring based on the genetic makeup of the parents. The ratios obtained from these crosses represent the probabilities of different genetic outcomes.

Using genetic crosses;

Example: Height of pea plants

Let T represent the allele for tallness

Let t represent the allele for dwarfness

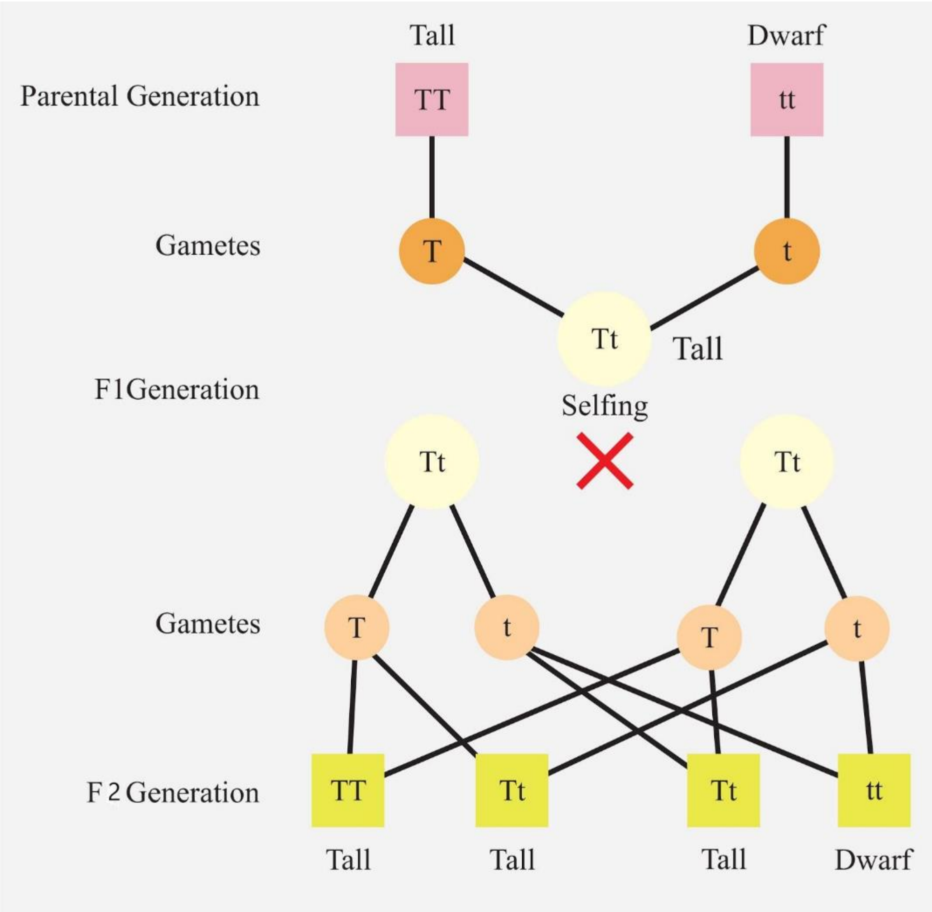


Figure 117: Monohybrid cross (height of pea plants)

In rabbits, long ears(L) are dominant over short ears (l). Show the genotypes and phenotypes for the offspring of a cross between two rabbits whose genotypes are (LL) and (ll).

Solution 1:

Parents Genotypes	***LL***	***x***	***ll***
	↓		↓
Genotypes of Gametes	***L***	***x***	***l***
F_1 Genotype of Offspring		***Ll***	
F_1 Phenotype of offspring	***All long ears***		

Activity 4.4: (a) Understanding the meaning of the terms used in genetics

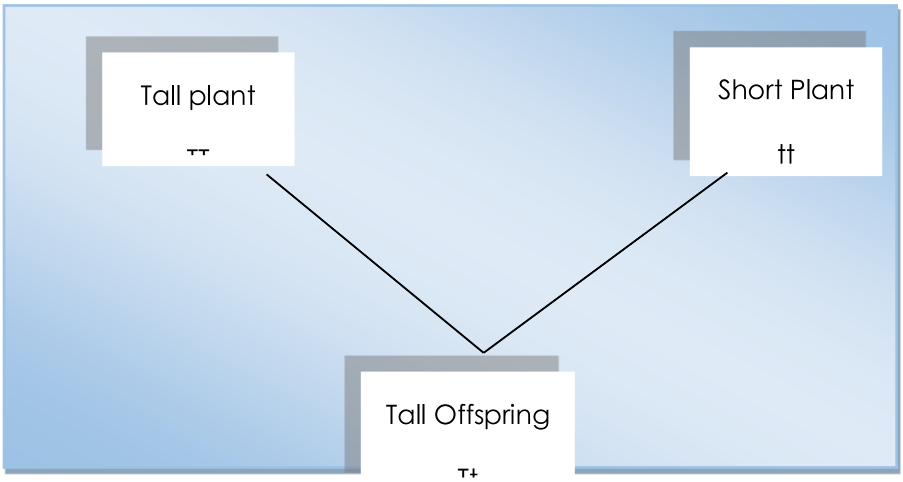
Key question: What is meaning of each of the terms used in genetics?

What you need: Reference materials, a note book and a pen.

What to do:

1. Research and discuss about the meanings of the terms; allele, phenotype, genotype, heterozygous, homozygous, dominant and recessive.

2. Study the figure below:



3. Which of the components of the figure above represent the following?

   i) Allele

   ii) Heterozygous

   iii) Recessive

   iv) Phenotype

   v) Genotype

   vi) Homozygous

   vii) Dominant

4. What type of cell division is responsible for the formation of gametes?

Activity 4.4: (b) Using genetic diagrams/crosses to illustrate the process of inheritance

Key question: How can the process of inheritance be illustrated using

genetic diagrams?

What you need: Reference materials, the Internet, a note book, a pen

What to do

1. In rabbits the trait/characteristic for fur color is represented using letter B. Black fur is dominant over grey fur.

Figure 118: Rabbits

I) Write the letter of the dominant allele.

ii) Write the letter of the recessive allele.

iii) Write the homozygous dominant genotype (2 alleles).

iv) Write the heterozygous genotype (2 alleles).

v) Write the homozygous recessive genotype.

vi) Write the genotype for grey fur.

vii) Write the genotype for Black fur

viii) Write the phenotype for iii) (above)

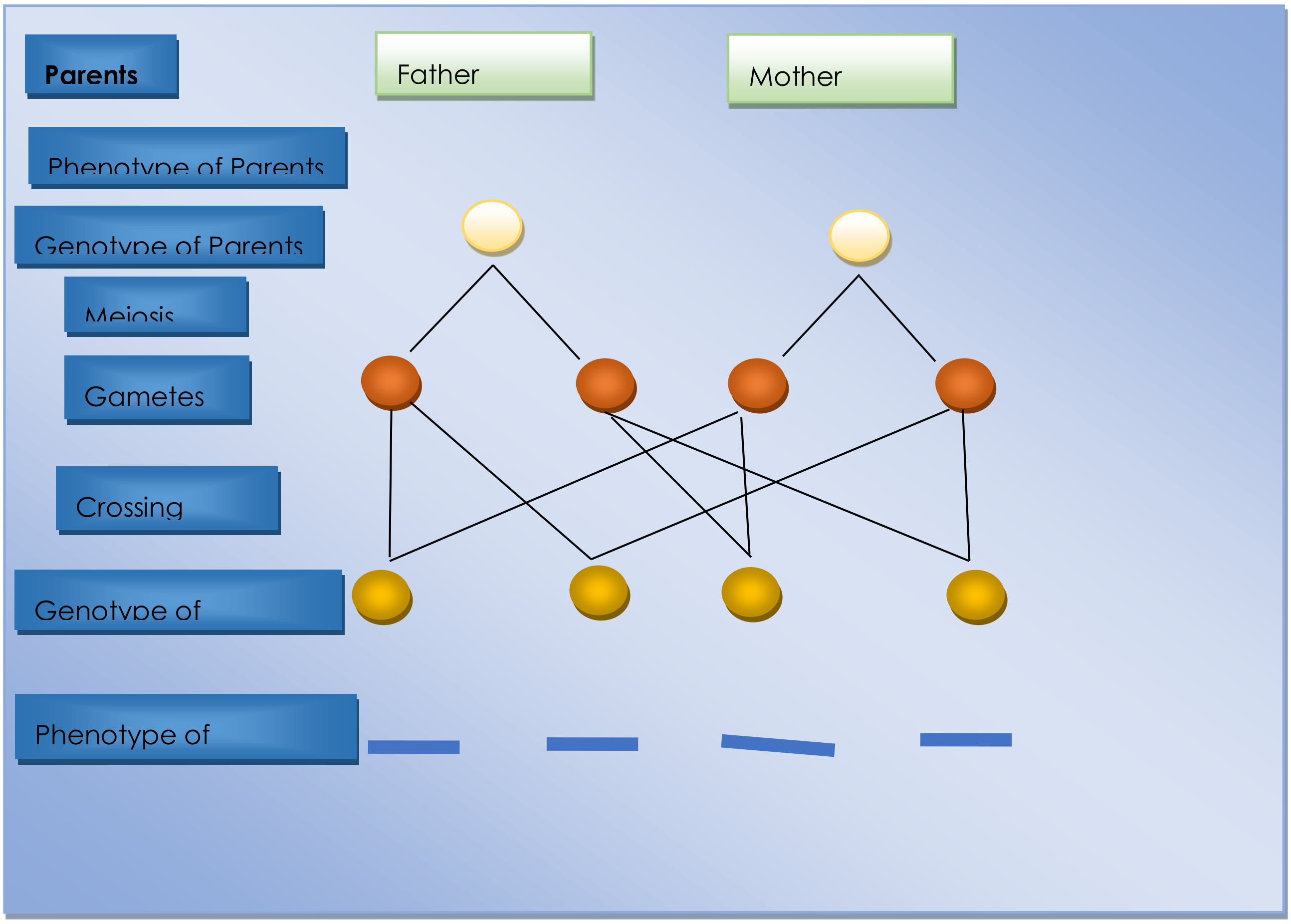
ix)Write the phenotype for iv) (above)

x) Write the phenotype for v) (above)

2. Complete the possible genetic crosses in the cases below.

Case I - If the male rabbit is homozygous dominant and the female rabbit is homozygous recessive.

Case II-If both rabbits are heterozygous.



4.3: Incomplete Dominance and Co-dominance

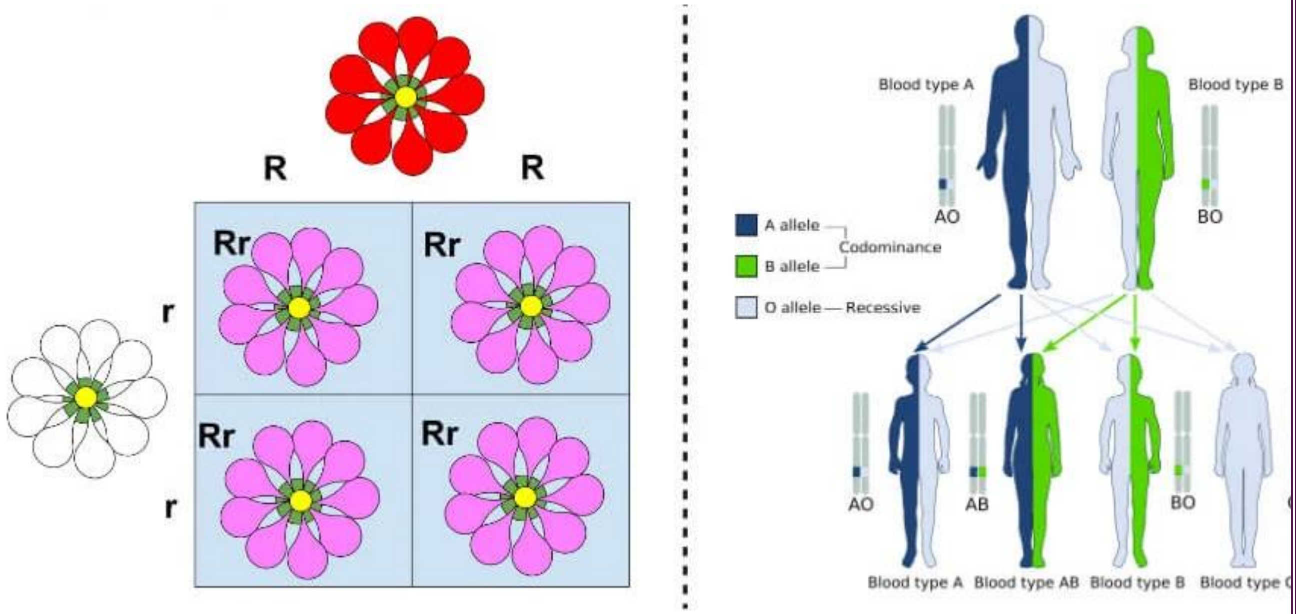


Figure 119: Incomplete Dominance and Co-dominance

1. **Incomplete Dominance**

- In incomplete dominance, neither allele is completely dominant over the other, and the heterozygous phenotype is an intermediate or blending of the two homozygous phenotypes.
- Example: A classic example is the flower color in snapdragons. If a red-flowered plant (RR) is crossed with a white-flowered plant (WW), the heterozygous offspring (RW) will have pink flowers—a blend of the red and white colors.

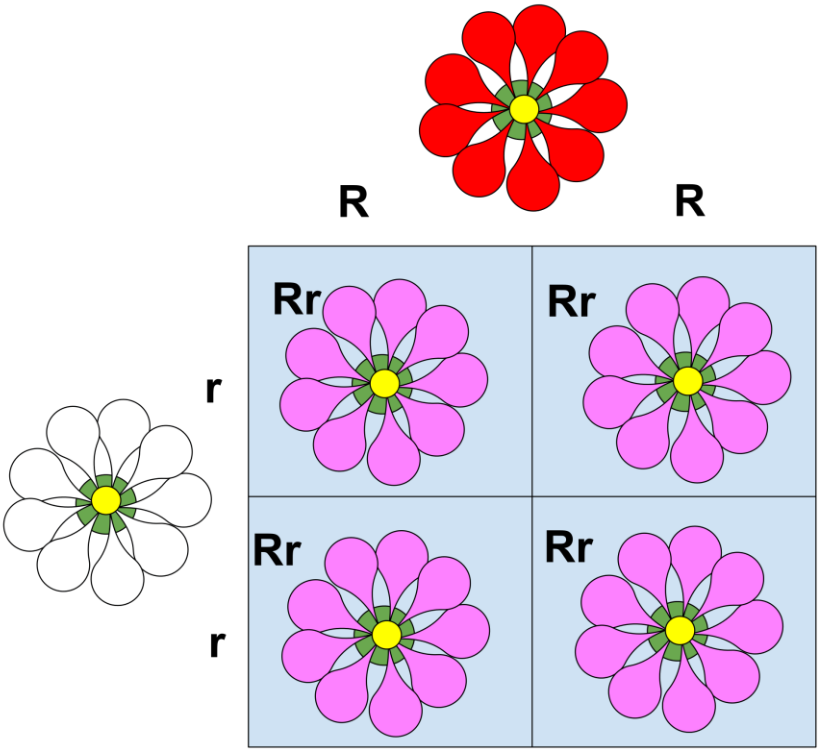


Figure 120: Incomplete Dominance

Genotypic and Phenotypic Ratios:

- RR (red): 1/4
- WW (white): 1/4
- RW (pink): ½

2. **Co-dominance**

- In co-dominance, both alleles in a heterozygous genotype are fully expressed, and neither is dominant or recessive. This results in a phenotype that shows the contribution of both alleles.

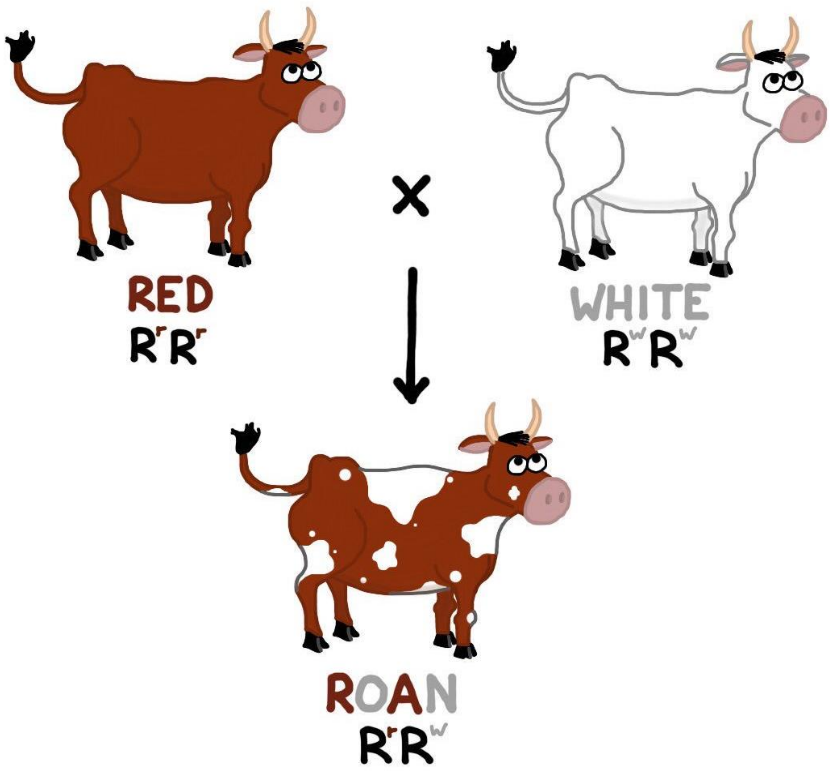


Figure 121: Co-dominance structure

- Example: A classic example is the ABO blood group system in humans. The alleles for blood type are A, B, and O. If an individual has an AO genotype, they will express both A and O blood types. Similarly, an individual with an AB genotype will express both A and B blood types.

Blood type	Genotype	
A	I^A, I^O	AO
	I^A, I^A	AA
B	I^B, I^O	BO
	I^B, I^B	BB
AB	I^A, I^B	AB
O	I^O I^O	OO

- Genotypic and Phenotypic Ratios:
- AA (Type A): 1/4
- BB (Type B): 1/4
- AO (Type A): 1/4
- BO (Type B): 1/4

Activity 4.5: Understanding incomplete dominance and co-dominance

Do this activity in a group?

Key question: What is incomplete dominance and co-dominance?

What you need: Reference materials about incomplete dominance and co- dominance, the Internet

What to do:

1. Research and write down the meaning and at least two examples of traits representing;

l) Incomplete dominance

ii) Codominance

2. Describe how one of the traits identified in each case is inherited.

Share your work with the whole class.

Self-study: How is the knowledge of inheritance important to you as an individual and asses its significance to society.

4.4: Sex Determination in Humans

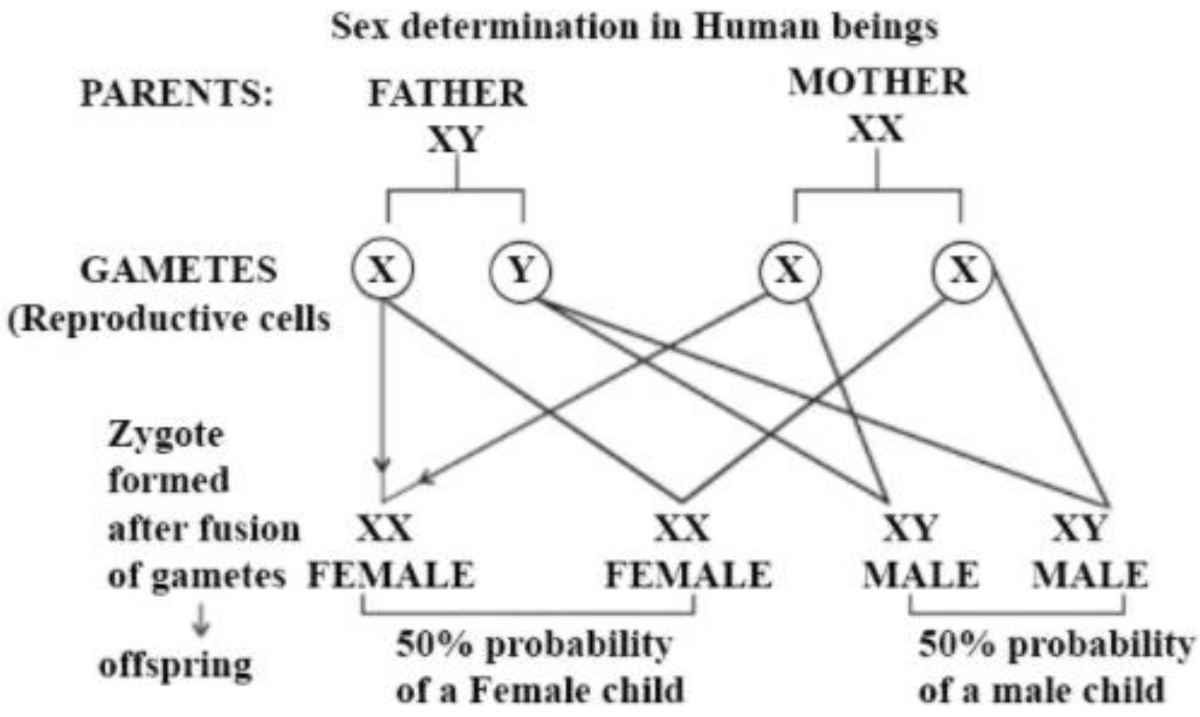


Figure 122: Sex determination in human beings

In humans, sex determination is based on the combination of sex chromosomes inherited from the parents. The two sex chromosomes are designated as X and Y, and they determine an individual's biological sex. The combination of these sex chromosomes determines whether an individual will develop as male (XY) or female (XX).

The process of sex determination in humans can be summarized as follows:

1. **Contribution of Sex Chromosomes**

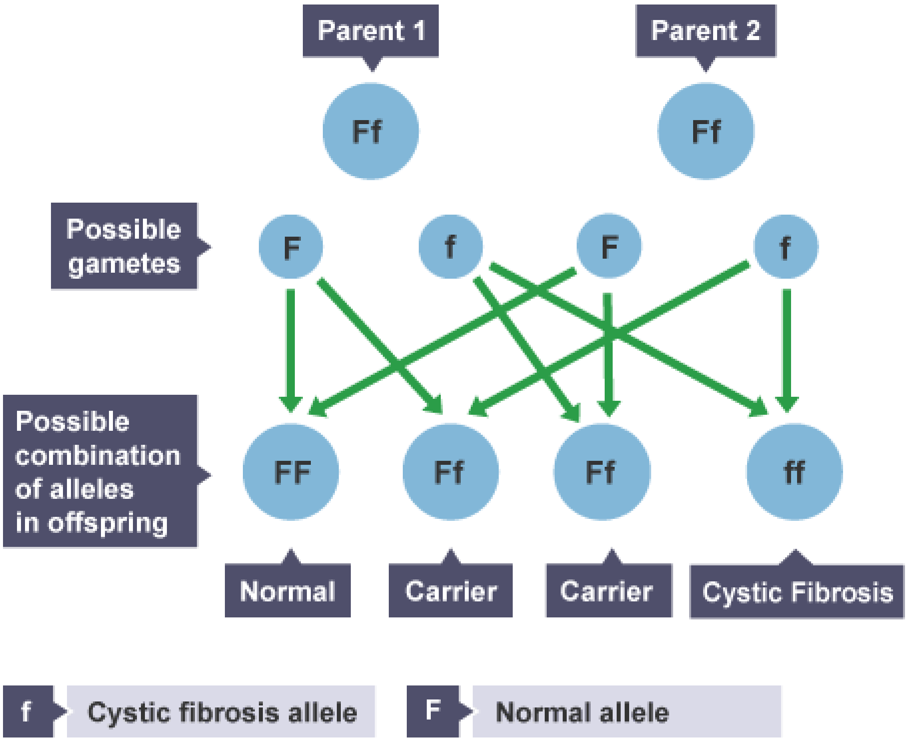


Figure 123: sex determination in humans

- Each parent contributes one sex chromosome to the offspring during fertilization.
- Females have two X chromosomes (XX), and males have one X and one Y chromosome (XY).

2. **Fertilization:**

- During fertilization, a sperm cell from the father (which carries either an X or a Y chromosome) fuses with an egg cell from the mother (which always carries an X chromosome).

3. **Combinations and Sex of Offspring**

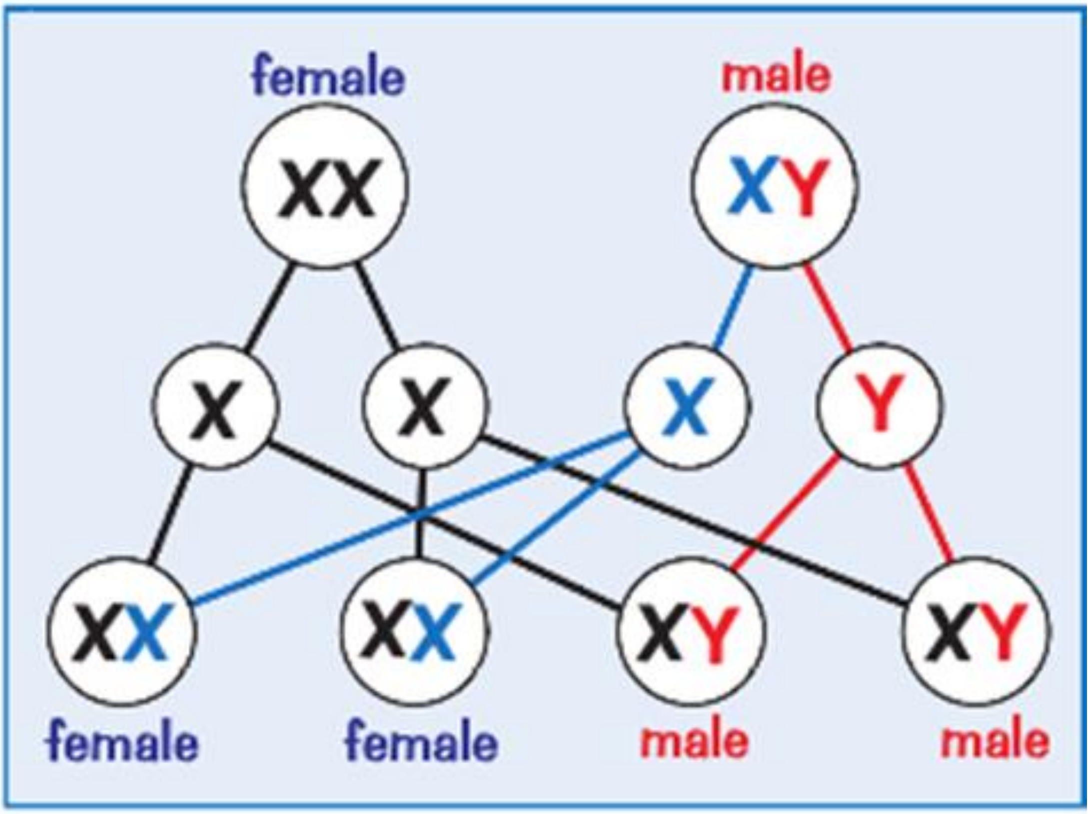


Figure 124: Combinations and Sex of Offspring

- If a sperm carrying an X chromosome fertilizes an egg (X), the resulting zygote will have the XX chromosome combination, and the individual will be female (XX).
- If a sperm carrying a Y chromosome fertilizes an egg (X), the resulting zgote will have the XY chromosome combination, and the individual will be male (XY).

4. **Role of SRY Gene**

- The presence of the Y chromosome carries a critical gene called the SRY (Sex-determining Region Y) gene. This gene triggers the development of male characteristics, such as the formation of testes.

5. **Hormonal and Developmental Pathways**

- In individuals with the XX chromosome combination, the absence of the SRY gene leads to the development of ovaries and the female reproductive system.
- In individuals with the XY chromosome combination, the presence of the SRY gene initiates the development of testes and the male reproductive system.

6. **Hormonal Influences During Development:**

- The testes and ovaries produce hormones that influence the development of secondary sexual characteristics during puberty. Testosterone, produced by the testes, promotes the development of male secondary sex characteristics.

In Activity 4.7, you will discuss how an individual becomes either male.

Activity 4.6: Explaining how sex is determined in humans

Do this activity in a group

Key question: How is sex determined in humans?

What you need: Reference materials about sex determination in humans, a note book and a pen.

What to do

1. Discuss why some people are male and others are female.

2. Using reference materials and/ or the Internet, research about the genotype of males and females in terms of the X and Y chromosomes. What have you discovered?

3. Research and give a detailed description of how sex is determined in humans. Illustrate this using a suitable genetic cross.

4. From your genetic cross, what is the probability that you are either male or female.

5. Which parent determines the sex of the offspring? Why is this so?

Share your work with the other groups.

4.5: Sex Linkage

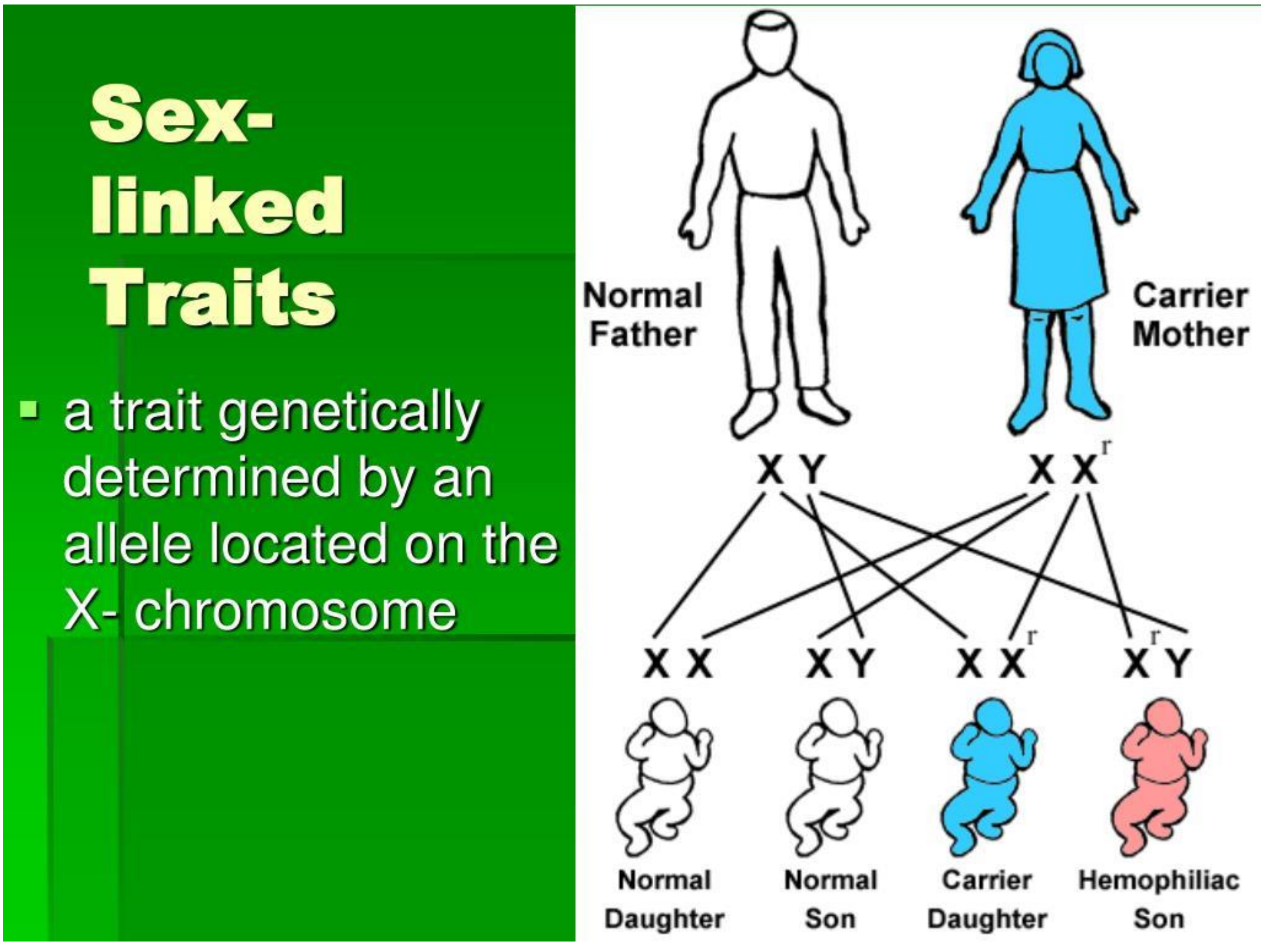


Figure 125: Sex Linkage

Linkage is a situation where genes responsible for different traits are located on the same chromosome and are therefore transmitted/ inherited together. What is sex linkage?

Sex linked traits are determined by genes located on the sex chromosomes and are therefore transmitted together with sex. These traits are more evident in males than in females because they are normally determined by recessive alleles which are only located on the X chromosomes and can only be phenotypically expressed in females in a homozygous condition showing that both parents had the recessive allele.

Sex-linked traits are associated with the genes located on the sex chromosomes (X and Y chromosomes). The most well-known sex-linked traits are found on the X chromosome, as it is larger and carries a greater number of genes. The Y chromosome has fewer genes, and Y-linked traits are relatively rare. Here are examples of sex-linked traits associated with the X and Y chromosomes:

X-Linked Traits

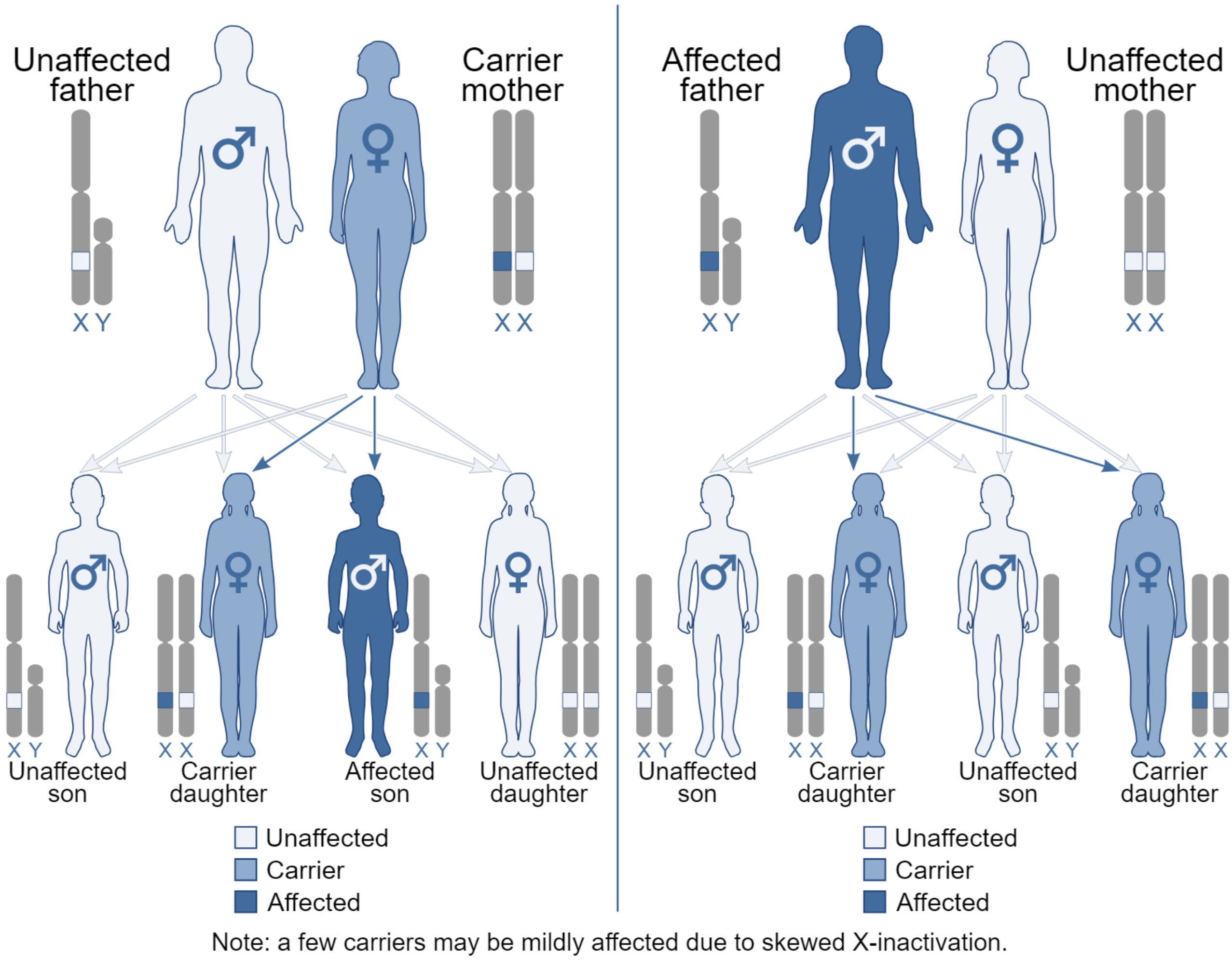


Figure 126: X-linked recessive

1. **Color Blindness:**

- Type: X-Linked Recessive
- Description: The inability to perceive certain colors. The most common form is red-green color blindness.
- Inheritance: Typically affects males more frequently than females. Females can be carriers if they inherit one copy of the recessive allele.

2. **Hemophilia**

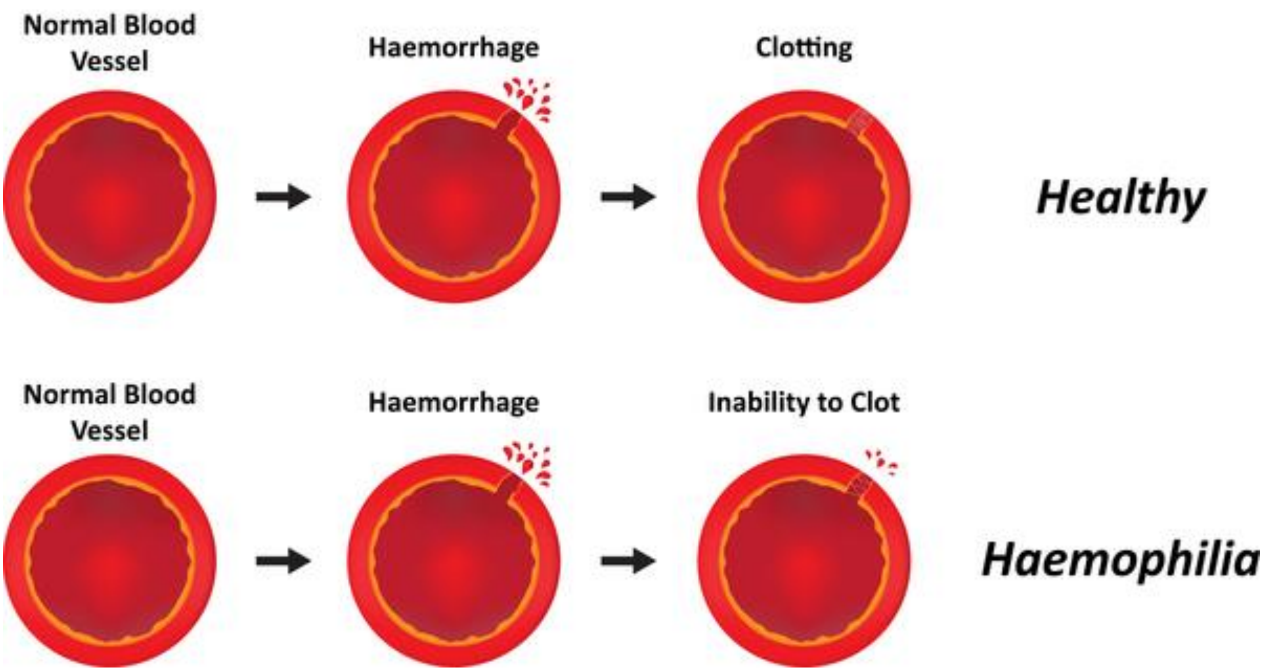


Figure 127: Hemophilia

- Type: X-Linked Recessive
- Description: A disorder where the blood lacks clotting factors, leading to difficulty in blood clotting.

- Inheritance: Primarily affects males. Females can be carriers and may show mild symptoms if they inherit the recessive allele from both parents.

Y-Linked Trait

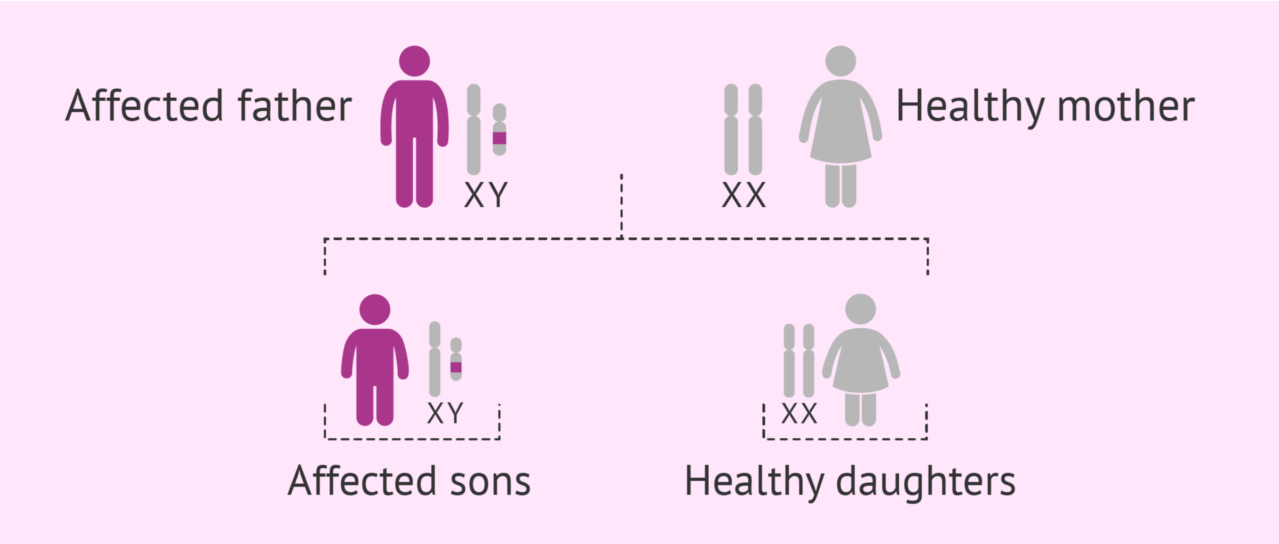


Figure 128: Y-Linked Trait

1. **SRY Gene (Sex-determining Region Y):**

- Type: Y-Linked
- Description: The SRY gene determines maleness in humans by initiating the development of testes, which produce male hormones.
- Inheritance: Passed directly from father to son. Females do not inherit the Y chromosome.

In activity 4.8, you will discover the meaning and explain sex linkage in humans. This will help you get an understanding of traits and disorders which are sex linked.

Activity 4.7: Exploring sex linkage in humans

Do this activity in a pair

Key question: What is sex linkage?

What you need: Reference materials, the Internet.

What to do:

1. Research and discuss about the meaning of sex linkage and how it occurs.

2. Find out the examples of sex-linked traits associated with the X and Y

chromosomes.

3. Carryout a genetic cross to show the transmission of one of the traits you have identified.

4. Discuss why males may be more prone to these disorders than females.

Present your work to the whole class for discussion

Sample Activity of Integration

People always wonder why sometimes some children resemble/ take up characteristics of one of their parents while the others don't. Some believe that when people stay together for long, they start to resemble each other while other people oppose it. There is also a belief that failure to produce a boy is the mother's fault. Some of these issues have caused conflicts in families.

Task: As a genetic, write a newspaper article to clear these confusions.

Chapter summary

In this chapter, you have learned that:

- Cell division is the process through which cells increase in number
- Inheritance is the process through which characteristics are passed on from parents to off springs.
- In complete dominance, both alleles are phenotypically expressed in the offsprings whereas in 'incomplete' dominance, the two alleles result into formation of the third phenotype that does not look like either of the parents
- In humans, sex is determined by X and Y sex chromosomes

Chapter 5: Variation and Selection

Key words

- Natural selection
- Variation
- Artificial selection
- Mutation
- Evolution

- Sickle cell anemia
- Albinism

Learning outcomes

By the end of this chapter, you will 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 anemia, 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

BIBLICAL INTEGRATION

"For we are God's handiwork, created in Christ Jesus to do good works, which God prepared in advance for us to do." - Ephesians 2:10. This verse reminds us that just as each of us is uniquely created with purpose, the variations in nature are part of a divine design, contributing to the diversity and resilience of life.

Through the study of variation and selection, we gain insights into the intricate processes that drive evolution and adaptation. Ephesians 2:10 encourages us to recognize the

purposeful design in the diversity around us, reinforcing the value of each unique characteristic in the tapestry of life.

Introduction

You have interacted with different humans and other organisms of the same species. You must have noticed that these organisms never exactly resemble although they possess similar basic characteristics to enable them breed and produce viable offspring. Look at your siblings, do you exactly resemble in all aspects? Which differences can you site?

Within the individuals from a particular region there are differences in their skin color and other features. Some individuals differ right from birth. In other cases, differences develop at a later stage as people interact with different environments. What could be the cause of these differences?

In simple terms, height, skin colour and other genetic characteristics are said to vary. The word "vary" comes the word "variation" which is used to mean differences that exist among organisms of the same species.

In this chapter, you will understand that variation is as a result of differences in the genetic make-up of an organism but can also be associated with the environment and that it can lead to evolution of new species over time.

5.1: Factors that Cause Variation

Variation for example in sex and color is associated with different factors. These variations can be used to group organisms, Sex, for example is used to determine whether an organism is male or female.

Variation in individuals within a population is a fundamental aspect of biology and is influenced by both genetic and environmental factors.

Factors that contribute to variation

1. **Genetic Variation**

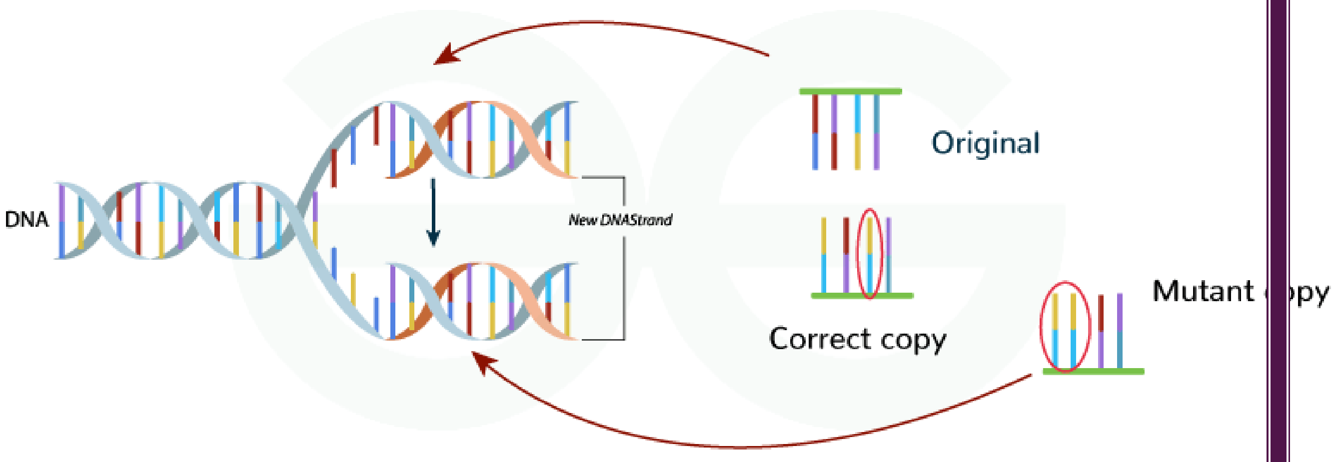


Figure 129: genetic variation

- Mutation: Changes in the DNA sequence can occur spontaneously during replication or due to external factors (e.g., radiation, chemicals). Mutations introduce new genetic variations.

- Recombination: During sexual reproduction, genetic material is shuffled between homologous chromosomes, leading to unique combinations of genes in offspring.

2. **Environmental Factors**

- Nutrition: Variation in access to nutrients during development can influence growth, body size, and overall health.
- Exposure to Toxins: Environmental toxins, pollutants, or chemicals can impact an individual's health and contribute to variation.
- Temperature and Climate: Environmental conditions, such as temperature and climate, can influence the development and adaptation of organisms.

3. **Epigenetic Factors**

- Epigenetics: Epigenetic modifications, such as DNA methylation and histone modification, can influence gene expression without changing the underlying DNA sequence. These modifications can be influenced by environmental factors and affect how genes are turned on or off.

4. **Random Processes**

- Genetic Drift: In small populations, random changes in allele frequencies can occur due to chance rather than natural selection.

- Gene Flow: The movement of genes between populations through migration can introduce new alleles and contribute to variation.

5. **Sexual Reproduction**

- Crossing Over: During meiosis, homologous chromosomes exchange genetic material through crossing over, contributing to genetic diversity.
- Independent Assortment: During meiosis, different combinations of alleles segregate independently, leading to a variety of possible genetic combinations in offspring.

6. **Cultural Practices**

- Human Cultural Practices: Human populations exhibit cultural diversity, including practices related to diet, lifestyle, and social behaviors, which can contribute to variations in health and adaptation.

7. **Adaptation**

- Natural Selection: Variations that confer a selective advantage in a given environment are more likely to be passed on to subsequent generations. Over time, this process leads to adaptations to specific ecological niches.

8. **Random Events**

- Founder Effect: When a small group of individuals establishes a new population, the allele frequencies may be different from the original population due to chance.
- Bottleneck Effect: A drastic reduction in population size can result in a loss of genetic diversity due to random survival of certain individuals.

In Activity 5.1, you will understand the genetic and environmental factors that bring about variation in organisms of the same species and the different types of variations. This will help you to appreciate why organisms differ from each other.

Activity 5.1: Exploring causes of variation

Do this activity in a group

What you need: Reference materials about causes variation; the Internet

What to do:

1. Discuss the meaning of variation.
2. Carefully study the picture below and.

Figure 130: variation

I) Note the variations among the organisms in the picture.

ii) Among the variations you have noted in I), which ones can you clearly use to group organisms into two groups and which type of variation is this?

iii) Apart from the variations noted, which other variations exist among the organisms?

iv) What do you think causes variations in different organisms?

Explain your responses.

Share your responses with the whole class.

5.2: Mutations

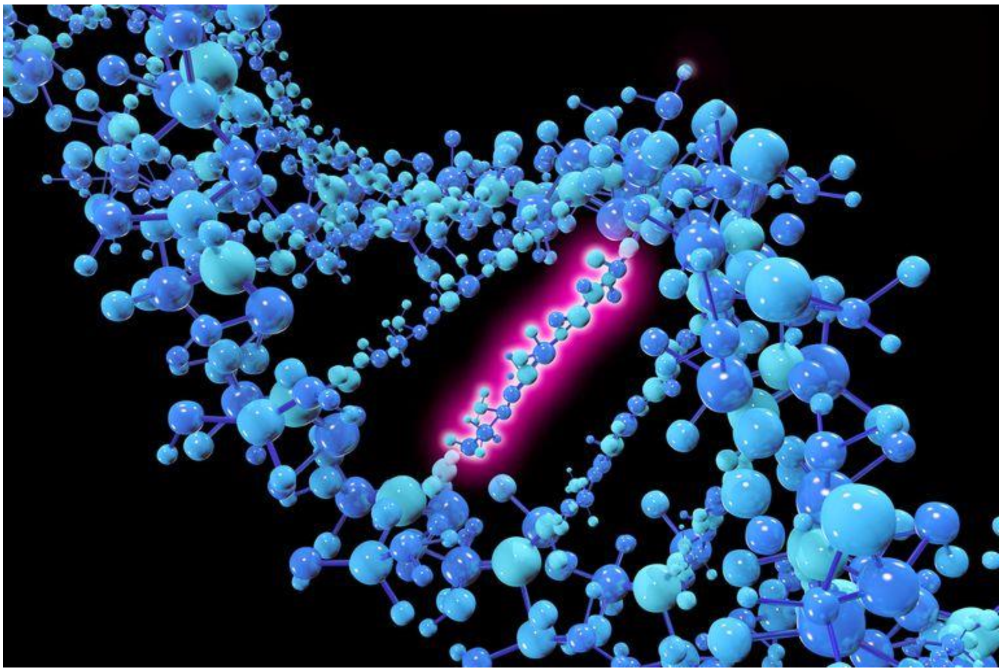


Figure 131: DNA Mutations

Sometimes it happens that new characteristics arise in the offspring which had never been witnessed in that lineage. In this case, a mutation is said to have occurred. Mutations are changes in the DNA sequence of an organism's genome. If this occurs in somatic cells, only part of the organism where the cell is located gets affected but if it occurs in the gametes, the entire offspring gets affected and the new characteristic/mutation is inherited. Mutations may occur by change in either gene structure or chromosome number or structure. Mutations can be beneficial, neutral or harmful.

Mutations can have a range of effects on organisms, and their impact can depend on the type of mutation, its location in the genome, and the specific genes involved.

1. **Beneficial Mutations**

Figure 132: Beneficial Mutations

- Beneficial mutations provide an advantage to the organism in a particular environment. They may lead to improved survival, reproduction, or adaptability to changing conditions.
- Examples of beneficial mutations include:
- Antibiotic Resistance: Some bacteria acquire mutations that confer resistance to antibiotics, allowing them to survive in the presence of these drugs.

- Pigmentation Adaptations: Mutations affecting pigmentation can be beneficial for camouflage or protection from harmful UV radiation.
- Drought Resistance: Plants with mutations that enhance their ability to tolerate drought conditions may have a survival advantage in arid environments.

2. **Neutral Mutations**

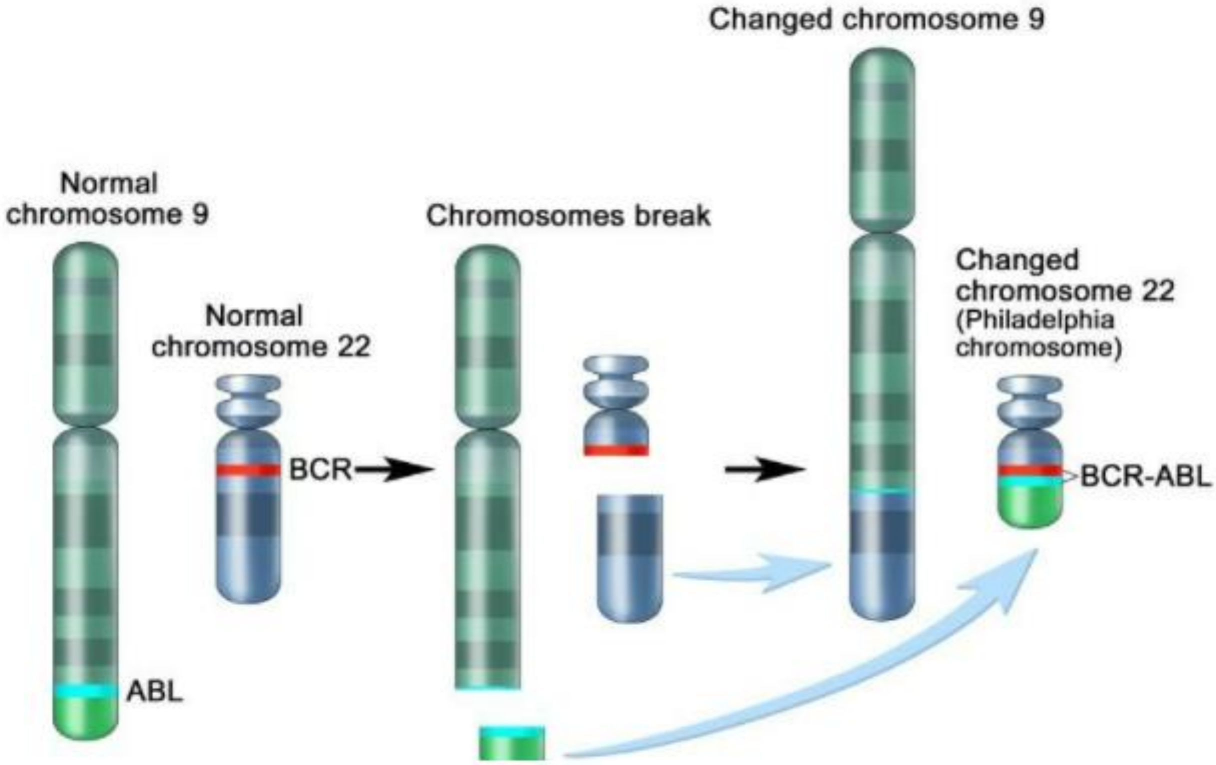


Figure 133: Neutral Mutations

- Neutral mutations have no discernible effect on an organism's phenotype or fitness. They may occur in non-coding regions of the genome or in coding regions where the amino acid sequence remains unchanged or doesn't affect protein function.

- Examples of neutral mutations include:
- Silent Mutations: Nucleotide changes that do not result in an amino acid change due to the redundancy of the genetic code.
- Intronic Mutations: Mutations in non-coding regions within genes that do not affect gene function.
- Synonymous Mutations: Nucleotide changes that result in a different codon but code for the same amino acid.

3. **Harmful or Deleterious Mutations**

- Harmful mutations have a negative impact on an organism's fitness and can lead to reduced survival or reproductive success.
- Examples of harmful mutations include:
- Loss-of-Function Mutations: Mutations that disrupt the normal function of a gene, leading to the loss of a beneficial protein or cellular process.
- Point Mutations in Essential Genes: Nucleotide changes in critical genes that result in non-functional or malfunctioning proteins eg for sickle cell anaemia, a point/ substitution mutation occurs.
- Frameshift Mutations: Insertions or deletions of nucleotides that shift the reading frame of a gene, often leading to premature stop codons and non-functional proteins.

It's important to recognize that the classification of a mutation as beneficial, neutral, or harmful depends on the specific context of the organism and its environment. What may be beneficial in one environment could be harmful in another. Additionally, the effects of mutations are subject to natural selection, which acts to increase the frequency of beneficial mutations and reduce the frequency of harmful mutations over evolutionary time.

Effect of mutation in a plant.

Figure 134: Example of mutation in plants

In Activity 5.2, you will discover that mutations have different effects in organisms which may be beneficial, harmful or neutral. This will enable you to be able to identify conditions caused by mutations and explain their effects.

Activity 5.2: Discovering the effects of mutations in organisms

Key question: What are the effects of mutation in organisms?

What you need: Reference materials about mutation, the Internet

What to do:

1. Research about mutations and;

l) Discuss its effects in organisms.

ii) Explain how mutations happen in organisms.

iii) Using examples, classify mutations as;

a) Neutral b) Harmful c) Beneficial

iv) What are the significances of each type of mutation classified above?

Present your findings to the whole class,

5.3: Genetic Disorders

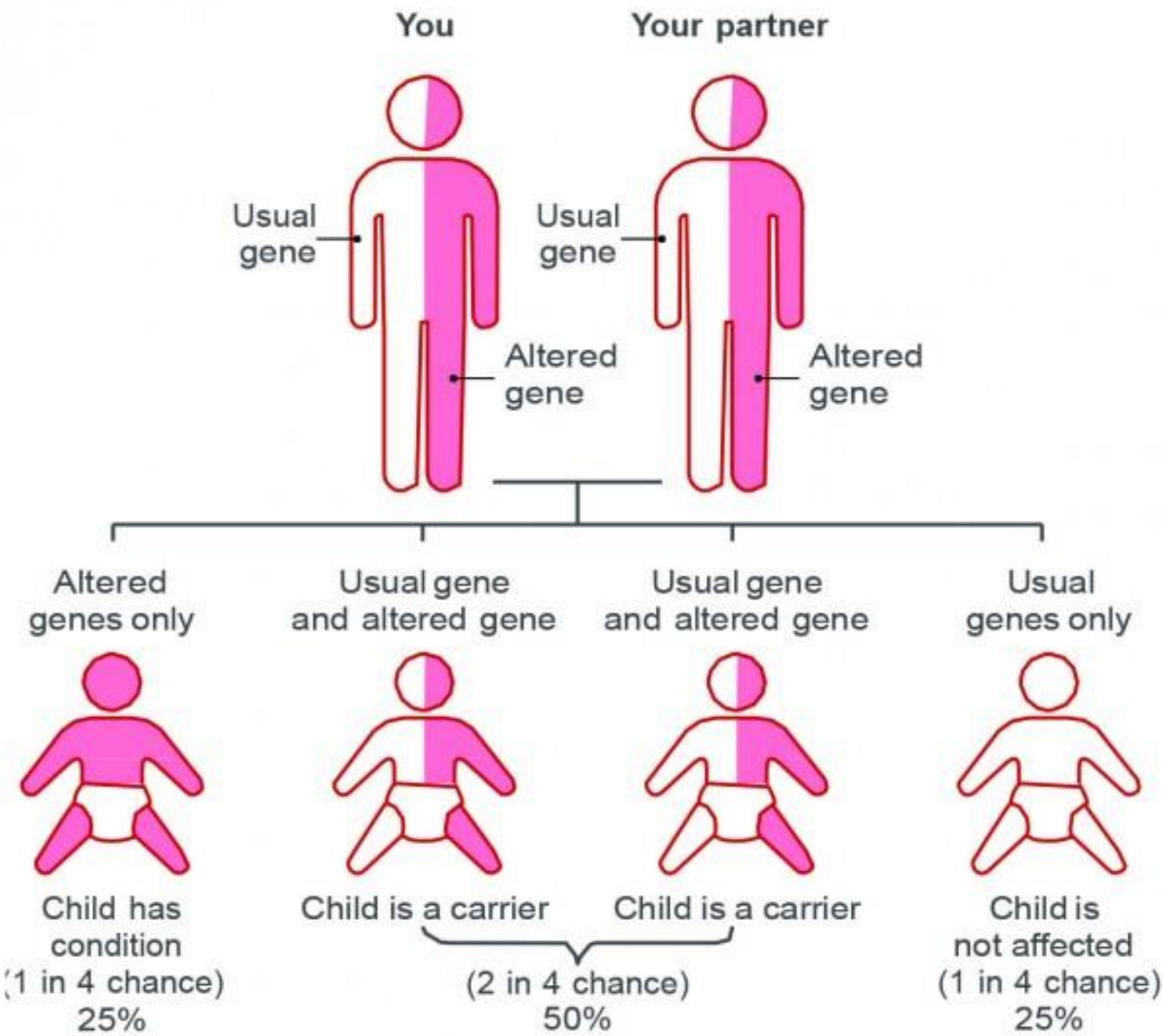


Figure 135: Genetic Disorders

Sometimes changes occur in the normal genetic set up of gametes and this results into genetic disorders. The changes may be as a result of mutations in the chromosomes where the sequence of genes is altered resulting into sometimes beneficial effects but usually the effects are harmful to organisms. Some disorders are as a result of gene mutations and may affect body cells. Many of these disorders result into diseases.

Figure 136: Genetic disorders in humans

In Uganda, as in many other countries, there are genetic disorders that are more prevalent due to various factors, including genetic diversity, consanguinity (marriage between close relatives), and historical population patterns. It's important to note that the prevalence of specific genetic disorders can vary within different regions of the country. Here are some genetic disorders that may be relatively common in Uganda:

1. **Sickle Cell Disease**

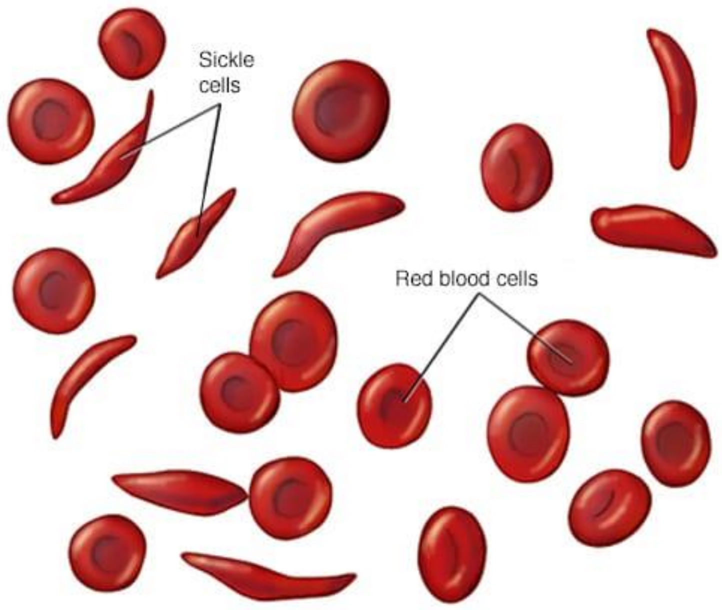


Figure 137: Sickle Cells

- Sickle cell disease is relatively common in Uganda, especially in populations where the sickle cell trait (carrying one copy of the abnormal hemoglobin gene) is prevalent. The disease is associated with misshaped red blood cells, leading to various health complications.

2. **Thalassemia**

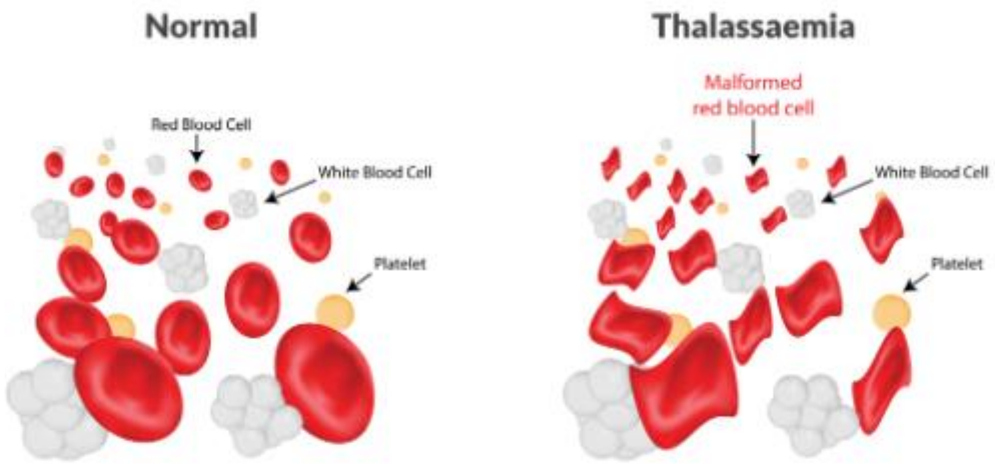


Figure 138: Thalassemia

- Thalassemia is another inherited blood disorder that can be more common in populations with a history of consanguinity. It involves abnormalities in the production of hemoglobin, leading to anaemia.

3. **Hemophilia**

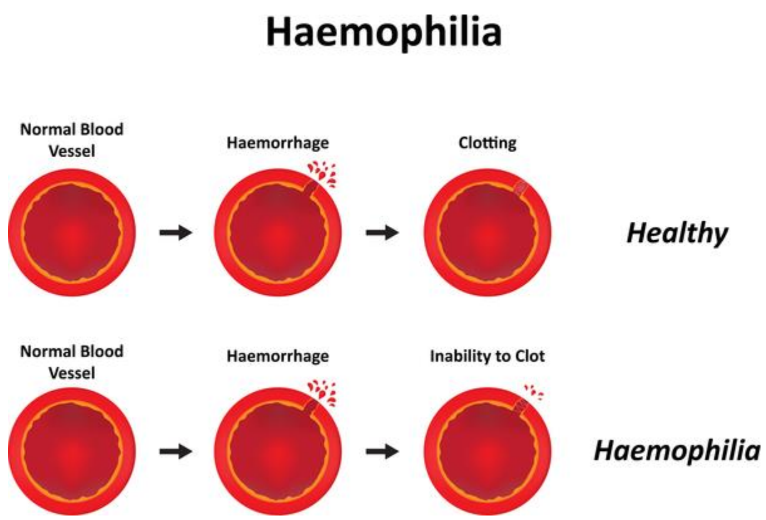


Figure 139: Hemophilia

- Hemophilia, a genetic disorder that impairs blood clotting, may be observed in Uganda. Hemophilia A and B are caused by deficiencies in clotting factors.

4. **Genetic Anaemia**

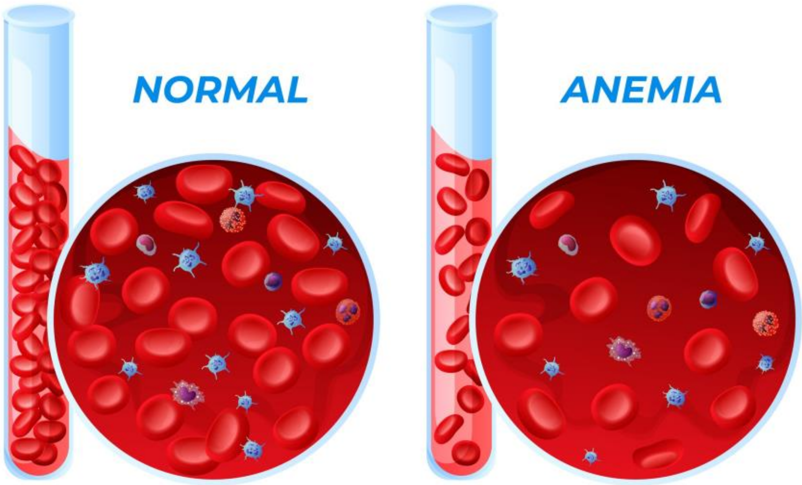


Figure 140: Genetic Anaemia Structure

- Various genetic anaemia, including those associated with deficiencies in hemoglobin synthesis or red blood cell structure, may be present.

5. **Albinism**

Figure 141: Albinism

- Albinism is a genetic condition characterized by a lack of pigment in the skin, hair, and eyes. Individuals with albinism may face unique health challenges, including sun sensitivity.

In Activity 5.3, you will understand the diseases associated with genetic disorders. This will help you to identify individuals with such conditions and explain how such conditions develop.

Activity 5.3: Identifying diseases associated with genetic disorders

Do this activity in a pair

Key question: What are the common diseases associated with genetic disorders?

What you need: Reference materials about genetic disorders, the Internet

What to do

1. Study Figure 5.4 and;

I) Note down any differences you have identified.

ii) Research and explain the differences noticed above and how they come about.

iii) What other genetic disorders do you know? Explain how they come about.

Present your findings to the whole class.

5.4: Natural Selection

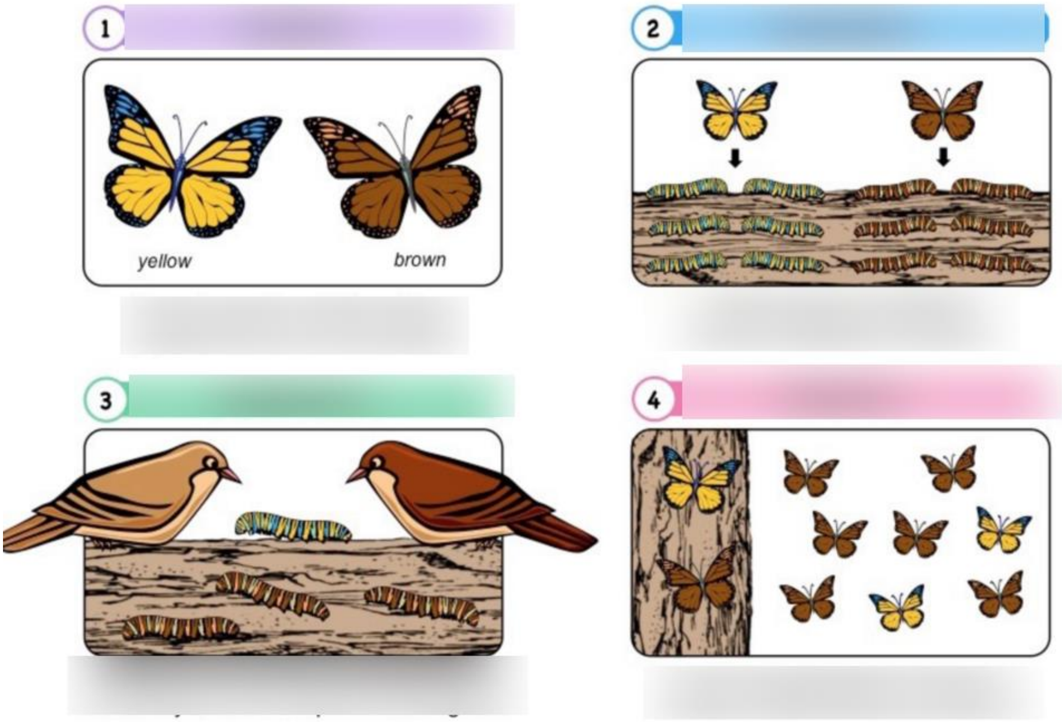


Figure 142: Natural Selection

As earlier seen, organisms of a given species usually have variations in their characteristics and are therefore differently adapted to survive in their environment. Those with favorable characteristics are able to survive reach adulthood and reproduce themselves. This way, they pass on their characteristics to the next generation.

Others are selected against by nature, they are out competed and may die before reproductive age and their genes are eliminated from nature.

Natural selection is a fundamental concept in evolutionary biology that explains how traits within a population change over time.

It is a process through which certain heritable traits become more or less common in a population based on their impact on the survival and reproduction of individuals. Natural selection is a key mechanism that drives the evolution of species.

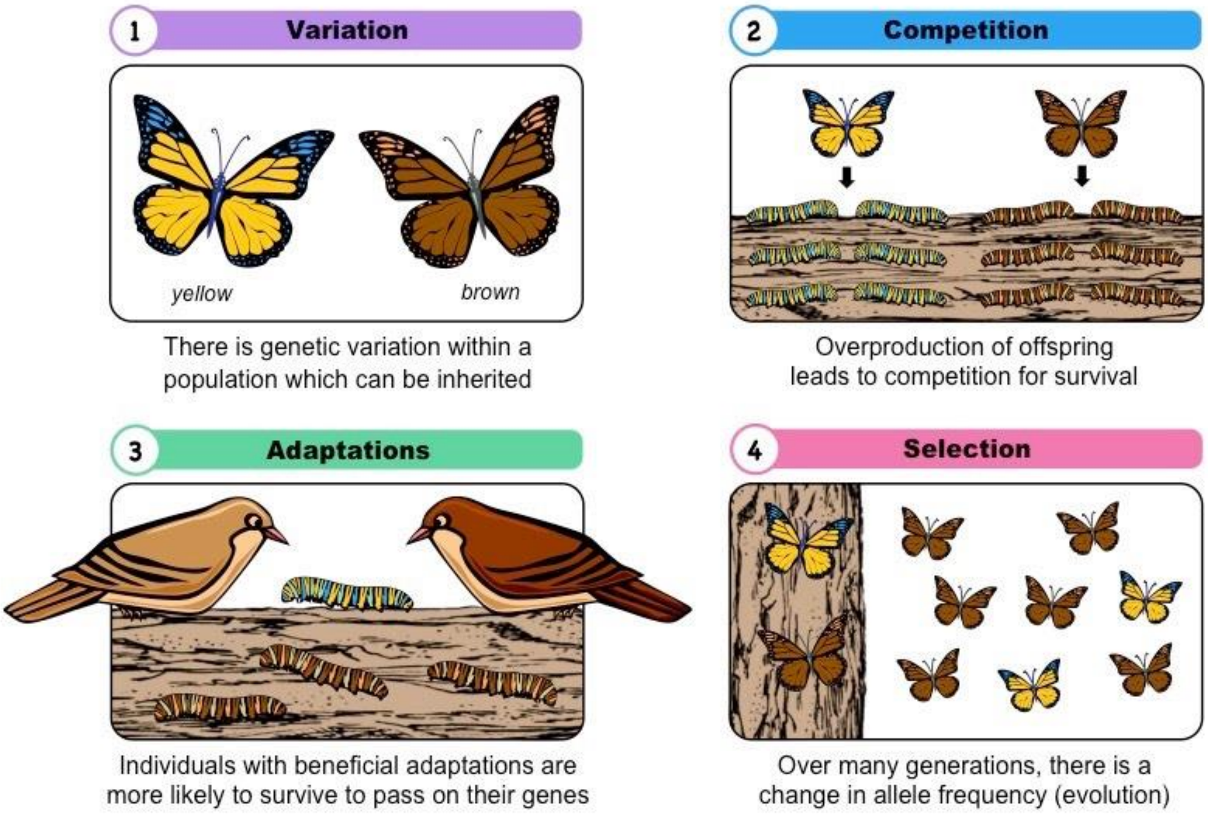


Figure 143: Components of natural selection

- Individuals within a population exhibit variation in their traits. This variation can be influenced by genetic factors, environmental factors, or a combination of both.
- Some of the variation in traits is heritable, meaning that it can be passed from parents to offspring through genetic inheritance.
- Populations have the potential to produce more offspring than the environment can support. This leads to a "struggle

for existence" as individuals compete for limited resources such as food, water, mates, and shelter.

- Individuals with certain traits have a better chance of surviving and reproducing in a given environment. These advantageous traits may enhance an individual's ability to find food, avoid predators, or secure mates.
- Environmental factors, such as climate, predation, and resource availability, act as selection pressures. Traits that are beneficial in a particular environment increase an individual's likelihood of surviving and reproducing, while traits that are disadvantageous decrease an individual's chances.
- Natural selection is the differential survival and reproduction of individuals with specific traits. Individuals with traits that confer a higher fitness (ability to survive and reproduce) are more likely to pass on their genes to the next generation.
- Over time, as individuals with advantageous traits reproduce and pass on those traits to their offspring, the frequency of those traits increases in the population. This process leads to adaptation, where the population becomes better suited to its environment.
- The genetic makeup of a population changes over time as the frequencies of alleles (different forms of a gene) associated with advantageous traits increase.

- This change in allele frequencies is a key indicator of the action of natural selection.
- Cumulatively, over many generations, natural selection can lead to significant changes in a population, potentially resulting in the emergence of new species. This is the process of evolution.

Natural selection is one of the mechanisms proposed by Charles Darwin in his theory of evolution by natural selection. It explains how species can change over time, adapt to their environments, and diversify into different forms. It remains a cornerstone of modern evolutionary biology.

In Activity 5.4, you will discover how natural selection serves as a mechanism of evolution. This will help you explain how new species develop and others become extinct as a result of natural selection.

In Activity 5.4: Explaining natural selection as a mechanism of evolution

Do this activity in a pair

Key question: How does natural selection cause evolution?

What you need: the Internet, reference materials about natural selection as a mechanism of evolution

What to do:

1. Research and discuss the meaning of natural selection and evolution.
2. Explain how natural selection leads to evolution of new species.

Present your findings to the whole class.

5.5: Artificial Selection and Breeding

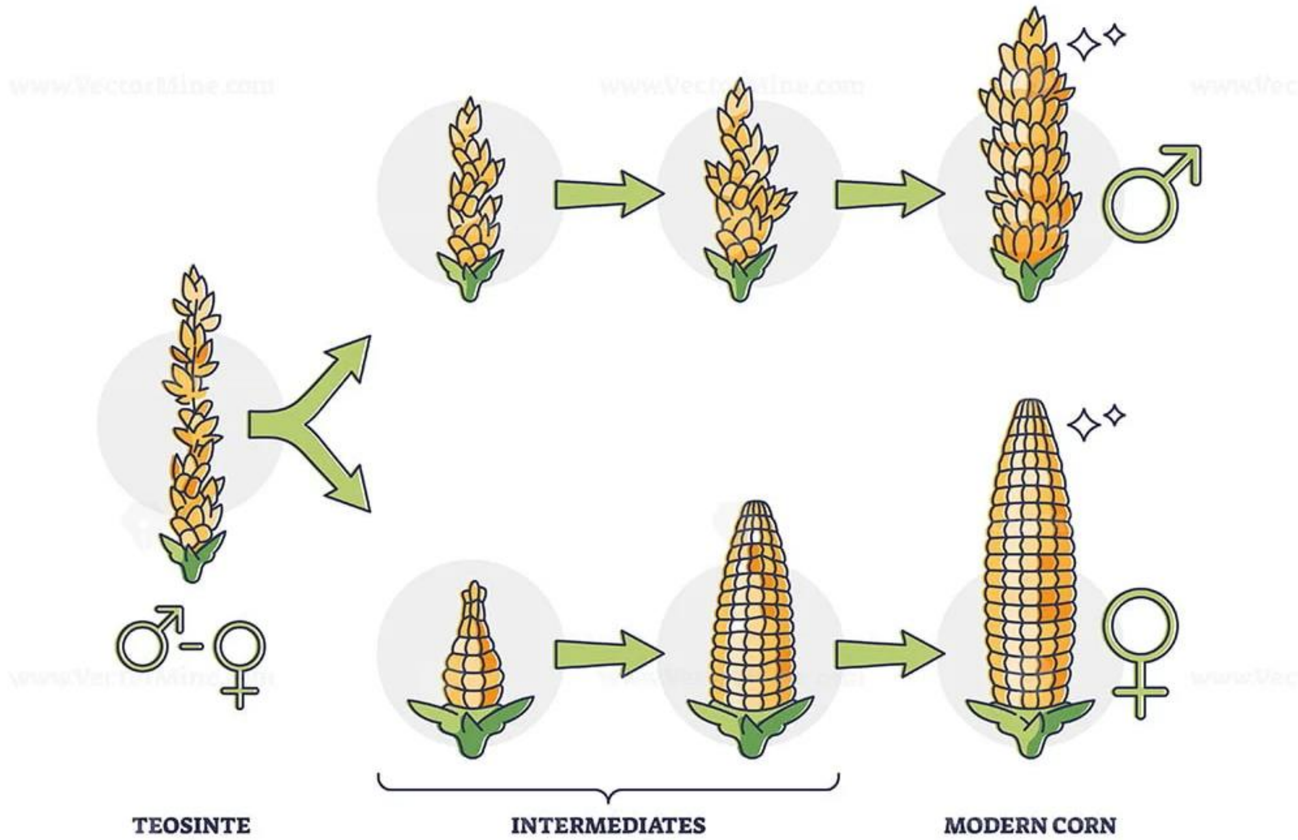


Figure 144: Artificial selection

Humans have at times influenced the survival of some organisms with favorable characteristics at the expense of those with poor or undesirable characteristics. This works more like natural selection. Can you give examples of situations where humans influence the survival of some desirable characteristics?

This knowledge has majorly been used in the breeding process in plants and animals.

Artificial selection is a controlled process in which humans intentionally choose certain individuals with desirable traits to be the parents of the next generation. This process is commonly used in agriculture and animal husbandry to improve the characteristics of crops and livestock.

How artificial selection works

1. **Identifying Desired Traits**

- Breeders first identify the traits they want to enhance or suppress in a population. These traits can include qualities such as size, color, resistance to diseases, productivity, or any other characteristic deemed desirable.

2. **Selection of Parental Stock:**

- Individuals with the desired traits are selected as parents. This process involves evaluating the genetic makeup of potential breeding pairs and choosing those with the highest likelihood of passing on the desired traits to their offspring.

3. **Reproduction:**

- The selected individuals are allowed to reproduce. This can be done through natural mating or artificial insemination, depending on the species and the breeding goals.

4. **Generation of Offspring**

- The offspring inherit genetic material from both parents.
- The goal is to produce individuals with an increased frequency of the desired traits in the population.

5. **Repetition of the Process**

- The process is repeated over multiple generations. Each time, breeders select individuals with the most desirable traits from the previous generation to be the parents of the next generation.

6. **Cumulative Effect**

- Over time, the frequency of the desired traits increases in the population, while the frequency of undesired traits decreases. This leads to the development of populations or breeds with specific characteristics that align with human preferences or needs.

E**xamples of artificial selection include:**

Agriculture: Selective breeding is used to develop crop varieties with improved yield, resistance to pests, and other desirable characteristics.

Figure 145: Examples of artificial selection

Livestock Farming: Animals are selectively bred to enhance traits such as milk production, meat quality, disease resistance, or specific behaviors.

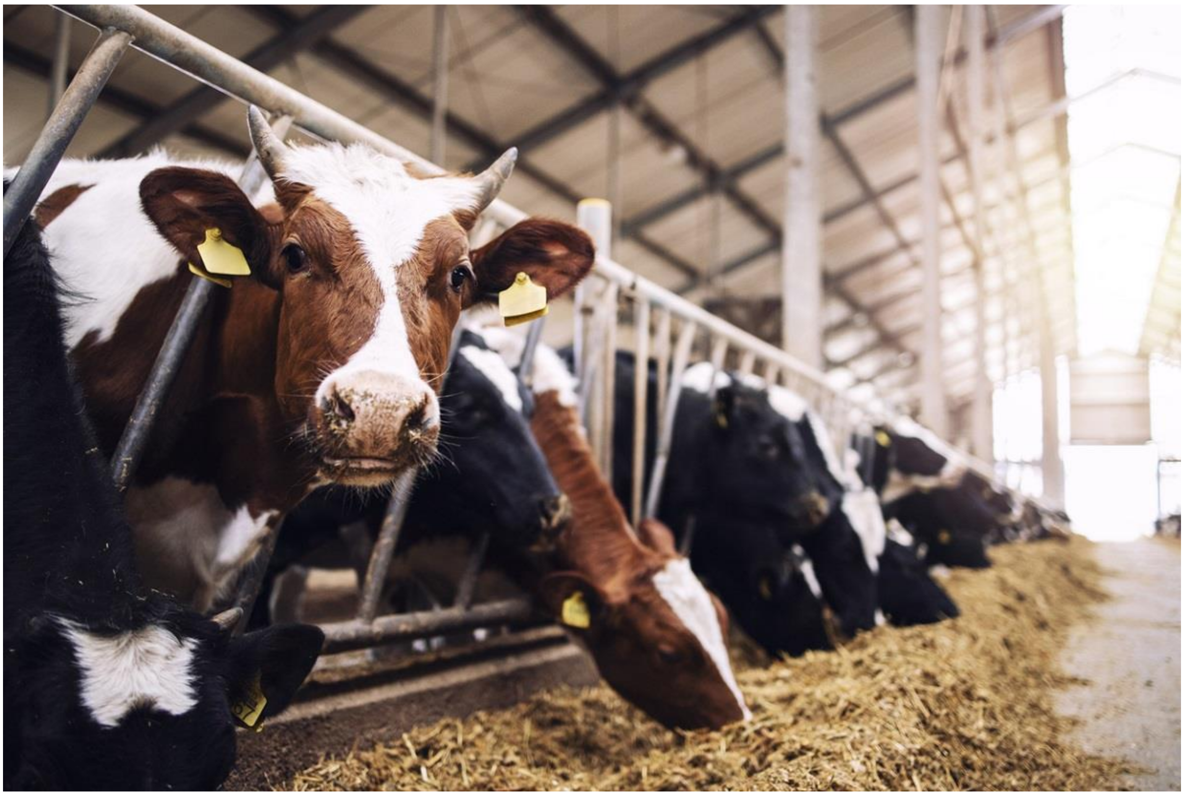


Figure 146: Livestock Farming

Pets

Selective breeding is employed to develop specific breeds of dogs, cats, and other pets with desired physical and behavioral traits.

Ornamental Plants

Flower and ornamental plant breeders use artificial selection to create varieties with unique colors, shapes, and sizes.

Figure 147: Ornamental Plants

Artificial selection, also known as selective breeding, has been widely employed by humans for centuries to modify and enhance the traits of plants and animals. This intentional breeding process offers several benefits, and its applications span various fields such as agriculture, animal husbandry, and ornamental horticulture. Here are some key benefits of artificial selection:

1. **Improved Productivity**

- Agriculture: Selective breeding is extensively used in crops to improve yield, resistance to pests and diseases, and overall productivity. This contributes to increased food production to meet the growing demands of the global population.

2. **Enhanced Quality of Products**

- Livestock Farming: Artificial selection in livestock aims to improve the quality of products such as meat, milk, and wool. Breeding for specific traits, such as marbling in beef or milk production in dairy cows, results in higher-quality products for human consumption.

3. **Disease Resistance**

- Plants and Animals: Selective breeding can be employed to develop varieties that are resistant to diseases and pests. This reduces the reliance on pesticides and contributes to more sustainable agricultural practices.

4. **Desirable Physical Traits**

- Pets and Ornamental Plants: Artificial selection is widely used in the development of specific breeds of dogs, cats, and ornamental plants. This allows for the creation of pets and plants with desired physical characteristics, temperament, and appearance.

5. **Specialized Traits**

- Working Animals: Selective breeding is used to develop working animals with specialized traits. For example, certain dog breeds are selectively bred for herding, hunting, guarding, or assistance tasks. Horses and other animals have been selectively bred for specific work purposes as well.

6. **Adaptation to Local Conditions**

- Crops: Selective breeding can be used to develop crop varieties that are well-adapted to local environmental conditions, such as specific soil types, climates, or altitudes. This improves agricultural sustainability and resilience.

7. **Conservation of Genetic Diversity**

- Endangered Species: In conservation efforts, artificial selection is sometimes used to manage captive populations of endangered species. This helps maintain genetic diversity and enhances the chances of successful reintroduction into the wild.

8. **Rapid Trait Development**

- Speed of Change: Artificial selection allows for the relatively rapid development of specific traits compared to natural selection.

- This can be particularly important in addressing immediate needs, such as disease resistance or changing market demands.

9. **Selective Breeding for Research Purposes**

- Genetic Studies: Selective breeding can be employed in research to study the genetic basis of specific traits. By creating populations with controlled genetic backgrounds, scientists can better understand the genetic mechanisms underlying certain characteristics.

10. **Economic Benefits**

- Efficiency and Profitability: Farmers and breeders can achieve economic benefits by selectively breeding for traits that enhance efficiency, reduce resource input, and increase profitability.

In Activity 5.5, you will understand how artificial selection has been used in selective breeding in plants and animals and this will equip you with knowledge of how this is done and prepare you for a possible carrier path in future or help you in your future home projects.

Activity 5.5: Exploring the use of artificial selection in selective breeding

Key question: How is artificial selection used in selective bleeding?

What you need: Reference materials, the Internet, a recorded talk about selective breeding

What to do

1. listen to a talk about selective breeding and;

I) Discuss the uses of artificial selection in animal and plant breeding.

ii) Explain the mechanisms of artificial selection used in selective breeding.

iii) Research and write down the benefits of artificial selection in selective breeding

Sample Activity of Integration

Three orange farmers bought seedlings from different locations. They all planted their seedlings at the same time and in the same conditions. The orange plants for farmer A matured in just 1 year and the fruits were large and many but not tasty and prone to disease. The plants for farmer B matured in two years and the fruits were many, medium sized with an average taste while the plants for farmer C matured in three years, the fruits produced were small and few in number but very tasty and resistant to disease.

The farmers met and each bragged about how their oranges are the best. A person passing by asked the farmers why is it that they all planted oranges but each of them had a different yield and characteristics. The farmers failed to explain and have called you for help.

Task: Write an article that can help the farmers understand the differences in their yields.

TERM THREE

Theme: Inter-Relationships

Chapter 6: Concept of Ecology

Key words

- Ecology
- Habitat
- Community
- Species
- Ecosystem

Learning outcomes

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

a) Define the term ecology and its significance.
b) Explain what a habitat is and give examples.
c) Identify different communities within ecosystems.
d) Differentiate between species and their roles in an ecosystem.
e) Describe the components and interactions within an ecosystem.

BIBLICAL INTEGRATION

"The earth is the Lord's, and everything in it, the world, and all who live in it." - Psalm 24:1. This verse reminds us that every aspect of the natural world, including the diverse interactions within ecosystems, is part of God's creation and should be respected and preserved.

By studying ecology, we gain insights into the complex interactions that sustain life on Earth. Psalm 24:1 calls us to recognize the interconnectedness of all creation, highlighting the importance of maintaining ecological balance for the well-being of all organisms.

Introduction

You might have realized that in nature, different organisms live in different places where they interact with other organisms and nonliving things in order to survive. In this chapter, you will understand the concepts of habitats, communities and ecosystems.

6.1: Meaning of Ecology

In Figure 6.1, shows an anthill in which termites live and interact with the non- living components like soil just like other organisms interact with each other and the nonliving components of their environment.

Figure 148: Ecology study

Ecology is the scientific study of the interactions among organisms and their environments. It examines the relationships between living organisms, including plants, animals, and microorganisms, and the biotic and abiotic components of their surroundings. Ecology encompasses a wide range of scales, from individual organisms to entire ecosystems and the biosphere. The field of ecology is essential for understanding the structure, function, and dynamics of ecosystems and how they respond to environmental changes.

Key concepts in ecology include:

- **Biotic Factors:** Living components of an ecosystem, including plants, animals, fungi, and microorganisms.
- **Abiotic Factors:** Non-living components of an ecosystem, such as temperature, sunlight, soil, water, and nutrients.
- **Habitat:** The specific environment in which an organism or community of organisms resides.
- **Niche:** The role or function of an organism within its ecosystem, including its interactions with other organisms and its use of resources.
- **Food Chains and Food Webs:** Descriptions of the flow of energy through ecosystems, illustrating the transfer of energy from one organism to another.

- **Ecosystem Services:** Benefits that humans obtain from ecosystems, such as clean water, pollination of crops, and climate regulation.

Ecology plays a crucial role in addressing environmental challenges, informing conservation efforts, and understanding the interconnectedness of life on Earth. It provides insights into how ecosystems function, how species interact, and how human activities can impact the health of the planet.

Living organisms interact with nonliving components of their environment in various ways.

These interactions are fundamental to the functioning of ecosystems and influence the survival, growth, and reproduction of organisms.

Examples of how living organisms interact with nonliving things

1. **Photosynthesis (Plants and Sunlight)**

- Living Organisms: Plants.
- Non-living Component: Sunlight.
- Interaction: Plants engage in photosynthesis, a process that converts sunlight into chemical energy. Through this interaction, plants use sunlight to synthesize carbohydrates, producing oxygen as a byproduct.

2. **Respiration (Animals and Oxygen)**

- Living Organisms: Animals.
- Nonliving Component: Oxygen (from the atmosphere).
- Interaction: Animals undergo respiration, a process that involves the intake of oxygen from the air and the release of carbon dioxide. Oxygen from the nonliving atmosphere is crucial for the survival of animals.

3. **Nutrient Uptake (Plants and Soil Nutrients)**

- Living Organisms: Plants.
- Nonliving Component: Soil nutrients (e.g., nitrogen, phosphorus).
- Interaction: Plants absorb essential nutrients from the soil, including nitrogen, phosphorus, and other minerals. These nonliving components are critical for plant growth and development.

4. **Water Absorption (Plants and Water)**

- Living Organisms: Plants.
- Nonliving Component: Water.
- Interaction: Plants absorb water from the soil through their roots. Water, a nonliving component, is essential for various physiological processes in plants, including photosynthesis and nutrient transport.

5. **Predation (Predator-Prey Interactions)**

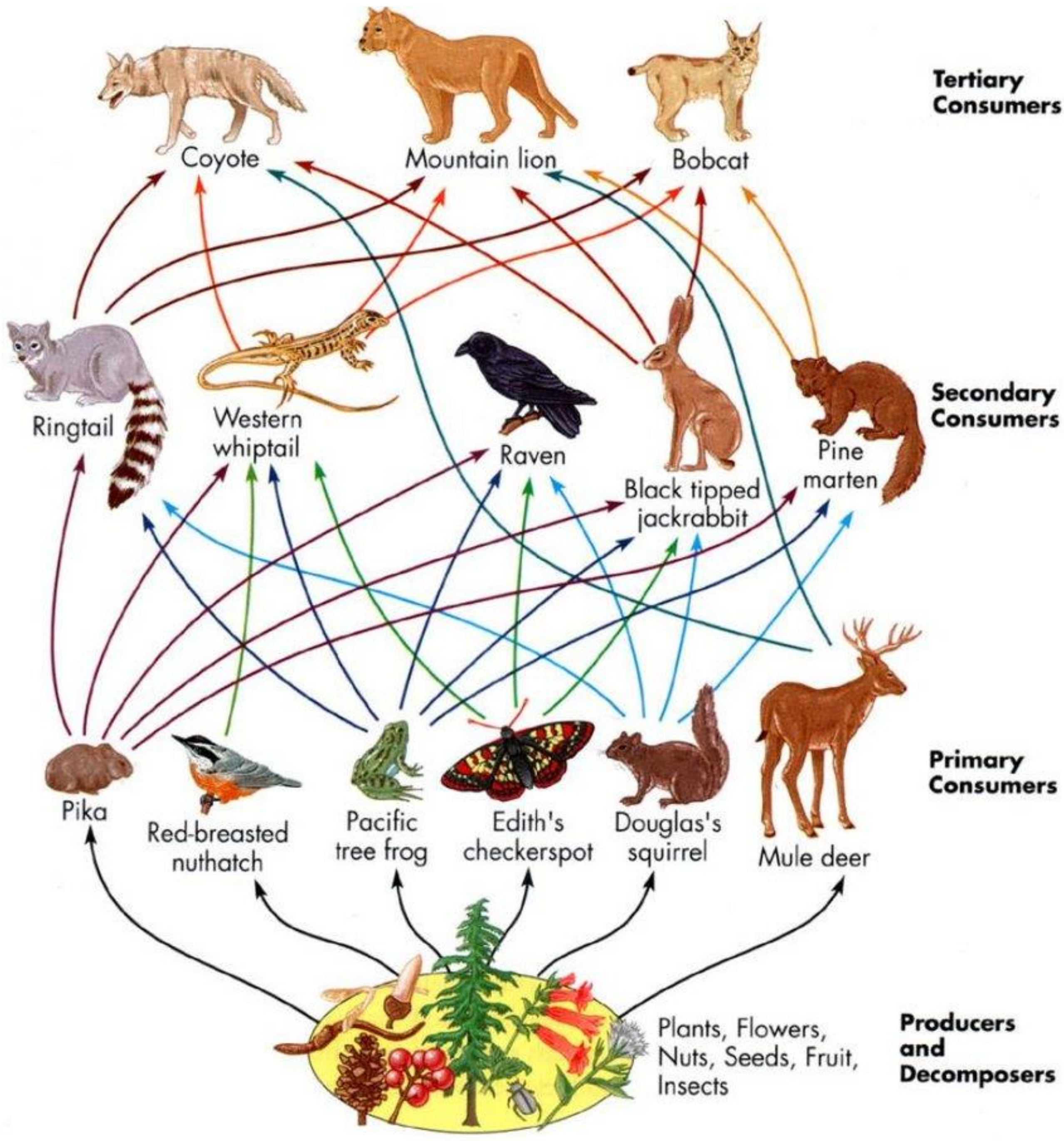


Figure 149: Predator-Prey Interactions

- Living Organisms: Predators and prey.

- Nonliving Component: Physical environment.
- Interaction: Predators hunt and consume prey as a means of obtaining energy. While the interaction involves living organisms, the physical environment (nonliving) serves as the backdrop for these predator-prey dynamics.

6. **Mimicry (Living Organisms and Abiotic Features)**

- Living Organisms: Certain species (e.g., stick insects, leaf-tailed geckos).
- Nonliving Component: Abiotic features (e.g., sticks, leaves).
- Interaction: Some living organisms have evolved to mimic nonliving elements in their environment as a form of camouflage. This interaction helps them avoid predation by blending into their surroundings.

7. **Nesting (Birds and Materials)**

- Living Organisms: Birds.
- Nonliving Component: Nesting materials (e.g., twigs, leaves, feathers).
- Interaction: Birds use nonliving materials from their environment to construct nests for breeding and raising offspring. This interaction is crucial for reproductive success.

8. **Migration (Animals and Climate)**

- Living Organisms: Migratory animals (e.g., birds, mammals).
- Nonliving Component: Climate and weather patterns.
- Interaction: Migratory animals respond to nonliving environmental cues, such as temperature and daylight, when undertaking long-distance migrations for breeding, feeding, or avoiding harsh conditions.

In **Activity 6.1**, you will find out the meaning of the term ecology.

Activity 6.1: Finding out the meaning of ecology

Do this activity in a group

Key question: What is ecology?

What you need: a chart showing a water pond or an aquarium with living organisms

What to do:

1. Look at figure 6.1 and figure 6.2 above and identify;
   i) The living organism
   ii) Non-living things
2. In what ways do the living organisms identified above interact with each other?
3. Giving examples mention how living organisms interact with nonliving things

4. What do you think will happen to the living organisms if the nonliving things are removed? Give reasons for your answer.
5. Using your responses from 1-4 and the knowledge from senior one, what is your understanding of the term ecology?

Compare your responses with those of another group.

6.2: Ecosystems, Community and Habitats

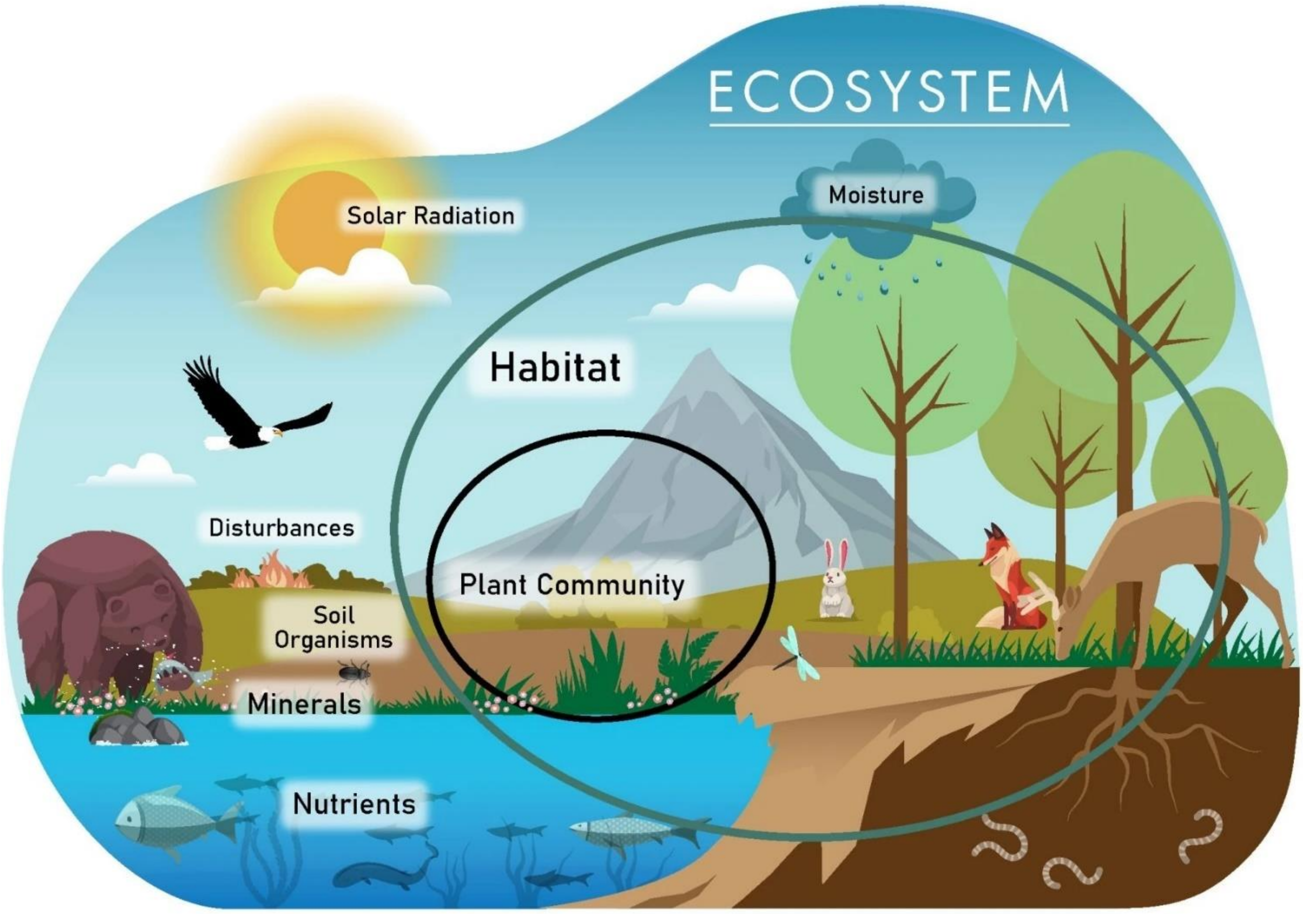


Figure 150: Community, habitat and ecosystem

Habitat: A habitat is the specific environment or place where an organism or a community of organisms lives. It encompasses both biotic (living) and abiotic (nonliving) components, providing the necessary conditions for the survival and reproduction of the organisms inhabiting it. Habitats can vary widely and include terrestrial environments (such as forests, deserts, and grasslands), aquatic environments (such as lakes, rivers, and oceans), and even microhabitats within larger ecosystems (such as the bark of a tree or the leaf litter on a forest floor).

Community: A community refers to the assemblage of different populations of species that inhabit the same habitat and interact with each other. In other words, a community is a group of populations living and interacting in a defined area. These interactions can include relationships such as predation, competition, symbiosis, and more.

The concept of a community emphasizes the ecological relationships among species within a given habitat and provides insights into the biodiversity and ecological dynamics of an area.

Ecosystem: An ecosystem is a more comprehensive and integrated concept that includes both the living organisms (biotic components) and the physical environment (abiotic components) in a specific geographic area. It represents a functional unit where organisms interact with each other and their physical surroundings, exchanging energy and matter. Ecosystems can range in size from small microecosystems to large-scale landscapes or even the entire biosphere.

They involve complex networks of relationships, including nutrient cycling, energy flow, and ecological processes. Ecosystems can be terrestrial or aquatic, and they play a crucial role in maintaining ecological balance and sustaining life on Earth.

- Habitat: The specific place or environment where an organism or community lives.
- Community: The group of different populations of species that inhabit the same habitat and interact with each other.
- Ecosystem: A functional unit comprising living organisms and their physical environment in a specific geographic area, involving interactions and exchanges of energy and matter.

Activity 6.2: Understanding the meaning of a habitat, community and an ecosystem

Do this activity in a group

Key question: What do understand by a habitat, community and ecosystem?

What you need: A pen, a notebook

1. Study Figure 6.2 and;

i) Name the living organisms that you see.

ii) Which organism are of the same species?

iii) Where does each of the organisms identified live?

2. What name would you give to those places in I) above

   (a) Home

   (b) Habitat

   (c) Tertiary

3. What general name would you give to a group of organisms belonging same species?

(a) Herd

(b) Clan

4. Discuss your responses with the rest of the class and come up with a common understanding of the terms habitat and community, Give examples of each.

6.3: Types of Ecosystems

There are five major types of ecosystems in Africa which include; water body and forest ecosystems. See Figure '6.3. In Activity 6.3, you will explore them and their distinguished features.

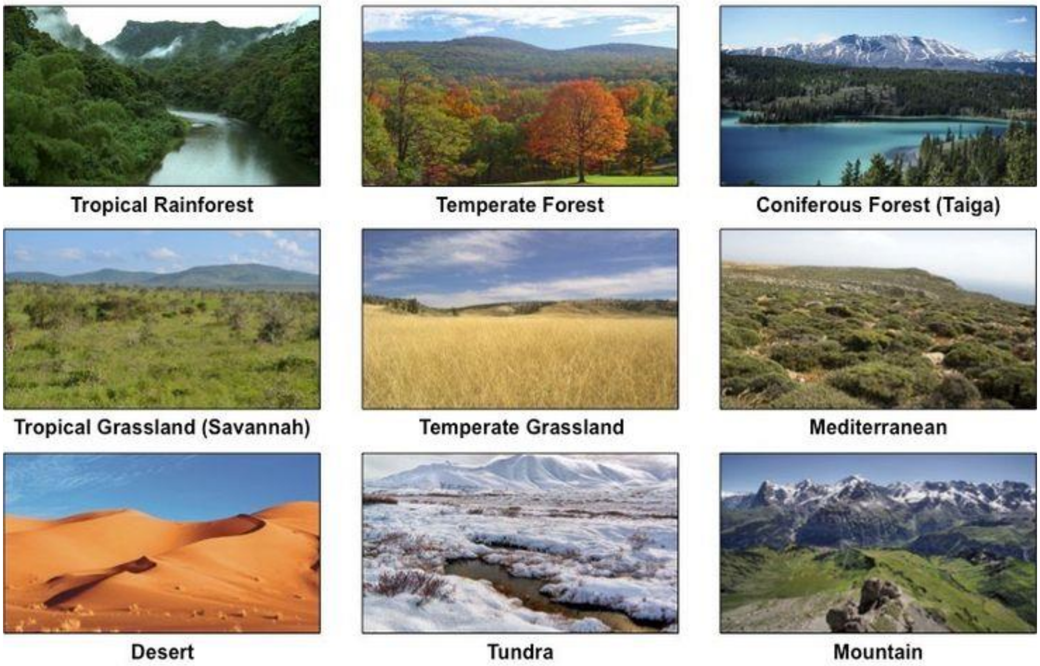


Figure 151: Ecosystems

Africa is a vast and diverse continent with a wide range of ecosystems, each characterized by distinct climatic, geographic, and ecological features. While it's challenging to categorize all the ecosystems into a fixed number, here are five major types of ecosystems found in Africa.

1. **Savannah Ecosystems**

- Description: Savannahs are extensive grassland ecosystems characterized by a mix of grasses and scattered trees, often with a distinct wet and dry season. They are prevalent in various regions across Africa.

- Key Features: Acacia trees, grasses, herbivores (e.g., zebras, giraffes), and carnivores (e.g., lions, cheetahs).

2. **Desert Ecosystems**

Figure 152: Desert Ecosystems

- Description: Deserts are arid ecosystems with low precipitation and often extreme temperatures. Africa is home to several deserts, including the Sahara in the north and the Kalahari in the south.

- Key Features: Sparse vegetation adapted desert plants (e.g., cacti), sand dunes, and animals with specialized adaptations (e.g., camels, fennec foxes).

3. **Rainforest Ecosystems**

Figure 153: Rainforest Ecosystems

- **Description:** Rainforests are lush and biodiverse ecosystems with high rainfall and consistent temperatures. The Congo Basin and parts of West Africa are known for their tropical rainforests.
- **Key Features:** Dense vegetation, tall trees, diverse plant and animal species (e.g., gorillas, chimpanzees, diverse bird species), and high humidity.

4. **Mountain Ecosystems**

Figure 154: Mountain ecosystems

- **Description:** Mountain ecosystems are found in various mountain ranges across Africa, such as the Rwenzori Mountains and the Atlas Mountains. They exhibit variations in temperature, vegetation, and biodiversity with increasing elevation.
- **Key Features:** Alpine vegetation, unique plant and animal adaptations to high altitudes, and varying ecosystems with elevation.

5. **Aquatic Ecosystems**

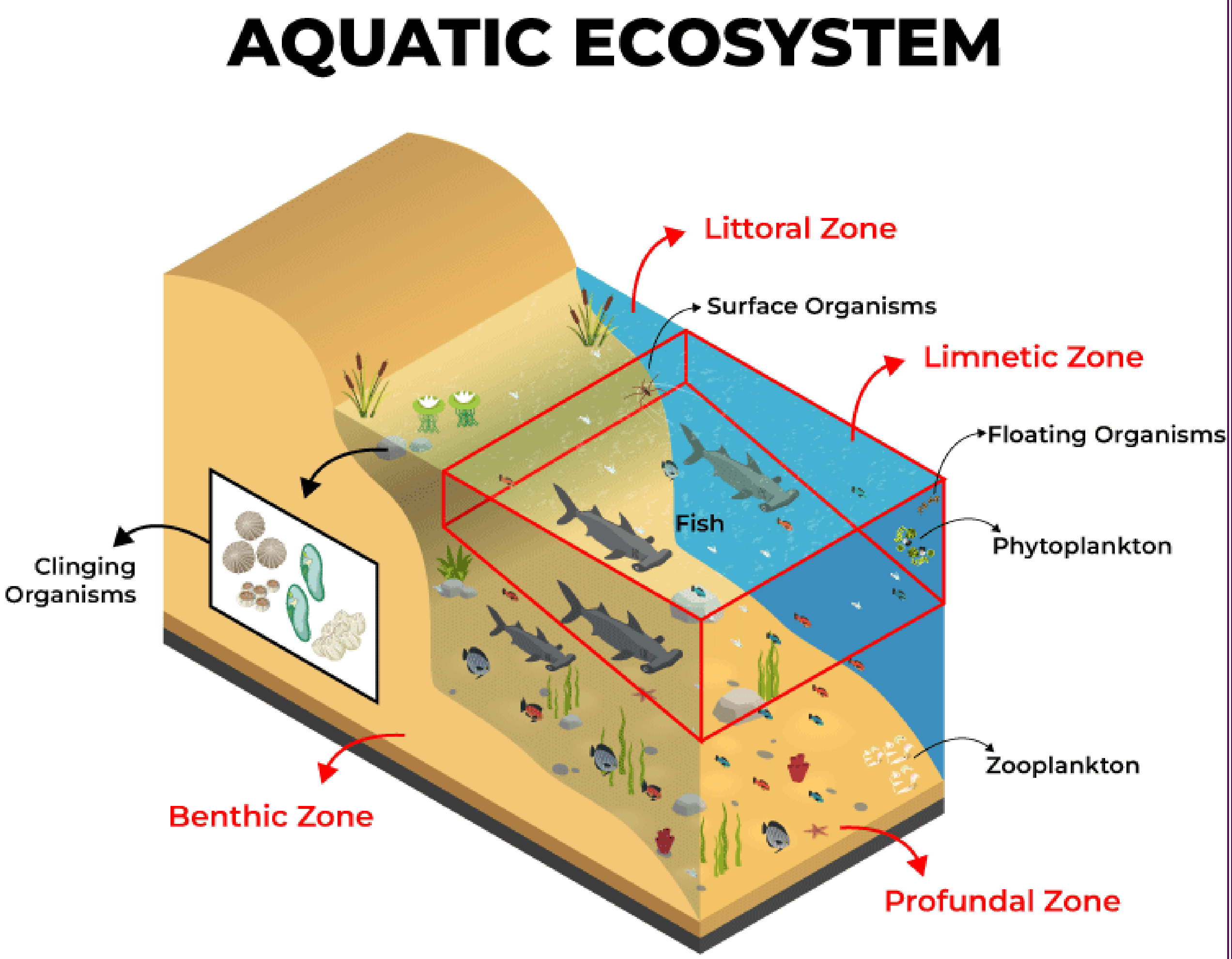


Figure 155: Aquatic ecosystem

- **Description:** Africa is surrounded by diverse aquatic ecosystems, including freshwater systems (lakes, rivers), wetlands, and marine ecosystems along its extensive coastlines.

- **Key Features:** Lakes (e.g., Lake Victoria, Lake Tanganyika), major rivers (e.g., Nile, Congo), wetlands (e.g., Okavango

Delta), and marine environments with coral reefs and marine life.

Activity 6.3: Understanding different types of ecosystems

Do this activity in a pair

Key Question: What are the different types of ecosystems?

What to do:

1. Study the figure 6.3 and research about types of ecosystems. Use your findings to complete the table below.

Figure	Name of ecosystem	Main distinguishing features	Examples of living organisms in the ecosystem	Examples of non-living organisms in the ecosystem	Examples of ecosystem in Africa
A					
B					
C					
D					
E					

Present your work to other pairs for comparison

Sample Activity of integration

The government has decided to establish a zoo in your community in order to boost tourism. Among the living organisms to be exhibited in the zoo are crocodiles, chimpanzees, spear grass, jack-fruit trees, buffaloes, papyrus plants, cactus plants, monitor lizards, Uganda knobs and crested cranes. The area where the zoo is being proposed to be put is an abandoned construction site. You have been employed as a zoo manager and your task is to transform the abandoned construction site into the zoo.

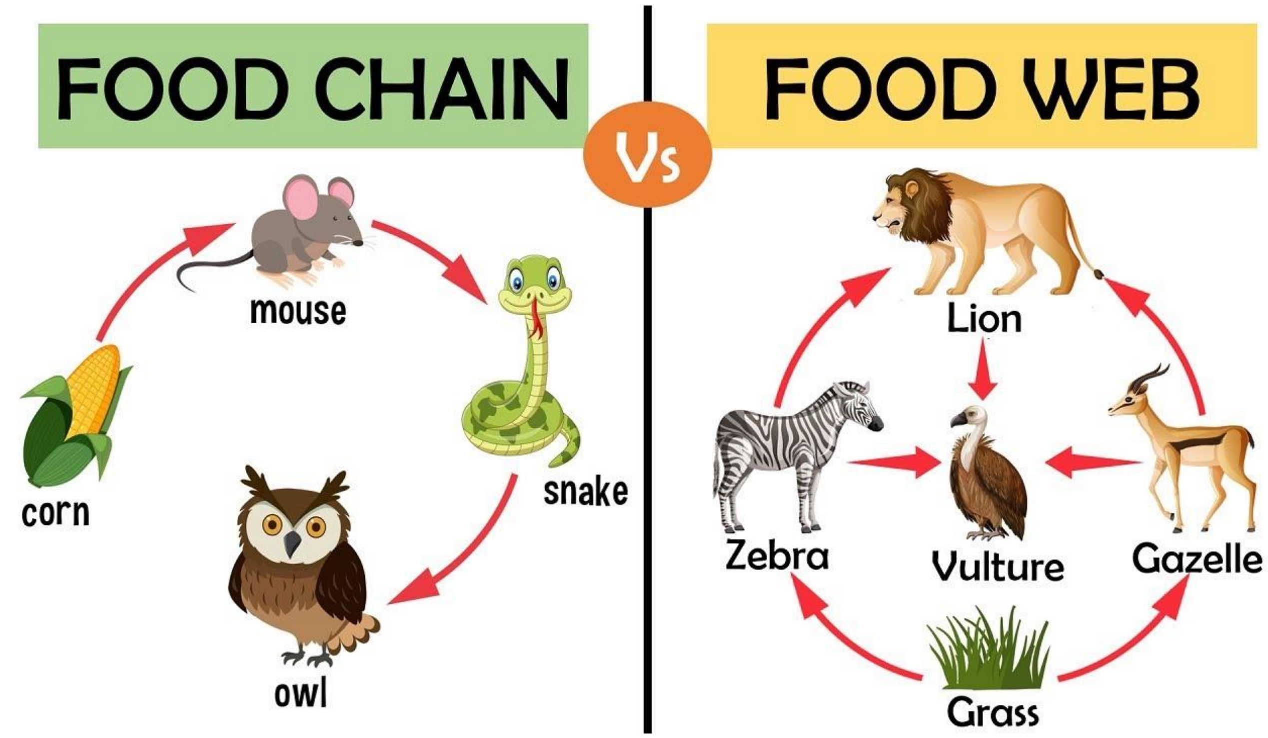
Task: Draw a proposed plan of the zoo

Chapter Summary

In this chapter, you have learnt that

1. Ecology is a way in which different organisms live and interact with other organisms and nonliving things in the environment.
2. There are different types of eco system which include water body, forest and savanna

Chapter 7: Food Chains and Food Webs



Key words

- Food chain
- Food webs
- Producers
- Consumers
- Decomposer

- Ecological pyramid
- Pyramid of numbers
- Trophic level

Learning outcomes

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 process involved in the carbon cycle and its role in maintaining the carbon dioxide balance in the atmosphere

BIBLICAL INTEGRATION

"Then God said, 'Let the earth bring forth living creatures according to their kinds—livestock and creeping things and beasts of the earth according to their kinds.' And it was so." - Genesis 1:24. This verse emphasizes the diversity and interconnectedness of life created by God, which is reflected in the complex relationships within food webs and ecosystems.

Understanding food chains and food webs helps us appreciate the delicate balance of ecosystems. As stewards of God's creation, we must recognize our role in maintaining

this balance, ensuring the sustainability of our environment for future generations, in alignment with Genesis 1:24.

Introduction

In senior two, you learnt about how different organisms obtain food. You realized that some organisms make their food while some organisms depend on others as food. This therefore is a feeding relationship. This relationship is a key aspect 'in an ecosystem. In this chapter, you will appreciate the interdependence of organisms in an ecosystem.

7.1: Food Chains

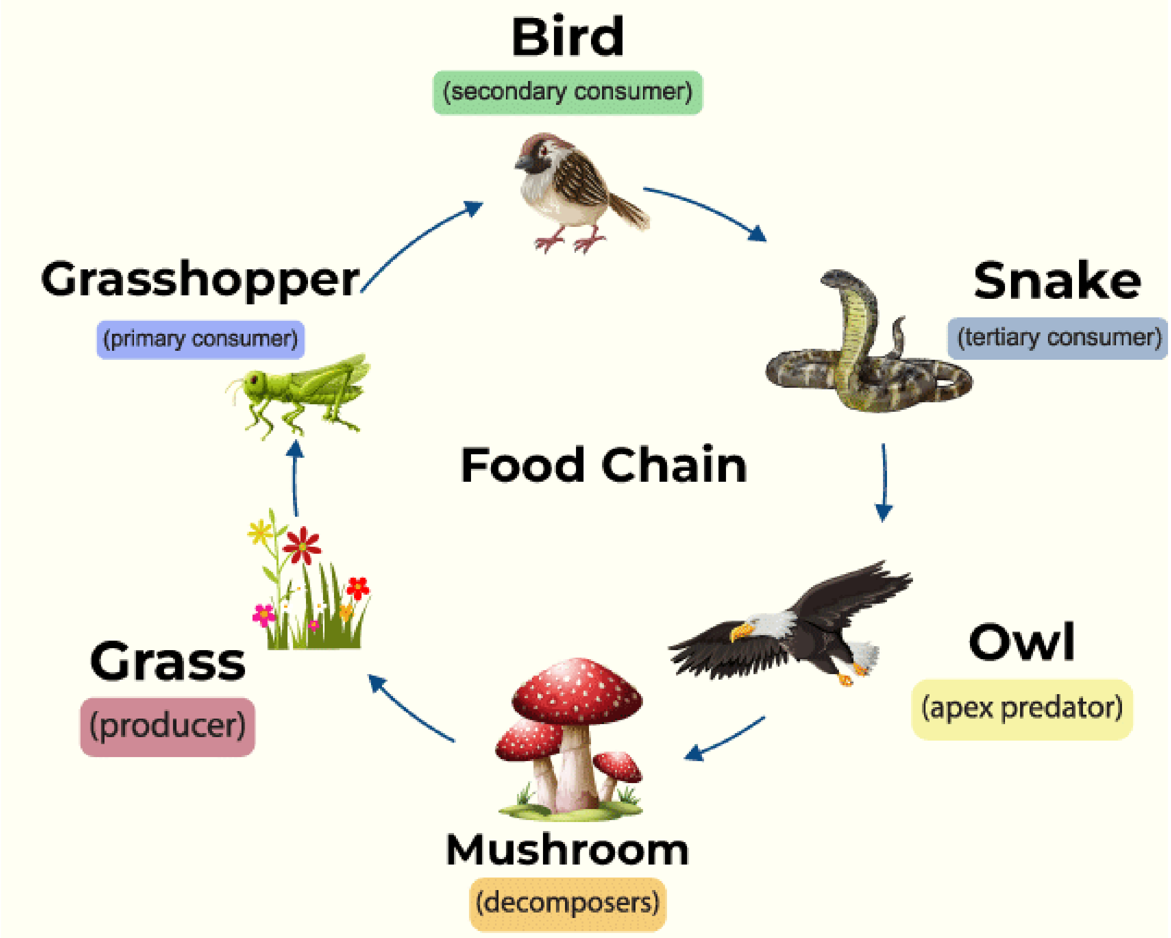


Figure 156: Food chain

You learnt that plants manufacture food that most organisms depend on.

How do you think the manufactured food from the plants gets to animals like lions? In Activity 7.1, you will discover how this happens.

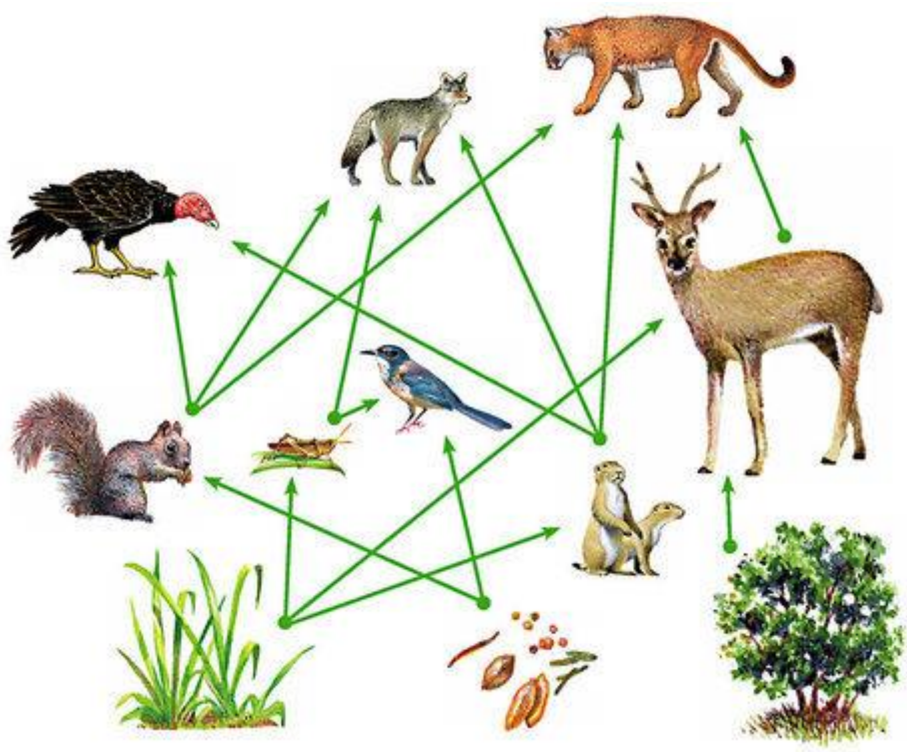


Figure 157: Some organisms in a feeding relationship

A food chain is a linear sequence of organisms, each dependent on the next as a source of food. It illustrates the flow of energy and nutrients through an ecosystem, showing who eats whom. In a typical food chain, there are different trophic levels, each representing a step in the transfer of energy. The main components of a food chain include:

1. **Producers (Autotrophs)**

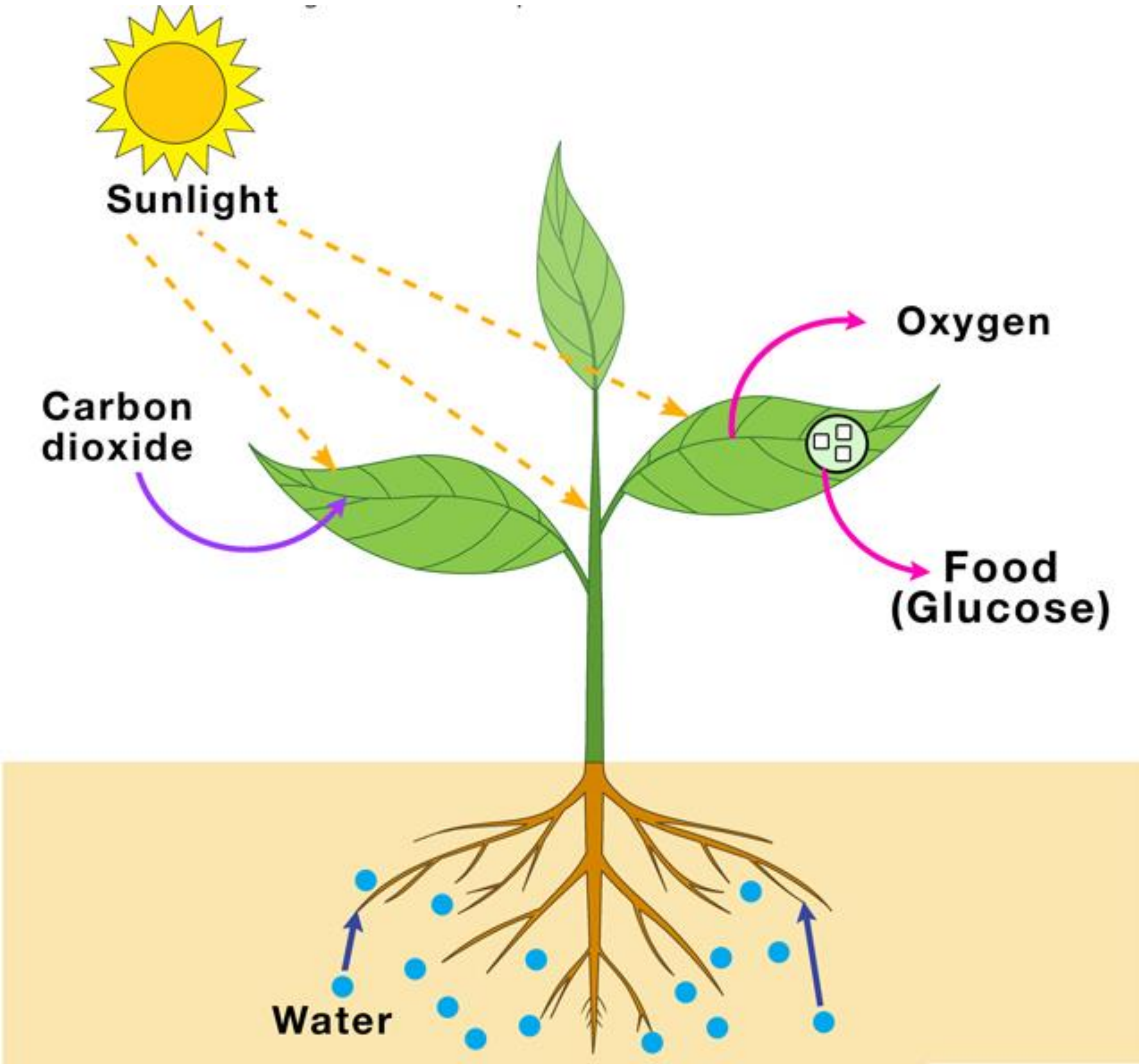


Figure 158: Autotrophs

- **Role:** Producers are organisms that produce their own food through photosynthesis or chemosynthesis. They form the base of the food chain.
- **Examples:** Plants, algae, and certain bacteria.

2. **Primary Consumers (Herbivores)**

Figure 159: Herbivores

- **Role:** Primary consumers are organisms that consume producers (plants) for their energy and nutrients.
- **Examples:** Herbivores such as rabbits, deer, and insects.

3. **Secondary Consumers (Carnivores or Omnivores)**

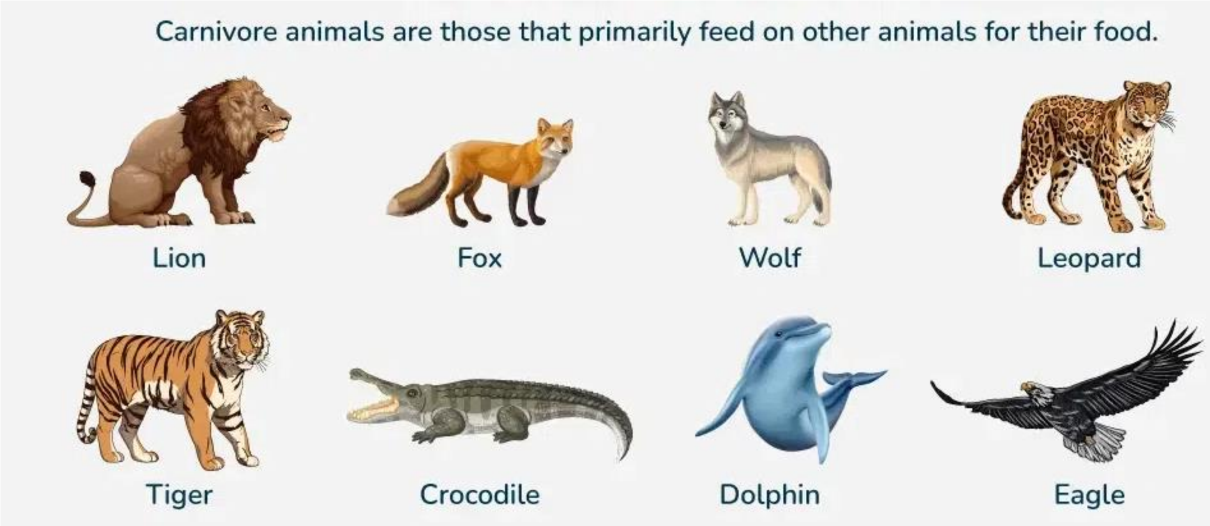


Figure 160: Carnivore animals

- **Role:** Secondary consumers are organisms that feed on primary consumers. They obtain energy by consuming herbivores.
- **Examples:** Carnivores (meat-eaters) like lions, wolves, or omnivores (eating both plants and animals) like bears.

4. **Tertiary Consumers**

- **Role:** Tertiary consumers are organisms that consume secondary consumers. They are at a higher trophic level in the food chain.
- **Examples:** Apex predators like eagles, sharks, or large carnivores that may prey on other carnivores.

5. **Quaternary Consumers and Beyond**

- **Role:** Quaternary consumers are organisms that may feed on tertiary consumers, and the chain can continue with quinary consumers, senary consumers, and so on.
- **Examples:** Predators at higher trophic levels that consume organisms from lower trophic levels.

Decomposers

- **Role:** Decomposers break down the remains of dead organisms and organic matter into simpler substances. They play a vital role in recycling nutrients back into the ecosystem.
- **Examples:** Bacteria, fungi, and certain insects.

Simplified example of a terrestrial food chain

1. **Grass (Producer)**
    - Produces its own food through photosynthesis.
2. **Rabbit (Primary Consumer)**
    - Eats grass for energy and nutrients.
3. **Fox (Secondary Consumer)**
    - Hunts and eats rabbits for energy.
4. **Eagle (Tertiary Consumer)**
    - Hunts and eats foxes for energy.

5. **Decomposers**

- Bacteria and fungi break down the remains of dead organisms, returning nutrients to the soil.

Each step in the food chain represents a trophic level, and energy is transferred from one level to the next. However, it's important to note that energy is not efficiently transferred between trophic levels, and the pyramid-shaped structure of energy levels reflects this inefficiency.

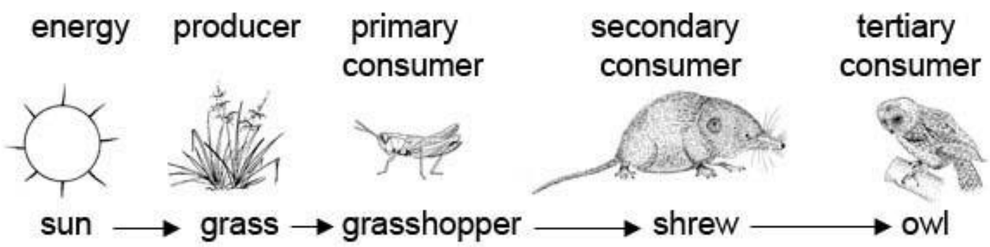


Figure 161: structure of energy levels

Activity 7.1: Constructing a food chain

Do this activity in a pair

Key Question: How do organisms depend on each other to obtain energy?

What to do: Reference materials, the internet

1. Study figure 7.1 and Identify which organisms feed on each other and fill the blank spaces.
   i) ………………..is eaten by …………….
   ii) ……………………..is eaten by ……………………which is eaten by
   iii) …………….. is eaten by …………is eaten by ………..is eaten by……………
2. From your response in iii), replace the phrase "is eaten by" with an arrow and construct a food chain.
3. In your own understanding, what do you think is being transferred from one organism to another in the process of feeding?
4. What is your understanding of a food chain?

Share your responses with other pairs

7.2: Food Webs

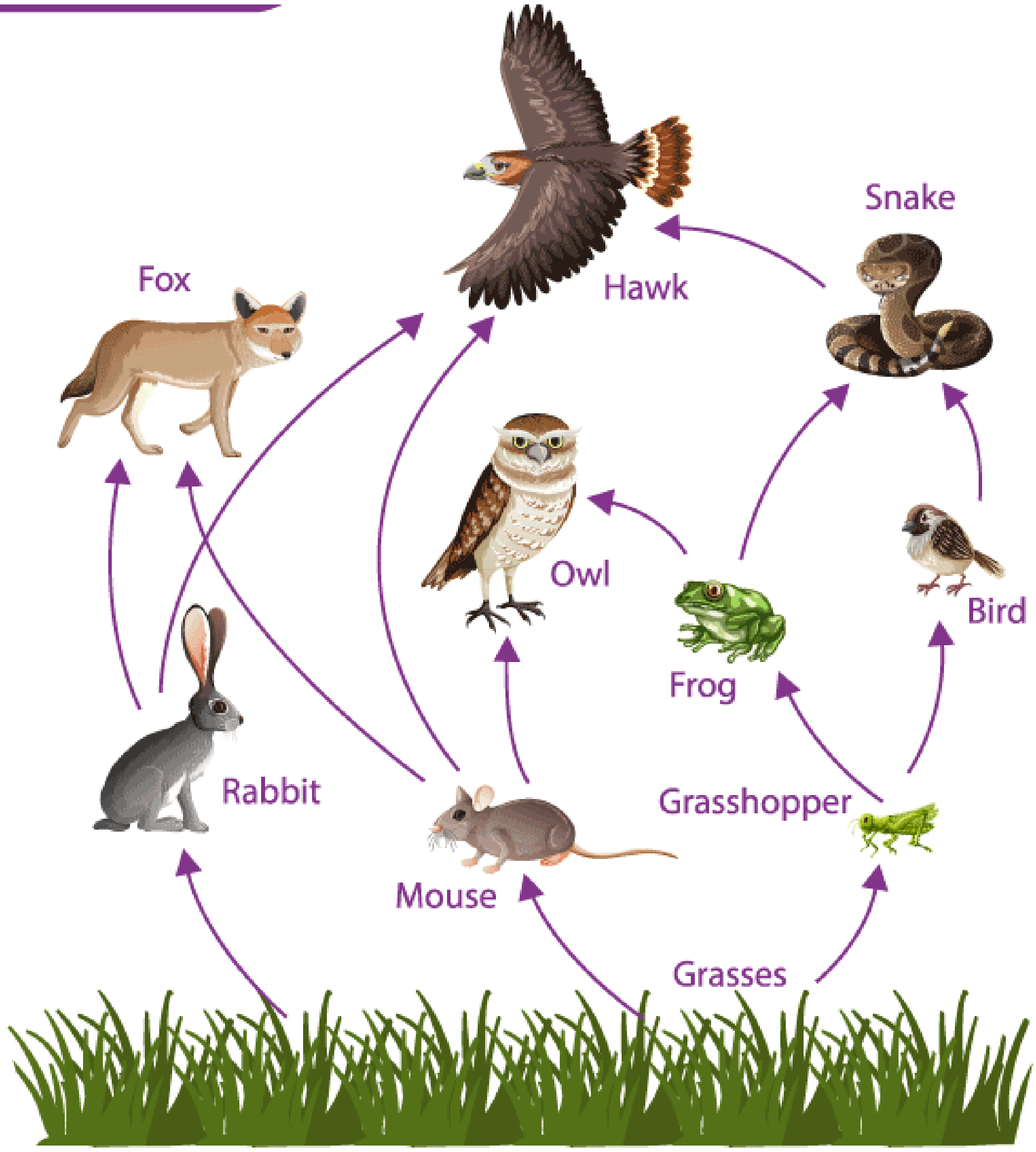


Figure 162: Food Webs

A food web is a more complex and interconnected representation of feeding relationships within an ecosystem compared to a simple linear food chain.

It consists of multiple interconnected food chains, illustrating the various ways in which organisms in an ecosystem are linked through their feeding interactions. Unlike a food chain that shows a single path of energy flow, a food web captures the complexity of multiple trophic levels and the interactions among different species.

Key features of a food web include

1. **Trophic Levels**

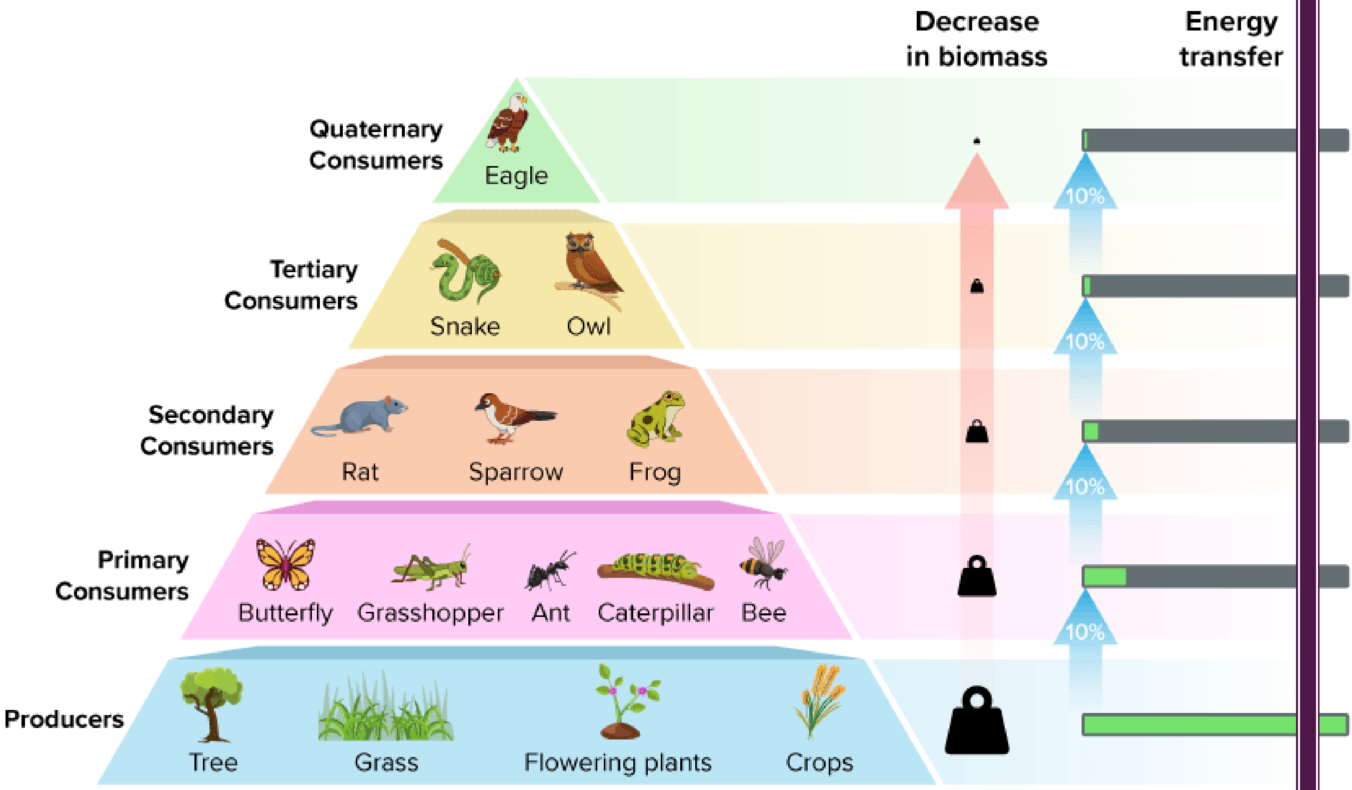


Figure 163: Trophic Levels

- **Producers:** Plants, algae, and other organisms capable of photosynthesis or chemosynthesis.
- **Primary Consumers:** Herbivores that feed on producers.
- **Secondary Consumers:** Carnivores that feed on primary consumers.

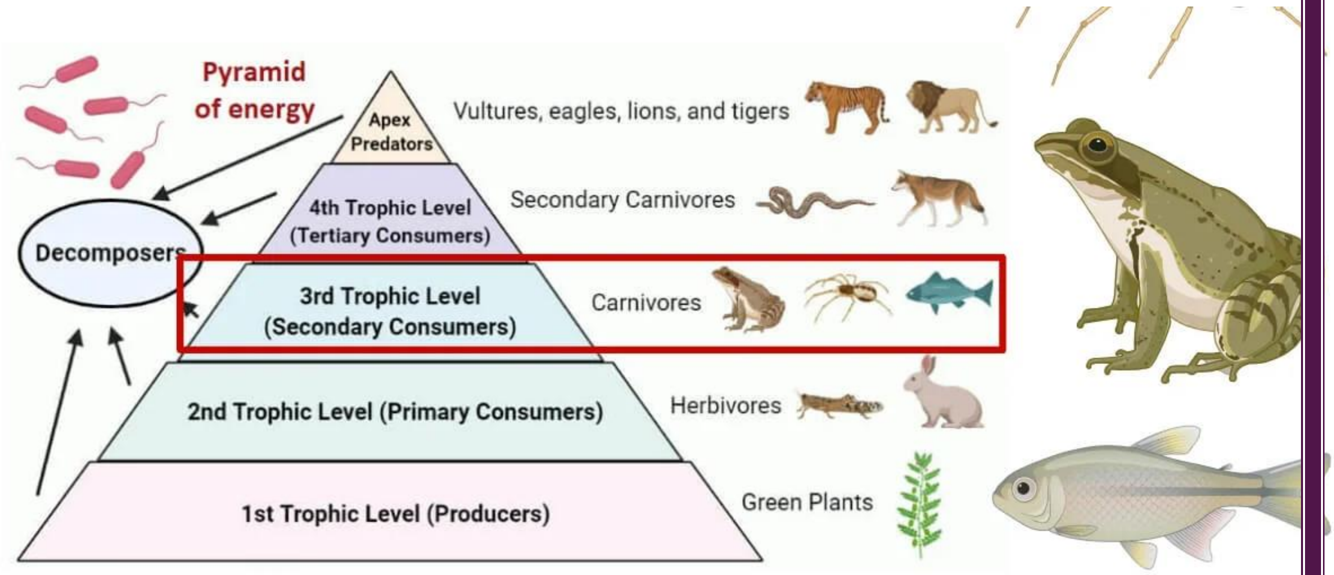


Figure 164: Secondary Consumers

- **Tertiary Consumers:** Carnivores that feed on secondary consumers.

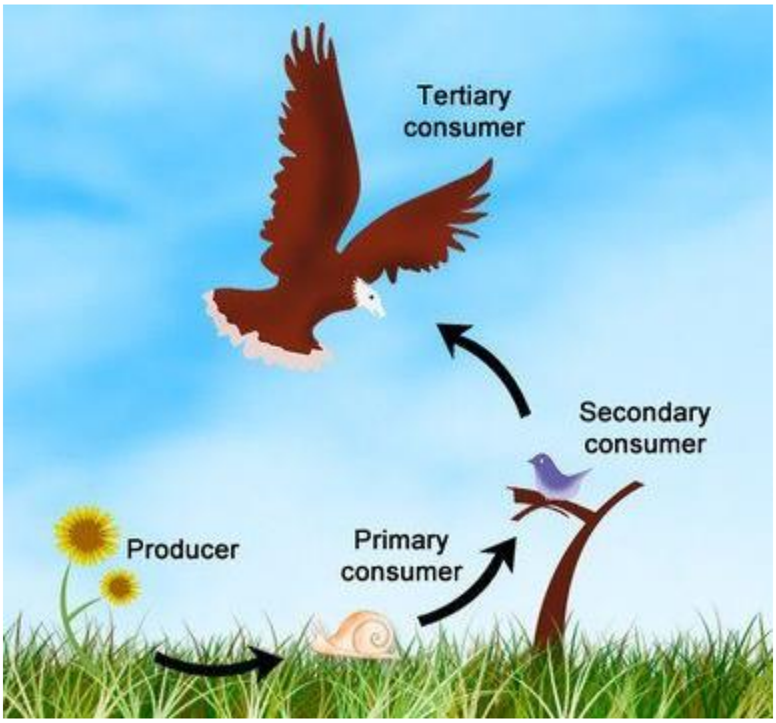
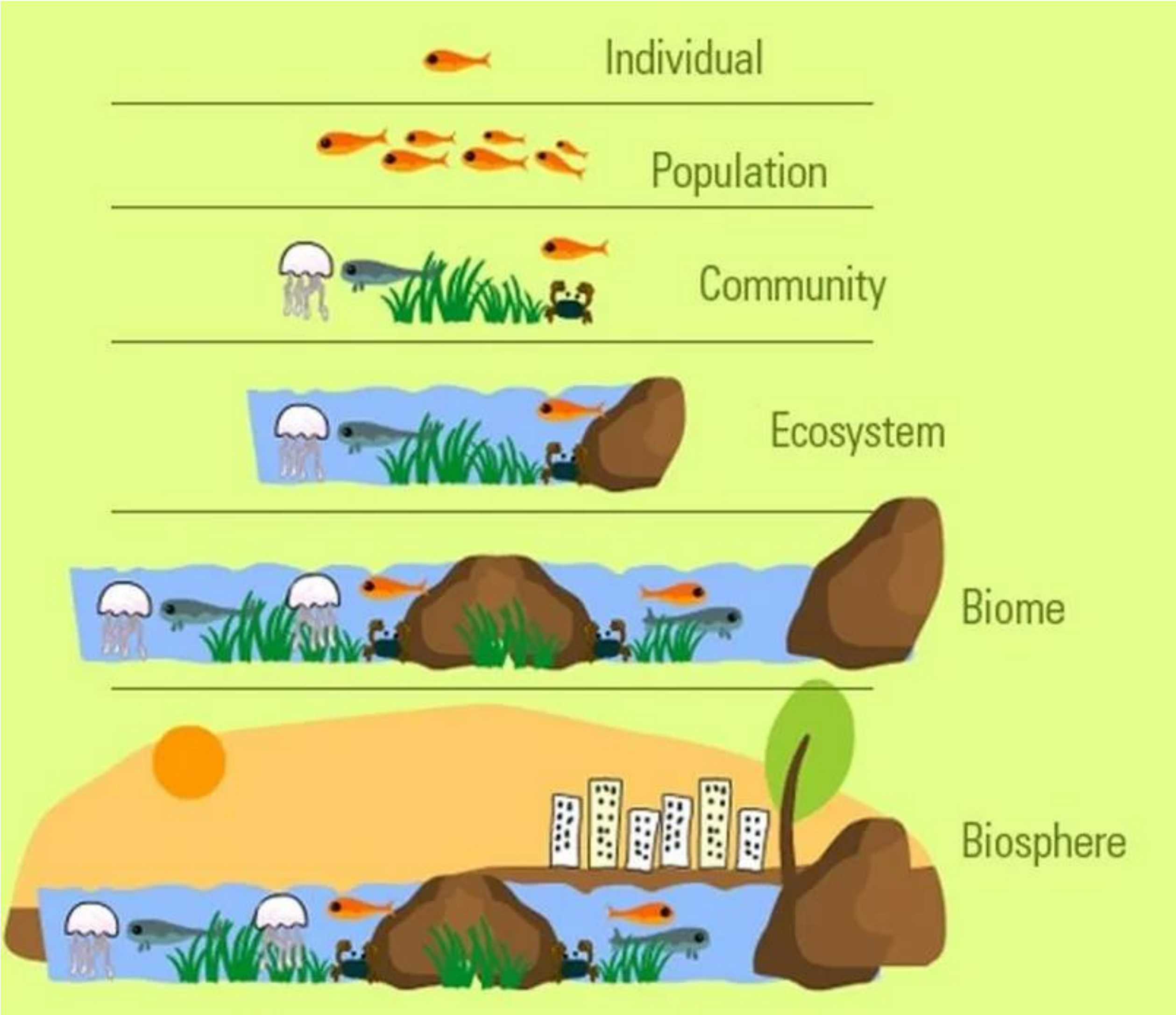


Figure 165: Tertiary consumer

2. **Interconnectedness**



- Organisms are part of multiple food chains, reflecting the complexity of their diets and interactions. For example, a predator may have multiple prey species, and a prey species may be consumed by different predators.

3. **Omnivores**

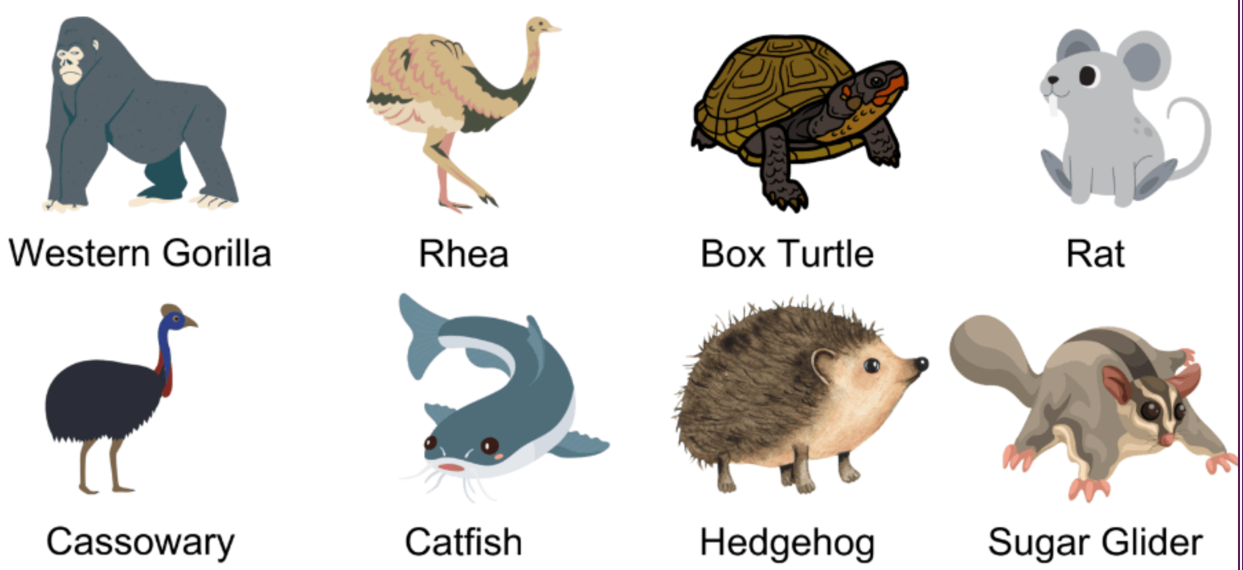


Figure 166: Omnivorous animals

- Omnivores play a significant role in food webs as they can consume both plants (producers) and animals (consumers). They may have multiple feeding relationships.

4. **Decomposers**

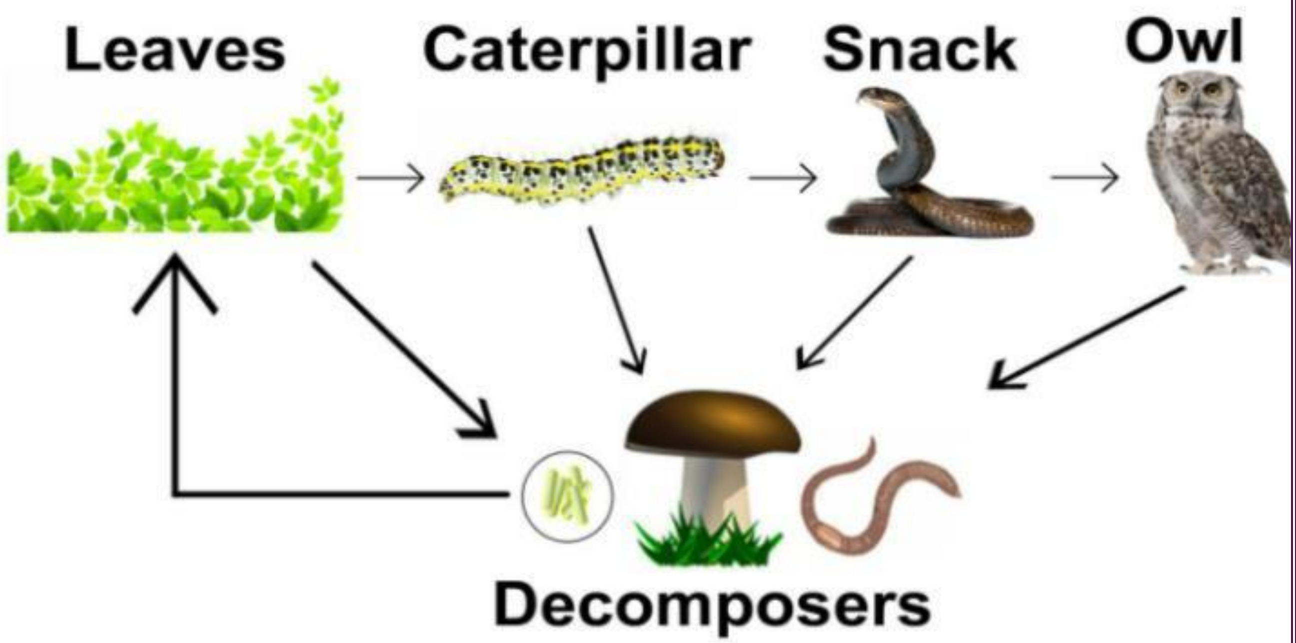


Figure 167: Decomposers

- Decomposers break down dead organic matter, returning nutrients to the soil and completing the nutrient cycle. They play a crucial role in recycling organic material within the ecosystem.

5. **Energy Flow**

- Energy flows through the food web, starting with producers capturing sunlight or inorganic compounds. This energy is transferred through different trophic levels as organisms are consumed.

6. **Keystone Species**

Figure 168: Keystone Species

- Certain species in a food web may have a disproportionately large impact on the ecosystem. These are known as keystone species, and their removal can have cascading effects on other species in the community.

7. **Complexity**

- Food webs can become highly intricate, especially in diverse ecosystems. They reflect the dynamic and interconnected nature of ecosystems, with numerous species interacting in various ways.

Activity: Exploring the Food Web in Your Local Ecosystem

Objective: Students will explore and construct a simple food web based on the organisms found in their local environment, identify trophic levels, and understand the complexity of feeding relationships within an ecosystem.

Materials Needed

- Paper and pencils
- Internet access or books for research on local flora and fauna
- Local field guide (optional)
- Colored pencils or markers

Instructions

1. **Field Exploration**:

   Take a walk in the school garden or any nearby natural area and observe the plants and animals around you. List down as many organisms as you can, including plants, insects, birds, and other animals. Make sure to include producers (plants), herbivores (primary consumers), and carnivores (secondary/tertiary consumers).

2. **Categorizing Trophic Levels**

Using your list of observed organisms, categorize each into one of the following trophic levels:

- **Producers** (plants, algae, etc.)
- **Primary consumers** (herbivores)
- **Secondary consumers** (carnivores)
- **Tertiary consumers** (top predators)

3. **Create a Food Web**

a) Draw a food web on paper, starting with the **producers** at the bottom. Use arrows to indicate the feeding relationships. For example, show which animals eat the plants, which carnivores eat the herbivores, and so on. Use different colors for each trophic level (e.g., green for producers, blue for primary consumers, etc.).

4. **Add Omnivores and Decomposers**

b) Include **omnivores** (organisms that eat both plants and animals) and **decomposers** (such as fungi or earthworms). Draw their connections to multiple parts of the food web to reflect the complexity of their feeding relationships.

5. **Identify a Keystone Species**

c) Research or discuss in class which organism in your food web might be a **keystone species**. Explain why this species has a significant impact on the ecosystem and what might happen if it were removed.

6. **Class Discussion**

d) Present your food web to the class and discuss the interconnectedness of the ecosystem. Explore how energy flows through the food web and how removing one species can affect the entire system.

e) Fill in the blank spaces. Organisms that are eaten by other organisms but do not eat others are called …………………… this is because these organisms ……… their own food. Organisms which do not make their own food but depend on others (eat or are eaten by) are referred to as ………………………

7.3: Ecological Pyramids

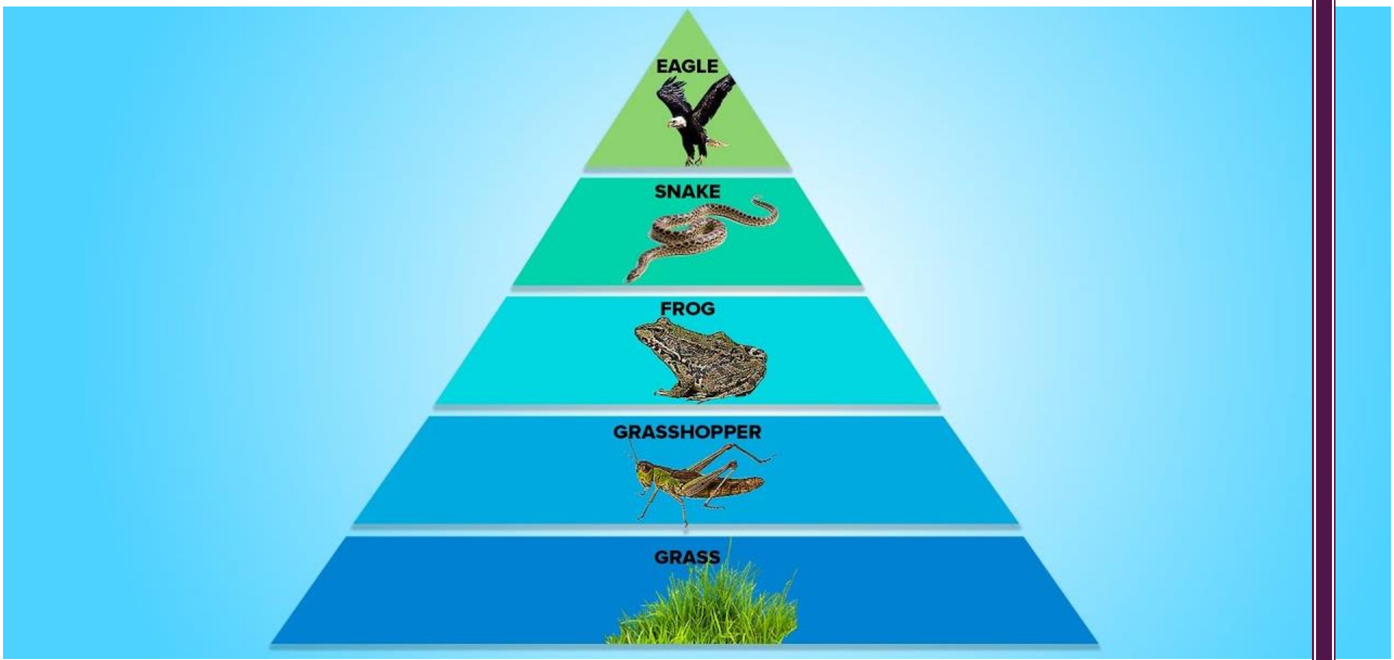


Figure 169: Ecological pyramid

What comes to your mind when you hear the word pyramid? What shape does it have? Which part of the shape is wide? A pyramid is a triangular structure that has a wide base and a narrow tip.

Ecological pyramids have a triangular shape too and are used to represent the relationship between different organisms in an ecosystem.

Ecological pyramids are graphical representations of the trophic structure and energy flow in an ecosystem. These pyramids help visualize the relationships between different trophic levels and the distribution of energy, biomass, or the number of organisms.

There are three main types of ecological pyramids: pyramid of energy, pyramid of biomass, and pyramid of numbers.

1. **Pyramid of Energy**

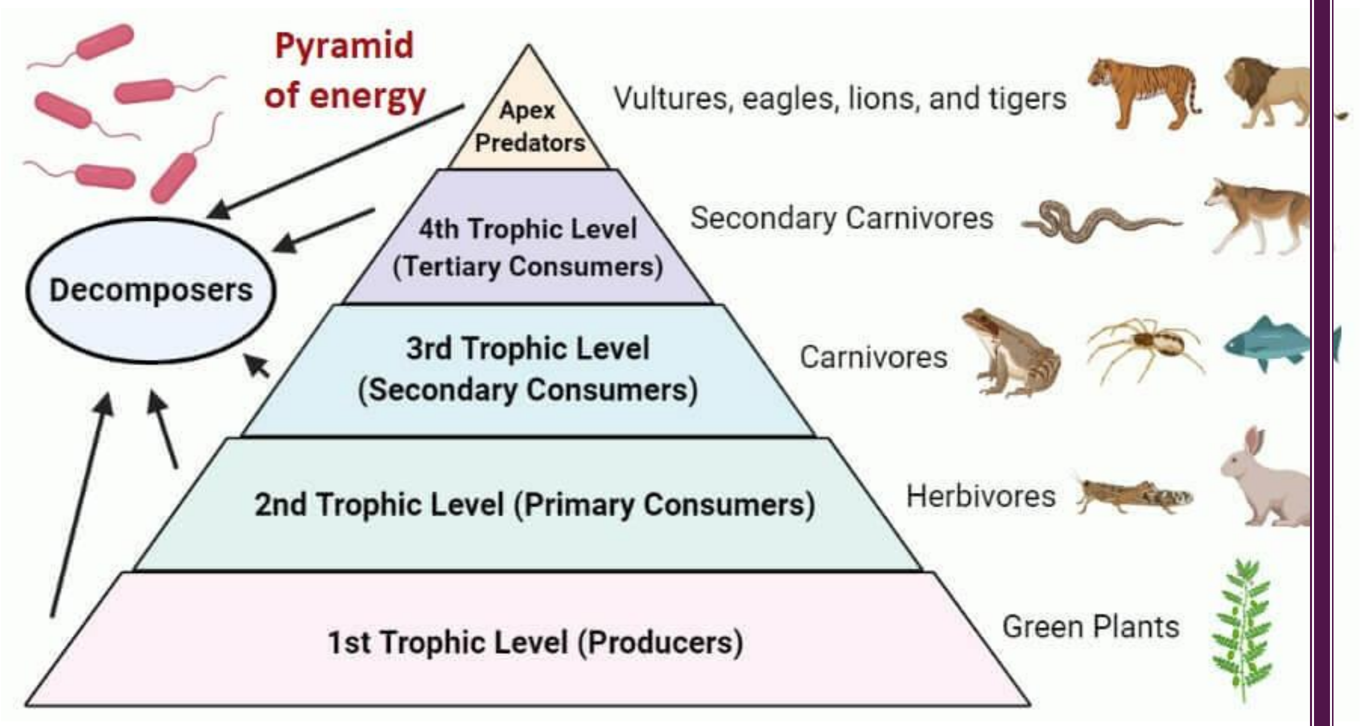


Figure 170: Pyramid of energy

- **Representation:** It depicts the flow of energy through the trophic levels of an ecosystem.

- **Units:** Measured in units of energy per unit area per unit time (e.g., kilocalories per square meter per year).
- **Shape:** Always upright, as energy is lost as heat with each trophic level.
- **Explanation:** The base of the pyramid represents the producers (plants), and each higher level represents a trophic level. Energy decreases as it moves up the pyramid, reflecting the energy lost in metabolism and heat production.

2. **Pyramid of Biomass**

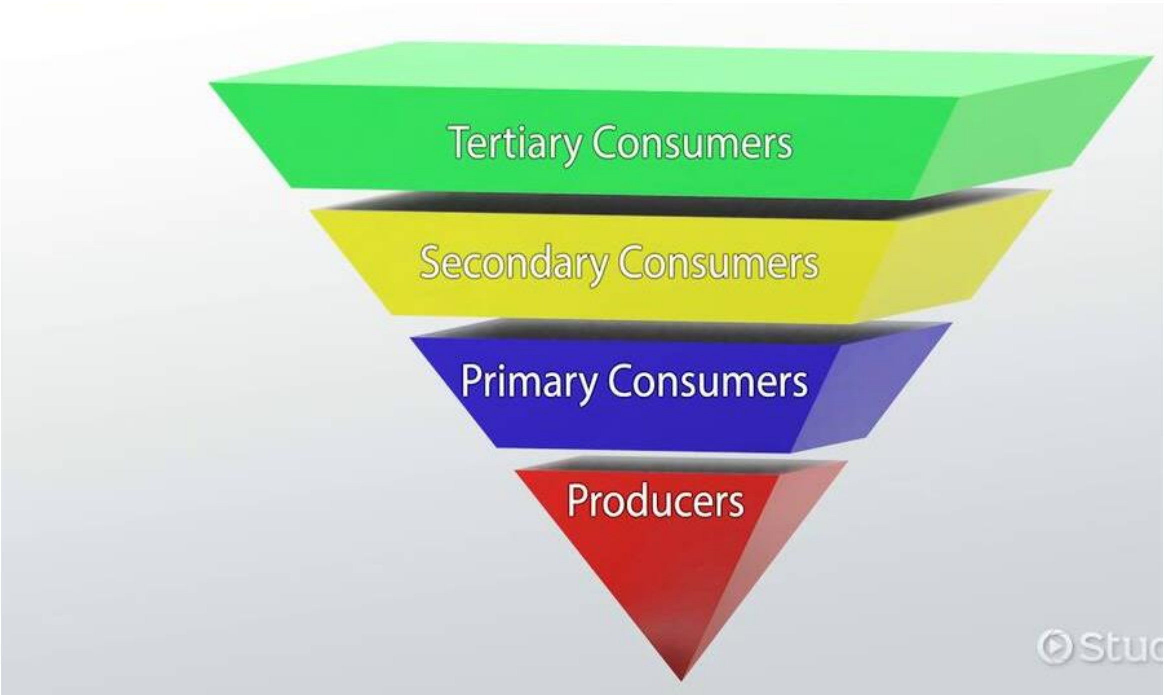


Figure 171: Pyramid of Biomass

- **Representation:** It illustrates the total mass of living organisms at each trophic level.

- **Units:** Measured in units of mass per unit area (e.g., grams per square meter).
- **Shape:** Generally, the pyramid is upright, but it can be inverted in certain ecosystems where the biomass of lower trophic levels is higher than that of higher trophic levels.
- **Explanation:** The base of the pyramid represents the biomass of producers, and each higher level represents the biomass of consumers. Biomass decreases with each trophic level due to energy loss and metabolic inefficiencies.

3. **Pyramid of Numbers**

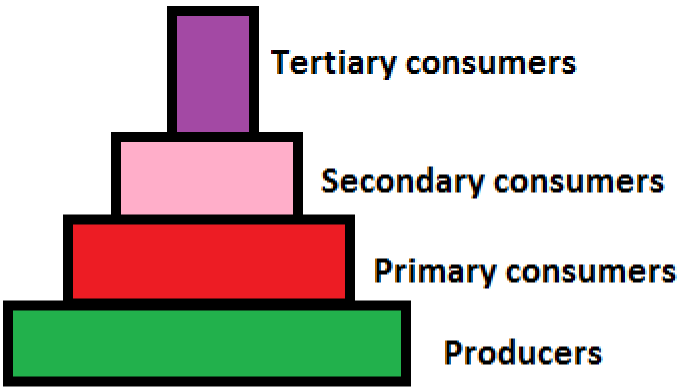


Figure 172: Pyramid of numbers

- **Representation:** It shows the number of individual organisms at each trophic level.
- **Units:** Count of individual organisms.
- **Shape:** Can be upright, inverted, or even

pillar-shaped, depending on the structure of the ecosystem.

- **Explanation:** The base of the pyramid represents the number of producers, and each higher level represents the number of consumers. The shape of the pyramid is influenced by the reproductive strategy of the organisms in the ecosystem. In some cases, the pyramid may be inverted, especially in ecosystems where a large number of small organisms support a smaller number of larger consumers.

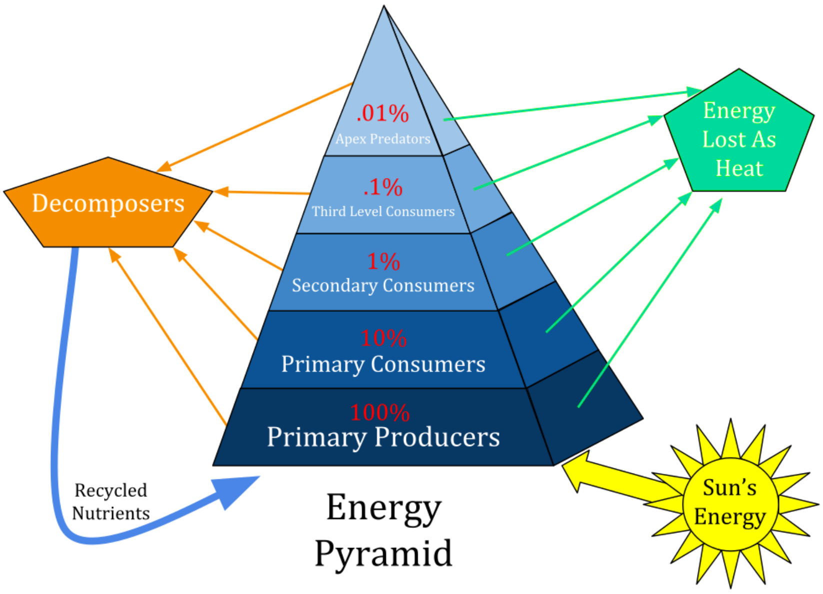


Figure 173: Constructing a pyramid of numbers

Do this activity in a group

Key question: How can you construct a pyramid of numbers?

What you need: pegs, a marker

What to do

1. In a school compound, learners counted the following numbers of organisms: plants 500, insects 150, birds 50 and cats 10.

2. Use a triangular shape (pyramid) to represent the nurtures of the organisms counted in a decreasing order.

From the pyramid you realize that organisms are at different feeding levels. These feeding levels are called trophic levels i.e. position that e organism occupies in the feeding relationship). The trophic levels are producers, primary and secondary consumers.

3. Redraw your pyramid use it to categories the organisms as producers, primary consumers and secondary consumers.
4. Which organisms belong in the first/lowest level of the pyramid?
5. Why is the number of producers more than that of the primary and secondary consumers?
6. What would happen if the number of consumers became more than that of the producers?
7. As an environmentalist, what would you do to ensure sustainability of the ecosystem?

Compare your responses with those of another group.

7.4: The Carbon Cycle

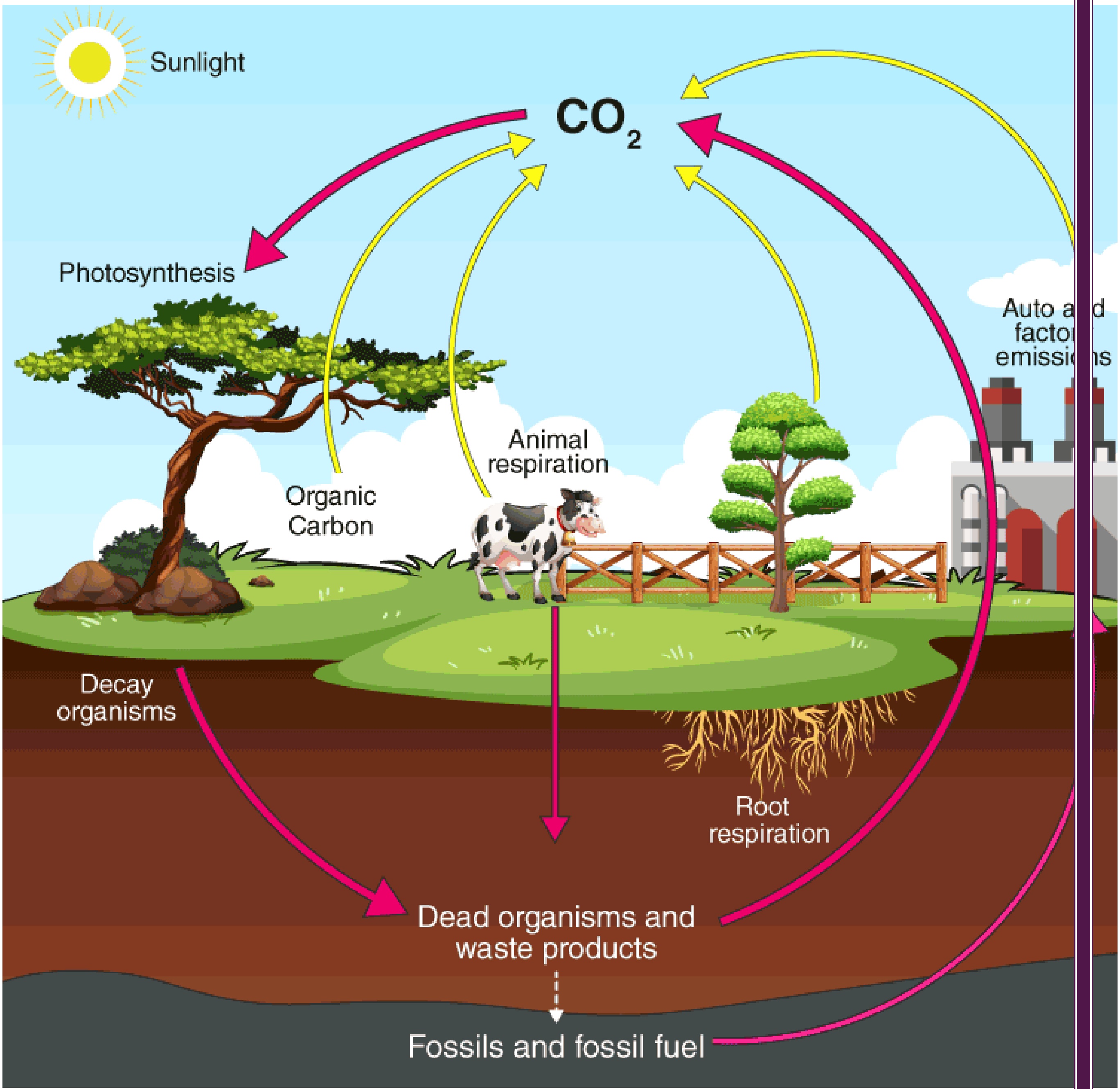


Figure 174: Carbon Cycle

In senior two, you learnt that plants use carbon dioxide to make their food. Where do you think carbon dioxide comes from and how do the plants get it?

In Activity 7.4, you will explore the carbon cycle. This will help you to understand the different forms in which carbon is stored and how it is transformed/changed from one form to another.

The carbon cycle involves the continuous movement of carbon between the atmosphere, oceans, land, and living organisms. It comprises various processes and reservoirs that contribute to the cycling of carbon in different forms.

Elements and processes of the carbon cycle

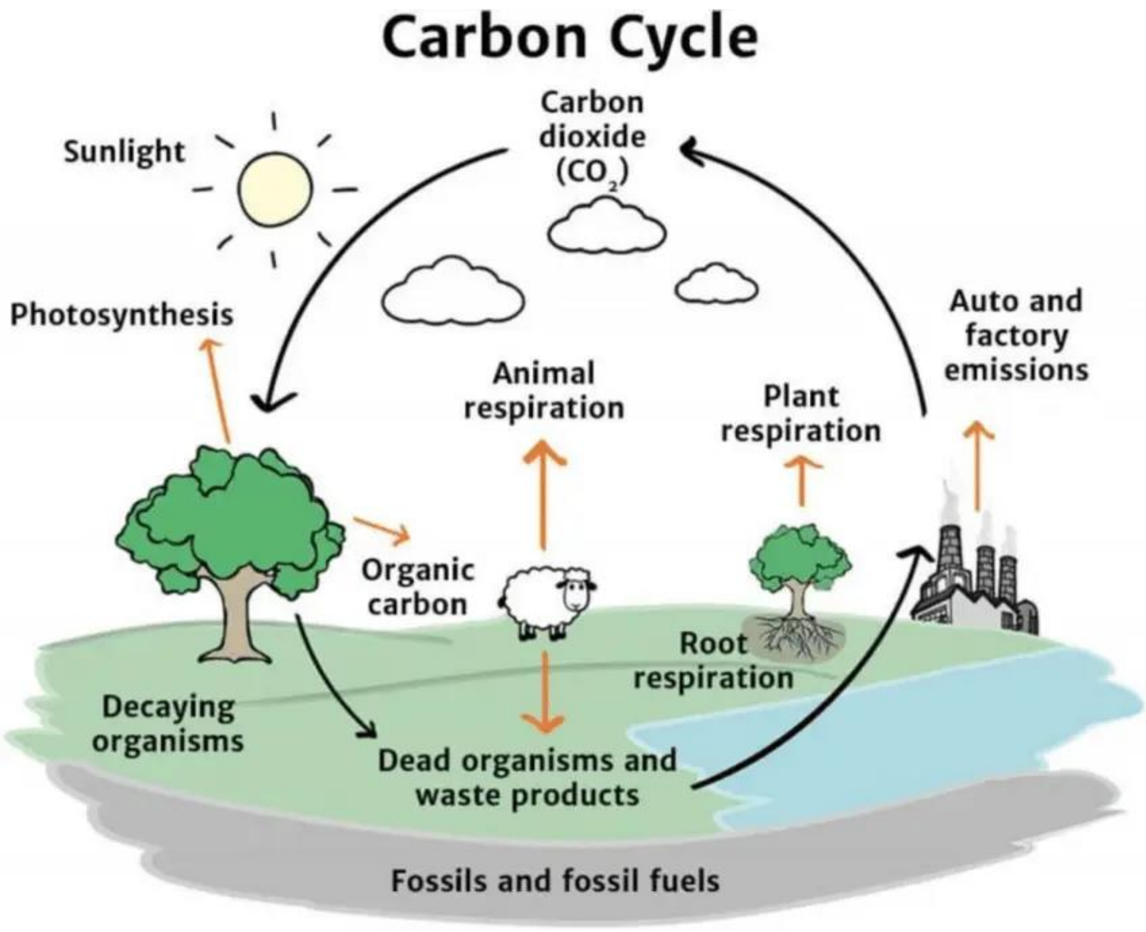


Figure 175: processes of the carbon cycle

1. **Atmosphere (Carbon Dioxide)**

1. Carbon dioxide (CO_2) in the atmosphere is a major reservoir of carbon.
2. Carbon dioxide is exchanged between the atmosphere and other reservoirs through processes such as photosynthesis, respiration, and combustion.

2. **Photosynthesis**

- **Process:** Plants, algae, and certain bacteria take in carbon dioxide from the atmosphere during photosynthesis. They convert carbon dioxide into organic compounds, primarily carbohydrates, using sunlight as an energy source.

3. **Respiration**

- Both plants and animals undergo respiration, releasing carbon dioxide back into the atmosphere as they break down organic compounds to obtain energy.

4. **Decomposition**

- Decomposers, such as bacteria and fungi, break down dead organic matter, releasing carbon dioxide and returning nutrients to the soil.

5. **Combustion**

- Both natural events (e.g., wildfires) and human activities (e.g., burning fossil fuels) release carbon stored in organic matter back into the atmosphere as carbon dioxide.

6. **Oceans (Dissolved Carbon):**

- **Source:** Oceans act as a significant carbon sink, absorbing carbon dioxide from the atmosphere.
- Carbon dioxide dissolves in seawater, forming dissolved inorganic carbon (DIC), bicarbonate ions (HCO3-), and carbonate ions (CO32-). Marine organisms use these forms of carbon to build shells and skeletons.

7. Soil (Organic and Inorganic Carbon)

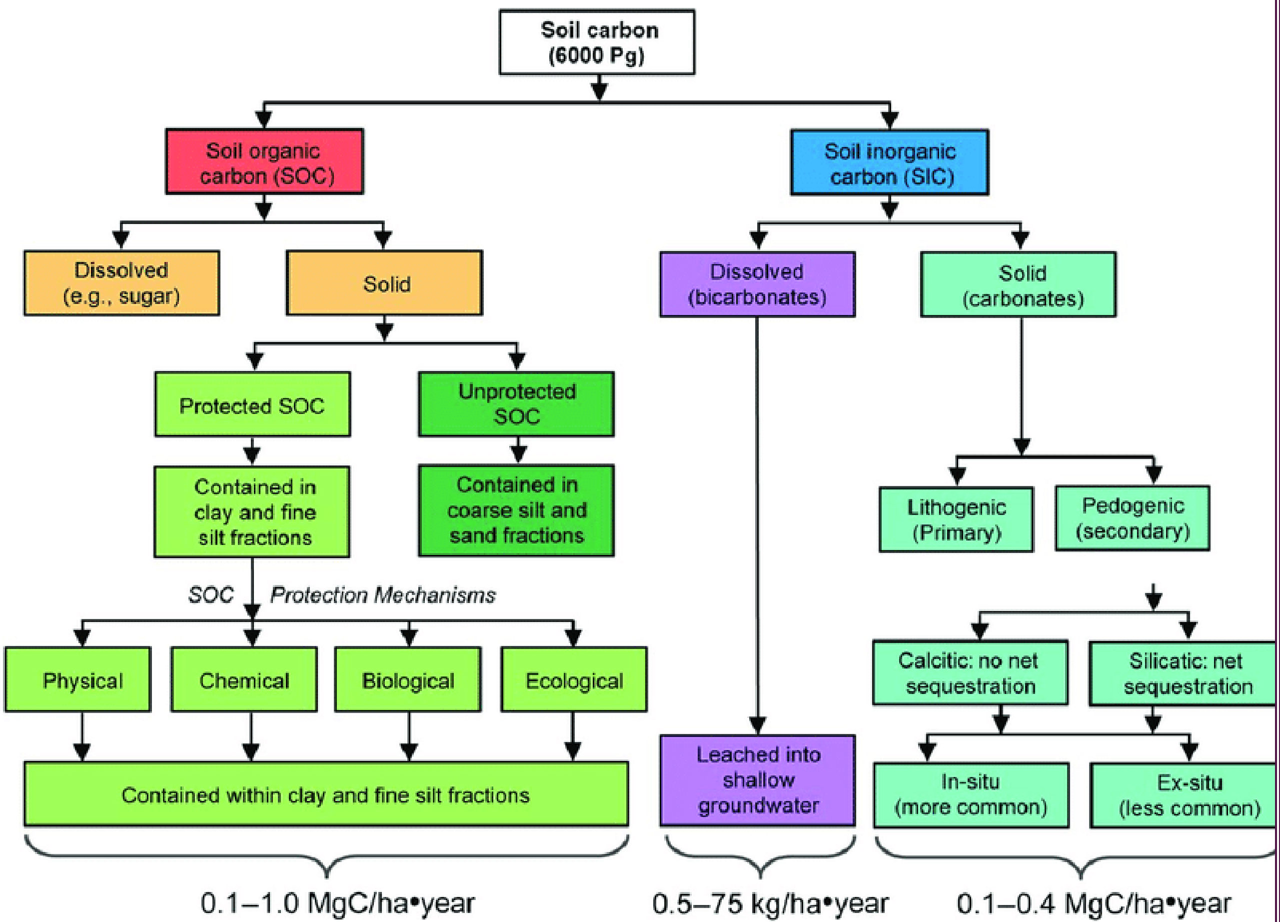


Figure 176: Organic and Inorganic Carbon

- **Source:** Soils store both organic carbon (from plant and animal residues) and inorganic carbon (carbonates).

- Plants contribute organic carbon to the soil through the deposition of organic matter. Over time, organic carbon can undergo decomposition or be stored in the soil for longer periods.

8. Carbon Sequestration (Long-term Storage):

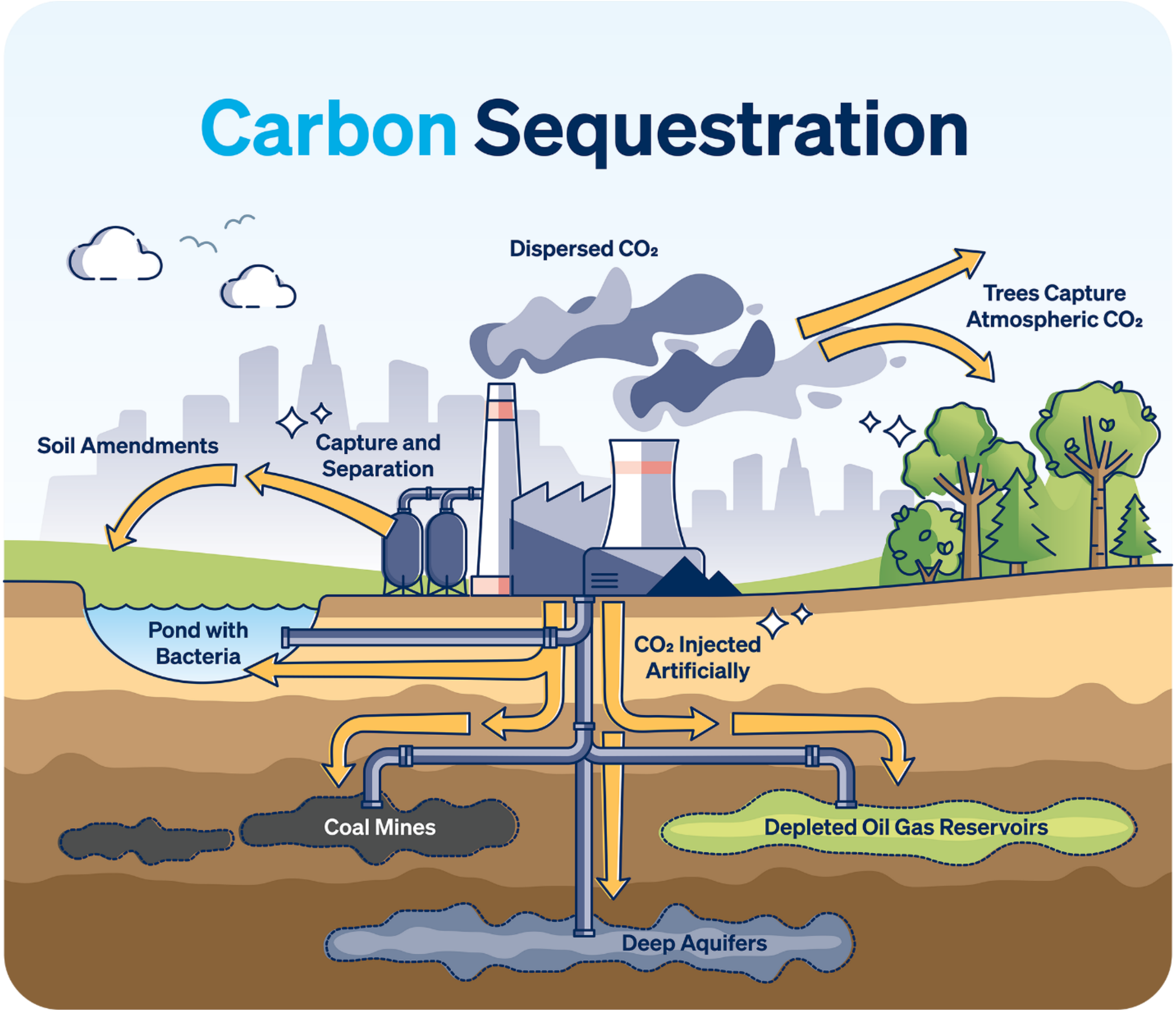


Figure 177: Carbon Sequestration

- Some carbon is sequestered or stored in long-term sinks, such as forests, peatlands, and soil. This acts as a natural buffer against atmospheric carbon dioxide.

In Activity 7.4: Exploring the carbon cycle

Do this activity in a group

Key question: What do you understand by the term carbon cycle?

What you need: Reference materials, the Internet

What to do:

1. Study figure 7.2 and.

i) Identity the living organisms and substances that emit/release carbon dioxide in the atmosphere.

ii) Mention how each of the living organisms/substances identified in I) above, emits/releases the carbon dioxide.

iii) Mention how each of the living organisms/substances identified in ii) above acquire carbon

iv) Using your responses from I) to ii) above and Figure 7.2, draw a carbon cycle.

2. Research about the carbon cycle and.

i) Explain the role of the sun in the carbon cycle.

ii) What would be the effect of high levels of carbon dioxide in the atmosphere.

iii) Use the Carbon cycle to explain how the levels of carbon dioxide in the atmosphere are maintained.

iv) What recommendations would you give to the people in the homestead in Figure 7.2 in order to reduce the amount of carbon dioxide emission.?

Discuss your responses with other groups.

Sample Activity of integration

A forest in Uganda is home to many organisms which include a variety of plants, snakes, a variety of birds and insects, leopards, monkeys, squirrels, rats, fungi and many microscopic organisms. These organisms stay in the forest and rarely come out since they get all their food within the forest.

A community living near the forest realized that there was good market for charcoal in the nearby town. They have decided to clear the trees, burn charcoal and get money to boost agriculture

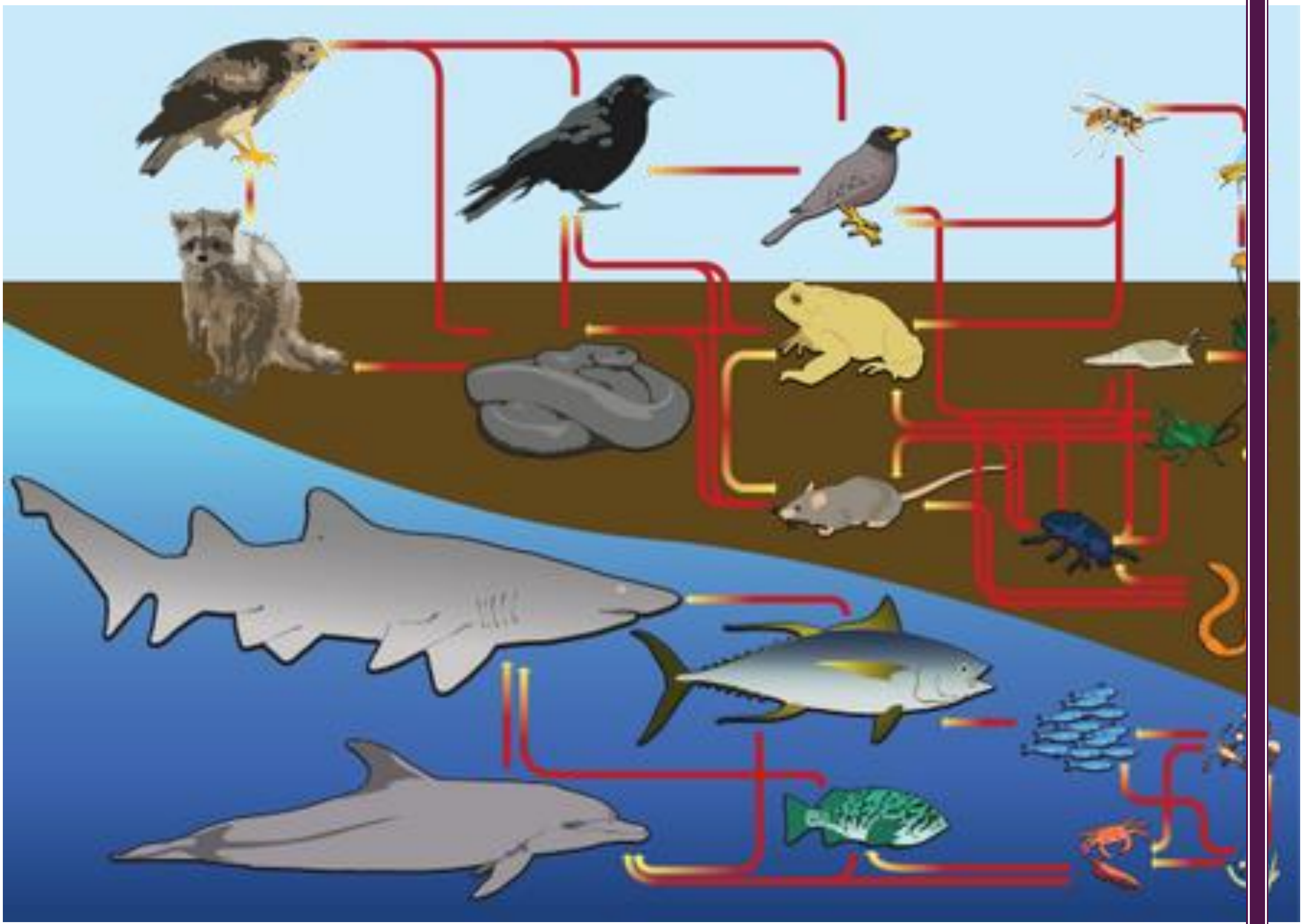
Task: using knowledge about feeding relationships, write a speech containing the information you will deliver to the community.

Chapter summary

In this chapter, you have learnt that:

1. In a food chain, a series of organisms each depend on the next as a source of food
2. A food web is a natural interconnection of food chains
3. The ecological pyramid is used to represent the relationship between different organisms in an eco-system.
4. Plants use carbon dioxide during photosynthesis.

Chapter 8: Associations in Biological Communities



Key words

- Competition
- Prey
- Predator
- Symbiosis
- Parasite

Learning outcomes

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, mutualism, commensalism and parasitism and appreciate their roles in an ecosystem

d) Recognize the role of parasites and vectors in the transmission of common diseases such as malaria, bilharzia, nagana and sleeping sickness.

e) Know the adaptations of parasites to their mode of life.

BLICAL INTEGRATION

In nature, we observe that all creatures have roles that support the balance of ecosystems, similar to how humans are urged to support and care for one another. As stated in 1 Corinthians 12:14, "For the body does not consist of one member but of many." This verse emphasizes the importance of unity and interdependence among individuals, reflecting the natural world's interconnectedness.

Understanding the various associations in biological communities highlights the complexity and balance of

ecosystems. By recognizing these relationships, we can better appreciate the natural world's intricacies and our role in maintaining environmental harmony.

Introduction

Organisms naturally interact with and depend on each other and the environment in different ways. Why do you think that organisms need each other? In this chapter, you will appreciate that organisms naturally interact in different ways with one another in a given habitat. This will help you to appreciate your interaction with other organisms.

8.1: Competition in Organisms

Figure 178: Competition in Organisms

As the number of organisms increase in an ecosystem, the available resources become insufficient. This results into competition.

Competition in organisms refers to the interaction between individuals or species for limited resources in their environment. These resources can include food, water, territory, mates, or any other essential factors necessary for survival and reproduction. Competition is a fundamental ecological concept, influencing the distribution and abundance of organisms within ecosystems. There are two main types of competition: intraspecific competition and interspecific competition.

1. **Intraspecific Competition**

Figure 179: Intraspecific Competition

- **Definition:** Intraspecific competition occurs between individuals of the same species.
- **Nature:** This form of competition involves members of a population vying for the same resources within their habitat.
- **Examples:** Intraspecific competition can manifest in various ways, such as competition for mates, nesting sites, food, or territory. For instance, male animals might compete for the attention of females during the breeding season.

2. **Interspecific Competition**

Figure 180: Interspecific Competition

- **Definition:** Interspecific competition occurs between individuals of different species.
- **Nature:** This competition arises when different species share similar ecological niches or require the same resources.
- **Examples:** Examples of interspecific competition include different species of birds competing for the same type of insect prey, or plants competing for sunlight, water, and nutrients in a shared ecosystem.

In Activity 8.1, you will explore competition in living organisms.

Figure 181: Wild dogs fighting for a caucus

In Activity 8.1: Exploring the competition in organisms

Do this activity in a pair?

Key question: What is competition in organisms?

What you need: a video clip showing competition in organisms

What to do:

1. Study figure 8.1 or watch a video clip showing competition in organisms:
   i) Describe what is happening.
   ii) What do you think led to the actions in I) above?
2. What other resources do you think organisms compete for in order to survive?
3. Discuss how other different organisms compete for the resources identified in 2) above.

4. From your findings derive the meaning of the term competitions as regards organisms

8.2: Predator-prey Relationships

Figure 182: Predator-prey Relationships

In nature, there are animals that depend on others as food. Have you ever seen an animal kill another for food? These animals are known as predators and the animals they hunt, kill and eat are known a preys.

Figure 183: Relationship between a lion and a buffalo

Predator-prey relationships are ecological interactions between two organisms, where one organism, the predator, consumes another organism, the prey. These interactions are a fundamental aspect of ecosystems and play a crucial role in regulating populations and maintaining biodiversity. Predator-prey relationships are dynamic and often lead to adaptations in both predators and prey.

Key Features of Predator-Prey Relationships:

Adaptations:

- **Prey Adaptations:** Prey species often evolve various adaptations to avoid predation. These adaptations can include camouflage, warning colouration (aposematism), defensive structures (such as spines or shells), and behaviors like mimicry or escape mechanisms.
- **Predator Adaptations:** Predators, in turn, may evolve adaptations that enhance their hunting abilities, such as specialized teeth, claws, or sensory adaptations like keen eyesight or acute hearing.

Examples of predator-prey relationships include lions and gazelles, wolves and deer, sharks and seals, and owls and rodents. These interactions are dynamic and can be influenced by various factors such as environmental conditions, availability of resources, and the presence of other species within the ecosystem.

In Activity 8.2: Brainstorming on predator-prey relationships

Do this activity in a pair

Key question: how do predators and prey interact?

What you need: pen, notebook

1. Study the figure 8.2 above and giving reasons, identify the;
   i) Predator
   ii) Prey
2. List down the examples of predators and prey animals that you know
3. The table below shows the number of predators and, preys in a certain habitat. Study it and;

Years	Cats	Rats
2011	6	55
2012	6	62
2013	17	70
2014	21	76
2015	15	65

2016	12	60
2017	8	54
2018	13	55
2019	15	67
2020	11	73

i. Present this information using a suitable graph

ii. From your graph, describe the predator-prey relationship

iii. What do you think would happen if the population of predators become higher than that of the prey;

4. Describe how are prey organisms adapted for survival?

Share your responses with another pair.

8.3: Inter-Relationships

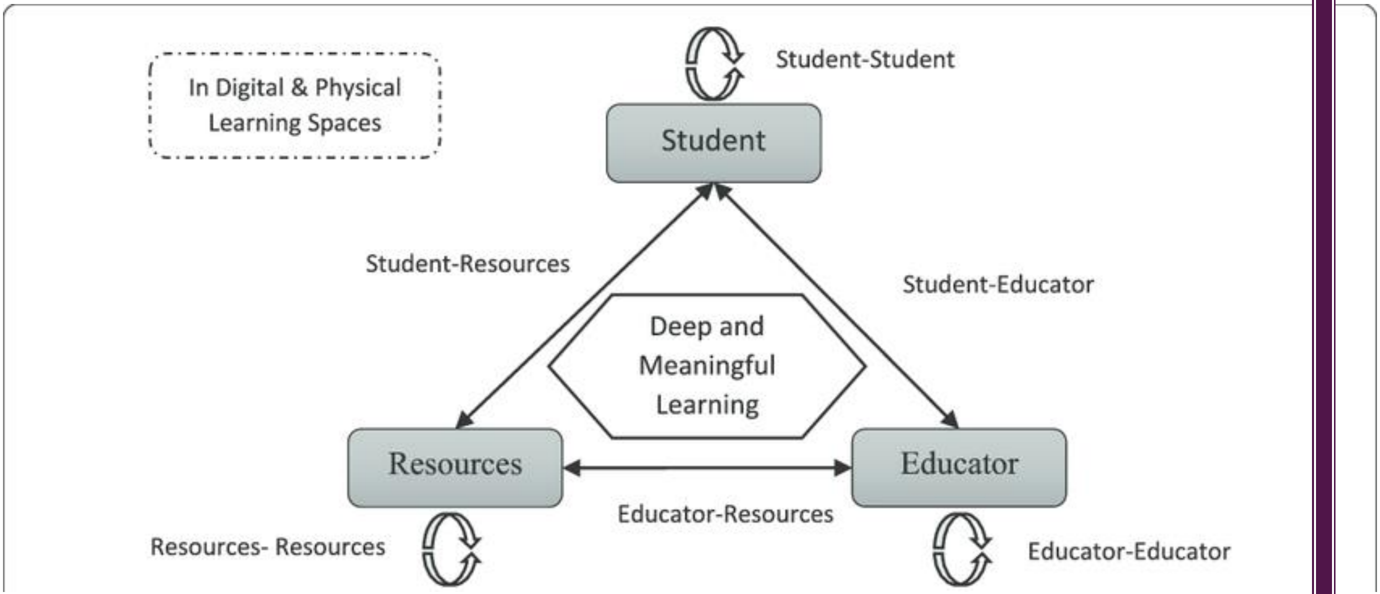


Figure 184: Inter-Relationships

Symbiosis is a biological interaction between two different species living in close physical association with each other. In a symbiotic relationship, the interacting organisms, known as symbionts, can be of the same or different species.

These interactions can be mutualistic, commensalistic, or parasitic, depending on the nature of the relationship and the benefits or harm incurred by the organisms involved.

Mutualism, commensalism, and parasitism are three types of symbiotic relationships that describe the interactions between different species in an ecosystem. These relationships involve the close association of organisms with one another, and they can have varying effects on the fitness and survival of the species involved.

Mutualism

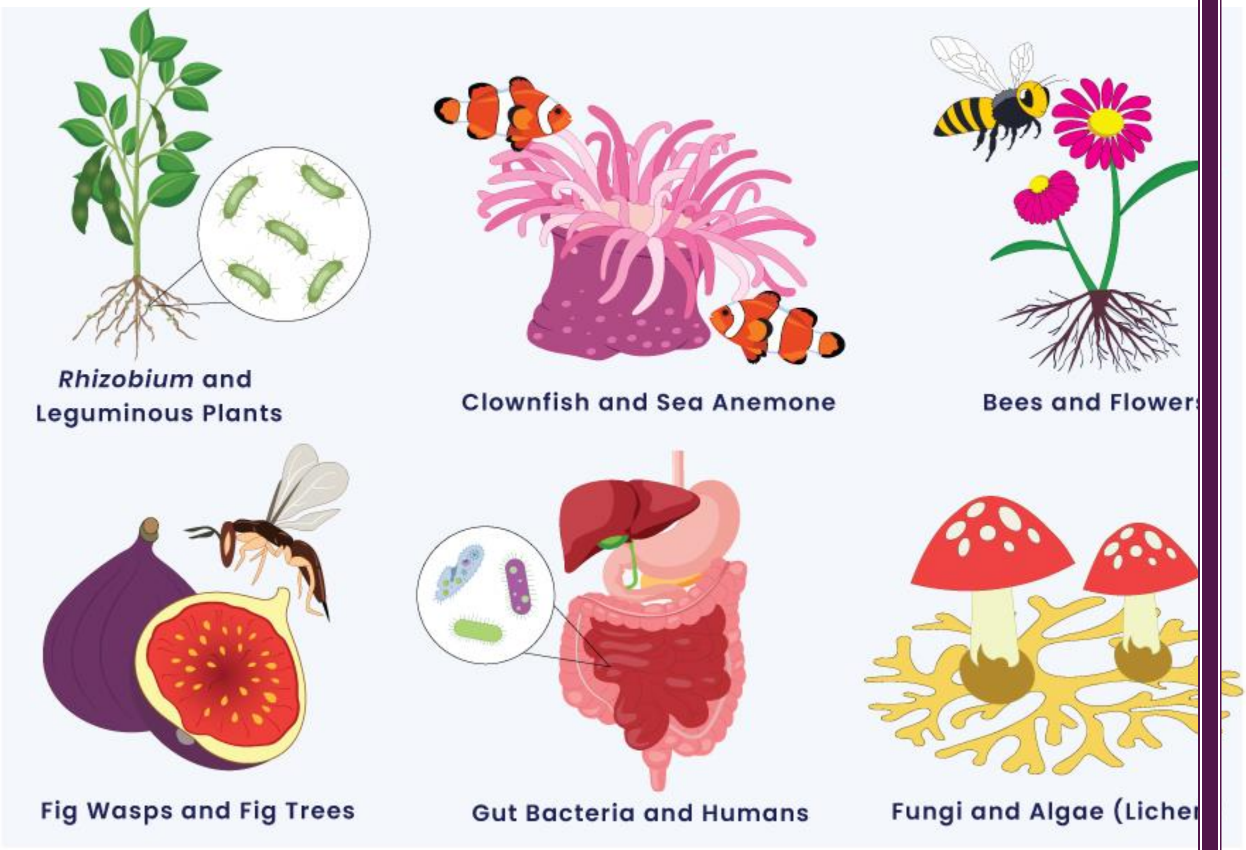


Figure 185: Mutualism

1. **Definition:** Mutualism is a symbiotic relationship in which both species benefit from the association.
2. **Interaction:** Both organisms receive a net positive effect, and their survival, reproduction, or another aspect of their fitness is enhanced.
3. **Examples:**
    - **Pollination:** Flowers and pollinators (e.g., bees, butterflies) benefit each other. The plant receives assistance in reproduction through pollination, while the pollinator obtains nectar as a food source.

- **Nitrogen-Fixing Bacteria:** Some plants form mutualistic relationships with nitrogen-fixing bacteria. The bacteria convert atmospheric nitrogen into a form that plants can use, and in return, the plants provide the bacteria with nutrients.

Commensalism

Figure 186: Commensalism

- **Definition:** Commensalism is a symbiotic relationship in which one species benefits, and the other is neither helped nor harmed.
- **Interaction:** While one organism benefits, the other is generally unaffected, and there is no significant impact on its fitness.

Examples

- **Epiphytic Plants:** Plants that grow on other plants (epiphytes) may benefit by gaining access to sunlight and nutrients without harming the host plant.
- **Remoras and Sharks:** Remora fish attach themselves to sharks to gain protection and access to prey without harming the shark. The relationship is considered commensal because the shark is typically unaffected.

Parasitism

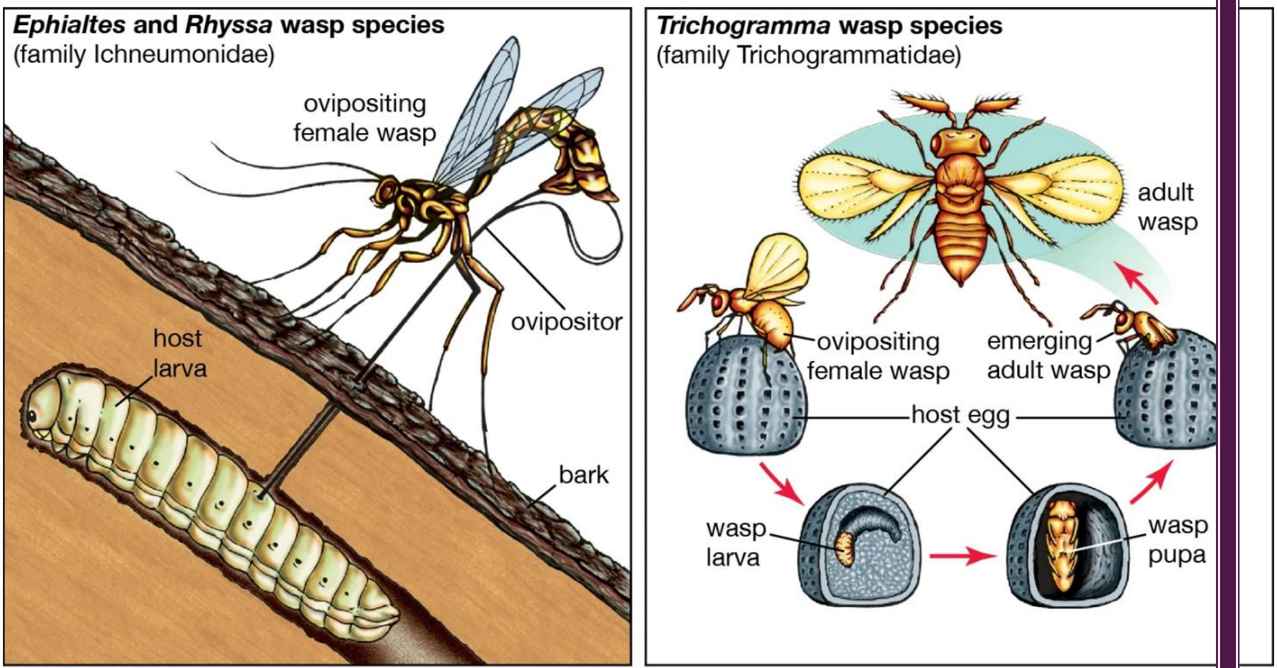


Figure 187: Parasitism

- **Definition:** Parasitism is a symbiotic relationship in which one organism, the parasite, benefits at the expense of the other organism, the host, which is harmed.
- **Interaction:** The parasite derives nutrients or resources from the host, often causing harm to the host in the process.

Examples

- **Ticks and Mammals:** Ticks feed on the blood of mammals, including humans, to obtain nutrients. The host experiences harm in the form of blood loss and potential transmission of diseases.
- **Mistletoe and Trees:** Mistletoe plants are parasitic on trees, extracting nutrients and water from the host tree. This can weaken the tree and, in severe cases, lead to its death.

These three types of symbiotic relationships represent different strategies that species have evolved to interact with each other in ecosystems. The outcomes of these interactions can have significant implications for the structure and functioning of ecological communities.


A


B

In Activity 8.3: Understanding forms of symbiotic relationships

Do this activity in a group

Key question: Explain the different forms of relationships and their significance in A, B and C

What you need: a dictionary, a note book

1. Use a dictionary to find out the meaning of:

    i) Mutualism

    ii) Commensalism

iii) Parasitism

2. Study the image in figure 8.3 and complete the table

Image	**Type of relationship**	**Reason**
A		
B		
C		

3. Name other pairs of organisms which show similar relationships

4. Discuss the significance of inter relationships in an ecosystem.

Compare your responses with those of another group.

8.4: Adaptation of Parasites to their Mode of Life

Figure 188: Parasites to their Mode of Life

You have seen that one of the forms of symbiosis is parasitism. What do you think a parasite is?

A parasite is an organism that lives in or on another organism, known as the host, and obtains nutrients and resources at the expense of the host's well-being. The relationship between a parasite and its host is often characterized by the parasite benefiting while the host is harmed to some extent. Parasitism is a type of symbiotic relationship, where the parasite relies on the host for its survival and reproduction.

For parasites to be successful in their mode of life, they must develop special adaptations that allow them to thrive in a parasitic lifestyle, where they depend on a host organism for nutrients and often cause harm to the host. These adaptations enable parasites to exploit their hosts successfully and complete their life cycle. Here are some common adaptations seen in parasites:

1. **Attachment Mechanisms**

- **Structures for Attachment:** Many parasites have specialized structures that help them attach to the host. These structures can include suckers, hooks, spines, or adhesive organs that allow the parasite to cling to the host's tissues.

2. **Morphological Adaptations:**

- **Reduced Size and Simplified Body:** Parasites often have a streamlined and simplified body structure, reducing unnecessary features. This adaptation helps them navigate within the host and increases their efficiency in acquiring nutrients.

3. **Specialized Mouthparts:**

- **Piercing or Sucking Mouthparts:** Parasites commonly possess specialized mouthparts, such as piercing or sucking structures, to access host tissues or fluids. This adaptation allows them to feed on the host's resources.

4. **Immunoevasion:**

- **Avoiding Host Immune Response:** Successful parasites have evolved mechanisms to evade or modulate the host's immune system. This may include strategies to hide from the immune response, inhibit immune cell function, or produce molecules that mimic host tissues.

5. **Life Cycle Strategies:**

- **Complex Life Cycles:** Many parasites have complex life cycles involving different stages and often multiple hosts. This complexity may include asexual and sexual reproduction, allowing the parasite to exploit different host environments and complete its life cycle.

6. **Host Specificity**

- **Host Recognition and Specificity:** Parasites may have adaptations that enable them to recognize and infect specific hosts. This specificity ensures that the parasite is adapted to the host's environment and can effectively exploit its resources.

7. **Mimicry**

- **Mimicking Host Molecules:** Some parasites can produce molecules that mimic those of the host. This mimicry helps them avoid detection by the host's immune system.

8. **Behavioral Adaptations**

- **Manipulating Host Behavior:** Some parasites can alter the behavior of their hosts to increase their own chances of survival and transmission. For example, parasites may induce changes in host feeding behavior or induce risk-taking behavior to enhance transmission to the next host.

9. **Reproductive Strategies**

- **High Reproductive Output:** Parasites often produce a large number of offspring to increase the chances of transmission to new hosts. High reproductive output compensates for the challenges and risks associated with a parasitic lifestyle.

Resistance to Host Defenses

- **Mechanisms to Resist Host Defenses:** Parasites may have evolved mechanisms to resist or overcome host defense mechanisms. This can include the production of enzymes that break down host tissues or the ability to evade detection by changing surface antigens.

These adaptations highlight the diversity of strategies that parasites employ to exploit their hosts successfully.

The evolution of these adaptations is shaped by the ongoing arms race between parasites and their hosts, where both parties continually adapt to each other's strategies.

In Activity 8.4, you will discover adaptations of parasites to their mode of life.

In Activity 8.4: Discovering the general adaptations of parasites

Do this activity in a group

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

What you need: a tick, a tapeworm, hand tenses, gloves forceps

What to do

1. Study the specimens provided and;
   i) What observable characteristics do you note from each specimen?
   ii) Could the specimens be having other characteristics you were not able to observe? Discuss and identify these characteristic.
   iii) For each of the specimens provided, explain how their characteristics help them to adapt to their mode of life.

Share your findings with the rest of the class.

8.5: Common Parasitic Diseases

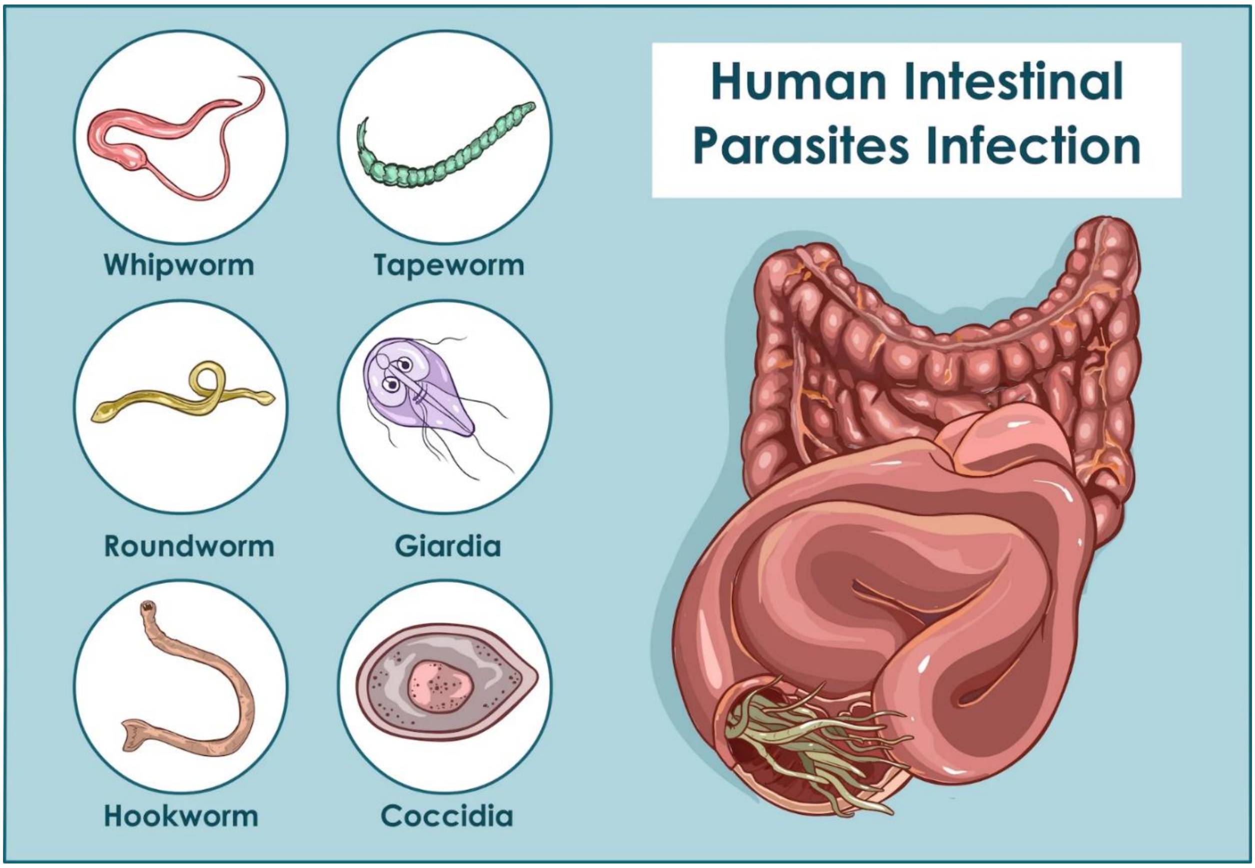


Figure 189: Human intestinal parasite infection

Most parasites are disease causing agents in living organisms. Which name is given to organisms that transfer parasites?

Parasitic diseases are a significant public health concern in many parts of the world, including Uganda. The prevalence of these diseases can be influenced by factors such as climate, sanitation practices, and access to healthcare. Some common parasitic diseases in Uganda include:

1. **Malaria:** Malaria is a mosquito-borne disease caused by Plasmodium parasites.

Figure 190: mosquito

It is a major health concern in Uganda, with transmission occurring throughout the country. The use of insecticide-treated bed nets and antimalarial medications are key strategies for prevention and control.

2. **Intestinal Parasites**

Figure 191: Intestinal Parasites

- **Schistosomiasis (Bilharzia):** This disease is caused by parasitic worms of the Schistosoma species and is transmitted through contact with contaminated water. It affects various organs, including the intestines and bladder.

Figure 192: Schistosomiasis

- **Soil-Transmitted Helminths (STH):** These include roundworms, hookworms, and whipworms. Infections often result from poor sanitation and hygiene practices.

***African Trypanosomiasis* (Sleeping Sickness):**

Figure 193: African Trypanosomiasis

This is a parasitic infection caused by Trypanosoma parasites and transmitted by tsetse flies. The disease can affect the central nervous system and is endemic in some regions of Uganda.

3. ***Lymphatic Filariasis* (Elephantiasis):**

Figure 194: Elephantiasis

Caused by filarial worms transmitted by mosquitoes, this disease can lead to chronic swelling of the limbs and genitals.

4. **Onchocerciasis (River Blindness)**

Figure 195: River Blindness

This parasitic infection is caused by the filarial worm *Onchocerca volvulus* and is transmitted by black flies. It can lead to skin and eye problems, including blindness.

Parasites and vectors play crucial roles in the transmission of various diseases. These organisms contribute to the spread of pathogens (disease-causing agents) among hosts, including humans, animals, and plants. Understanding the roles of parasites and vectors is essential for developing strategies to control and prevent the transmission of infectious diseases.

key aspects of their roles

1. **Parasites:**

   - **Definition:** Parasites are organisms that live in or on another organism (host) and derive nutrients at the host's expense.
   - **Role in Disease Transmission:**

- **Pathogenic Parasites:** Some parasites are themselves pathogens that cause diseases. Examples include Plasmodium species (malaria parasites), Trypanosoma species (causing sleeping sickness), and various helminths (worms) responsible for diseases such as schistosomiasis.

2. **Vectors:**

- **Definition:** Vectors are organisms, typically arthropods like mosquitoes, ticks, fleas, or flies, that can transmit pathogens from one host to another.
- **Role in Disease Transmission:**
- **Mechanical Vectors:** Some vectors mechanically transfer pathogens from one host to another without the pathogen undergoing significant development or replication within the vector. For example, flies can mechanically transmit pathogens from fecal matter to food.
- **Biological Vectors:** Biological vectors play a more active role in the life cycle of the pathogen. The pathogen undergoes development or multiplication within the vector before being

transmitted to a new host. Examples include mosquitoes transmitting Plasmodium parasites causing malaria or ticks transmitting Borrelia bacteria causing Lyme disease.

3. **Mechanisms of Transmission**

- **Direct Transmission:** In some cases, parasites or vectors directly transmit pathogens to hosts through bites, ingestion, or contact.
- **Vector-Borne Transmission:** Many diseases are transmitted through vector bites. The vector becomes infected by feeding on an infected host, and when it subsequently feeds on a new host, it injects the pathogen into the host's bloodstream.

In Activity 8.5, you will find out the role of parasites and vectors in transmitting diseases.

In Activity 8.5: Identifying the role of parasites and vectors in transmission of diseases

Do this activity in a group

Key question: How do parasites and vectors transmit diseases?

What you need: reference materials about vectors, the internet

1. Have you ever suffered from malaria or seen someone suffer from it?
2. How do you think you acquired malaria?
3. What causes malaria?

4. Discuss and identify other common parasitic diseases, their causes and mode pf transmission
5. **Record your findings in the table below**

Parasite	Disease	Mode of transmission	Vector

6. Discuss how the transmission of the diseases in the table can be prevented?

Compare your responses with those of other groups.

Sample activity of integration

A group of leaners visited Murchison fall national park and during the game ride, they were very shocked to see a pride of lions feasting on an antelope, a group of hyenas were moving around nearby and howling at the lions. They also saw a group of buffalos and many visibly had a number of ticks on them. However, they also saw egrets on the buffalos. When they went back, they decided to write to the park management.

This is part of their letter

To the management,

Murchison falls national game park.

Dear sir,

RE: <u>ADVICE ON HOW TO ORGANISE ANIMALS IN THE PARK.</u>

We visited the park last week and we were shocked to see animals eating other animals and al lot of buffalos were infested with ticks. So we came up with some advice that the park could use.

1. **Separate the animals so that each species is given its own space and the space fenced off so that they do not mix up**
2. **Provide food for all animals in the park by planting fruit trees and grass for the plant eaters then giving the carnivores meat.**
3. **Spray the animals with acaricides to kill the ticks.**

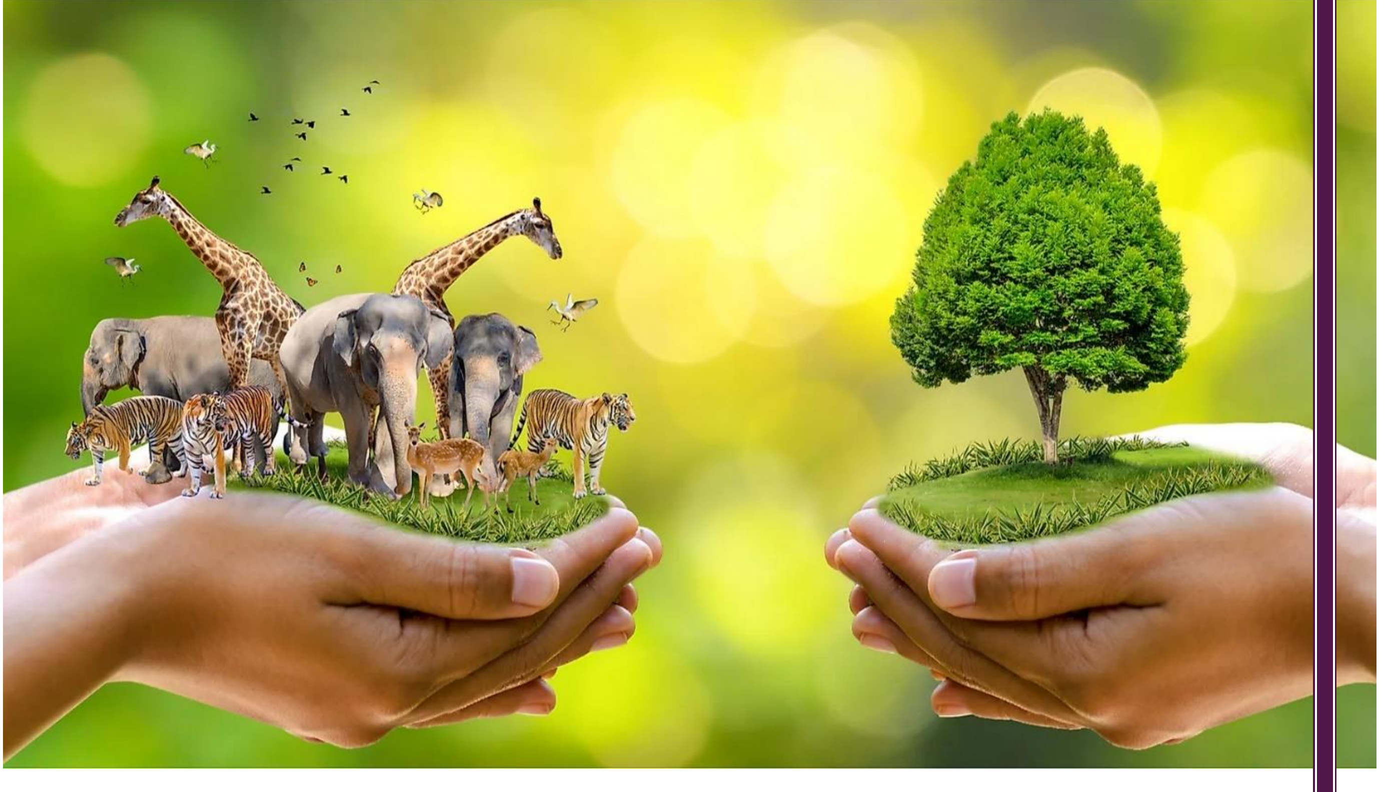
Task: you were the game ranger in charge of their visit and you have been asked to write a letter to reply to the aggrieved learners.

Chapter summary

In this chapter, you have learned about:

1. As a number of organisms increase in an eco-system, the available resources reduce which leads to completion.
2. Predator-prey relationship involves predators which kill and eat other animals and preys which are killed and eaten.
3. Interrelationships include mutualism, commercialism and parasitism
4. Parasites have special adaptations to their mode of life

Chapter 9: Humans and the Natural Environment



Key words

- Environment
- Pollution
- Natural resources
- Sustainable development goals (SDGs)

Learning outcomes

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

a) Understand why there is a world-wide focus on sustainability and 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 suggestions about how to preserve the natural environment for all living things.

d) Understand the sources, effects and control of air, land and water pollution.

BIBLICAL INTEGRATION

In the stewardship of the environment, we are reminded of God's command in Genesis 2:15: "The Lord God took the man and put him in the Garden of Eden to work it and take care of it." This verse emphasizes our responsibility to care for the Earth, ensuring that natural resources are used wisely and preserved for future generations.

Understanding the interconnection between human activities and the natural environment is crucial. By recognizing the impact we have on our natural

resources and committing to sustainable practices, we can help ensure a healthier planet for ourselves and future generations, aligning our actions with the global goals for sustainability and our biblical mandate to care for creation.

Introduction

Which natural resources do you know that Uganda is endowed with? In many regions most of these natural resources have been negatively affected by human activities.

In this chapter, you will appreciate that Uganda has different natural resources. You will also appreciate that our activities have an impact on

these resources and recognize the reasons why countries have committed to global Sustainable Development Goals (SDGs).

9.1: Uganda's Natural Resources

Figure 196: The source of river Nile

Uganda is often referred to as "The Pearl of Africa," a phrase coined by Sir Winston Churchill in his 1908 book, "My African Journey." Churchill used this term to describe the country's natural beauty and its diverse range of landscapes, wildlife, and resources. Several factors contribute to Uganda's reputation as the "Pearl of Africa":

1. **Scenic Beauty:** Uganda is blessed with stunning landscapes, including lush green hills, fertile plains, and impressive mountain ranges. The country is home to the "Mountains of the Moon" (the Rwenzori Mountains) and boasts breathtaking scenery around Lake Victoria, the largest lake in Africa.

2. **Rich Biodiversity:** Uganda is known for its incredible biodiversity, with a wide variety of plant and animal species. It is home to numerous national parks and wildlife reserves, including Bwindi Impenetrable National Park and Mgahinga Gorilla National Park, where visitors can encounter endangered mountain gorillas.
3. **Source of the Nile River:** The Nile River, one of the longest rivers in the world, has its source at Lake Victoria in Uganda. The country's connection to this iconic river adds to its allure and significance.
4. **Cultural Diversity:** Uganda is culturally diverse, with over 50 distinct ethnic groups, each contributing to the nation's rich cultural tapestry. The diversity is evident in languages, traditional dances, music, and art.
5. **Warm and Friendly People:** Ugandans are often described as warm and friendly, contributing to the positive experiences of visitors. The hospitality and friendliness of the people have become part of Uganda's appeal.
6. **Mild Climate:** The country generally has a favorable climate with mild temperatures, making it a pleasant destination for travelers throughout the year.
7. **Adventure Opportunities:** Uganda offers various adventure activities, including trekking to see mountain gorillas and chimpanzees, hiking in the Rwenzori Mountains, and white-water rafting on the Nile River.

8. **Conservation Efforts:** Uganda has made significant strides in wildlife conservation, particularly in protecting endangered species like the mountain gorilla. The commitment to conservation enhances the country's reputation as a responsible custodian of its natural resources.

Overall, the combination of natural beauty, cultural richness, and diverse attractions has led to Uganda being affectionately known as "The Pearl of Africa." This moniker reflects the country's unique and captivating qualities that have made it a compelling destination for tourists and explorers.

In Activity 9.1, you will explore the natural resources found in Uganda.

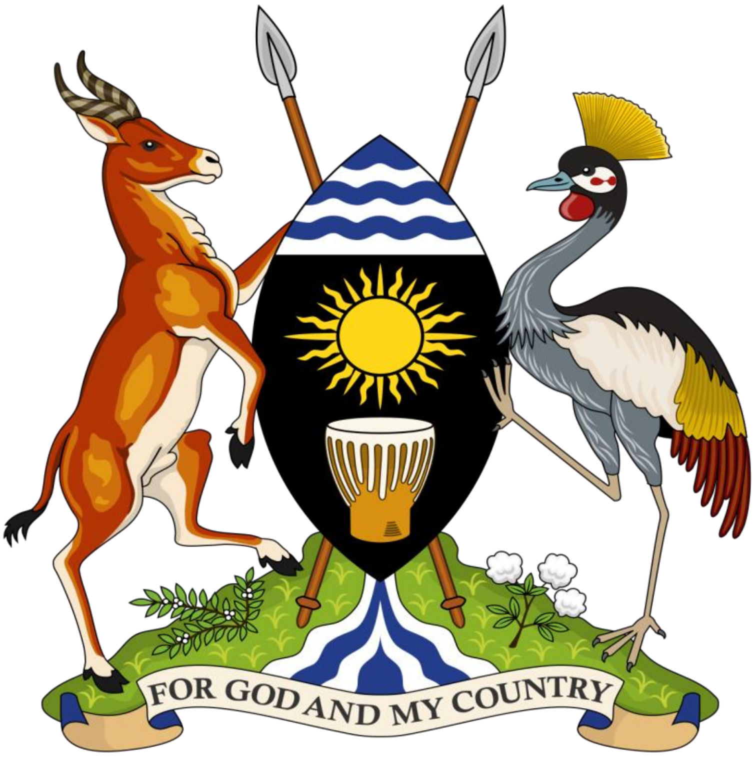


Figure 197: The Uganda court of arms

Uganda is endowed with a variety of natural resources that contribute to its economic development and biodiversity. These resources are spread across different sectors, including agriculture, forestry, minerals, water bodies, and wildlife. Here are some of the key natural resources found in Uganda:

1. Agricultural Resources

- **Arable Land:** Uganda has fertile soils, and a significant portion of the land is suitable for agriculture, supporting the cultivation of crops such as coffee, tea, bananas, maize, and various fruits and vegetables.
- **Water Resources:** The country is crisscrossed by several rivers and lakes, providing water for irrigation and supporting agriculture.

2. Mineral Resources

- **Copper:** Uganda has copper deposits, and exploration activities have been ongoing to assess the commercial viability of mining this mineral.
- **Cobalt:** Cobalt is found in some areas of Uganda, often associated with copper deposits.
- **Limestone:** Limestone deposits are present in various parts of the country, and there are potential applications in the cement industry.

3. Forestry Resources

Figure 198: Mabira forest

- **Timber:** Uganda has significant forested areas with valuable timber resources. However, deforestation and illegal logging are ongoing challenges.
- **Non-Timber Forest Products:** Forests provide various non-timber products, including medicinal plants, fruits, and honey.

4. Wildlife and Biodiversity

Figure 199: Lake Mburo National parks

- **National Parks:** Uganda is renowned for its rich biodiversity and is home to several national parks and wildlife reserves, such as Bwindi Impenetrable National Park, Queen Elizabeth National Park, and Murchison Falls National Park.
- **Endangered Species:** The country is a habitat for endangered species such as mountain gorillas, chimpanzees, and various species of antelope.

5. Water Resources

- **Lakes and Rivers:** Uganda is blessed with numerous lakes and rivers, including Lake Victoria, Lake Albert, Lake Kyoga, and the Nile River, providing water for various purposes such as agriculture, industry, and domestic use.

6. Renewable Energy Resources

Figure 200: Karuma Hydro power

- **Hydropower:** Uganda has substantial hydropower potential, and several hydropower projects are in operation or under development, contributing to the country's energy needs.

7. Oil and Gas:

- **Oil Reserves:** Uganda has discovered significant oil reserves in the Albertine Rift region. The development of the oil and gas sector is a major focus for future economic growth.

8. Fisheries:

- **Inland Fisheries:** Uganda's lakes and rivers support a vibrant inland fisheries industry, providing a source of livelihood and nutrition for many communities.

9. Tourism Resources

Figure 201: Lake mutanda

- **Scenic Landscapes:** The country's diverse landscapes, including mountains, lakes, and national parks, make it a popular destination for ecotourism and wildlife safaris.

Activity: Identifying the natural resources in Uganda

Do this activity in a pair

Key question: what are the natural resources found in Uganda.

What you need: A Ugandan atlas, reference materials about natural resources in Uganda.

What to do:

1. Using the knowledge of Geography, what do you understand by the term natural resources?
2. Study the figure 205 and identify the natural resources represented.
3. Using the Atlas, identify and list other natural resources in Uganda.
4. Describe ways through which you can utilize non-renewable natural resources at school and in your village without depleting them.
5. Compare our responses with those of another air.

9.2: Factors that Affect Natural Resources/Ecosystems

Figure 202: Murchison falls

Human beings carry out several activities to sustain life. These activities together with natural factors have an impact on the natural environment/ ecosystems. In Activity 9.2, you will discover how natural factors and human activities affect the natural resources/ecosystems.

Several factors can significantly affect natural resources, influencing their availability, sustainability, and overall quality.

These factors are diverse and can vary depending on the type of natural resource, whether it be renewable or non-renewable.

Factors that affect natural resources

1. **Population Growth:** The rate of population growth directly impacts the demand for natural resources. As the global population increases, so does the demand for food, water, energy, and other essential resources. Population pressure can lead to overexploitation and depletion of natural resources.
2. **Technological Advancements:** Advances in technology can both positively and negatively impact natural resources. Improved technologies may enhance resource extraction efficiency, but they can also contribute to increased pollution and environmental degradation.
3. **Economic Development:** Economic growth and industrialization can lead to higher consumption of natural resources. Rapid industrial development often requires large quantities of raw materials, energy, and water, putting pressure on ecosystems and depleting resources.
4. **Land Use Changes:** The conversion of natural habitats for agriculture, urbanization, or infrastructure development can have significant consequences for ecosystems and biodiversity. Deforestation, in particular, can lead to the loss of valuable resources, including timber and biodiversity.
5. **Climate Change:** Changes in climate patterns, including shifts in temperature and precipitation, can impact the

availability and distribution of natural resources. This can affect agriculture, water resources, and the frequency of extreme weather events.

6. **Overexploitation:** Unsustainable harvesting or extraction of natural resources, such as overfishing, deforestation, or excessive groundwater pumping, can deplete these resources and lead to long-term environmental degradation.
7. **Pollution:** Pollution from industrial, agricultural, and urban activities can contaminate air, water, and soil, negatively affecting the quality of natural resources. Pollution can harm ecosystems, reduce biodiversity, and compromise human health.
8. **Policy and Governance:** The effectiveness of natural resource management is influenced by the presence of sound policies, regulations, and governance structures. Weak governance, corruption, and inadequate enforcement of regulations can lead to unsustainable resource use.
9. **Globalization:** The interconnectedness of the global economy can lead to the exploitation of natural resources in one region to meet the demands of another. This can result in the so-called "resource curse," where resource-rich countries may face challenges related to economic inequality and instability.

10. **Environmental Awareness and Conservation Efforts:** Public awareness, advocacy, and conservation efforts play a crucial role in the sustainable management of natural resources. Conservation initiatives, protected areas, and sustainable practices can help mitigate the negative impacts of resource exploitation.

Activity 9.2: Identifying the natural factors and human activities that affect the ecosystem

Do this activity in a group

Key question: Describe the man activities and natural factors that affect natural resources

Project 9.1

Design a product that can minimize the effects of human activities in your school environment.

9.3: Pollution

Figure 203: Air Pollution

Activities such as power generation, road construction and industrialization have been encouraged as ways of improving the economic status of Uganda. As a result, many manufacturing plants, power generation dams and roads have been established. These activities produce waste products that are released into the environment.

What do you think are some of the waste products from the industries? What could be their effects on the environment?

Pollution refers to the introduction of contaminants or substances into the environment that cause adverse effects. These contaminants, known as pollutants, can come from various sources and can affect air, water, soil, and even noise levels. Pollution poses risks to human health, ecosystems, and the balance of the environment. It can take various forms, including air pollution, water pollution, soil pollution, noise pollution, and more.

Common sources of pollution

Air Pollution

Figure 204: Air Pollution

- **Industrial Emissions:** Factories and manufacturing processes release pollutants such as particulate matter, sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOCs).
- **Vehicle Exhaust:** Combustion engines in cars, trucks, and other vehicles emit pollutants, including carbon monoxide (CO) and nitrogen oxides.
- **Power Plants:** Burning of fossil fuels in power plants releases pollutants into the air, contributing to air pollution.
- **Agricultural Activities:** Agricultural practices, including the use of certain fertilizers and pesticides, can release pollutants into the air.

Water Pollution

Figure 205: Water Pollution

- **Industrial Discharges:** Industries release pollutants, including heavy metals and chemicals, into water bodies through discharges and runoff.
- **Agricultural Runoff:** Pesticides, herbicides, and fertilizers from agricultural fields can contaminate rivers and streams.
- **Improper Waste Disposal:** Dumping of untreated sewage, chemicals, and other waste into water bodies contributes to water pollution.
- **Oil Spills:** Accidental or deliberate release of oil into oceans and rivers can lead to water pollution.

Soil Pollution

Figure 206: Soil Pollution

- **Industrial Activities:** Factories and industrial facilities can release contaminants into the soil, including heavy metals and hazardous chemicals.
- **Agricultural Practices:** Use of pesticides, herbicides, and chemical fertilizers can contribute to soil pollution.
- **Improper Waste Disposal:** Improper disposal of solid waste, including hazardous waste, can contaminate the soil.
- **Mining Operations:** Mining activities can release pollutants into the soil, affecting land quality.

Noise Pollution

Figure 207: Noise Pollution

- **Transportation:** Traffic noise from vehicles, airplanes, and trains is a significant source of noise pollution.
- **Industrial Machinery:** Noise generated by industrial equipment and machinery.
- **Construction Activities:** Noise from construction sites and related activities.
- **Recreational Activities:** Loud events, concerts, and other recreational activities can contribute to noise pollution.

Plastic Pollution

Figure 208: Plastic Pollution

- **Improper Disposal:** Littering and improper disposal of plastic waste contribute to plastic pollution.
- **Single-Use Plastics:** Packaging materials, disposable items, and single-use plastics contribute to environmental pollution.
- **Microplastics:** Microscopic particles of plastic can come from the breakdown of larger plastic items.

Thermal Pollution

Figure 209: Thermal Pollution

- **Power Plants:** Thermal pollution can result from the discharge of heated water from industrial processes and power plants into natural water bodies.

The effects of pollution are diverse and can have significant impacts on the environment, human health, and ecosystems.

Effects associated with pollution

1. Human Health

- **Respiratory Problems:** Air pollution, especially from particulate matter and pollutants like nitrogen oxides and sulfur dioxide, can lead to respiratory diseases such as asthma, bronchitis, and lung cancer.
- **Waterborne Diseases:** Contaminated water sources can transmit waterborne diseases like cholera, dysentery, and other gastrointestinal illnesses.
- **Cancer Risk:** Exposure to certain pollutants, including carcinogens, can increase the risk of cancer.

2. Environmental Impact

- **Biodiversity Loss:** Pollution can harm and disrupt ecosystems, leading to the decline of plant and animal species.
- **Aquatic Ecosystem Degradation:** Water pollution can harm fish and other aquatic life, leading to the decline of biodiversity in rivers, lakes, and oceans.
- **Soil Contamination:** Pollutants in the soil can affect soil fertility, harm plant life, and disrupt ecological balance.

3. Climate Change

- **Global Warming:** Greenhouse gas emissions, such as carbon dioxide and methane, contribute to the warming of the Earth's atmosphere, leading to climate change.
- **Extreme Weather Events:** Climate change induced by pollution is associated with more frequent and severe weather events, including hurricanes, floods, and droughts.

4. Water Quality and Availability

- Water pollution can render drinking water sources unsafe, leading to health risks for human populations.
- Excessive nutrient runoff, often from agricultural activities, can cause eutrophication in water bodies, leading to oxygen depletion and fish kills.

5. Soil Fertility and Agriculture

- Soil pollution, often due to the use of pesticides and chemical fertilizers, can lead to reduced crop productivity.
- Pollutants in the soil can be absorbed by plants, leading to contamination of the food chain and potential health risks for consumers.

6. Noise Disturbance:

- Prolonged exposure to high levels of noise can lead to hearing impairment.
- Noise pollution can cause stress and disturb sleep patterns, impacting mental health.

7. Ocean Pollution:

- Plastic pollution, oil spills, and chemical contaminants can harm marine life, leading to entanglement, ingestion of plastics, and disruption of ecosystems.
- Pollutants and rising sea temperatures can contribute to coral reef degradation.

8. Visual Impact:

- Pollution, particularly litter and plastic waste, can visually degrade natural landscapes and urban environments.

9. Social and Economic Impact:

- The health impacts of pollution can lead to increased healthcare costs for treating pollution-related diseases.
- Pollution-related health issues can lead to reduced productivity in affected populations.

10. Loss of Ecosystem Services

- Pollution can disrupt the normal functioning of ecosystems, leading to a loss of vital services such as pollination, water purification, and soil fertility.

In Activity 9.3, you will find out the sources, effects and control of pollution.

Activity 9.3: Finding out the sources, effects and measures to control pollution Do this activity in a group.

Key question: what is pollution and how can it be controlled?

What to do:

1. What do you understand by the terms pollution and pollutants?
2. Move around your school and identify signs and sources of pollution. Record your findings in your notebook.
3. Using reference materials and or the internet, research about land, air and water pollution. For each type of pollution, design a poster showing the pollutants, their sources and effects.
4. Using your findings in 2) suggest the possible ways through which you would address the problem of pollution.

9.4: Recycling Waste Products

Figure 210: Recycling Waste Products

Recycling or re-using waste is one of the ways of ensuring sustainable resource utilization.

Waste materials can be reused through various processes and strategies, contributing to resource conservation, environmental sustainability, and the reduction of waste sent to landfills.

Ways waste materials can be reused

Repurposing and Upcycling:

- Repurposing involves giving an item a new purpose, while upcycling involves transforming waste materials into products of higher value.
- Example: Old wooden pallets transformed into furniture or used glass bottles turned into decorative lamps.

1. **Composting Organic Waste**

Figure 211: Composting food wastes

- Composting is the decomposition of organic waste materials, such as food scraps and yard waste, into nutrient-rich compost that can be used as fertilizer.
- Example: Food waste, leaves, and grass clippings can be composted to create nutrient-rich soil amendments.

Textile Recycling

Figure 212: Textile Recycling

- Textile recycling involves collecting and processing used textiles to create new products or materials.
- Example: Old clothing and fabrics can be recycled into new textiles, insulation, or even turned into rags.

Electronic Waste Recycling

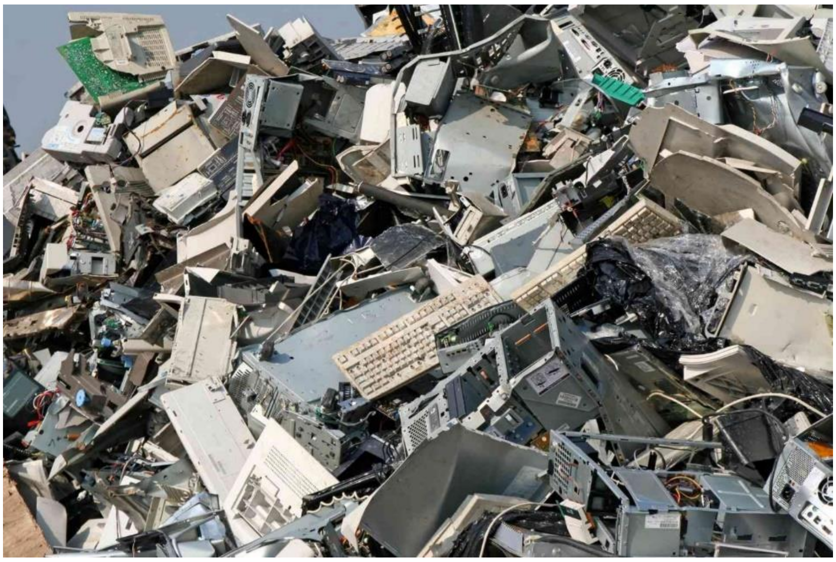


Figure 213: Electronic Waste Recycling

- E-waste recycling involves recovering valuable materials from electronic devices to be used in the manufacturing of new electronics.
- Example: Old computers and smartphones can be disassembled, and their components such as metals and plastics can be recycled.

Building Material Reuse

- Salvaging and reusing building materials from construction and demolition projects.
- Example: Reusing bricks, wood, or tiles from demolished structures in new construction projects.

Bottle and Can Redemption Programs

- Programs where consumers return used bottles and cans to receive a deposit or incentive, promoting recycling.
- Example: In some places, returning empty beverage containers to a recycling center for a refund.

Packaging Reuse

- Reusing packaging materials such as boxes, bubble wrap, and packing peanuts.
- Example: Businesses and individuals can reuse cardboard boxes for shipping, reducing the need for new packaging materials.

Plastic Containers and Bags Reuse

- Reusing plastic containers and bags for storage or as packaging.
- Example: Refilling and reusing plastic water bottles, or using reusable grocery bags instead of single-use plastic bags.

Furniture and Appliance Reuse:

- Donating or selling used furniture and appliances instead of discarding them.
- Example: Donating old furniture to charitable organizations or selling used appliances to individuals in need.

Tire Recycling:

- Recycling old tires into new products or using them for alternative purposes.
- Example: Ground-up rubber from old tires can be used to make playground surfaces or athletic field infill.

Art and Craft Projects:

- Using waste materials in creative projects or as art supplies.
- Example: Creating sculptures from scrap metal, mosaics from broken tiles, or jewelry from discarded materials.

Reusing waste materials requires a shift in mindset and practices, emphasizing the value of materials beyond their initial use. It not only conserves resources but also reduces the environmental impact associated with manufacturing and disposal. Education and awareness programs can play a crucial role in promoting a culture of waste reduction and reuse.

Activity 9.4: Recycling and re-using solid waste in your community

Do this activity in a group.

Key question: Explain how waste materials can be re-used

What you need: protective wear, reference materials, the internet, precaution: take care while handling waste materials and wear protective gear

What to do:

1. Using a suitable container, collect waste from the following areas
    i) Kitchen
    ii) Canteen
    iii) Classroom

2. Covert the waste from each of these areas into products that can be used.

3. Research on and describe ways in which the different categories of garbage can be reused or recycled.

Show your products to the rest of the class

9.5: Sustainability of Natural Resources

Figure 214: Sustaining natural resources

The United Nations set a collection of goals designed to achieve a better and more sustainable future for all. These goals are referred to as Sustainable Development Goals (SDGs).

The Sustainable Development Goals (SDGs) related to natural resources are primarily addressed within Goal 12: "Ensure sustainable consumption and production patterns." However, several other SDGs also intersect with natural resource management and conservation.

Here are the key SDGs related to natural resources and the reasons why countries have embraced them:

1. Goal 12: Ensure Sustainable Consumption and Production:

Targets:

- Target 12.2: "By 2030, achieve the sustainable management and efficient use of natural resources."
- Target 12.5: "By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse."

Reasons for Embracing:

- **Resource Scarcity:** Many countries recognize the finite nature of natural resources and the need to manage them sustainably to avoid depletion and ensure availability for future generations.
- **Environmental Impact:** Unsustainable consumption and production patterns contribute to environmental degradation, deforestation, loss of biodiversity, and climate change. Embracing Goal 12 helps mitigate these impacts.

2. **Goal 15: Life on Land:**

- **Targets:**
- Target 15.1: "By 2020, ensure the conservation, restoration, and sustainable use of terrestrial and inland freshwater ecosystems and their services."
- **Reasons for Embracing:**
- **Biodiversity Conservation:** Many countries recognize the importance of preserving terrestrial ecosystems and biodiversity to maintain ecological balance and support sustainable development.

3. **Goal 14: Life Below Water:**

   - **Targets:**
   - Target 14.2: "By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts."
   - **Reasons for Embracing:**
   - **Marine Resource Conservation:** Countries with coastlines recognize the importance of sustainable management of marine resources to protect biodiversity, support fisheries, and preserve the health of oceans.

4. Goal 6: Clean Water and Sanitation:

- **Targets:**
- Target 6.4: "By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity."
- **Reasons for Embracing**
- **Water Resource Management:** Countries aim to ensure the sustainable use of freshwater resources to address water scarcity, support agriculture, and provide clean water for communities.

5. Goal 13: Climate Action

- **Targets:**
- Target 13.2: "Integrate climate change measures into national policies, strategies, and planning."
- **Reasons for Embracing**
- **Natural Resource Impact of Climate Change** Climate change has significant implications for natural resources, including changes in precipitation patterns, sea level rise, and extreme weather events. Countries aim to address climate change to protect natural resources.

6. **Goal 7: Affordable and Clean Energy**

- **Targets**
- Target 7.2: "By 2030, increase substantially the share of renewable energy in the global energy mix."
- **Reasons for Embracing**
- **Reducing Dependence on Non-Renewable Resources:** Transitioning to clean and renewable energy sources helps reduce the reliance on finite and environmentally harmful fossil fuels.

7. **Goal 11: Sustainable Cities and Communities:**

- **Targets:**
- Target 11.6: "By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management."
- **Reasons for Embracing:**
- **Urban Resource Management:** Many countries are focusing on sustainable urban development to address the environmental impact of cities, including waste management and air quality.

Reasons for Embracing SDGs Related to Natural Resources

1. **Global Interconnectedness:** Countries recognize that natural resource management is a shared global responsibility, and sustainable practices contribute to global well-being.
2. **Long-Term Viability:** Sustainable management of natural resources ensures their availability for future generations, promoting long-term economic and environmental sustainability.
3. **Environmental Stewardship:** Many countries are committed to being responsible stewards of the environment, understanding that the health of natural resources is critical for ecological balance.
4. **International Commitments:** The SDGs provide a framework for international cooperation, and countries often embrace them to fulfill commitments to global sustainability and development.
5. **Economic Opportunities:** Sustainable practices related to natural resources can lead to the development of green industries, job creation, and economic growth.
6. **Resilience to Environmental Challenges:** Addressing natural resource challenges contributes to building resilience against environmental threats, such as climate change and biodiversity loss.

7. **Quality of Life:** Ensuring sustainable consumption and production patterns directly contributes to improved quality of life, health, and well-being for current and future populations.

In Activity 9.5, You will find out the SDGs related to natural resources and why countries have embraced them.

Activity 9.5: Discovering the SDGs related to natural resources

Key question: How do the SDGs address sustainability of natural resources?

What you need: resource person, a questionnaire, the internet

1. Interview the district natural resource Officer on sustainability of natural resources. Your interview should address the following:
   i) Countries that have committed to the SDGs
   ii) Reasons why the countries committed to the SDGs
   iii) The particular SDGs related to natural resources.
   iv) The importance of SDGs related to natural resources.
2. How can you advise your community to contribute to the SDGs?

Make notes on SDGs as regards environmental sustainability.

Sample Activity of integration

In Uganda, urbanization is taking place at a very high rate and pollution growth in towns is very high. It can be observed that many plants and animals that were common before cannot be seen. The weather patterns have also changed for worse and natural calamities have also increased.

Your school has decided to take action. Design an awareness poster to be placed in different towns

Chapter Summary

In this chapter, you have learned about:

1. Uganda is endowed with different natural resources which unfortunately have been misused.
2. There are several factors which affect natural resources which include human activity such as road construction.
3. Pollution is as a result of release of different waste products in the environment
4. Recycling waste products is one way of safeguarding the environment
5. Sustainable development goals were designed to achieve a better and more sustainable future for all.

Glossary

Abortion: Deliberate termination of a human pregnancy.

Albinism: An inherited disorder where there is little on production of the pigment melanin.

Antenatal care: The routine health check of pregnant woman.

Asexual reproduction: Reproduction without production and fusion of garments.

Birth control: A method used to prevent pregnancy.

Commercialism: A relationship where two organisms live together with one benefiting from the other.

Community: Population of different species living together in the same habitat.

Competition: A condition of striving to win.

Consumers: In an Eco system, these are organisms which cannot make their own

food. They feed on others.

Decomposer: An Organism that breakdown other dead organisms and their wastes and cause decay.

Down Syndrome: Arising from a defect involving chromosomes.

Ecology: The Study of living things in their environment.

Eco system: A natural unit consisting of living and nonliving elements interacting

to produce a stable system.

Embryo: An unborn offspring in the process of development.

Endangered species: A specie near to extinction.

Environment: Everything in the surrounding that affects the organism.

Evolution: The Reproduction of new species of organisms from existing organisms by a series of small changes over a long period.

Family planning: The practice of controlling the number of children one should have.

Fertilization: The fusion of the nuclei of two gametes to produce a zygote.

Flower: The seed bearing part of a plant.

Food chain: A series of organisms each depending on the nest a source of food.

Food Chain: A food relation in an ecosystem where energy is transferred from plants through a series of organism by each stage feeding on preceding.

Food web: A system of Interlocking and interdependent food chains.

Fruit: The sweet and fleshy product of a tree.

Gametes: The sex cells.

Gene: A unit of hereditary material located in chromosomes.

Gene: A unit of hereditary which is transferred from a parent to the offspring.

Genetic disorder: An inherited condition cause by DNA.

Germination: Onset of growth of a seed.

Habitat: A place where animals/species live.

Host: An organism that supports another organism living in or on its body

Inheritance: Existing in something as permanent characteristic.

Liver: organ which detoxifies various metabolites and produces necessary biochemical for the body.

Marketing: A process of inducing a branch or twigs to produce roots while still attached to the mother plant.

Meiosis: A type of cell division that reduces the number of chromosomes in the parent cell by half and produces four gamete cells.

Menstruation: The breakdown of the lining of the uterus which occurs when implantation has not taken place.

Menstruation: The process of shedding the endometrium when implantation doesn't take place.

Natural selection: A process whereby organisms better adapt to their environment tend to survive and produce more offspring.

Ovary: A female gland in which eggs form.

Ovum: A mature female reproductive cell.

Placenta: An organ in the uterus that supplies blood and nutrients to the growing baby.

Pollination: Transfer of pollen grains from anther to stigma.

Predator: An animal that kills and feed on other animals

Prey: An Animal that is hunted and killed by another.

Propagation: The bleeding of specimens of plants or animals by natural process

from the parents.

Pyramid of numbers: Way of expressing numbers of each trophic level.

Reproduction: Giving rise to new individuals of a particular specie.

Seed: The unit of reproduction of a flowering plant.

Seed dispersal: The spread of seed away from their parents.

Sex linkage: Describes the sex specific patterns of inheritance.

Species: A group of living organisms.

Trait: A distinguishing quality or characteristic typically belonging to a person.

Trophic level: A position an organism occupies in a food web.

Variation: A change or slight difference in condition amount or level within certain limits.

Vectors: An organism that transmits diseases.

Zygote: The product of the fusion of two gametes.