Introduction to Horticulture

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NTRODUCTION TO HORTICULTURE

Botany

- structure and life phenomena exhibited by plants
- Agronomy
- Horticulture
  - hortus (garden)
  - colere (to cultivate)

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What makes up a plant?

- living factories that produce their own food
- serve as food source for nearly all other living organisms
  - cells
  - photosynthesis
  - water (85 - 90 % by weight)
    - Solvent for mineral and sugar transport

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External plant parts-roots, stems, buds, leaves, flowers, fruits and seeds

Leaves, stems, roots, flowers, fruits, and seeds are known as plant organs. Each 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; they are not directly involved in sexual reproduction. Vegetative parts often are used in asexual forms of reproduction such as cuttings, budding, or grafting.

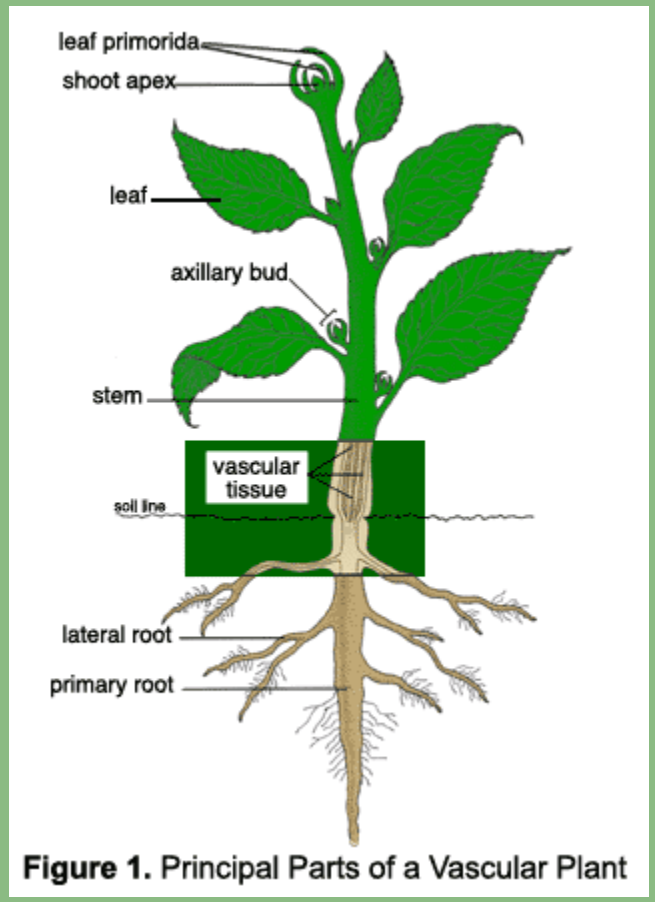

Figure 1. Principal Parts of a Vascular Plant

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Plant Classification

- Growth Habit
- Structure or Form
- Leaf retention
- Climatic Adaptation
- Use
- Botanical or Scientific Classification

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Plant Classification

- Growth Habit
  - Annuals
    - complete a life cycle (seed to flowering to re-seeding) in one growing season and then die
  - Perennials
    - may go through repeated flowering and seeding cycles before dying
    - may grow for several years before flowering and dying
  - Biennials
    - How do they differ?

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Plant Classification

- Structure or Form
  - Herbaceous -- tender stemmed species
  - Woody -- hard fibrous stems
    - Form
      - » Vine
      - » Shrub
      - » Tree (includes tree shape also…weeping, vase, etc.)

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Plant Classification

- Leaf retention
  - Deciduous
  - Evergreen
    - broad-leaved -- azaleas, some magnolias
    - needle-leaved -- pine, redwood

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Plant Classification

- Climatic Adaptation
  - Perennial plants are classified according to minimum temperatures they will tolerate
    - tropical, subtropical, temperate
  - Cool- and warm-season plants
    - cool season grow best with average daytime temperatures of 55^{o} to 75^{o} F (carrot, asparagus, spinach, broccoli)
    - warm season grow best with average daytime temperatures of 65^{o} to 95^{o} F (tomato, sweet corn)

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Plant Classification

- Use
  - Fruits
  - Herbs
  - Vegetables

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Plant Classification

- Botanical or Scientific Classification
  - Genus + specific epithet (species)
    - Red Raspberry (common name)
    - *Rubus idaeus*, or Rubus ideaus
  - Grouped according to similarities in morphology

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Plant Classification

- Botanical or Scientific Classification
  - Varieties
  - Cultivars
  - Clone

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Plant Classification

- Most horticulturally important plants belong to
  - Coniferphyta - cone-bearing plants
    - gymnosperms - seeds exposed at base of scales
  - Anthrophyta - true flowering plants
    - angiosperms - seeds buried in fruit developed from ovary
    - further divided into
      - » Monocots - “one seed leaf” - *Gramineae* grasses
      - » Dicots - “two seed leaves” - *Rosaceae*

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Plant Classification

- Monocots - “one seed leaf” - *Gramineae* grass
- Dicots - “two seed leaves” - *Rosaceae*
  - What are some of the differences?

Monocots	Dicots
Vascular tissues scattered in stem	Vascular tissues in circular pattern
Flower parts in three	Flower parts in 4-5 or multiples
Leaf veins parallel	Leaf veins branched

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Plant Growth

- Irreversible increase in plant size due to increased cell number and/or size

Three Critical Processes for Growth

- Photosynthesis
- Respiration
- Transpiration

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Plant Growth

- Photosynthesis
  - Process by which green plants produce their own carbohydrates and obtain chemical energy
  - Plant cells, in presence of chlorophyll and light, convert carbon dioxide (CO_2) and water (H_2O) to carbohydrates
  - Net result is transformation of light energy into chemical energy

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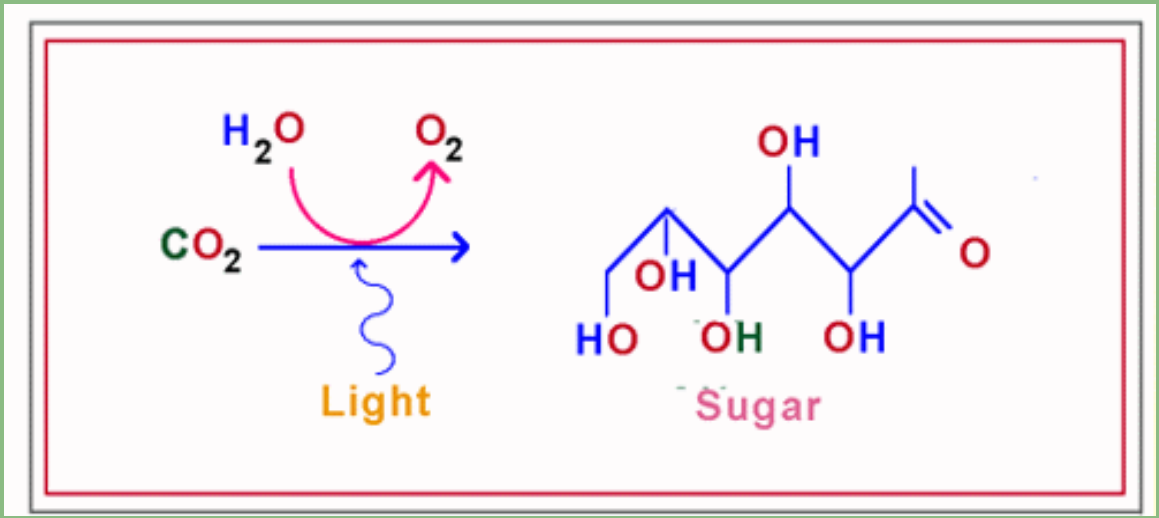
A model of Photosynthesis



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Plant Growth

- ***Photosynthesis***
  - Energy is “stored’ in chemical bonds
  - By-product is evolution of free oxygen (O2)

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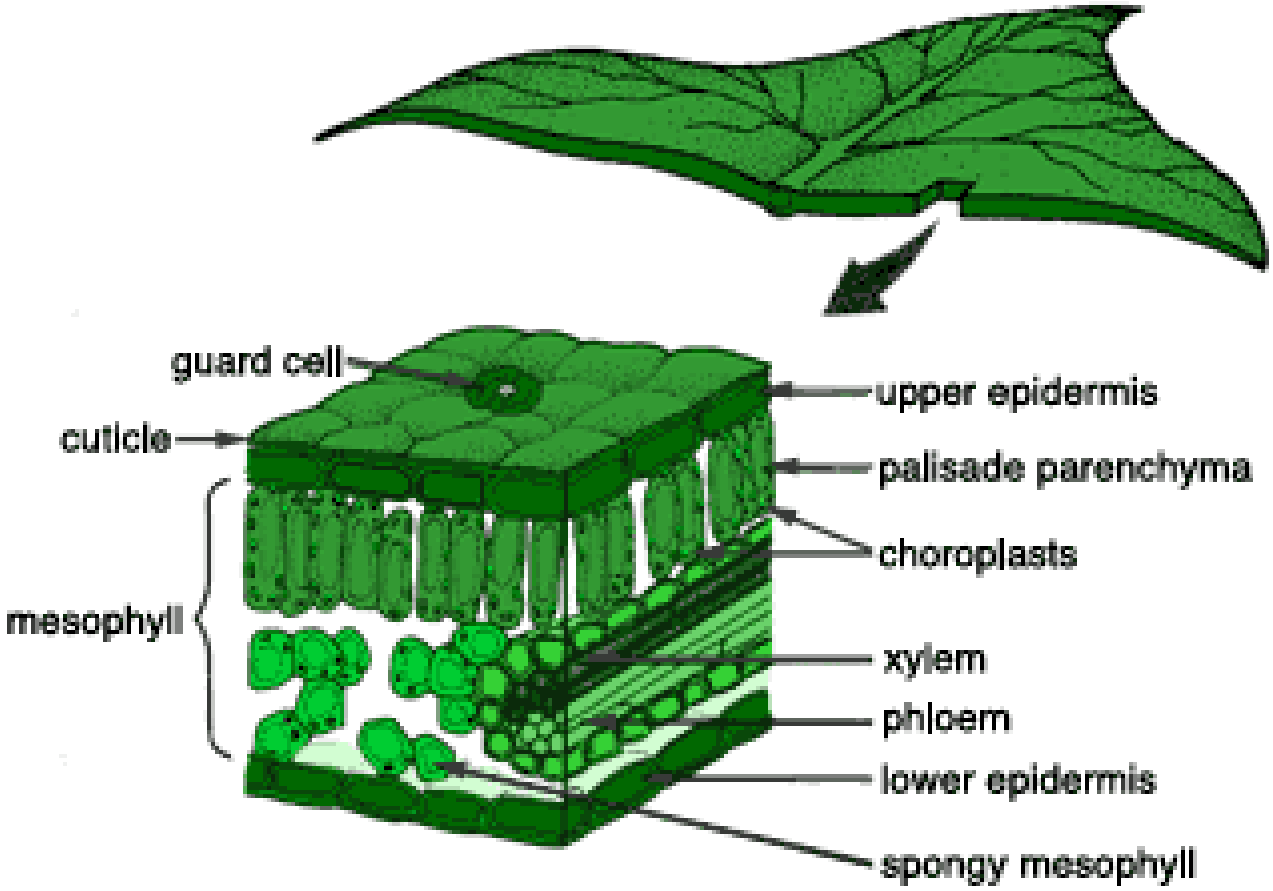

Figure 12a Leaf cross section

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Plant Growth

- Photosynthesis
  - Requirements
    - Stomata must be open to allow CO2 to enter leaf
    - Adequate light must reach leaf
    - Water must be available to the plant
    - Mineral nutrients must be available to plant

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How might this affect plant growth?

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Plant Growth

- ***Photosynthesis***
  - Fate of carbohydrates produced
    - combined with minerals to synthesize more complex compounds for cell growth
    - converted to more complex carbohydrates (sugars and starches) or fats and stored (where?)
    - biologically combusted to release stored chemical energy, a process called respiration

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Plant Growth

- ***Respiration***
  - occurs in cells through complicated series of reactions regulated by enzymes
  - uses oxygen
  - releases CO2 and water

$$C_6H_{12}O_6 + 6\ O_2 \xrightarrow{\text{energy}} 6\ CO_2 + 6\ H_2O + \text{Energy}$$

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Plant Growth

- ***Respiration***
  - rate dependent on
    - temperature
    - availability of oxygen and carbohydrates
  - occurs at all times in living material, even after harvest
  - post-harvest respiration affects how fruits and vegetables are stored

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Plant Growth

- Cycling of Photosynthesis and Respiration
  - What conditions would impact cycling?

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Plant Growth

- Cycling of Photosynthesis and Respiration
  - Photosynthesis requires light, and ceases at night
  - Respiration occurs all the time, but is driven by temperature
    - it nearly doubles for every 18^{o}F rise in temperature between 40^{o}F and 96^{o}F

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Plant Growth

- Cycling of Photosynthesis and Respiration
  - Rate of photosynthesis must exceed rate of respiration
  - Why?
  - What happens when water is limited?

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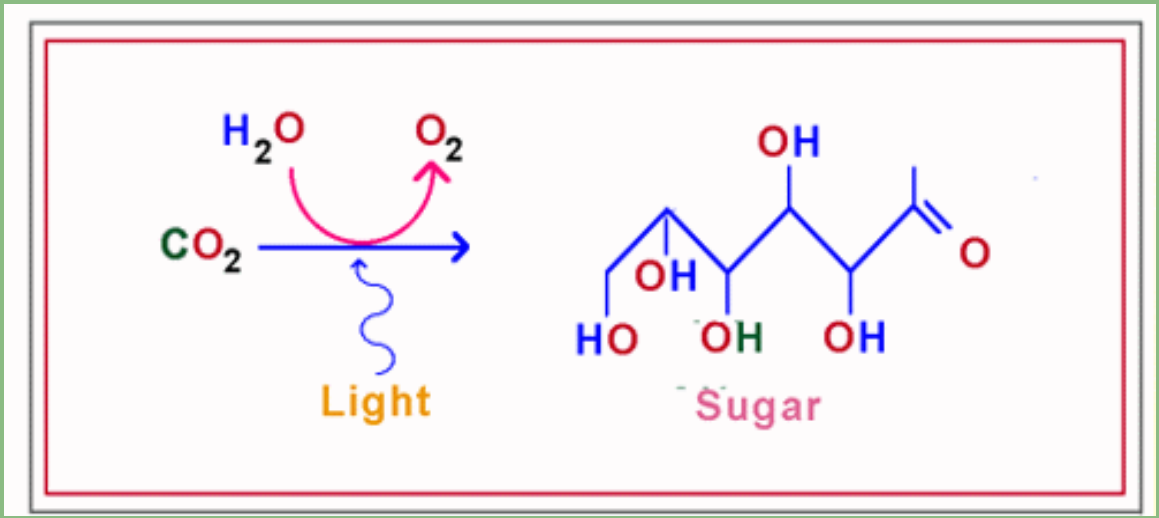
A model of photosynthesis



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Plant Growth

- Respiration
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  - releases CO2 and water

$$C_6H_{12}O_6 + 6\ O_2 \xrightarrow{\text{energy}} 6\ CO_2 + 6\ H_2O + \text{Energy}$$

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Plant Growth

- Water and Nutrient Uptake
  - Most of water and nutrient uptake occurs in roots
  - Some nutrient uptake requires roots to expend energy
  - Water uptake is largely passive and in response to a gradient

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How might this affect water and nutrient uptake?

Nemotode attack on tomato roots

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Plant Growth

- ***Transpiration***
  - Evaporative loss of water vapor from plant leaves through stomata
  - Related to ***translocation*** through xylem

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Porous pot analogy to plant transpiration

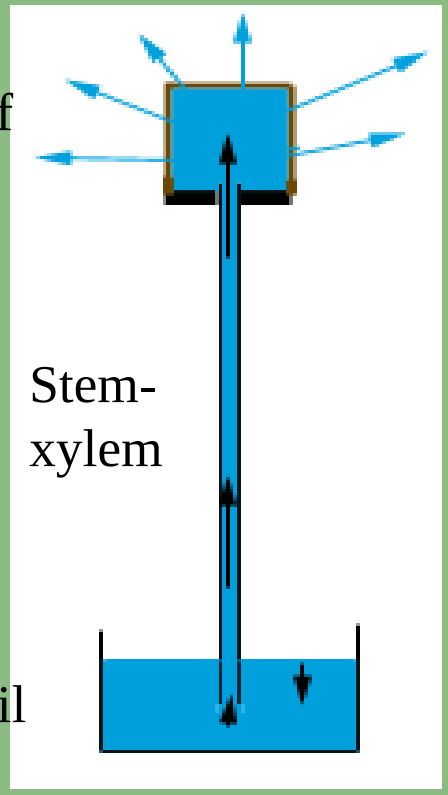

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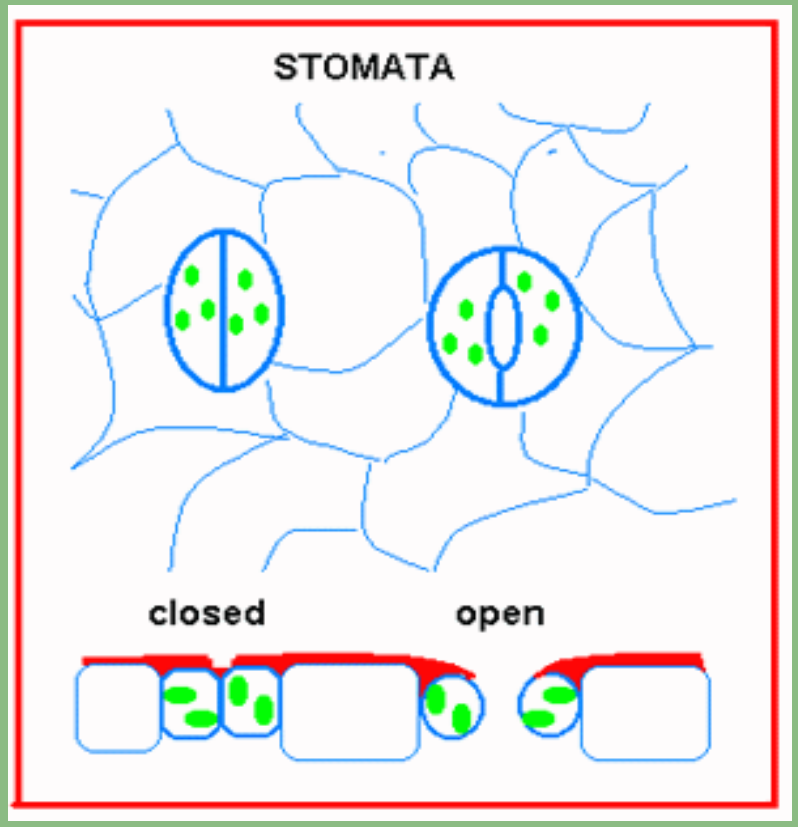
Diagram of leaf cells and leaf epidermis with stoma



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Stoma in epidermal peel of chrysanthemum

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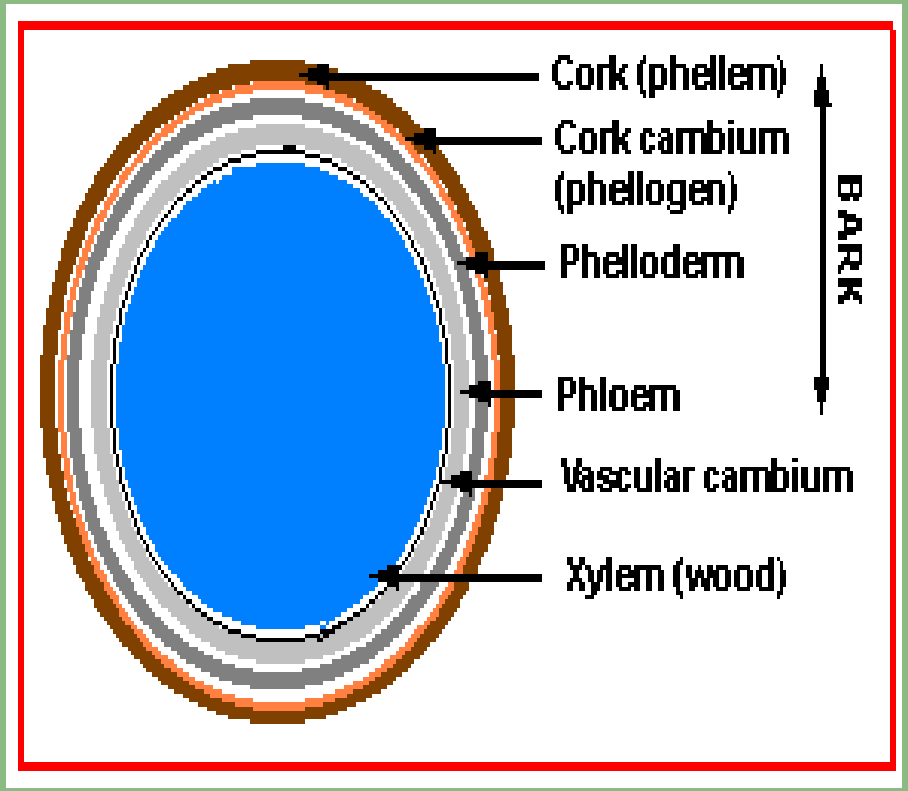
Diagram of the cross-section of a woody perennial plant



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- Plant Growth
  - Transpiration
    - Rate depends on
      - environmental factors (which ones?)
      - degree of stomatal opening
      - amount of available soil water

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- Plant Growth
  - Transpiration
    - In temperate plants transpiration ceases.
      - When?
      - Why?
    - How is transpiration different in succulents?
    - Transpiration is affected by wind….

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- Plant Growth
  - Transpiration
    - Helps to cool plants during day
    - Transports minerals from soil and organic compounds produced in roots

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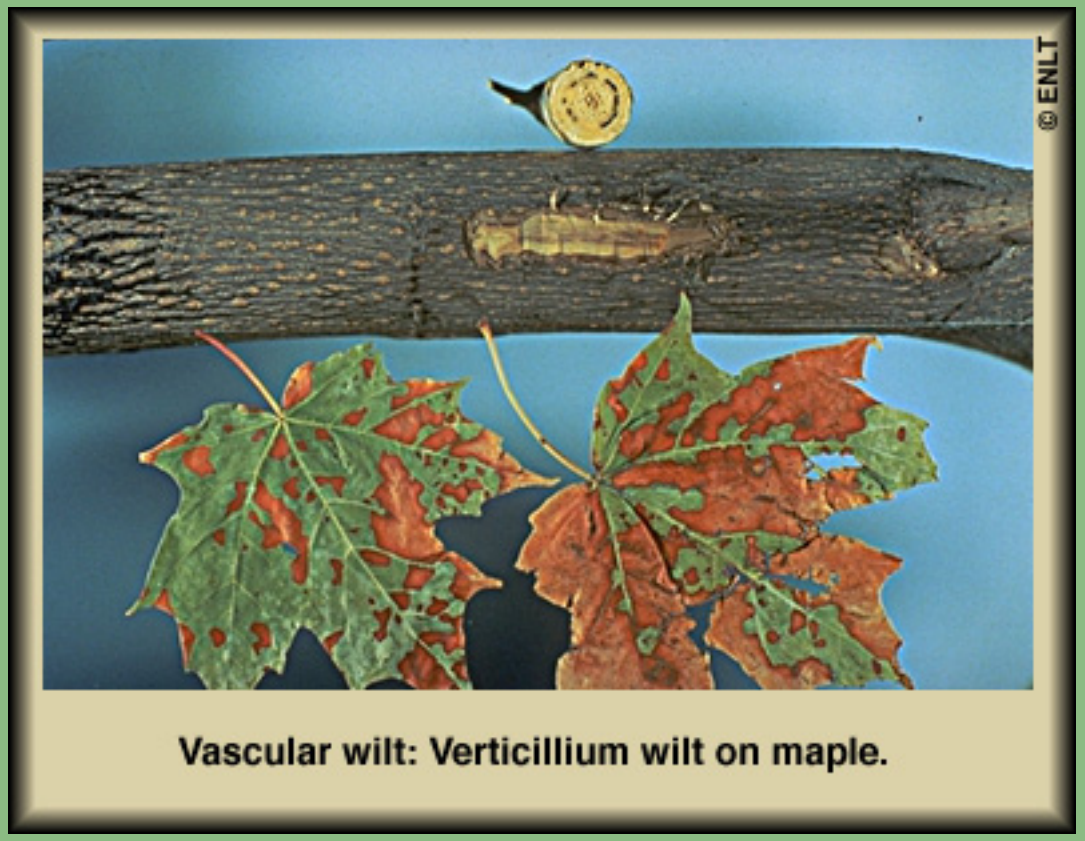
Impacts of a vascular wilt disease on maple



Vascular wilt: Verticillium wilt on maple.

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Plant Growth

- Translocation
  - Movement of water, nutrients, food etc. from one part of the plant to another
  - Can occur from cell to cell, and in intercellular spaces
  - Mostly occurs in xylem (water and nutrients) and phloem (carbohydrates)
  - Why are many insects phloem feeders?

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Plant Development

- Dormancy
  - Plant parts that are alive but not growing
  - Mechanism to survive adverse conditions
  - In order to survive, must contain stored food reserves to support what process?
  - Can be physical or physiological
    - Day length --Hard seed coat
    - Chill hours --Closed cone

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Reproductive Development

- The goal for many horticultural plants
  - Flowers
  - Fruits
  - Seeds

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Reproductive Development

- Flower Induction
  - From our old friend the meristem
  - Timing differs among species
    - annuals may flower within weeks of germination
    - many woody perennials initiate flowers in previous year
    - Why is this important for your lilacs?

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Reproductive Development

- Flower and Fruit Development
  - Controlled by day length, light intensity, temperature, soil moisture content, nutritional status of plant
  - Pollination - self-, cross- (wind, insect)
  - Fertilization
    - Only fraction of flowers normally mature
    - “drop” at petal fall
    - “June drop” 4 to 6 weeks after petal fall
- Fruit Quality and Ripening

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Reproductive Development

- Fruit Quality and Ripening
  - Sugars and aromatic compounds begin to accumulate
  - Some fruits picked when physiologically mature but not fully ripe
    - Tomato, banana, avocado, apples
  - Other fruits must be allowed to mature on plant
    - grapes, citrus, strawberries
  - What conditions promote ripening? (Hint - our old friend photosynthesis)

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How Plants Function

- Plant responses to
  - daylength
  - light intensity
  - light quality
  - temperature
    - Interactions of photoperiod and temperature
  - soil moisture conditions
  - carbon dioxide and oxygen concentrations
  - nitrogen nutrition
  - stress

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How Plants Function

- Plant responses to
  - Daylength
    - affects flower initiation, vegetative development, or onset of dormancy in some plants
    - Plant leaves are sensors of critical photoperiods
      - » Short-day plants - light period less than 12 hours long (chrysanthemum, poinsettia, strawberry)
      - » Long-day plants - light period 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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How Plants Function

- Which of these requirements can we change in the garden?
  - daylength
  - light – intensity and quality
  - temperature
  - soil moisture conditions
  - carbon dioxide and oxygen concentrations
  - nitrogen nutrition
  - stress

ant responses to stress:


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Marginal Necrosis

Sunburn on Tree Trunk

Acute Lack of Water


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Review:

- Plant Classification
- Photosynthesis
- Respiration
- Transpiration
- Translocation

Thank You---Any Questions?