

How Plants Grow

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How plants grow

- Genetic guidance system
- Cells, tissues, and organs
- Photosynthesis and respiration
- Transpiration and water
- Mineral nutrition
- Meristems
- Hormones
- Dormancy
- Flowering

"Studies on the growth of plants"

Leonardo da Vinci

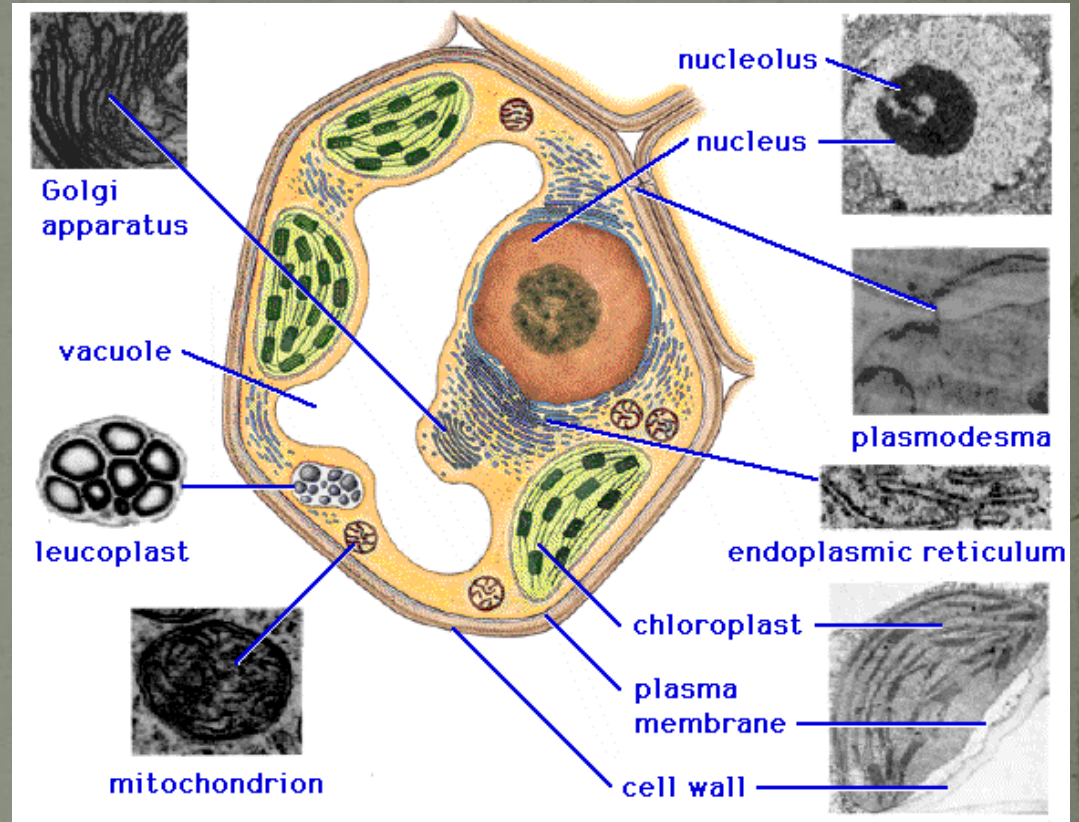
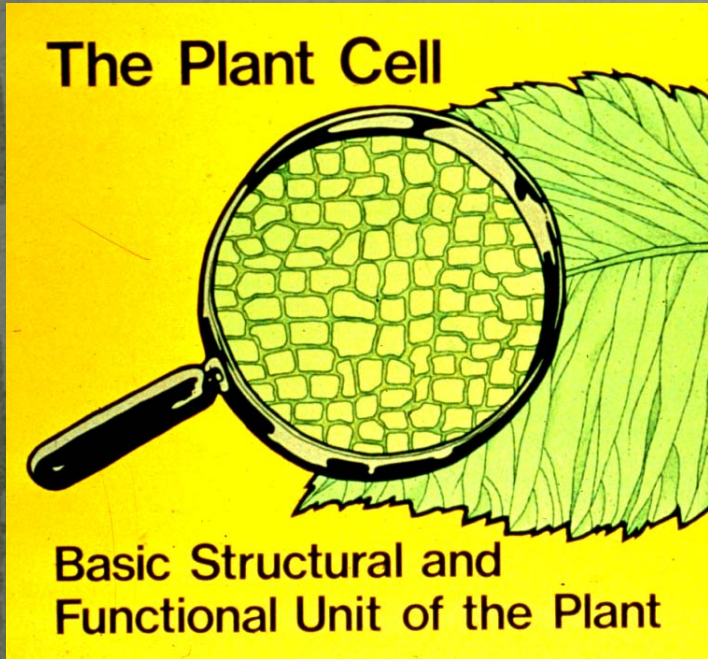
ca. 1495-1500



Handwritten notes in Leonardo da Vinci's cursive script, written in reverse (mirror image) on the right page of the notebook. The text is partially obscured by the sketches and is difficult to read.



Cell Structure



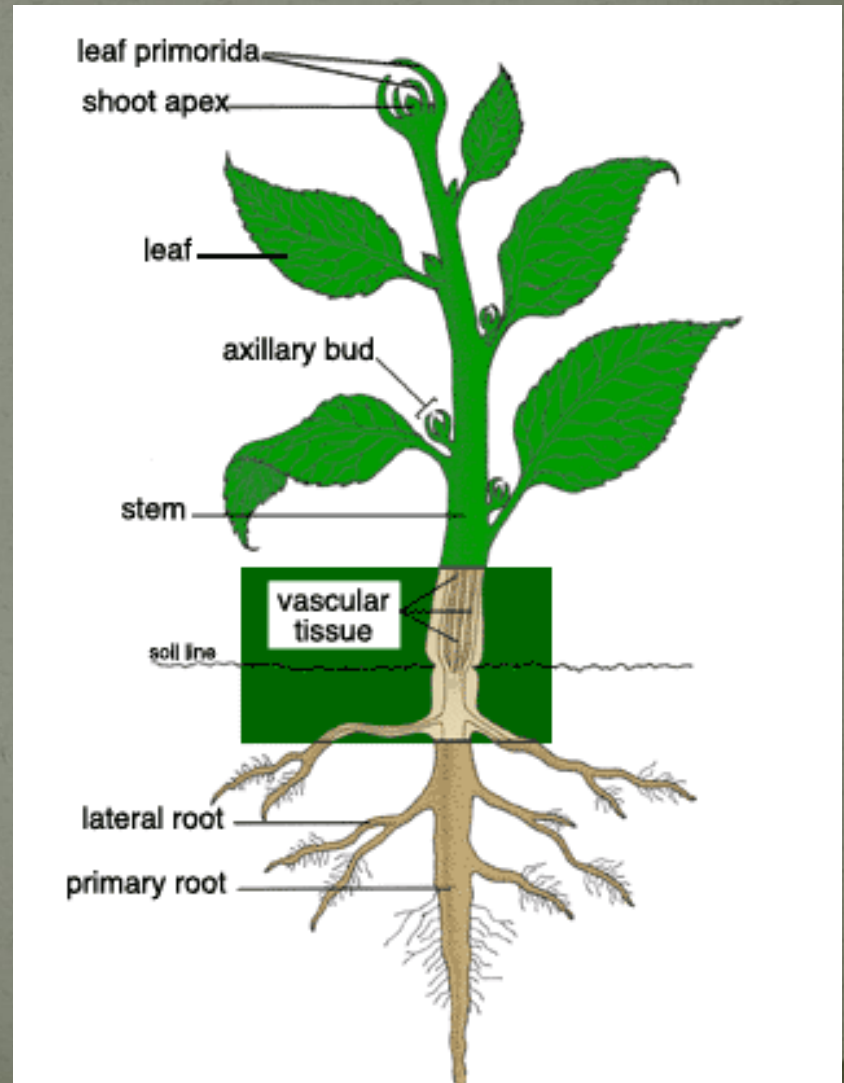
Plant organs: roots, stems, buds, leaves, flowers, fruits and seeds

An organ is an organized group of tissues that work together to perform a specific function.

Sexual reproductive parts produce seed; they include flower buds, flowers, fruit, and seeds.

Vegetative parts include roots, stems, shoot buds, and leaves.

- Not directly involved in sexual reproduction.
- Vegetative parts often are used in asexual forms of reproduction such as cuttings, budding, or grafting.

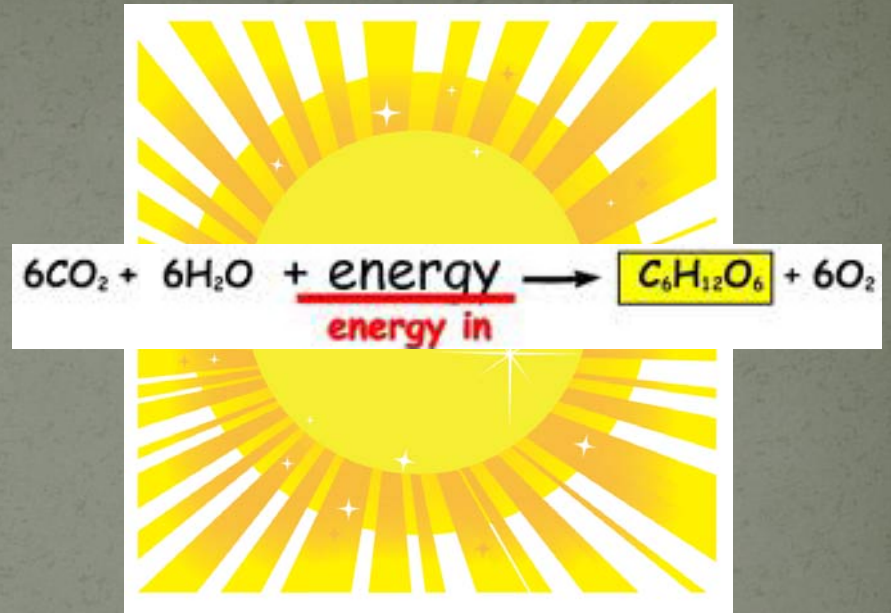


Photosynthesis

A close-up photograph of a green leaf, showing the detailed network of veins. The veins are a lighter green color, contrasting with the darker green of the leaf's surface. The veins form a complex, branching pattern that fills the entire frame.

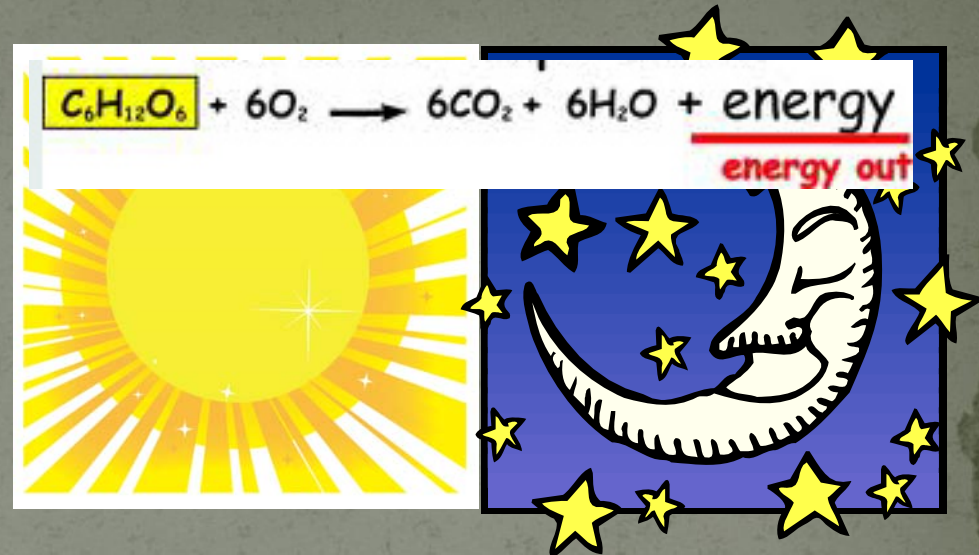
Process by which green plants produce a stable, useable energy form from the sun

Photosynthesis



- Light energy from the sun
- Carbon dioxide from the air
- Water and minerals from roots and soil
- Sugars and carbohydrates produced
- Oxygen produced

Respiration



- Oxygen from the air
- Stored sugar and carbohydrate
- Energy produced
- Carbon dioxide produced

Photosynthesis versus Respiration

Photosynthesis

- only in light
- only in green tissue such as leaves and some stems

Respiration

- occurs in the dark and light
- occurs in all living tissue
- enzyme regulated and rate is dependent on temperature

GENERAL RELATIONSHIPS
OF RESPIRATION, PHOTOSYNTHESIS,
AND PLANT GROWTH TO TEMPERATURE

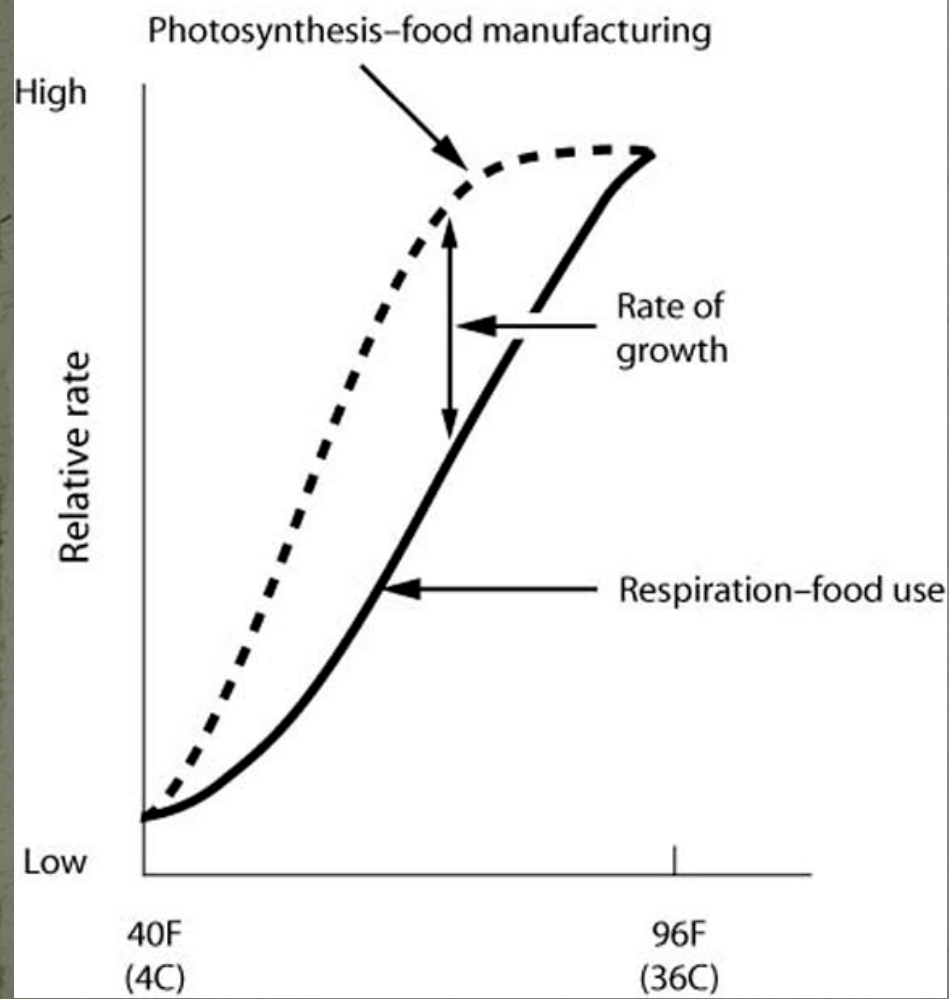


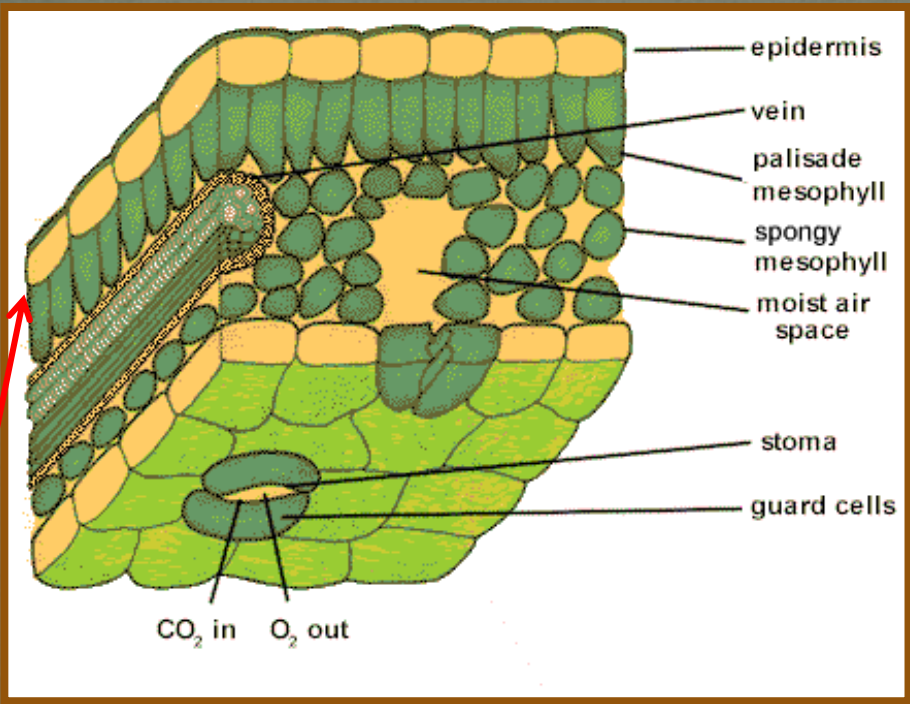
Photo. > Resp. = Plant Growth
Photo. < Resp. = Plant Death

Respiration nearly doubles for every 18°F rise in temperature between 40°F and 96°F

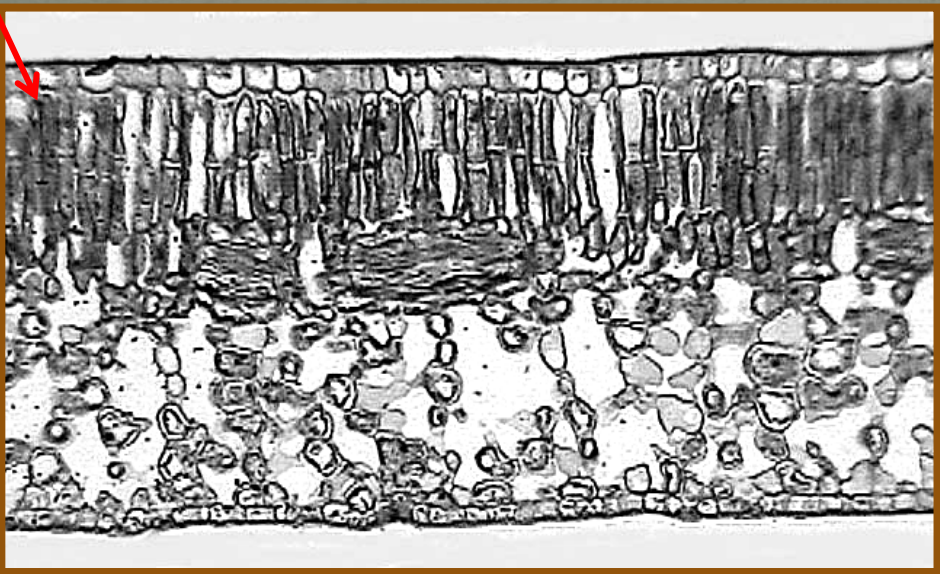
Photosynthesis versus Respiration

What happens when you put a plant in the dark?

What happens when you pick and store fruit or vegetables?

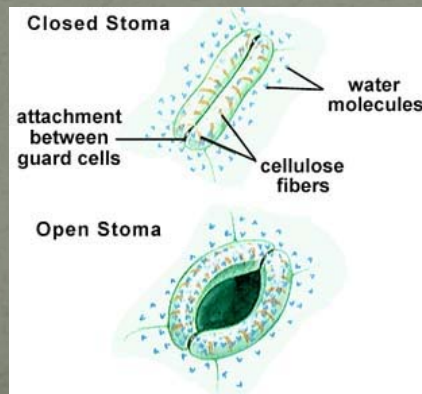
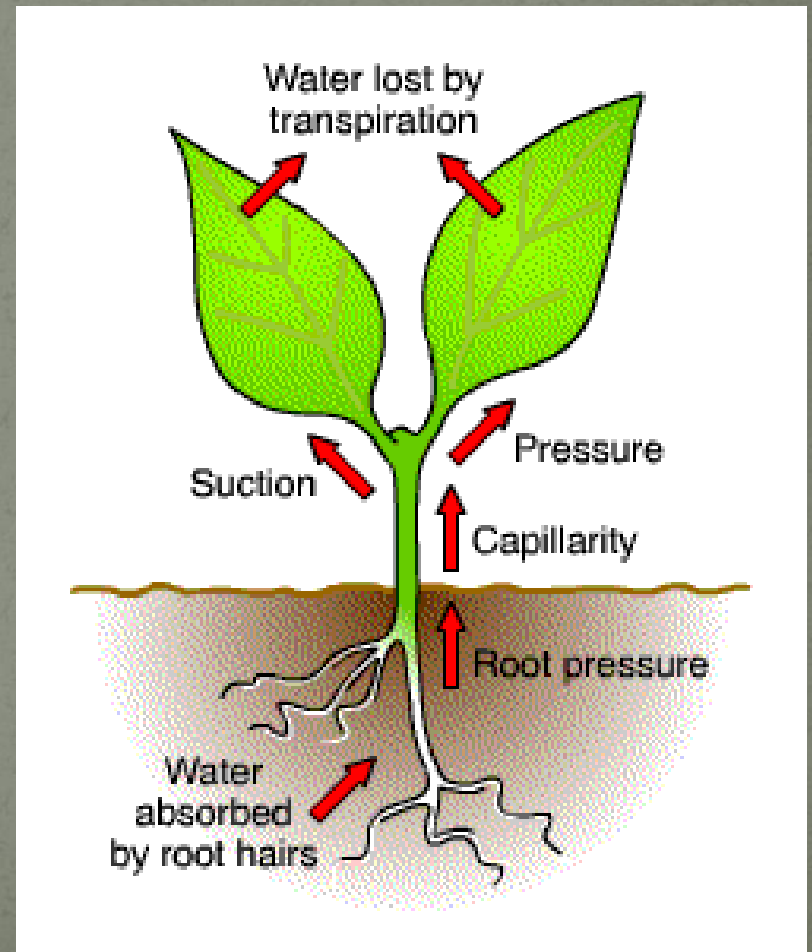
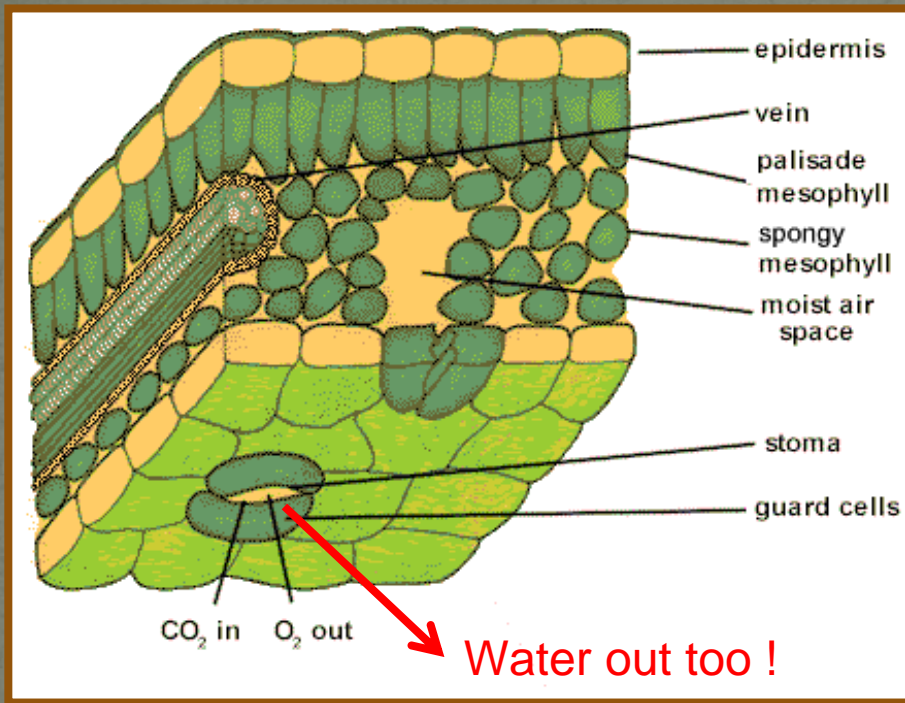


top

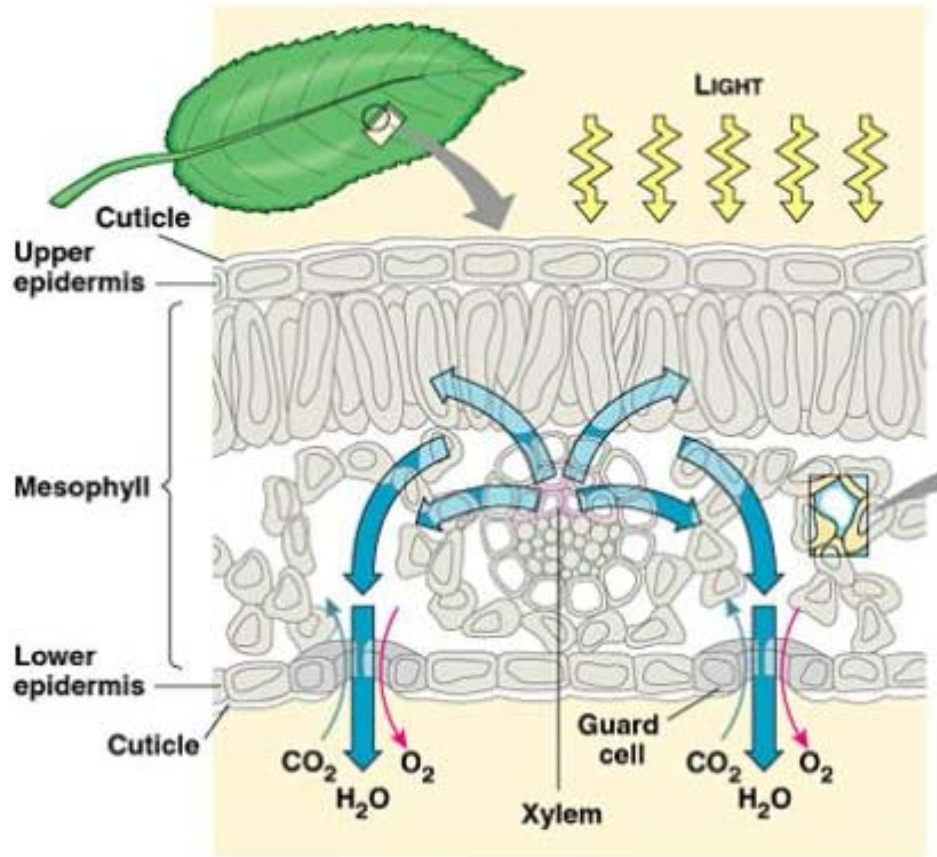


Plants are built to receive light and absorb carbon dioxide

Transpiration



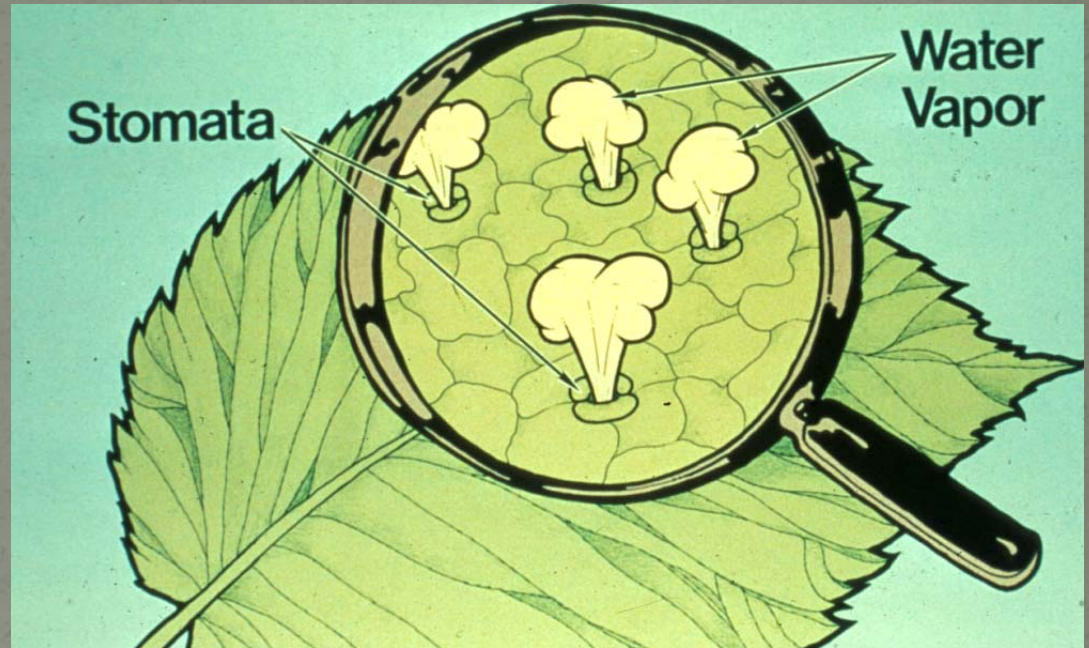
Transpiration



- Evaporation of water cools leaf
- Evaporation of water “pulls” water up through the plant

Factors Affecting Transpiration

- Light
- Temperature
- Humidity
- Wind Velocity
- Soil Moisture



Photosynthesis versus Respiration

- What happens when you limit soil water and stomates close?

How might these
affect plant
growth?



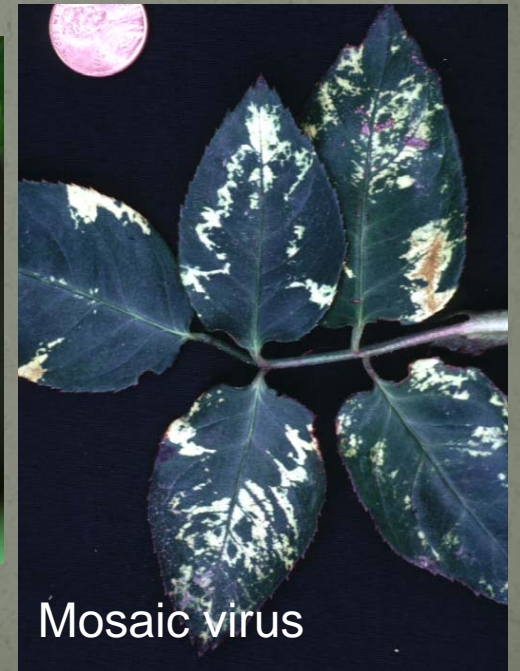
Powdery mildew



Rust

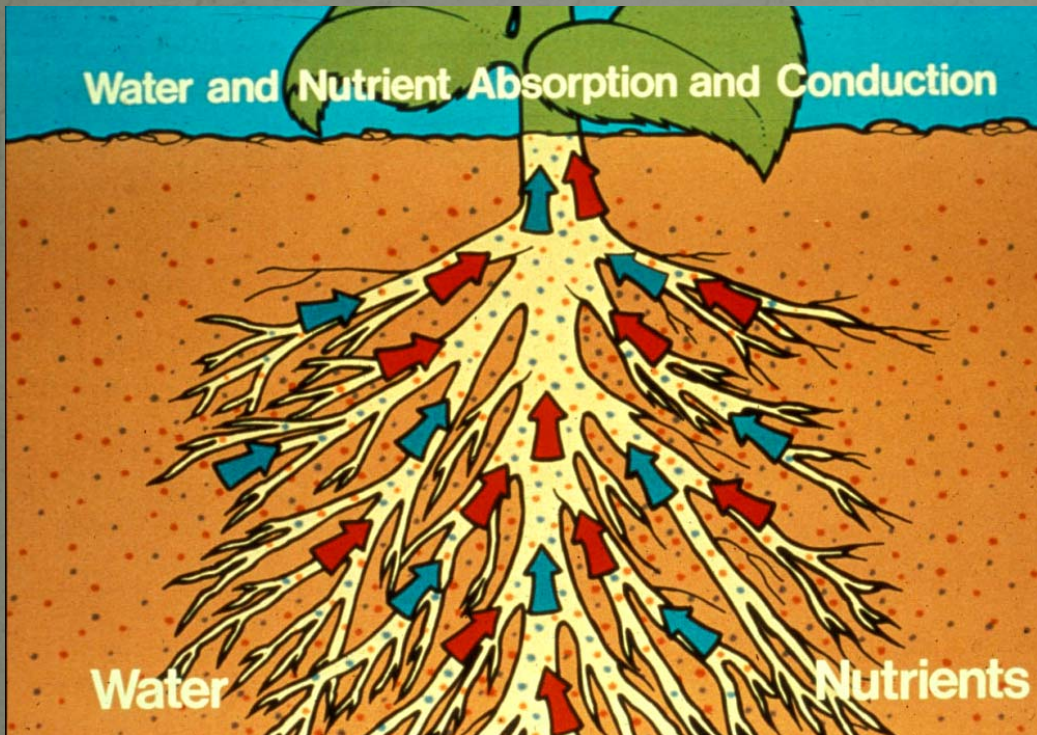


Magnesium deficiency



Mosaic virus

Mineral Nutrient Uptake



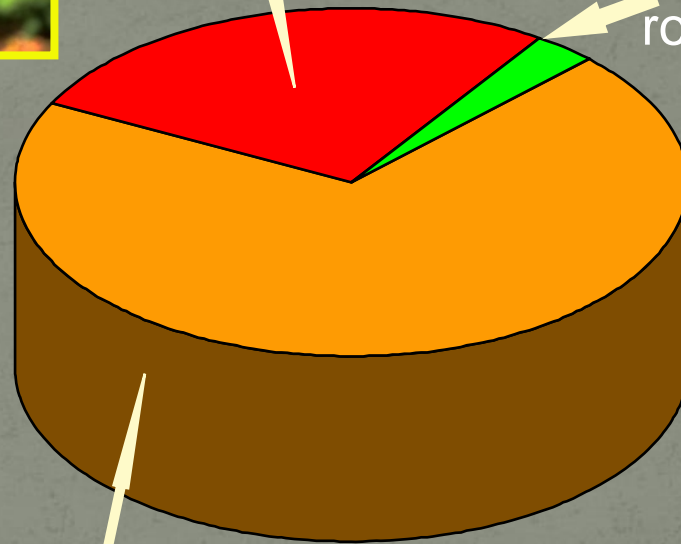
- **Passive:** flow along with the conduction of water
- **Selective:** roots can actively distinguish one nutrient from another nutrient
- **Selective uptake:** requires energy and therefore sugars and starches and oxygen

Organic matter - 27%
(carbon, sugars)



Minerals - 3%

from soil by
root

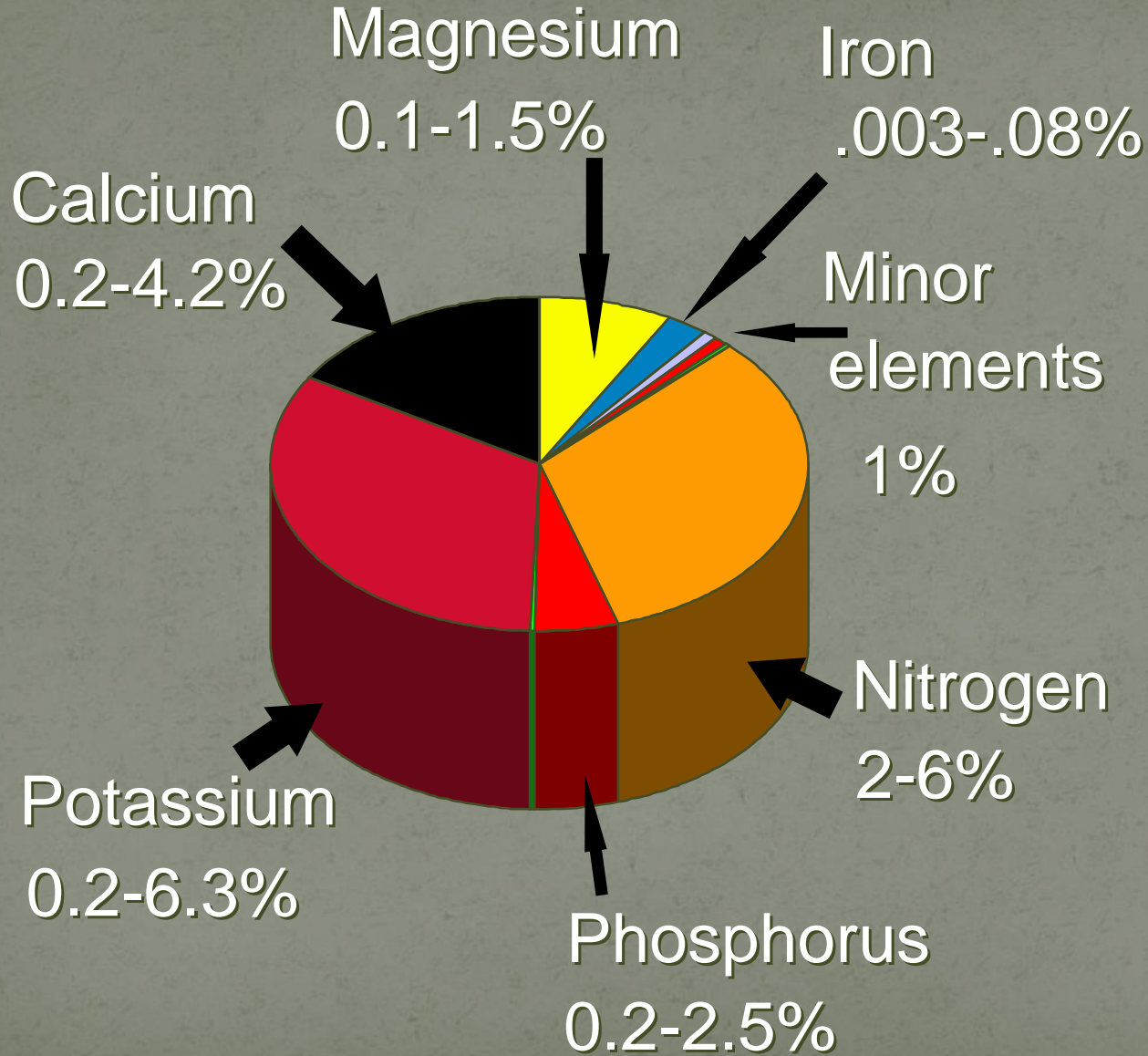


Plant Composition

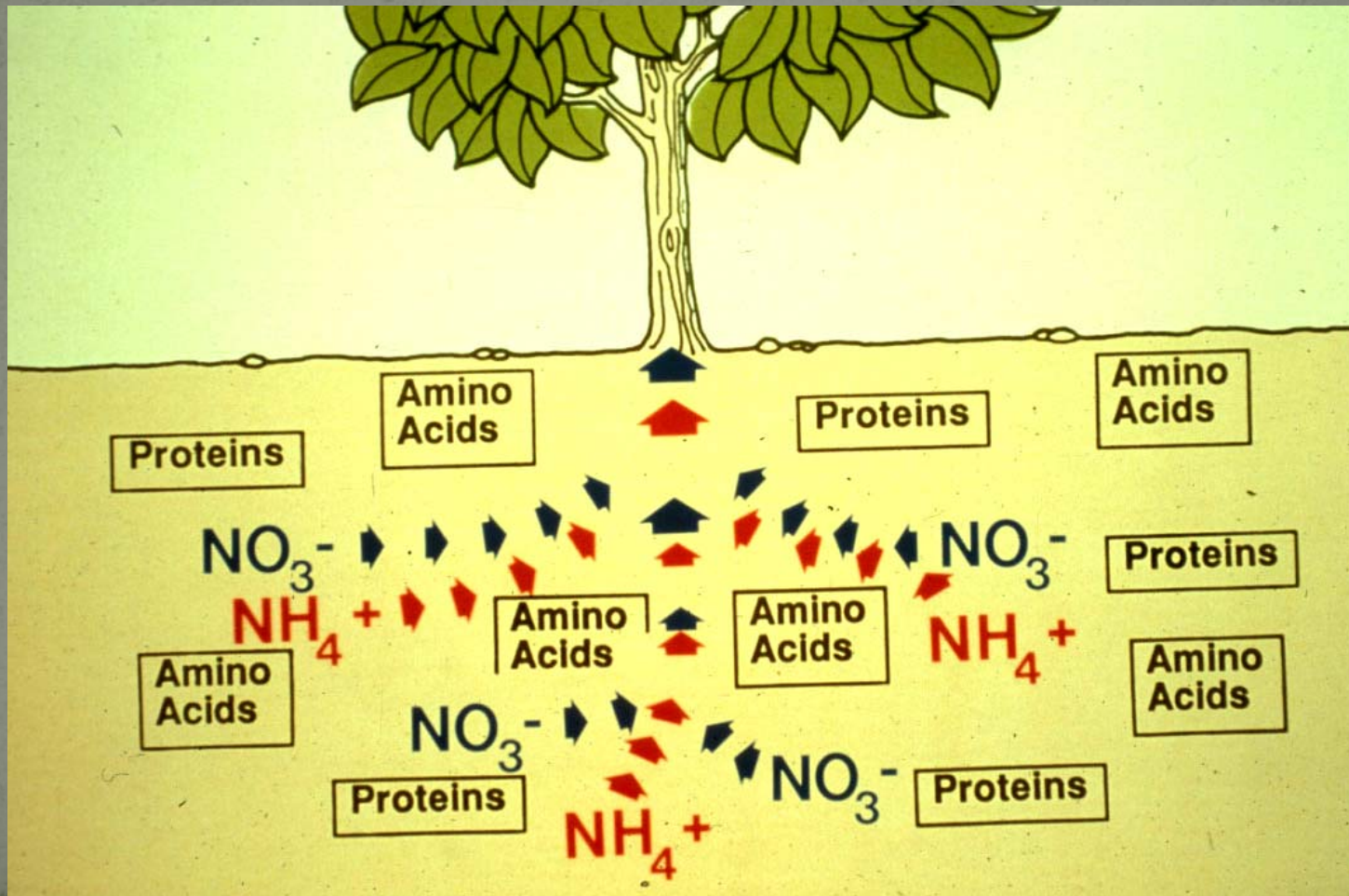
Water - 70%
from soil by roots



Mineral Composition



Nitrogen Sources



Remember the Meristems

Merizein (μερίζειν), meaning to divide.

A **meristem** is the tissue in most plants consisting of undifferentiated cells capable of dividing and producing all the specific cells, tissues, and organs

Shoots

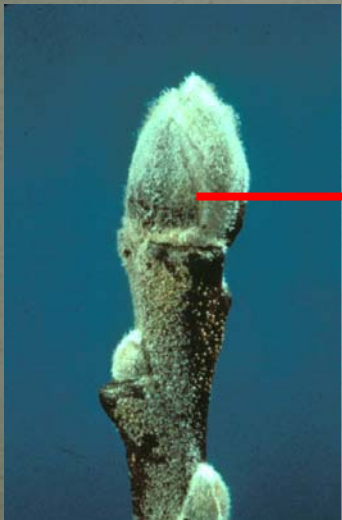
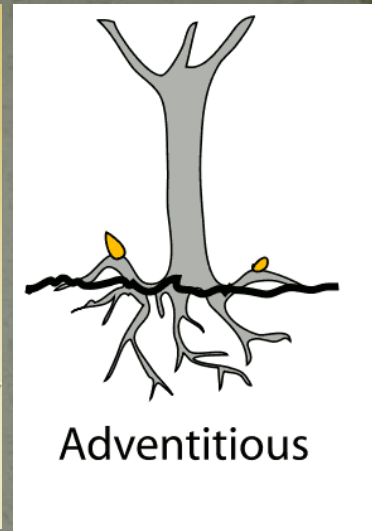
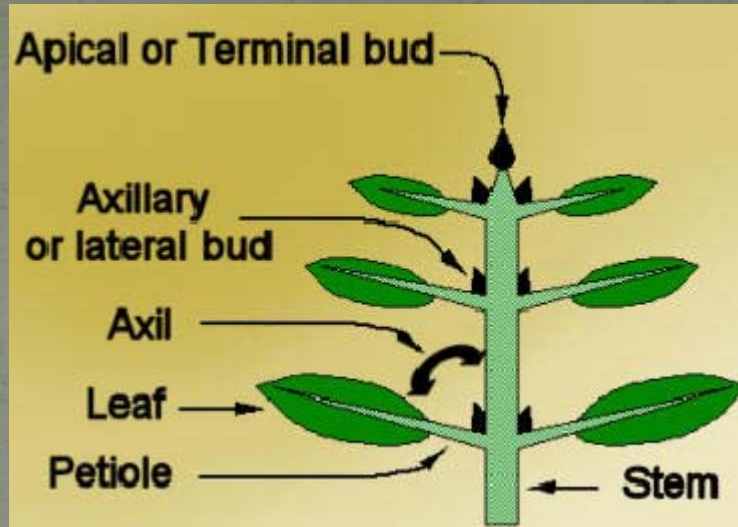


Roots



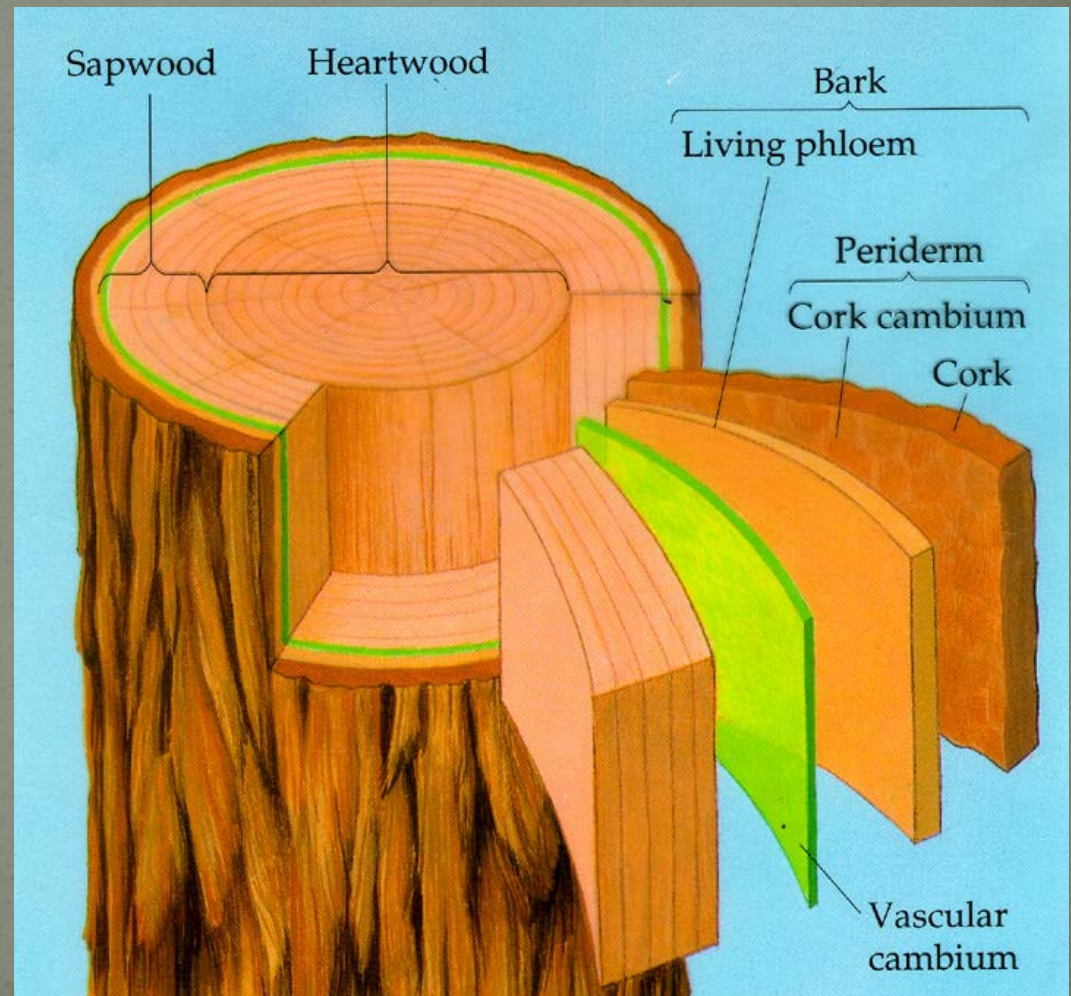
Meristems

- Apical
- Lateral buds
- Adventitious buds
- Vegetative or flowering buds



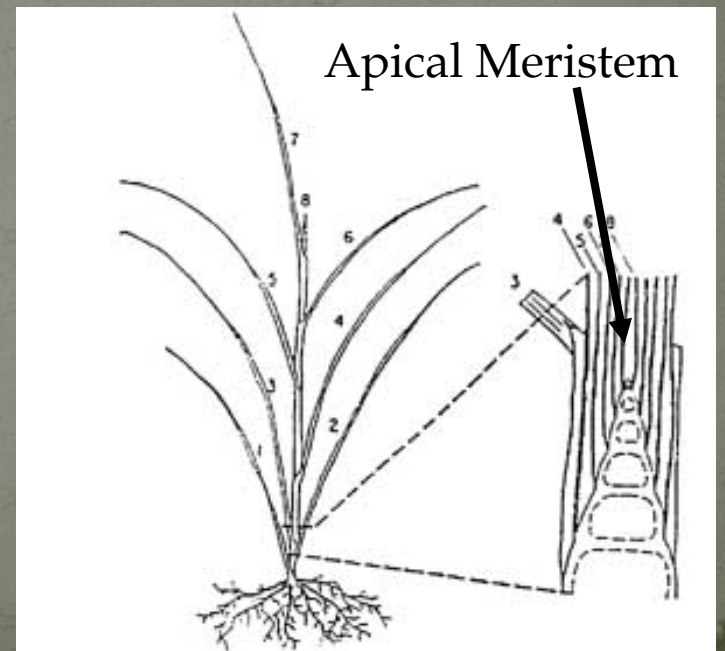
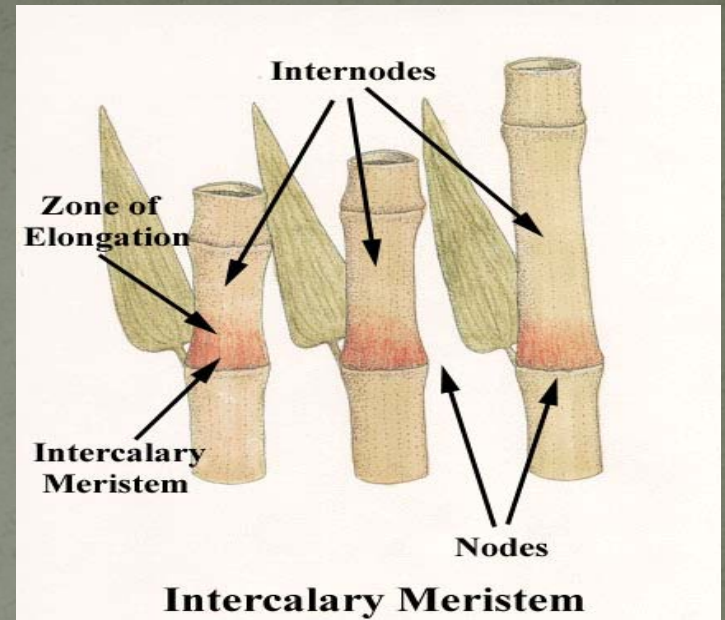
Woody plant meristems

- Vascular cambium
- Cork cambium



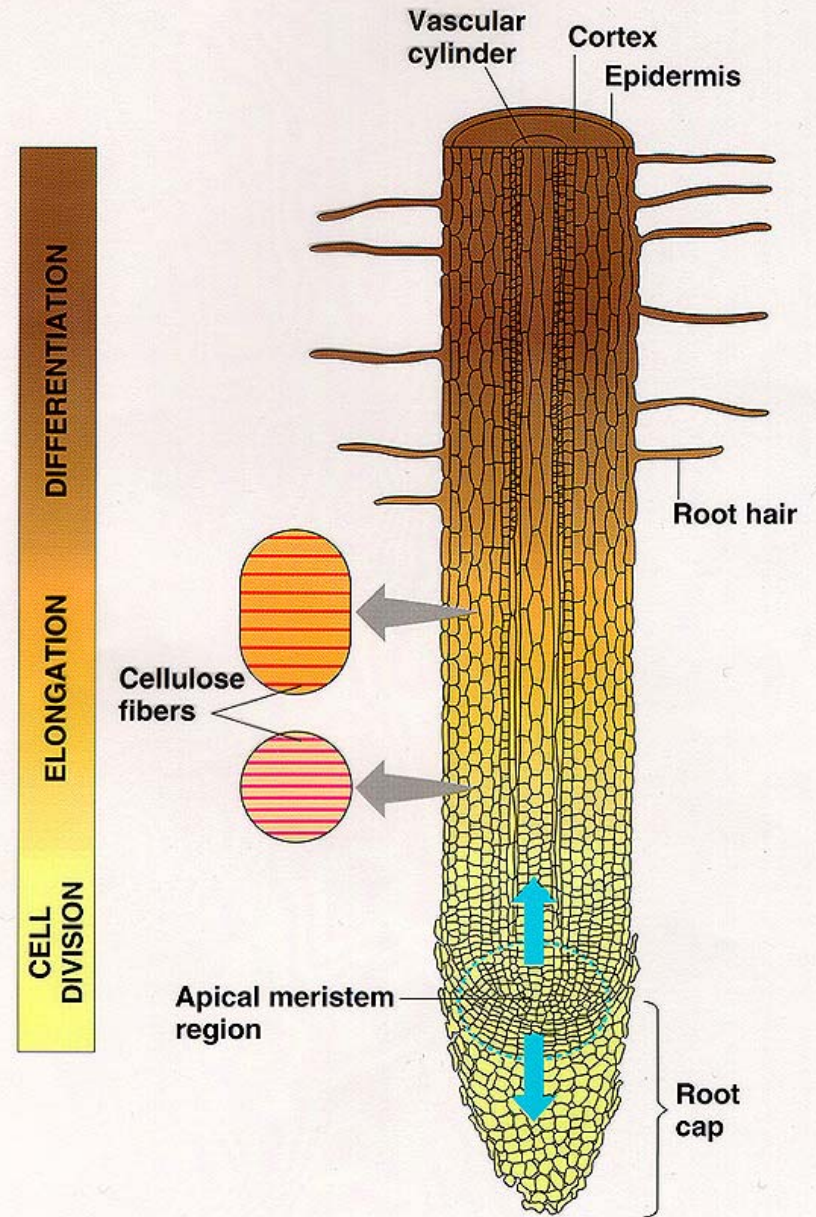
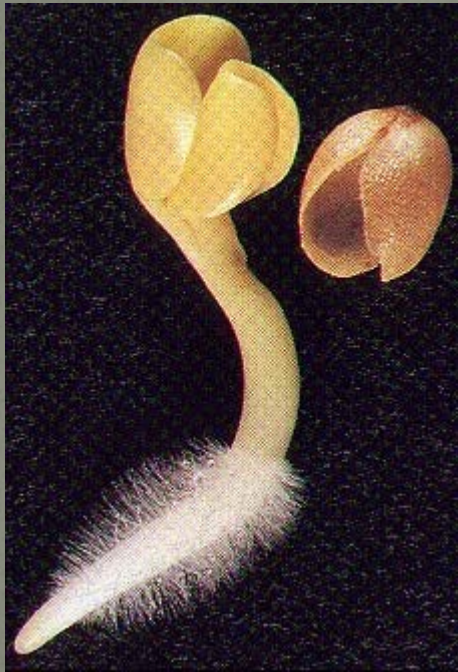
Grass meristems

- Apical meristems
- Intercalary meristems

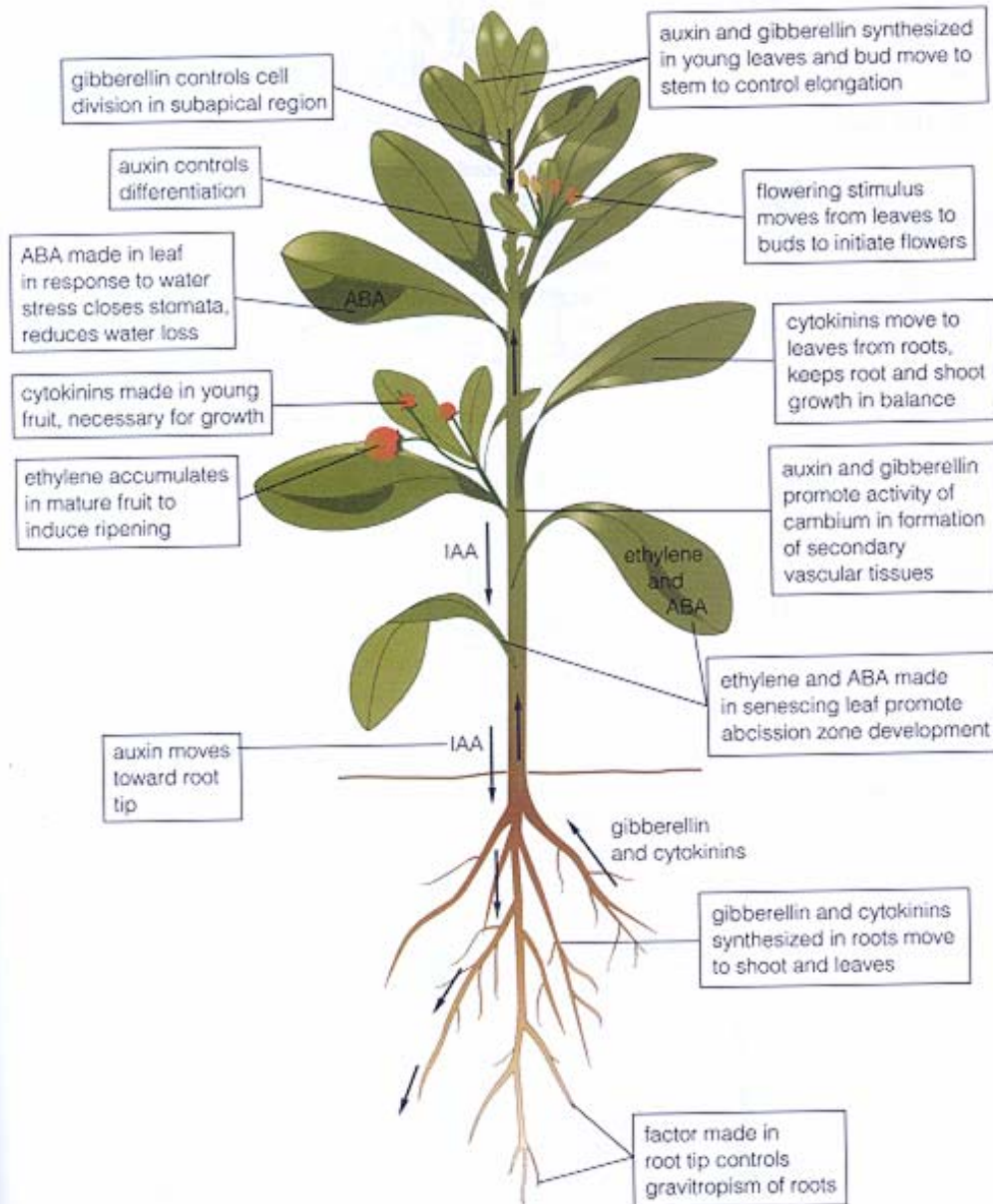


Root meristems

- apical meristems = root tips



Hormones



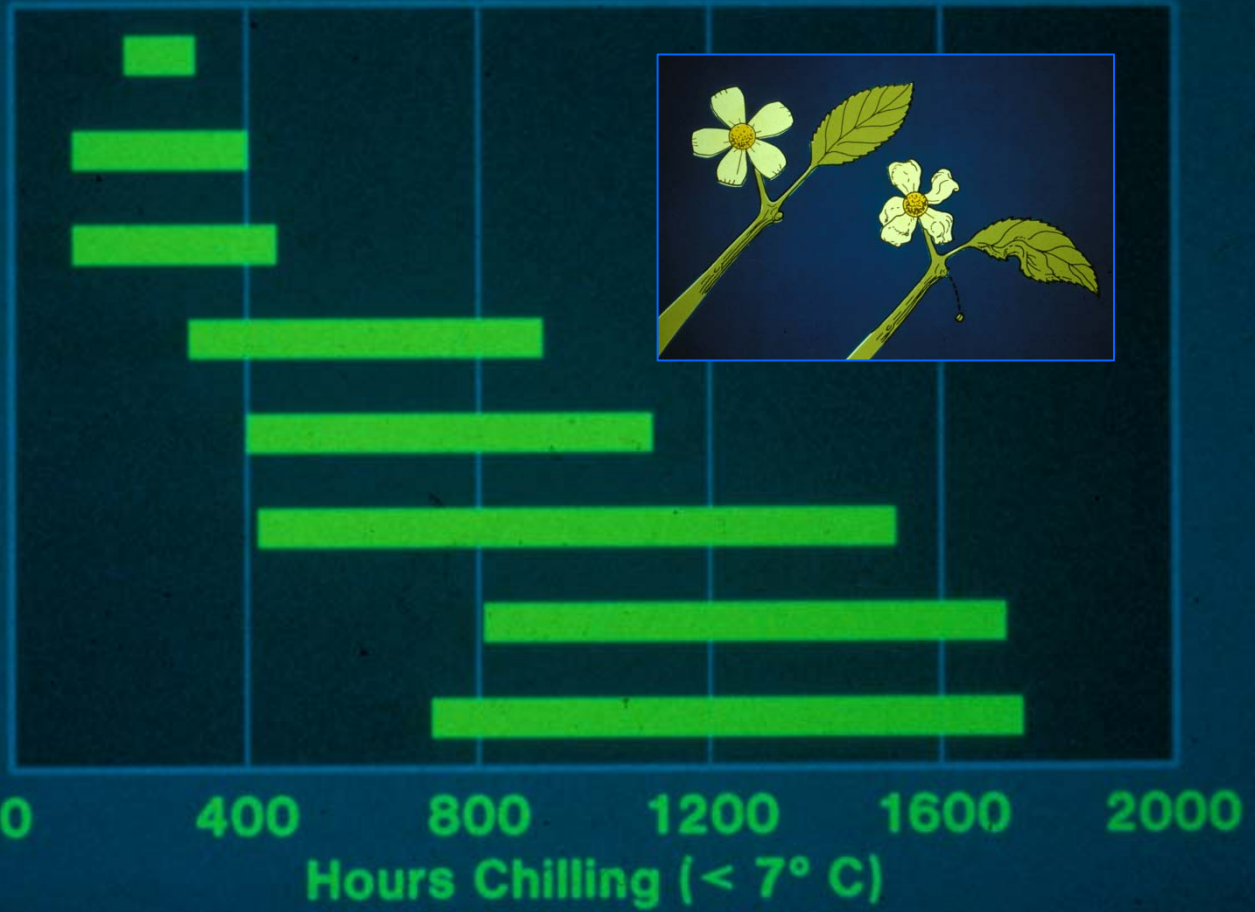
- Auxins
- Cytokinins
- Gibberillins
- Ethylene
- Abscisic acid (ABA)

Dormancy

- Mechanism to survive adverse conditions
- Must have stored food reserves to support respiration
- Physical dormancy
 - Closed cone
 - Hard seed coat
- Physiological dormancy
 - Day length
 - Chill hours (fruit trees, bulbs)

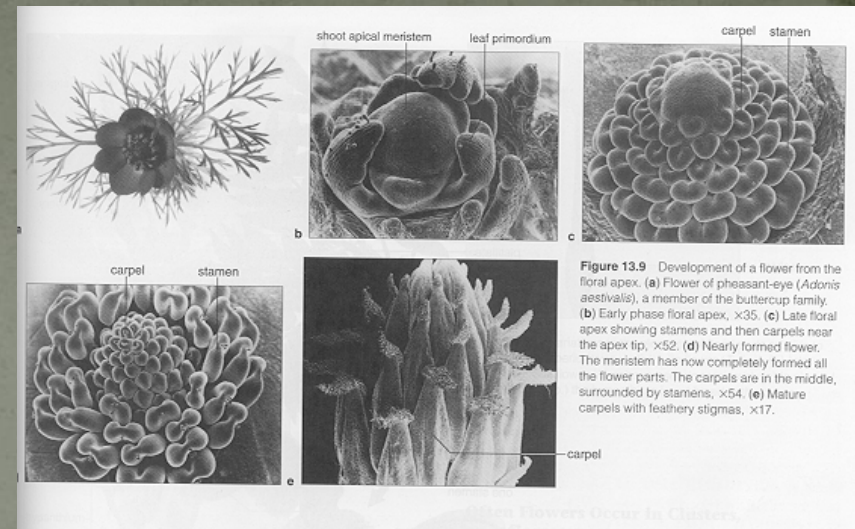
Chilling Requirements to Break Winter Rest

- Strawberry
- Grape
- Almond
- Apricot
- Peach
- Walnut
- Apple
- Plum



Flower induction

- Meristems receives “signal” to change from a vegetative to flowering state
- Timing differs among species
 - Annuals may flower within weeks of germination
 - Biennials and Perennials
 - Many woody perennials initiate flowers in previous year
- Can be controlled by day length, light intensity, air temperature, soil moisture, carbohydrate, mineral nutrition



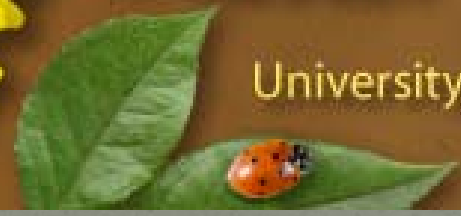
Flower induction by day length

- Short-day plants - light period usually less than 12 hours long (chrysanthemum, poinsettia, strawberry)
- Long-day plants - light period usually more than 14 hours long (fuchsia, spinach, perennial ryegrass)
- Day neutral - processes not affected by day length (fruits and nuts, grapes, corn)



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Master Gardener Program

University of California Cooperative Extension 

Any Questions?



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