Introduction to Horticulture

University of California Cooperative Extension
Pamela Geisel
Statewide Coordinator Master Gardener Program
Farm Advisor, Environmental Horticulture
INTRODUCTION TO HORTICULTURE

Botany
– structure and life phenomena exhibited by plants
– Agronomy
– Horticulture
  • hortus (garden)
  • colere (to cultivate)
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
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.
Plant Classification

- Growth Habit
- Structure or Form
- Leaf retention
- Climatic Adaptation
- Use
- Botanical or Scientific Classification
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
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° to 75° F (carrot, asparagus, spinach, broccoli)
  – warm season grow best with average daytime temperatures of 65° to 95° 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
Plant Classification
– Botanical or Scientific Classification
  • Varieties
  • Cultivars
  • Clone
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?

<table>
<thead>
<tr>
<th></th>
<th>Monocots</th>
<th>Dicots</th>
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</thead>
<tbody>
<tr>
<td>Vascular tissues scattered in stem</td>
<td>Vascular tissues in circular pattern</td>
<td></td>
</tr>
<tr>
<td>Flower parts in three</td>
<td>Flower parts in 4-5 or multiples</td>
<td></td>
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<tr>
<td>Leaf veins parallel</td>
<td>Leaf veins branched</td>
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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 (CO2) and water (H2O) to carbohydrates

• Net result is transformation of light energy into chemical energy
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A model of Photosynthesis

Courtesy of Ohio State University
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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

- guard cell
- cuticle
- mesophyll
- upper epidermis
- palisade parenchyma
- chloroplasts
- xylem
- phloem
- lower epidermis
- spongy mesophyll
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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
How might this affect plant growth?

Powdery mildew on Rose

Courtesy of Ohio State University
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
Plant Growth

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

\[ C_6H_{12}O_6 + 6 \, O_2 \xrightarrow{\text{energy}} 6 \, CO_2 + 6 \, H_2O + \text{Energy} \]
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
Plant Growth

– Cycling of Photosynthesis and Respiration
  • What conditions would impact cycling?
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°F rise in temperature between 40°F and 96°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

Courtesy of Ohio State University
Plant Growth

– Respiration

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

\[ \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2 \xrightarrow{\text{energy}} 6 \text{CO}_2 + 6 \text{H}_2\text{O} + \text{Energy} \]
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
How might this affect water and nutrient uptake?

Nemotode attack on tomato roots

Courtesy of Ohio State University
Plant Growth

– *Transpiration*

• Evaporative loss of water vapor from plant leaves through stomata

• Related to *translocation* through xylem
Porous pot analogy to plant transpiration
Diagram of leaf cells and leaf epidermis with stoma

Courtesy of Ohio State University
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Stoma in epidermal peel of chrysanthemum

Courtesy of Ohio State University
Diagram of the cross-section of a woody perennial plant

Courtesy of Ohio State University
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• Plant Growth
  – Transpiration
    • Rate depends on
      – environmental factors (which ones?)
      – degree of stomatal opening
      – amount of available soil water
• **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
Impacts of a vascular wilt disease on maple
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?
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
  – Chill hours

--Hard seed coat
--Closed cone
Reproductive Development
– The goal for many horticultural plants
  • Flowers
  • Fruits
  • Seeds
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?
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
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)
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
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)
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
Plant responses to stress:
Leaf dema caused by wood-produced secretion deficit
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?