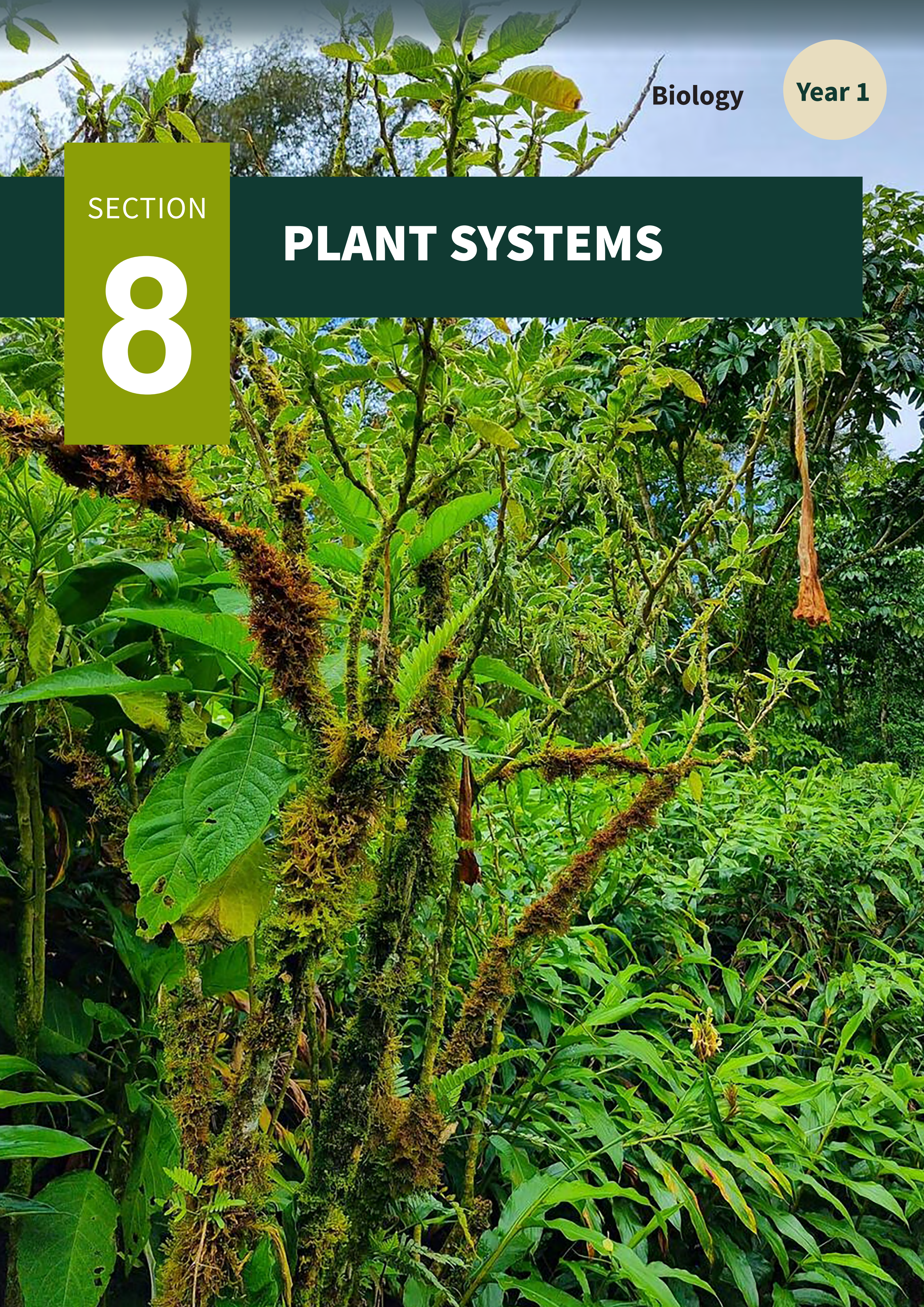
Biology

Year 1

SECTION

8

PLANT SYSTEMS



SYSTEMS OF LIFE

Plant Systems

INTRODUCTION

Monocotyledons and dicotyledons are major components of ecosystems, with monocotyledons exhibiting parallel leaf veins and flower parts in multiples of three, and dicotyledons featuring netlike leaf veins and flower parts in multiples of four or five. Understanding factors promoting healthy growth is crucial for conservation and crop enhancement, as well as understanding their ecological, medicinal, and aesthetic significance. This knowledge is interdisciplinary, connecting with subjects like Agriculture, Home Economics, Business, and Art and Design.

In this section, you will learn about the morphology, tissue organisation, and functions of flowering plants, including their major classes: monocotyledon and dicotyledon. Monocotyledon refers to the first seed leaf in the embryo, while dicotyledon is a pair of leaves. This distinction at the beginning of a plant's life cycle leads to significant differences.

At the end of this section, you will be able to:

- Distinguish between the external and internal features of monocotyledonous and dicotyledonous plants and relate plant structures to their functions.
- Relate the tissues of the leaf, stem, and roots of monocotyledonous and dicotyledonous plants to their functions.

Key Ideas:

- Flowering plants also known as angiosperms produce seeds that are enclosed in fruits.
- Flowering plants belong to the division, Angiospermophyta.
- Forbs (herbs), grasses and grass-like plants, broad-leaved trees, shrubs, vines and most fresh-water aquatic plants are flowering plants.

- Flowering plants have
  - o *flowers for sexual reproduction*
  - o *endosperm which provides food for the developing embryo, the cotyledons, and sometimes the seedlings*
  - o *seeds enclosed within a fruit*
  - o *xylem and phloem tissues that transport water, nutrients*
- Cotyledon refers to the 'first seed leaf', present in the embryo.
- Monocotyledon is a type of flowering plant, whose embryo (seed) stores only one cotyledon. Monocotyledonous plants contain seeds with a single cotyledon, parallel-veined leaves, scattered vascular bundles in the stem, the absence of a typical cambium, and an adventitious root system. Examples are grass, maize, banana, and bamboo.
- Dicotyledons belong to the group of flowering plants which typically have two cotyledons, or embryonic leaves, in their seeds. Their flowers generally have parts in fours or fives or multiples thereof. Examples of dicotyledons are Tridax, Talinum, and cocoa.
- Monocotyledonous root is a fibrous root with many thin roots that originate from the stem and make a wide network found close to the surface of the soil.
- The **transverse section of the root** revealed: the **epidermis** which is the outermost layer with hairs to absorb water and mineral salts, the **cortex** to provide strength and stores food, **endodermis** that separates the cortex from the central, vascular bundle for transportation of substances and central part the **pith**.
- T.S. of monocotyledonous stem shows four main regions/tissues such as **epidermis, hypodermis, ground tissues** and **vascular bundles**
- The Epidermis is made up of the upper epidermis (adaxial surface) which is a thin cuticle and has fewer stomata and the lower epidermis (abaxial surface) which is a thicker cuticle and has more stomata (hypostomatic distribution). Trichomes and hairs are present on both surfaces.
- The mesophyll layer is also made up of **palisade mesophyll** which is a single layer, compact and rich in chloroplast and **spongy mesophyll**, which is loosely packed, irregular cells with numerous intercellular spaces.

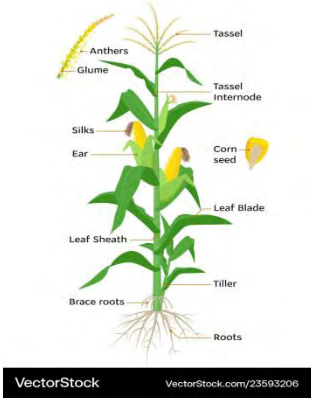
- Vascular bundles are scattered, parallel, and equidistant, the **xylem** is located towards the upper epidermis whilst the **phloem** is found towards the lower epidermis.
- **Bulliform cells** are large, empty cells in the upper epidermis, which regulate turgor pressure.
- **Sclerenchyma cells** provide mechanical support while **Stomatal guard cells** regulate the stomatal aperture.
- The dicot root is a tap root with smaller lateral branches transverse section of the dicot root shows: the epiblema/piliferous layer which is the outermost layer with hairs to absorb water and mineral salts, and **cortex** to provide strength and stores food, **endodermis** the inner lining of the cortex, pericycle that surrounds the **vascular bundles** for transportation of substances.
- A transverse section of the dicotyledonous stem shows four main regions/ tissues such as **epidermis, cortex, pith** and **vascular bundles**
- The primary factors which affect plant growth are **light, water, temperature** and **nutrients.**
- Factors such as **soil quality**, **water availability, temperature, light**, and **gardening** and **farming techniques** promote healthy growth of plants and increase crop production.

THE MORPHOLOGY OF FLOWERING PLANTS

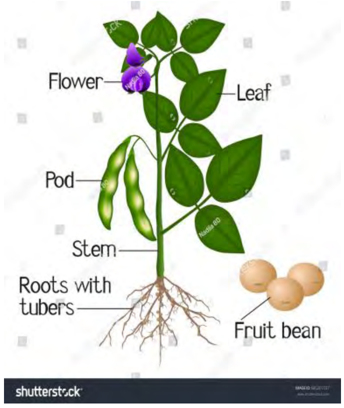
Flowering plants

Flowering plants are plants that produce flowers and fruits. They are called angiosperms (meaning “seeds enclosed within fruits”), and they belong to the division, Angiospermophyta. They include plant groups such as all forbs (flowering plants without woody stems, also known as herbs), grasses and grasslike plants, a large group of broad-leaved trees, shrubs, vines and most fresh-water aquatic plants.

(a) Pineapple Plant



(b) Maize Plant



(c) Soya bean Plant

(d) Water Lettuce

(e) Flamboyant Tree

(f) Water Lily

Fig. 8.1: Diagrams of some flowering plants

Features that Distinguish Monocotyledonous (monocots) from Dicotyledonous (dicots) Plants, and the Degree to which they Differ in Each Factor

1. **Cotyledons**
   a. **Monocots:** Have one cotyledon (seed leaf) in their seeds.
   b. **Dicots:** Have two cotyledons in their seeds.

   Difference: This is the primary distinction, with monocots having a single embryonic leaf and dicots having two.

2. **Leaf Venation**
   a. **Monocots:** Exhibit parallel venation, where the veins run parallel to each other.
   b. **Dicots:** Exhibit reticulate (net-like) venation, where the veins form a branching network.

Difference: The pattern of leaf veins is a clear visual indicator, with monocots having simpler, parallel veins and dicots having a more complex, net-like structure.

3. **Flower Parts**
   a. **Monocots:** Flower parts are typically in multiples of three (e.g., three petals, six stamens).
   b. **Dicots:** Flower parts are typically in multiples of four or five (e.g., four or five petals, ten stamens).

   Difference: The number of flower parts can help identify whether a plant is a monocot or dicot, with monocots having fewer, more uniform parts and dicots having more varied arrangements.

4. **Vascular Bundles in Stems**
   a. **Monocots:** Vascular bundles (xylem and phloem) are scattered throughout the stem.
   b. **Dicots:** Vascular bundles are arranged in a ring.

   Difference: The arrangement of vascular tissue is distinct, with monocots having a more dispersed pattern and dicots having a more organised, ring-like structure.

5. **Root System**
   a. **Monocots:** Typically have a fibrous root system, with many thin roots spreading out from the base of the plant.
   b. **Dicots:** Typically have a taproot system, with one main root growing deep into the soil and smaller lateral roots branching off.

   Difference: The root structure is another key difference, with monocots having a more surface-level, spreading root system and dicots having a deeper, central root.

6. **Pollen Structure**
   a. **Monocots:** Pollen grains usually have a single furrow or pore (mononucleate).
   b. **Dicots:** Pollen grains usually have three furrows or pores (tricolpate).

   Difference: The structure of pollen grains can be used to differentiate between the two groups, with monocots having simpler pollen and dicots having more complex pollen.

These features help botanists and plant enthusiasts identify and classify flowering plants into monocots and dicots, each group having distinct characteristics that influence their growth, reproduction, and ecological roles.

Some Common Angiosperms and their Importance in their Respective Habitats in Ghana

1. **Oil Palm (*Elaeis guineensis*)**

Fig. 8.2: Oil Palm

Habitat: Tropical rainforests and plantations

Importance:

a. **Economic Value:** Major source of palm oil, which is a significant export product for Ghana.

b. **Biodiversity:** Provides habitat for various species of birds, insects, and small mammals.

c. **Soil Health**: The leaf litter from oil palms contributes to soil fertility.

2. **Cocoa (*Theobroma cacao*)**

Fig. 8.3: Cocoa

Habitat: Tropical rainforests and cultivated plantations

Importance:

a. **Economic Importance:** Cocoa is a critical cash crop for Ghana, contributing significantly to the economy.

b. **Biodiversity:** Cocoa plantations support a variety of shade-tolerant plants and animals.

c. **Cultural Significance**: Integral to the livelihoods and traditions of many Ghanaian communities.

3. **Baobab (*Adansonia digitata*)**

Fig. 8.4: Baobab

Habitat: Savannas and dry regions

Importance:

a. **Nutritional Value:** Baobab fruit is rich in vitamins and minerals, providing essential nutrients to local communities.

b. **Water Storage:** The tree can store large amounts of water in its trunk, helping it survive dry seasons.

c. **Cultural Significance:** Often considered a symbol of resilience and longevity in many African cultures.

4. **Shea Tree *(Vitellaria paradoxa)***

Fig. 8.5: Shea Tree

Habitat: Savannas and woodlands

Importance:

a. **Economic Value:** Source of shea butter, which is used in cosmetics and food products.
b. **Biodiversity:** Provides habitat and food for various wildlife species.
c. **Soil Conservation:** Helps prevent soil erosion with its extensive root system.

5. **African Mahogany (*Khaya spp.*)**

Fig. 8.6: African Mahogany

Habitat: Tropical forests

Importance:

a. **Timber:** Provides high-quality wood used in furniture and construction.

b. **Biodiversity:** Supports a range of forest species, contributing to ecosystem health.

c. **Economic Value**: Timber export is an important source of income for local communities.

These angiosperms play crucial roles in their ecosystems and economies, supporting biodiversity, contributing to soil and water health, and providing significant economic and cultural benefits.

Activity 8.1

1. Go around your school compound with your friends and pick as many flowering plants as possible.
2. Carefully observe them
3. Write all observable features common to monocotyledons
4. Write all observable features common to dicotyledons
5. Compare your findings to other groups.
6. Make a PowerPoint presentation on the similarities and differences between monocotyledons and dicotyledons to be presented in class

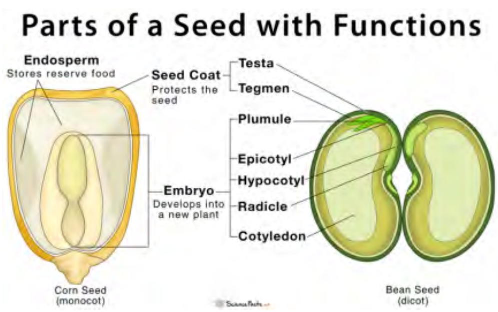
Activity 8.2

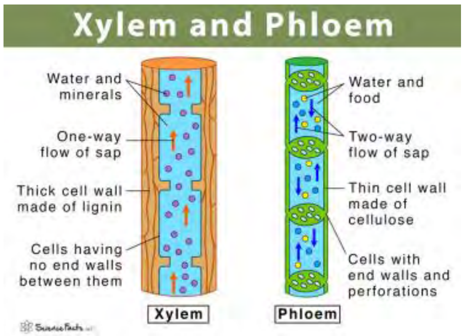
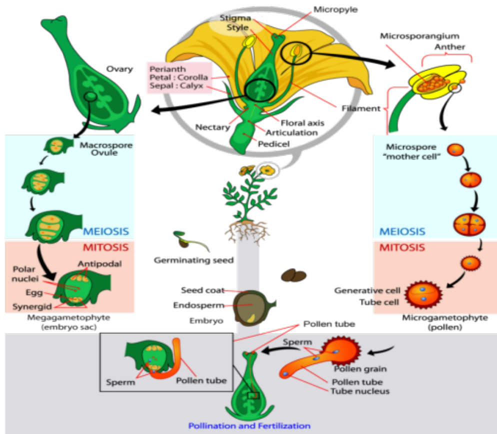
1. Make a poster on monocotyledonous and dicotyledonous plants, focusing on the features common to both groups of plants.
2. Outline the importance of up to five different angiosperms in their named habitats.

FEATURES THAT DISTINGUISH ANGIOSPERMS FROM OTHER PLANTS

Angiosperms comprise over 90% of plant species on Earth. The table below lists some features that distinguish angiosperms from other plants and make them the most diverse and dominant group of plants.

Table 8.1: Features of angiosperms

Feature	Description	Image
Possess flowers	These are the reproductive organs of flowering plants which are not found in any other seed plants.	A flower of a flamboyant. The odd pale petal, also known as the standard petal, has 'honey guides' which help insects find their way to the nectaries. 
Possess an endosperm	The endosperm is formed after fertilisation but before the zygote divides, and it provides food for the developing embryo, the cotyledons, and sometimes the seedlings.	
Possess enclosed seeds	Angiosperms have seeds enclosed within a fruit. The fruit develops from the ovary of the flower and protects the seeds while they develop.	Peas (seeds, from ovules) inside the pod (fruit, from fertilized carpel) 

Feature	Description	Image
Possess xylem and phloem tissues	They possess xylem and phloem, specialised tissues that transport water, nutrients, and sugars throughout the plant.	
Some possess structures for vegetative propagation	Vegetative propagation is propagation without sex. i.e. asexual reproduction	Vegetative propagation of leaf of Bryophyllum 
They exhibit double fertilization	This involves the fusion of one sperm cell with the egg cell to form the embryo, and another sperm cell combining with two polar nuclei to form the triploid endosperm. This process is not found in other plant groups.	

1. **Flowers**
   - *Reproductive Structures:* Flowers are the reproductive organs of angiosperms, facilitating the exchange of genetic information through pollination.
   - *Diversity:* Flowers come in a wide variety of shapes, sizes, and colours, adapted to attract specific pollinators.
2. **Seeds Enclosed in Fruits**
   - *Protection:* The seeds of angiosperms are enclosed within fruits, which protect the seeds and aid in their dispersal.

- *Dispersal Mechanisms:* Fruits can be adapted for dispersal by wind, water, or animals, increasing the chances of seed germination in suitable habitats.

3. **Vascular System**
   - *Xylem and Phloem:* Angiosperms have a well-developed vascular system consisting of xylem (for water transport) and phloem (for nutrient transport).
   - *True Vessels:* The xylem contains true vessels, which are more efficient in water transport compared to the tracheid found in gymnosperms.

4. **Double Fertilisation**
   - *Unique Process:* Angiosperms undergo double fertilisation, where one sperm fertilises the egg to form a zygote, and another sperm fuses with two other nuclei to form the triploid endosperm.
   - *Endosperm Formation:* The endosperm provides nourishment to the developing embryo, enhancing seedling survival.

5. **Diverse Habitats**
   - *Adaptability:* Angiosperms can grow in a wide range of habitats, from tropical rainforests to deserts.
   - *Variety of Forms:* They can be trees, shrubs, herbs, or vines, showing great morphological diversity.

6. **Complex Root and Shoot Systems**
   - *Roots:* Angiosperms have complex root systems that anchor the plant and absorb water and nutrients from the soil.
   - *Shoots:* The shoot system, including stems and leaves, supports the plant and is the primary site for photosynthesis.

7. **Heterosporous**
   - *Spore Production:* Angiosperms produce two types of spores: microspores (which develop into pollen grains) and megaspores (which develop into ovules).
   - *Pollination:* Pollen grains are transferred from the anther to the stigma, leading to fertilisation and seed formation.

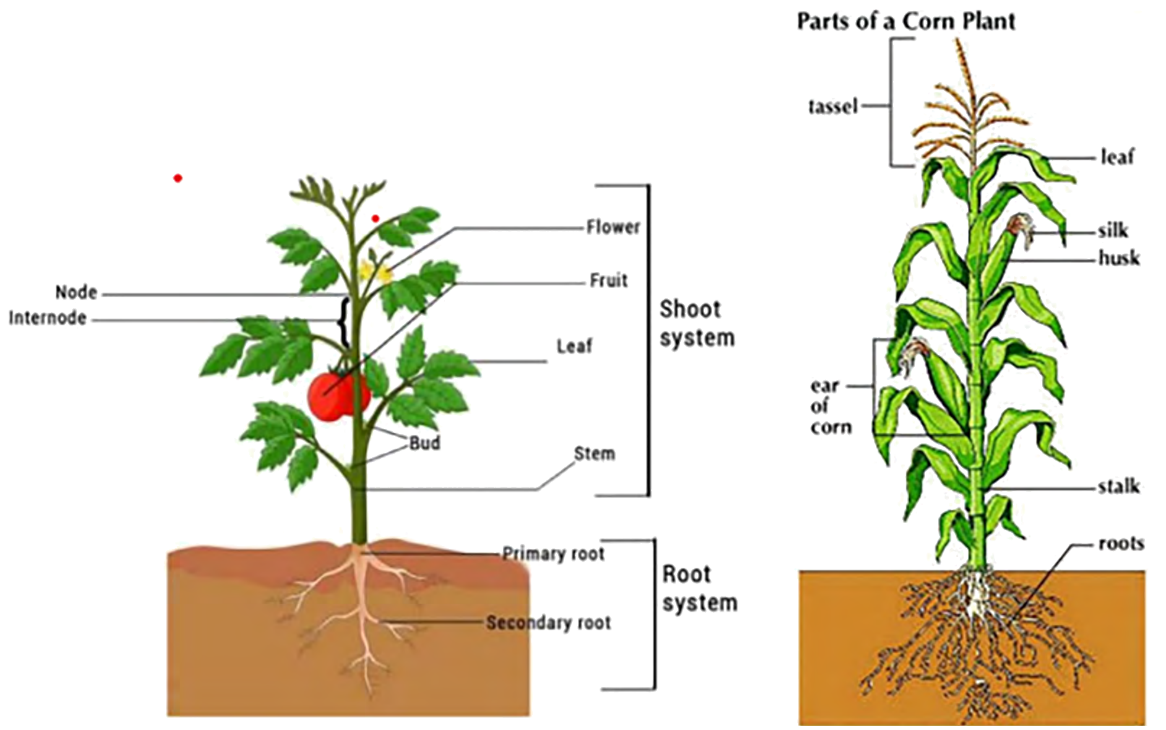
These characteristics make angiosperms highly successful and adaptable, allowing them to dominate most terrestrial ecosystems and stand out from other plants.

Activity 8.3

1. Collect samples of flowering plants around your school compound.
2. Use sample plants to identify features common to monocotyledonous and dicotyledonous plants. (Pictures can be used with the samples to better the understanding) .
3. Create a poster on monocotyledonous and dicotyledonous plants, focusing on the features that are common to both groups of plants.
4. Use sample plants, your poster and pictures to identify general features that make angiosperms different from other plants.

IDENTIFYING MORPHOLOGICAL FEATURES THAT DISTINGUISH MONOCOTYLEDONOUS PLANTS FROM DICOTYLEDONOUS PLANTS

Compare the morphology of the two classes of flowering plants below



(a) Dicotyledonous Plant

(b) Monocotyledonous Plant

Fig. 8.7: The External Features of the Two Classes of Angiosperms

There are two broad classes of angiosperms/flowering plants. These are the **monocotyledonous** plants and **dicotyledonous** plants

External Features of Monocotyledonous Plants and Dicotyledonous Plants

Monocotyledonous plants

1. **Single Cotyledon**: monocotyledons have seeds with one embryonic leaf or cotyledon.
2. **Leaf Venation**: Leaves typically have parallel veins. That is the arrangement of veins and veinlets are parallel to the midrib.
3. **Flower Parts**: Floral organs are usually in multiples of three (e.g., three petals, and six stamens).
4. **Root System**: They possess a fibrous root system with adventitious roots (arising from non-root tissues).
5. **Stem Structure**: Vascular bundles are scattered throughout the stem and not arranged in a ring.
6. **Pollen Grains:** Pollen grains usually have a single aperture (opening) or furrow.
7. Examples of monocotyledonous plants are oil palm, bamboo, banana, cocoyam, grains and cereals such as maize plants, millet, rice, and grasses.

Dicotyledonous plants

1. **Two Cotyledons**: dicotyledons have seeds with two embryonic leaves or cotyledons.
2. **Leaf Venation**: Leaves typically have a net-like or reticulated venation pattern. That is the arrangement of veins and veinlets are in a net form.
3. **Flower Parts**: Floral organs are usually in multiples of four or five (e.g., four or five sepals or petals).
4. **Root System**: They possess a taproot system, with a primary root that grows deep into the soil and smaller lateral roots branch off.
5. **Stem Structure**: Vascular bundles are arranged in a ring within the stem.
6. **Pollen Grains:** Pollen grains usually have three apertures or furrows.
7. Dicotyledonous plants include cowpeas, soya beans, mangoes, oranges, cashews, and cocoa.

Major differences between monocotyledonous and dicotyledonous Plants

Table 8.2: Major Differences between Monocotyledons and Dicotyledon

Monocots	Dicots
The embryo consists of a single cotyledon	The embryo consists of two cotyledons
Flower parts are present in multiples of three	Flower parts are present in multiples of four or five
Major leaf veins are parallel	Major leaf veins are reticulated
Stem vascular bundles are scattered	Stem vascular bundles are in the form of a ring
Roots are adventitious	Roots develop from radicle
Example: Rice, Wheat, Maize	Example: Beans, Water lily, Cinnamon

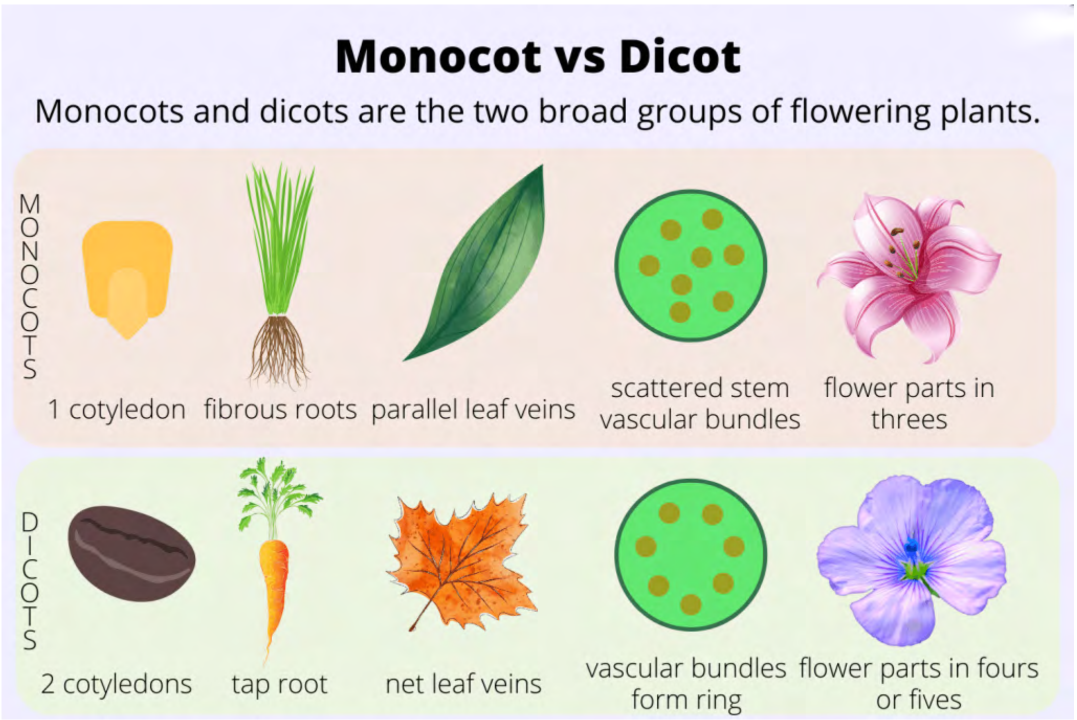


Fig. 8.8: Differences between Monocotyledons and Dicotyledons

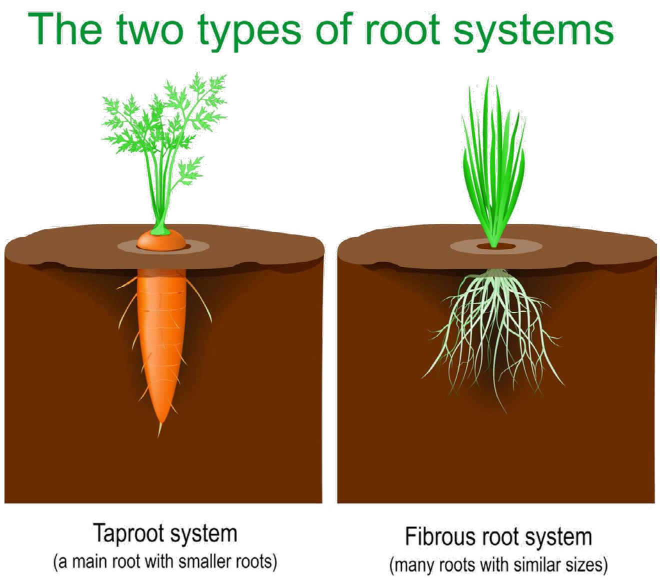


Fig. 8.9: Types of Roots

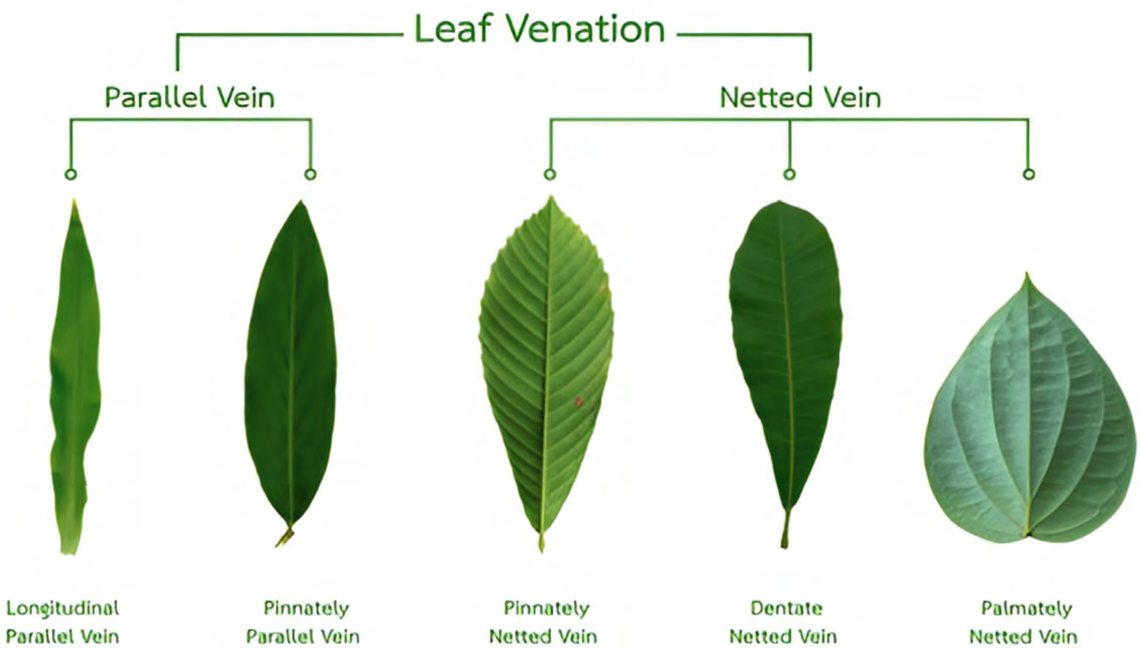


Fig. 8.10: Leaf Venation

Relating the structure of monocotyledons and dicotyledons to their functions

Structure	Monocotyledons	Dicotyledons
Seeds	*Have one cotyledon (seed leaf). This single cotyledon helps in the rapid absorption of nutrients from the endosperm, which is crucial for the early growth of the seedling.*	*Have two cotyledons. These cotyledons often store nutrients that support the seedling until it can perform photosynthesis.*
Leaves	*Typically, have long, narrow leaves with parallel veins. This structure is efficient for water transport and supports the plant in environments where water conservation is essential.*	*Usually have broader leaves with a network of veins. This allows for more efficient photosynthesis and gas exchange, supporting the plant's growth and energy needs.*
Stems	*Have scattered vascular bundles. This arrangement provides flexibility and strength, which is beneficial for plants like grasses that need to bend without breaking.*	*Have vascular bundles arranged in a ring. This structure supports secondary growth, allowing the stem to become thicker and stronger over time, which is essential for woody plants.*
Roots	*Typically have a fibrous root system. This type of root system spreads out widely, providing stability and efficient nutrient absorption from the soil surface.*	*Usually have a taproot system. The main root grows deep into the soil, anchoring the plant and accessing deeper water sources.*
Flowers	*Flower parts are usually in three or multiples of three. This pattern can attract specific pollinators and support efficient reproduction.*	*Flower parts are typically in four or five or multiples of four or five. This diversity in flower structure can attract a wide range of pollinators, enhancing reproductive success.*

These structural differences between monocotyledons and dicotyledons are adaptations that help them thrive in their respective environments and fulfil their biological roles effectively.

Activity 8.4: Differences Between Monocotyledonous and Dicotyledonous Plants

Materials Needed:

- A variety of seeds (e.g., corn, beans)
- Magnifying glass
- Notebook and pen
- Ruler
- Knife (for adult supervision)

Procedure:

1. **Seed Observation:**
   - **a.** Take a few seeds of each type (corn for monocotyledons, beans for dicotyledons).
   - **b.** Use a magnifying glass to observe the seeds closely.
   - **c.** Note the number of cotyledons (seed leaves). monocotyledons have one, while dicotyledons have two.
2. **Germination:**
   - **a.** Plant the seeds in separate pots and water them regularly.
   - **b.** Observe the seedlings as they grow. monocotyledons will have a single leaf emerging first, while dicotyledons will have two.
3. **Leaf Examination:**
   - **a.** Once the plants have grown a few leaves, examine the leaf veins.
   - **b.** Monocotyledons have parallel veins, while dicotyledons have a branched or net-like vein pattern.
4. **Flower Observation:**
   - **a.** If the plants flower, count the number of petals.
   - **b.** Monocotyledons typically have flower parts in multiples of three, while dicotyledons have them in multiples of four or five.

5. **Root System:**
   - **a.** Carefully uproot one plant of each type.
   - **b.** Observe the root system. monocotyledons have a fibrous root system, while dicotyledons have a taproot system.

6. **Recording Observations:**
   - **a.** Use your notebook to record your observations at each stage.
   - **b.** Draw diagrams of the seeds, leaves, and roots to illustrate the differences.

7. **Create a PowerPoint presentation to Summarise your understanding of the two broad classes of angiosperms.**
   - **a.** Present your work to your colleagues in class for discussion.
   - **b.** Think through the presentations of your friends.
   - **c.** Compare your views on morphological adaptations, similarities and differences between monocotyledonous and dicotyledonous plants.

This hands-on activity will help you see the differences between monocotyledons and dicotyledons. Have fun exploring the plant world!

Activity 8.5: Similarities Between Monocotyledonous and Dicotyledonous Plants

Objective: To observe and identify the similarities between monocotyledonous and dicotyledonous plants through hands-on examination and microscopic analysis.

Materials Needed:

- Monocotyledonous plant samples (e.g., corn, grass)
- Dicotyledonous plant samples (e.g., bean, sunflower)
- Microscope
- Slides and cover slips
- Scalpel or razor blade
- Staining solution (e.g., iodine or methylene blue)
- Notebook and pen for observations

Procedure:

1. **Sample Collection:** Collect samples of monocotyledonous and dicotyledonous plants. Ensure you have both root and stem sections for each type.
2. **Preparation of Slides:**
   - **a.** Carefully cut thin cross-sections of the root and stem from both monocotyledonous and dicotyledonous plants.
   - **b.** Place the sections on slides and add a drop of staining solution to enhance the visibility of the structures.
   - **c.** Cover with a cover slip.
3. **Microscopic Examination:** Observe the slides under the microscope. Focus on identifying the following structures in both monocotyledons and dicotyledons:
   - **a.** Epidermis
   - **b.** Cortex
   - **c.** Vascular bundles
   - **d.** Pith (if present)
4. **Observation and Comparison:**
   - **a.** Make drawings of the observed structures in your notebook.
   - **b.** Note the similarities in the basic anatomy of monocotyledonous and dicotyledonous roots and stems, such as the presence of epidermis, cortex, and vascular bundles.
5. **Discussion:**
   - **a.** Discuss your findings with your colleagues.
   - **b.** Highlight the similarities observed, such as the presence of similar tissue types and functions in both monocotyledons and dicotyledons.
6. **Record your findings:**
   Summarise the key similarities between monocotyledons and dicotyledons, emphasising their shared features and roles in plant survival and ecology.

INTERNAL STRUCTURES AND FUNCTIONS OF A MONOCOTYLEDONOUS ROOT

The internal structures of a monocotyledonous root consist of the following parts and structures from outside to inside:

1. *Epidermis:* It is the outermost protective layer of compact parenchyma cells with no intercellular spaces. The piliferous layer of the epidermis is thrown into finger-like projections known as root hairs. The root hairs are tubular and unicellular and help to increase the surface area of the root for the absorption of water and mineral salts.
2. *Cortex:* The cortex consists of thin-walled rounded or oval-shaped multi-layered parenchyma cells with intercellular spaces. Starch grains are abundantly present in this layer. The functions of the cortex are **food storage**, **protection from injuries**, and **conduction of water and minerals to inner tissues.**

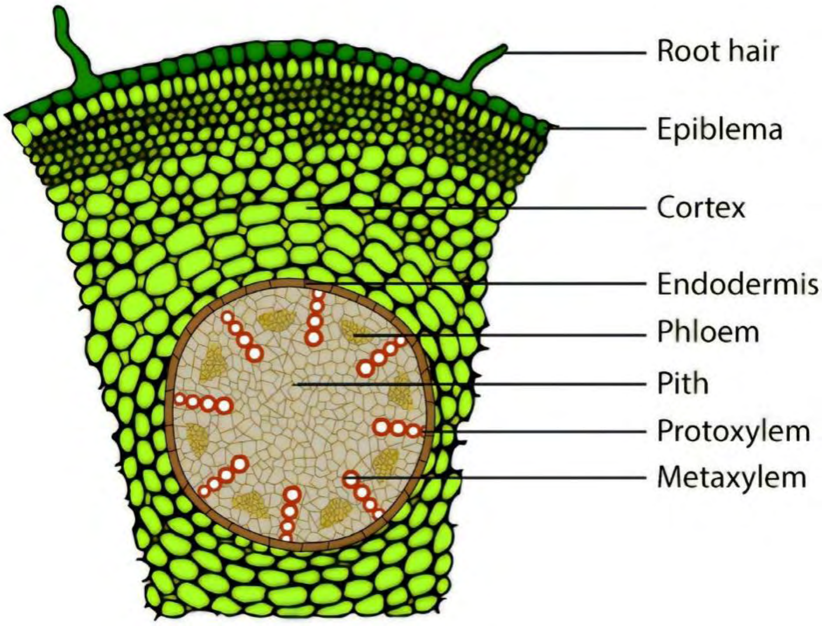


Fig. 8.11: Diagram of the T.S. of monocotyledonous root

3. *Endodermis:* It is the innermost layer of the cortex and is composed of a single layer of barrel-shaped compact cells lacking intercellular spaces. The transverse walls of endodermal cells are thickened with an internal strip of suberin and lignin. These thickenings are called Casparian strips (named after *Johann Xaver Robert Caspary,* a German botanist). The Casperian strips control the movement of substances from the cortex into the vascular cylinder also known as the stele.

4. *Vascular cylinder/stele:* This comprises the tissues that are present inside the endodermis. It includes the pericycle and vascular tissues.
5. *Pericycle:* It is composed of single-layered sclerenchyma cells and gives rise to the lateral roots.
6. *Vascular system:* The vascular system consists of alternating strands of xylem and phloem.

The xylem and the phloem are separated by a layer of sclerenchyma conjunctive tissue. In between the xylem and the phloem bundles (conducting tissues) is found the cambium. There is also the presence of many-layered parenchyma or sclerenchyma tissues. They help in the storage of food and mechanical support.

Activity 8.6: Observing the internal structures/tissues of monocotyledonous roots

Materials needed:

- Razor blade.
- Petri dish
- Paintbrush/forceps
- Dropping pipette
- Microscope slide
- Coverslip
- Young monocotyledonous plants e.g. maize, elephant grass, *Cammelina sp*.

Caution: Handle razor blade with care.

Chemicals: Iodine solution, (Other stains can be used)

Procedure:

1. Obtain a young bean seedling (or a young plant e.g. maize, elephant grass, *Cammelina sp*.).
2. With a sharp razor blade, cut a very thin transverse section of the root of any of the above-named plants.
3. Float the sections in a petri dish of water.
4. Pour some iodine solution into a petri dish.

5. Using a paint brush/forceps, transfer one of your thinnest sections into the iodine solution and leave it there for three minutes.
6. Lift the section out of the iodine and mount it in a drop of water on a microscope slide.
7. Cover the section with a cover slip and examine it under;
   a. the low power of the microscope
   b. change the objective lens to high power magnification.
8. Compare your section with the diagram above (Fig 8.11)
9. Make a label drawing of the transverse section of monocotyledonous roots as observed under the microscope.

NOTE: Research from the internet, and other relevant biology books on the transverse sections and the longitudinal sections of monocotyledonous roots. Identify the various parts/tissues and write down their functions by completing the table below. Please compare your answers with your colleagues and show them to your teacher.

Table 8.3: Root Structure Parts

Root structure part	Function
Root hairs	
Epidermis	
Cortex	
Endodermis	
Pericycle	
Phloem	
Xylem	

THE INTERNAL STRUCTURES AND FUNCTIONS OF A MONOCOTYLEDONOUS STEM

The internal structure of a monocotyledonous stem has vascular bundles near the outside edge and scattered throughout the stem. The parenchyma tissue lies between the vascular bundles. There is no pith region in the internal structure of the monocotyledonous stem. The structures and tissues are arranged as follows:

1. ***Epidermis***: It is the single outermost layer composed of small, thin-walled, somewhat barrel-shaped parenchymatous cells that are tightly packed without intercellular species. It is externally covered with a thick cuticle. A few stomata are present on the epidermis. Usually, trichomes or epidermal hairs are lacking.

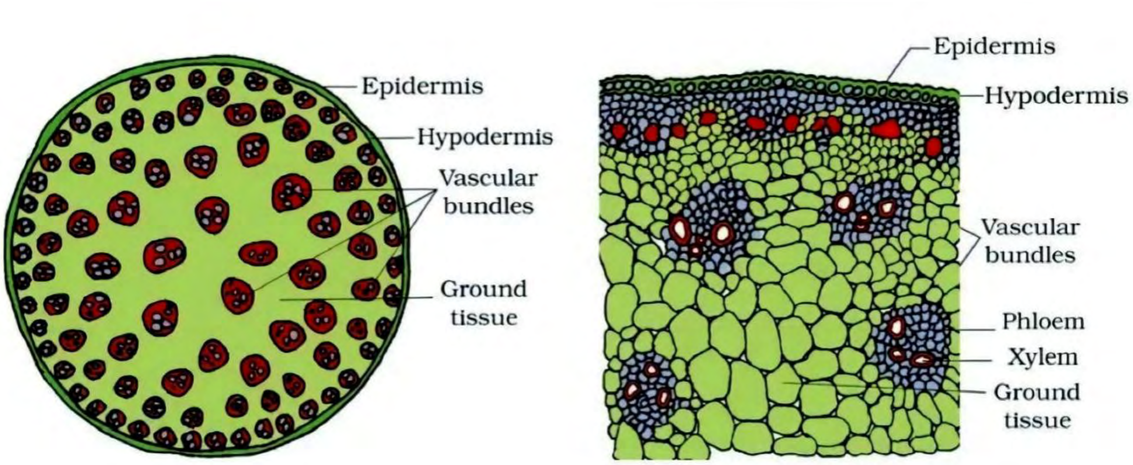


Fig. 8.12: Transverse Section of Monocotyledonous Stem

2. ***Cortex**:* It lies below the epidermis. The cortex is composed of the following regions:

   a. *Hypodermis:* It lies just below the epidermis. It is comprised of two to three layers of thick-walled lignified sclerenchymatous cells, without intercellular spaces. It helps in mechanical support.

   b. *Ground tissue:* It contains a continuous mass of thin-walled, round parenchymatous tissue which lies below the hypodermis. Intercellular spaces are present. Cells are rounded or polygonal in shape. There is no differentiation of the general cortex, endodermis, pericycle, pith, and rays. Vascular bundles are irregularly spaced in this region.

   c. *Vascular bundles:* Vascular bundles are irregularly scattered in the ground tissues. Vascular bundles occurring in the peripheral region are smaller in size and compactly arranged. In contrast, those occurring towards the central region are larger and widely placed. All the vascular bundles have similar structures. Each vascular bundle consists of xylem towards the centre.

3. ***Xylem*** tissue consists of tracheids, xylem vessels, xylem fibres and xylem parenchyma. Its main functions are to conduct water and mineral salts from the roots to the leaves and also for structural support and storage of some organic materials.

4. ***Phloem*** tissue lies outside the xylem and is partly present near the metaxylem vessels. It is composed of sieve elements, companion cells and phloem fibres and phloem parenchyma. The phloem conducts organic food from the sites of photosynthesis to other parts of the plant.

Activity 8.6: Observing the internal tissues/structures of young monocotyledonous

Materials needed:

- Razor blade.
- Petri dish
- Paintbrush/forceps
- Dropping pipette
- Microscope slide.
- Cover slip.
- Microscope
- Young monocotyledonous plants e.g. maize, *Cammelina* sp.

Chemical: Iodine solution

Caution: Handle razor blade with care.

Procedure:

1. With a sharp razor blade, cut very thin transverse sections of the stem of a young maize plant /elephant grass and put them in a petri dish containing iodine solution for about three minutes
2. Pick the section out of the iodine solution and mount it in a drop of water on a microscope slide
3. Cover the specimen with a cover slip and mount it on a microscope observe it under low power of the microscope and then change to high power magnification
4. Using the **Fig. 8.13** as a guide, identify the various parts of the transverse section of the stem.

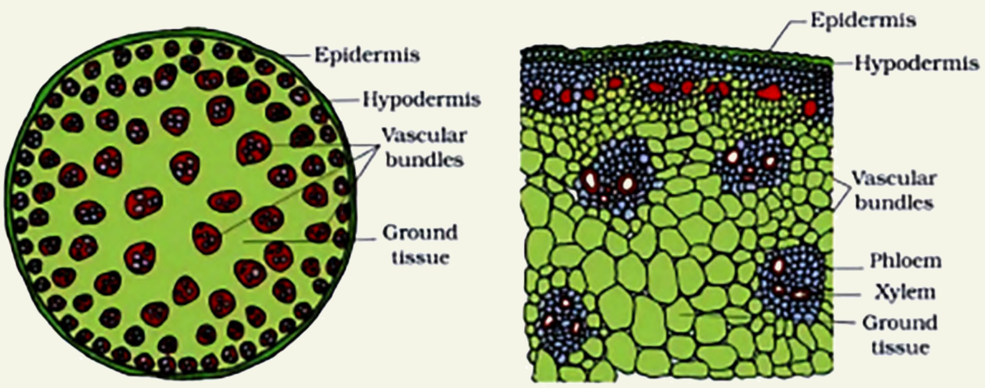


Fig. 8.13: Diagram of the transverse section (T.S.) of a Monocotyledonous Stem

5. Compare your section with the diagram above -*T.S. of monocotyledonous root* (left one under low power of the microscope and then right one under high power magnification)
6. Research from the internet, and other relevant biology books on the transverse sections and the longitudinal sections of monocotyledonous roots.
7. Make a label drawing of the transverse section of monocotyledonous roots as observed under the microscope and the longitudinal section of the stem.
8. Click on the link for the video https://youtu.be/tSwF_XlY9pQ
9. Identify the various parts/tissues and write down their functions by completing the table below.

   Please compare your answers with your colleagues and show them to your teacher

Table 8.4: Parts of Internal Structure of Stem

Parts of internal structures stem	Function
Epidermal hairs	
Epidermis	
Cortex	
Hypodermis	
Ground tissue	
Phloem	
Xylem	

THE INTERNAL STRUCTURES OF A MONOCOTYLEDONOUS LEAF

Monocotyledonous leaves, found in plants such as grasses, cereals, and lilies, exhibit distinct internal structures adapted for efficient photosynthesis, gas exchange, and water conservation. The internal structure of a monocotyledonous leaf consists of Epidermis (outermost layer) mesophyll (photosynthetic tissue), vascular tissue (xylem and phloem) and Sclerenchyma (supportive tissue).

The key features of the internal structure of a monocotyledonous leaf includes:

- **a.** Hypostomatic distribution of stomata (more stomata on lower epidermis)
- **b.** Parallel venation (veins run parallel to each other)
- **c.** Single layer of palisade mesophyll
- **d.** Absence of cambium (non-woody)
- **e.** Bulliform cells (regulate turgor pressure)

The leaf of a monocotyledonous plant comprises the following tissues and structures:

1. **Epidermis:** This is the outermost layer of the leaf, and it is found on both the upper and lower surfaces. It has the following features:
    - a. It consists of a single layer of parenchyma cells without intercellular spaces.
    - b. The cells are covered with a protective layer called the cuticle.
    - c. Stomata are present on both the upper and lower epidermis.
    - d. Some large, thin-walled parenchyma cells are found on the upper epidermis and are known as bulliform cells. Bulliform cells help in leaf curling when there is a water shortage, thus reducing water loss due to evaporation.
    - e. Beneath the undifferentiated mesophyll tissue is a single layer of epidermis called the lower epidermis, located on the lower (abaxial) surface of the leaf.
    - f. Cells of the lower epidermis are cubic or barrel-shaped and closely arranged with minimal intercellular spaces.

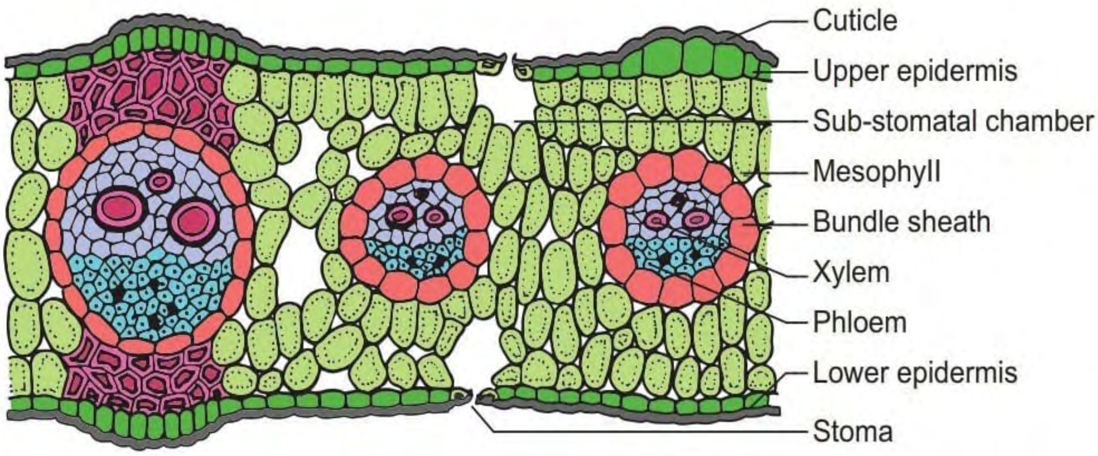


Fig. 8.14: Diagram of the transverse section (T.S.) of monocotyledonous leaf

Note: The number of stomata on the lower epidermis is normally higher than the number of stomata in the upper epidermis. Gas exchange occurs through the stomata of the upper and lower epidermis via diffusion. Just below the stomata of the epidermal layers on both surfaces, air spaces and sub-stomatal chambers are present, connecting the stomatal pores to the intercellular spaces of the spongy mesophyll.

These air spaces act as reservoirs for carbon dioxide to be used for photosynthesis and water vapour to help reduce excessive transpiration.

2. **Mesophyll Cells**: They are masses of cells found between the upper and lower epidermis. They possess the following features:

   a. Unlike dicotyledonous leaves, there is no differentiation between palisade and spongy parenchyma.

   b. The cells in the mesophyll are parenchyma and are irregularly arranged with intercellular spaces.

   c. These cells contain chloroplasts for photosynthesis.

3. **Vascular Bundles**: Numerous vascular bundles are present in the leaf. They have the following features:

   a. Some bundles are small, while others are large.

   b. Each bundle consists of a xylem and phloem and is surrounded by a sheath of parenchyma cells called the bundle sheath.

   c. The vascular bundles are conjoint, collateral, and closed, with the xylem located towards the upper epidermis and the phloem towards the lower epidermis.

4. **Vascular System**: This is formed from multiple vascular bundles in parallel arrangements. The central vascular bundle is the largest. They show the following characteristics:
   a. The vascular bundles are conjoint, collateral, and closed.
   b. Each bundle is surrounded by a double-layered bundle sheath. The outer layer of the bundle sheath consists of thin-walled cells, while the inner layer is composed of thick-walled cells.
   c. Sclerenchyma patches are found on the upper and lower surfaces of large vascular bundles, closely associated with the epidermal layers (although there is no such association between sclerenchyma and small vascular bundles). They provide mechanical support and strength to the plant.
   d. Xylem is located towards the upper surface, while phloem is located towards the lower surface.

Functions of the Monocotyledonous Leaf

1. **Photosynthesis:** The chloroplasts present in the palisade parenchyma cells are responsible for capturing sunlight and converting it into chemical energy through photosynthesis. This process produces glucose, which serves as the primary source of energy and carbon compounds for the plant.
2. **Transpiration**: The stomata facilitate transpiration: the loss of water vapour from the plant. Transpiration aids in the regulation of temperature, nutrient uptake, and the transport of water and minerals from the roots to the leaves.
3. **Storage:** Some monocotyledonous leaves, such as those of onion plants, are modified to store nutrients, enabling the plant to survive adverse conditions or periods of dormancy.
4. **Protection:** The epidermis and cuticle provide protection against mechanical injuries, pathogens, and excessive water loss. Additionally, some monocotyledonous leaves have adaptations like spines or thorns, acting as deterrents against herbivores.

Adaptations of a monocotyledonous Leaf

Monocotyledonous leaves have evolved several adaptations to thrive in diverse environments:

1. **Parallel Venation:** Unlike dicotyledonous leaves with reticulate (net) venation, monocotyledonous leaves exhibit parallel venation, where veins

run parallel to each other. This arrangement maximises the surface area available for photosynthesis and ensures efficient nutrient distribution.

2. **Long and Narrow Shape:** Many monocotyledonous leaves are long and narrow and lie close to vertical. This minimises the surface area exposed to direct sunlight, which helps to reduce water loss through transpiration and prevents overheating, particularly in hot and arid environments.
3. **Thick Cuticle:** Monocotyledonous leaves often possess a thicker cuticle compared to dicotyledonous leaves. The thick cuticle acts as a barrier, reducing water loss and protecting the leaf from excessive evaporation, especially in dry and windy conditions.
4. **Sunken Stomata:** In some monocotyledonous species, the stomata are found in sunken cavities, known as stomatal crypts. This adaptation provides additional protection against water loss by creating a humid microclimate that reduces transpiration rates.
5. **Presence of Bulliform Cells:** These are specialised cells found in the upper epidermis of many monocotyledonous leaves. These cells are responsible for leaf rolling or folding, which helps reduce the leaf's surface area and minimize water loss during periods of drought or heat stress.
6. **Sheathing Leaf Base:** Monocotyledonous leaves often have a sheathing leaf base, where the leaf wraps around the stem. This adaptation provides structural support to the leaf and prevents excessive movement, reducing the risk of damage from wind or physical stress.

Activity 8.7

1. Research from textbooks, and other books from the school library and online sources at the ICT centre to find information about the internal structures of a monocotyledonous leaf.
2. Compare your notes with those of your friends
3. Finalise your notes on the various internal structures of a monocotyledonous leaf.

Activity 8.8: An experiment to investigate the internal structure of a monocotyledonous leaf and relate it to its functions

Materials needed:

- Fresh monocotyledonous leaves (e.g., maize, wheat, or rice)
- Microscope slides
- Microscope
- Leaf cross-section model (where available)/Leaf cross-section drawings
- Staining solutions (e.g., iodine or safranin)
- Distilled water

Procedure:

1. **Leaf Preparation**
   a. Cut a thin cross-section of the leaf using a razor blade or microtome.
   b. Place the section on a microscope slide.
2. **Staining**
   a. Apply a few drops of staining solution to the leaf section.
   b. Let it sit for 5-7 minutes to allow the stain to penetrate.
3. **Microscopic Observation**
   a. Observe the stained leaf section under the microscope.
   b. Identify, draw and label the different tissues (epidermis, mesophyll, vascular bundles).
4. **Relating Structure to Function**
   Use drawing to relate the internal structure to the leaf's functions (photosynthesis, transpiration, support).

Questions to Investigate:

1. What are the different tissues present in the monocotyledonous leaf?
2. How do the tissues relate to the leaf's functions?
3. How does the internal structure adapt to the leaf's environment?

THE INTERNAL STRUCTURE AND FUNCTIONS OF A DICOTYLEDONOUS ROOT

The transverse section of a dicotyledonous root shows the following distinct regions

1. Epiblema/Piliferous layer
2. Cortex
3. Endodermis
4. Pericycle
5. Vascular bundles
6. Pith

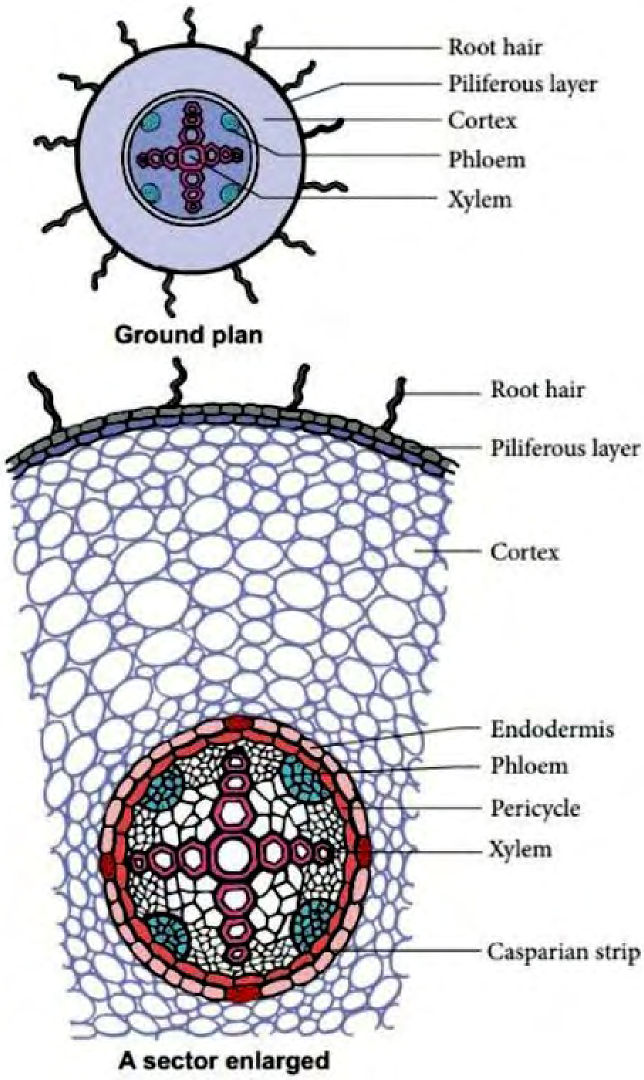


Fig. 8.15: Diagram of the T.S. of dicotyledonous root

Parts, Functions and Adaptations on Dicotyledonous Root

Now let us discuss the functions of the parts of the Dicotyledonous Root

a. *Xylem tissue:* This transports water and mineral salts absorbed by the root from the soil to other parts of the plant for photosynthesis and metabolism.

b. *Phloem tissue:* This transports sugars and organic materials from the leaves to other parts of the plant for growth. Both the xylem and phloem tissues are arranged in a central core to ensure efficient transport of water, minerals and nutrients.

c. *Endodermis:* This has the Casparian strip which regulates the movement of water and nutrients into the vascular tissues and prevents harmful substances from entering the plant.

d. *Pericycle:* This contains meristematic (dividing) cells which give rise to lateral roots that branch from the main roots to absorb more water and mineral salts from the soil.

e. *Cortex:* This stores carbohydrates and other essential nutrients and acts as a reservoir for energy that provides support and protection for the internal tissues in the dicot root.

f. *Epiblema/Piliferous layer:* This is the outermost (epidermal) layer of plant roots that is found in the root hair region formed by a single layer of compactly arranged, barrel-shaped parenchyma cells with a thin wall that are involved in the absorption of water.

Activity 8.9: Observing the tissues of young dicotyledonous roots

Materials needed:

- Razor blade.
- Petri dish
- Paintbrush/forceps
- Dropping pipette
- Microscope slide
- Coverslip
- Young dicotyledonous plant e.g. bean seedling, *Talinum sp.* or *Helianthus sp.*)

Chemicals: Iodine solution, (Other stains can be used)

Caution: Handle razor blade with care.

Procedure:

1. Obtain a young bean seedling (or a young plant of Helianthus or Talinum).
2. With a sharp razor blade, cut a very thin transverse section of root of any of the above-named dicotyledonous plants.
3. Float the sections in a petri dish of water.
4. Pour some iodine solution into a petri dish.
5. Using a paint brush/forceps, transfer one of your thinnest sections into the iodine solution and leave it there for three minutes.
6. Lift the section out of the iodine and mount it in a drop of water on a microscope slide.
7. Cover the section with a cover slip and examine it under;
   a. the low power of the microscope
   b. change the objective lens to high power magnification.
8. Compare your section with the diagrams *T.S. of the dicotyledonous root above*
9. Make a label drawing of what your observation of the dicotyledonous roots as observed under the microscope.

STRUCTURE,FUNCTIONS AND ADAPTATIONS OF A DICOTYLEDONOUS STEM

Dicot stems have several internal structures with various adaptations that allow them to support growth and development.

1. **Epidermis:** This forms the outermost layer of cells that protects the stem from mechanical injuries and water loss. It may have stomata for gaseous exchange.
2. **Cortex:** It is a region made up of parenchyma cells to provide support, store food and undertake lateral transport of water and nutrients.
3. **Vascular bundles:** These are structures arranged in a ring around the stem. They contain the xylem for the upward transport of water and mineral salts, and the phloem for the transport (translocation) of food nutrients (mainly sugars and other organic compounds).

4. **Xylem tissue** contains specialised cells such as vessel elements, tracheids, fibres and parenchyma cells that are adapted for water transport in the stem.
5. **Phloem tissue** is made up of specialised cells such as sieve tube elements, companion cells, phloem fibres and phloem parenchyma cells which are adapted for nutrient transport.
6. **Pith:** This is located at the centre of the stem. It has parenchyma cells for the storage and transport of nutrients. It also provides the plant with support.

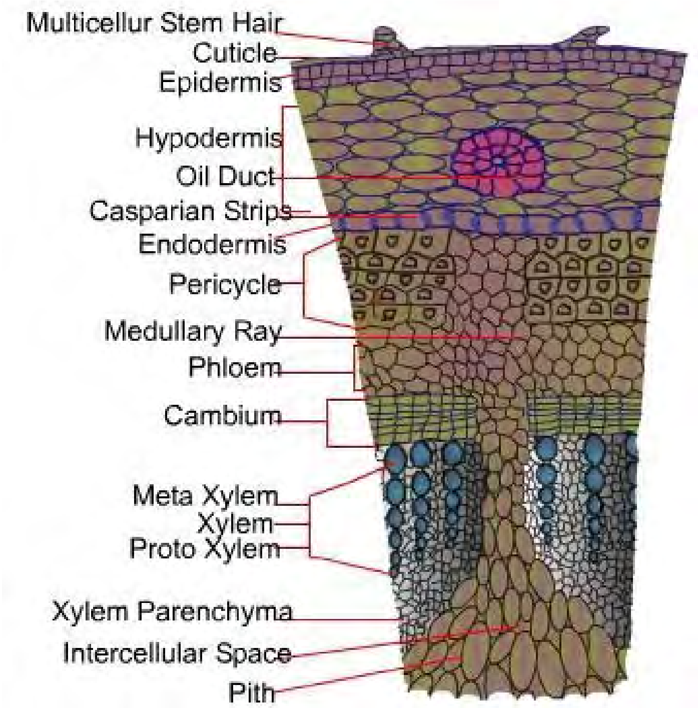


Fig. 8.16: A Labelled Diagram of the Transverse Section (T.S.) of Dicotyledonous Stem (Sunflower)

Activity 8.10: Observing the internal tissues/structures of dicotyledonous stems

Materials needed:

- Razor blade.
- Petri dish
- Paintbrush/forceps
- Dropping pipette
- Microscope slide.
- Cover slip.

- Microscope
- Young dicotyledonous plant e.g. bean seedling, *Talinum sp.* or *Helianthus sp.*)

Chemical: Iodine solution

Caution: Handle razor blade with care.

Procedure

1. With a sharp razor blade, cut very thin transverse sections of the stem of bean seedling/ *Talinum sp.* or *Helianthus sp*. and put them in a petri dish containing iodine solution for about three minutes
2. Pick the section out of the iodine solution and mount it in a drop of water on a microscope slide
3. Cover the specimen with a cover slip and mount on microscope observe it under low power of the microscope and then change to high power magnification
4. Using the diagram in **Fig. 8.16** above as a guide, identify the various parts of the transverse section of the stem.
5. Collect a permanent slide of a dicotyledonous stems in transverse section from your teacher.
6. Examine each one of them under the low power of the microscope.
7. Draw to show the distribution of the various tissues in the transverse section of the dicotyledonous stems.

Activity 8.11

Search from the internet(videos), and other relevant biology books on the functions of the tissues of the stem and roots dicotyledonous plants and use the finding to complete the table below. Compare your answers with your colleagues and show them to your teacher.

Table 8.5: Plant Tissues

Plant tissue	Function
Epidermis	
Cortex	
Endodermis	
Pericycle	
Phloem	
Xylem	
Pith	

INTERNAL STRUCTURES AND FUNCTIONS OF THE DICOTYLEDONOUS LEAF

Most leaves possess certain common features, such as an epidermal layer covering each surface. The ground tissue located between the two epidermal layers is referred to as mesophyll. Vascular bundles, commonly known as veins, are embedded within the mesophyll. The structure and characteristics of each of these layers vary significantly among different leaves. The internal structure of a dicotyledonous leaf shows these regions with the following features:

1. **Epidermis:** It is the leaf's outer covering and serves as the boundary between the atmosphere and the underlying mesophyll. The upper and lower epidermis encase the mesophyll tissues, both of which are protected by a cuticular layer. This layer consists of tightly packed, thin-walled parenchyma cells that lack chloroplasts. In most dicotyledonous leaves, the lower epidermis has guard cells that regulate the opening and closing of the stomata. Generally, the upper epidermis is heavily cuticularised, while the lower epidermis features numerous stomata, in contrast to the upper epidermis, which has none.

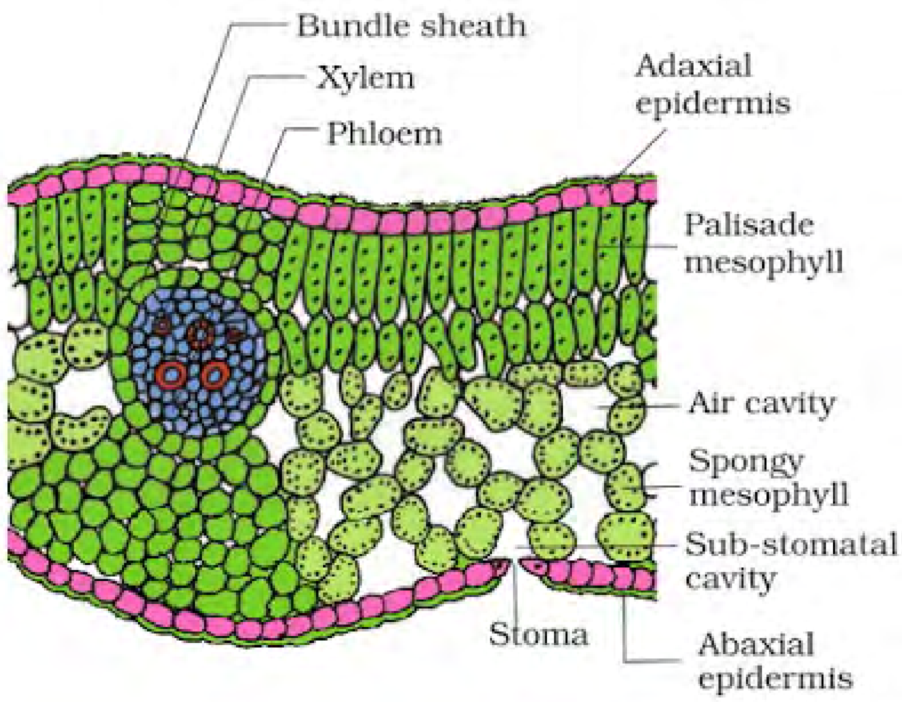


Fig. 8.17: Diagram of the T.S. of a dicotyledonous leaf (Mangifera indica)

2. **Mesophyll:** This is the ground tissue between the upper and lower epidermis. It is differentiated into palisade mesophyll and spongy mesophyll tissues.

   a. Palisade mesophyll lies towards the upper epidermis and consists of one, two or three layers of elongated cells, densely packed with intercellular spaces and many chloroplasts. This ensures efficient gas exchange and photosynthesis.

   b. Spongy parenchyma lies towards the lower epidermis and is made from loosely arranged, irregular, thin-walled parenchyma cells with large intercellular spaces, air cavities and fewer chloroplasts. This maximises efficient gas exchange for photosynthesis.

3. **Vascular bundles:** The vascular bundles encompass the xylem, phloem and cambium tissues. The xylem is situated closer to the upper epidermis, whilst the phloem is positioned nearer the lower epidermis. The cambium cells undergo active division to generate new cells. A prominent central vascular bundle, known as the mid-vein, is connected to numerous smaller vascular bundles or veins. Collenchyma tissue may also be found in association with bundle sheath cells. The xylem is composed of non-living components, specifically vessels and tracheids. Water and mineral conduction, as well as mechanical support, are facilitated by the tracheids and vessels of the xylem, whilst lateral transport is aided by the parenchyma. The phloem

is composed of living tissue, including sieve tubes, companion cells, and some parenchyma cells for packing. Food material transportation is carried out by the phloem's companion cells and sieve tubes, whereas the phloem parenchyma assists in both lateral conduction and storage of these nutrients.

IDENTIFICATION OF FACTORS THAT AFFECT GROWTH AND DEVELOPMENT IN FLOWERING PLANTS

Factors that affect growth and development in flowering plants

1. Four primary factors which affect plant growth are light, water, temperature and nutrients.
2. Changing any of these four factors can cause changes in plant growth, resulting in poor or improved growth.
3. A good understanding of these factors will make you a good farmer or gardener.

Fig. 8.18: Flowering Plants

Light

Photosynthesis: Light energy drives photosynthesis, producing glucose for growth.

Intensity: Increasing light intensity boosts photosynthesis, but excessive light can cause photoinhibition.

Duration: Longer daylight exposure promotes flowering and fruiting in plants.

Quality: Different wavelengths (e.g., blue, red) regulate plant development, such as stem elongation and flowering.

Effects of light on the growth of plants

Increased light: Promotes leaf growth, stem elongation, fruiting and flowering.

Decreased light: Reduces growth, causes etiolation (stretching), and inhibits flowering.

Water

To survive, plants need water. Most plants are made up of nearly 90 percent water. Without the appropriate amounts of water, plants will be stressed and eventually die. Even plants that live in the desert such as the cactus need water, they just need less of it than other types of plants.

Photosynthesis: Water is essential for photosynthesis and nutrient uptake.

Turgor pressure: Water maintains cell turgidity, supporting plant structure.

Transpiration: Water loss through transpiration regulates temperature.

Effects of water on the growth of plants

Adequate water: Supports healthy growth, fruiting, and flowering.

Excessive water: Causes root rot, nutrient deficiencies, and reduced growth.

Insufficient water: Leads to wilting, reduced growth, and increased susceptibility to disease.

Nutrients

Macronutrients (NPK): Nitrogen (leaf growth), Phosphorus (root development), Potassium (overall health).

Micronutrients (e.g., Fe, Zn, Cu): Essential for enzyme function, photosynthesis, and growth regulation.

Effects of nutrients on the growth of plants

Adequate nutrients: Supports healthy growth, fruiting, and flowering.

Deficiencies: Cause stunted growth, yellowing leaves, and reduced yields.

Excess nutrients: Can lead to toxicity, reduced growth, and environmental pollution.

Fig. 8.19: A photo of a gardener watering crops

Temperature

Temperature plays an important role in plant growth. Warm temperatures generally encourage germination and subsequent growth. A warmer temperature will stimulate chemical reactions inside the cells of a plant, and this will speed up respiration, transpiration, and the photosynthesis process.

Metabolic rate: Temperature influences enzyme activity, affecting growth and development.

Photosynthesis: Optimal temperatures (20-25°C) enhance photosynthesis.

Hormone regulation: Temperature affects hormone production, regulating growth and flowering.

Effects of temperature on growth of plants

Optimal temperature (20-25°C): Supports healthy growth and flowering.

High temperature (above 30°C): Increases water loss, reduces growth, and causes heat stress.

Low temperature (below 15°C): Slows growth, inhibits flowering, and causes chilling injury. Plant growth will be slower during cooler periods.

Soil texture and quality

One of the problems that gardeners and farmers often face is that the soil that they use has an imbalance or lack of nutrients. All the macro and micronutrients need to be present in order for plants to grow well.

One of the best ways to ensure proper plant growth is by using natural compost or manure in the soil. This will add the missing nutrients to the soil as well as providing valuable structure to the soil, to help it hold water and stop it turning to dust and blowing away.

Using inorganic fertiliser may not provide the plant with all essential nutrients and will not bind the soil. In fact, many inorganic fertilisers only contain phosphorous, potassium, and nitrogen and will not have the other micro and macronutrients that promote plant growth.

If you have diseased plants, they are likely to be missing micro or macronutrients. For example, blossom rot that is found on tomato plants is often caused by a lack of calcium. Just like people, plants that do not have a healthy supply of appropriate nutrients are less likely to thrive.

Interactions between factors

1. *Light-temperature interaction:* Optimal light and temperature combine for maximum photosynthesis.
2. *Water-nutrient interaction:* Adequate water dissolves nutrients to facilitates nutrient uptake.
3. *Temperature-nutrient interaction:* Optimal temperatures (20-30°C) enhance microbial activity which affects nutrient availability and uptake.

Understanding these factors and their interactions helps optimize growing conditions for flowering plants, promoting healthy growth, development, and productivity.

Good gardening and farming practices

For example, regular crop rotation and the addition of water, manure and compost creates healthy plants which grow well and provide good quality produce for the population.

Here are some good gardening and farming practices:

Gardening

1. *Crop rotation:* Rotate crops to avoid depleting soil nutrients and to reduce pests and diseases.
2. *Soil conservation:* Use mulch, cover crops, and terracing to prevent soil erosion.

3. *Organic amendments:* Use compost, manure, and green manure to improve soil fertility.
4. *Efficient watering*: Use drip irrigation and mulch to conserve water.
5. Integrated pest management: Use a combination of techniques to manage pests and diseases.
6. *Companion planting:* Plant complementary crops together to improve growth and reduce pests.
7. *Record keeping:* Keep records of planting, harvesting, and weather patterns to inform future decisions.

Farming

1. *Sustainable crop selection:* Choose crops suitable for the local climate and soil conditions.
2. *Precision agriculture:* Use technology to optimise inputs and reduce waste.
3. *Soil testing:* Regularly test soil to determine nutrient levels and pH.
4. *Irrigation management:* Use efficient irrigation systems and schedule watering based on soil moisture levels.
5. *Integrated nutrient management:* Use a combination of organic and inorganic fertilisers to maintain soil fertility.
6. *Pest and disease monitoring:* Regularly monitor fields for pests and diseases and take action promptly.
7. *Conservation agriculture:* Adopt practices like no-till or reduced-till farming to reduce soil disturbance.
8. *Livestock management:* Implement practices like rotational grazing to maintain soil health and reduce erosion.
9. *Biodiversity conservation:* Plant a variety of crops and maintain ecological balance.
10. *Continuous learning:* Stay updated on new techniques and technologies to improve farming practices.

Remember, good gardening and farming practices prioritise soil health, efficient resource use, and environmental sustainability.

Activity 8.12

Search from textbooks and available sources (audio and video documentaries, articles, online resources:

- Identify factors influencing plant growth
- Design and conduct experiments to test hypotheses
- Analyse data and draw conclusions
- Communicate findings effectively

Materials needed:

- Flowering plant seeds
- Soil
- Water
- Light sources (e.g., sunlight, lamps)
- Thermometer
- Fertiliser
- Data collection materials (e.g., paper, pencils, measuring tape)

Procedure:

1. Small groups are assigned a factor to research (e.g., light, water, soil, temperature, fertiliser).
2. Research and gather information from credible sources.
3. Each group is to formulate a hypothesis related to their assigned factor.
4. Each group should design an experiment to test their hypothesis.
5. Consider variables, controls, and data collection methods.
6. Conduct the experiments, following the designed procedures. Collect data and make observations.
7. Analyse data and draw a conclusion
8. Each group is to analyse their data draw conclusions and relate their findings to the broader question.
9. Each group presents their findings to the class and receives peer feedback

Activity 8.13: Investigate the effects of light, temperature, water, soil texture, and quality on the growth and development of flowering plants.

In small groups at assigned workstations. Set up your experiments and record initial observations, measure and record growth (height, leaf size, etc.) every 2 days for 2 weeks, analyse data, identify patterns, draw conclusions as well as share findings and compare results.

Materials needed:

- Flowering plant seeds (e.g., maize sprouts, bean sprouts)
- Soil with varying textures (clay, sand, loam)
- Containers (pots or trays)
- Water
- Thermometer
- Light sources (natural, artificial)
- Fertiliser (optional)
- Measuring tape
- Stopwatch
- Data sheet

Experimental Design

Work Station 1: Light

1. 3 containers with the same soil and plant
2. Place one in direct sunlight
3. One in partial shade
4. One in complete darkness
5. Measure and record growth every 2 days

Work Station 2: Temperature

1. 3 containers with the same soil and plant
2. Place one in warm temperature (25°C)
3. One in moderate temperature (20°C)
4. One in cool temperature (15°C)

5. Measure and record growth every 2 days

Work Station 3: Water

1. 3 containers with the same soil and plant
2. Water one excessively
3. Water one moderately
4. Water one minimally
5. Measure and record growth every 2 days

Work Station 4: Soil Texture

1. 3 containers with the same plant
2. Use clay soil in one
3. Use sandy soil in one
4. Use loamy soil in one
5. Measure and record growth every 2 days

Work Station 5: Soil Quality

1. 3 containers with the same plant
2. Use fertilised soil in one
3. Use unfertilised soil in one
4. Use soil with poor drainage in one
5. Measure and record growth every 2 days

Safety Precautions

1. Handle plants gently
2. Avoid overwatering
3. Use protective gloves when handling soil
4. Ensure proper ventilation

Debriefing Questions

1. What factors affect flowering plant growth?
2. How do different conditions impact plant development?
3. What conclusions can be drawn from the data?
4. How can this knowledge be applied in real-world situations?

EXTENDED READING

- https://www.botanytoday.com/angiosperms
- https://byjus.com/biology/angiosperms/
- https://www.britannica.com/plant/angiosperm/Distribution-and-abundance
- https://plant-evolution.com/chapter-6/monocotyledons-and-dicotyledons/
- https://www.toppr.com/guides/biology/difference-between/monocotyledons-and-dicotyledons/
- https://youtu.be/Pv1ONCDHDJE
- https://youtu.be/48PxeaoHrRI
- https://youtu.be/2htD8PGNfbM
- https://youtu.be/av5mntU2Tao

REVIEW QUESTIONS

Review Questions 8.1

1. List any six features that distinguish monocotyledonous plants from dicotyledonous plants, hence, state the degree to which these two groups of flowering plants differ in each factor.
2. Name two examples each of a monocot and dicot plants. Describe how one of them is adapted to a named habitat for successful living. Level
3. Study the collection of the flowering plants you have sampled during the class tours of the school compound.
   a. Identify the names of at least six specimens collected.
   b. List the set of morphological features each share with:
      i. Flowering plants
      ii. Monocotyledons
      iii. Dicotyledons

Review Questions 8.2

1. List three examples each of monocotyledonous and dicotyledonous plants.
2. Describe four similarities between monocotyledonous and dicotyledonous plants.
3. Identify and discuss at least six characteristics of angiosperms that make them different from other plants.

Review Questions 8.3

1. List at least five external features of and differences between monocotyledonous plants and dicotyledonous plants
2. Copy and complete the table below

Monocotyledon	Dicotyledon
The monocotyledonous embryos have a single cotyledon	a.
They have a fibrous root system	b.
c.	Leaves in dicotyledons have reticulate or net venation
In monocotyledonous flowers, the count of parts of the flower is a multiple of three or equal to three	d.

Review Questions 8.4

1.

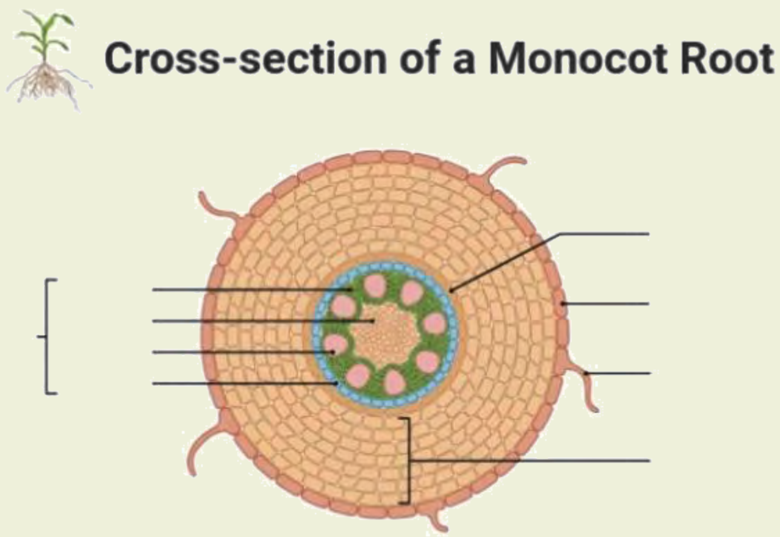


Fig. 8.20: Cross Section of Monocotyledonous Root

Monocot Stem

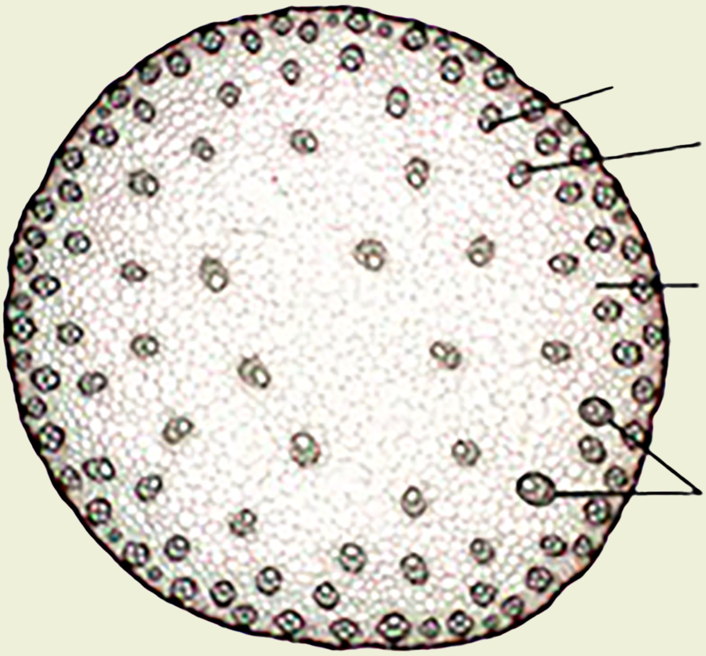


Fig. 8.21: Cross Section of Monocotyledonous Stem

Write or march the following words with the correct parts of the diagrams with the guidelines above, root hair, epidermis, cortex, endodermis, pith, pericycle, xylem, phloem, vascular bundle(s) and ground tissue.

2. List at least four internal structures of a monocotyledonous stem and its root and describe their functions.
3. Compare and contrast the transverse section of the monocotyledonous stem and the monocotyledonous root.

Review Questions 8.5

1. Name some common parts of the internal structures of a monocotyledonous leaf and give their functions.
2. Describe the various features of the parts of the internal structures of a monocotyledonous leaf.
3. Discuss the adaptations of the leaf of a monocotyledonous plant to its functions.
4. Evaluate the significance of specialised cells (e.g. bulliform cells) in a monocotyledonous leaf in relation to habitat adaptation.

Review Questions 8.6

1. The diagrams (X and Y) below are the transverse section of a dicot stem and the transverse section of a dicot root respectively study them carefully and name the parts labelled with the letters A, B, C, D, E, F, G, H, I. J

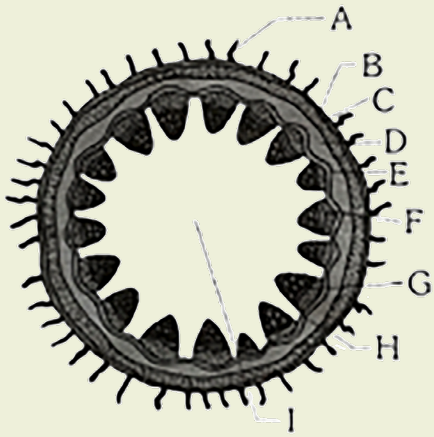


Fig. 8.22: X

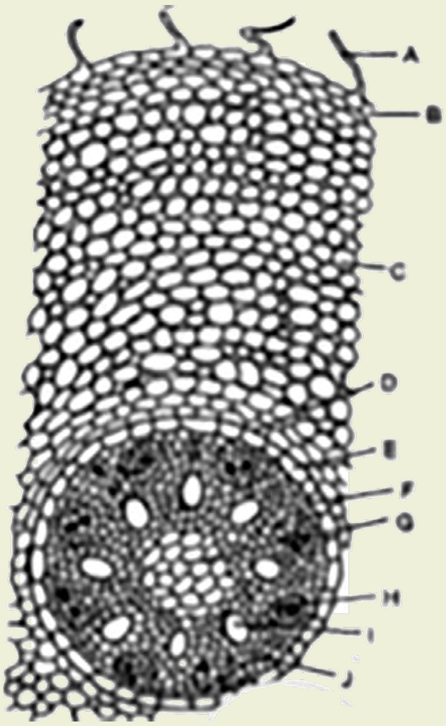


Fig. 8.23: Y

2. State the function of any four internal structures/tissues of stem and roots such as phloem, xylem, pericycle, cortex, pith, and endodermis.
3. Tabulate at least four differences between the transverse sections of dicot stem and dicot root

Review Questions 8.7

1. List at least five factors that are essential for the growth and development of flowering plants.
2. Describe how one of these factors affects the growth of a crop plant of your choice

Project Work

Submit a written report on your key findings of an investigation on one factor necessary for the growth and development of seedlings in your classroom or school environment. E.g. light, water, temperature or artificial fertiliser.

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GLOSSARY

- **Aperture** – small opening or pore in various structures.
- **Abaxial epidermis**- the outermost layer of cells on the lower surface of a leaf
- **Adaxial epidermis**- the uppermost layer of cells on the upper surface of a le**af.**
- **Bulliform cells**– a type of specialized epidermal cell found in the leaves of plants, particularly in monocots.
- **Casparian strip**- specialized structure found in plant roots, particularly in the endodermis layer.
- **Cotyledon** – also known as seed leaf. The first leaf/leave to emerge from a seedling during germination.
- **Dicotyledon** - a flowering plant with two cotyledons (seed leaves).
- **Endodermis-** specialized layer of cells in plant stems and roots serving as boundary between the inner cortex and outer vascular tissue.
- **Endosperm**- a tissue produced in the seeds of flowering plants which serve as a food reserve for the developing embryo.
- **Endocytosis**- process by which cells take in substances from outside the cell by engulfing them with their cell membrane.
- **Embryo**- a developing multicellular organism in its early stages, typically from fertilization to the formation of a foetus.
- **Exocytosis-** process by which cells release substances to the outside environment through vesicle.
- **Heat stress**- period in which plants are subjected to high temperatures long enough to permanently alter their ability to function or grow normally.
- **Hypostomatic**- refers to leaves that have stomata only on the underside of the leaf.
- **Lignin-** a tough woody substance in plant cell walls.
- **Mesophyll –** the middle layer of a leaf, located within the upper and lower epidermis.
- **Monocotyledon**- a flowering plant with one cotyledon (seed plant)
- **Osmoregulation**- process by which an organism regulates the balance of water and ions within its body fluids to maintain proper cellular functions.

- **Palisade mesophyll-** a layer of tightly packed, elongated cells located just below the upper epidermis of a leaf.
- **Pathogenic**- ability of an organism, substance, or factor to cause disease or harm.
- **Pericycle-** a layer of cells located innermost to the endodermis, surrounding the vascular tissue.
- **Phagocytosis**- a cellular process in which cells engulf (take in) and absorb particles, bacteria, dead cells and debris (a type of endocytosis).
- **Photo inhibition**- the light-induced loss of photosynthetic activity.
- **Pinocytosis**- the cellular uptake of liquids and dissolved substances by the formation of small vesicles.
- **Pseudopodium**- a temporary extension of a cell's membrane often used for movement, engulfing particles and absorbing nutrients.
- **Suberin**- a waxy, waterproof substance found in plants.
- **Transpiration**- process by which water is lost as water vapour from the aerial parts of the plants mainly through the stomata.
- **Trichomes-** small hair-like structures that grow on the surface of plants, particularly on leaves, stems and flowers.
- **Vesicle**- a small fluid-filled sac formed by a membrane.

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(GAST)

List of Contributors

NAME	INSTITUTION
Vincent Ahorsu	OLA SHS, Ho
Peter Blankson Daanu	Nkyeraa SHS
Very Rev. Lewis Asare	Prempeh College, Kumasi
Gloria N.D. Nartey	Nsutaman Catholic SHS