The Class of Science

LESSON. 2

b) PTERIDOPHYTES (Vascular plants)

Pteridophytes (also known as **Pteridophyta**) are a group of vascular plants that reproduce via spores rather than seeds. They are more advanced than bryophytes because they have vascular tissues (xylem and phloem), but they do not produce flowers or seeds. This group includes **ferns**, **horsetails**, and **club mosses**.

Detailed Features of Pteridophytes

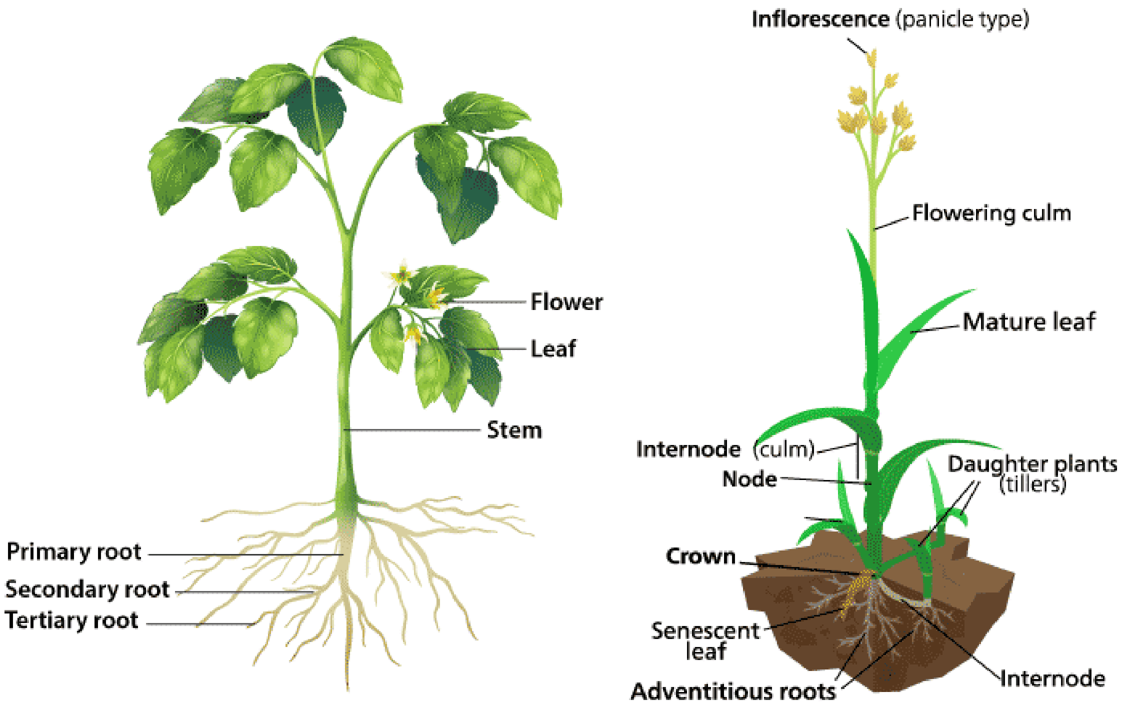
1. Vascular Tissue

- Pteridophytes have well-developed **vascular tissues**:
  - **Xylem**: Transports water and dissolved minerals from roots to the rest of the plant.
  - **Phloem**: Transports organic nutrients (like sugars) from photosynthesis throughout the plant.
- This vascular system allows pteridophytes to grow taller and larger than bryophytes, enabling them to colonize a wider range of environments.

2. True Roots, Stems, and Leaves

Pteridophytes have **true roots** that anchor them to the soil and absorb water and nutrients.

- They have **stems** (which may be underground as rhizomes or aboveground) that support the plant and transport nutrients.
- They have **leaves**, often large and complex, especially in ferns, where the leaves are called **fronds**. These leaves are capable of photosynthesis.



(a) Dicot plant (b) Monocot plant

3. Reproduction via Spores

- Pteridophytes reproduce by **spores** instead of seeds. Spores are produced in specialized structures called **sporangia**, often located on the underside of the leaves.
- In ferns, sporangia are grouped into clusters called **sori**.
- The **alternation of generations** life cycle is seen in pteridophytes:
  - The **sporophyte** (diploid) generation is dominant and is the visible, larger plant.
  - The **gametophyte** (haploid) generation is small, often heartshaped, and short-lived. It produces the gametes (sperm and eggs) for sexual reproduction.

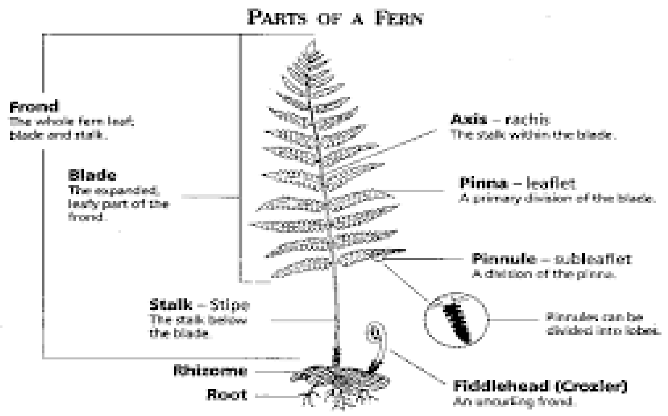
4. Alternation of Generations

- **Sporophyte (dominant phase)**: The larger, vascular plant that we commonly recognize as the fern or horsetail. It produces spores in sporangia.
- **Gametophyte (independent phase)**: A small, often microscopic plant (called a **prothallus** in ferns) that grows from a spore and produces male and female reproductive organs (antheridia and archegonia).
- **Water is necessary for fertilization**: Sperm swim through water to fertilize eggs, so pteridophytes are still somewhat dependent on moist environments for reproduction.

5. Distinctive Features of Ferns (Pterophyta)

- **Fronds**: Large, divided leaves. New fronds emerge as **fiddleheads**, coiled structures that unfurl as they grow.
- **Rhizomes**: Underground stems that ferns often use to spread horizontally, producing new fronds from the soil.

Sporangia in sori: Ferns produce spores in clusters of sporangia called sori, located on the undersides of the fronds.



6. Distinctive Features of Horsetails (Equisetophyta)

- **Jointed Stems**: Horsetails have hollow, jointed stems that contain silica, giving them a rough texture.
- **Reduced Leaves**: Horsetails have small, scale-like leaves, and photosynthesis occurs primarily in the green stem.
- **Strobili**: The spore-producing structures (sporangia) are organized in cone-like structures called **strobili** at the tips of stems.

7. Distinctive Features of Club Mosses (Lycopodiophyta)

- **Small, scale-like leaves**: Club mosses have small, simple leaves called **microphylls**, which have a single vein.

- **Strobili**: Like horsetails, club mosses produce sporangia in cone-like structures called strobili.

8. Habitat

- Pteridophytes generally prefer **moist, shaded environments**, though some can live in drier habitats. Their dependence on water for reproduction often restricts them to humid or damp areas such as forests, wetlands, and riverbanks. **Advantages of Pteridophytes**

1. **Vascular Tissue Allows for Taller Growth**
   - The presence of xylem and phloem allows pteridophytes to grow larger and taller than non-vascular plants, enabling them to access more sunlight and outcompete smaller plants like bryophytes.
2. **True Roots Provide Better Anchoring and Nutrient Uptake**
   - True roots allow pteridophytes to anchor themselves securely in the soil and access water and nutrients from deeper layers of the ground.
3. **Efficient Water and Nutrient Transport**
   - Vascular tissues enable more efficient transport of water and nutrients, allowing these plants to survive in a wider range of environments than bryophytes, especially in areas where water is not always abundant at the surface.

4. **Sporophyte Dominance**
    - The sporophyte generation is the dominant and more complex phase, allowing for greater reproductive success and the ability to produce and disperse large numbers of spores.
5. **Colonization of Diverse Habitats**
    - Pteridophytes can grow in various habitats, including temperate forests, tropical regions, and sometimes even semi-arid regions. Some species can tolerate marginally dry conditions due to their root system.

Disadvantages of Pteridophytes

1. **Dependence on Water for Reproduction**
    - Pteridophytes still rely on the presence of water for fertilization since their sperm must swim to reach the egg. This limits their ability to live and reproduce in dry or arid environments.
2. **Spores Have Limited Dispersal Capacity**
    - Spores, while numerous, have a limited capacity for dispersal compared to seeds. They must land in favorable conditions for the gametophyte to grow, and this stage is highly vulnerable to environmental conditions.
3. **Gametophyte Vulnerability**
    - The gametophyte phase of the life cycle is small, delicate, and short-lived, making it highly susceptible to drying out and being affected by environmental changes.
4. **Lack of Seeds**
    - Unlike seed plants, pteridophytes do not have the protective advantages that seeds offer, such as food storage for the developing embryo and the ability to remain dormant until conditions are favorable.
5. **Limited Ecological Range**
    - While pteridophytes can live in diverse habitats, they are most abundant in moist, shaded areas. Their reproductive dependence on

water limits their ability to colonize drier environments compared to seed plants.

Examples of Pteridophytes

1. **Ferns (Pterophyta)**:
    - **Common examples**: Maidenhair fern, bracken fern, tree ferns.
2. **Horsetails (Equisetophyta)**: ○ **Common example**: Equisetum arvense (field horsetail).
3. **Club Mosses (Lycopodiophyta)**:
    - **Common examples**: Lycopodium clavatum (common club moss), Selaginella (spike moss).

Summary of Pteridophyte Features:

- **Vascular plants**: They have xylem and phloem, allowing for efficient water and nutrient transport.
- **Reproduce via spores**: They do not produce seeds; instead, they reproduce through spores that develop in sporangia.
- **True roots, stems, and leaves**: Unlike bryophytes, pteridophytes have these well-defined structures.
- **Alternation of generations**: Dominant sporophyte phase and a smaller, independent gametophyte phase.
- **Water-dependent reproduction**: Fertilization requires water, limiting their growth in dry regions.
- **Diverse habitats**: They grow primarily in moist, shaded environments but are more diverse than bryophytes.

Pteridophytes are significant for their evolutionary advancement over bryophytes, but they still face limitations compared to seed-producing plants.

c). SPERMATOPHYTES

Spermatophytes, also known as **seed plants**, represent a highly advanced and diverse group of plants that reproduce via seeds. Seeds provide several advantages over spores, such as better protection for the developing embryo and the ability to remain dormant until conditions are favorable for growth.

Spermatophytes include both **gymnosperms** (e.g., conifers) and **angiosperms** (flowering plants), and they dominate most terrestrial ecosystems.

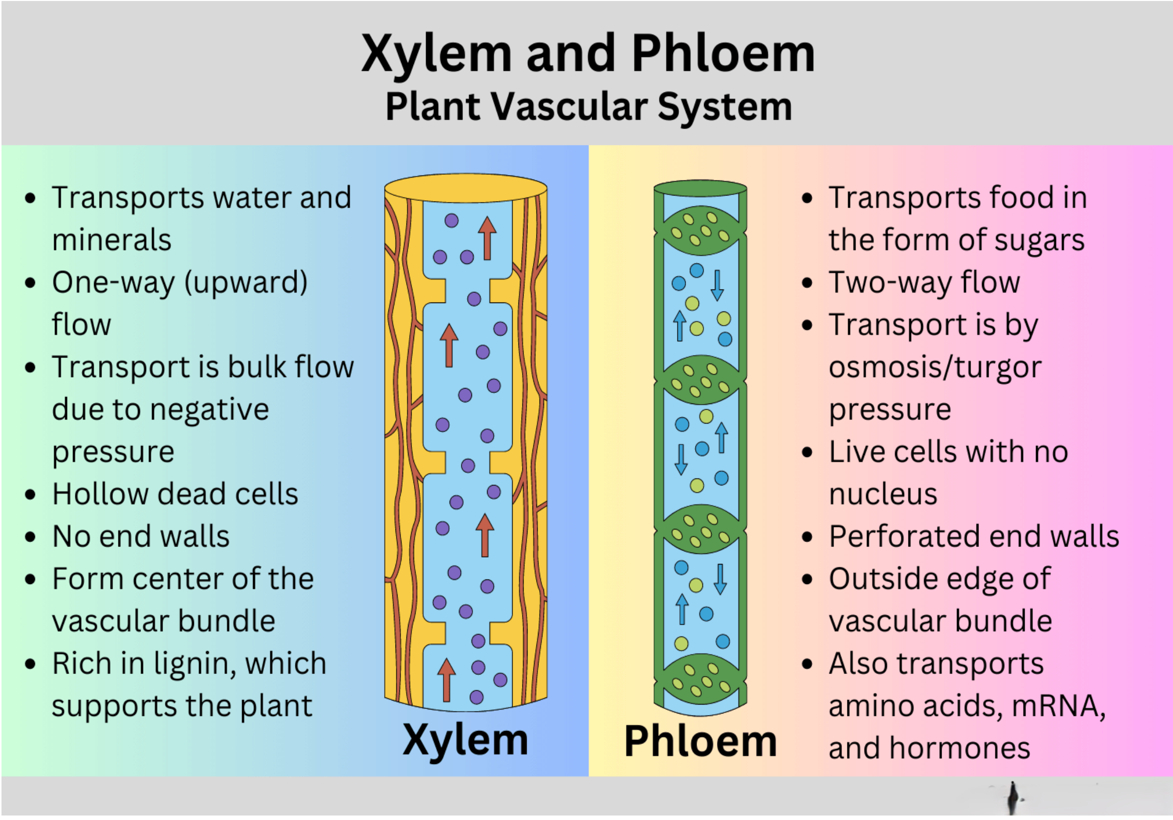
Key Features of Spermatophytes

1. Presence of Seeds

- **Seeds** are the primary reproductive units in spermatophytes. A seed contains:
  - **Embryo**: The young, developing plant.
  - **Seed coat**: A protective layer that shields the embryo from damage, desiccation, and unfavorable conditions.
  - **Endosperm or Cotyledons**: Nutrient-rich tissue that nourishes the embryo during early development.
- Seeds offer a significant evolutionary advantage because they protect the embryo and allow it to remain dormant for long periods until conditions are suitable for germination.

2. Vascular System

- Spermatophytes possess a well-developed **vascular system** consisting of:
  - **Xylem**: Conducts water and minerals from the roots to other parts of the plant.
  - **Phloem**: Transports sugars and nutrients produced by photosynthesis.
- This vascular system allows seed plants to grow larger and thrive in a wide range of habitats, from deserts to tropical forests.



3. True Roots, Stems, and Leaves

- **Roots**: Anchors the plant and absorbs water and nutrients from the soil.
- **Stems**: Support the plant and act as conduits for transporting nutrients between roots and leaves.
- **Leaves**: The primary site of photosynthesis, where light energy is converted into chemical energy (sugars) for the plant.

4. Reproduction by Seeds

- Spermatophytes produce seeds instead of spores. They undergo sexual reproduction, typically involving:
  - **Male gametophytes (pollen grains)**: Develop in male reproductive structures (anthers in angiosperms, pollen cones in gymnosperms).
  - **Female gametophytes (ovules)**: Contain the egg cells, which are fertilized by sperm cells delivered by pollen.
- After fertilization, the ovule develops into a seed, which will germinate into a new plant.

5. Dominant Sporophyte Generation

- In spermatophytes, the **sporophyte** generation (diploid) is dominant, meaning the main plant body we see is the sporophyte.
- The **gametophyte** generation (haploid) is highly reduced and often microscopic, existing only within the reproductive organs of the plant.

6. Advanced Reproductive Strategies

- **Pollen grains** are specialized structures that carry the male gametes. Unlike pteridophytes, spermatophytes are not dependent on water for fertilization because pollen can be transferred through wind, water, or animals (pollinators).
- The **seed** provides protection and nourishment for the developing embryo, allowing it to survive harsh conditions.
- Spermatophytes have developed specialized structures for reproduction:
    - **Flowers** (in angiosperms) attract pollinators and aid in the transfer of pollen.
    - **Cones** (in gymnosperms) protect and develop seeds.

Classification of Spermatophytes

Spermatophytes are broadly classified into two main groups:

1. **Gymnosperms**: Seed plants that do not produce flowers or fruits. The seeds are exposed (naked seeds) and are not enclosed within a fruit. Gymnosperms include: ○ **Conifers** (e.g., pines, firs, spruces)

    Cycads ○

    Ginkgo ○

    Gnetophyte

2. **Angiosperms**: Seed plants that produce flowers and fruits. The seeds are enclosed within a fruit, which develops from the ovary of the flower. Angiosperms are the most diverse and widespread group of plants. They are divided into:

- **Monocotyledons (Monocots)**: Plants with one seed leaf (cotyledon), parallel-veined leaves, and flower parts in multiples of three. Examples include grasses, lilies, and orchids.
- **Dicotyledons (Dicots)**: Plants with two seed leaves (cotyledons), net-veined leaves, and flower parts in multiples of four or five. Examples include roses, beans, and oaks.

Gymnosperms

Features:

- **Naked Seeds**: Seeds are exposed on the surface of cone scales and are not enclosed within a fruit.
- **Cone-bearing**: Gymnosperms typically produce cones (male and female). The male cones produce pollen, while the female cones produce ovules, which after fertilization develop into seeds.
- **Needle-like or Scale-like Leaves**: Many gymnosperms, especially conifers, have narrow, needle-shaped leaves that reduce water loss.
- **Wind Pollination**: Most gymnosperms rely on wind for pollination, which involves the transfer of pollen from male to female cones.
- **Examples**: Pines, firs, redwoods, cycads, and ginkgo. **Angiosperms**

Features:

- **Flowers**: Angiosperms produce flowers, which are specialized reproductive structures. Flowers attract pollinators such as insects, birds, or bats.
- **Fruit Production**: After fertilization, the ovary of the flower develops into a fruit, which contains and protects the seeds. Fruits also aid in seed dispersal by attracting animals or by other mechanisms (e.g., wind, water).
- **Broad Leaf Forms**: Most angiosperms have broad, flat leaves, though some monocots (e.g., grasses) have narrow, blade-like leaves.
- **Diverse Pollination Mechanisms**: In addition to wind and water, angiosperms often rely on animals (pollinators) for pollen transfer, which increases their reproductive efficiency.

- **Examples**: Roses, oak trees, wheat, sunflowers, and orchids. **Advantages of Spermatophytes**

1. **Seed Production**
   - Seeds provide protection and nourishment to the developing embryo, increasing the chances of survival compared to spores.
   - Seeds can remain dormant until conditions are favorable for growth, allowing plants to survive in a variety of climates.
2. **Efficient Reproductive Strategies**
   - Pollen grains protect the male gametes during their transfer, reducing the need for water-based fertilization (unlike bryophytes and pteridophytes).
   - Pollination mechanisms (wind, water, animals) allow spermatophytes to reproduce efficiently in diverse environments.
3. **Wide Range of Habitats**
   - The presence of true roots, vascular tissues, and leaves allows seed plants to thrive in a variety of habitats, from dry deserts to wet tropical forests.
4. **Dominant Sporophyte Generation**
   - The large and complex sporophyte generation is well-suited to terrestrial environments and allows for better competition with other plant species.
5. **Fruit and Seed Dispersal**
   - In angiosperms, fruits aid in seed dispersal by attracting animals that eat the fruit and transport the seeds to new locations, enhancing the plant's ability to colonize new areas.

Disadvantages of Spermatophytes

1. **Dependence on Pollinators (Angiosperms)**
   - Some angiosperms rely heavily on specific pollinators (e.g., bees, birds) for reproduction. If these pollinators decline, the plant species may also face reproductive challenges.
2. **Long Time to Maturity**
   - Many spermatophytes, especially trees, take a long time to reach maturity and produce seeds, which may be a disadvantage in rapidly changing environments.
3. **Vulnerability to Climate Change**
   - Some spermatophytes, particularly gymnosperms, are slow to adapt to rapid environmental changes, making them vulnerable to climate change.

Summary of Spermatophyte Features:

- **Vascular plants** with true roots, stems, and leaves.
- **Seed-producing**: Reproduce via seeds rather than spores.
- **Dominant sporophyte generation**: The larger, visible plant is the diploid sporophyte.
- **Pollen grains**: Enable fertilization without the need for water.
- **Wide variety of pollination mechanisms**: Wind, water, or animalassisted pollination.
- **Classification**: Divided into gymnosperms (cone-bearing plants) and angiosperms (flowering plants).

Spermatophytes have successfully adapted to nearly every terrestrial environment and have become the most dominant group of plants due to their reproductive efficiency, seed-based survival strategy, and advanced vascular systems.

Characteristics of Class Monocotyledonae

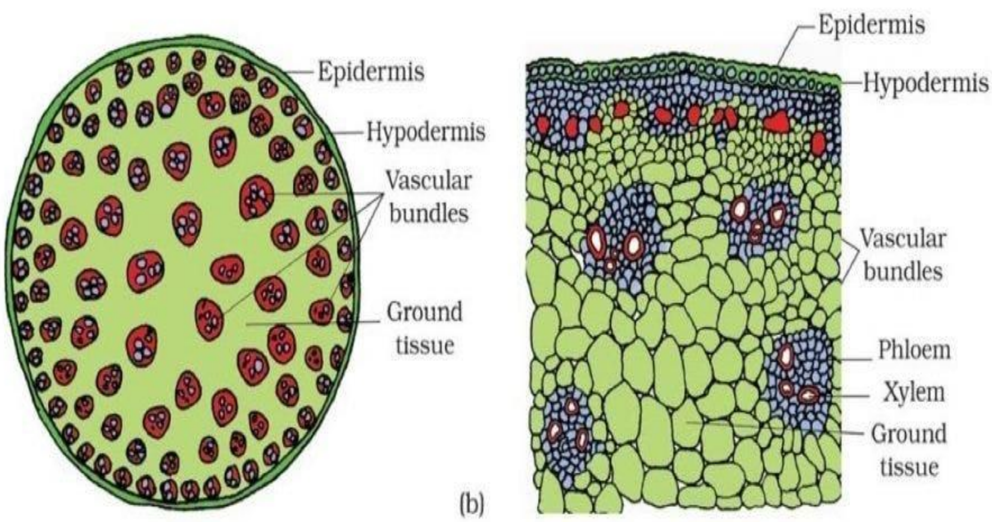
Monocotyledonae (monocots), is a class of angiosperms:

1. **Single Cotyledon**: Seeds of monocots have a single embryonic leaf or cotyledon.

2.Parallel Venation: The leaves of monocots typically show parallel venation, where veins run parallel to each other.

3. Fibrous Root System: Monocots usually have a fibrous root system, with roots branching from the stem base without a dominant central root (taproot).

4. **Scattered Vascular Bundles:** The vascular bundles (xylem and phloem) are scattered throughout the stem rather than arranged in a ring.



5. **Flower Parts in Multiples of Three:** The flowers of monocots typically have floral parts (petals, sepals, stamens, etc.) in multiples of three (3 or 6).

6. Absence of Secondary Growth: Most monocots lack secondary growth, meaning they do not typically produce wood or grow in girth through the formation of rings.

7. Narrow, Strap-like Leaves: Monocots often have long, narrow leaves, such as grasses, lilies, and orchids.

8. Monosulcate Pollen: Pollen grains of monocots generally have a single pore or furrow (monosulcate) compared to the tricolpate pollen found in dicots.

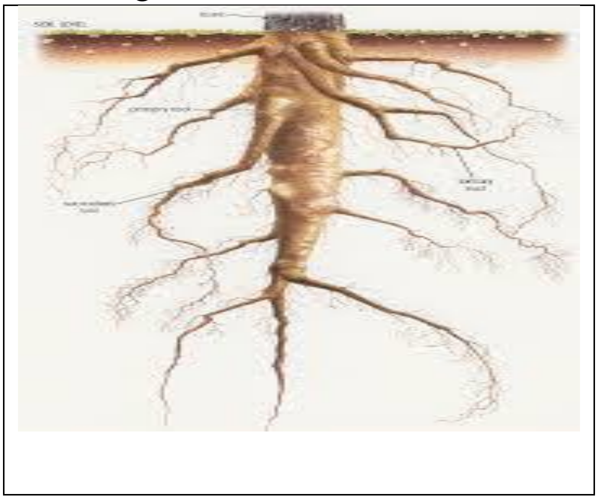
Characteristics of Class Dicotyledonae

This is a class of angiosperms;

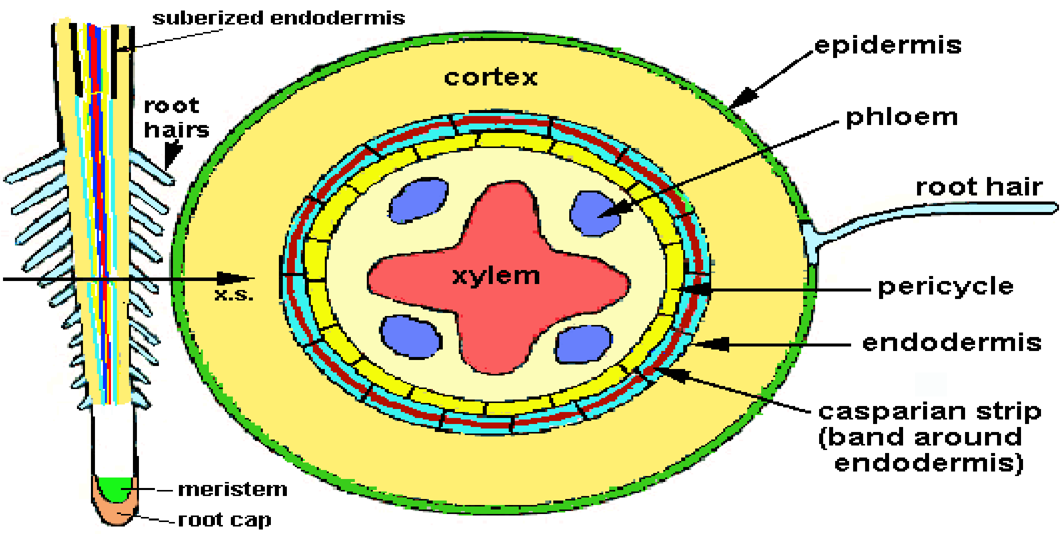
1. **Two Cotyledons**: Seeds of dicots have two embryonic leaves or cotyledons.

2. **Reticulate Venation**: The leaves of dicots generally have a network-like (reticulate) venation pattern, with interconnected veins forming a web-like structure.

3. **Taproot System**: Dicots typically have a well-developed taproot system, with one main root that grows downward and smaller lateral roots branching off.



4. **Vascular Bundles in a Ring**: In dicot stems, the vascular bundles (xylem and phloem) are arranged in a ring around the periphery of the stem.



5. **Flower Parts in Multiples of Four or Five**: The flowers of dicots generally have floral parts (petals, sepals, stamens, etc.) in multiples of four or five.

6. **Presence of Secondary Growth**: Many dicots exhibit secondary growth, allowing them to grow in girth and produce wood through the formation of vascular cambium (e.g., trees and shrubs).

7. **Broad, Net-veined Leaves**: Dicots often have broad leaves with a distinct branching venation, unlike the narrow leaves seen in monocots.

8. **Tricolpate Pollen**: Dicots typically produce pollen grains with three pores or furrows (tricolpate), as opposed to the single pore (monosulcate) in monocots.