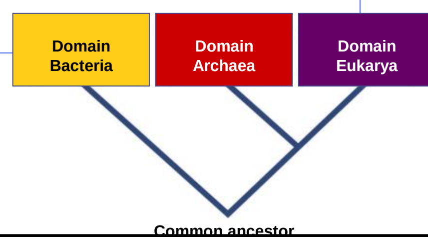


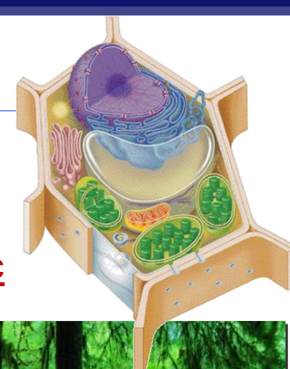

Kingdom: Plants

Photosynthetic Eukaryotes

Plants

- General characteristics
  - eukaryotes
  - autotrophs, photosynthetic
  - cell wall
    - cellulose
  - not mobile



Root Structure and Growth

- What are the main tissues in a mature root?
- A mature root has an outside layer, called the epidermis, and also contains vascular tissue and a large area of ground tissue.

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Root Structure and Growth

As soon as a seed begins to sprout,

- it puts out its first root to draw water and nutrients from the soil.
- rapid cell growth pushes the tips of the growing roots into the soil.
  - The new roots provide raw materials for the developing stems and leaves before they emerge from the soil.

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Types of Root Systems

- The two main types of root systems are:
  1. taproot systems
     - mainly in dicots
     - ex. dandelions
  2. fibrous root systems
     - mainly in monocots
     - Ex. Grasses

Taproot System

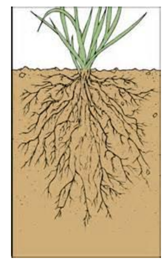
In some plants, the primary root grows long and thick and gives rise to smaller branch roots. The large primary root is called a taproot.

The taproots of oak and hickory trees grow so long that they can reach water several meters below the surface.

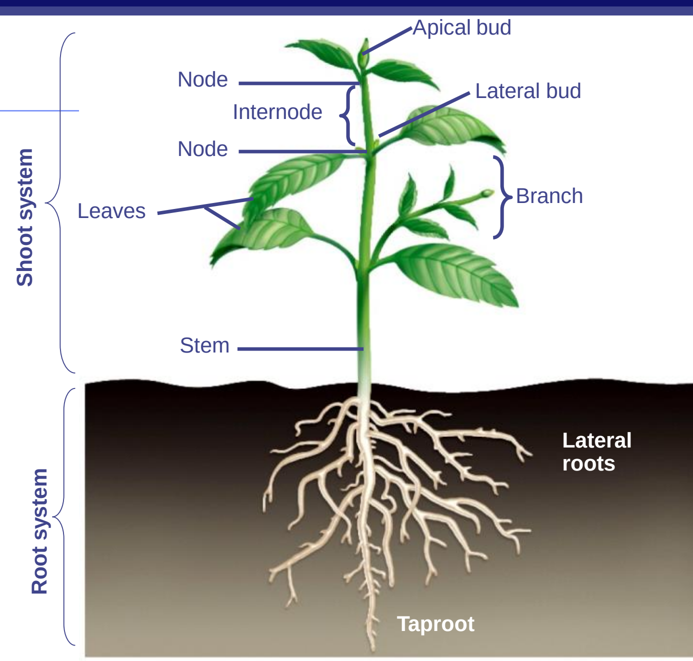
For example, a dandelion has a short, thick taproot that stores sugars and starches.

Fibrous Root System

In other plants, such as grass, the system begins with one primary root. But it is soon replaced by many equally sized branch roots that grow separately from the base of the stem.



The extensive fibrous root systems produced by many plants help prevent topsoil from being washed away by heavy rain.

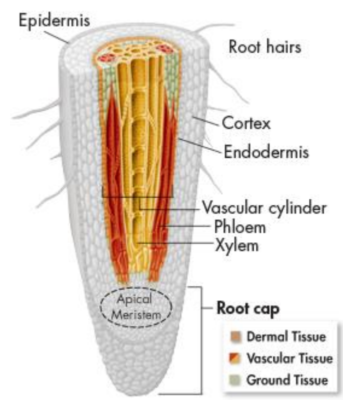


Anatomy of a Root

As seen in the figure, a mature root has:

- an outside layer of dermal tissue, called the epidermis,
- and also contains vascular tissue and
- a large area of ground tissue.

The root system plays a key role in water and mineral transport.



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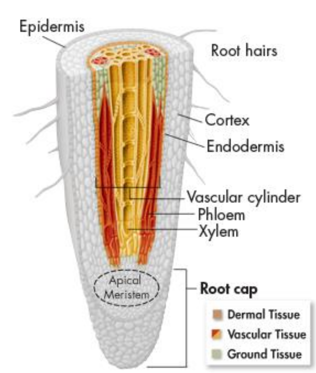
Dermal Tissue: Epidermis

The root's epidermis performs the dual functions of protection and absorption.

Its surface is covered with thin cellular projections called **root hairs**, which penetrate the spaces between soil particles and produce a large surface area that allows water and minerals to enter.



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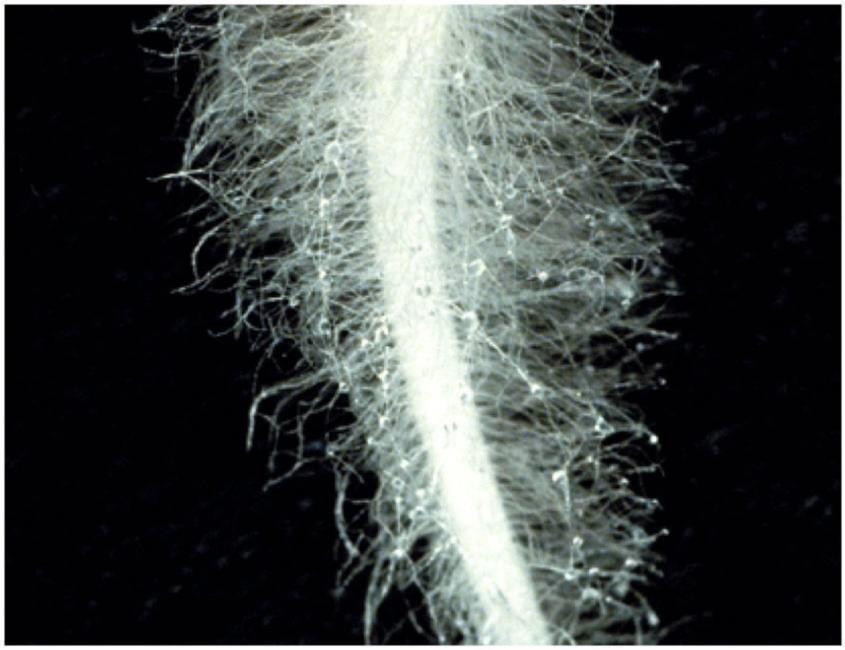
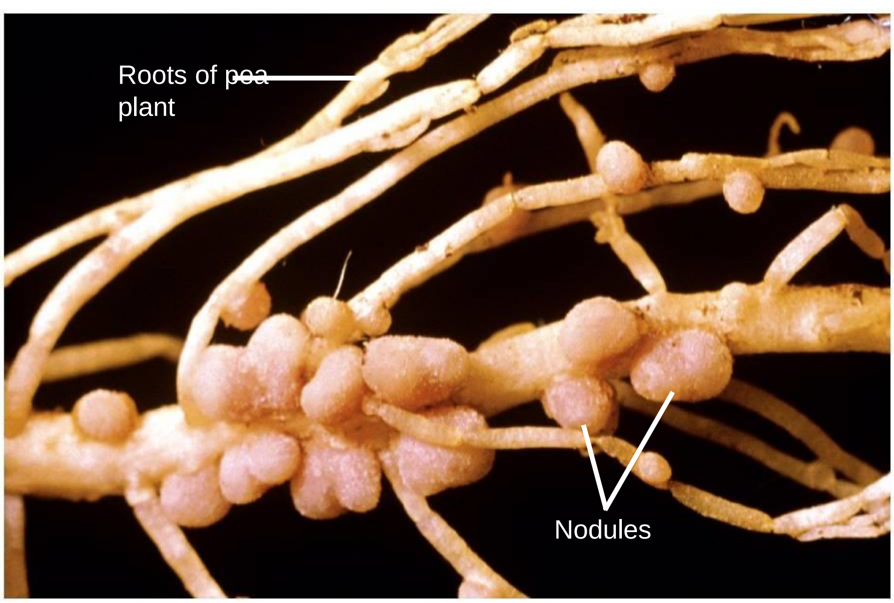


Absorbing water and nutrients



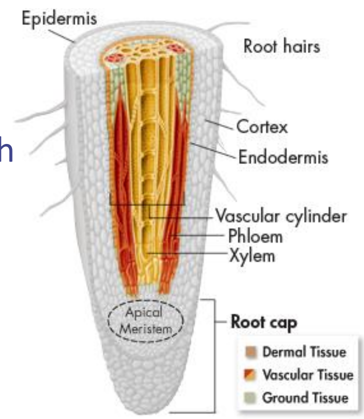
Host symbionts

Ground Tissue

Just inside the epidermis is a region of ground tissue called the **cortex**.

Water and minerals move through the cortex from the epidermis toward the center of the root.

The cortex also stores the products of photosynthesis, such as starch.



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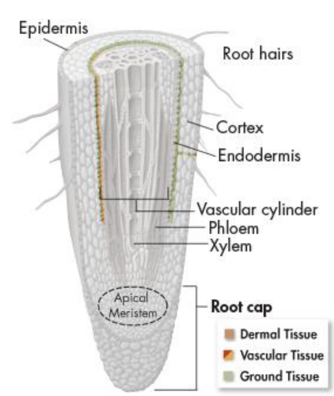
Ground Tissue

A layer of ground tissue known as the **endodermis** completely encloses the vascular cylinder.

The endodermis plays an essential role in the movement of water and minerals into the center of the root



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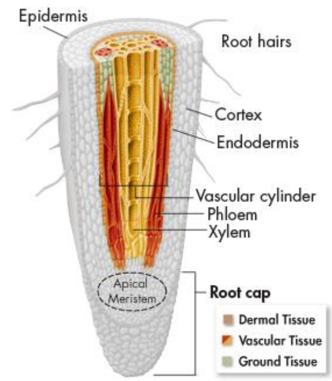
Vascular Tissue

At the center of the root, the xylem and phloem together make up a region called the **vascular cylinder**.

Dicot roots like the one shown in the figure have a central column of xylem cells.

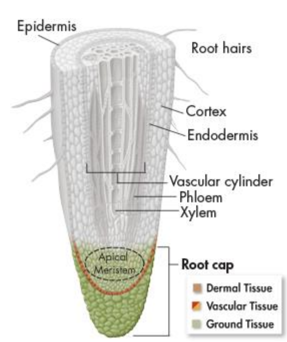


Apical Meristem

Roots grow in length when apical meristems produce new cells near the root tips.

A tough **root cap** protects the meristem as the root tip forces its way through the soil, secreting a slippery substance that eases the progress of the root through the soil.

Cells at the tip of the root cap are constantly being scraped away, and new root cap cells are continually added by the meristem.



Root Functions

- What are the different functions of roots?
- Roots support a plant, anchor it in the ground, store food, and absorb water and dissolved nutrients from the soil.

Uptake of Plant Nutrients

To grow, flower, and produce seeds, plants require a variety of inorganic nutrients. The nutrients needed in largest amounts are nitrogen, phosphorus, potassium, magnesium, and calcium.

The functions of these essential nutrients within a plant are described below.

Essential Plant Nutrients

Nutrient (Chemical Symbol)	Some Roles in Plant	Result of Deficiency
Nitrogen (N)	• Proper leaf growth and color • Synthesis of amino acids, proteins, nucleic acids, and chlorophyll	• Stunted plant growth • Pale yellow leaves ▶
Phosphorus (P)	• Synthesis of DNA • Development of roots, stems, flowers, and seeds	• Poor flowering • Stunted growth
Potassium (K)	• Synthesis of proteins and carbohydrates • Development of roots, stems, and flowers • Resistance to cold and disease	• Weak stems • Stunted roots • Edges of leaves turn brown ▶
Magnesium (Mg)	• Synthesis of chlorophyll	• Thin stems • Mottled, pale leaves
Calcium (Ca)	• Cell growth and division • Cell wall structure • Cellular transport • Enzyme action	• Stunted growth • Curled leaves ▶

Active Transport of Dissolved Nutrients

The cell membranes of root hairs and other cells in the root epidermis contain active transport proteins.

Active transport brings the mineral ions of dissolved nutrients from the soil into the plant.

The high concentration of mineral ions in the plant cells causes water molecules to move into the plant by osmosis.

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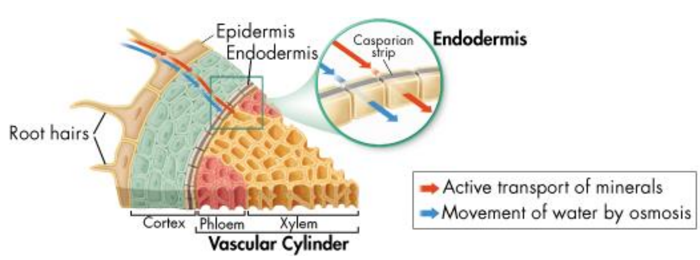
Water Movement by Osmosis

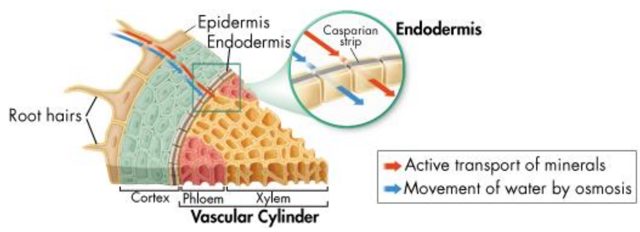
By using active transport to accumulate mineral ions from the soil, cells of the epidermis create conditions under which osmosis causes water to "follow" those ions and flow into the root, as shown in the figure.



Movement Into the Vascular Cylinder

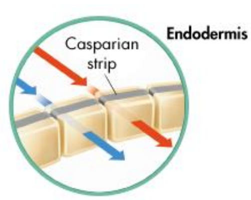
Next, the water and dissolved minerals pass through the cortex and move toward the vascular cylinder.

The cylinder is enclosed by a layer of cortex cells known as the endodermis. Where the cells of the endodermis meet, the cell walls form a special waterproof zone called a **Casparian strip**.



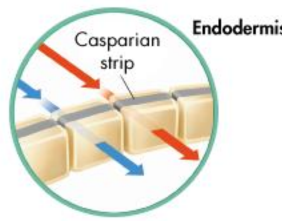
Movement Into the Vascular Cylinder

The waxy Casparian strip forces water and minerals to move through the cell membranes of the endodermis rather than in between the cells. This enables the endodermis to filter and control the water and dissolved nutrients that enter the vascular cylinder.



Movement Into the Vascular Cylinder

The Casparian strip also ensures that valuable nutrients will not leak back out. As a result, there is a one-way passage of water and nutrients into the vascular cylinder.

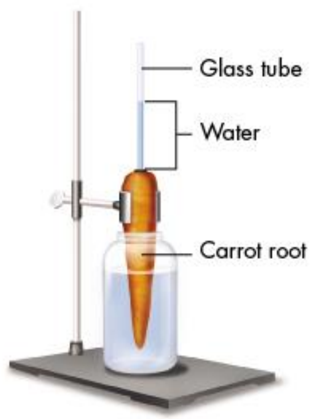


Root Pressure

As minerals are pumped into the vascular cylinder, more and more water follows by osmosis, producing a strong pressure.

Contained within the Casparian strip, the water has just one place to go—up. Root pressure, produced within the cylinder by active transport, forces water through the vascular cylinder and into the xylem. As more water moves from the cortex into the vascular cylinder, more water in the xylem is forced upward through the root into the stem.

Root Pressure Demonstration



In this setup, a glass tube takes the place of the carrot plant's stem and leaves. As the root absorbs water, root pressure forces water upward into the tube.

Stem Structure and Function

- What are three main functions of stems?
- Aboveground stems have several important functions: Stems produce leaves, branches, and flowers; stems hold leaves up to the sun; and stems transport substances throughout the plant.

Stem Structure and Function

What do water chestnuts, bamboo shoots, asparagus, and potatoes all have in common? They are all types of stems. Stems vary in size, shape, and method of development.

Aboveground stems have several important functions: Stems produce leaves, branches, and flowers; stems hold leaves up to the sun; and stems transport substances throughout the plant.

Stems make up an essential part of the water and mineral transport systems of the plant. Xylem and phloem form continuous tubes from the roots through the stems to the leaves. These vascular tissues allow water, nutrients, and other compounds to be carried throughout the plant.

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Stem Structure and Function

In many plants, stems also function in storage and aid in the process of photosynthesis.

For example, desert cacti have thick green stems that carry out photosynthesis and are adapted to store water.

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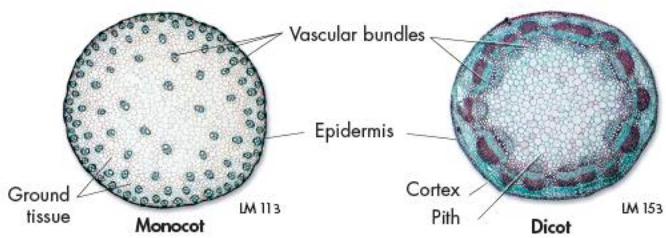
Anatomy of a Stem

Stems contain dermal, vascular, and ground tissue.

Stems are surrounded by a layer of epidermal cells that have thick cell walls and a waxy protective coating.

These cross sections through a monocot and dicot stem show the epidermis, vascular tissue, and ground tissue.

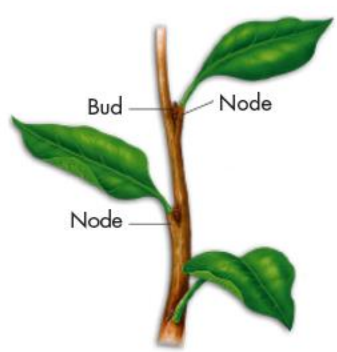


Anatomy of a Stem

Growing stems contain distinct **nodes**, where leaves are attached, as shown in the figure.

Small buds are found where leaves attach to the nodes. **Buds** contain apical meristems that can produce new stems and leaves.

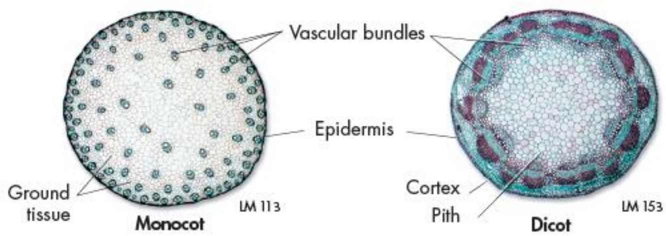
In larger plants, stems develop woody tissue that helps support leaves and flowers.



Vascular Bundle Patterns

In monocots, clusters of xylem and phloem tissue, called **vascular bundles**, are scattered throughout the stem, as shown in the cross section below left.

In most dicots and gymnosperms, vascular bundles are arranged in a cylinder, or ring, as shown in the cross section below right.

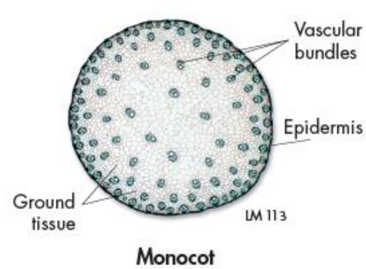


Monocot Stems

This cross section of a monocot stem shows the epidermis, which encloses ground tissue and vascular bundles.

Vascular bundles are scattered throughout the ground tissue.

The ground tissue is fairly uniform, consisting mainly of parenchyma cells.

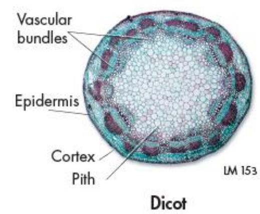


Dicot Stems

Young dicot stems have vascular bundles that are generally arranged in a ringlike pattern, as shown in this cross section.

The parenchyma cells inside the ring of vascular tissue are known as **pith**, while those outside form the cortex of the stem.

These tissue patterns become more complex as the plant grows and the stem increases in diameter.



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Growth of Stems

- How do primary growth and secondary growth occur in stems?
- Primary growth of stems is the result of elongation of cells produced in the apical meristem. It takes place in all seed plants.
- In conifers and dicots, secondary growth takes place in meristems called the **vascular cambium** and **cork cambium**.

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Primary Growth

A plant's apical meristems at the roots and shoots produce new cells and increase its length. This growth, occurring at the ends of a plant, is called **primary growth**. It takes place in all seed plants.

The figure below shows the increase in a plant due to primary growth over several years.

Rege

Secondary Growth

As a plant grows larger, the older parts of its stems have more mass to support and more fluid to move through their vascular tissues. As a result, stems increase in thickness, which is known as **secondary growth**.

The figure below illustrates the pattern of secondary growth in a dicot stem.

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Secondary Growth

Secondary growth is very common among dicots and non-flowering seed plants such as pines, but is rare in monocots. This limits the girth of most monocots.

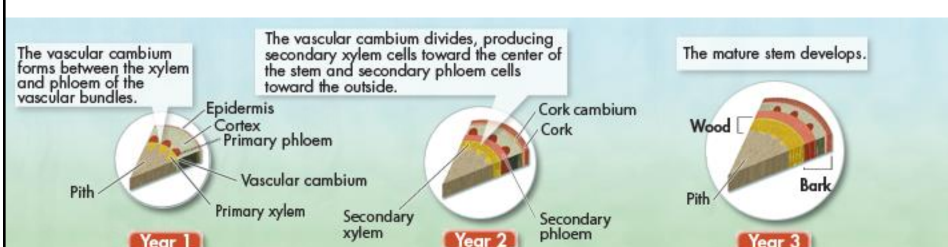
Unlike monocots, most dicots have meristems within their stems and roots that can produce true secondary growth. This enables them to grow to great heights because the increase in width supports the extra weight.

Secondary Growth

In conifers and dicots, secondary growth takes place in meristems called the vascular cambium and cork cambium.

The **vascular cambium** produces vascular tissues and increases the thickness of stems over time.

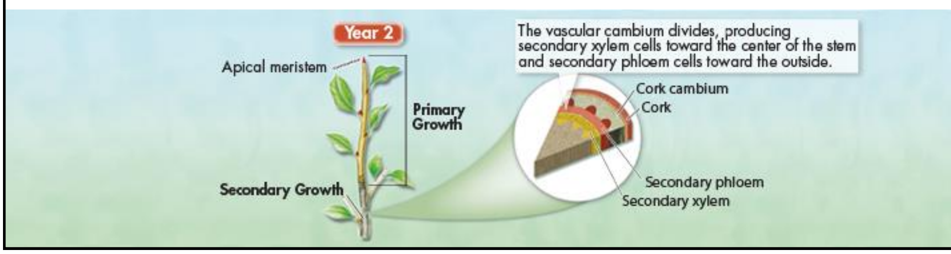
The **cork cambium** produces the outer covering of stems.



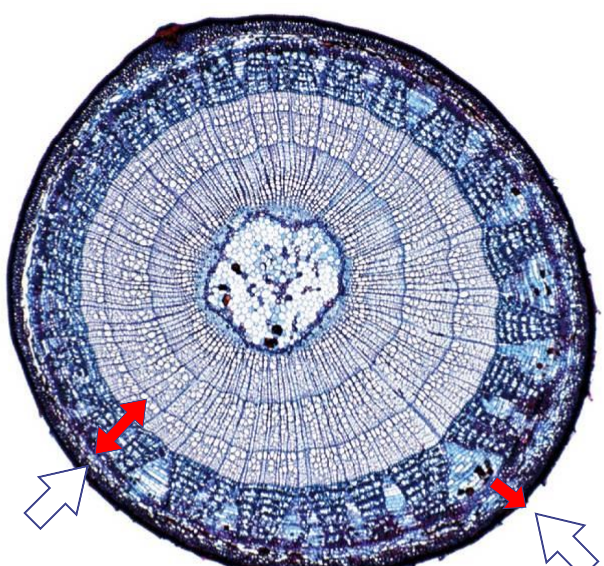
Growth From the Vascular Cambium

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

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



Woody stems contain two lateral meristems.



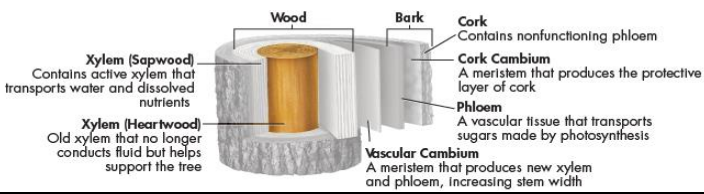
Vascular cambium adds cells on inside and outside

Cork cambium adds cells to the outside

Formation of Wood

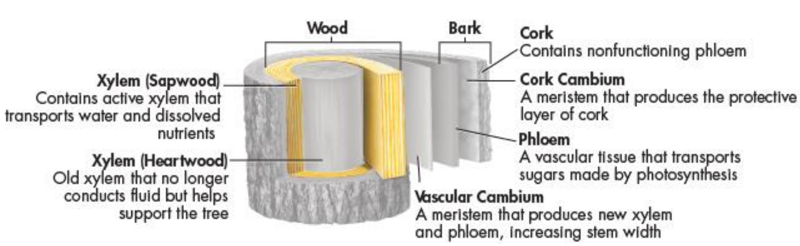
Most of what is called “wood” is actually layers of secondary xylem produced by the vascular cambium.

As woody stems grow thicker, the older xylem near the center of the stem no longer conducts water and becomes **heartwood**. Heartwood usually darkens with age because it accumulates colored deposits.

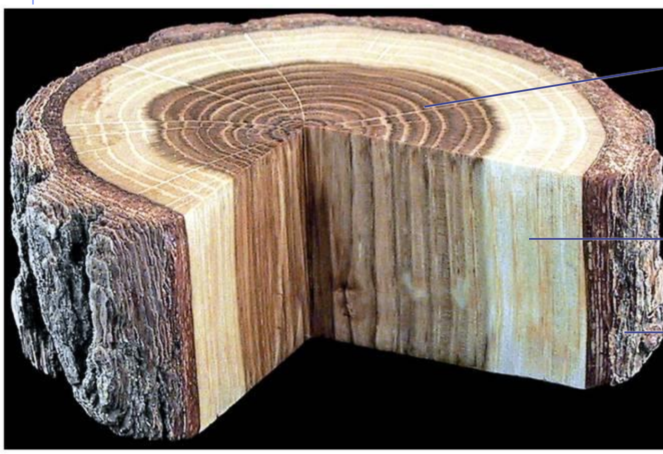


Formation of Wood

Heartwood is surrounded by **sapwood**, which is active in fluid transport and is, therefore, usually lighter in color.



Heartwood and sapwood have different functions.



Tree Rings

When growth begins in the spring, the vascular cambium begins to grow rapidly, producing large, light-colored xylem cells, resulting in a light-colored layer of early wood.

As the growing season continues, the cells grow less and have thicker cell walls, forming a layer of darker late wood.

This alternation of dark and light wood produces what we commonly call tree rings.

Tree Rings

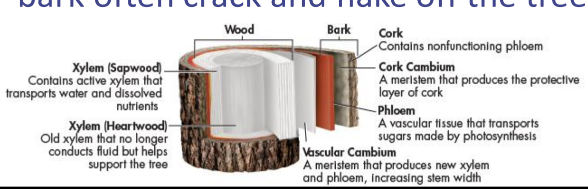
Each ring has light wood at one edge and dark wood at the other, making a sharp boundary between rings.

Usually, a ring corresponds to a year of growth. By counting the rings in a cross section of a tree, you can estimate its age.

The size of the rings may even provide information about weather conditions. Thick rings indicate that weather conditions were favorable for tree growth, whereas thin rings indicate less-favorable conditions.

Formation of Bark

In a mature stem, all of the tissues found outside the vascular cambium make up the **bark**, as shown in the figure. These tissues include phloem, the cork cambium, and cork. As a tree expands in width, the oldest tissues may split and fragment. The cork cambium surrounds the cortex and produces a thick, protective layer of waterproof cork that prevents the loss of water from the stem. As the stem increases in size, outer layers of dead bark often crack and flake off the tree.



Lesson Overview Leaves

Leaf Structure and Function

How is the structure of a leaf adapted to make photosynthesis more efficient?

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

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Lesson Overview Leaves

Anatomy of a Leaf

To collect sunlight, most leaves have a thin, flattened part called a **blade**. The flat shape of a leaf blade maximizes the amount of light it can absorb.

The blade is attached to the stem by a thin stalk called a **petiole**.

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

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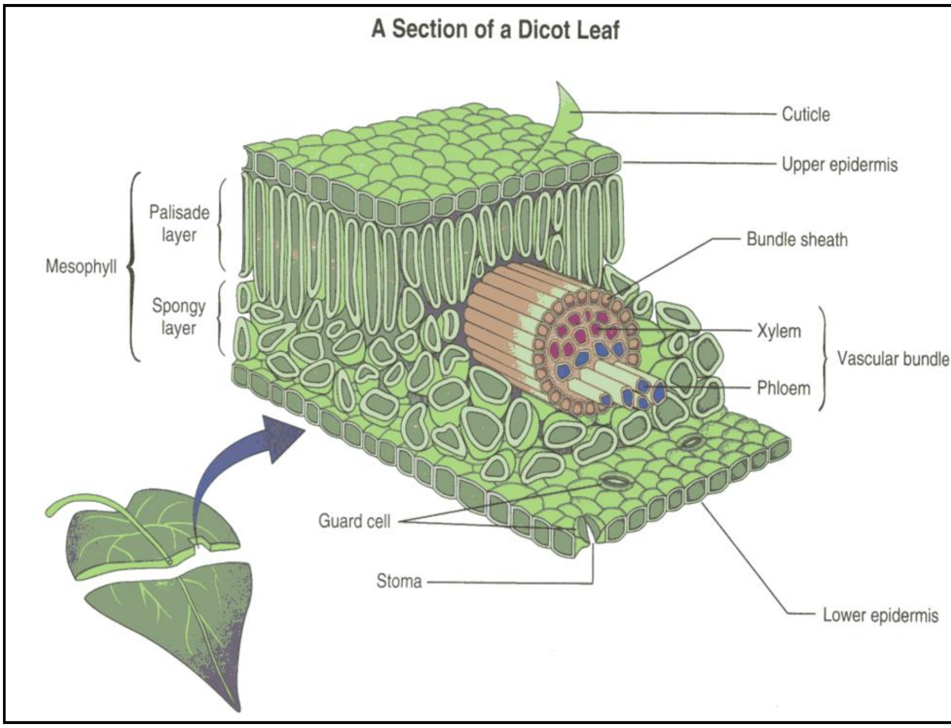
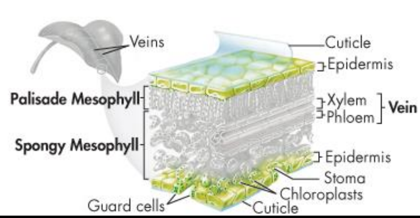


Lesson Overview Leaves

Dermal Tissue

The top and bottom surfaces of a leaf are covered by the epidermis, which has tough, irregularly shaped cells with thick outer walls.

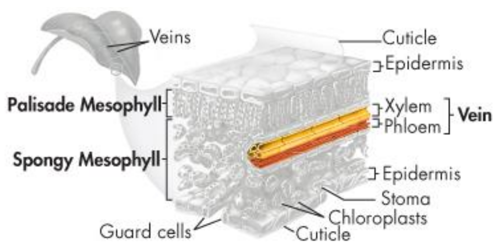
The epidermis of nearly all leaves is covered by a waxy cuticle, a waterproof barrier that protects the leaf and limits water loss through evaporation.



Lesson Overview Leaves

Vascular Tissue

Xylem and phloem tissues are gathered together into bundles called leaf veins that run from the stem throughout the leaf.



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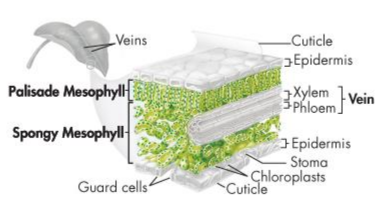
Lesson Overview Leaves

Photosynthesis

Beneath the upper epidermis is a layer of cells called the **palisade mesophyll**, containing closely packed cells that absorb light that enters the leaf.

Beneath the palisade layer is the **spongy mesophyll**, which has many air spaces between its cells.



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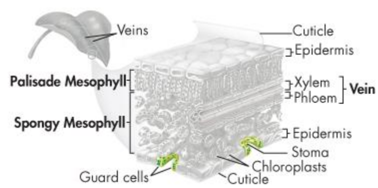
Lesson Overview Leaves

Photosynthesis

The air spaces in the spongy mesophyll connect with the exterior through **stomata**, small openings in the epidermis that allow carbon dioxide, water, and oxygen to diffuse into and out of the leaf.



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Lesson Overview Leaves

Transpiration

The walls of mesophyll cells are kept moist so that gases can enter and leave the cells easily. However, water also evaporates from these surfaces and is lost to the atmosphere.

Transpiration is the loss of water through leaves. This lost water may be replaced by water drawn into the leaf through xylem vessels in the vascular tissue.

Transpiration helps to cool leaves on hot days, but it may also threaten the leaf's survival if water is scarce, as seen in this wilting plant.

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Lesson Overview Leaves

Gas Exchange and Homeostasis

- What role do stomata play in maintaining homeostasis?
- Plants maintain homeostasis by keeping their stomata open just enough to allow photosynthesis to take place but not so much that they lose an excessive amount of water.

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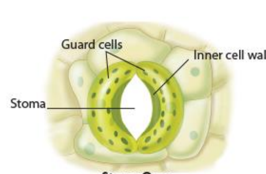
Lesson Overview Leaves

Gas Exchange

Leaves take in carbon dioxide and give off oxygen during photosynthesis.

When plant cells use the food they make, the cells respire, taking in oxygen and giving off carbon dioxide.

Plant leaves allow gas exchange between air spaces in the spongy mesophyll and the exterior by opening their stomata.



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Lesson Overview Leaves

Homeostasis

If stomata were kept open all the time, water loss due to transpiration would be so great that few plants would be able to take in enough water to survive.

Plants maintain homeostasis by keeping their stomata open just enough to allow photosynthesis to take place but not so much that they lose an excessive amount of water.

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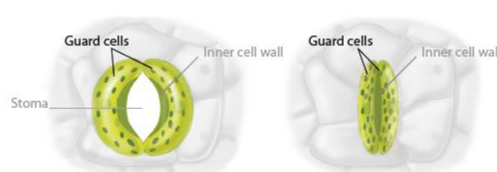
Lesson Overview Leaves

Homeostasis

Guard cells, shown in the figure, are highly specialized cells that surround the stomata and control their opening and closing. Guard cells regulate the movement of gases into and out of leaf tissues.

Carbon dioxide can enter through the open stomata, and water is lost by transpiration.



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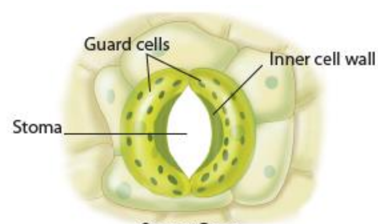
Homeostasis

When water is abundant, it flows into the leaf, raising water pressure in the guard cells, which opens the stomata.

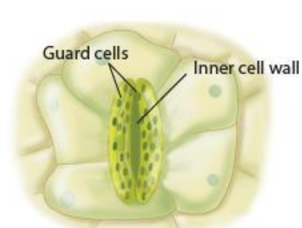
The thin outer walls of the guard cells are forced into a curved shape, which pulls the thick inner walls away from one another, opening the stoma.



Lesson Overview Leaves

Homeostasis

When water is scarce, water pressure within the guard cells decreases, the inner walls pull together, and the stoma closes. This reduces further water loss by limiting transpiration.



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Lesson Overview Leaves

Homeostasis

In general, stomata are open during the daytime, when photosynthesis is active, and closed at night, when open stomata would only lead to water loss.

However, stomata may be closed even in bright sunlight under hot, dry conditions in which water conservation is a matter of life and death.

Guard cells respond to conditions in the environment, such as wind and temperature, helping to maintain homeostasis within a leaf.

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Lesson Overview Leaves

Transpiration and Wilting

Osmotic pressure keeps a plant's leaves and stems rigid.

High transpiration rates can lead to wilting. Wilting results from the loss of water—and therefore pressure—in a plant's cells.

Regents Biology

Lesson Overview Leaves

Adaptations of Leaves

The leaves of these plants have adaptations to the dry or low-nutrient conditions in which they live.

- **Pitcher Plant:** The leaf of a pitcher plant is modified to attract and then digest insects and other small prey. Such plants typically live in nutrient-poor soils and rely on animal prey as their source of nitrogen.
- **Rock Plant:** The two leaves of a rock plant are adapted for hot, dry conditions. They are rounded, which minimizes the exposure of their surface to the air. They also have very few stomata.
- **Spruce** The narrow leaves of a spruce tree contain a waxy epidermis as well as stomata that are sunken below the surface of the leaf. These adaptations reduce water loss from the leaves.
- **Cactus:** Cactus leaves are actually nonphotosynthetic thorns that protect against herbivores. Most of the plant's photosynthesis is carried out in its stems.

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Water Transport

- What are the major forces that transport water in a plant?

- The combination of transpiration and capillary action provides over 90 percent of the force that moves water through the xylem tissues of a plant.

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Transpiration

As water evaporates through open stomata, the cell walls within the leaf begin to dry out.

The dry cell walls draw water from cells deeper inside the leaf's vascular tissue so that water is pulled up through xylem.

The hotter and drier the air, and the windier the day, the greater the amount of water lost and the more water the plant draws up from the roots.

An Analogy for Transpirational Pull

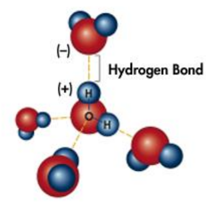
Imagine a chain of clowns who are tied together and climbing a tall ladder. When the first clown reaches the top, he falls off, pulling the clowns behind him up and over the top.

Similarly, as water molecules exit leaves through transpiration, they pull up the water molecules behind them.

How Cell Walls Pull Water Upward

Water molecules are attracted to one another by a force called cohesion. Water cohesion is especially strong because of the tendency of water molecules to form hydrogen bonds with each other.

Water molecules can also form hydrogen bonds with other substances. This results from a force called **adhesion**, which is attraction between unlike molecules.



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How Cell Walls Pull Water Upward

The tendency of water to rise in a thin tube is called **capillary action**. Water is attracted to t walls of the tube, and water molecules are attracted to on another.

The thinner the tube, the higl the water will rise inside it, as shown in the figure.

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Putting It All Together

Xylem tissue is composed of tracheids and vessel elements that form many hollow, connected tubes. These tubes are lined with cellulose cell walls, to which water adheres very strongly.

When transpiration removes water from the exposed walls, strong adhesion forces pull in water from the wet interior of the leaf. That pull is so powerful that it extends down through the tips of roots to the water in the soil.

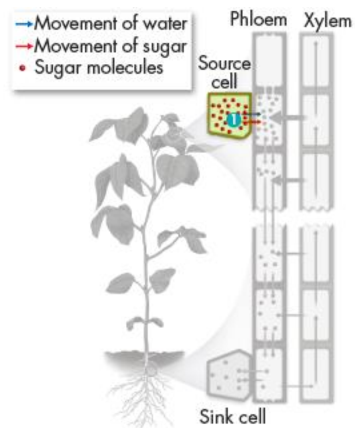
Nutrient Transport

- What drives the movement of fluid through phloem tissue in a plant?
- Changes in nutrient concentration drive the movement of fluid through phloem tissue in directions that meet the nutritional needs of the plant.

Nutrient Transport

The leading explanation of phloem transport is known as the **pressure-flow hypothesis**, shown in the figure.

1. The membranes of sieve tube cells can use active transport to move sugars from their cytoplasm into the sieve tube itself.



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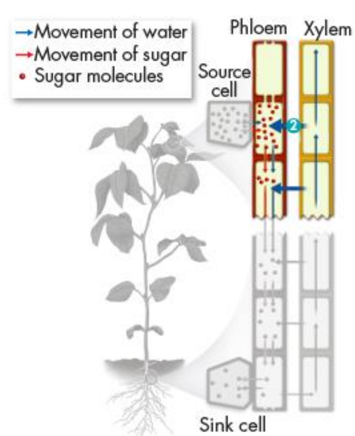
Nutrient Transport

2. Water then follows by osmosis, creating pressure in the tube at the source of the sugars.



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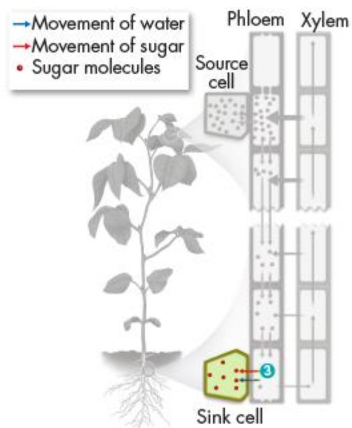
Nutrient Transport

3. If another region of the plant has a need for sugars, they are actively pumped out of the tube and into the surrounding tissue. Water then leaves the tube via osmosis, reducing the pressure.

The result of the pressure-flow system is the flow of nutrient-rich fluid from the sources of sugars (source cells) to the places where sugars are used or stored (sink cells).



Nutrient Transport

The pressure-flow system gives plants flexibility in responding to changing seasons.

During the growing season, sugars from the leaves are directed into ripening fruits or into roots for storage.

As the growing season ends, the plant drops its fruits and stores nutrients in the roots.

As spring approaches, phloem cells in the roots pump sugars back into phloem sap, and the pressure-flow system raises these sugars into stems and leaves to support rapid growth.

- Explain the diversity of plants as a product of evolution

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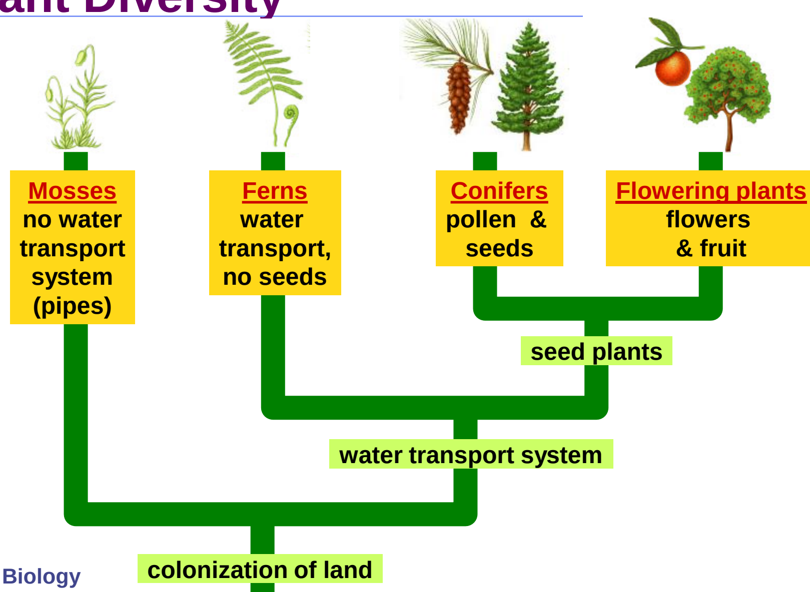
Plant Diversity



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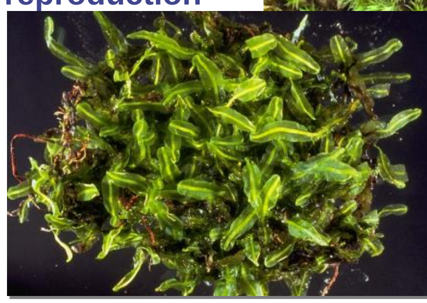
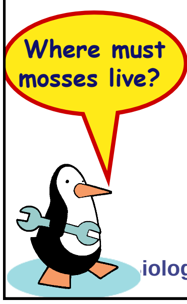
Mosses

- Characteristics
  - no water transport system
    - no true roots
  - swimming sperm
    - need water to reproduce
  - spores for reproduction
    - no seeds





iology

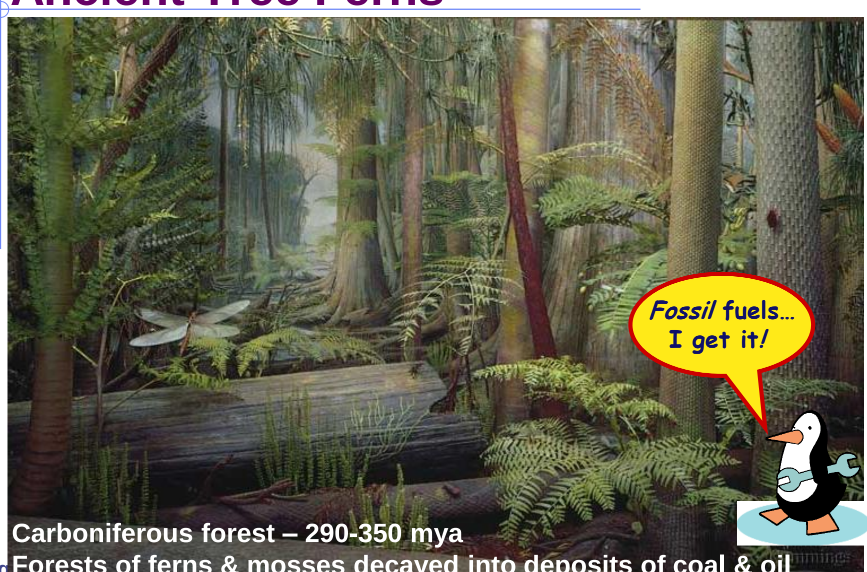
Peat Bog

"Peat Moss"

Ferns

- Characteristics
  - water transport system
    - xylem & roots
  - swimming sperm
    - need water to reproduce
  - spores for reproduction
    - no seeds

Ancient Tree Ferns



Carboniferous forest – 290-350 mya
Forests of ferns & mosses decayed into deposits of coal & oil

Modern Tree Ferns

Conifers (Evergreens)

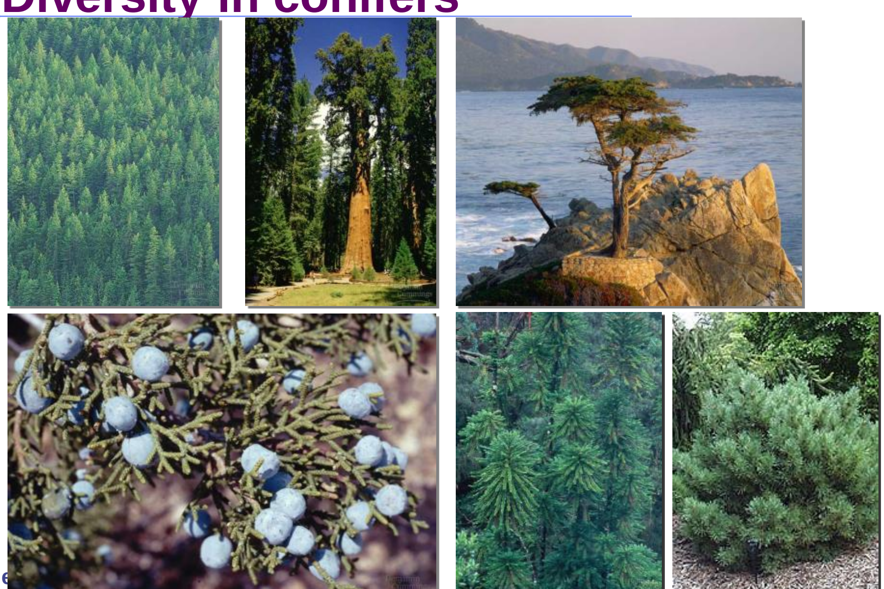
- Characteristics
  - water transport system
    - xylem, roots
  - seeds
    - "naked" seeds in cone (no fruit)
  - pollen
    - sperm that doesn't have to swim

Ancient conifers

ginkgo

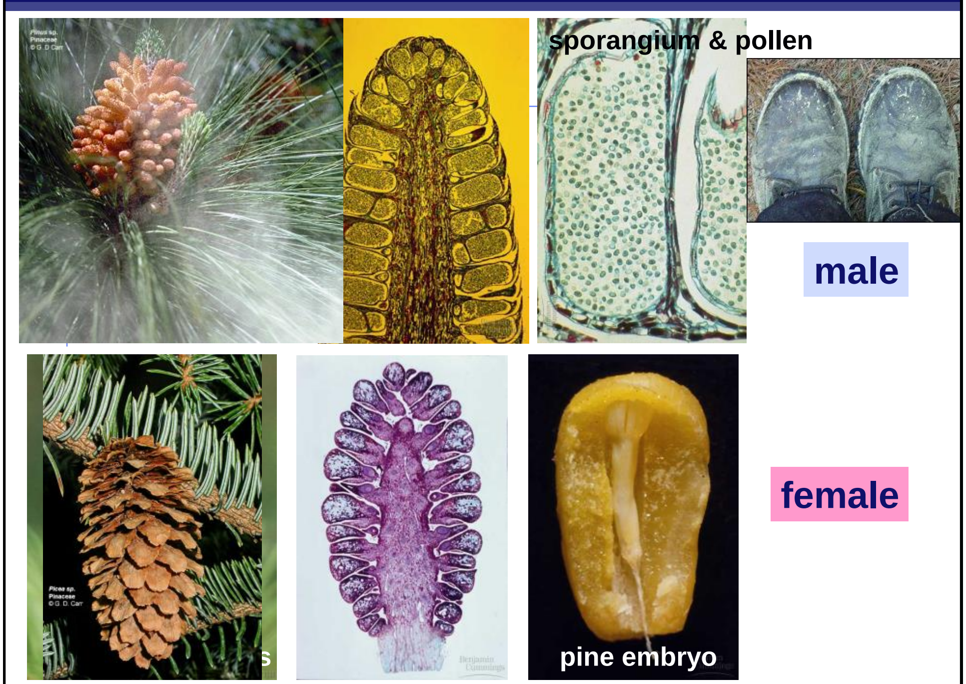
cycad

Diversity in conifers



Cones & “naked” seeds

Reg

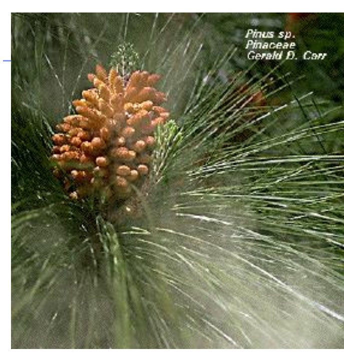


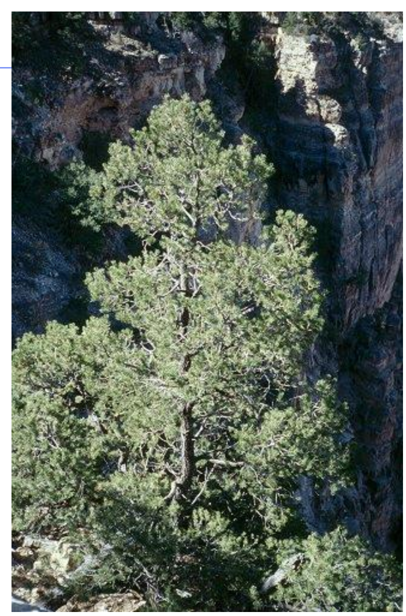
male

female

What are gymnosperms?

- Plants that produce seeds on woody structures called cones.
- Seeds are not protected by fruit, nor do they produce flowers.





Reproductive Structures

- Microspores are produced in the male cone and give rise to the male gametophyte, eventually developing into pollen grains.
- Megaspores (contained within ovule) are produced in the female cone and give rise to the female gametophyte.

The Process

- In conifers, pollen is carried by wind to the ovule and the male gametophyte contained in the pollen grain produces a pollen tube which provides a way for the sperm cell to reach the egg.

After fertilization…

- The zygote develops into an embryo.

Flowers and Fruits

- What are the key features of angiosperm reproduction?
- Angiosperms reproduce sexually by means of flowers. After fertilization, ovaries within flowers develop into fruits that surround, protect, and help disperse the seeds.

Flowers and Fruits

The origin of flowering plants is the most recent among the origins of all plant phyla.

Flowering plants originated on land and soon came to dominate Earth's plant life.

Angiosperms develop unique reproductive organs known as flowers, shown in the figure.

Flowers contain **ovaries**, which surround and protect seeds.

Advantages of Flowers

Flowers are an evolutionary advantage to plants because they attract animals that carry pollen with them to the next flower they visit. This means of pollination is much more efficient than the wind pollination of most gymnosperms.

Advantages of Fruits

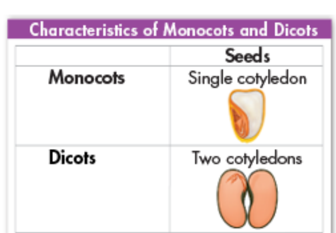
After pollination, the ovary develops into a **fruit**, a structure containing one or more matured ovaries. The wall of the fruit helps disperse the seeds contained inside it. The development of the multiple ovaries of a blackberry flower into the cluster of fruits that make up one berry is shown.

When an animal eats a fleshy fruit, seeds from the fruit enter the animal's digestive system. By the time the seeds leave the digestive system, the animal may have traveled many kilometers.

By using fruit, flowering plants increase the ranges they inhabit.

Angiosperm Classification

When an animal For many years, flowering plants were classified according to the number of seed leaves, or **cotyledons**, in their embryos. Those with one seed leaf were called **monocots**. Those with two seed leaves were called **dicots**.

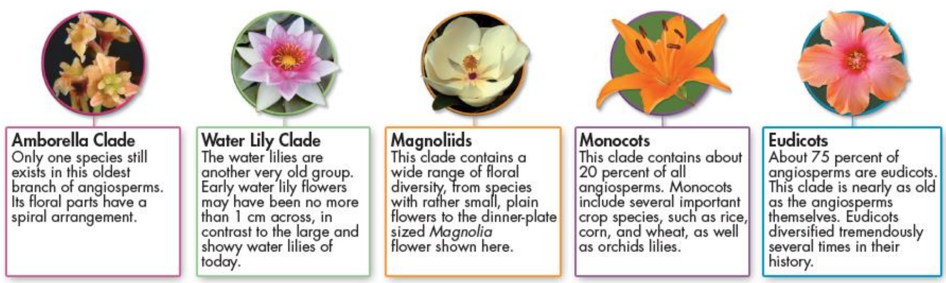


Characteristics of Monocots and Dicots

	Seeds
Monocots	Single cotyledon
Dicots	Two cotyledons

Angiosperm Classification

Scientific classification places the monocots into a single group but places the dicots in different categories.



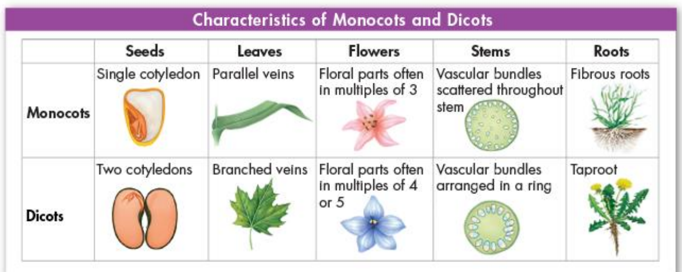
Angiosperm Diversity

- How are different angiosperms conveniently categorized?
- Angiosperms are often grouped according to the number of their seed leaves, the strength and composition of their stems, and the number of growing seasons they live.

Monocots and Dicots

The differences between monocots and dicots include the distribution of vascular tissue in stems, roots, and leaves, and the number of petals per flower.

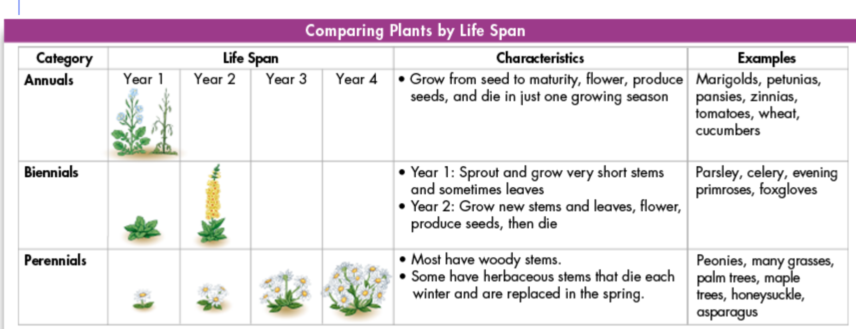
The characteristics of monocots and dicots are compared in the table below.



Characteristics of Monocots and Dicots

	Seeds	Leaves	Flowers	Stems	Roots
Monocots	Single cotyledon	Parallel veins	Floral parts often in multiples of 3	Vascular bundles scattered throughout stem	Fibrous roots
Dicots	Two cotyledons	Branched veins	Floral parts often in multiples of 4 or 5	Vascular bundles arranged in a ring	Taproot

Annuals, Biennials, and Perennials: Characteristics and Examples

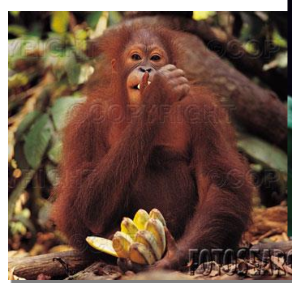


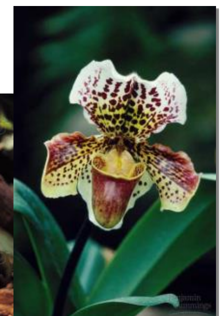
Comparing Plants by Life Span

Category	Life Span				Characteristics	Examples
	Year 1	Year 2	Year 3	Year 4		
Annuals					• Grow from seed to maturity, flower, produce seeds, and die in just one growing season	Marigolds, petunias, pansies, zinnias, tomatoes, wheat, cucumbers
Biennials					• Year 1: Sprout and grow very short stems and sometimes leaves • Year 2: Grow new stems and leaves, flower, produce seeds, then die	Parsley, celery, evening primroses, foxgloves
Perennials					• Most have woody stems. • Some have herbaceous stems that die each winter and are replaced in the spring.	Peonies, many grasses, palm trees, maple trees, honeysuckle, asparagus

Flowering plants

- Characteristics
  - <u>water transport system</u>
    - xylem, roots
  - <u>flower</u>
    - specialized structure for sexual reproduction
  - <u>pollen</u>
    - sperm that doesn't have to swim
  - <u>seeds within fruit</u>





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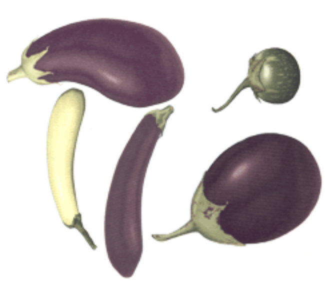
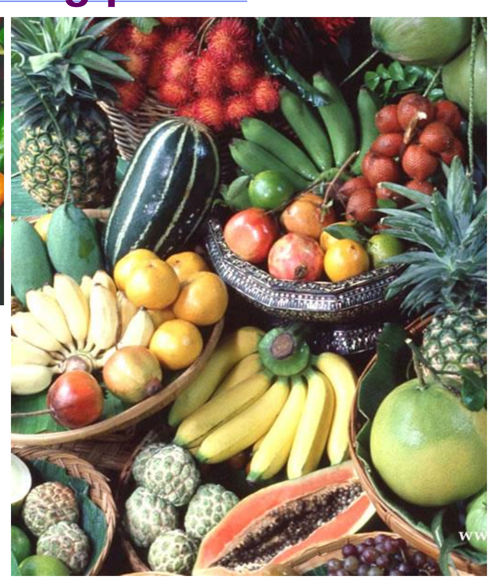
Angiosperm: fruiting plants





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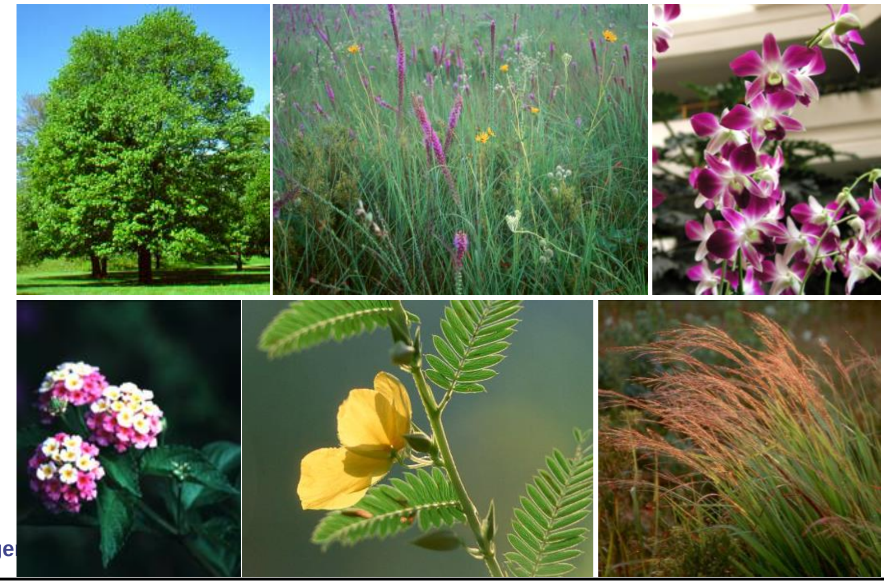
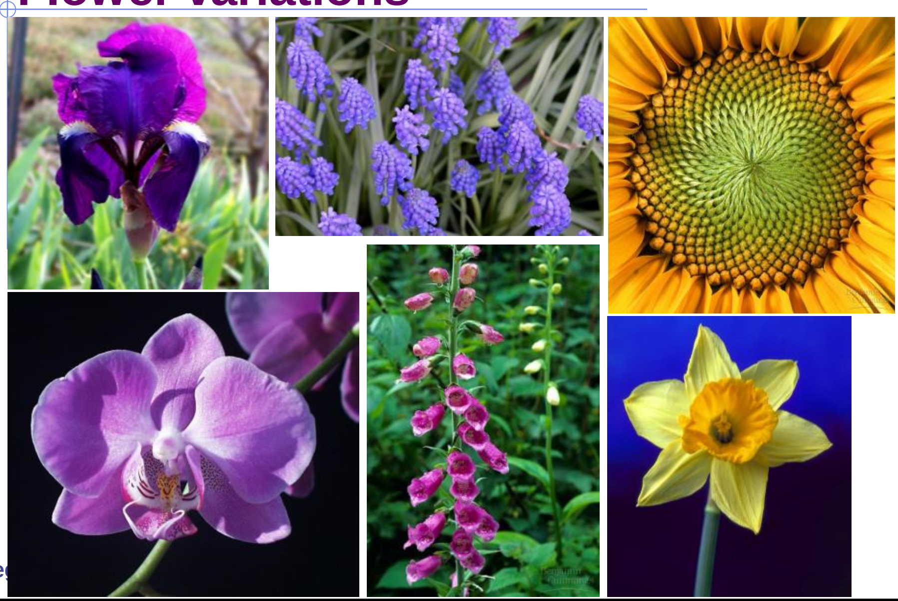
Angiosperm: flowering plants

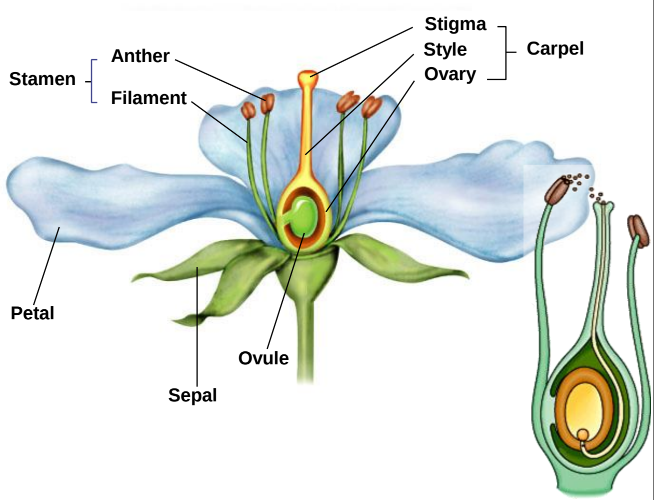


Flower variations

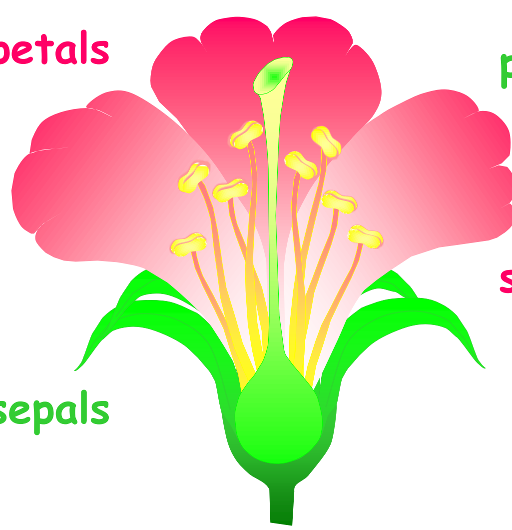


Flower

- 4 rings of flower parts
  - sepals
  - petals
  - stamens
    - male
  - carpel
    - female



Most flowers have 4 basic parts.



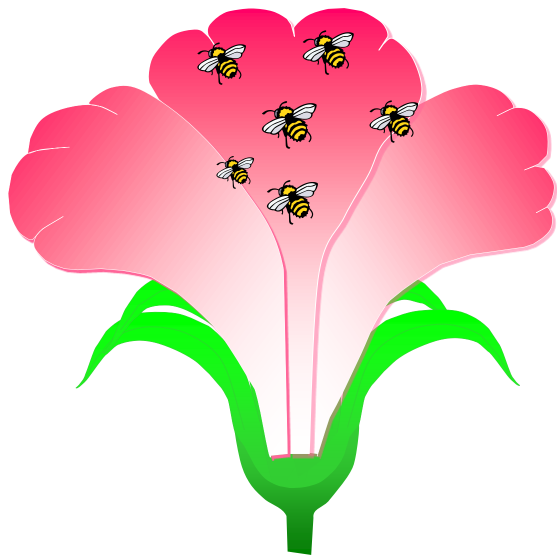
Some floral structures are nonessential; they are not required for reproduction.

sepals

leaf-like structures which protect the flower before blooming

petals

colorful, protect reproductive structures, attract pollinators



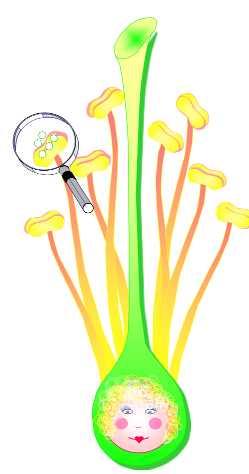
Some floral structures are essential for reproduction to occur.

pistil ♀

Female organ, produces egg(s)

stamens ♂

male organs, produce sperm in pollen grains



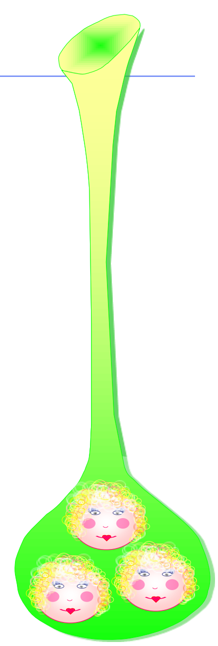
Stamens ♂ are made of 2 parts.

anther

produces pollen

filament

Pistils (♀) are made of 3 parts.



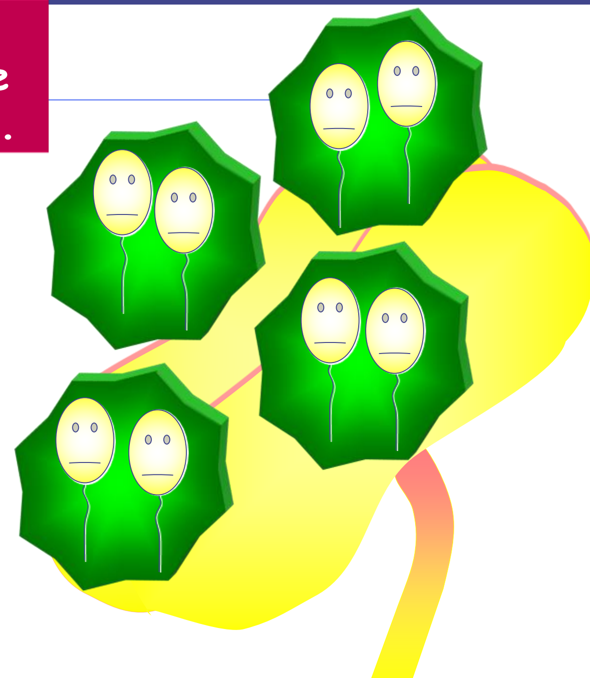
stigma

style

ovary

produces egg(s)

Inside every pollen grain are two sperm cells.



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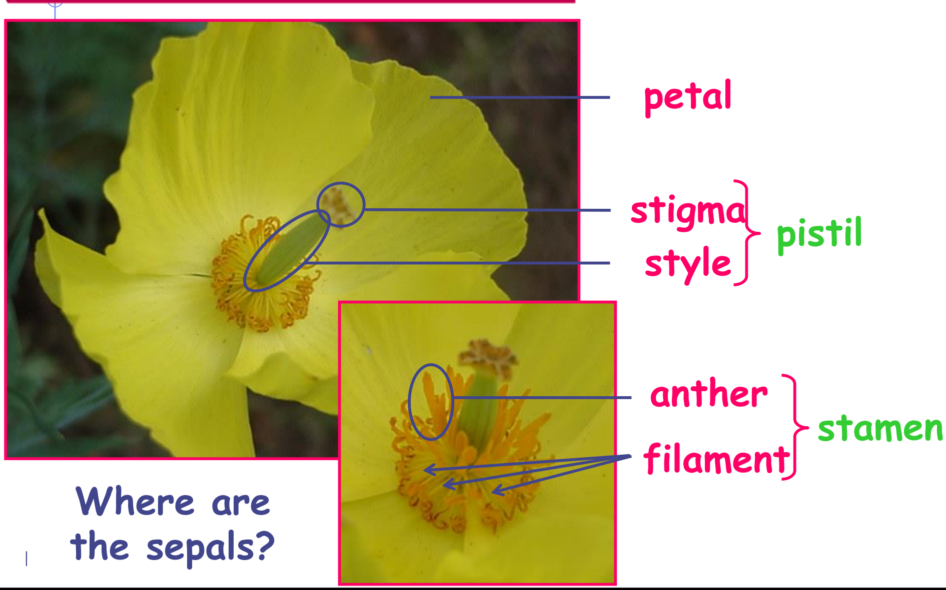
Identify the structures in this flower.



Where are the sepals?

Identify the flower structures…

Rege

Reproduction

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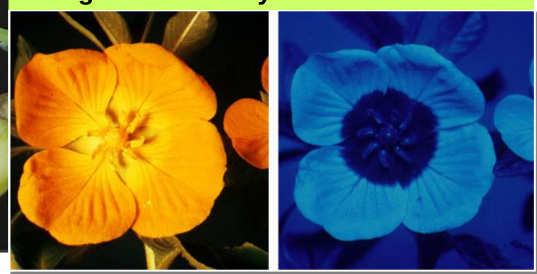
Co-evolution: flowers & pollinators

How a bee sees a flower…insects see UV light = a bulls-eye to the nectar

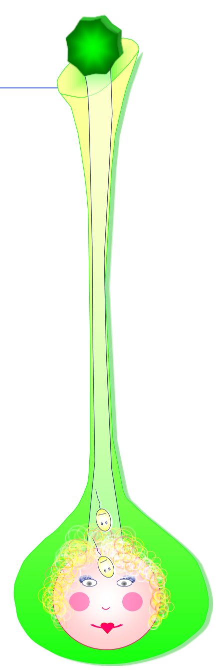


When pollen lands on the stigma, this process is called **pollination**.

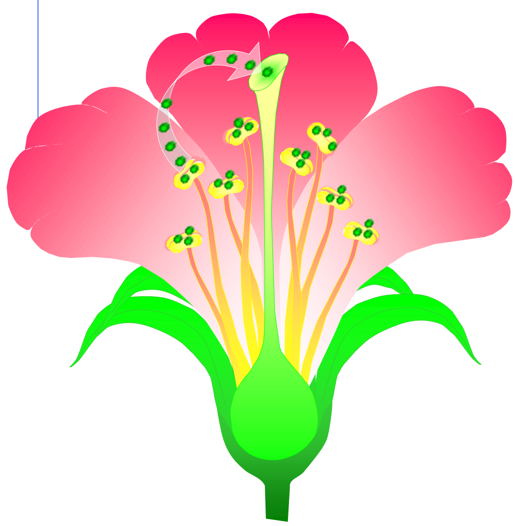
A pollen tube grows from the pollen grain and the sperm migrate to the egg.

The first sperm fertilizes the egg.

The egg and sperm unite in a process called **fertilization**.



There are 2 types of pollination.



When pollen lands on a stigma of the same flower, this is <u>self-pollination</u>.

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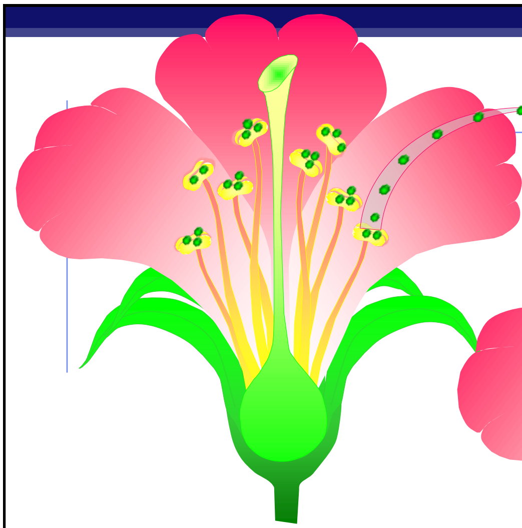

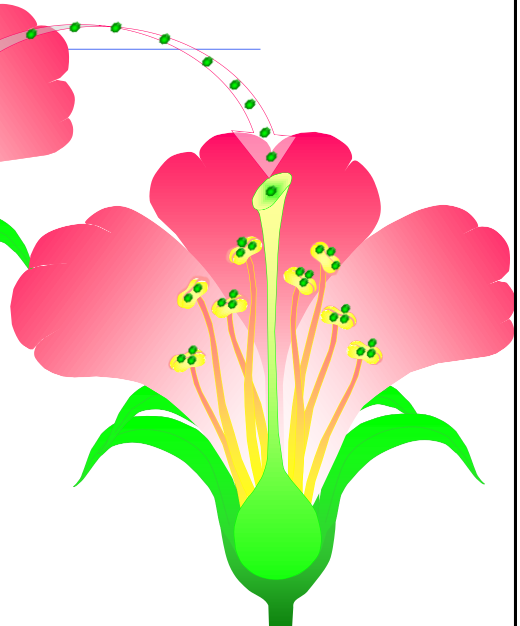

When pollen lands on a stigma of another flower, this is <u>cross-pollination</u>.

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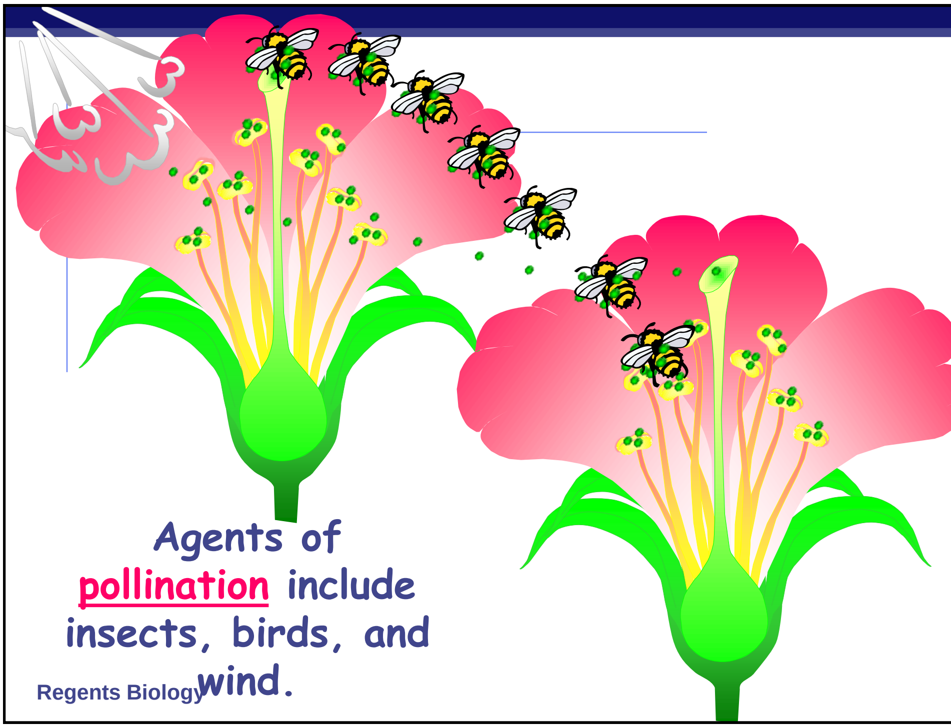

Agents of **pollination** include insects, birds, and wind.

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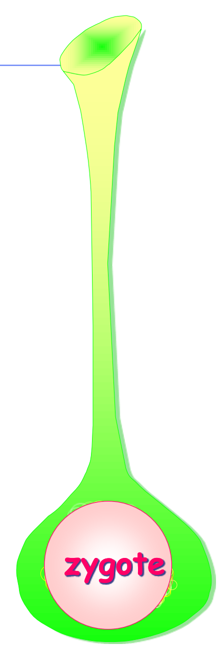
The egg and sperm unite in a process called **fertilization**.

The two cells (egg and sperm) become one new cell called a zygote.

The zygote begins to grow and develops into a seed.



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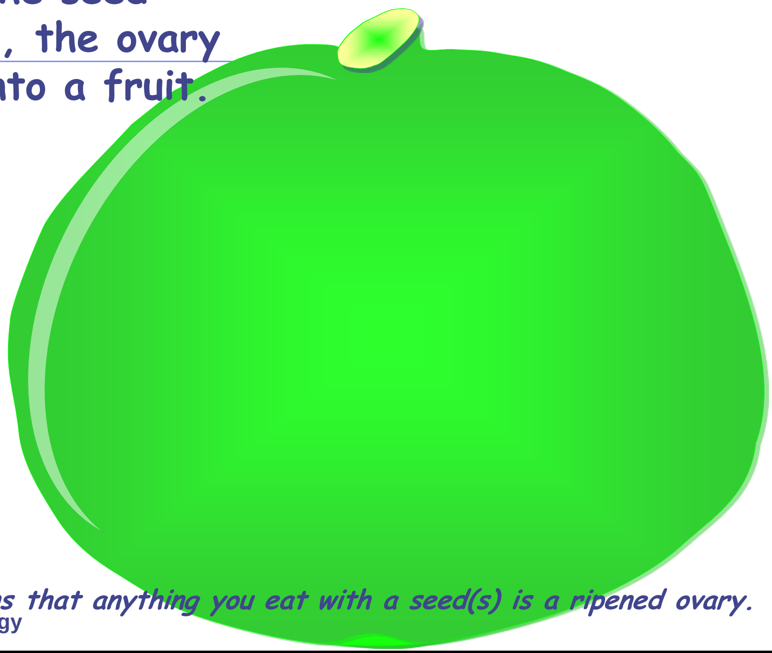
As the seed develops, the ovary grows into a fruit.



This means that anything you eat with a seed(s) is a ripened ovary.

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Formation of a Fruit

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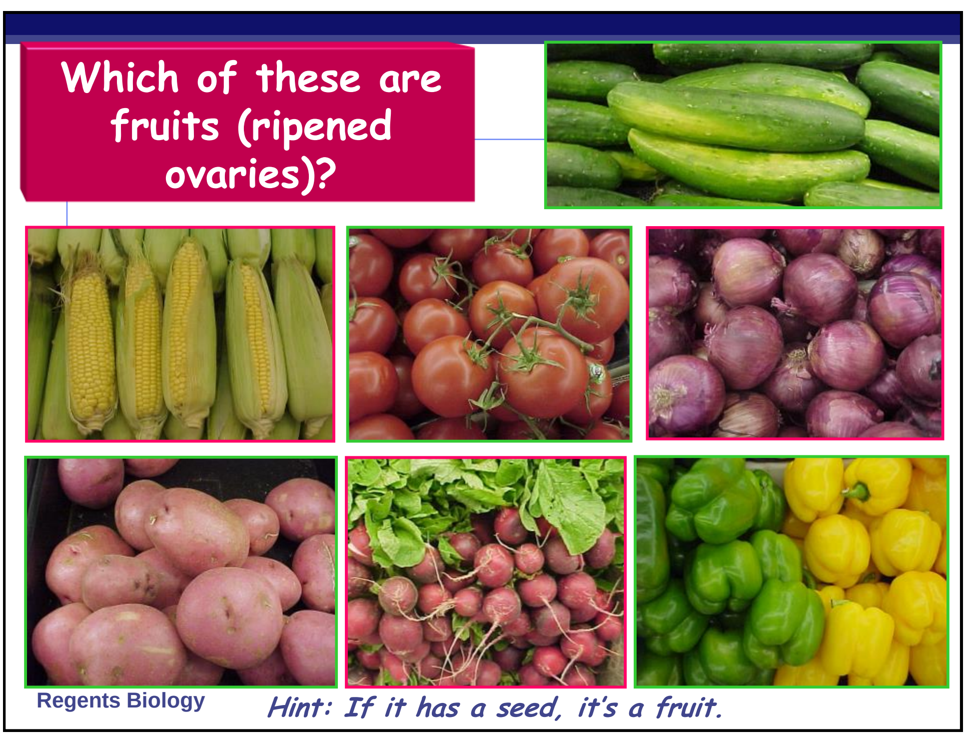
- Some plants develop fleshy fruits like apples, grapes, melons, tomatoes, squash, and cucumbers.
- Other plants develop dry fruits such as peanuts and walnuts, as well as grains such as wheat, barley, and rice.

Regents Biology

Examples of ripened ovaries.


Other fruits…


Which of these are fruits (ripened ovaries)?
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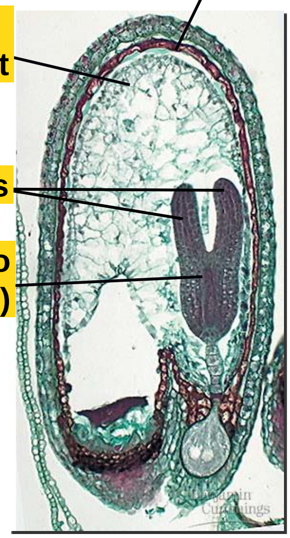
Hint: If it has a seed, it's a fruit.

Seed & Plant embryo

- Seed offers…
  - protection for embryo (new plant)
  - stored nutrients for growth of new plant



"seed" leaves = first leaves of new plant

Photoperiodism

- The response of flowering plants to the differences in the duration of light and dark periods in a day.
- Plants put into 3 categories:
  - Short-day, long-day, and day-neutral

Regents Biology

Photoperiodism has an effect on pollination

- Wildflowers bloom in late spring and early summer because bees and butterflies are numerous and most active.
- This almost ensures pollination.

Regents Biology

Seed Plant Structure

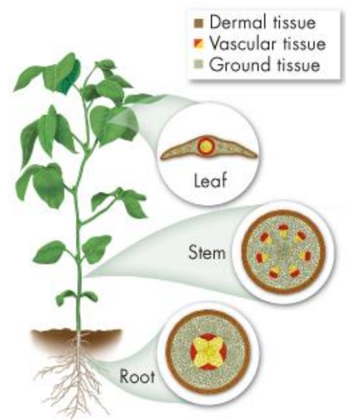
- What are the three principal organs of seed plants?
- The three principal organs of seed plants are roots, stems, and leaves.

Regents Biology

Seed Plant Structure

❑ The three principal organs of seed plants are:
- roots,
- stems, and
- Leaves

The organs are linked together by tissue systems that produce, store, and transport nutrients, and provide physical support and protection.



Roots

- Roots anchor plants in the ground, holding soil in place and preventing erosion.
- Root systems absorb water and dissolved nutrients.
- Roots transport these materials to the rest of the plant, store food, and hold plants upright against forces such as wind and rain.

Stems

Plant stems:

- provide a support system for the plant body,
- a transport system that carries nutrients, a defensive system that protects the plant against predators and disease.
- produce leaves and reproductive organs such as flowers.
- The stem's transport system lifts water from the roots up to the leaves and carries the products of photosynthesis from the leaves back down to the roots.

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Leaves

- Leaves are the plant's main photosynthetic organs.
- Leaves also expose tissue to the dryness of the air and, therefore, have adjustable pores that help conserve water while letting oxygen and carbon dioxide enter and exit the leaf.

Regents Biology

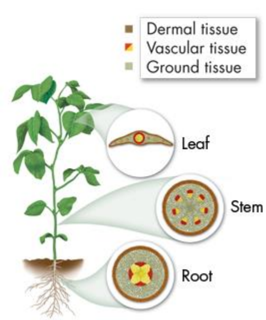
Plant Tissue Systems

- What are the primary functions of the main tissue systems of seed plants?
- Dermal tissue is the protective outer covering of a plant.
- Vascular tissue supports the plant body and transports water and nutrients throughout the plant.
- Ground tissue produces and stores sugars, and contributes to physical support of the plant.

Regents Biology

Plant Tissue Systems

- Plants have three main tissue systems:
  - dermal,
  - vascular, and
  - ground.



These cross sections of the principal organs of seed plants show that all three organs contain dermal tissue, vascular tissue, and ground tissue.

Regents Biology

Dermal Tissue

- Dermal tissue is the protective outer covering of a plant.
- Dermal tissue in young plants consists of a single layer of cells, called the **epidermis**.
- The outer surfaces of epidermal cells are often covered with a thick waxy layer called the **cuticle**, which protects against water loss. In older plants, dermal tissue may be many cell layers deep and may be covered with bark.
- Some epidermal cells have tiny projections known as trichomes that help protect the leaf and may give the leaf a fuzzy appearance.
- In roots, dermal tissue includes root hair cells that help absorb water.

Regents Biology

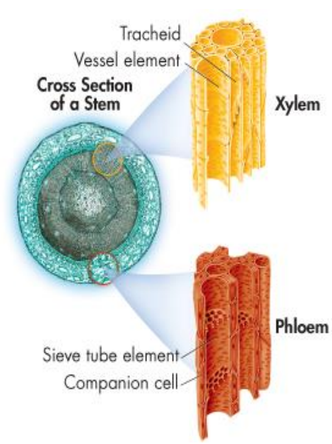
Vascular Tissue

Vascular tissue supports the plant body and transports water and nutrients throughout the plant.

The two kinds of vascular tissue are:

- xylem, a water-conducting tissue, and
- phloem, a tissue that carries dissolved food.

Both xylem and phloem consist of long, slender cells that connect almost like sections of pipe



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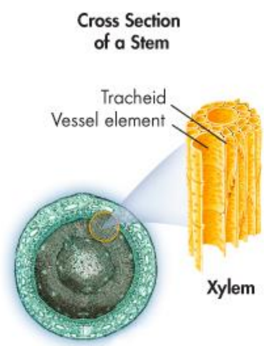
Xylem: Tracheids

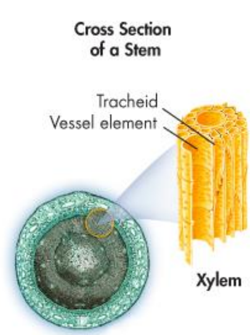
- All seed plants have xylem cells called tracheids.
- As they mature, tracheids die, leaving only their cell walls. These cell walls contain **lignin**, a complex molecule that gives wood much of its strength.
- Openings in the walls connect neighboring cells and allow water to flow from cell to cell.
- Thinner regions of the wall, known as pits, allow water to diffuse from tracheids into surrounding ground tissue.



Xylem: Vessel Elements

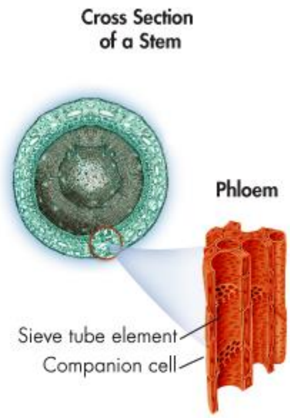
Angiosperms have a second form of xylem tissue known as **vessel elements**, which are wider than tracheids and are arranged end to end on top of one another like a stack of tin cans.

After they mature and die, cell walls at both ends are left with slit-like openings through which water can move freely.



Xylem: Sieve Tube Elements

- Unlike xylem cells, phloem cells are alive at maturity.
- The main phloem cells are **sieve tube elements**, which are arranged end to end, forming sieve tubes. The end walls have many small holes through which nutrients move from cell to cell.
- As sieve tube elements mature, they lose their nuclei and most other organelles. The remaining organelles hug the inside of the cell wall and are kept alive by companion cells.



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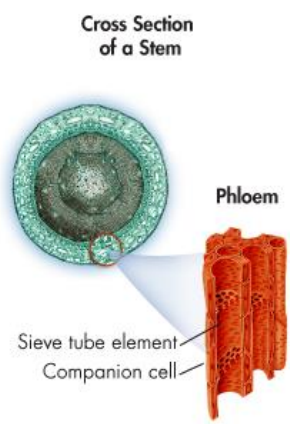
Phloem: Companion Cells

- The cells that surround sieve tube elements are called **companion cells**.
- Companion cells keep their nuclei and other organelles through their lifetime.



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Ground Tissue

Ground tissue produces and stores sugars, and contributes to physical support of the plant. It is neither dermal nor vascular.

Three types of ground tissue, which vary in cell wall thickness, are found in plants:

- parenchyma (thin cell walls),
- collenchyma (thicker cell walls), and
- sclerenchyma (thickest cell walls).

Ground Tissue

Parenchyma cells, the main type of ground tissue, have thin cell walls and a large central vacuole surrounded by a thin layer of cytoplasm. In leaves, these cells contain many chloroplasts and are the site of most of a plant's photosynthesis.

Collenchyma cells have strong, flexible cell walls that help support plant organs.

Sclerenchyma cells have extremely thick, rigid cell walls that make ground tissue such as seed coats tough and strong.

Plant Growth and Meristems

How do meristems differ from other plant tissues?

Meristems are regions of unspecialized cells in which mitosis produces new cells that are ready for differentiation.

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Plant Growth and Meristems

Even the oldest trees produce new leaves and new reproductive organs every year, almost as if they remained “forever young.”

The secrets of plant growth are found in meristems. **Meristems** are regions of unspecialized cells in which mitosis produces new cells that are ready for differentiation.

Meristems are found in places where plants grow rapidly, such as the tips of stems and roots.

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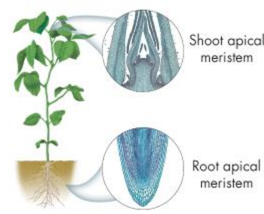
Apical Meristems

Because the tip of a stem or root is known as its apex, meristems in these regions are called **apical meristems**. Unspecialized cells produced in apical meristems divide rapidly as stems and roots increase in length.

The micrographs in the figure show examples of stem and root apical meristems.



Apical Meristems

At first, the new cells that are pushed out of meristems look very much alike: They are unspecialized and have thin cell walls.

Gradually, they develop into mature cells with specialized structures and functions. As the cells differentiate, they produce each of the tissue systems of the plant, including dermal, vascular, and ground tissue.

Meristems and Flower Development

The highly specialized cells found in cones and flowers are also produced in meristems.

Flower or cone development begins when the pattern of gene expression changes in a stem's apical meristem. These changes transform the apical meristem of a flowering plant into a floral meristem. Floral meristems produce the tissues of flowers, which include the plant's reproductive organs as well as the colorful petals that surround them.

Plant Tropisms

***All living organisms are sensitive to changes in their surroundings*. Plants are sensitive to light, moisture and gravity.**

Types of Tropisms

- Positive Tropism—growth towards the stimulus

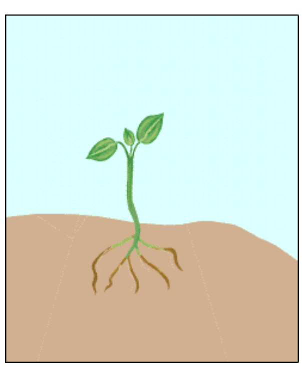
Plant is growing **TOWARDS** the light

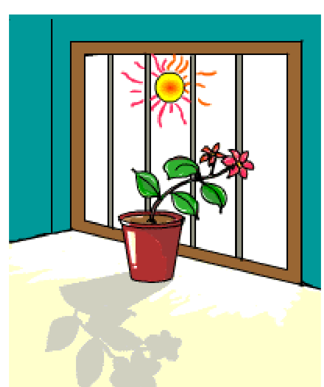
- Negative Tropism—growth away from the stimulus

Stem is growing ***AWAY from*** the center of the Earth (against gravity)

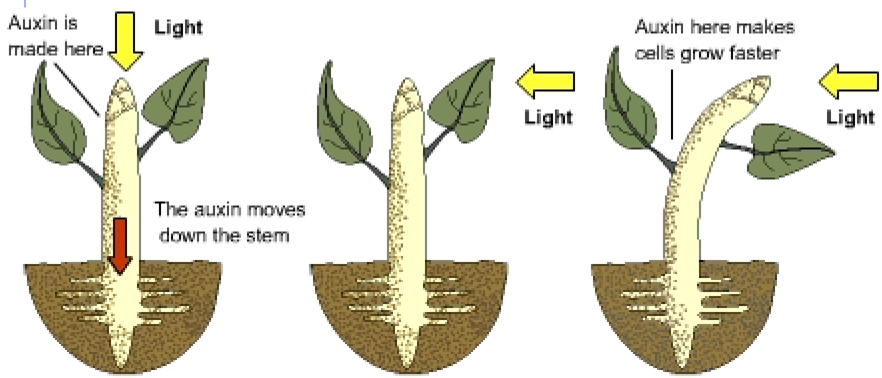
Phototropism

- Phototropism: the growth of a plant in response to **LIGHT**





How does Phototropism work?



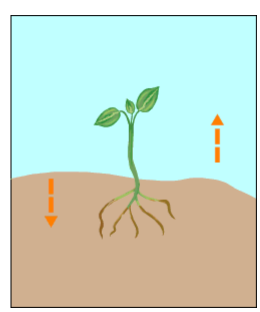
Auxin diffuses down the shoot stimulating growth.

If one side of the shoot is in the light, auxin diffuses away from the light.

The side of the shoot in the shade has more auxin, so grows faster, causing the shoot to bend towards the light.

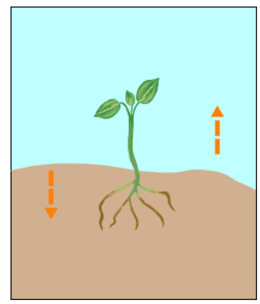
Geotropism or Gravitropism

Geotropism: (also called gravitropism) the growth of a plant in response to gravity



Positive and Negative

- **Negative Geotropism:** Plant stems growing upward **away** from the center of the Earth.
- **Positive Geotropism:** Downward growth of plant roots (**towards** the center of the Earth).



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What direction do you think the roots are growing?

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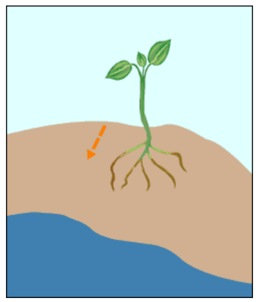
Hydrotropism

Hydrotropism: the growth of a plant in response to moisture



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Thigmotropism

Thigmotropism: the growth of a plant in response to touch or physical contact

(a) Unstimulated state (b) Stimulated state

Regents

Tropism Video Clips

- Time lapse fast growing corn, roots and leaves growing
  http://www.youtube.com/watch?v=iFCdAgeMGOA&feature=related
- Plant Physiology: Phototropic Response
  http://www.youtube.com/watch?v=zctM_TWg5Ik&feature=BF&playnext=1&list=QL&index=1

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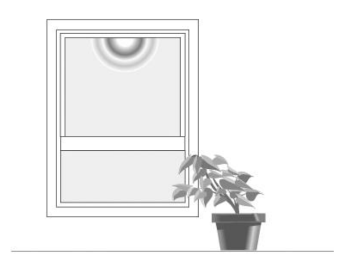
TROPISMS POP QUIZ!

1. What is the external stimulus that is responsible for the response of the plant shown in this illustration?

A) Gravity
B) fresh air
C) lack of water
D) sunlight



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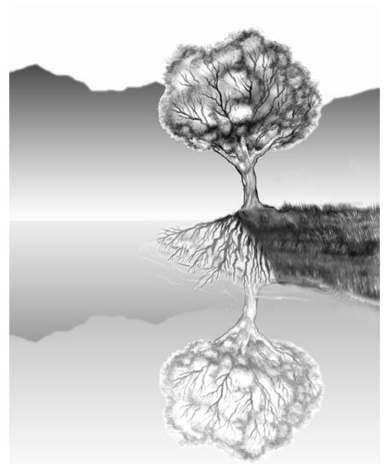
2. What are the two external stimuli shown in this illustration to which the roots are responding?

A) light and water
B) gravity and light
C) water and gravity
D) soil temperature and gravity



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3. Which tropism is best illustrated?

A) Geotropism
B) Hydrotropism
C) Phototropism

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4. Which tropism is best illustrated?

A) Geotropism
B) Hydrotropism
C) Phototropism

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5. Which tropism is best illustrated?

A) Geotropism
B) Hydrotropism
C) Phototropism

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Any Questions??