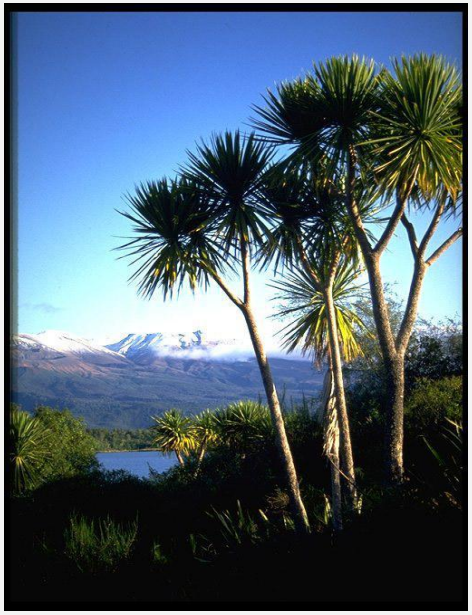
Plants

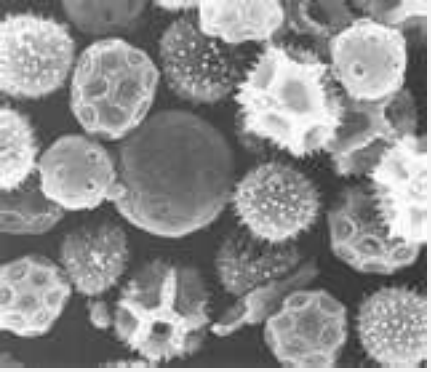
Yes, they are
LIVING!!

What is a Plant?

All plants are:

- Photosynthetic.
- Multicellular.
- Eukaryotic.
- Most plants can reproduce sexually.
- All plants have cellulose in their cell walls.





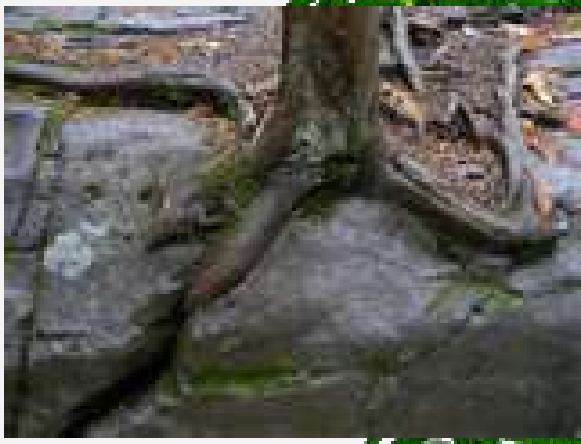
Plant History

Before living on land, plants needed to do 3 things:

1. Absorb nutrients from their surroundings using what organ? (what came first the organ or absorption of nutrients)
2. Conserve water with their

   Cuticle (waxy covering)
3. Achieve fertilization without water.

   (pollen and spores)



What Plants Need To Survive

- Sunlight
- Water & Minerals
- Gas Exchange – O_2 & CO_2
- Movement of water & nutrients – roots & leaves

Origins of Plants

- Evolved from photosynthetic algae and photosynthetic plant-like bacteria
- All Plants are multi-cellular & perform photosynthesis
- Green algae have the size, color, & appearance of plants but they are protists

Four Types of Plants

The Plant Kingdom

Kingdom Plantae

Non-Vascular Plants

Bryophytes

Liverworts

Marchantiophyta

Hornworts

Anthocerotophyta

Mosses

Bryophyta

Vascular Plants

Tracheophytes

Spore-Producing Plants

Pteridophyte

Club Mosses

Lycopodiophyta

Horsetails

Equisetophyta

Ferns

Pteridophyta

Seed-Producing Plants

Spermatophytes

Non-Flowering Plants

Gymnosperms

Conifers

Pinophyta

Cycads

Cycadophyta

Ginkgo

Ginkgophyta

Flowering Plants

Angiosperms

Plants with One Seed Leaf

Monocotyledon (Monocots)

Plants with Two Seed Leaves

Dicotyledon (Dicots)

1. NONVASCULAR PLANTS/ Bryophytes

- Lack true roots, stems and leaves.
- Small in size (usually < 3 cm tall).
- Nutrients and water transported by osmosis and diffusion.
- Require water for sexual reproduction.
- **Rhizoids** - hair-like projections that anchor the plant to growing surfaces.

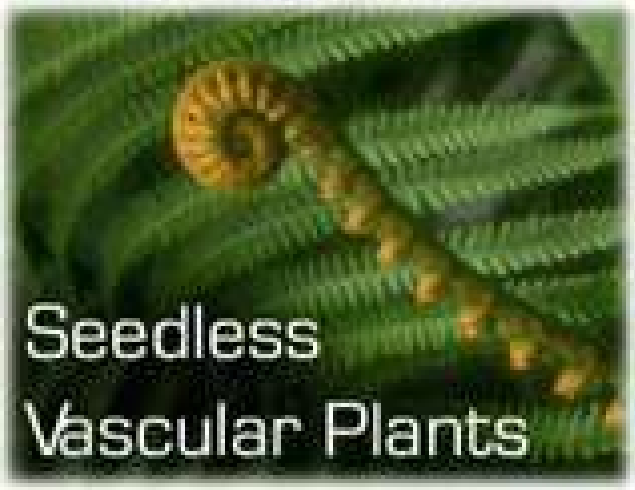
1. NONVASCULAR PLANTS

- ***Examples***:

  Mosses, **Liverworts**, and Hornworts

2. VASCULAR, SEEDLESS PLANTS

- Have both a xylem and phloem.
- Can grow to large sizes.
- Produce spores (not seeds).
- Have true roots, stems and leaves.
- Ex's: ferns, club mosses, horse tails and whisk ferns



Vascular, SEED Plants

- These are currently the most complex organisms of the plant kingdom.

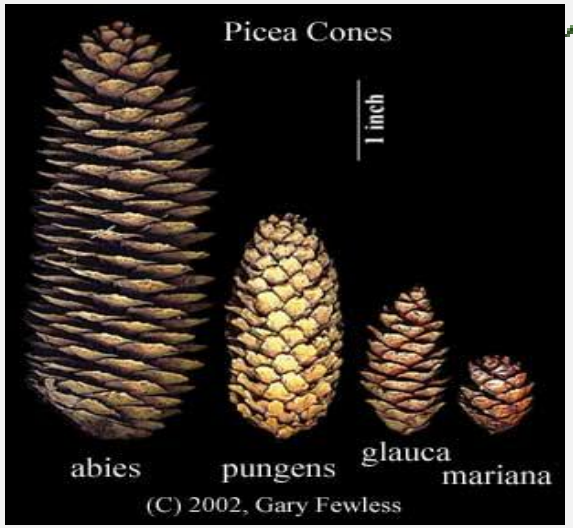
- Can be separated into <u>two subtypes</u>:

i. Gymnosperms

ii. Angiosperms

3. GYMNOSPERMS

- "Naked Seeds"
- Plants whose seeds do not develop within a sealed container (fruit).
- Cones/Pollen
  - Male and female cones
  - Wind pollination
  - Water pollination
  - Animal pollination



3. GYMNOSPERMS

Examples:

i. Conifers (redwood, pine, spruce, etc.)
ii. Cycads
iii. Ginkgo
iv. Gnetophytes

4. ANGIOSPERMS

- Flowering Plants…"Seed Cases"
  - Have a protective seed coat that others do not have (advantage over gymnosperms)
  - Seed coat- protects the seed from drying out
- Plants which produce seeds that develop while enclosed within a specialized structure (fruit).
- Most successful of all the plant groups.
- Flowers promote pollination and fertilization.

Angiosperm Parts

a. **Flowers** - reproductive structures that produce pollen and seeds.

b. **Fruits** - structure in which seeds of angiosperms develop and are used for seed dispersal.

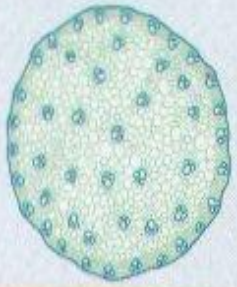
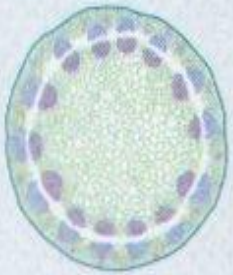
c. **Endosperm** - supply of stored food inside of seeds.

Angiosperm Types

Angiosperms can be divided into **two** sub-categories of plants as well:

i. Monocots

ii. Dicots

	Seed leaves	Veins in leaves	Vascular bundles in stems	Flower parts
Monocots	one cotyledon 	usually parallel 	scattered 	multiples of threes 
Dicots	two cotyledons 	usually netlike 	arranged in ring 	multiples of fours and fives 

Angiosperm Types

Monocots - flowering plants that produce seeds with one seed leaf (cotyledon).

- Usually produce flower parts in multiples of three and have long narrow leaves with parallel veins.
- Examples:

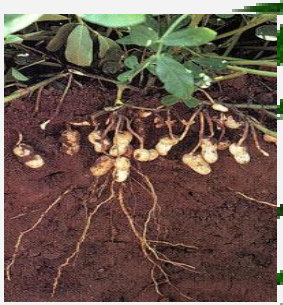
Irises, Tulips, Wheat, Corn, Rice, Grass

Angiosperm Types

Dicots - flowering plants that produce seeds with two seed leaves (cotyledons).

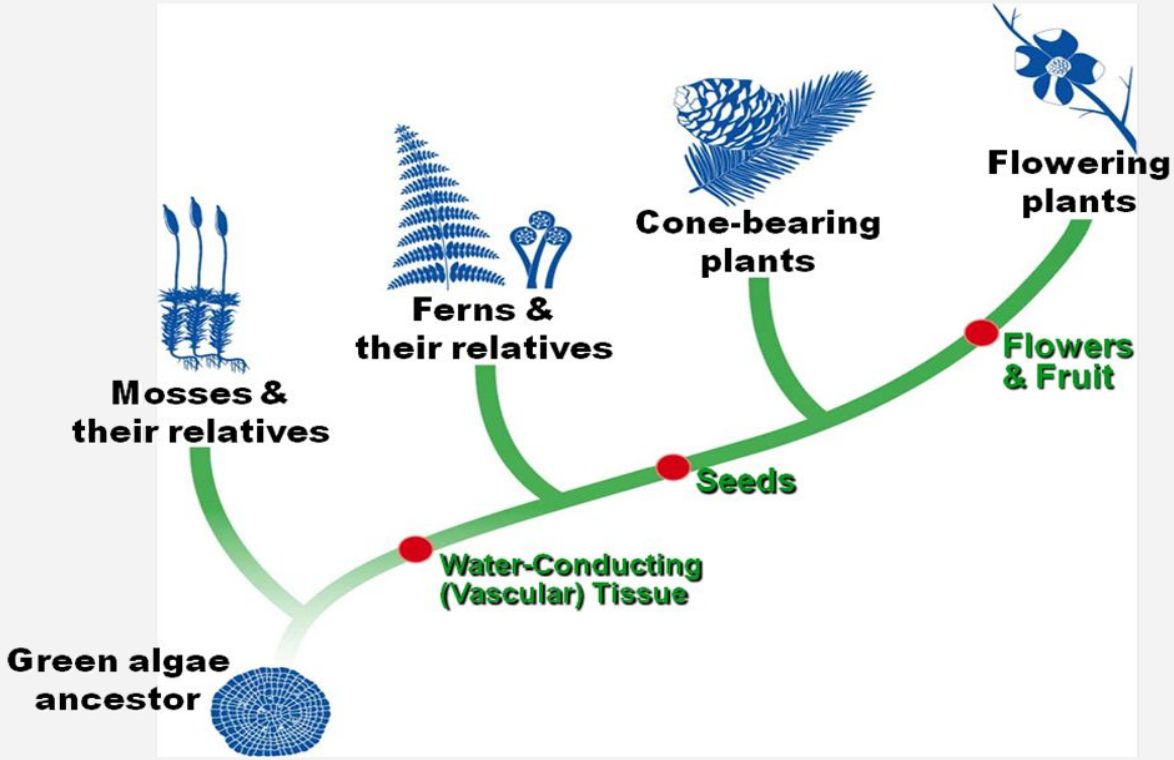
- Usually produce flower parts in twos, fours, or fives and have branching or netted veins.
- Examples:

Daises, Sunflowers, Lettuce, Beans, Peas, Apples, Roses, Tomatoes, Peanuts



Plant Evolution

- Importance of Plants: Without plants animals could not survive on land!!!



Plant Systems & Organization

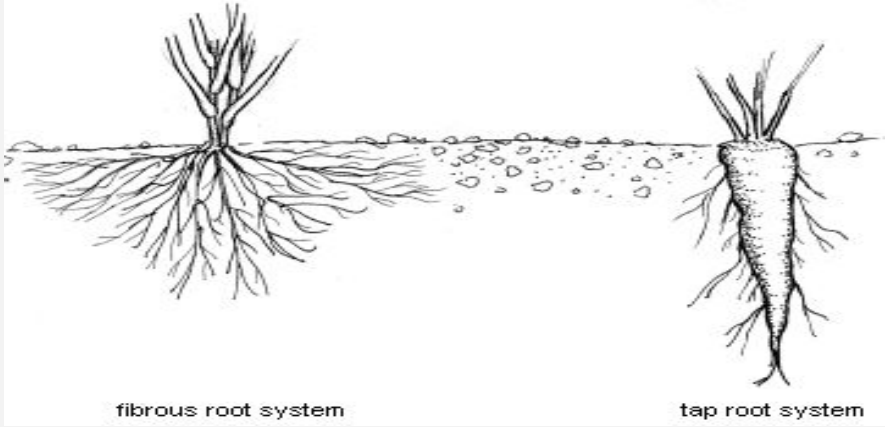
Seeded Plant Organization

- Organized into:
  - Tissues: Involved in transport of nutrients
    - Vascular- xylem & phloem
    - Dermal- cuticle wax, stomata & guard cells
    - Ground- Carbohydrate storage
  - Organs: Photosynthesis & transport of nutrients
    - Stems- conduct water & nutrients
    - Roots- take in water & nutrients
    - Leaves- photosynthesis
  - Systems:
    - Reproductive
    - Transport
    - Photosynthetic

Roots, Stems, & Leaves

Roots

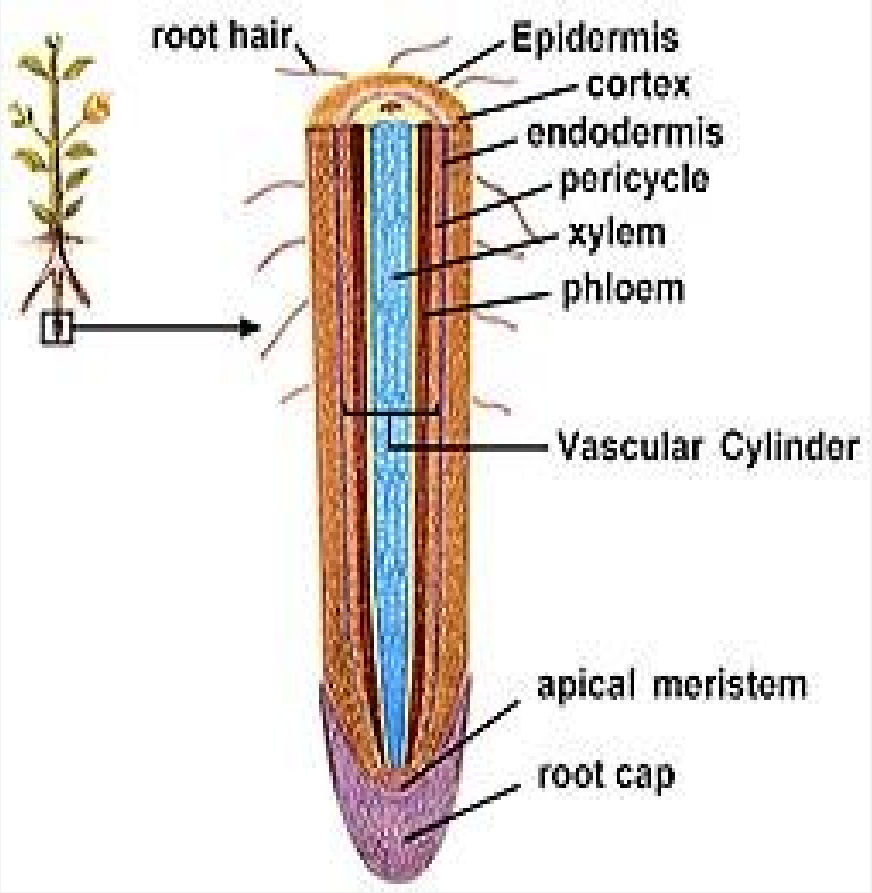
- **Tap root:** found mainly in dicots
  - grows long & thick while secondary (lateral) roots remain small
- **Fibrous root:** found mainly in monocots
  - branch to such an extent that no single root grows larger than the rest
  - adapted to absorb water that is close to the ground's surface



Roots

- Parts of a root cell: cell wall, nucleus, vacuole (**no chloroplasts)**
- **Absorbs water & dissolved nutrients/minerals**
- Root **hairs** (dermal tissue): use active transport to bring in nutrients from the soil & **osmosis** causes water to follow the minerals; increase the surface area available for water absorption
- Casparian Strip: specialized cells that work like a one way valve
  - ensure water and minerals do not exit once they have entered the plant roots
- Anchor plants in the ground, holding soil in place & preventing erosion
- 2 main types of roots:
  - **Tap** roots and Fibrous roots

Roots

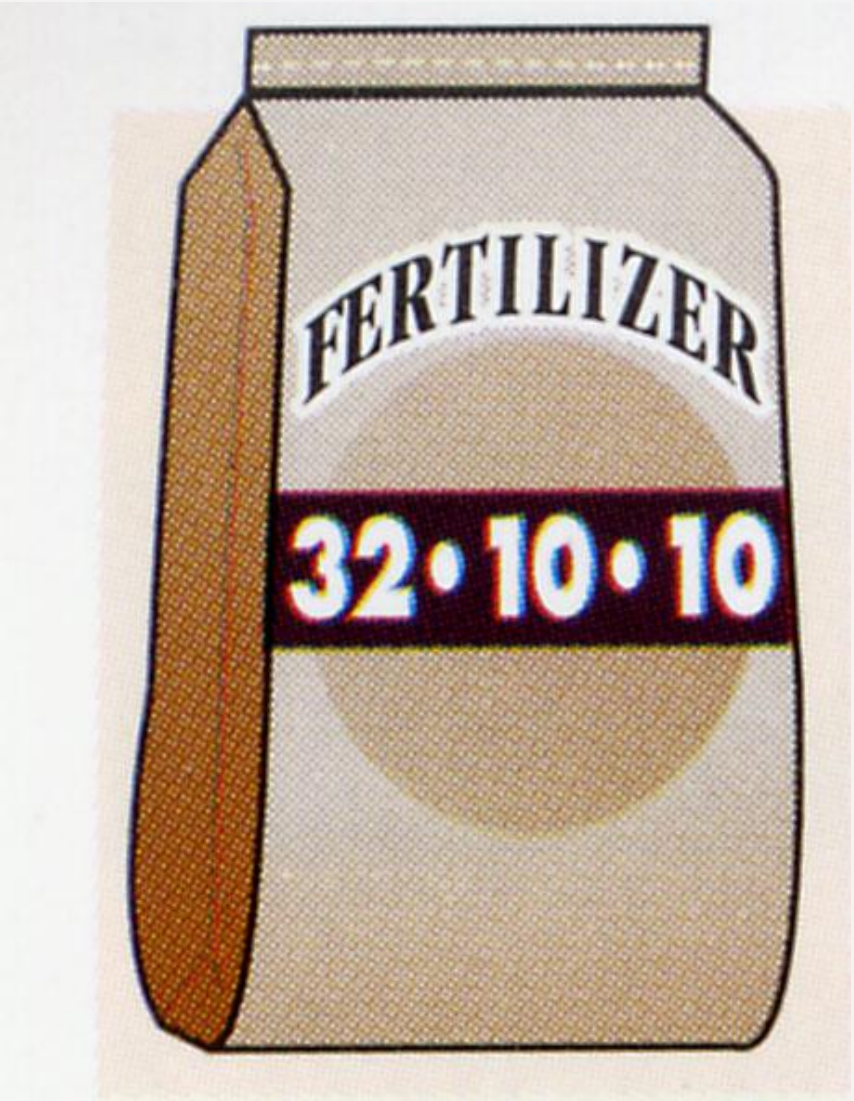


Root Structure

- Outside layer
- Epidermis
  - Root hairs
  - Cortex
- Central cylinder – vascular system
- Root Cap – cellular production
- Key role in water/mineral transport

R

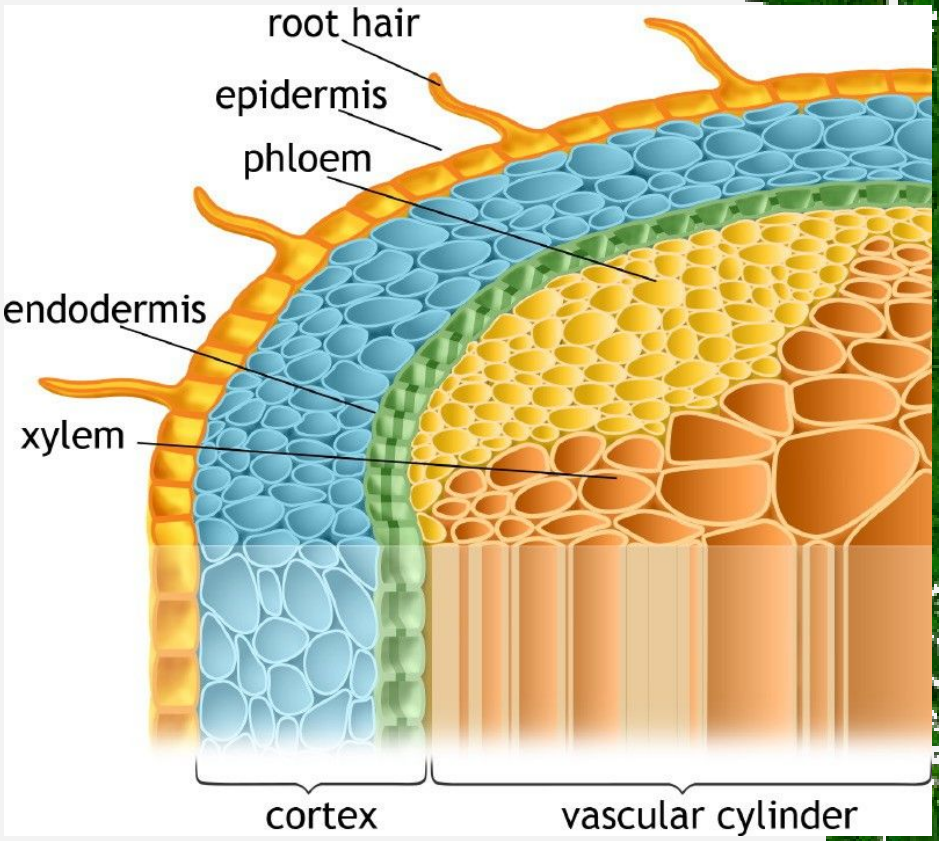
Roots



- Plant Nutrient Uptake
  - Soil type determines plant type
- Plant requirements
  - Oxygen, CO_2
  - Nitrogen
  - Phosphorus
  - Potassium
  - Magnesium
  - Calcium
  - Trace elements

Roots

- Active Transport in Plants
  - Root hairs use ATP
    - Pump minerals from soil
    - Causes water molecules to follow by osmosis
- Vascular Cylinder
  - Casparian Strip – water retention
- Root Pressure
  - Forces water up into the plant

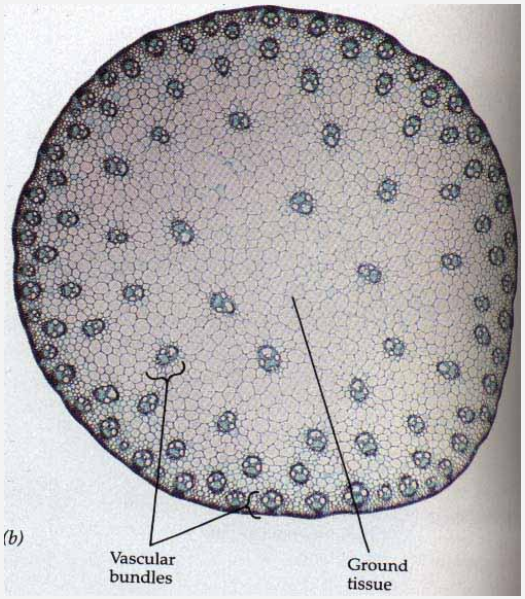


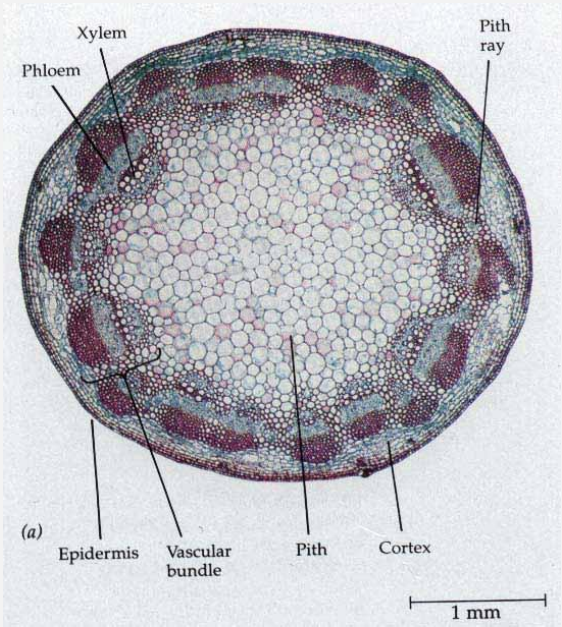
Specialized Tissues in Plants

Functions of the Roots

- Absorbs water and nutrients
- Anchor plant to the ground
- Hold soil in place and prevent erosion
- Protect from soil bacteria
- Transport water and nutrients
- Provide upright support

Stems





Stem Types

- ***Monocot*** – vascular bundles are scattered throughout
  - Distinct epidermis
- ***Dicot*** – vascular tissue arranged in a cylinder
  - ***Pith*** – parenchyma cells inside the ring

Stem Growth

Primary growth - cambium produces tissue and increases thickness

- Cork cambium – produces outer covering of stems
- new cells produced at the root tips and shoots
- Increases the length

Secondary growth – increase in stem width

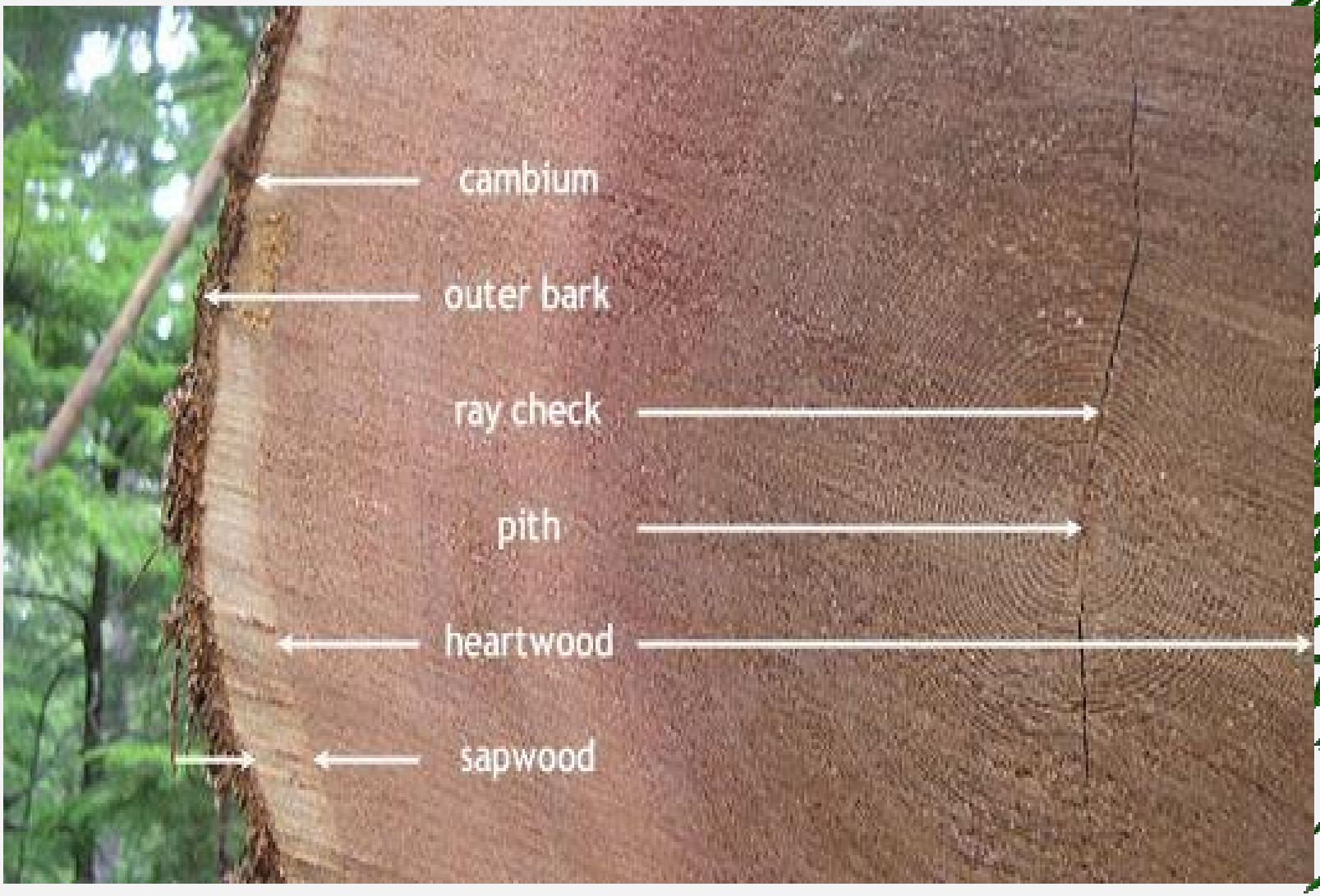
- Vascular

Stems

Formation of wood

- ***Wood* –** layers of xylem
- Produced year after year
- Results from the older xylem not conducting water – ***heartwood***
- Becomes darker with age
- ***Sapwood*** – surrounds heartwood

Layers of Wood



Stems

- Transport system that carries **nutrients**
- Defense system that protects the plant against predators & diseases
- Have 3 important functions - **produce leaves, branches, & flowers**
- Hold leaves up to the sunlight; transport substances between roots & leaves
- Stem contains vascular bundles (veins) that each contain xylem & phloem tissue

Vascular Tissue

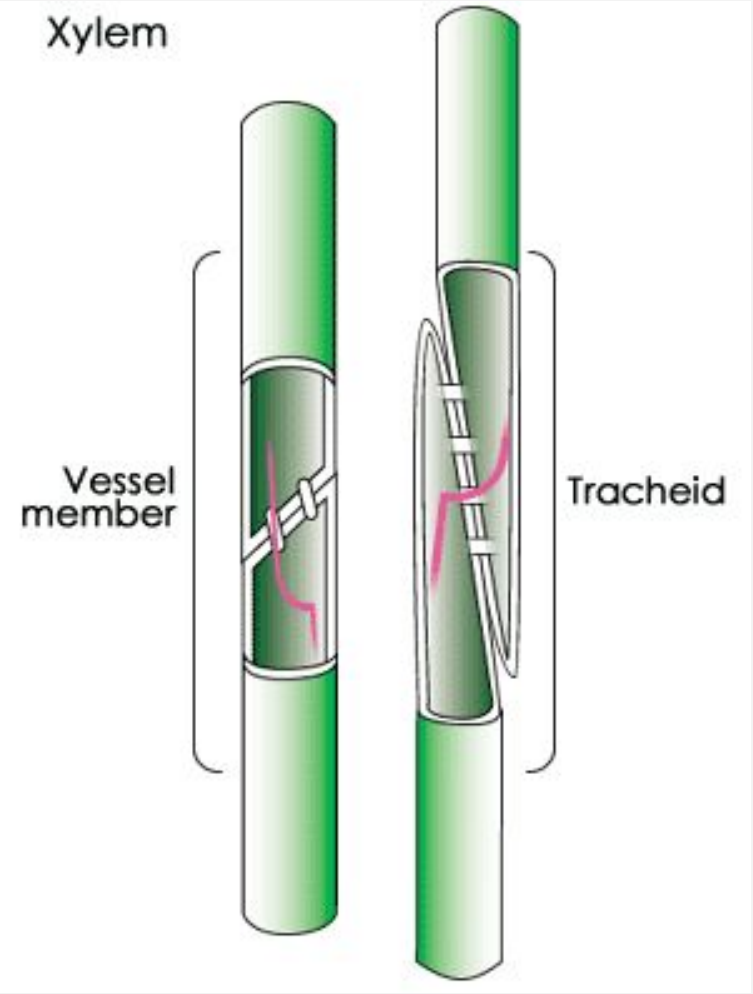
- **Transport** system (transports water and nutrients) in plants; internal system of interconnected **tubes** and **vessels**

- **2 types: Xylem and Phloem**

- **Xylem** **–** carries **water & minerals** ***upwards***
-
- **Phloem** – carries **sugars** produced by photosynthesis *down* from the leaves & nutrients are carried up to be used in photosynthesis

- Xylem and phloem ***differ in direction*** in which they transport materials

Specialized Tissues in Plants



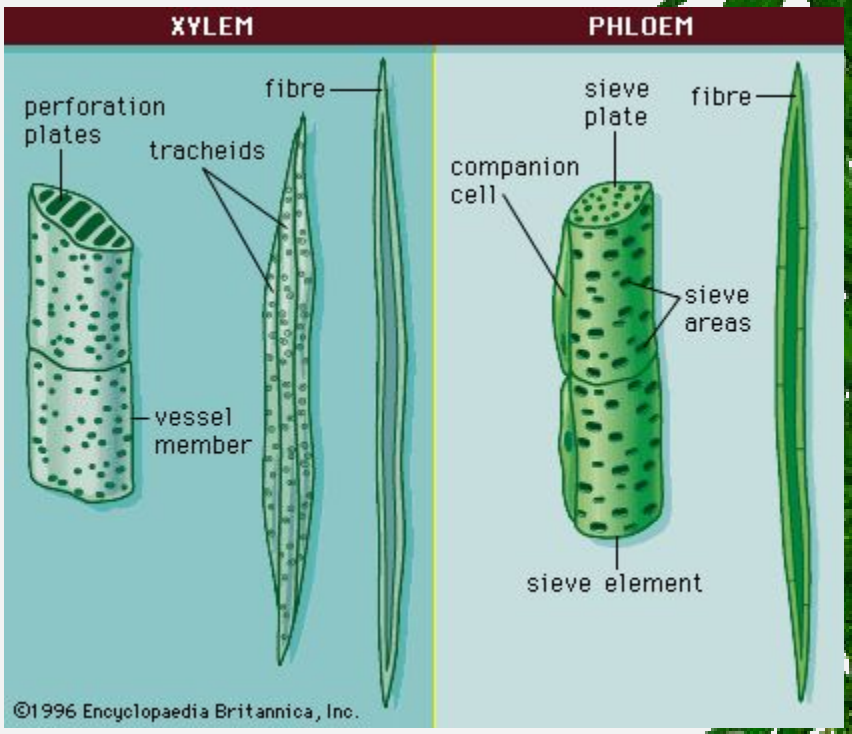
Xylem

- Two types
  - Seed plants
  - Angiosperms
- ***Tracheid*** – long narrow cells
- Walls are connected to neighboring cells
- Will eventually die
- ***Vessel Element*** – wider than tracheids

Specialized Tissues in Plants

Phloem

- ***Sieve Tube Elements***
  - Cells arranged end to end
  - Pump sugars and other foods
- ***Companion Cells***
  - Surround sieve tube elements
  - Support phloem cells



Stem Growth

- Plants unlike animals and other organisms grow throughout their lifetime
- New cells are produced at the tips of roots & shoots (at the ends), this growth in length is called **primary** growth
- Occurs in apical meristems, special embryonic tissue, where constant cell division takes place
- Occurs in all seed plants

Specialized Tissues in Plants

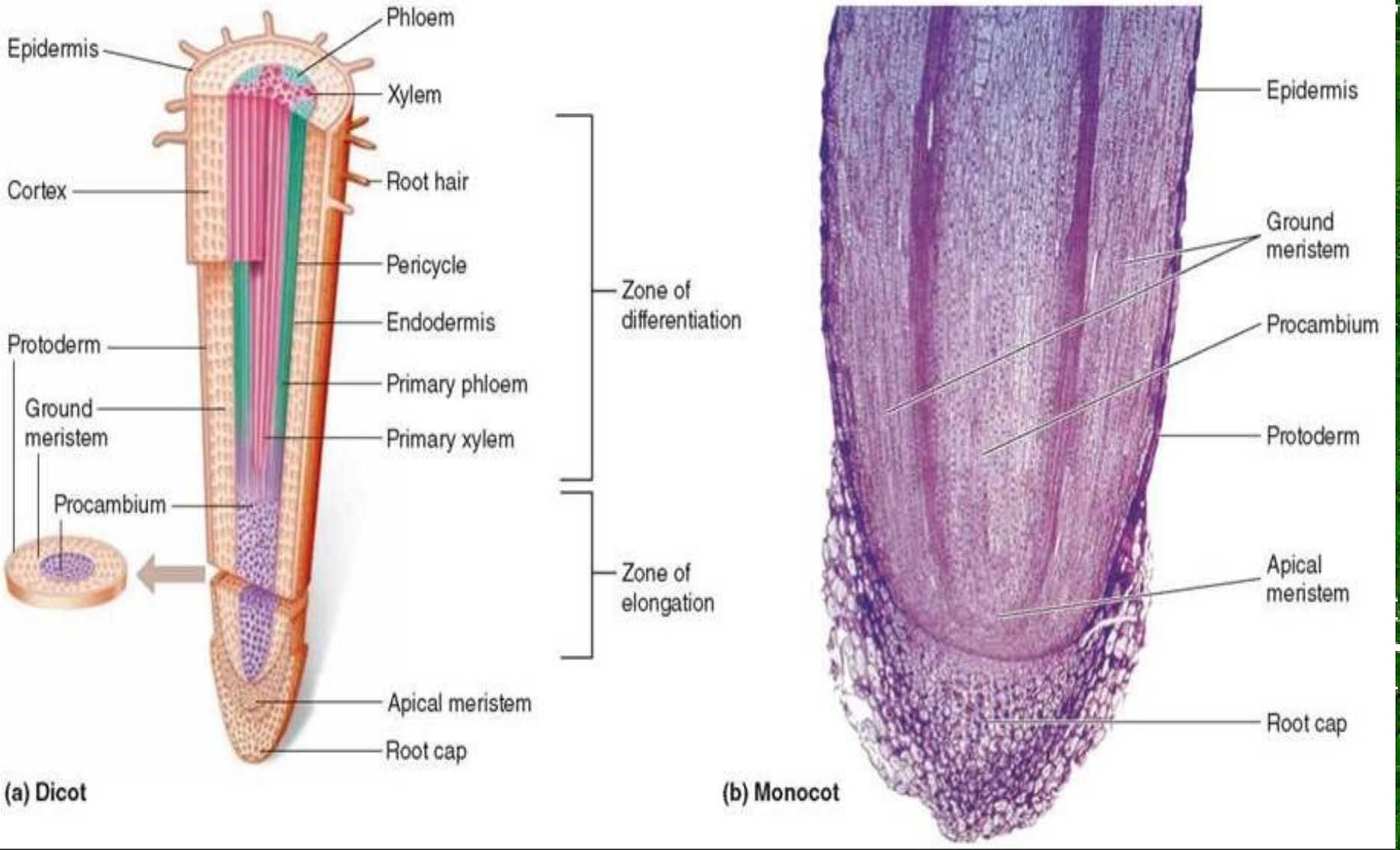
Plant Growth

- ***Meristems***
  - tissues responsible for growth
  - Undifferentiated cells
- ***Apical Meristem***
  - Produce growth increased length
- ***Differentiation***
  - Cells will assume roles in the plant

➢ Flower Development

- Starts in the meristem

Plant Growth



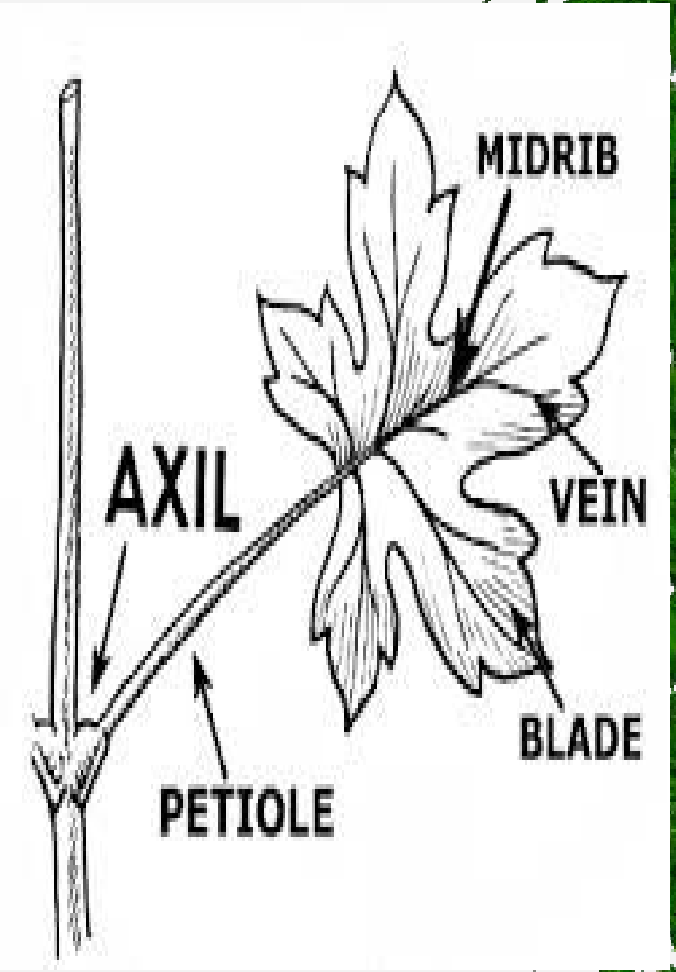
Specialized Tissues in Plants

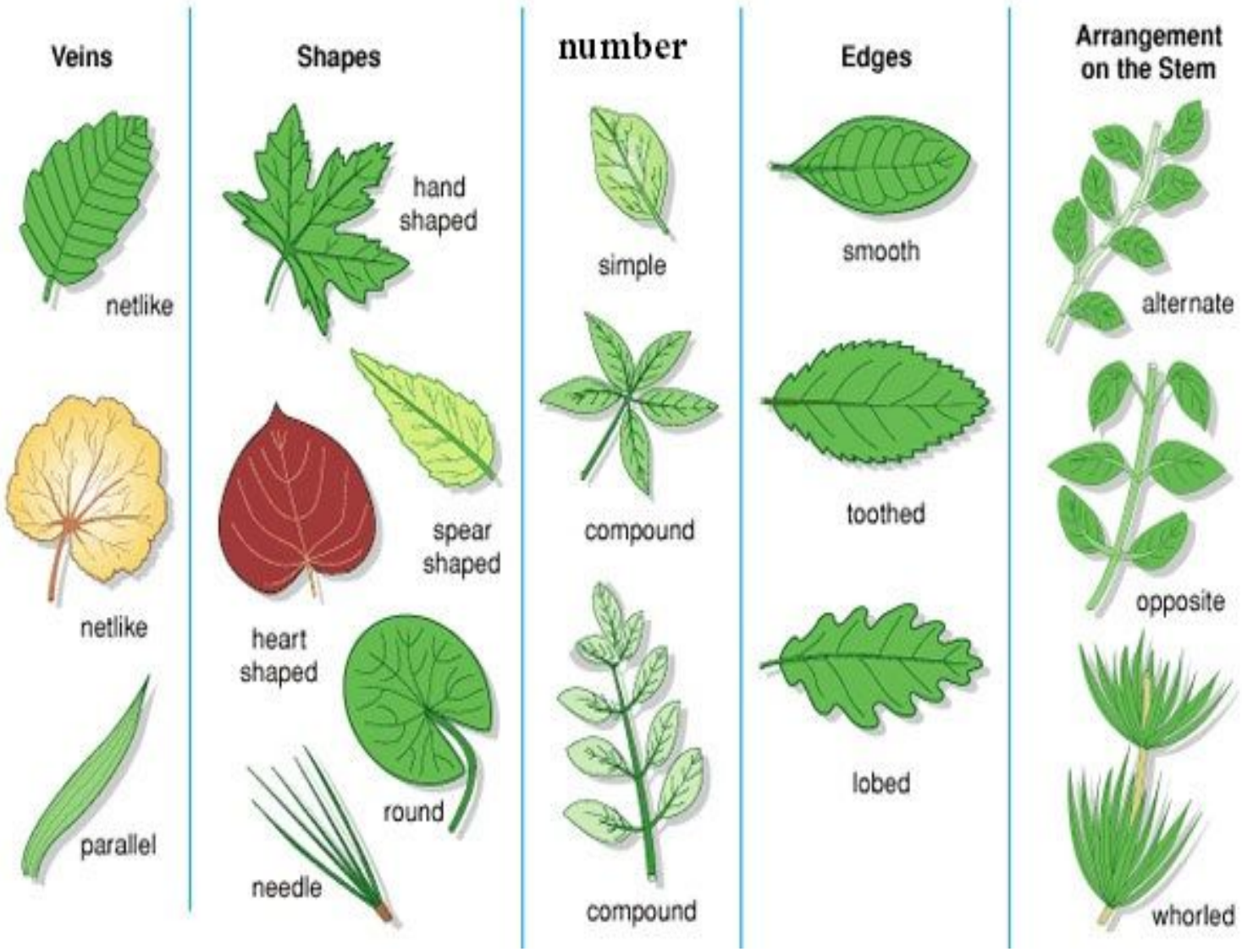
Functions of the Stems

- Support for the plant body
- Carries nutrients throughout plant
- Defense system to protect against predators and infection
- Few millimeters to 100 meters

Leaves

- Plant's main photosynthetic system
- Two parts: blade & petiole
  - Blade: thin flattened section (collects sunlight) - largest part
  - Petiole: structure (thin stalk) that attaches blade to stem (node)




Veins
netlike
netlike
parallel
Shapes
hand shaped
spear shaped
heart shaped
round
needle
number
simple
compound
compound
Edges
smooth
toothed
lobed
Arrangement on the Stem
alternate
opposite
whorled

Specialized Tissues in Plants

Functions of Leaves

- Main photosynthetic systems
- Susceptible to extreme drying
- Sight of oxygen/carbon dioxide intake and release

Specialized Tissues in Plants

- Dermal Tissue
  - Outer covering
  - Single layer of cells
  - ***Cuticle*** – waxy coating
    - ***Trichomes*** – Spiny projections on the leaf
  - Roots have dermal tissue
    - Root hairs
  - ***Guard Cells***

Leaves-Functions

Photosynthesis – occurs in the ***mesophyll***

- Palisade mesophyll – absorb light
- Spongy mesophyll – beneath palisade level
- ***Stomata* –** pores in the underside of the leaf
- ***Guard Cells*** – Surround the stomata

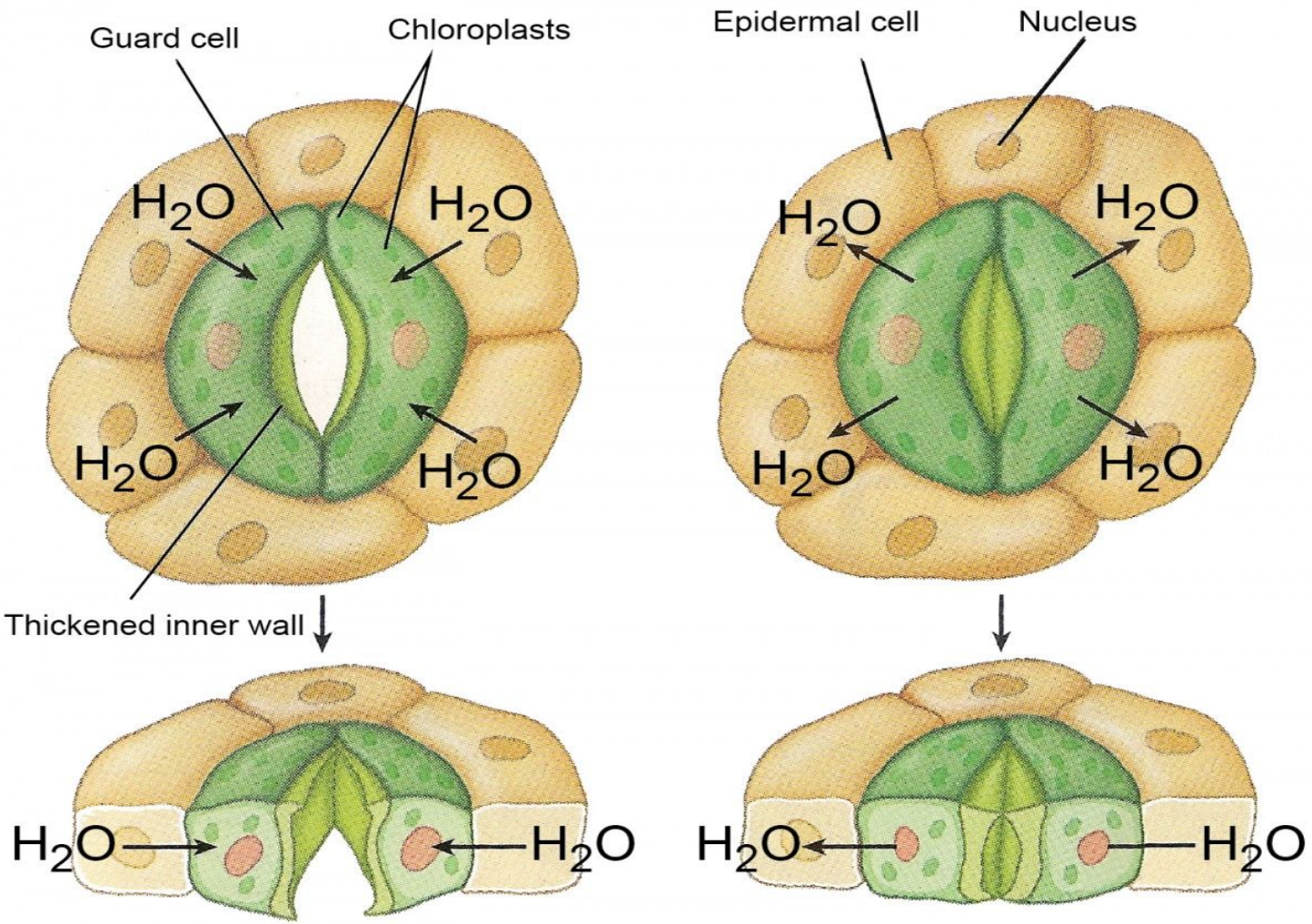
Leaf- Dermal Tissues

Stomata: pore-like openings in the underside of the leaf that allow for **gas exchange**: CO_2 diffuses into & O_2 diffuses out of the leaf

- Fluid exits through evaporation

Guard cells control the opening & closing of stomata

Cuticle: waxy covering that protects leaf & prevents water loss- found in cells on the plant surface


Guard cell
Chloroplasts
H_2O
H_2O
H_2O
H_2O
Thickened inner wall
H_2O
H_2O
Stoma open
Solute potential is high;
water moves into guard cells
Epidermal cell
Nucleus
H_2O
H_2O
H_2O
H_2O
H_2O
H_2O
Stoma closed
Solute potential is low;
water out of guard cells

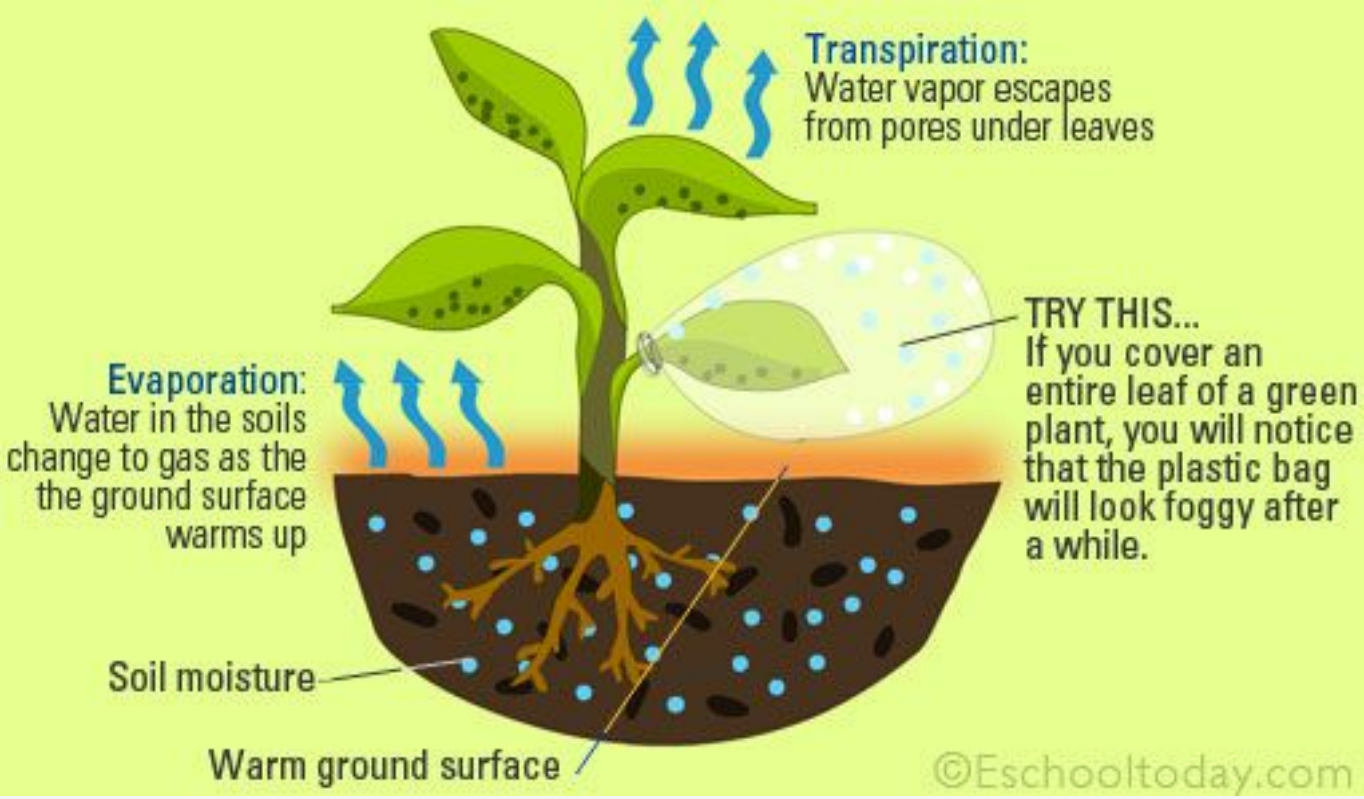
Transport in Plants

Transpiration

- Evaporation is the major moving force
- As water is lost, osmotic pressure moves water out of vascular tissue
- This pulls water up from the stem to the leaves
- Affected by heat, humidity, and wind

Leaves and Transpiration

- **Transpiration**
  - Loss of water through its leaves
  - Replaced by water drawn into the leaf



Transport in Plants

Controlling Transpiration

- Open the stomata – increase water loss
- Close the stomata – decrease water loss

Capillary Transport in Plants

Capillary transport results from both cohesive and adhesive forces

- Water molecules attracted to one another
- Water is also attracted to the xylem tubes in the plant
- Causes water to move from roots to the stem and upward
- Increases as the stem diameter decreases

Specialized Tissue/Cells in Plants

- **Some major types of plant cells:**
  - Parenchyma
  - Collenchyma
  - Sclerenchyma

- Tissues that are neither dermal nor vascular are **ground tissue**
- Ground tissue internal to the vascular tissue is **pith**
- Ground tissue external to the vascular tissue is **cortex**
- Ground tissue includes cells specialized for storage, photosynthesis, and support

Practice

- Based on what you know about the FUNCTION of leaves, why would the leaves at the **bottom of a tree be LARGER** than the leaves found near the top of a tree?

Practice

- Why can photosynthesis be difficult for some plants in the rainforest?

Plant Reproduction

Not just birds and bees do it…

Sexual Reproduction in Seedless Plants

- Fertilization for seedless plants usually occurs during or soon after rain, when the spores are covered with water.
- Only then can the spore/sperm swim to the egg.
- Once together they form a sporophyte, which can then continue its life cycle.

Sexual Reproduction in Seed Plants

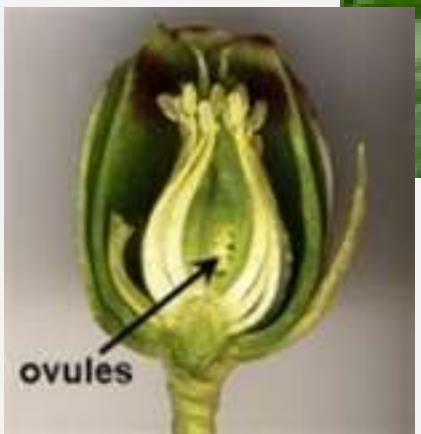
- Gymnosperms & Angiosperms (vascular, seed plants) do not release spores in rain like other plants.
- Benefit…water not needed!

Sexual Reproduction in Seed Plants

Examples of Reproductive Structures:

a) Pollen Grain - male gamete/gametophyte
(wind and animals transport pollen grains)

b) Ovule - female gamete/gametophyte
(remains with the plant)



Reproduction Terms (Seed Plants)

- Pollination - transfer of pollen grains from the male structures to the female structures.

- Seed Coat - the hardened outer cell layers of an ovule that protects the embryo.

Sexual Reproduction in Seed Plants Continued

- Gymnosperms – type of plant where seeds develop within **cones** (pine cones are used for reproduction)

- Angiosperms – type of plant where the seeds develop within **flowers**

Cones

- Benefit: Offer protection
- Drawback: Wind pollination mostly…not a lot of cone eating animals to distribute seeds
- Some species have “berry-like” cones for distribution…juniper & yew

Berry like

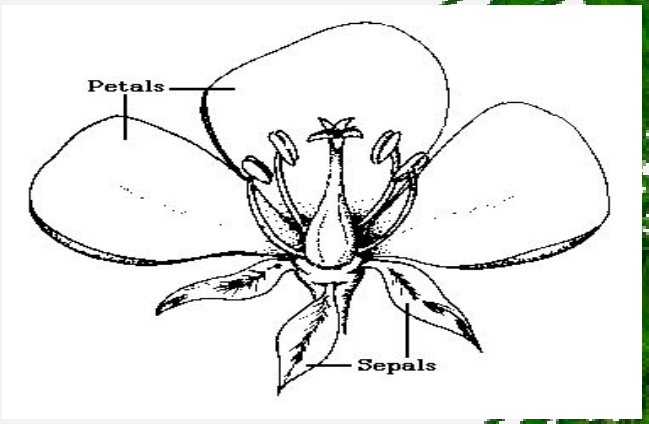
Flowers

- Benefit: Attracting pollinators…more directed “reproduction”
- Pollinators then carry pollen from one flower to another
- Drawback: Not as protective as cones (some flowers are tasty to both animals and people).

Angiosperms - Flowers

Flowers Have Four Whorls (Layers):

1. Sepals – the outermost layer= protection when the flower is a bud.
2. Petals –used to attract the pollinators.



Angiosperm - Flowers

3. Stamens –make pollen, consists of anther and filament

   Anther – pollen-producing sac on top of stamen.

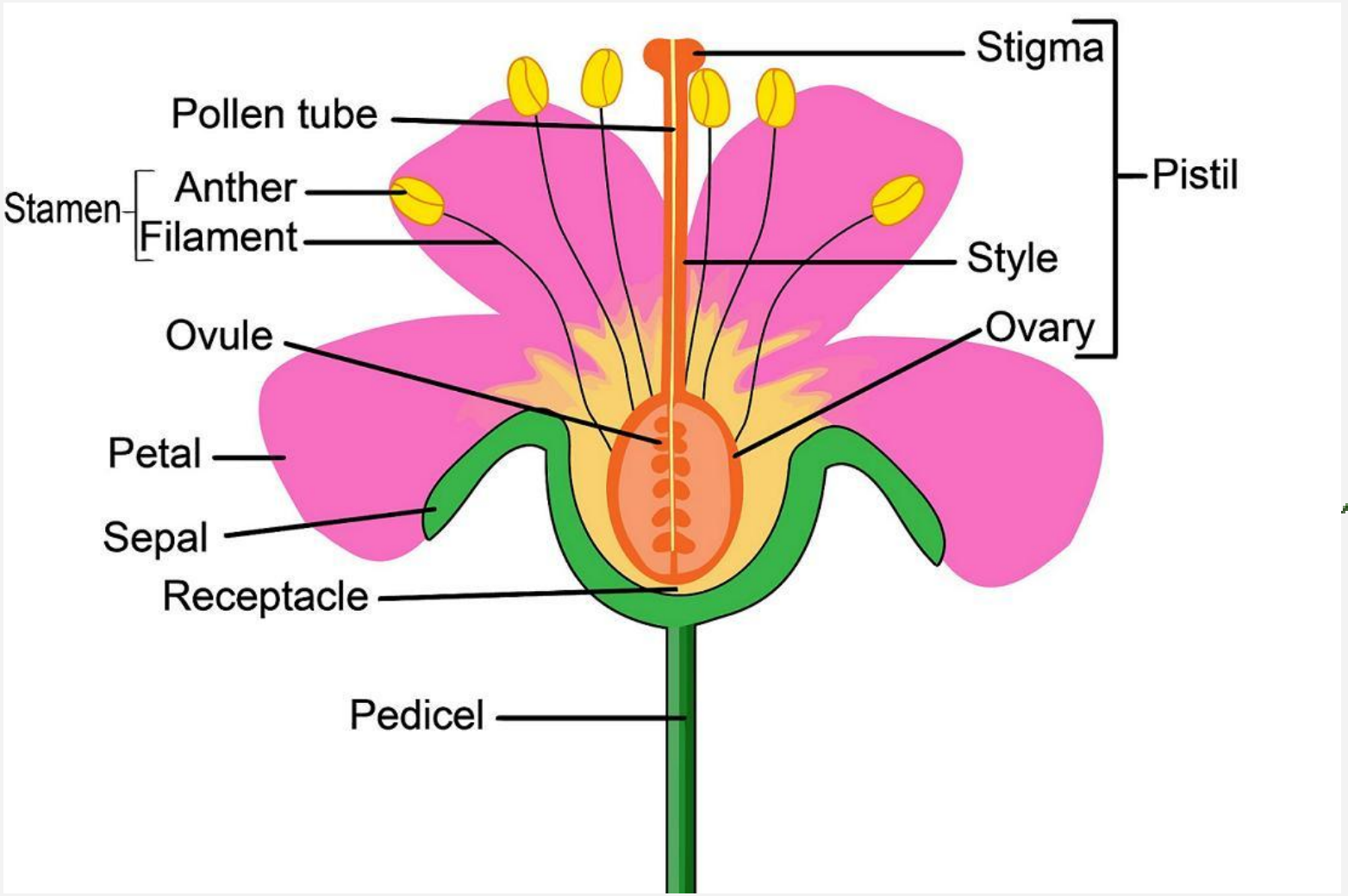
   - Pollen- covers/protects sperm

4. Pistils/Carpel –produces ovules.

   Ovary – the pistil's swollen lower portion is the spot where the ovules develop.

   Style – the stalk that rises from ovary.

   Stigma – the swollen, sticky tip of style- area where pollen lands and sticks


Stigma
Pollen tube
Pistil
Stamen
Anther
Filament
Style
Ovule
Ovary
Petal
Sepal
Receptacle
Pedicel

How flowers attract pollinators

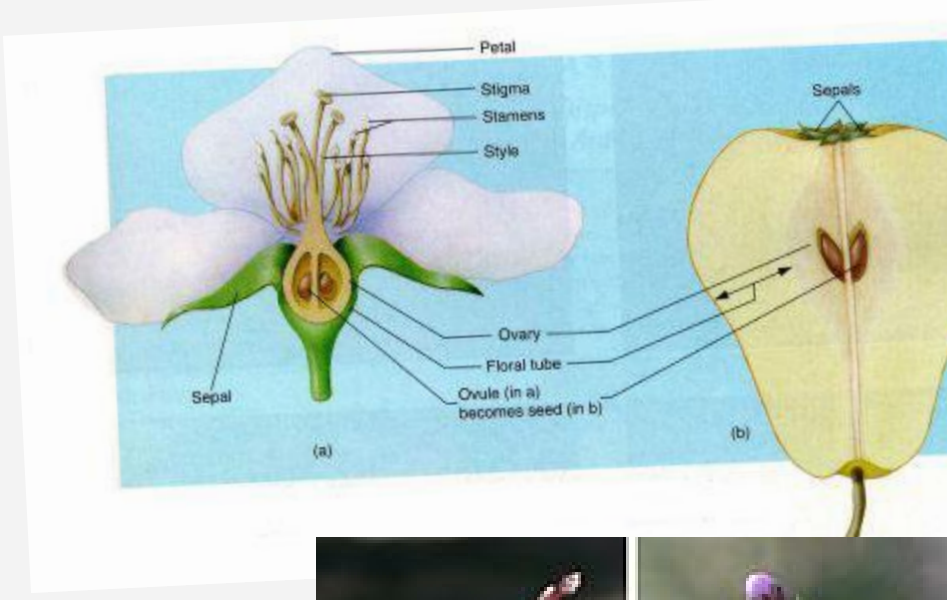
- Color (even white)
- Scent - Some smell sweet (promise of nectar, some smell terrible (flies are attracted to lay their eggs)
- Bribes – nectar
- Lies - hormones and shape may deceive wasps

Examples of Flower Pollinators:

a. Bees
b. Flies
c. Moths
d. Hummingbirds
e. Bats
f. Wind

Fruits

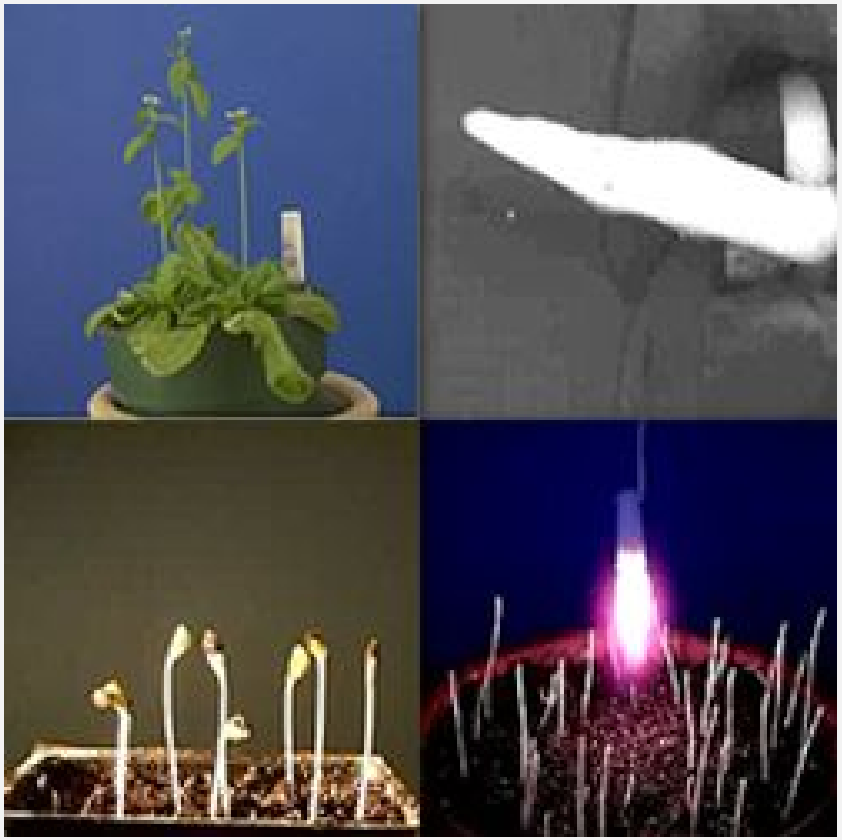
- A fruit is a ripened ovary
- The fruit:
  - protects the seeds
  - allows for distribution/dispersal of the seeds
  - is a source of food for other organisms



Plants & Environmental Influences

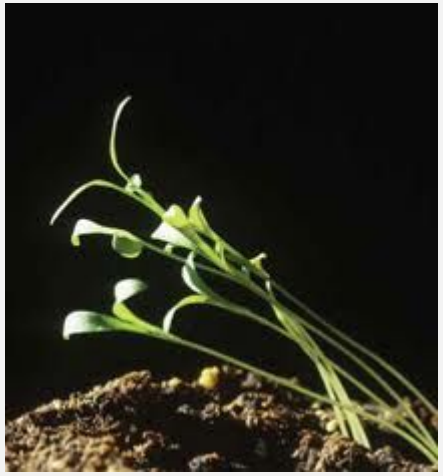
- Tropisms - a response in which a plant grows either toward or away from a stimulus
  - Phototropism - response to light
  - Gravitropism - response to gravity
  - Thigmotropism - response to touch

TROPISM- Plants MOVE



Tropism-
is a biological phenomenon, indicating growth or turning movement a plant in response to an environmental stimulus

Phototropism



- **Movement of plants toward light**
- **Maximizes amount of sun for photosynthesis to make their food.**

Phototropism
http://www.youtube.com/watch?NR=1&v=KQOC_bPrqFs&safety_mode=true&persist_safety_mode=1

Gravitropism

Movement of plants in response to gravity

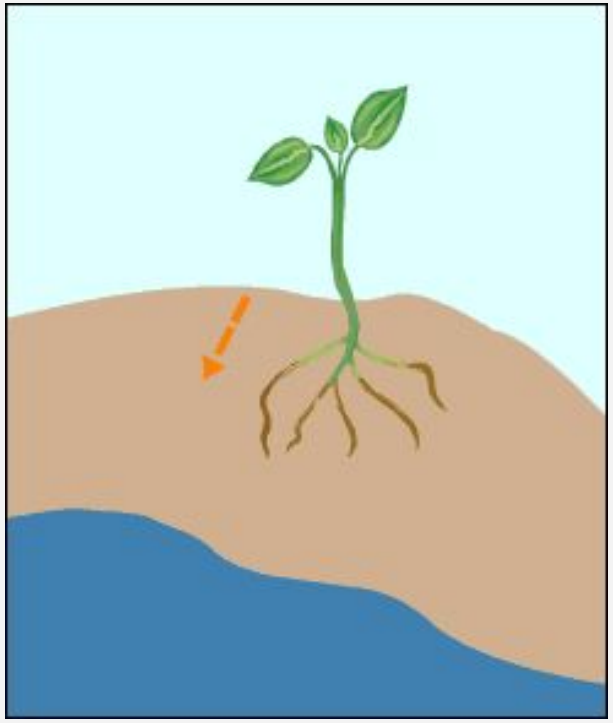
Positive is toward gravity (roots grow down)

Negative is away from gravity (shoot, stems, and leaves grow up)

Why?
Allows plants to grow properly and get nutrients and sunlight

http://www.youtube.com/watch?v=mYZXax8V_L0&feature=related&safety_mode=true&persist_safety_mode=1

Hydrotropism



Movement by plants toward water.

Why?
Roots search for and grow toward water, because it is needed for photosynthesis and to support cell structure.

http://virtualastronaut.tietronix.com/textonly/act25/text-plants.html

Thigmotropism

Plants moving in response to touch.
Positive is toward touch (vines wrap around structures)

Negative is away from touch (some plants close up when touched)

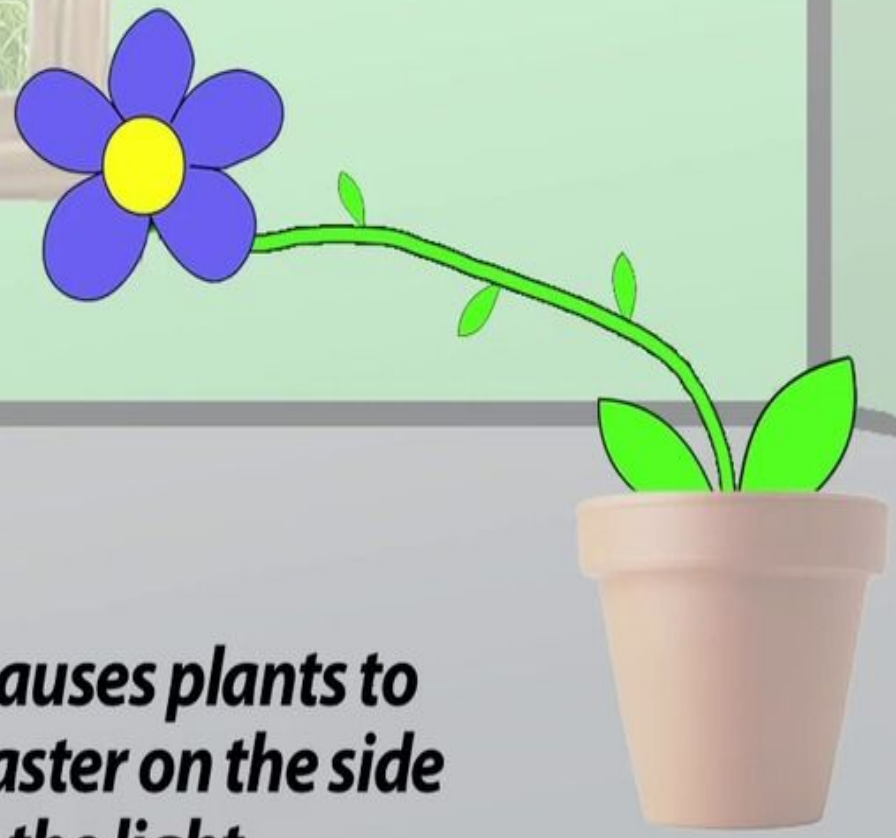
Why?
To support leaves as they grow higher to reach the sun to make more food (photosynthesis).

http://www.youtube.com/watch?v=8HeedWWe6VA&feature=related&safety_mode=true&persist_safety_mode=1

Phototropism

- Response to sunlight- bending of plants toward light sources
  - Maximizes exposure to light, thereby increasing the rate of sugar formation
- Controlled/triggered by hormones called auxins
- *Auxin* accumulates where light is LESS intense and causes elongation (cells with less light grow longer)
- In a stem, this growth pattern causes the stem to bend toward a light source

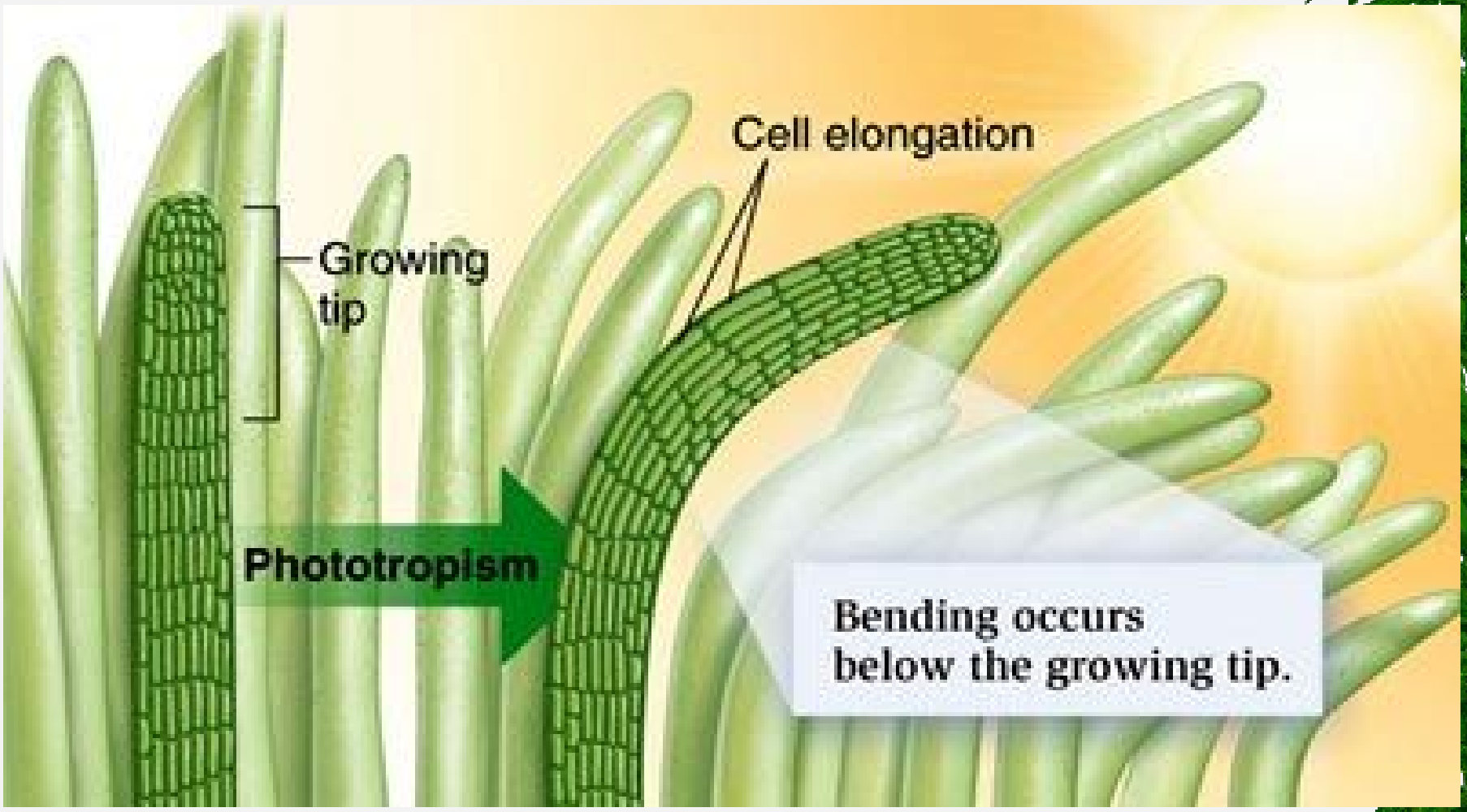
  -Greatest concentration of auxins in area of plant ***<u>further</u>*** away from light



Auxin

the chemical signal that causes plants to elongate and grow cells faster on the side of the plant farthest from the light

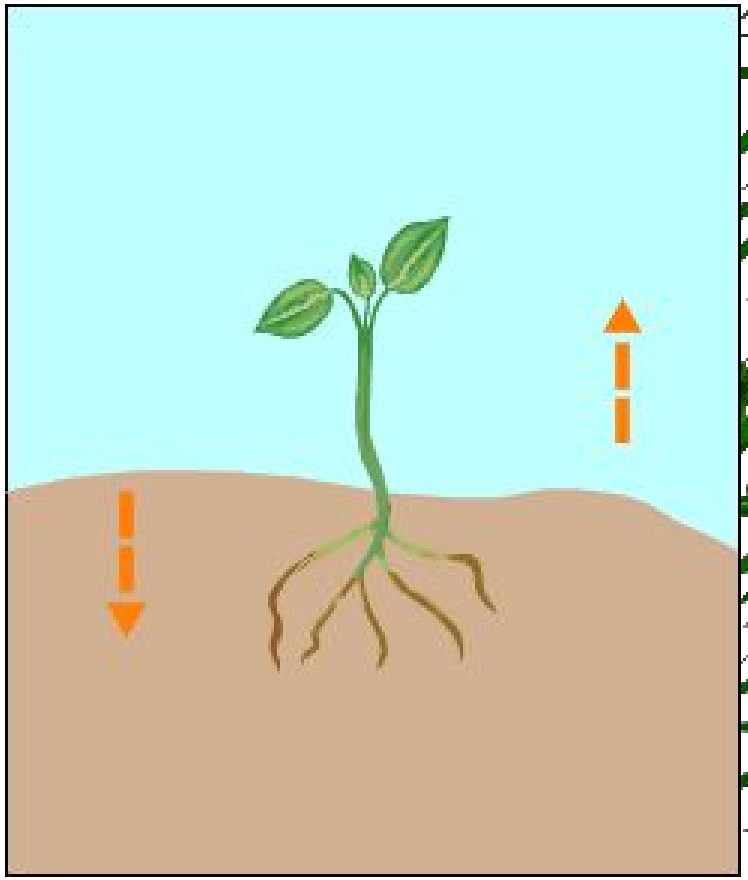
Phototropism



Gravitropism

- Growth in response to gravity
  - Roots= positive gravitropism because they grow in the direction of gravity
  - Stems= negative gravitropism because they grow in the opposite direction of gravity
  - gravitropism ensures that the plant will grow roots into the soil
- Gravity affects the distribution of auxin hormones in a cell
  - If a plant falls over, auxin accumulates in the bottom portion of the plant and the stem responds by growing upwards.

Gravitropism



Thigmotropism

- Growth of a plant in response to touch
- Ex: allows Morning Glory's vines to climb fences
- Ex: In forests, it allows vines to climb towards the light (sun)

Phototropism

Tropisms and Hormones Clip

Phototropism

Gravitropism

Thigmotropism

Nastic Movement

- Response to environmental stimuli but unlike tropic movements, the direction of the response is not dependent on the direction of the stimulus.
- Some of the most spectacular plant movements are nastic movements.
  - These include the closing of the carnivorous Venus Flytrap leaf when it captures prey or the folding of the mimosa leaf when it is disturbed.
  - Venus Fly Trap Clip

Photoperiodism

- Responsible for timing of seasonal activities such as flowering and growth
- Respond to periods of light and darkness
- Related to the number of hours that a plant spends in uninterrupted darkness
- Plant pigment phytochrome is responsible for photoperiodism
- Refer to plants as short-day or long-day plants
  - Short-day plants: chrysanthemums & poinsettias flower when days are short
  - Long-day plants: spinach and irises flower when days are long

Plant Hormones

Hormone = “to excite”

1) active in small amounts

2) produced in one part of plant & transported to another for action

3) action is specific for that site

Auxins

-stimulate growth but too much inhibits growth

functions:

1) root initiation, stem elongation
2) retard abscission (loss) of leaves & fruits
3) stimulates cell differentiation

Gibberellins

- Induces flowering
- Stimulates growth by increasing cell size & numbers
  - Effects of gibberellins

Cytokinins

1) induces cell division (cytokinesis)
2) affects root growth & differentiation
3) stimulates germination
4) delays **senescence** (aging); the progression of irreversible change that eventually leads to death