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TRY IT

Kingdom PLANTAE

Chapter 25

WARM-UP

Review Plant Kingdom

All plants exhibit Alternation of Generations. They have two different forms which they exist:

___ (spore producing) → ___ (2n) sporophyte stage produces haploid spores by ___. Haploid spores undergo ___ to produce gametophyte stage.

___ (gamete-producing) → Haploid (_); Gametophyte makes gametes (___ and ___) by mitosis.

___ (combine gametes) : ___ (2n) produces a new sporophyte (2n).

- Put the terms in order from simplest to most complex (angiosperms, ferns, flowers, gymnosperms, mosses & liverworts, seeds, vascular tissue):

- Non-vascular plants are called ___. Vascular tissue is found in ___ (vascular plants) : ___ (carries water) and ___ (carries food and minerals) in plants.

WARM-UP

Review Plant Kingdom

All plants exhibit Alternation of Generations. They have two different forms which they exist:

Sporophyte (spore producing) → Diploid (2n) sporophyte stage produces haploid spores by meiosis. Haploid spores undergo mitosis to produce gametophyte stage.

Gametophyte (gamete-producing) → Haploid (n); Gametophyte makes gametes (egg and sperm) by mitosis.

Fertilization: zygote (2n) produces a new sporophyte (2n).

- Simplest to most complex (mosses & liverworts → vascular tissue → ferns → seeds → gymnosperms → flowers → angiosperms):
- Non-vascular plants are called bryophytes. Vascular tissue is found in tracheophytes: xylem (carries water) and phloem (carries food and minerals) in plants.

Each plant organ (___, ___, ___) contain all three types of tissue:

- ____ (protective outer coating)
- ____ (support and storage)
- ____ (transport of water and nutrients)

Plants are categorized based on the length of their life cycle:

- ____ complete their life cycle in one year.
- ____ complete their life cycle in two years.
- ____ live for many years.

Each plant organ (roots, stems, leaves) contain all three types of tissue:

- Dermal (protective outer coating)
- Ground (support and storage)
- Vascular (transport of water and nutrients)

Plants are categorized based on the length of their life cycle:

- **Annuals** complete their life cycle in one year.
- **Biennials** complete their life cycle in two years.
- **Perennials** live for many years.

Lesson Objectives

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

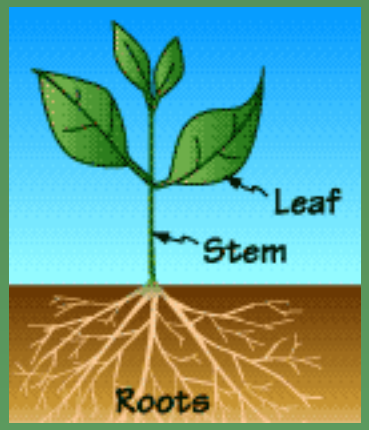
- ❑ Identify the major organs in plants, including the function and anatomy of each one?
- ❑ Distinguish herbaceous & woody plants, monocots & dicots.
- ❑ Explain the formation and aspects of secondary growth, including vascular tissue and bark.
- ❑ Understand how plants acquire nutrients from air, water, and soil (root pressure, capillary action, transpiration), including light absorption and guard cells.
- ❑ Identify Hormones and explain the process of germination.

- **Science Practice:** **Dichotomous Key PPT & Keying Out Trees**

Seed Plant Structure and Function

ANGIOSPERMS — the **flowering plants** — make up more than 90% of the plant kingdom.

Seed Plant Structure



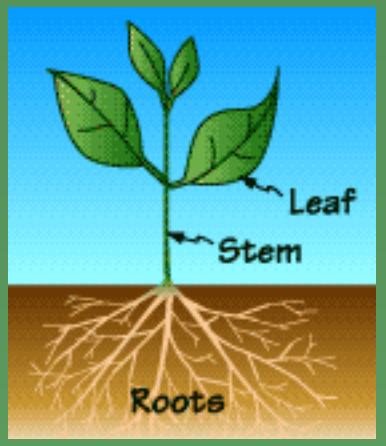
- **Three Principal Organs of Seed Plants:**

Roots, Stems, Leaves

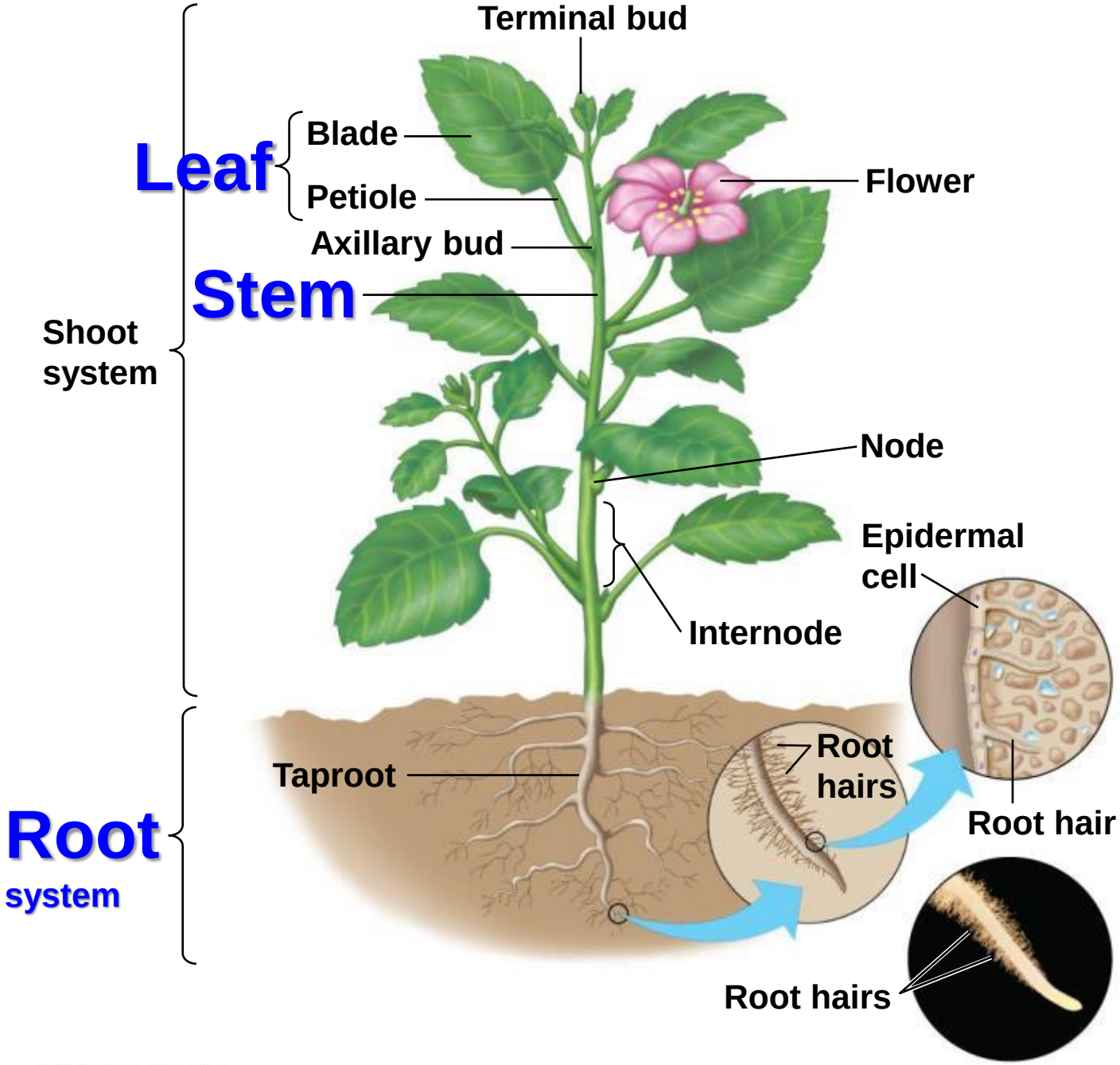
- They are linked together by systems that run the length of the plant.

- These systems produce, store, and transport nutrients, and provide physical support and protection.

Roots, Stems, Leaves



- Most necessary minerals as well as water are found deep in the ground in a steady supply (ROOTS). Store food.
- Energy is required for roots to work: photosynthesis (LEAVES).
- Transport throughout the plant as well as photosynthesis (STEMS).
- FLOWERS reproduce and store energy.


Terminal bud
Leaf
Blade
Petiole
Flower
Axillary bud
Stem
Shoot system
Node
Epidermal cell
Internode
Taproot
Root hairs
Root hair
Root
system
Root hairs

Roots

Functions:

- **Anchor** the plant in the ground.
- **Absorb water and nutrients** from soil.
- **Transport** absorbed substances to other parts of the plant.
- **Store Food** (Ex. Carrots, Radishes, Beets, Potatoes).
- **Prevent erosion**.

A rye plant (grass, e.g. oats, barley) has 14 million branch roots equaling 380 miles. Willow or cactus roots grow ~100 feet towards water.

Root Systems

Tap Root

Consists of one large Primary Root, with many smaller secondary roots.

- Most **Dicots** have this system.

Fibrous Root

Consists of Secondary roots without a dominant taproot.

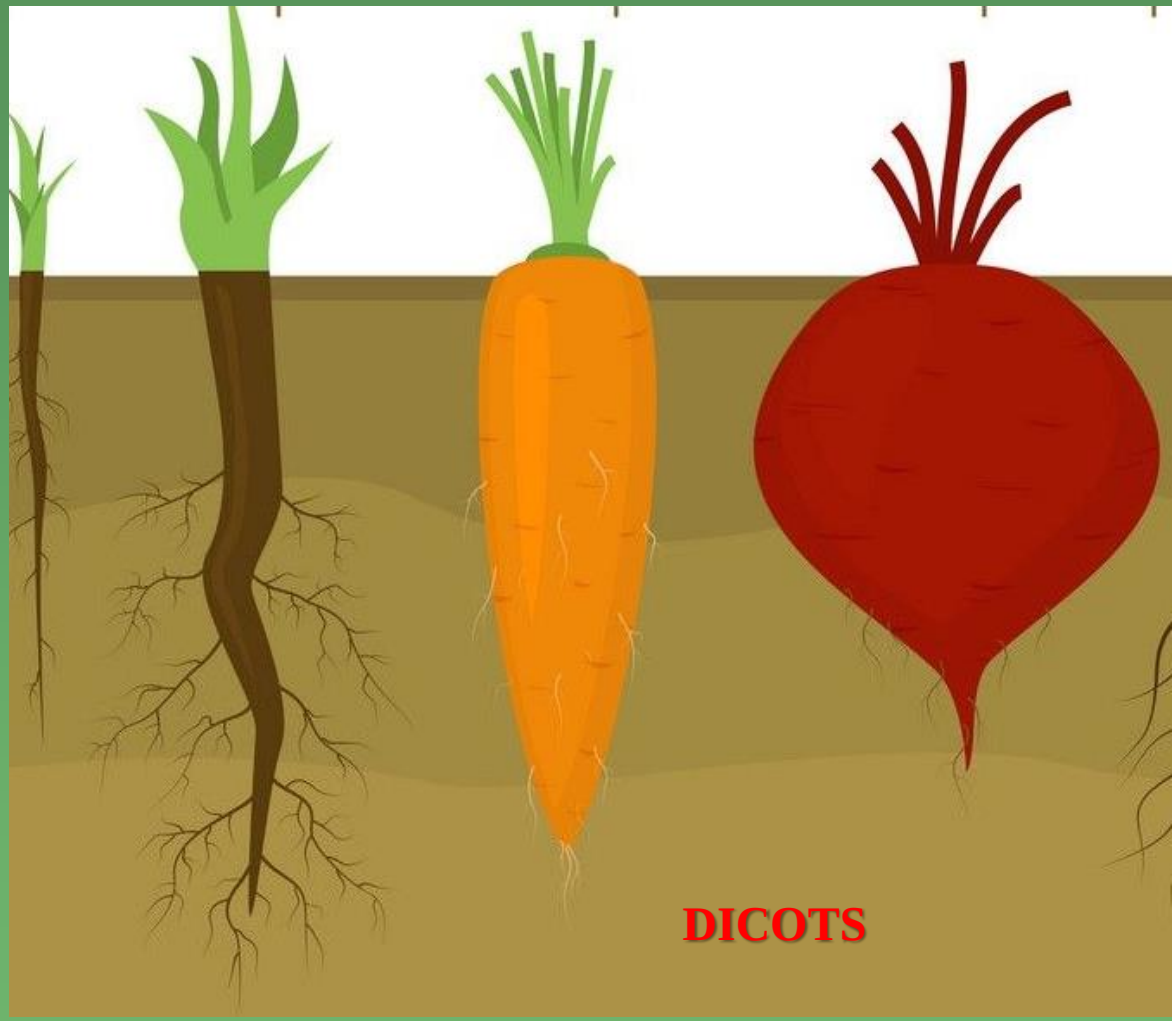
- Most **Monocots** have this system.

Seedlings produce PRIMARY roots. All roots branching from there are called secondary roots.

Fibrous Roots

MONOCOTS

Tap Root



Adventitious Roots

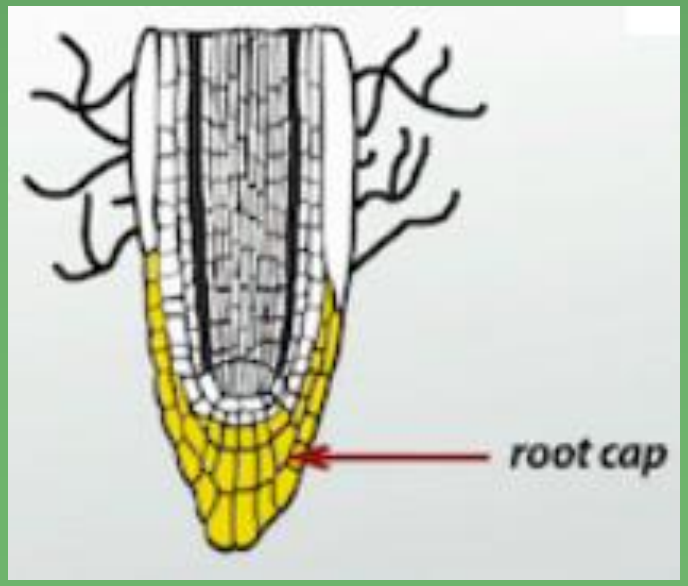
Roots that arise from a part of the plant that is NOT a root. Climbing roots and prop roots are examples.

Gives stability to the plant.

Root Structure

Root Cap

- Rounded tip containing dead cells.
- Protects the apical meristems of the root tip as it pushes through the soil.



Root Structure

Root Growth occurs behind the root cap in 3 Zones:

Zone of Cell Division:

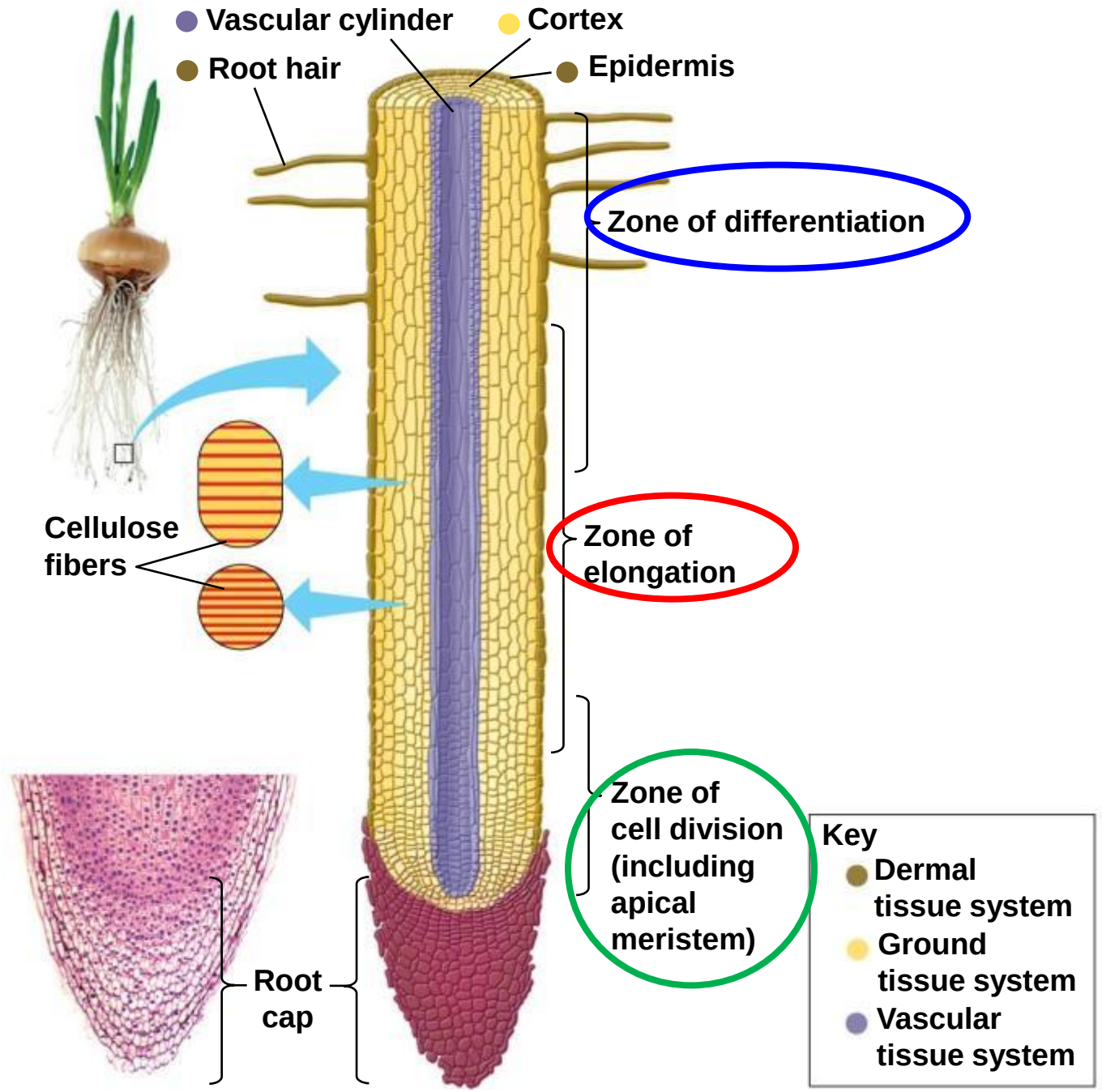
- Above the root cap; includes apical meristem.
- Area where cells undergo rapid Mitosis.

Zone of Elongation:

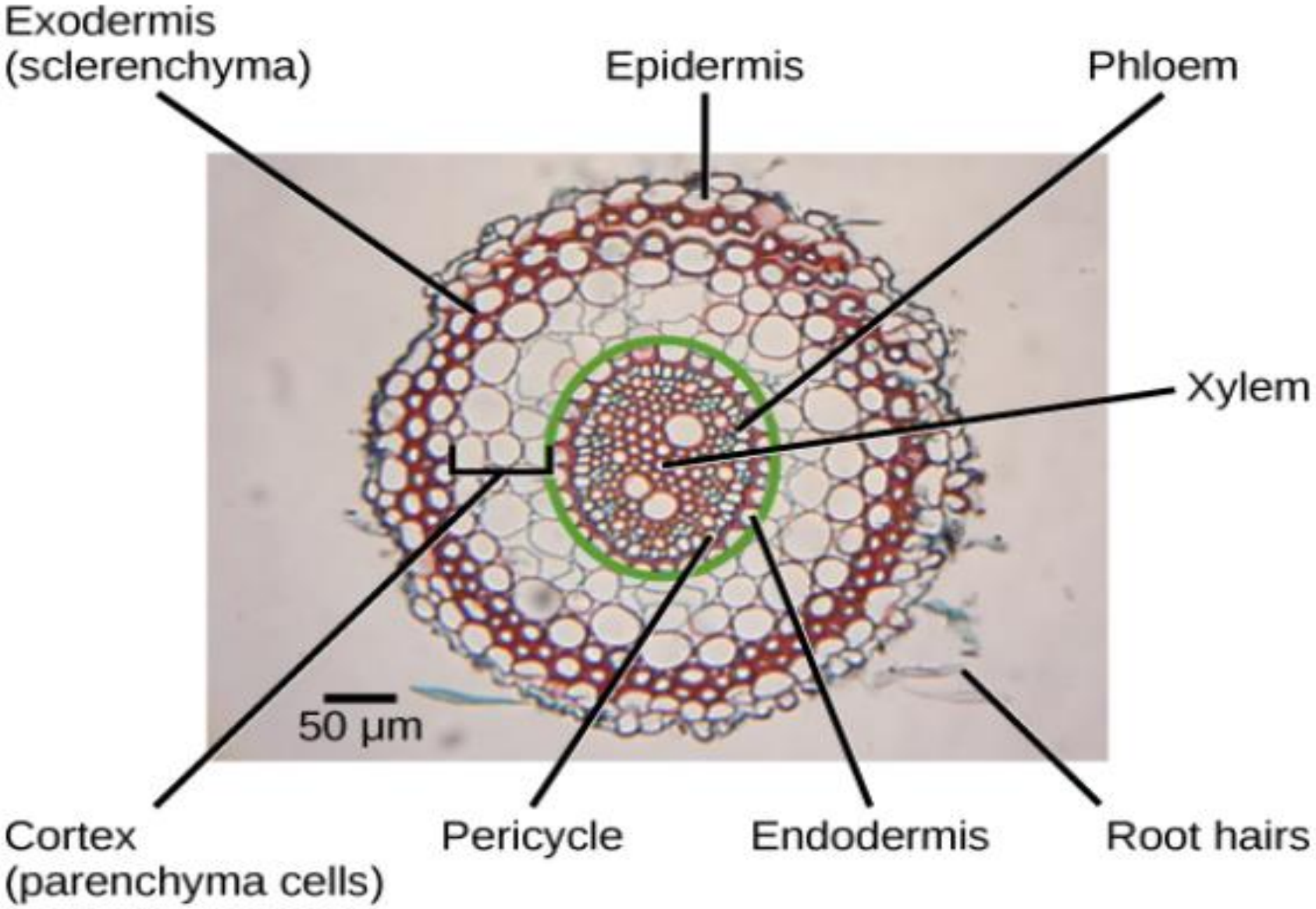
- Area where cells lengthen.

Zone of Differentiation:

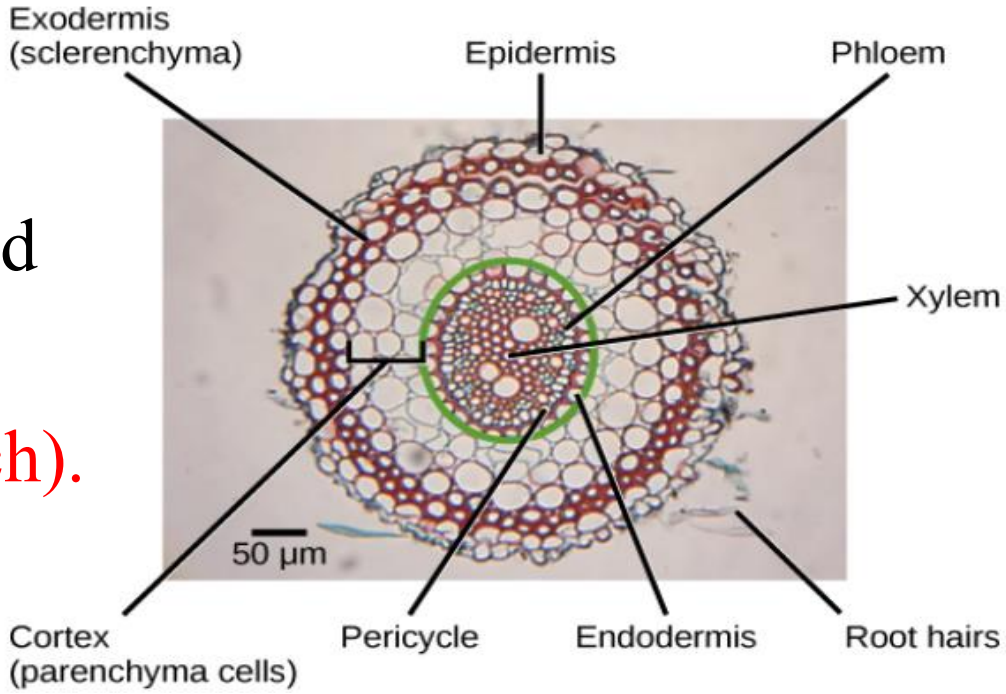
- Area where cells differentiate into dermal, vascular, and ground tissues.


Vascular cylinder
Cortex
Root hair
Epidermis
Zone of differentiation
Cellulose fibers
Zone of elongation
Zone of cell division (including apical meristem)
Root cap
Key
Dermal tissue system
Ground tissue system
Vascular tissue system

Cross Section of a Root (differentiation)



Cross Section of a Root (differentiation)



Xylem → transport water and minerals.

Cortex → storage area (starch).

Phloem → transport food (glucose) from leaves.

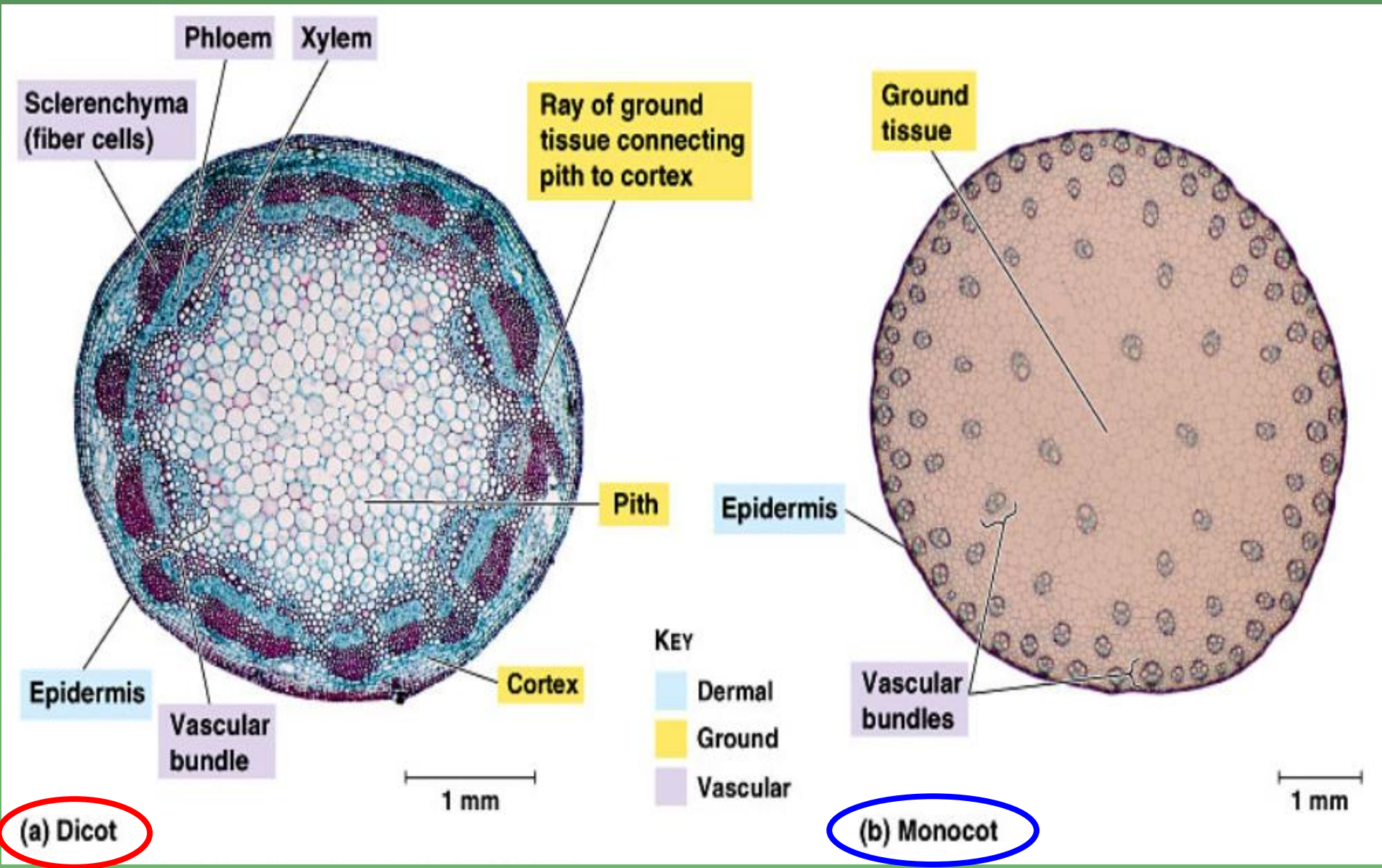
Pericycle → cells originating from secondary roots.

Endodermis → confines the central cylinder.

Epidermis → outer layer of cells; absorption and protection.

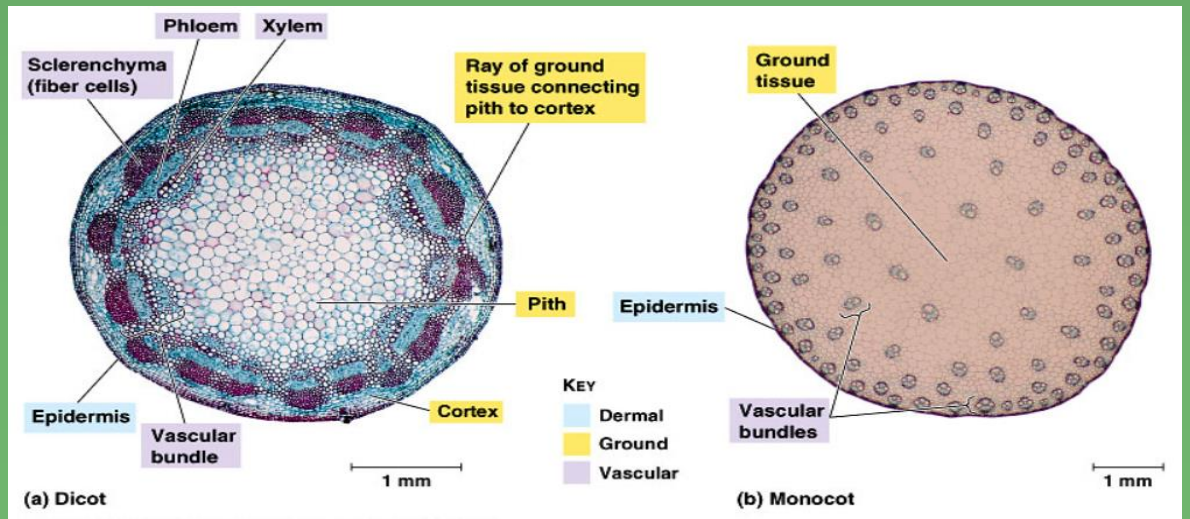
Root Hair → epidermal cells to increase surface area for absorption.

STEMS


Phloem
Xylem
Sclerenchyma (fiber cells)
Ray of ground tissue connecting pith to cortex
Pith
Epidermis
Cortex
Vascular bundle
1 mm
(a) Dicot
KEY
Dermal
Ground
Vascular
Ground tissue
Epidermis
Vascular bundles
1 mm
(b) Monocot

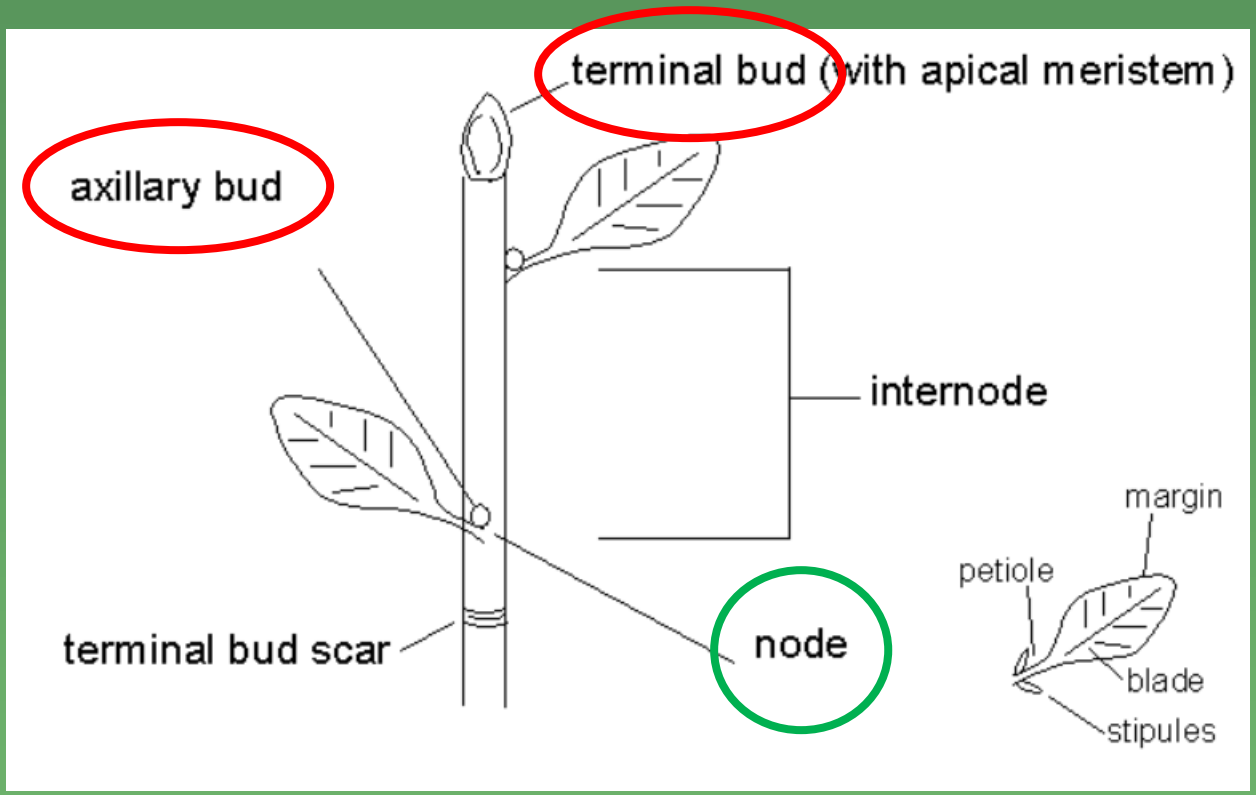
STEMS

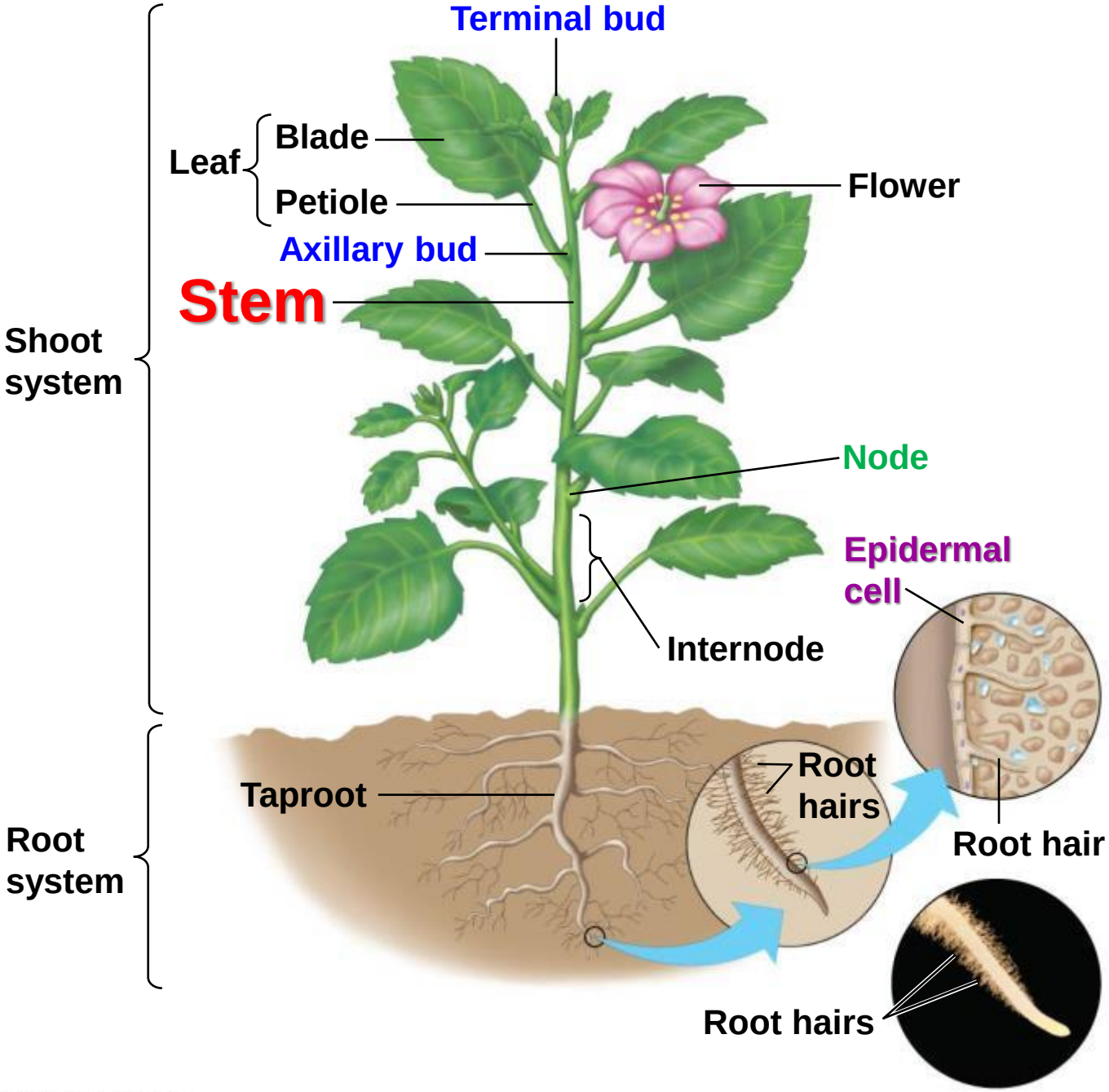
- **Functions:**
  - Support system for the plant body (leaves and branches).
  - Transport System that carries nutrients and water. throughout the plant.
- **Stems** contain cells from the 3 kinds of plant tissues: dermal, vascular, and ground.
- **Stems** are surrounded by a layer of epidermal cells that have thick cell walls and a waxy protective coat.



STEMS

- **Nodes:** where the leaf or branch is attached to the stem.
- **Buds:** Contain apical meristem that can produce new stems and leaves.
- **Stems** can develop woody tissue that helps support leaves and flowers.



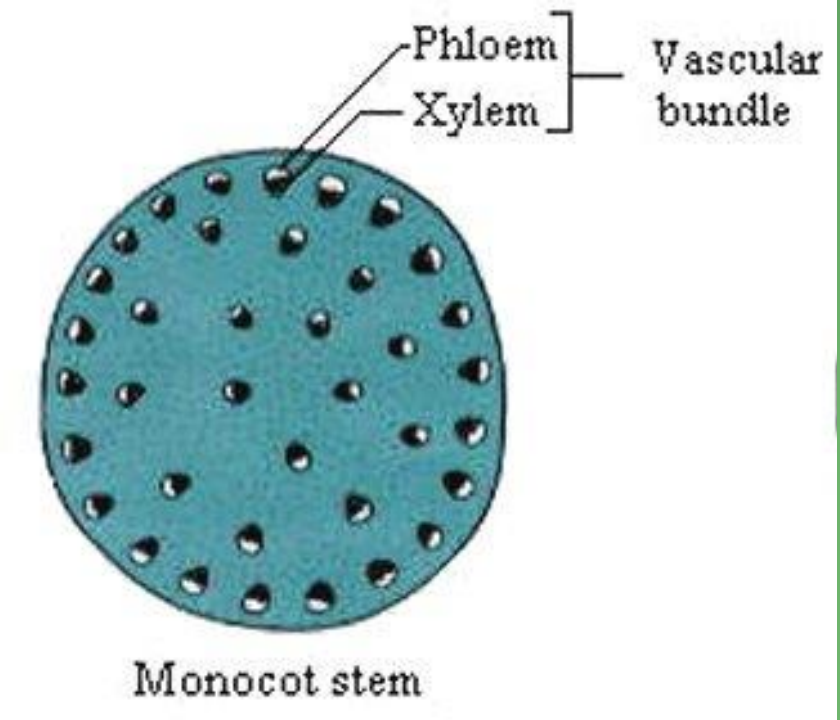

Terminal bud
Leaf
Blade
Petiole
Flower
Axillary bud
Stem
Shoot system
Node
Epidermal cell
Internode
Taproot
Root hairs
Root hair
Root system
Root hairs

Stems: Vascular Bundle Patterns

Vascular Bundle: cluster of xylem and phloem tissue.

MONOCOTS:

- Vascular bundles are scattered throughout the stem.



Monocot stem

Stems: Vascular Bundle Patterns

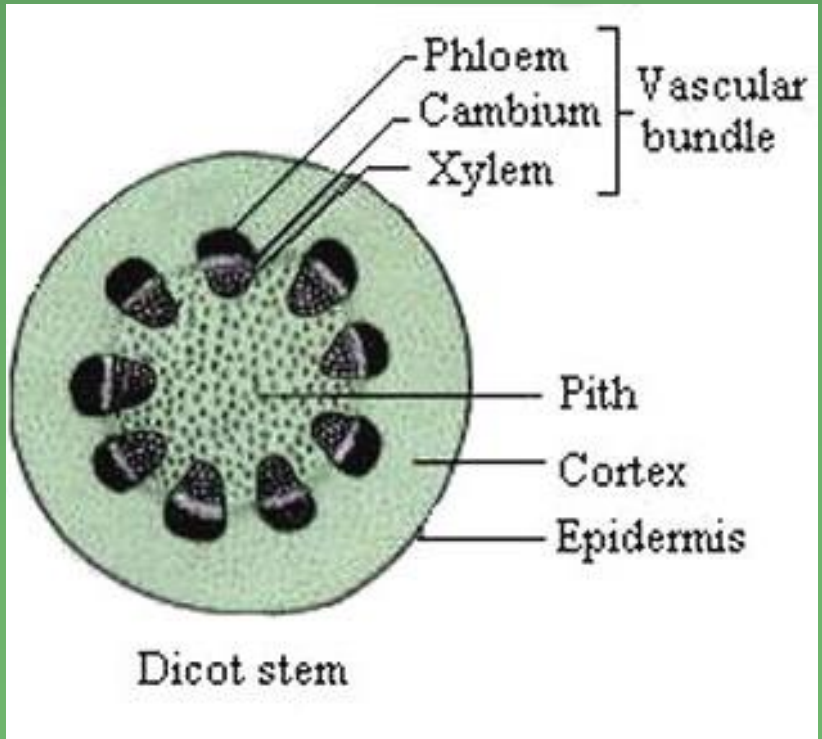
Herbaceous DICOTS:

- Vascular bundles form a ring near the outer part of stem.

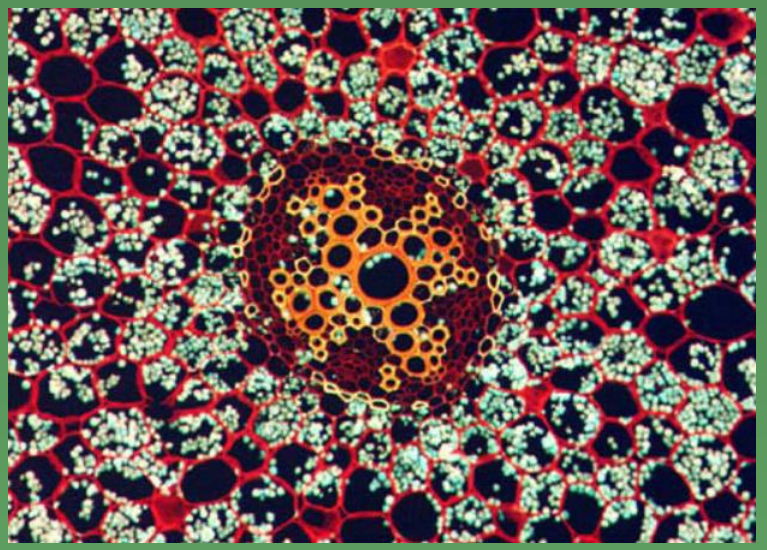
PITH → ground tissue cells inside the ring of vascular tissue.

CORTEX → ground tissue cells outside the ring of vascular tissue.

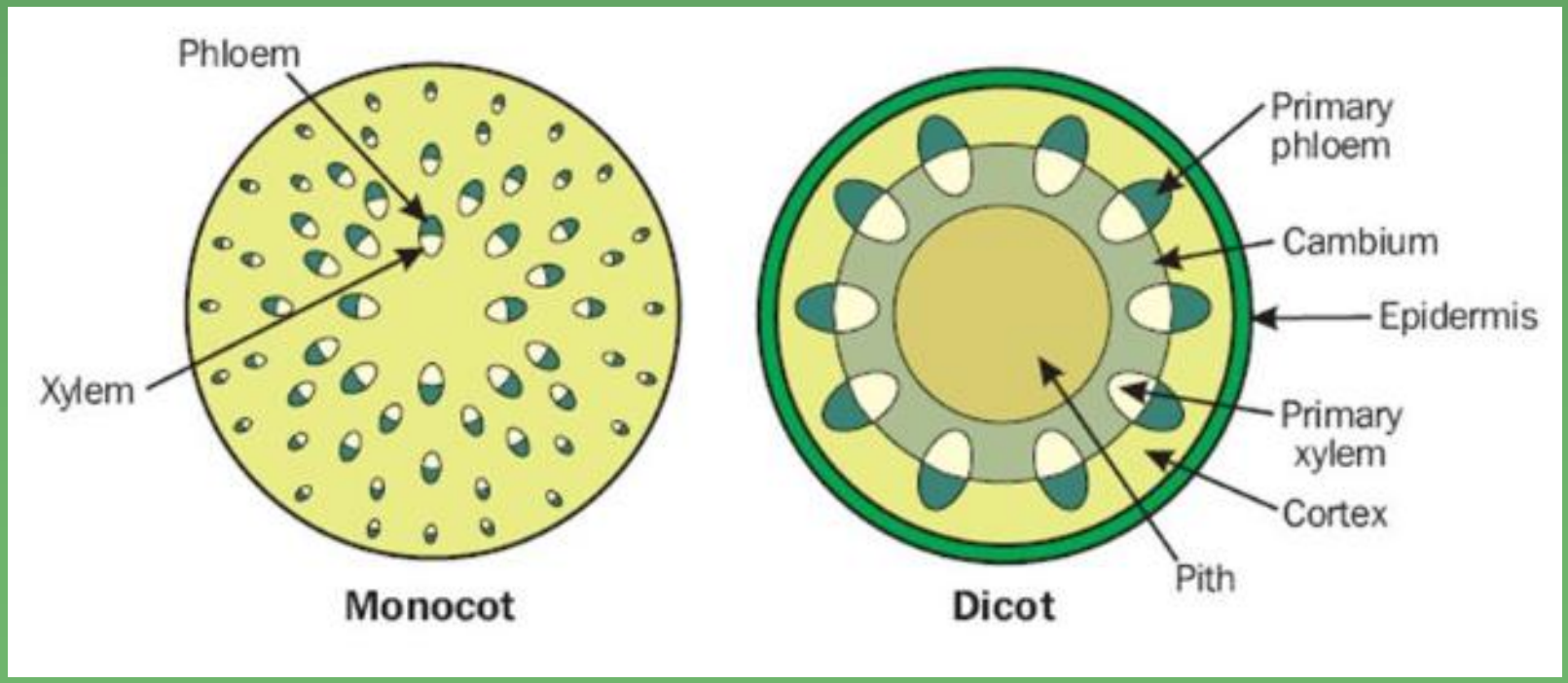
- Presence of Vascular Cambium, which forms new vascular tissue (xylem/phloem) as needed.

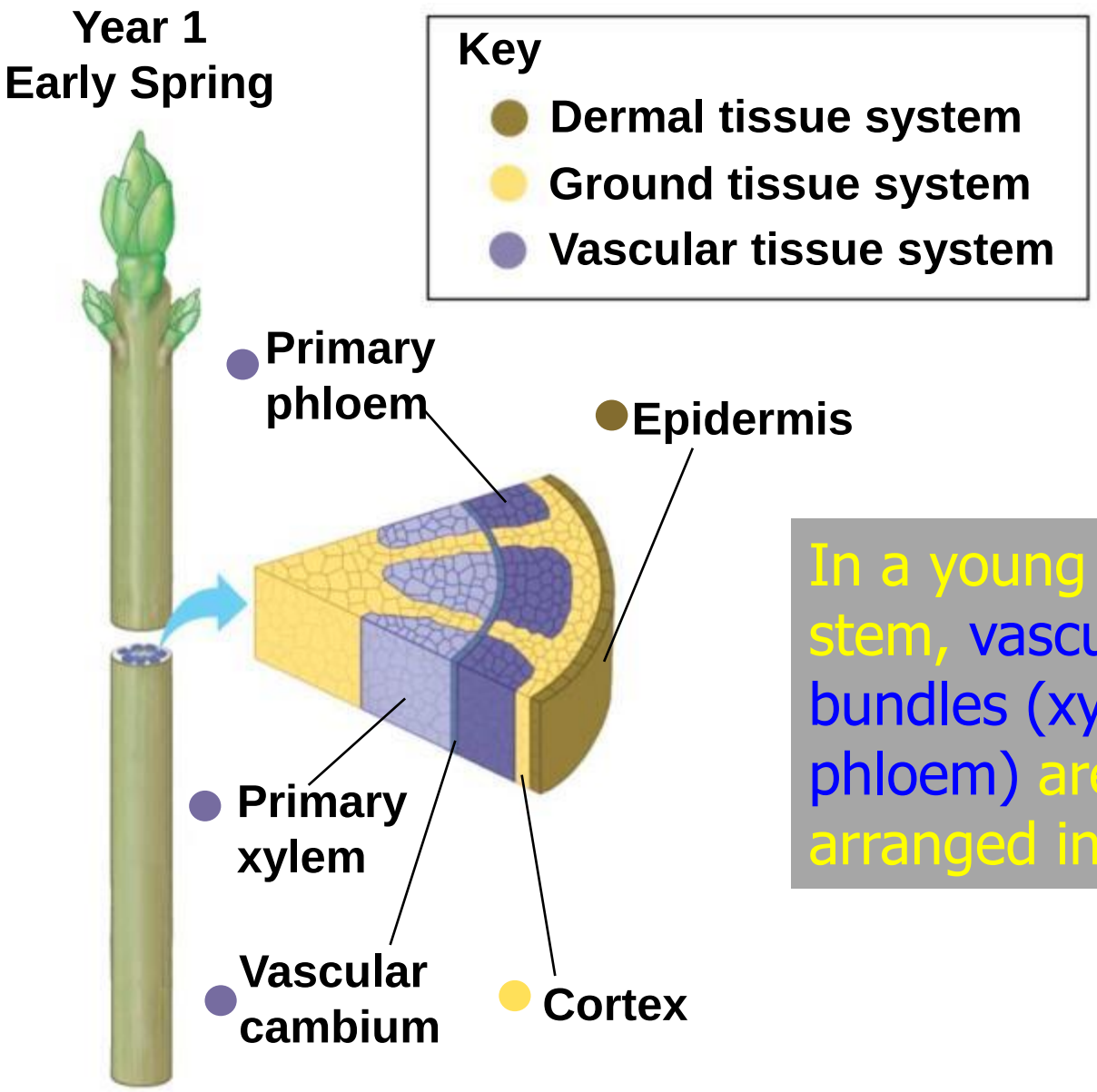


Herbaceous Stem



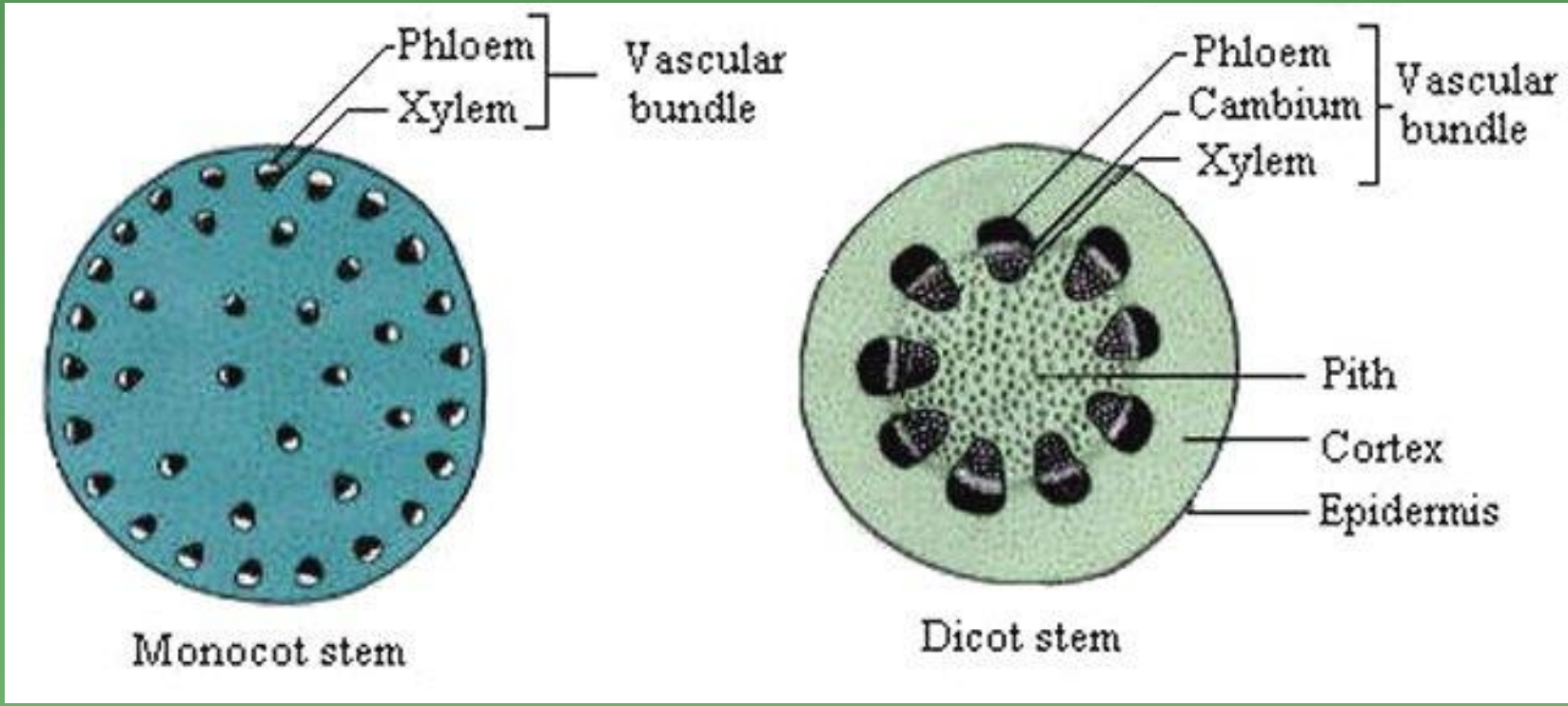
Herbaceous Stems have little to no secondary growth.





In a young dicot stem, vascular bundles (xylem and phloem) are arranged in a ring.

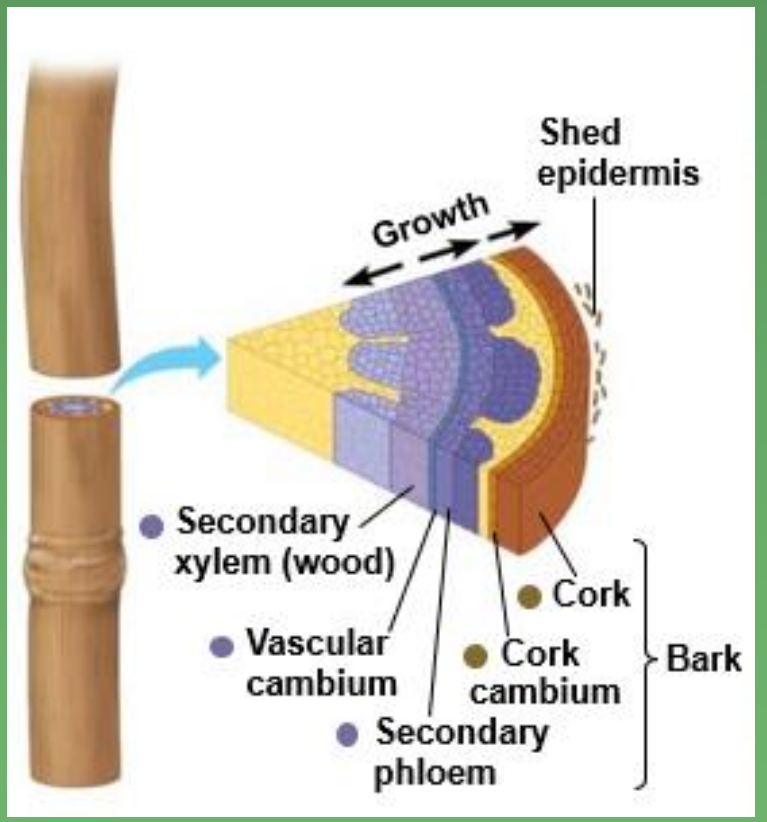
Monocot vs Dicot Stem



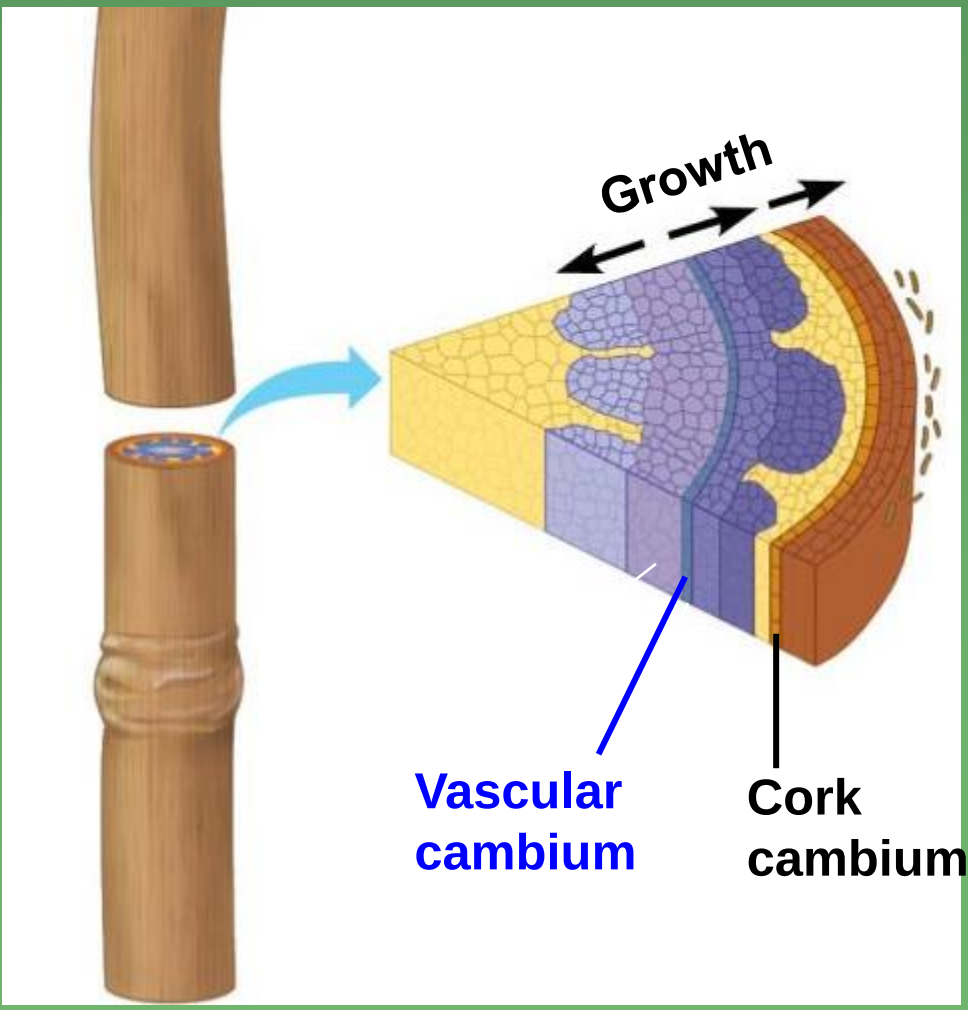
Secondary Growth increases the Diameter of WOODY Plants

SECONDARY Growth

- is an increase in thickness of stems and roots.
- occurs at lateral meristems.
- Dicots ONLY … most deciduous trees.



Secondary Growth increases the Diameter of Woody Plants

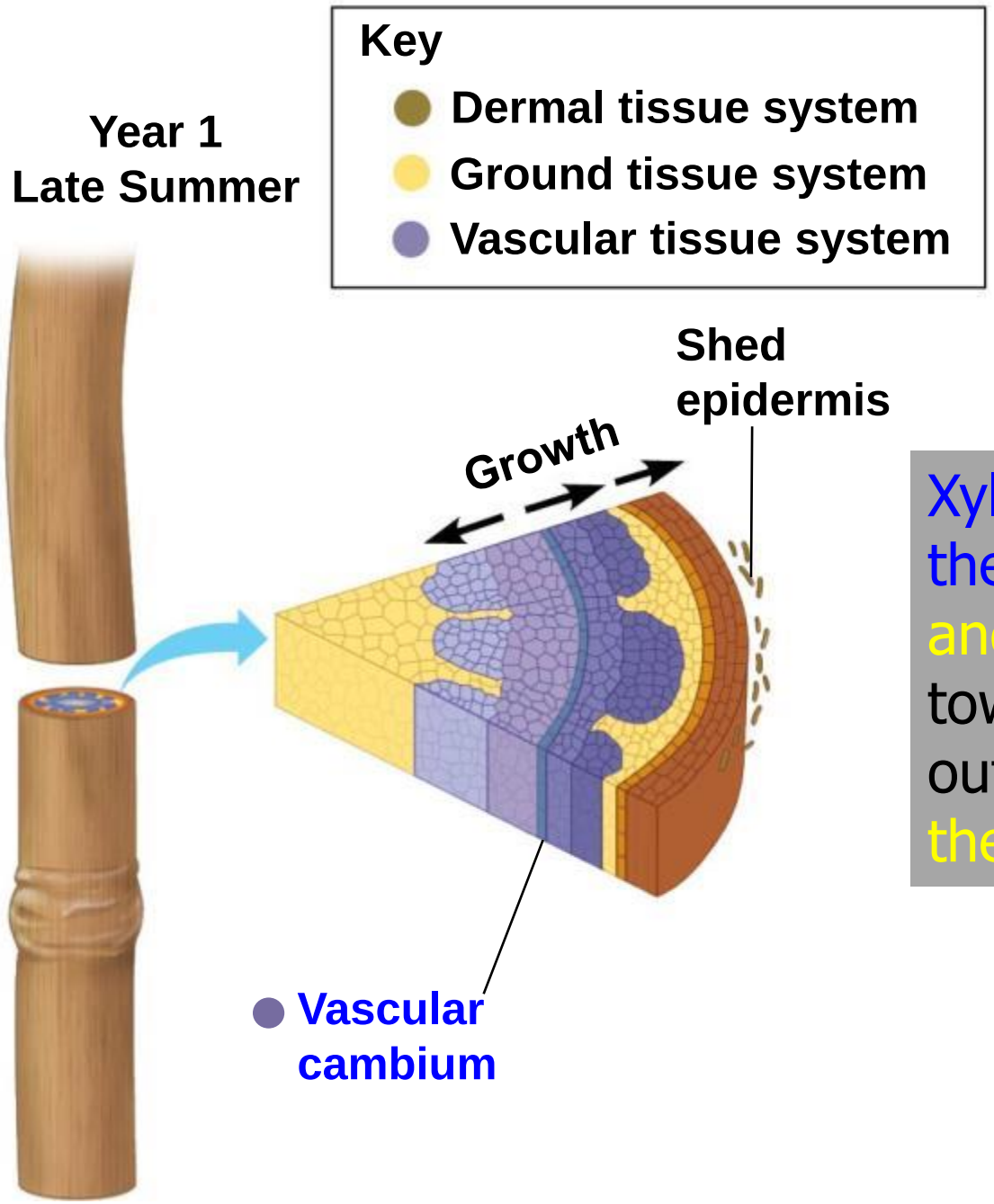


Lateral Meristems are areas of active cell division that exist in two cylinders that extend along the length of roots and shoots.

- **Vascular Cambium** is a lateral meristem that lies between primary xylem and primary phloem.
- **Cork Cambium** is a lateral meristem that lies at the outer edge of the stem cortex.

When secondary growth begins the vascular cambium appears as a thin, cylindrical layer of cells between the xylem and the phloem of each bundle.

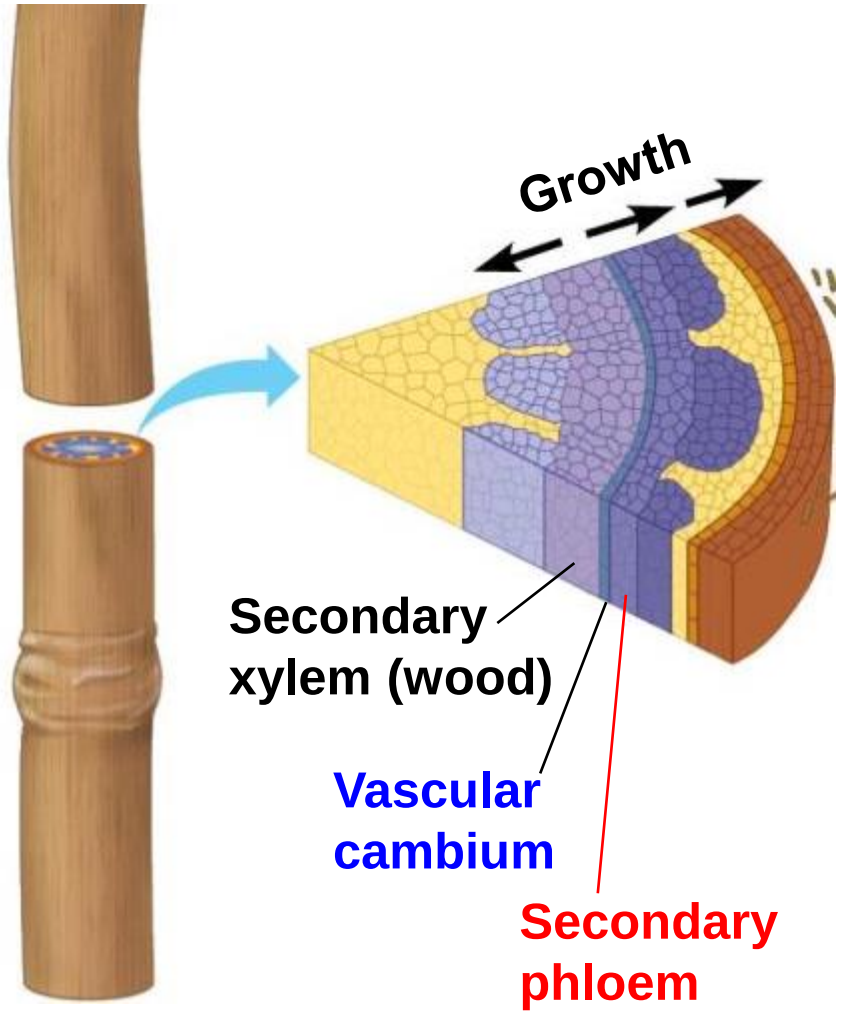
Divisions in the vascular cambium give rise to new layers of xylem and phloem.



Xylem toward the inside and Phloem toward the outside of the stem.

Year 1
Late Summer

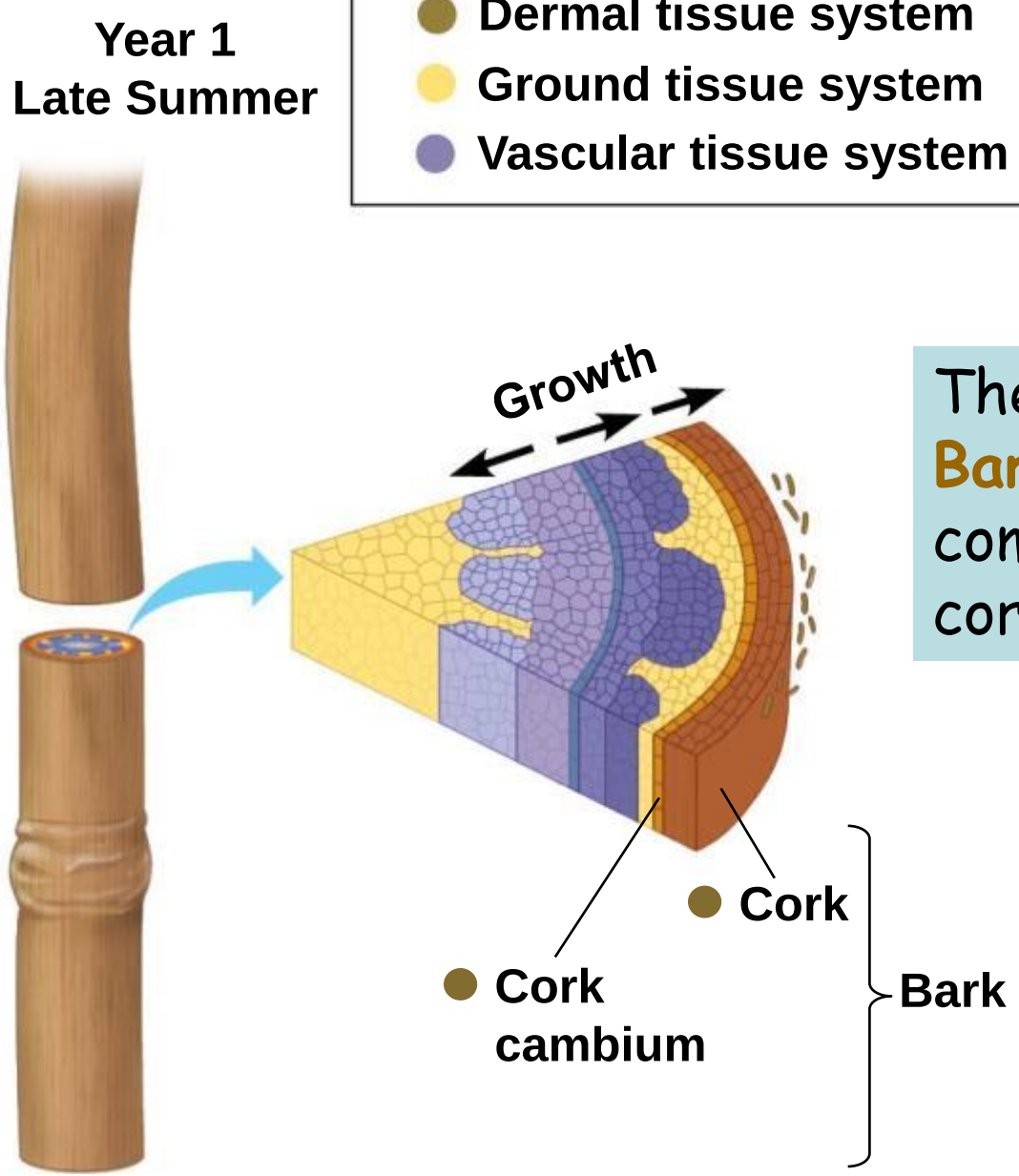
As a result of secondary growth, vascular cambium gives rise to two new tissues.



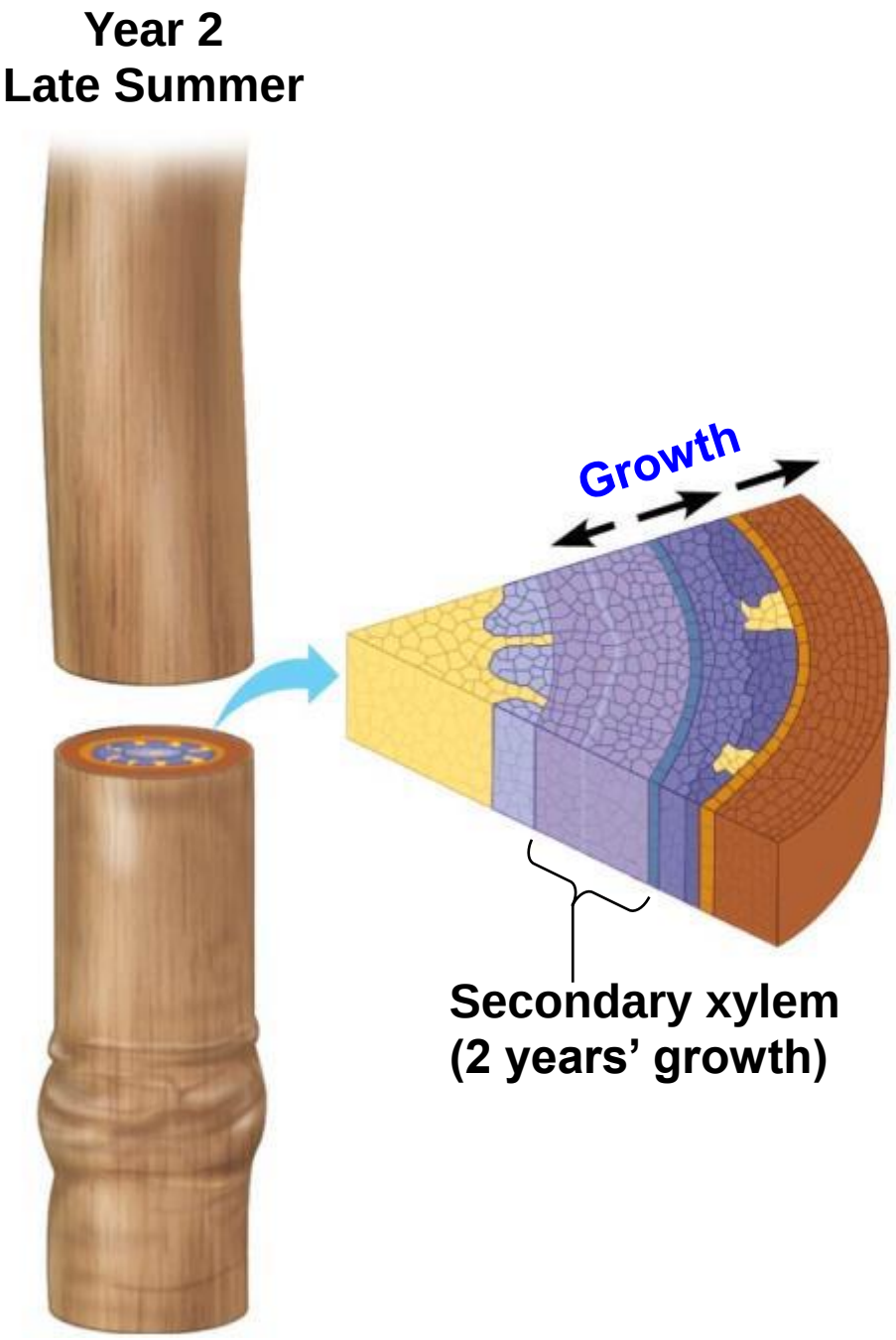
Secondary Xylem produces **Wood** toward the interior of the stem.

Secondary Phloem produces the INNER bark toward the exterior of the stem.

Cork Cambium produces cells in one direction (outward).

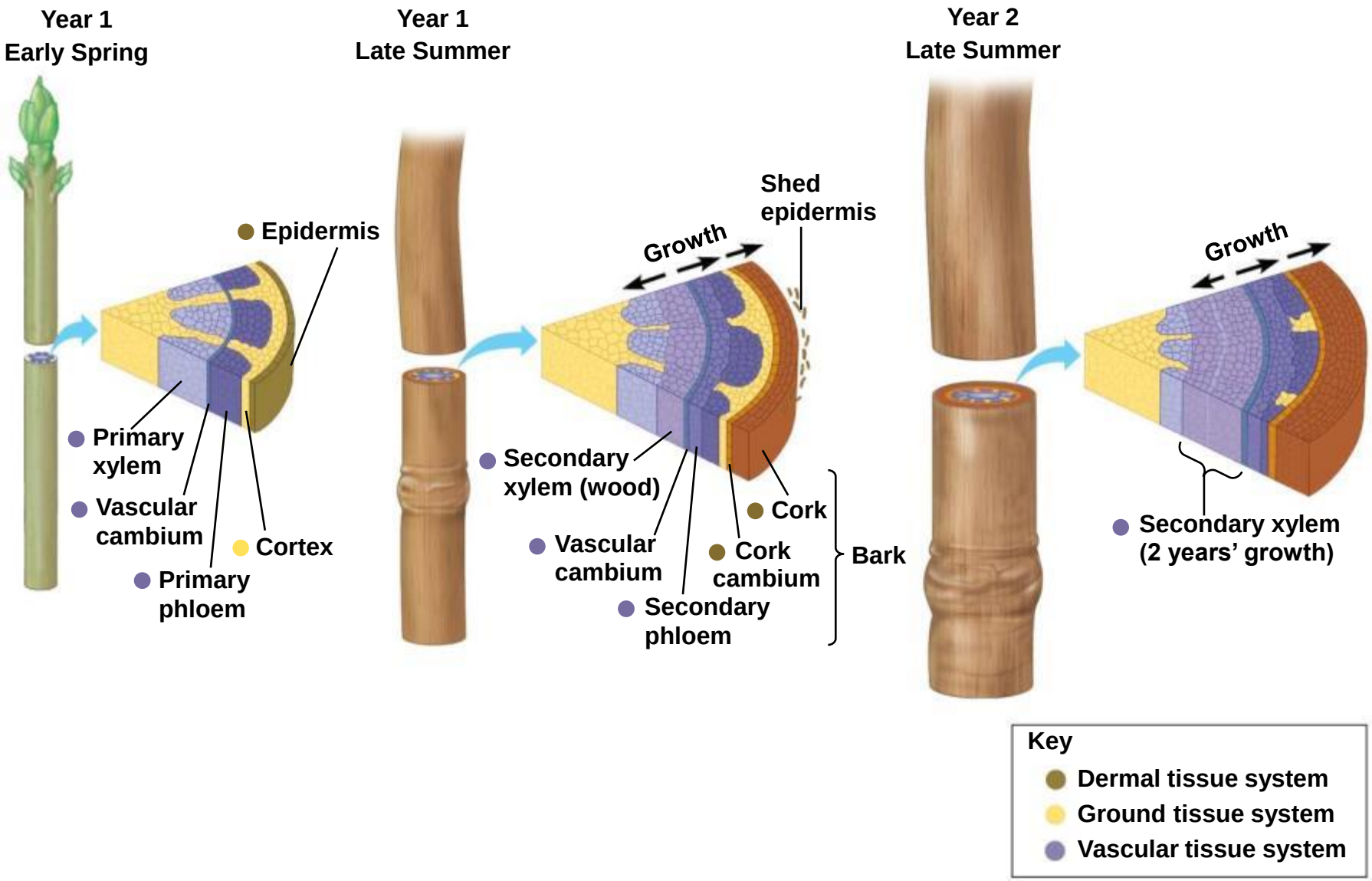


The **OUTER Bark** is composed of cork cells.

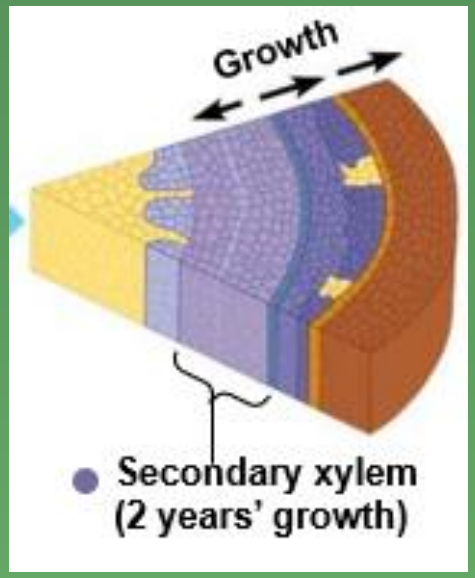


As a result the of secondary growth stem becomes wider.

Each year the cambium produces new layers of vascular tissue, causing the stem to become thicker and thicker.

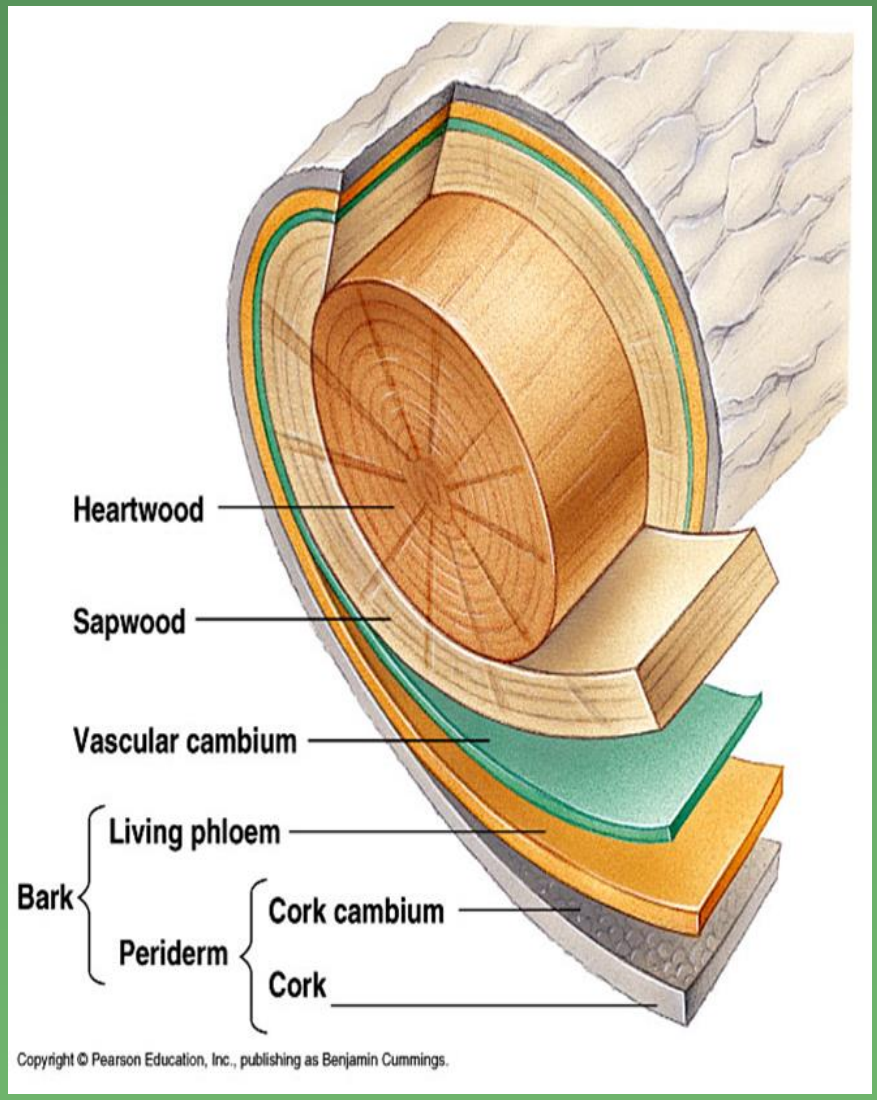

Year 1
Early Spring
Year 1
Late Summer
Year 2
Late Summer
Epidermis
Primary xylem
Vascular cambium
Cortex
Primary phloem
Growth
Shed epidermis
Secondary xylem (wood)
Vascular cambium
Cork
Cork cambium
Secondary phloem
Bark
Growth
Secondary xylem (2 years' growth)
Key
Dermal tissue system
Ground tissue system
Vascular tissue system

Formation of Wood and Bark



Wood

- Layers of Secondary Xylem produced by Vascular Cambium.
- These cells build up year after year; layer on layer.

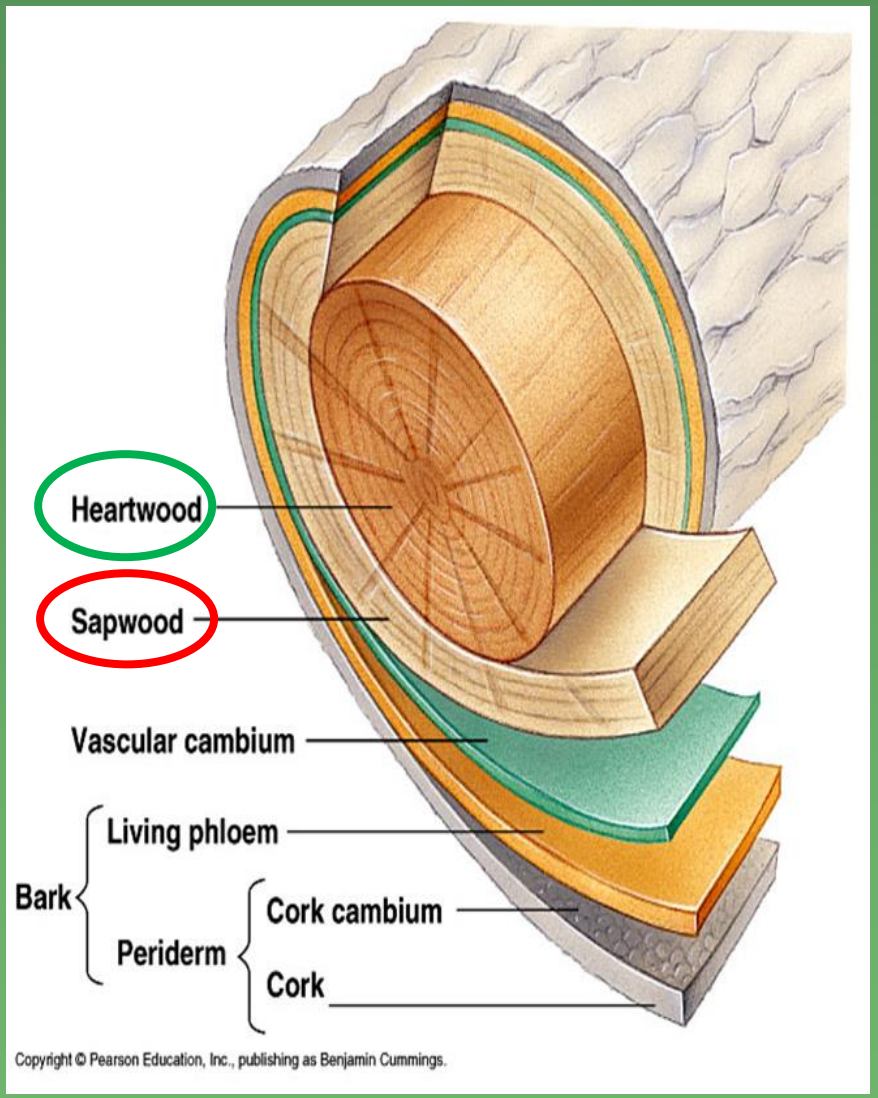


Formation of Wood and Bark

Wood

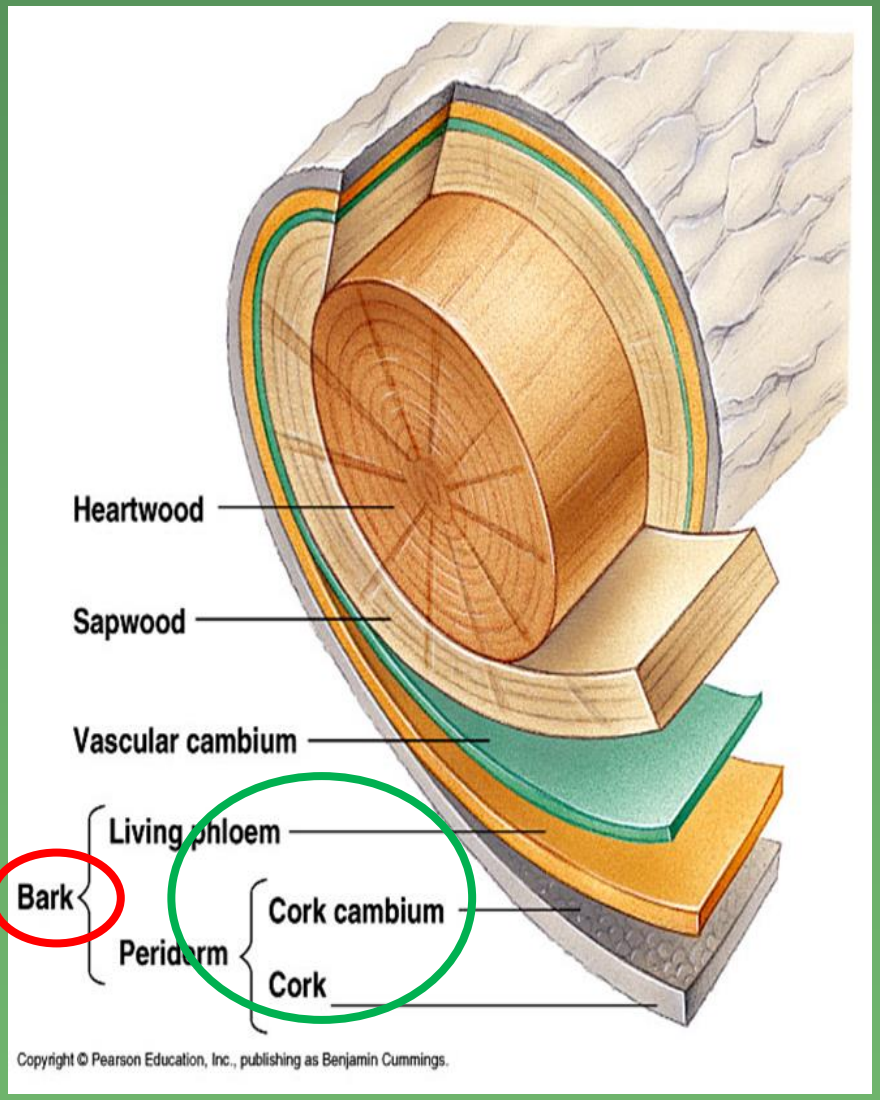
- As woody stems grow thicker, the older xylem near the center of the stem no longer conducts water and becomes **Heartwood.**

- **Sapwood** is active in water and nutrient transport.



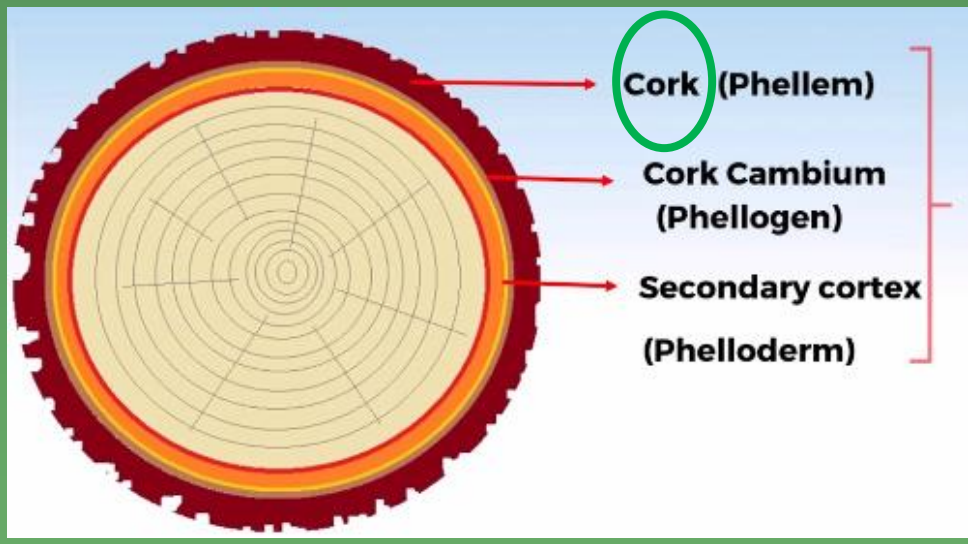
Formation of Wood and Bark

- In a mature stem, all of the tissues found outside the vascular cambium make up the **BARK.**
- These tissues include phloem, cork cambium, and cork.
- **As a tree expands in width, the phloem layer grows as well.**



Formation of Wood and Bark

- Cork Cambium surrounds the cortex, and produces a thick, protective layer of waterproof Cork that prevents loss of water from the stem.

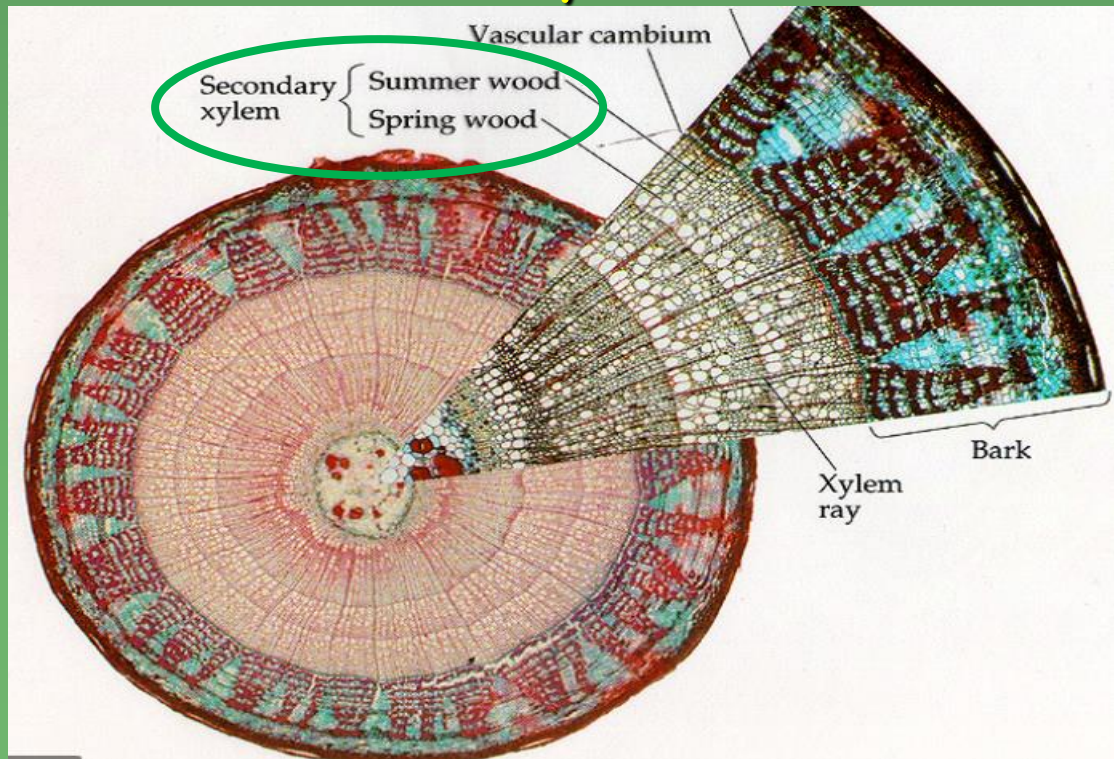


- As the stem increases in size, outer layers of dead bark often crack and flake off the tree.

Woody Stems: Tree Rings

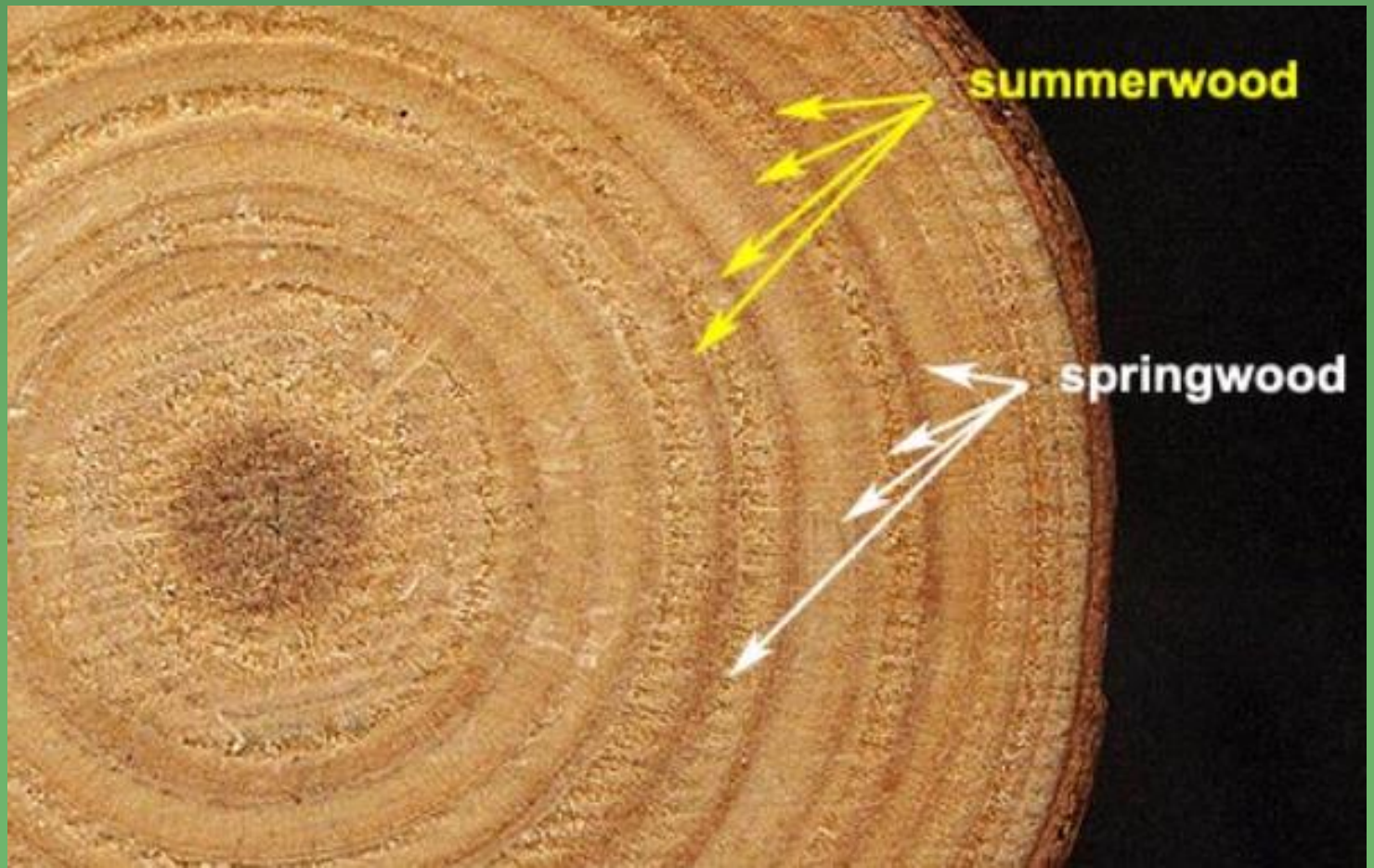
- In most of the Temperate Zone, Tree Growth is seasonal.
- In springtime when water is plentiful, a lot of xylem is needed to transport it, so more xylem is formed in spring than any other time of the year.

Spring xylem is larger and not as densely packed as the late summer xylem.



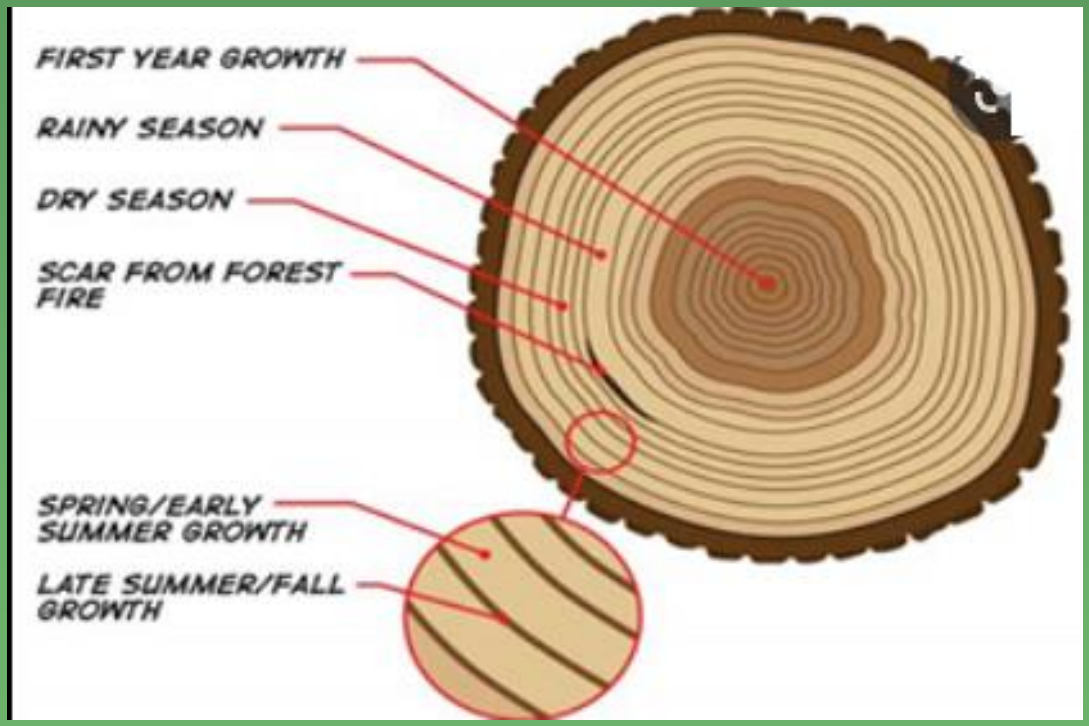
Woody Stems: Tree Rings

When a tree is cut down, the spring xylem is lighter in color, and the late summer xylem is darker.



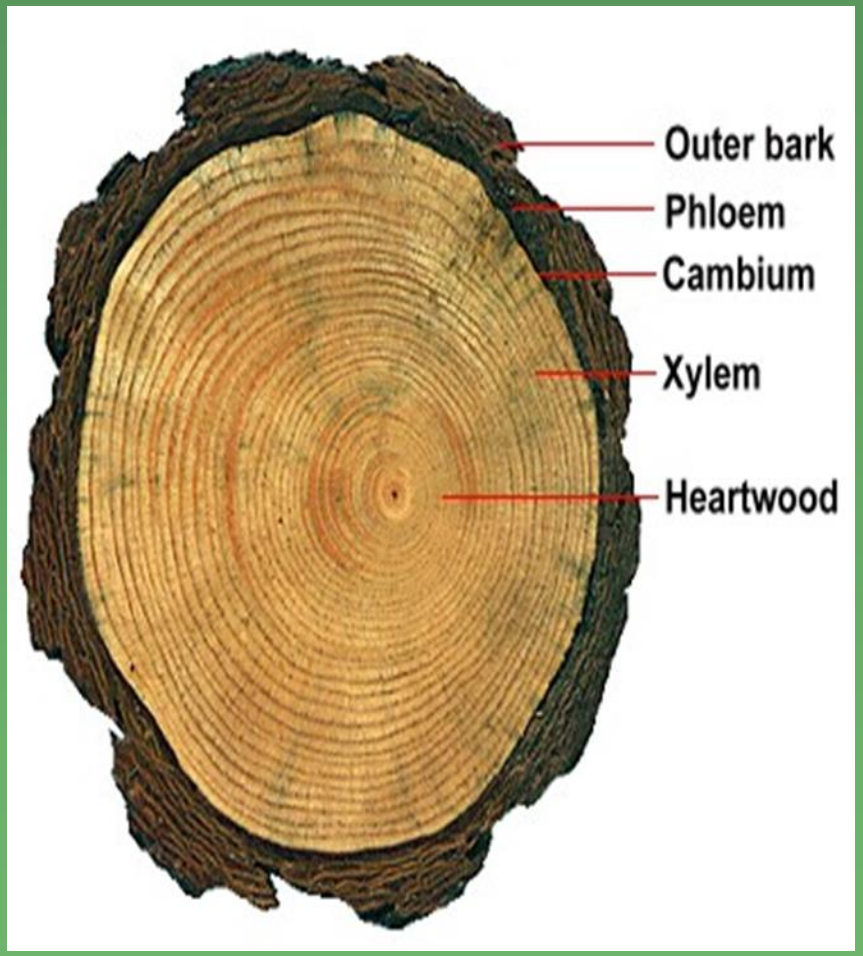
Woody Stems: Tree Rings

During the winter, when **no xylem** is made, a dark line forms between the late summer xylem of one season and the spring xylem of the new growing season.



Woody Stems: Tree Rings

- The number of rings present indicate how old the tree is.
- The thickness of the rings gives an idea of how harsh the climate was for any particular growing season (year).



Woody Stems: Tree Rings = Xylem Rings

- Spring Xylem is wide and light brown (grows rapidly).
- Summer Xylem is thin and darker (grow slower).

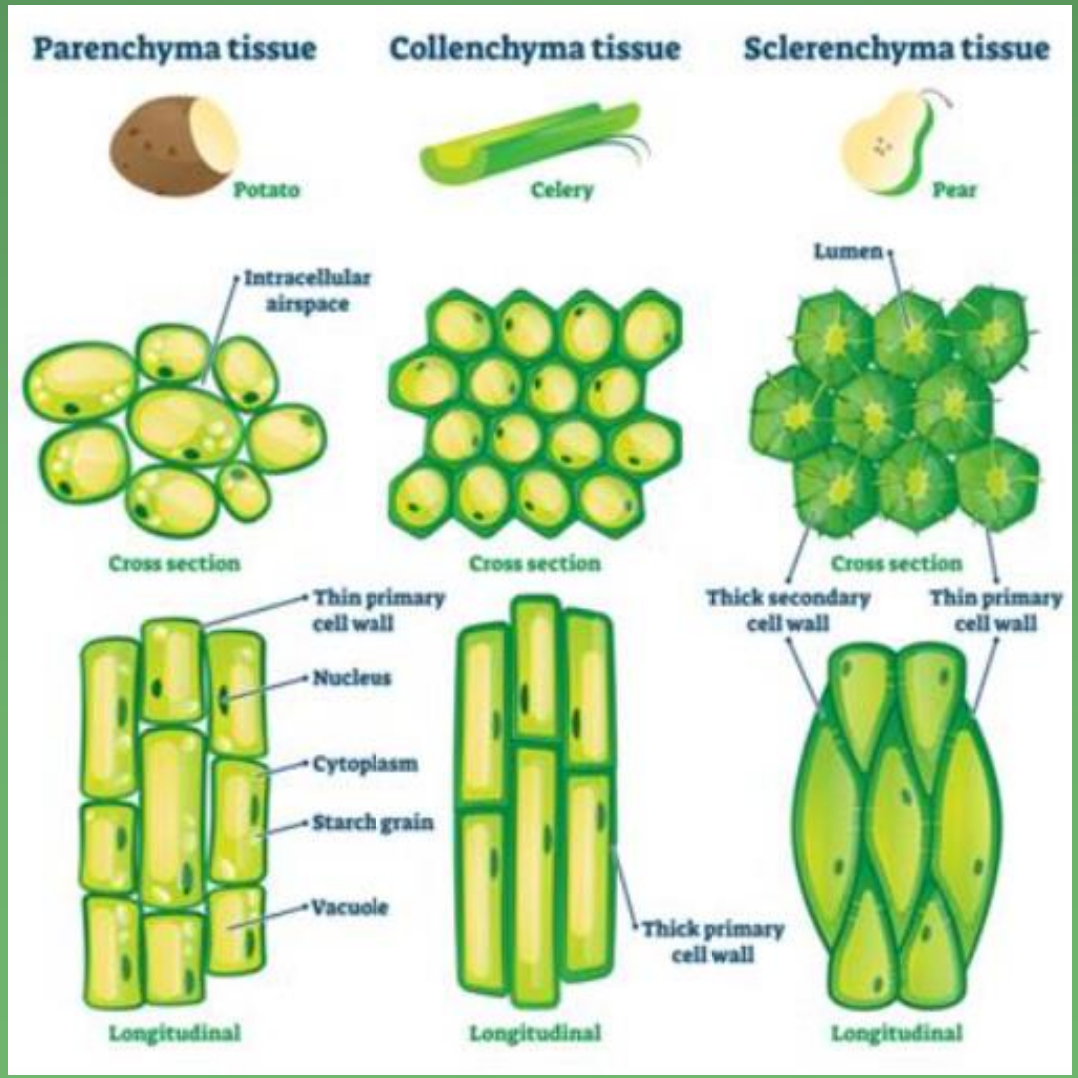
One Year's Growth = Each pair of light and dark rings.

Ground Tissue in WOODY Stems

PARENCHYMA
(photosynthesis in the pith).

COLLENCHYMA
(shoot support in areas of active growth & transport nutrients).

SCHLERENCHYMA
(support & protect shoot, transport water and nutrients).



What are the principle organs in every plant?

What are three types of roots and their purpose?

What are the three zones of root growth and their composition?

What are the principle organs in every plant?

Roots, stems, leaves

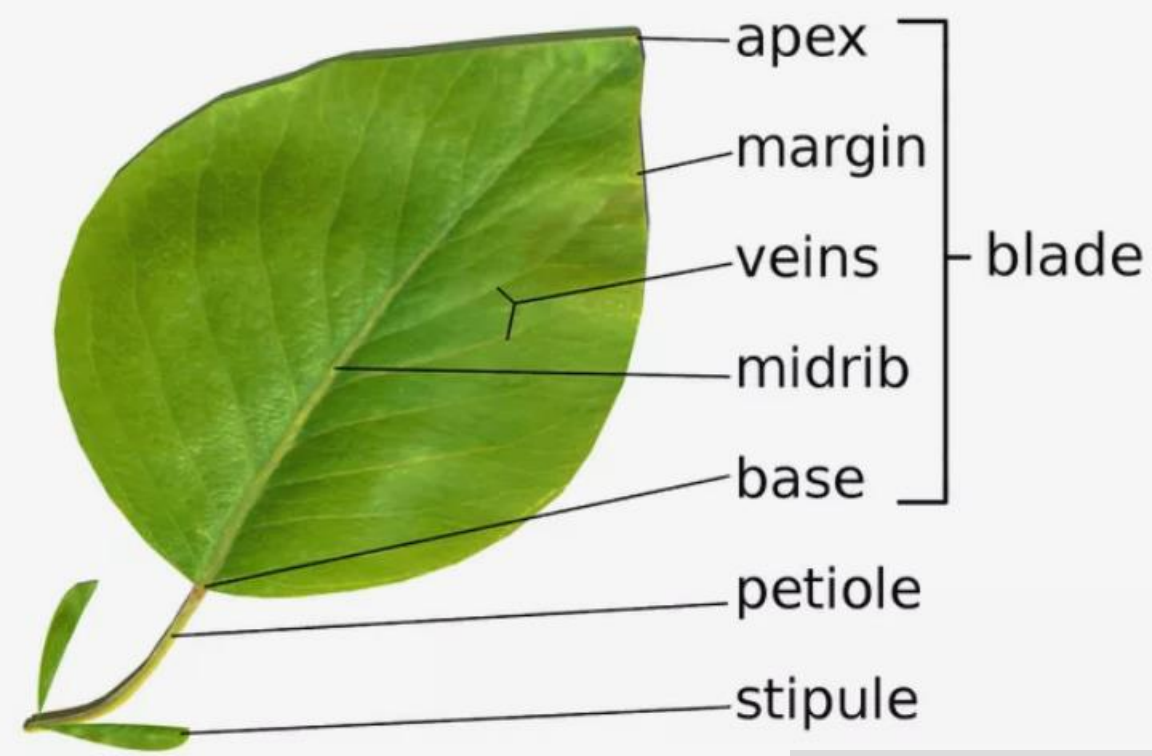
What are three types of roots and their purpose?

fibrous, tap, adventitious roots … intake of water and nutrients from the soil. Adventitious roots are above ground and support the plant.

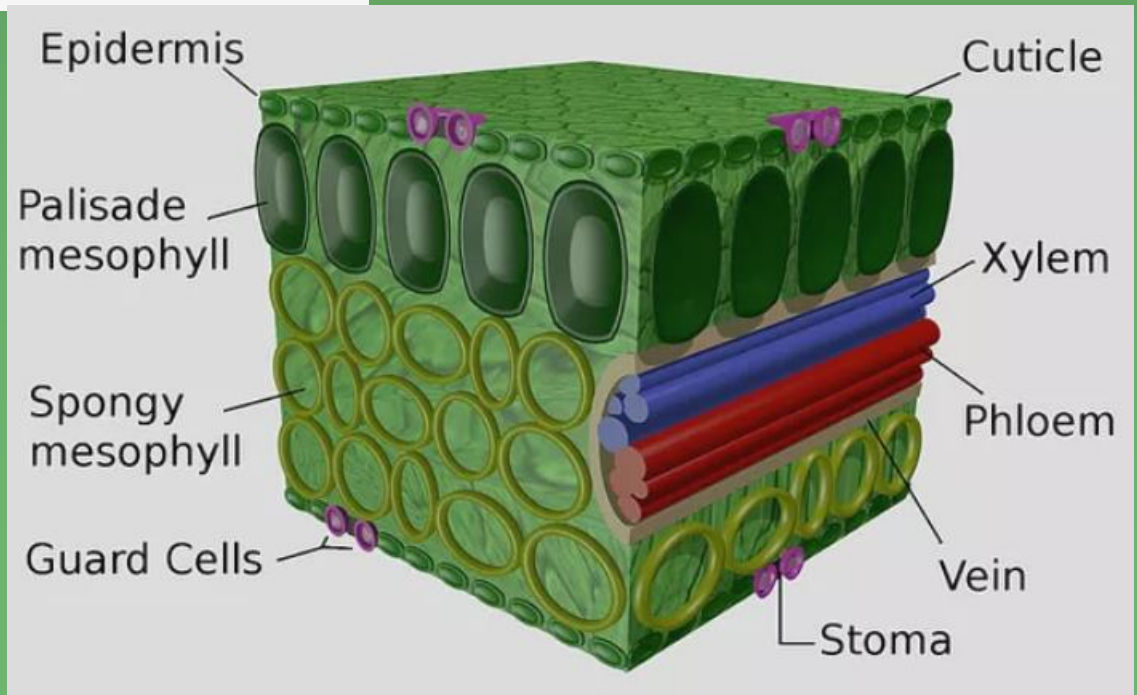
What are the three zones of root growth and their composition?

Cell division (apical meristem); Elongation;

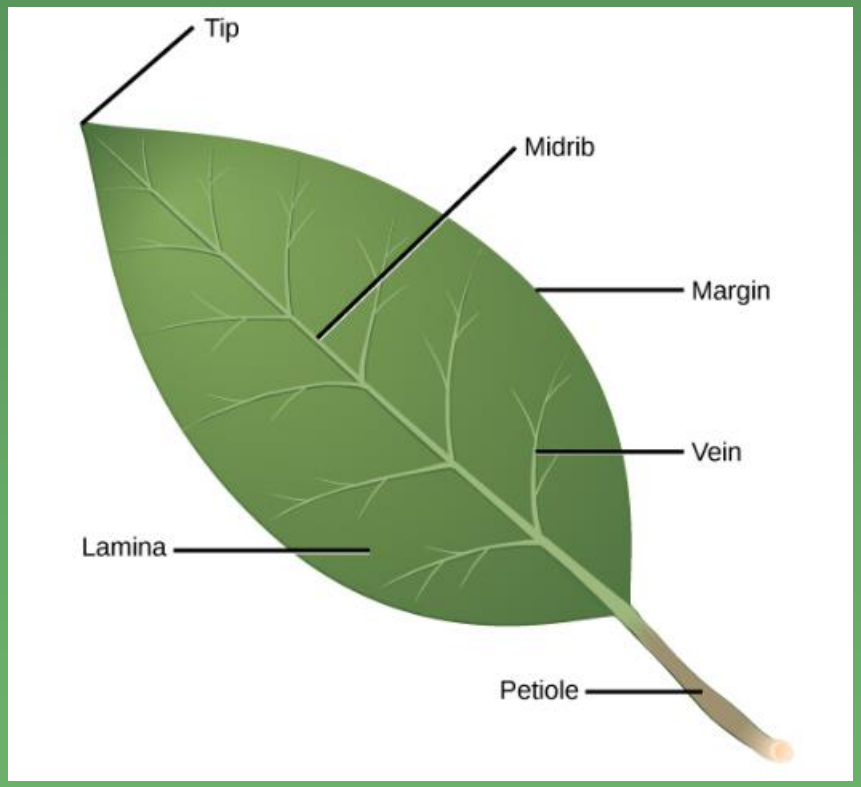
Differentiation (dermal, vascular, ground tissues)


apex
margin
veins
midrib
base
petiole
stipule
blade

LEAVES


Epidermis
Cuticle
Palisade mesophyll
Xylem
Spongy mesophyll
Phloem
Guard Cells
Vein
Stoma

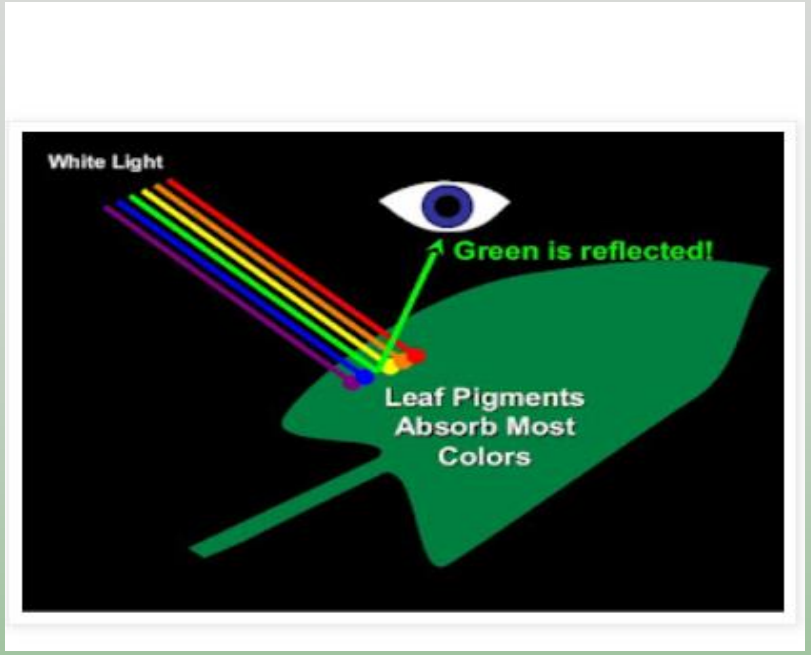
Leaves: Structure and Function

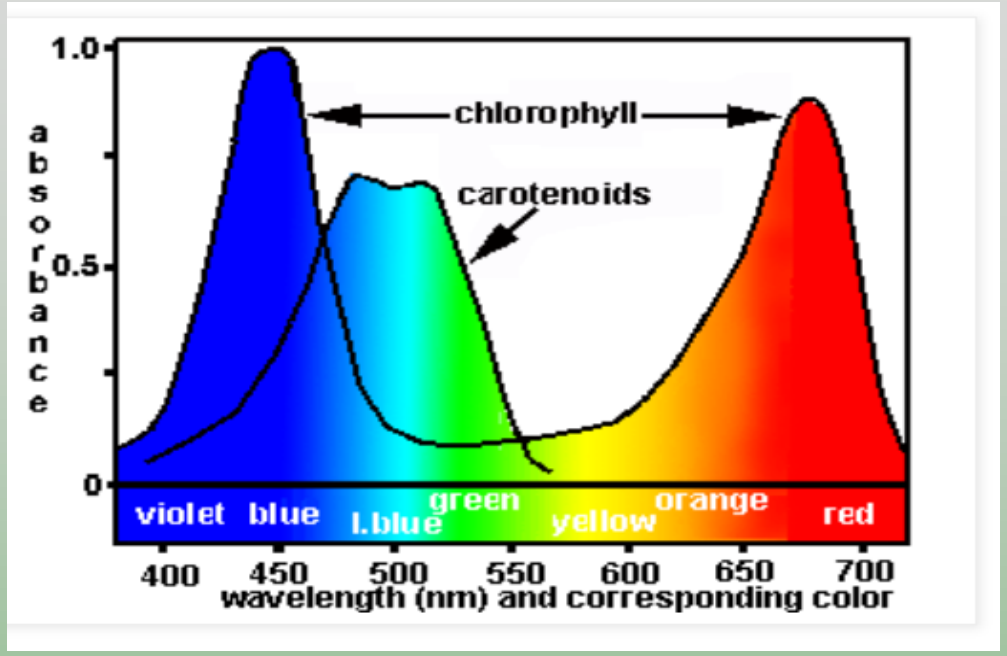


- Main photosynthetic organ of the plant.
- Leaves must have a way of obtaining CO_2 and **Water** as well as distributing end products.

Structure of a leaf is optimized to absorb light and carry out photosynthesis.

Leaves Absorb Light



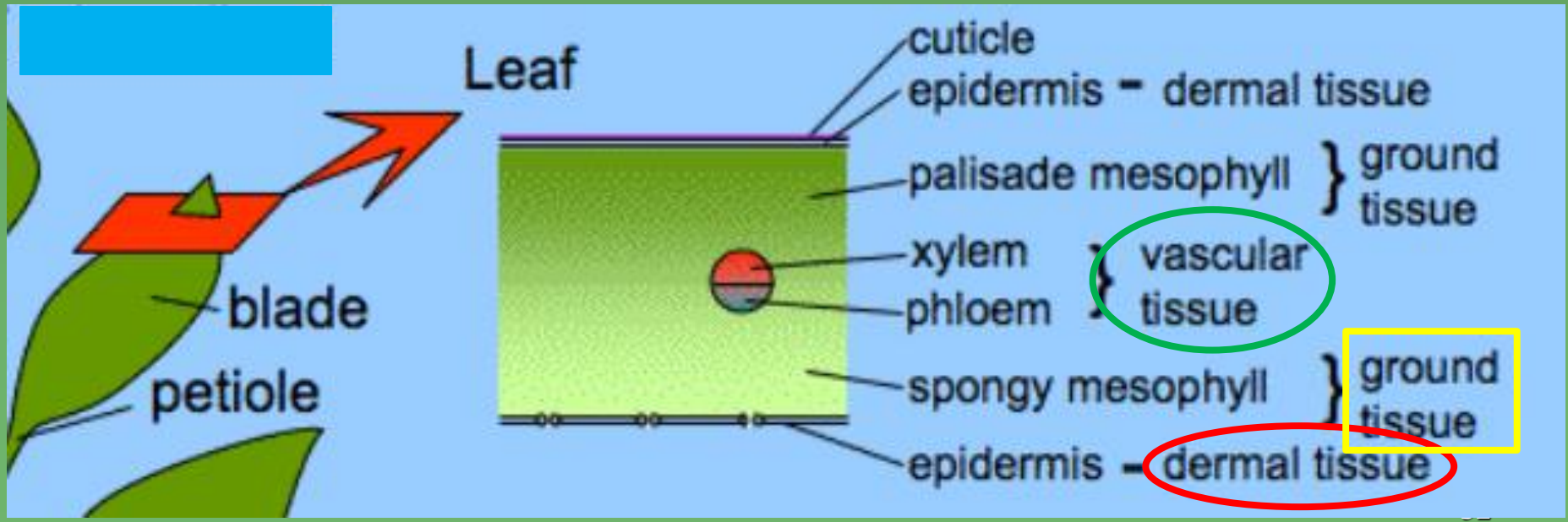


- Leaves appear GREEN because they REFLECT green light.
- Chlorophyll ABSORBS blue-violet and red light.
- Carotenoids ABSORB blue-violet and green (reflect orange).

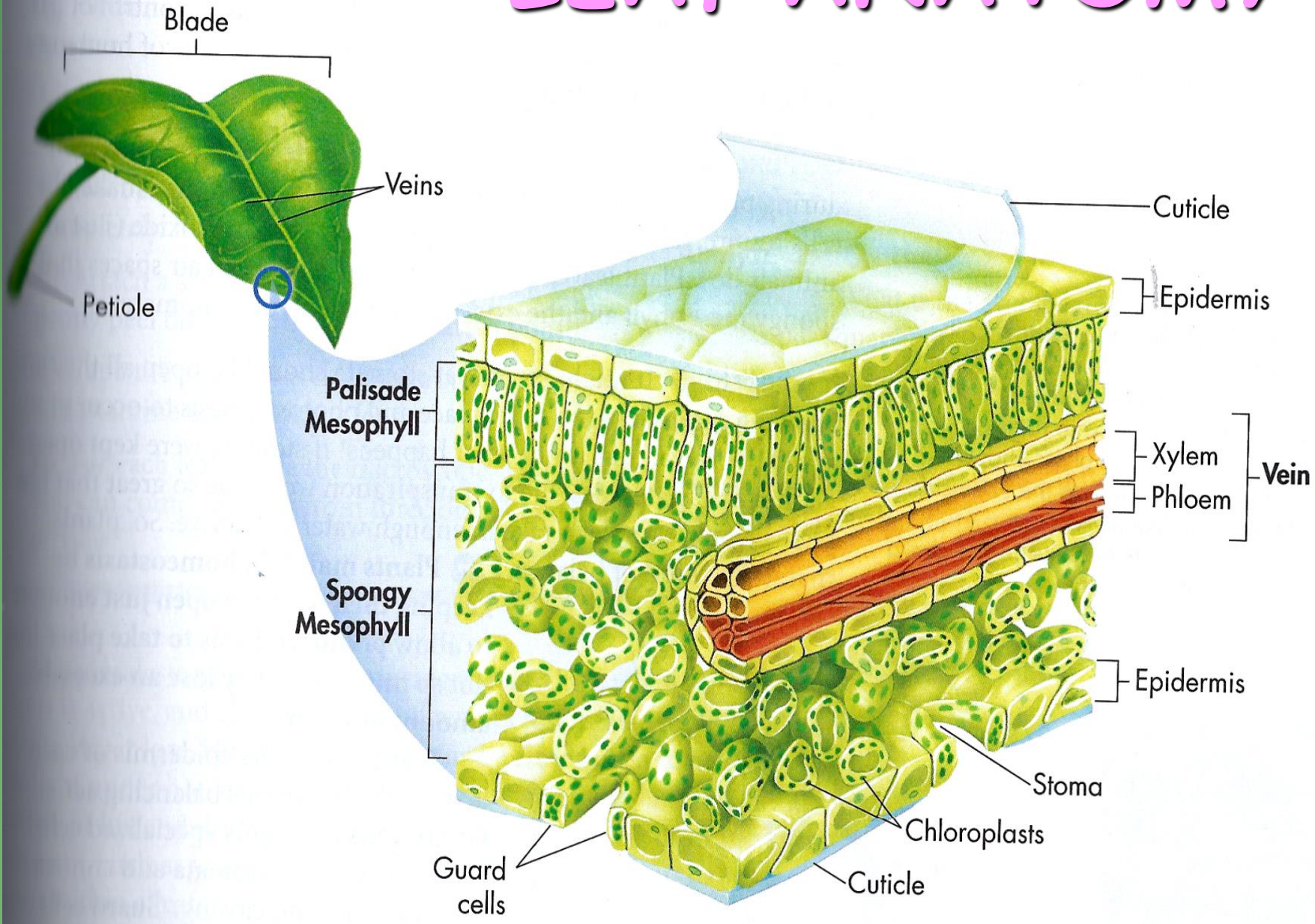
Leaves: Structure and Function

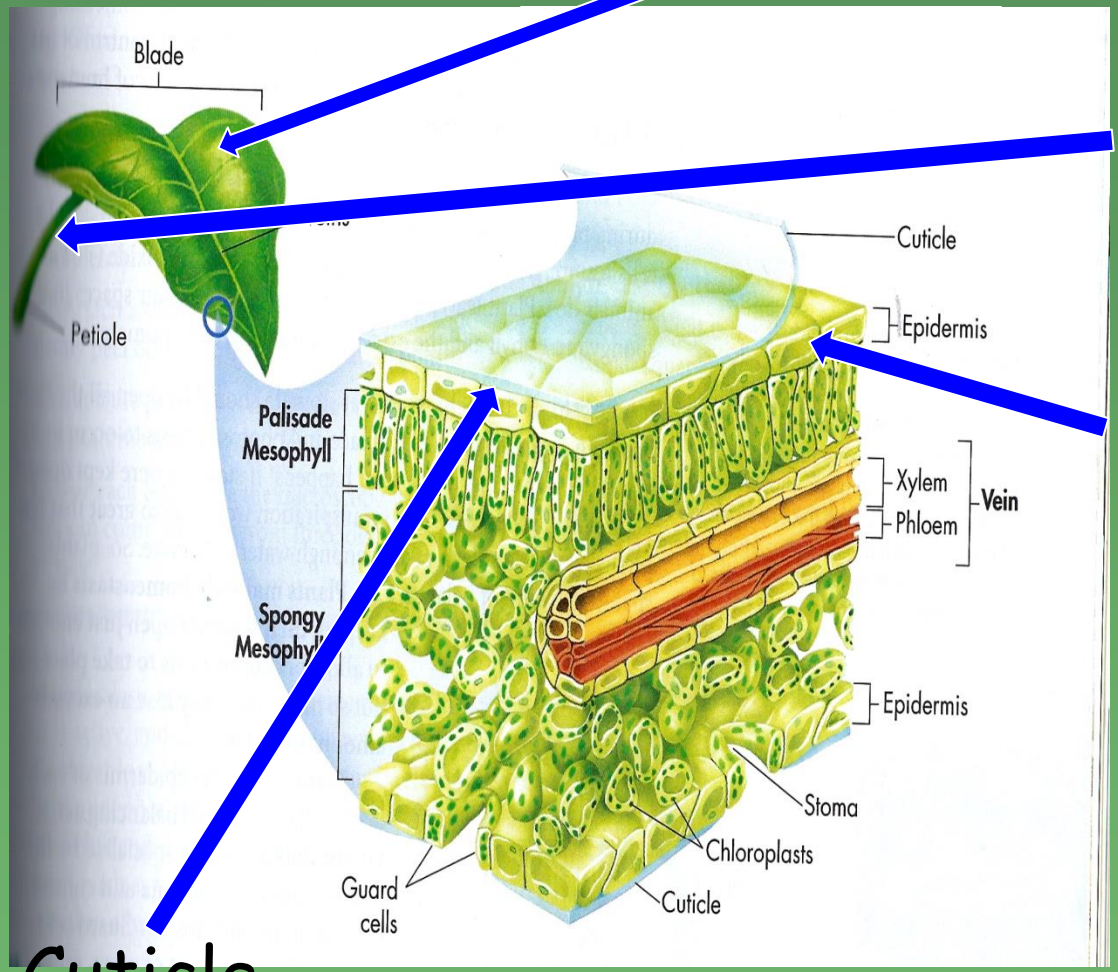
Like roots and stems, LEAVES have

- an outer covering of dermal tissue
- and inner regions of ground tissue
- and vascular tissues.



LEAf ANATOMY





Blade

Flat part of leaf (absorbs light – photosynthesis).

Petiole

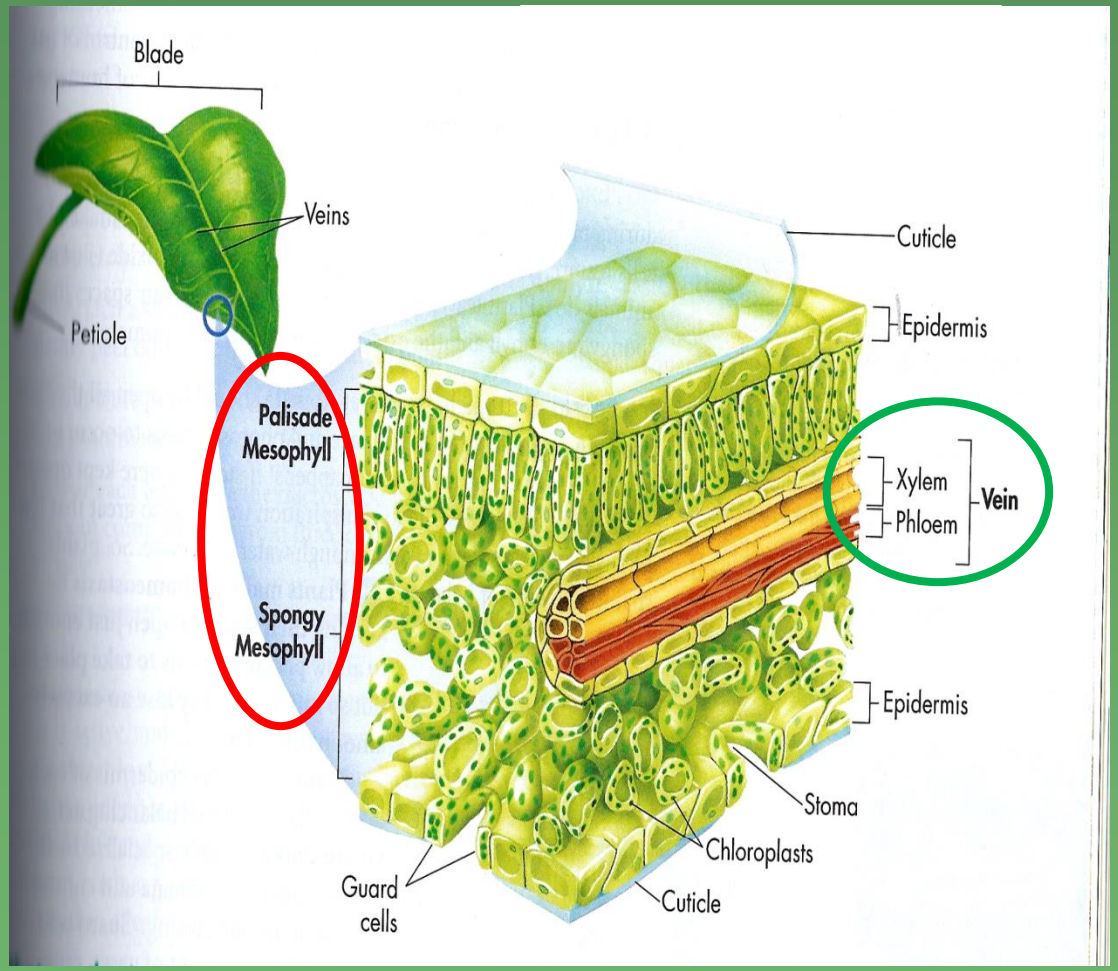
VASCULAR stalk that attaching leaf to stem.

Epidermis

Single layer of cells at the top and bottom of leaves (dermal tissue) that secretes the cuticle.

Cuticle

Layer of wax over the epidermis minimizing water loss (dermal tissue).



Veins (Vascular Tissue)

Xylem and Phloem are bundled in leaf veins that run from the stem throughout the leaves.

Mesophyll (Ground Tissue)

Area between leaf veins where photosynthesis occurs.

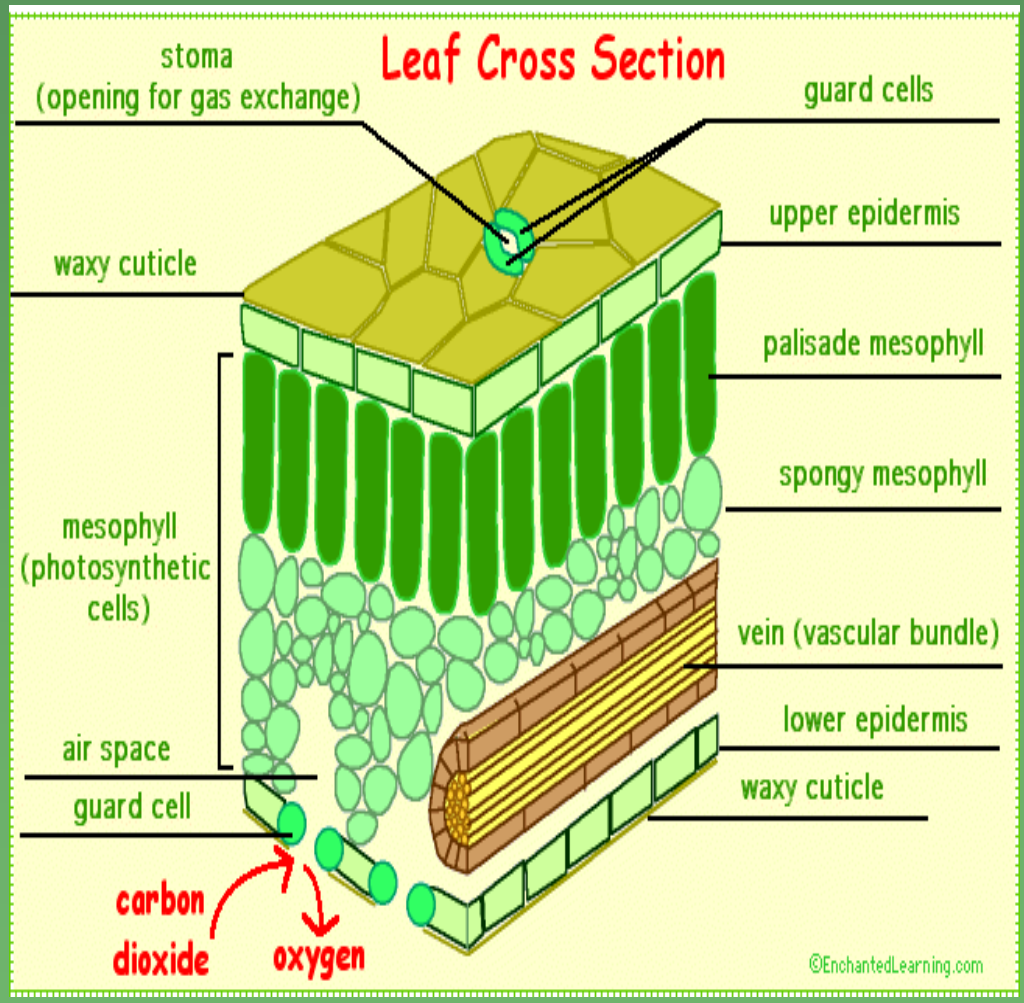
- Sugars produced here move to leaf veins where they enter the phloem for transport to the rest of the plant.

Leaves: Structure and Function

Two subtypes of Mesophyll:

- **PALISADE Mesophyll** directly underneath the epidermis; where Photosynthesis occurs.

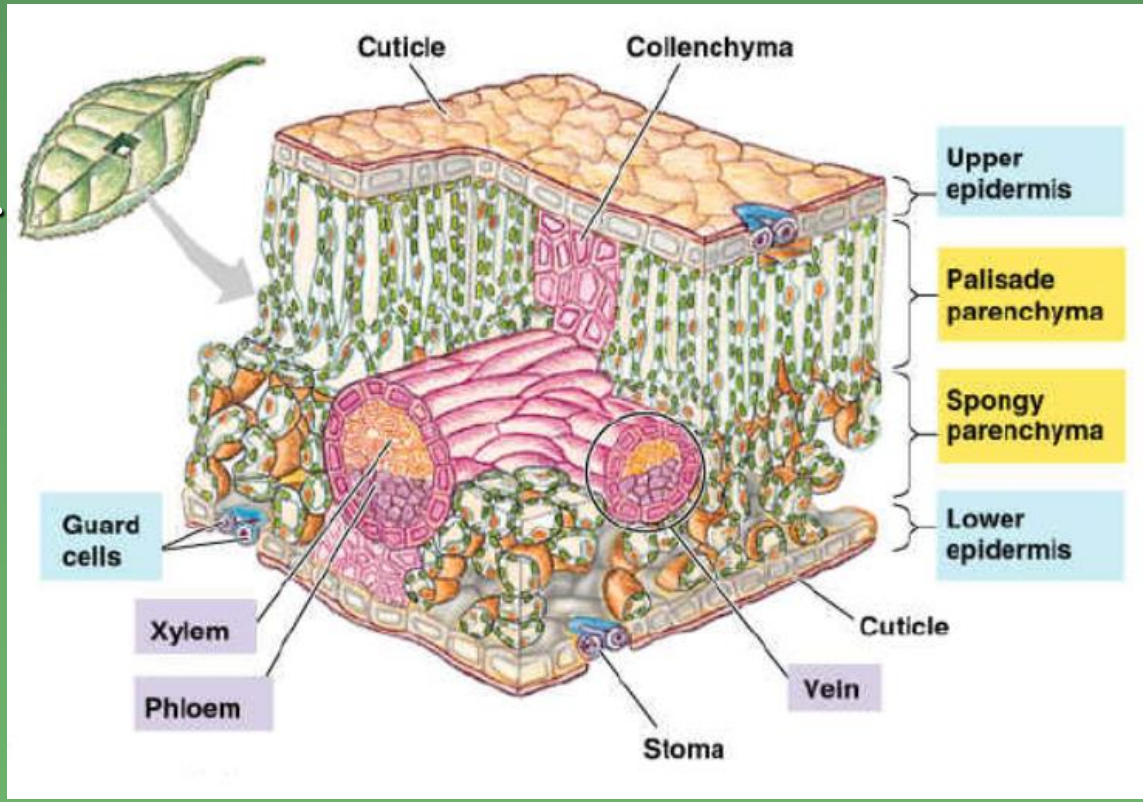
- **SPONGY Mesophyll:** beneath palisade layer; allows **gases and water** to move in and out of the leaf.



Leaves: Structure and Function

Palisade and Spongy PARENCHYMA cells

- Photosynthesis
- Growth; food storage.



COLLENCHYMA cells

- Support, flexibility
- Bend without breaking.

SCLERENCHYMA cells

Leaf veins; hard covering of seeds and nuts; found in fibers [cellulose]. Includes DEAD tissue.

Leaves: Structure and Function

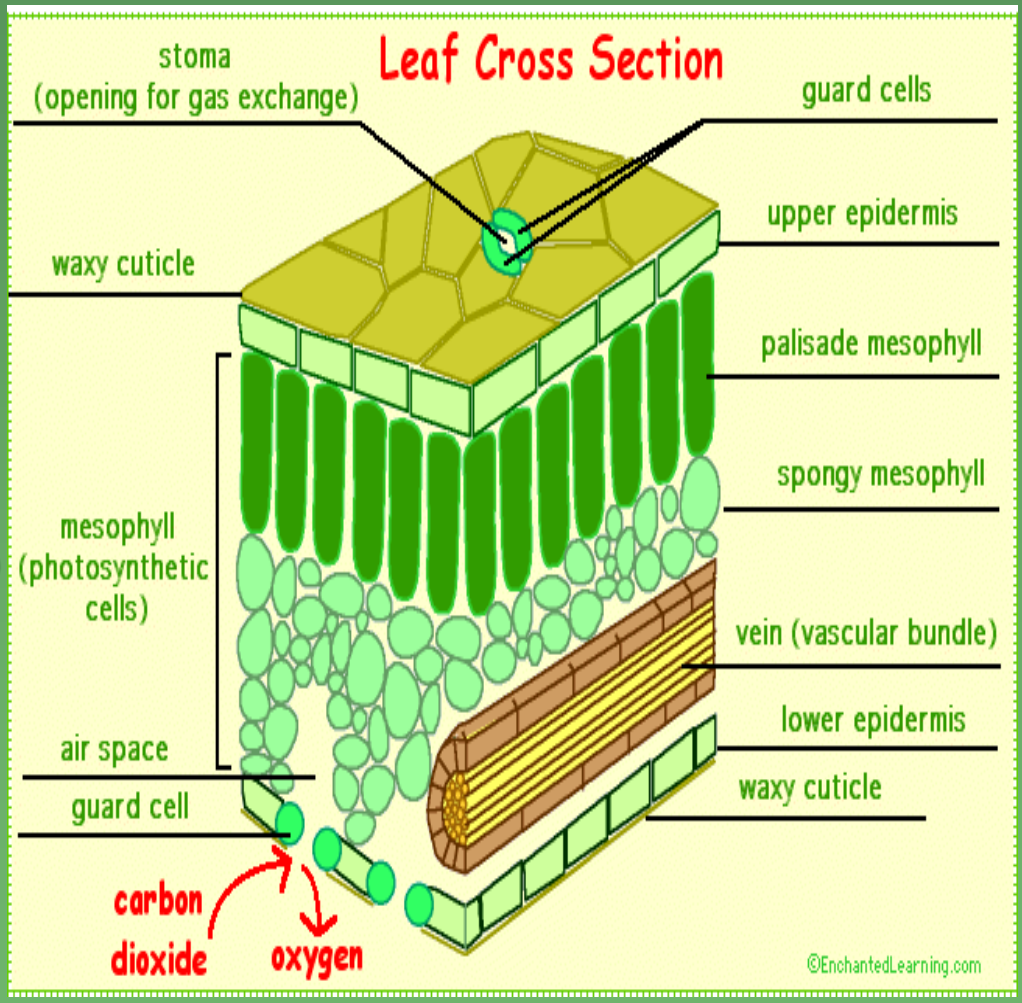
Guard Cells

Regulate the opening and closing of the stomates.

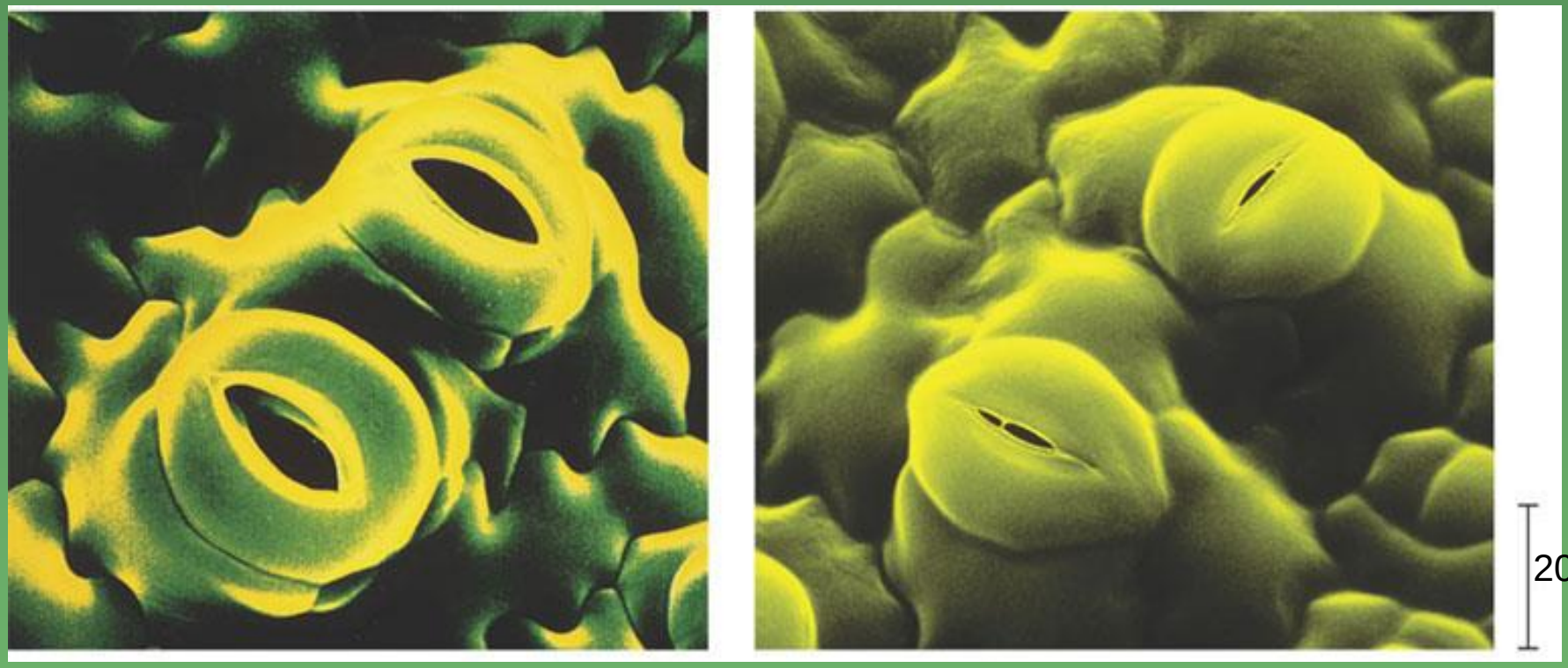
Stomates

Openings that permit CO_2 to enter and H_2O to exit the leaf in TRANSPIRATION.

Allows the release of O_2 produced in photosynthesis.



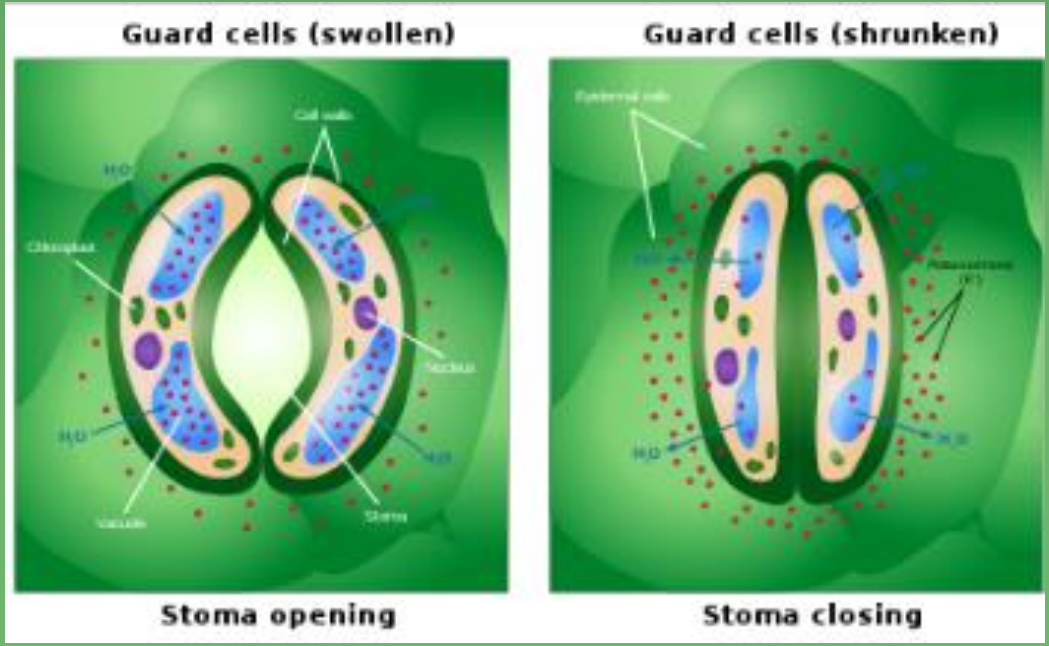
Leaves: Stomata



Leaves: Structure and Function

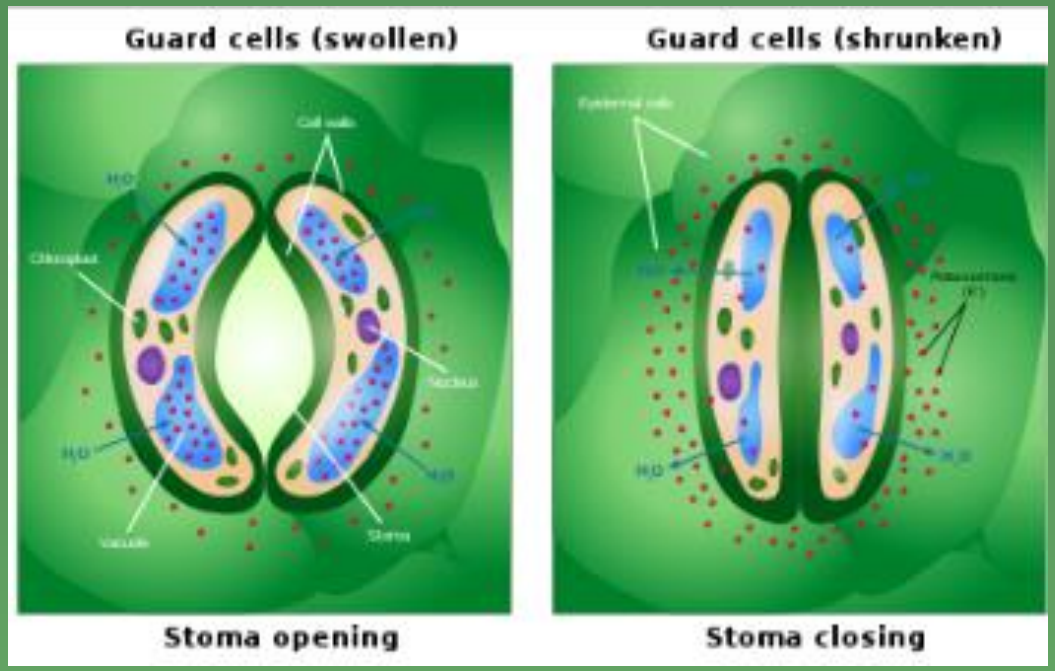
STOMATA

- Small openings in the underside epidermis of most leaves.
- Allow CO_2, Water, and Oxygen to diffuse into and out of the leaf, while helping to conserve water.
- Each is surrounded by two "guard cells".



Guard Cells

Close the stomata when there is poor water supply … e.g. at night (*low temperature, low light, low water*).



- At **daylight**, guard cells carry on photosynthesis, using up water in the cell (hypo-osmotic).
- Water from surrounding cells rush in (osmosis) to keep stomata open and ensure that water is plentiful during photosynthesis and due to build up of sugar. [**TURGOR**]
- Plants keep their stomata open just enough to allow photosynthesis and transpiration to take place but not so much that they lose an excessive amount of water.

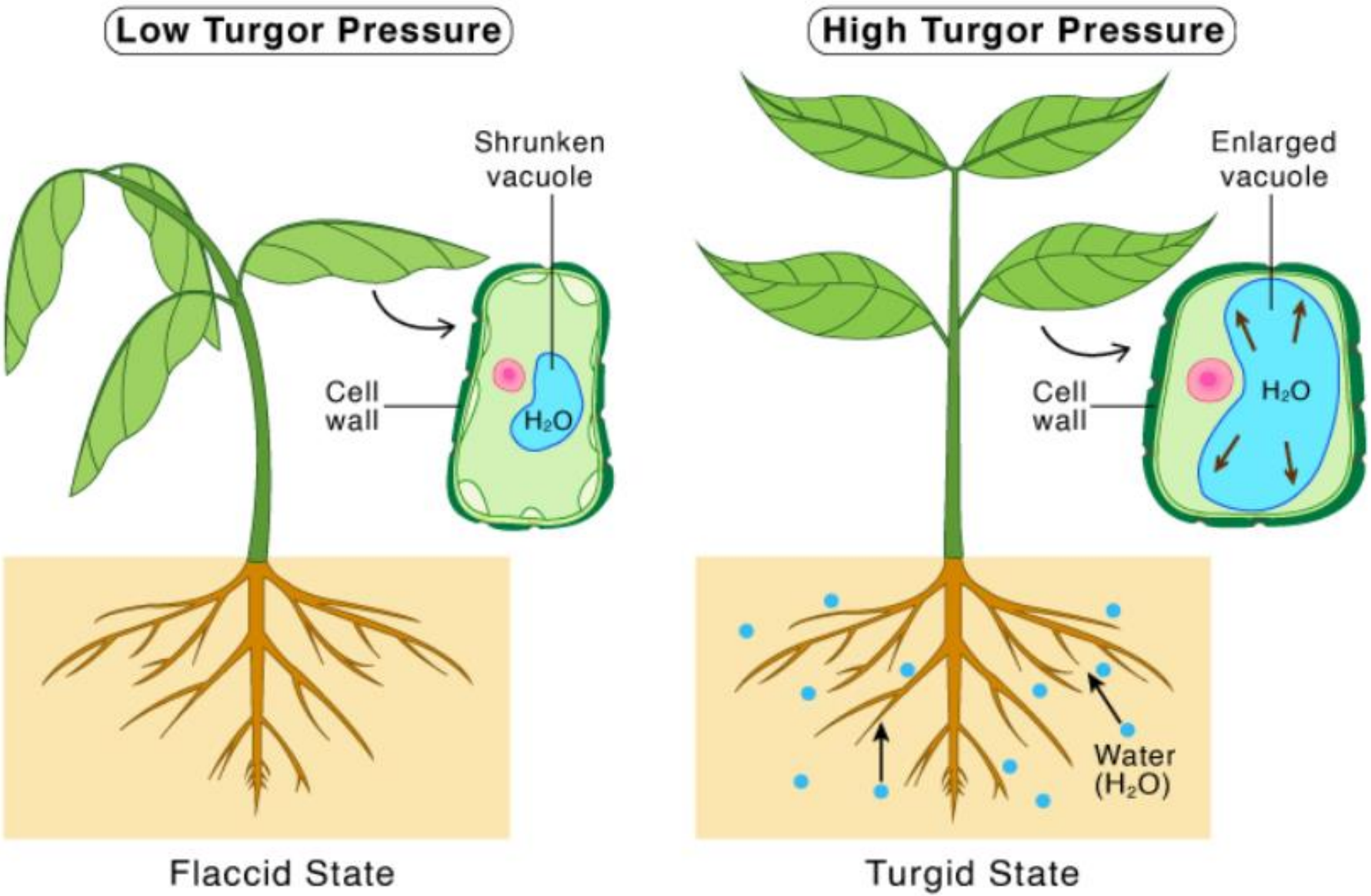
Turgor Pressure

The pressure exerted by the cell's fluid content against the cell wall

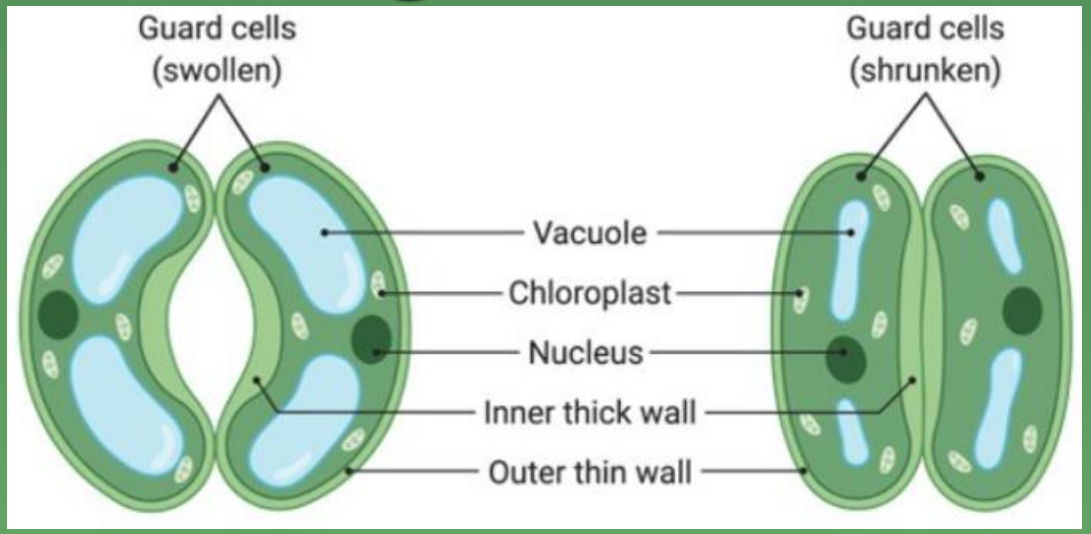
- Pressure exerted by fluid in a cell that presses the cell membrane against the cell wall.
- Turgor pressure is determined by the water content of the vacuole, resulting from osmotic pressure.
- Turgor is what makes living plant tissue rigid.
- Loss of turgor, resulting from the loss of water from plant cells, causes flowers and leaves to wilt.

Turgor Pressure

The pressure exerted by the cell's fluid content against the cell wall



Opening & Closing Stomata



Turgor Pressure

- Tie two "elongated" (not round) balloons together at the closed ends. (Do not tie the "open" ends.)
- Hold the open ends together so that you can blow air into each.
- Fill both balloons at the same time and watch the "stomates" open.
- Release some air and watch the "stomates" close.

What are two types of stems?

QUICK CHECK

What comprises a vascular bundle? Purpose?

What is a major difference between the vascular tissue of herbaceous and woody plants?

What is bark?

What are two types of stems?

herbaceous, woody

What comprises a vascular bundle? Purpose?

xylem → water

Phloem → minerals and nutrients

What is a major difference between the vascular tissue of herbaceous and woody plants?

herbs usually do NOT have secondary xylem & phloem or cork cambium produced by secondary growth

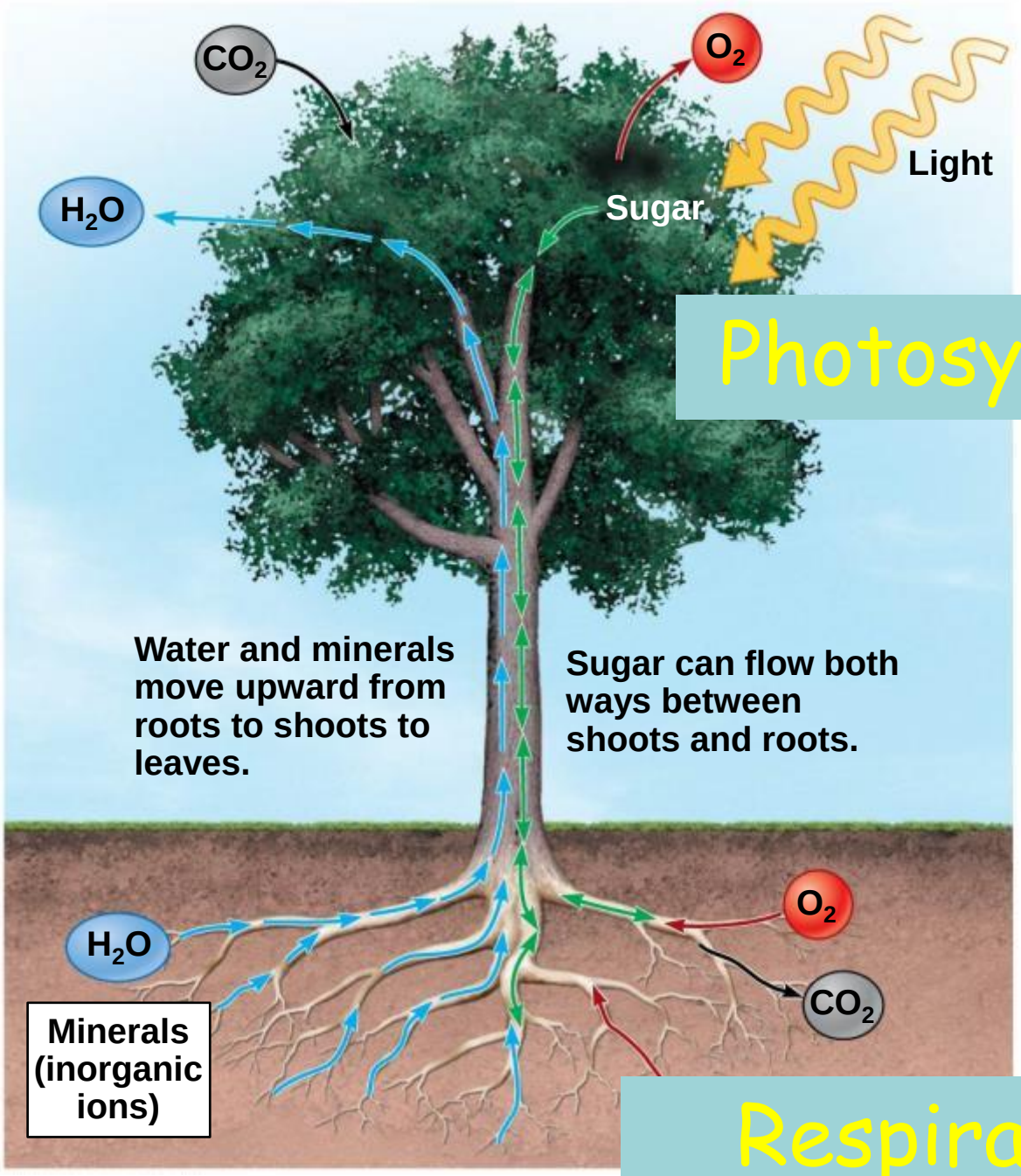
What is bark?

Secondary phloem, cork cambium, cork

The Uptake and Transport of Plant Nutrients

Plants acquire nutrients from air, water, and soil

- Plant growth uses air, water, and soil.
- Plants obtain water, minerals, and some oxygen from the soil.
- The sugars made by plants in PHOTOSYNTHESIS use carbon and oxygen from the atmosphere and hydrogen from water.
- Plants use CELLULAR RESPIRATION to break down some of these sugars, obtaining energy and consuming oxygen.



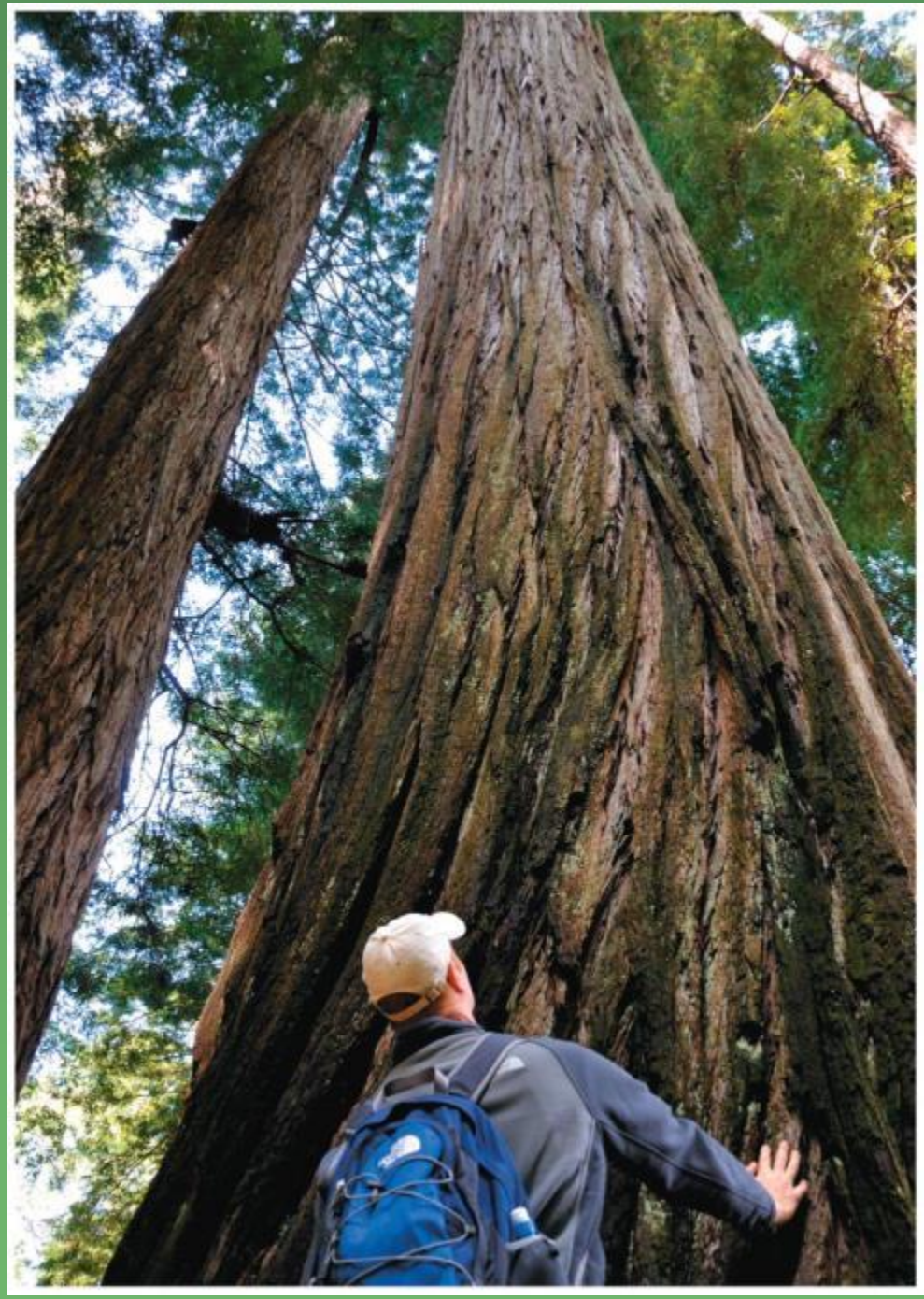
Photosynthesis

Respiration

Plants acquire nutrients from air, water & soil.

A plant must

- move water from its roots to its leaves.
- deliver sugars to specific areas of its plant body.

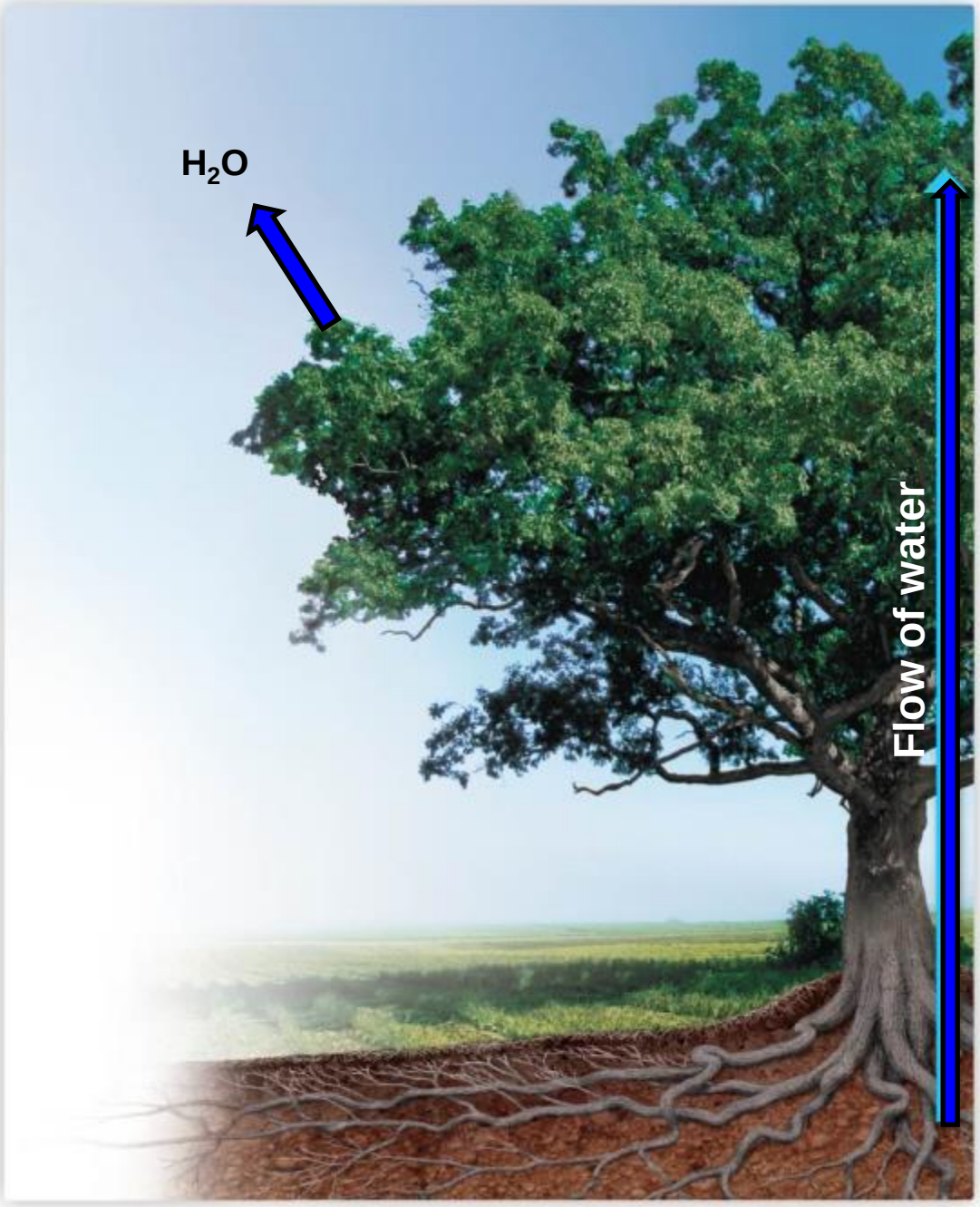


Water Transport in Plants

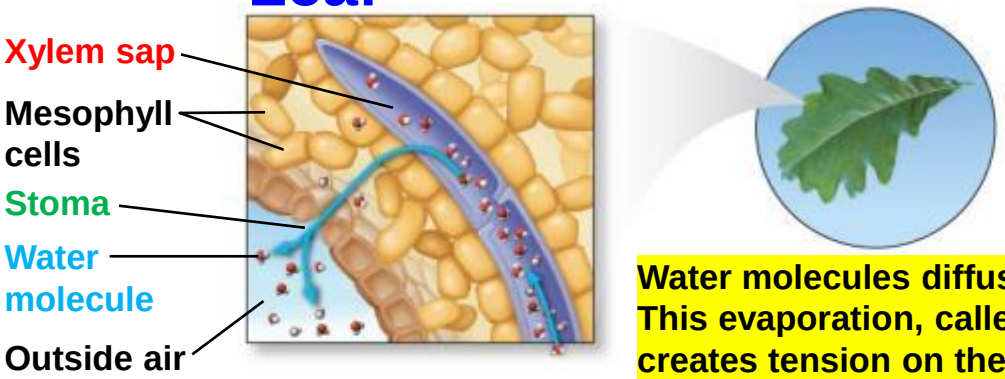
- Plants require a constant supply of water and dissolved minerals from the soil.
- This is provided as **Xylem Sap**, a solution of water and inorganic nutrients that flows from the roots through the shoot system to the tips of the leaves.
- **Xylem Sap** flows through Xylem Tissue, pulled by **TRANSPIRATION**, the loss of water from the leaves by evaporation.
- **Xylem Sap** Movement
  - is aided by the **Cohesion and Adhesion** of water molecules.
  - requires **No Energy** expenditure by the plant.

Water Transport in Plants

- Cohesion-Tension Theory
- There are 3 Major Forces that help transport Water in a Plant
  - **Root Pressure** – water entering the root pushes water upward in a plant stem.
  - **Capillary Action** – water is pulled up the thin xylem against gravity.
  - **Transpirational Pull** – loss of water from the leaves causes a negative pressure, pulling water up the tree.

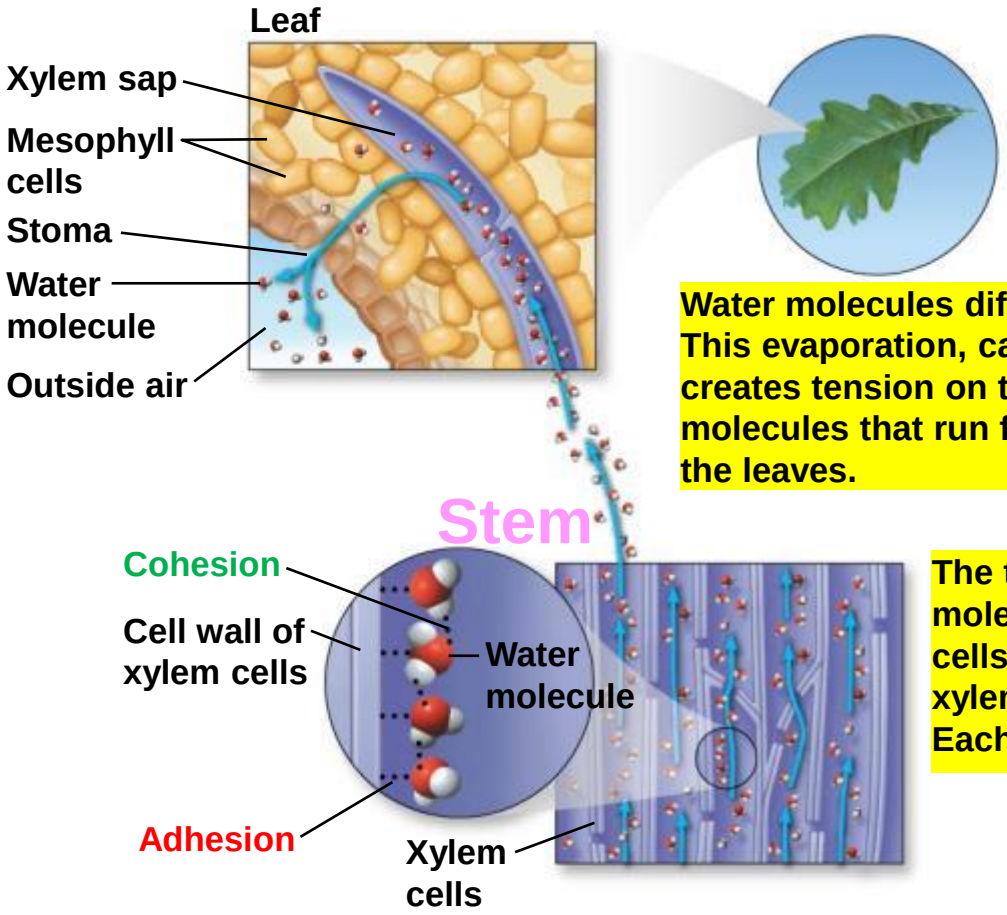

H_2O
Flow of water

Leaf



Water molecules diffuse out of stomata. This evaporation, called TRANSPIRATION, creates tension on the chain of water molecules that run from the roots to the leaves.

Transpirational Pull

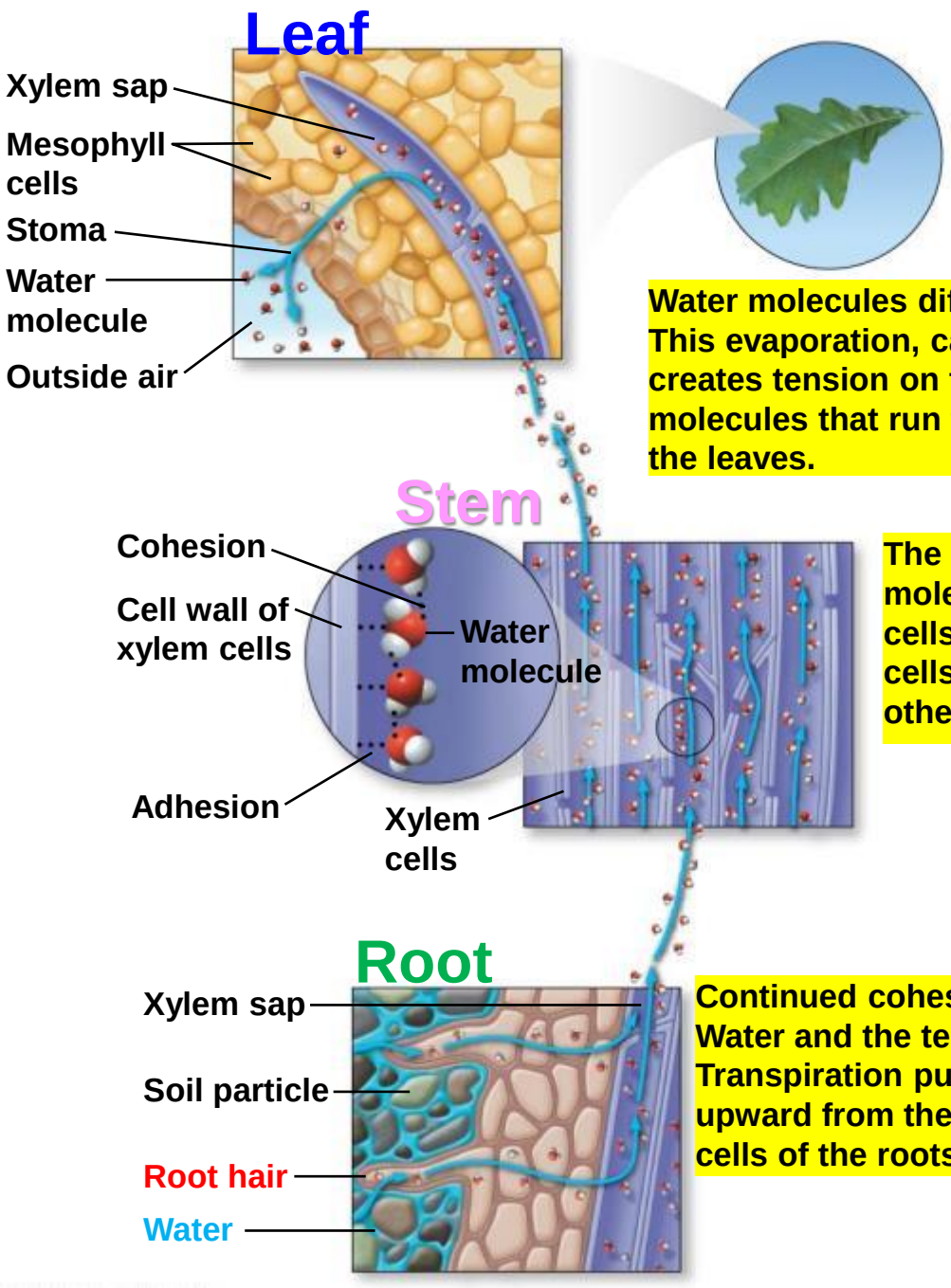


Water molecules diffuse out of stomata. This evaporation, called transpiration, creates tension on the chain of water molecules that run from the roots to the leaves.

Transpirational Pull

The tension pulls the chain of water molecules upward through the xylem cells. Water molecules cling to the xylem cells by adhesion and stick to Each other by cohesion.

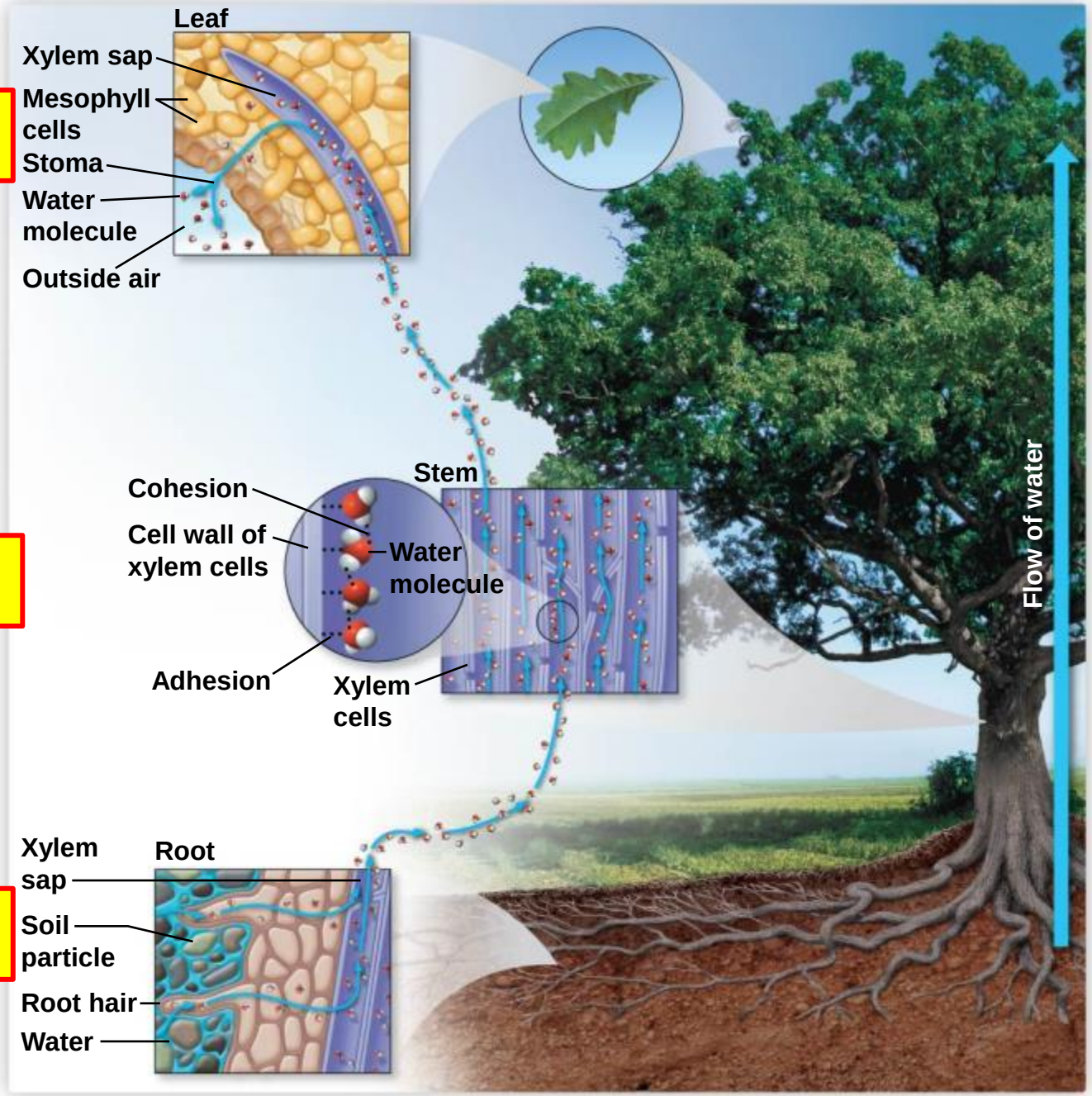
Capillary Action


Leaf
Xylem sap
Mesophyll cells
Stoma
Water molecule
Outside air
Water molecules diffuse out of stomata. This evaporation, called transpiration, creates tension on the chain of water molecules that run from the roots to the leaves.
Transpirational Pull
Stem
Cohesion
Cell wall of xylem cells
Water molecule
Adhesion
Xylem cells
The tension pulls the chain of water molecules upward through the xylem cells. Water molecules cling to the cells by adhesion and stick to each other by cohesion.
Capillary Action
Root
Xylem sap
Soil particle
Root hair
Water
Continued cohesion and adhesion of Water and the tension created by Transpiration pulls water and minerals upward from the soil into the xylem cells of the roots.
Root Pressure

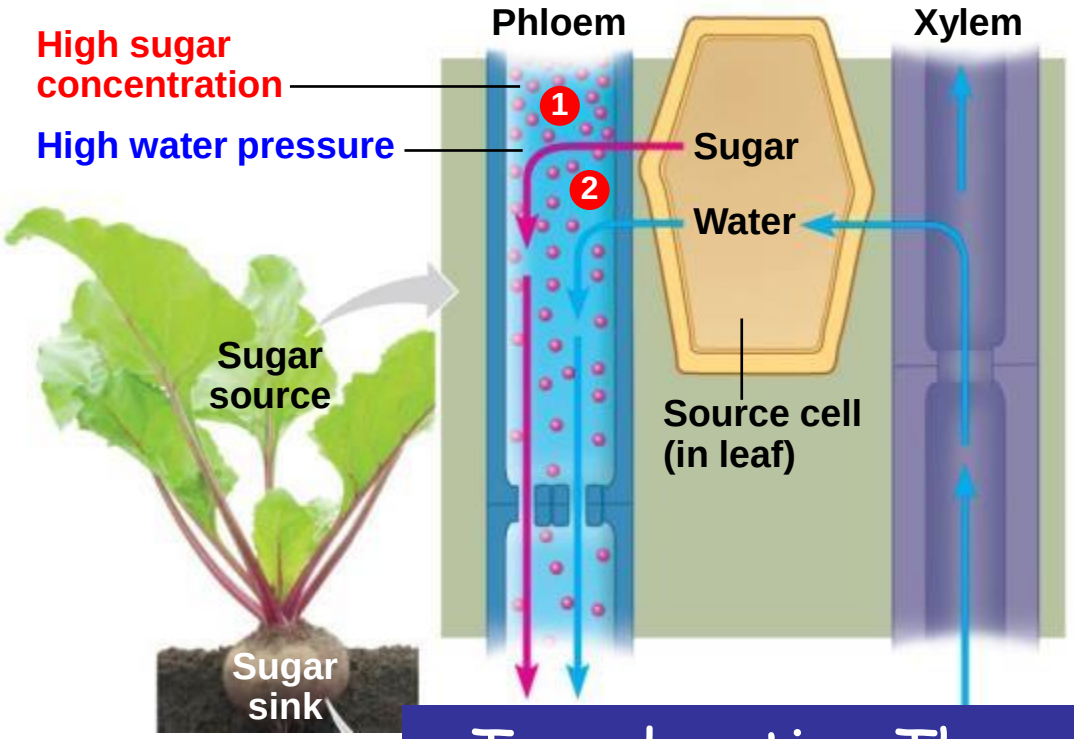
Transpirational Pull

Capillary Action

Root Pressure



Sugars (glucose) move from the leaves to the rest of the plant through the **PHLOEM**.



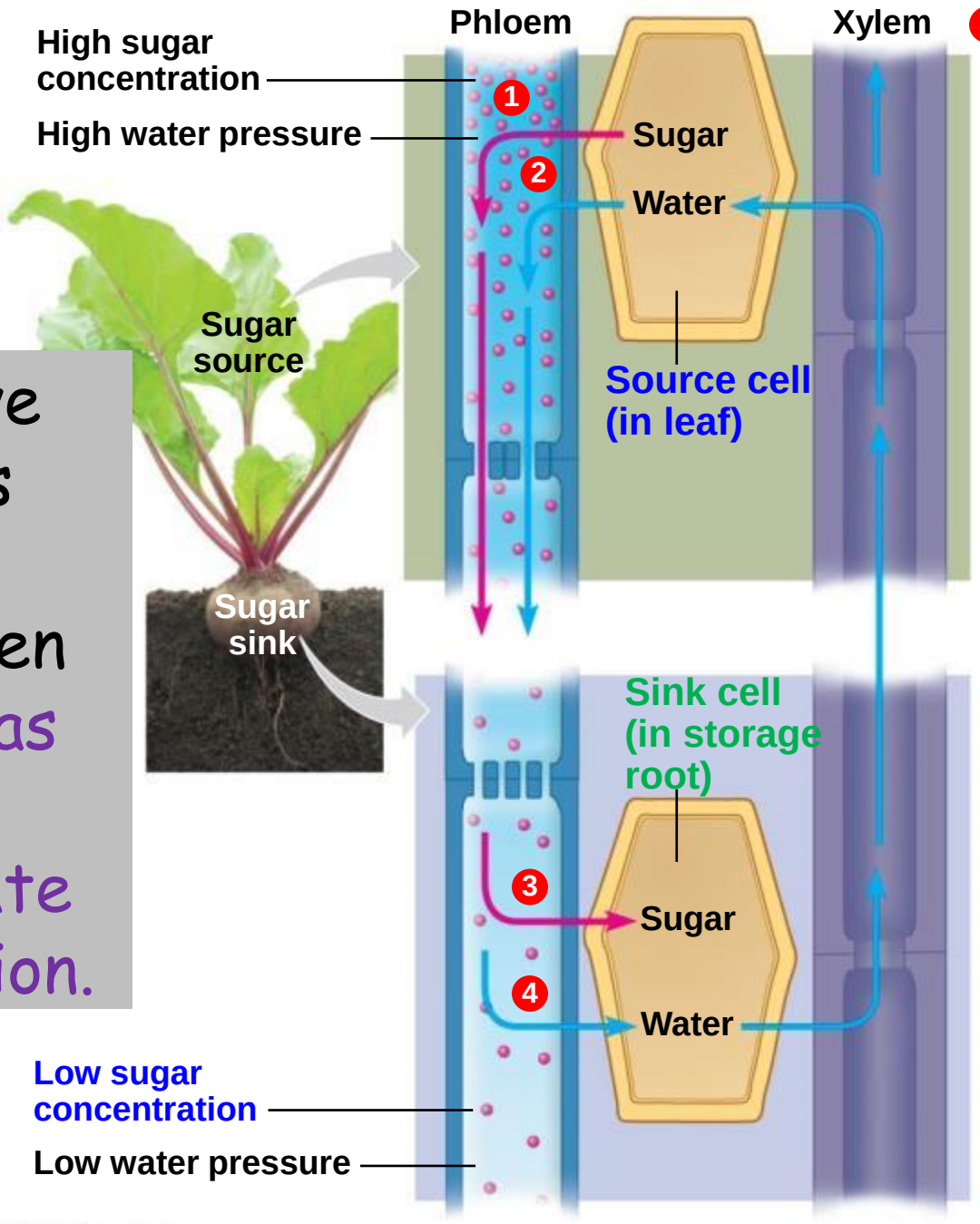
This is an Active Process (requires energy).

Translocation Theory

1. Leaves perform photosynthesis and have high concentration of sugars (glucose).
2. Osmosis causes water to enter to accommodate.

Areas of the plant not involved in photosynthesis constantly use carbohydrates for energy; therefore, their sugar concentration is lower than in the leaves.

Sugars move from leaves into the **phloem**, then toward areas of low carbohydrate concentration.



3 Sugar is "pushed" (through phloem) from Source Cells → Sink Cells

Sugars (glucose) are used mainly for energy.

Why are leaves green? What colors are absorbed?

Define Mesophyll.

Give three characteristics of guard cells.

What processes draw water up a tree?

How do sugars supply the plant?

Why are leaves green? What colors are absorbed?

QUICK CHECK

Leaves REFLECT green, absorb Violet, Blue and Red

Define Mesophyll

palisade layer → photosynthesis

spongy layer → gas (CO_2 and O_2) & water exchange

Give three characteristics of guard cells.

Found on the underside of leaves; stomates allow gas and water exchange; turgor pressure.

What processes draw water up a tree?

Root Pressure; Capillary Action; Transpiration

How do sugars supply the plant?

Active process (requires energy) through phloem; involves osmosis

Plant Hormones

- Chemical signals that control development of cells, tissues, and organs.
- **They also coordinate responses to the environment.**
- 5 Known Plant Hormones:
  - Auxins
  - Gibberellins
  - Cytokinins
  - Abscisic Acid
  - Ethylene

Hormones

Auxin – responsible for most tropisms.

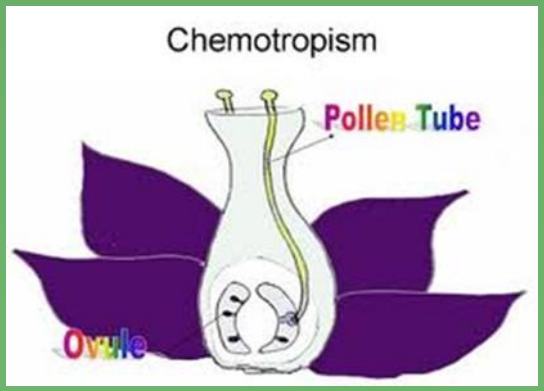
Tropism – Directional movement of a plant in response to an environmental stimulus.

Phototropism – directional growth of a plant toward a **light source.**

- Auxin accumulates in the stem opposite the direction of the sun.
- **This causes the cells on the "dark side" of the stem to elongate and bend the top of the stem toward the light.**

Hormones

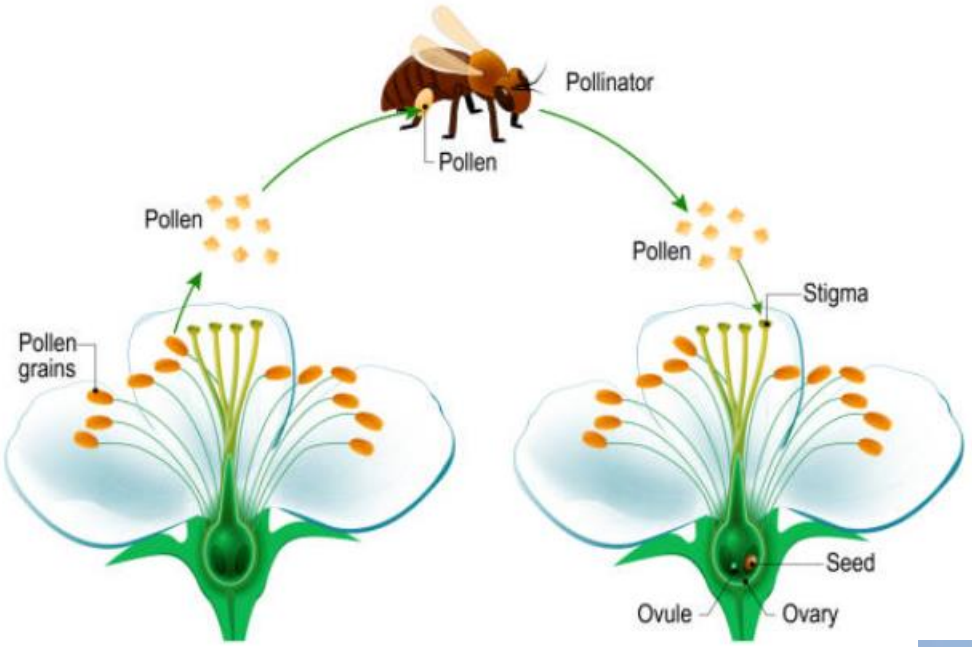
- Thigmotropism – plant's growth response to touching a solid object.
- Gravitropism – directional growth of a plant directly against gravity.
- Chemotropism – directional growth of a plant toward a positive chemical stimulus and away from a negative chemical stimulus.



Hormones

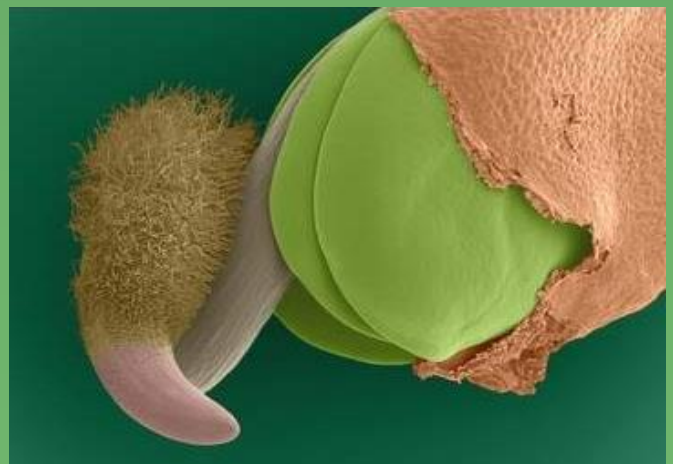
- Gibberellin: controls various developmental processes of a plant (Dormancy, Flowering, Germination, etc.).
- Cytokinins: promotes cell division in plant roots and shoots (Affect lateral growth and apical dominance).
- Abscisic Acid: slows plant metabolism, enhances plant response to environmental stress (drought, salinity, pathogens); e.g. causing dormancy.
- Ethylene: ripening of fruit, opening of flowers, shedding of leaves.

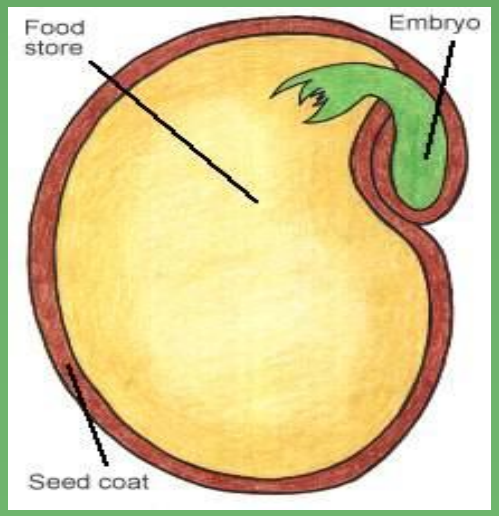
Pollination



Seeds

- After fertilization occurs, the ovary develops into a **Fruit**, and the ovule becomes a **Seed**.
- A **Seed** is an embryo of a plant that is encased in a **Seed Coat** (protective covering) and surrounded by **Endosperm** (food supply).
- An **Embryo** is an organism in its early stage of development.





Fruits

- Mature Ovary that contains the seeds.
- Many different kinds of fruit.
- Its purpose is to help spread seeds.

Seed Germination

- In order for germination to occur, 3 conditions must be met:
  - **Proper Moisture**
  - **Proper Temperature**
  - **Proper Oxygen**

- Most seeds do not require light for germination.

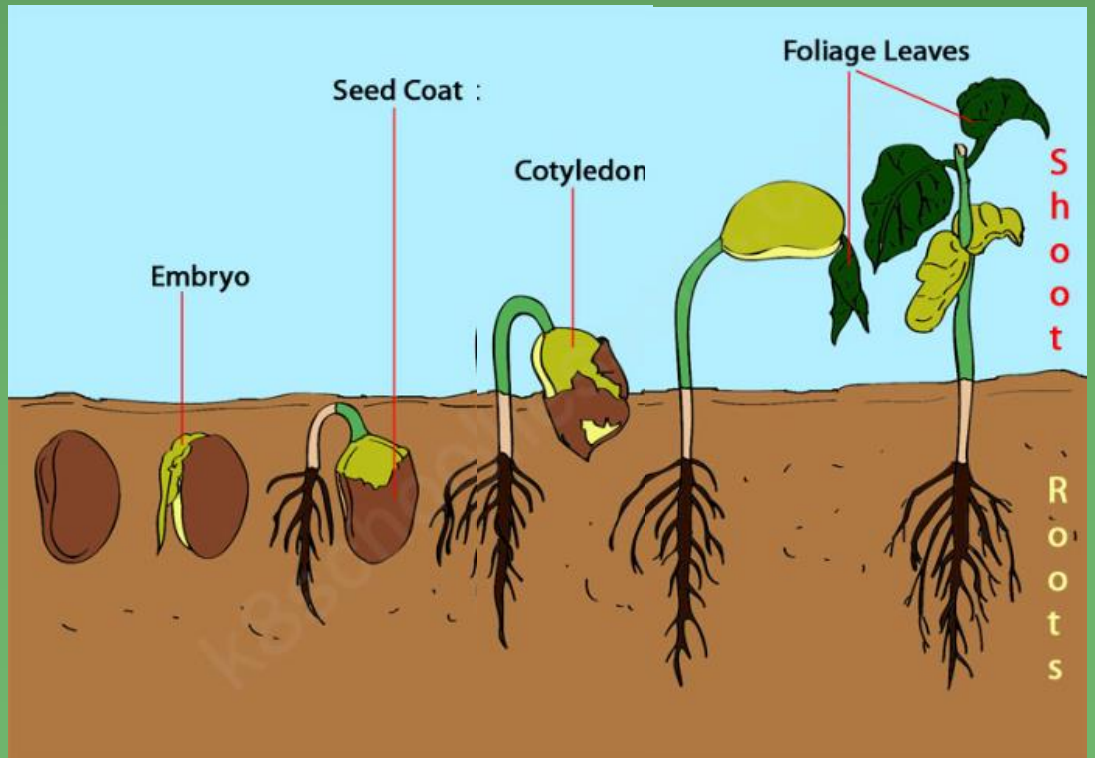
- Once proper environmental conditions have been met, the following general steps happen:
  1) Water must soften the seed coat and penetrate into the seed.
  2) Water hydrates the embryo and enzymes are activated that make the endosperm nutrients available to the growing embryo.

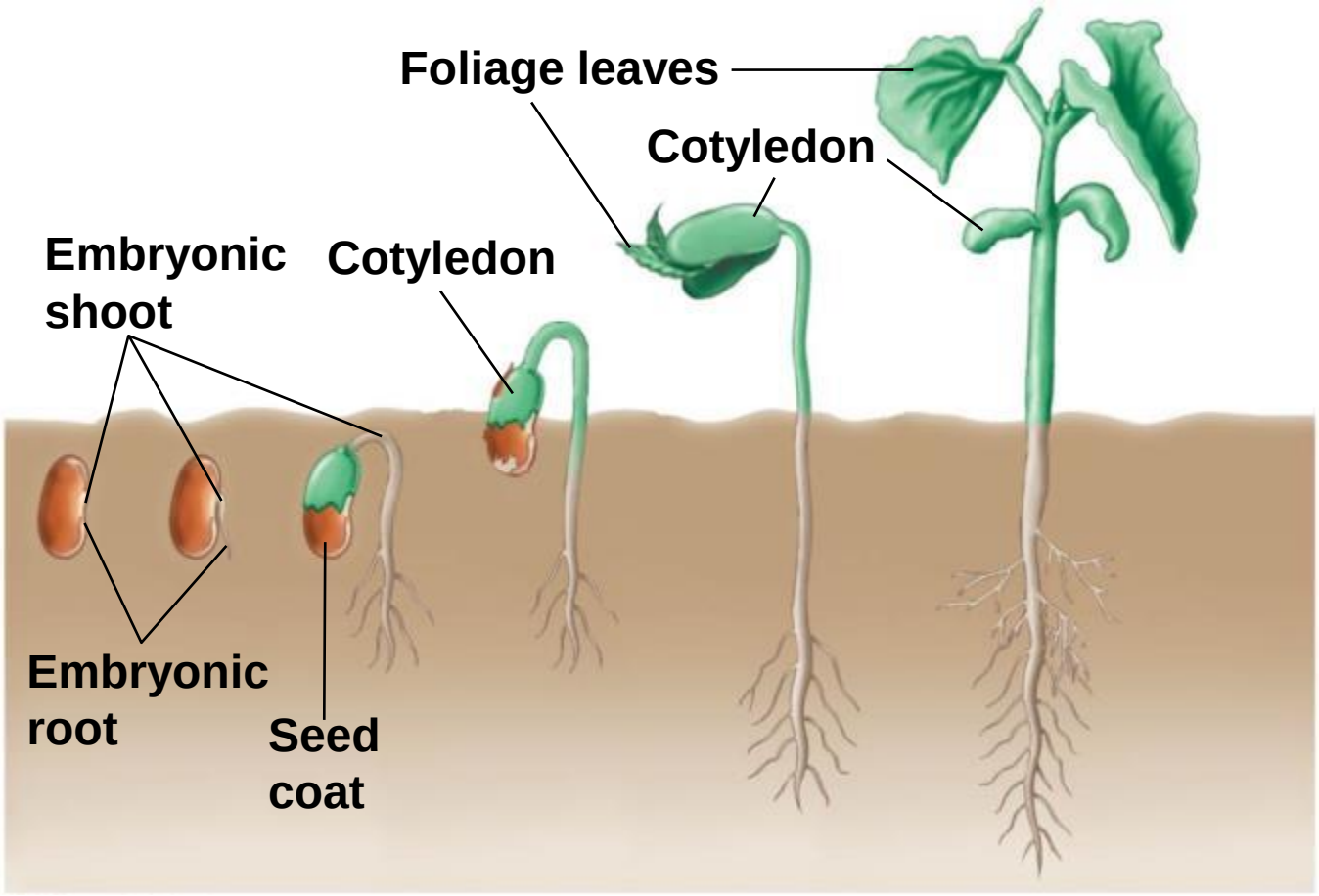
Seed Germination

3) Seed grows a root to access water and nutrients underground.

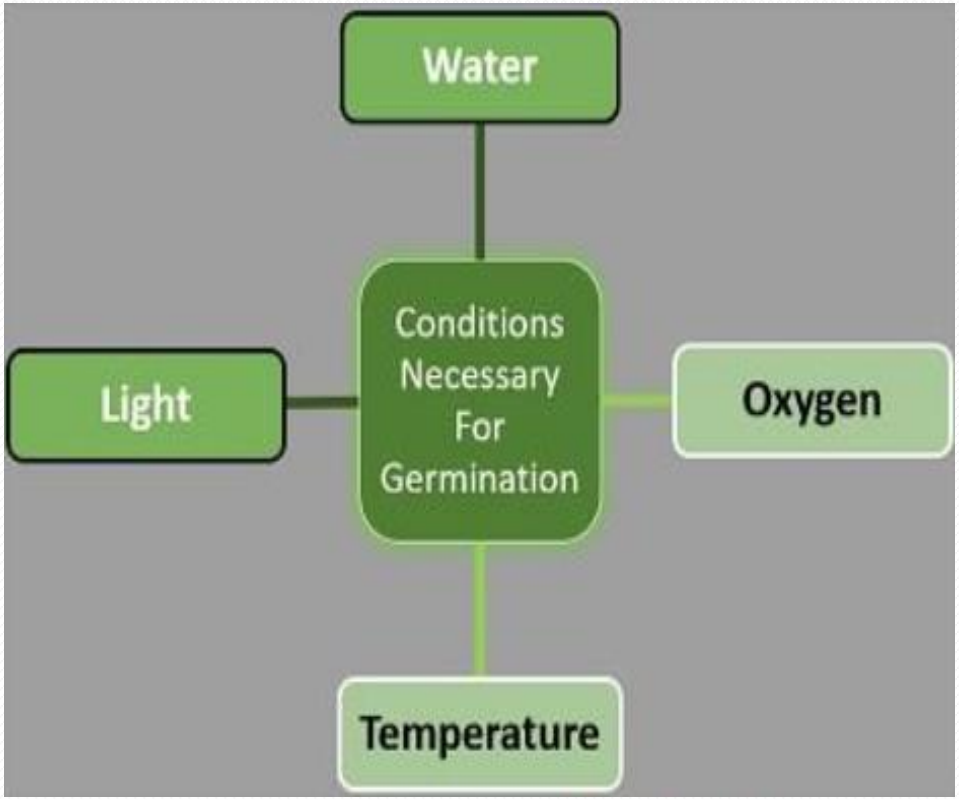
4) Seed grows shoots that grow towards the sun.

5) Seed leaves (Cotyledons) emerge from the seed and begin to perform Photosynthesis.




Foliage leaves
Cotyledon
Embryonic shoot
Cotyledon
Embryonic root
Seed coat

Factors that affect Seed Germination



What is phototropism? Which hormone controls it in plants?

QUICK CHECK

Matching

Abscisic acid	flowering, germination
Cytokinins	leaves fall off stem (deciduous trees)
Ehtylene	response to stress
Gibberllins	cell division

After fertilization, what happens to the ovary and ovule?

Place in order: cotyledon, embryo, leaves, photosynthesis, root, seed, shoot in terms of germination.

What is phototropism? Which hormone controls it in plants?

Plants grows toward light; auxins

Matching

Abscisic acid →response to stress

Cytokinins → cell division

Ethylene → leaves fall off stem (deciduous trees)

Gibberllins → flowering, germination

After fertilization, what happens to the ovary and ovule?

The ovary becomes fruit and the ovule a seed.

Place in order: cotyledon, embryo, leaves, photosynthesis, root, seed, shoot in terms of germination.

Seed → embryo → roots → shoot (stem) → cotyledon → leaves → photosynthesis