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Learning for Life

# Basic Botany

**The Science of Understanding Plants**
**Their Classification, Form and Function**

Information prepared by
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University of Georgia, Adapted for this
presentation by Mary Carol Sheffield

## Learning objectives

- **Basic plant parts -types of plant parts**
- **Vascular tissue & function**
- **Dicots & monocots**
- **Binomial nomenclature**

## Basic Botany Areas

- **Plant Taxonomy**
  – Plant identification, naming and classification
- **Plant Morphology**
  – Plant form and anatomy
- **Plant Physiology**
  – Plant functions and reactions

## Common Names - Nomenclature

- Common Names – Easy to use & remember
- Here is the Tulip Tree with flowers shaped like tulips
- Also called Saucer Magnolia and Japanese Magnolia
- There are several names for the same plant

*Magnolia × soulangeana*

## Common Names - Nomenclature

- Here is another Tulip Tree with leaves shaped like tulips
- Other common names are Yellow Poplar & Tulip Poplar
- There are two different plants with the same common name
- There are no rules to determine which name is correct
- However, each has only one botanical name

*Liriodendron tulipifera*

## Botanical Names - Nomenclature

- Botanical Names – Applied by botanist using the International Code of Botanical Nomenclature
- They seem difficult to learn & use since they are written in Latin
- They are precise – one name for each plant following the International Code
- The names also reflect the classification of the plants, or how they are related
- They follow the binomial system of nomenclature

## Binomial System of Nomenclature

- Binomial – Two name system of naming plants
- Genus is first name
- Species is second name
- Botanical Name – *Fothergilla major*
- Based on Species Concept – Populations of interbreeding plants

*Fothergilla major*

## Classification of Plants

- Families are made up of groups of related genera
- Each genus is made up of species
- Each species is a group of similar plants that are capable of interbreeding

**Oak Family – Fagaceae Includes**

*Quercus alba* – White Oak

*Quercus rubra* –Red Oak

*Fagus grandifolia* – Beech

*Castanea dentata* – American Chestnut

## Hybrids & Their Nomenclature

- Inter-specific Hybrids – crosses between species
  Example: (*Clematis lanuginosa* × *C. viticella)*
  Cross Named: *Clematis* × *jackmanii*
  Common Name: Jackman Clematis
- Inter-generic Hybrids – crosses between genera
  Example: (*Cupressus macrocarpa* × *Chamaecyparis nootkatensis*)
  Cross Named: × *Cupressocyparis leylandii*
  Common Name: Leyland Cypress

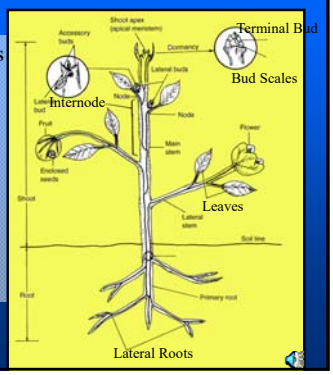
## Cultivars – Cultivated Plants

- Cultivars are developed, named & maintained by man
- Using the International Code of Botanical Nomenclature for Cultivated Plants
- Cultivar names are fancy names (non-Latin names)
- Made up of one, two or three words
- Cultivar plant names include genus, species & cultivar

*Acer rubrum* 'October Glory'

## Plant Form & Functions

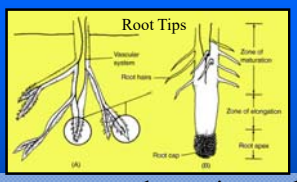
- Identify the plant parts from the illustration
- Terminal Bud
- Bud Scales
- Internode
- Leaves
- Lateral Roots



## Stem & Root Form & Function

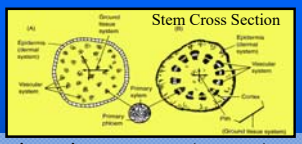
- Stems support leaves, flowers and fruits; transports food, water and nutrients
- Leaves make food and transpire water
- Buds produce new stems, leaves and flowers
- Flowers produce fruits and seeds
- Roots adsorb nutrients and water, anchor the plant, and can store food

## Root Form & Function




- The root cap protects the meristem, the area of cell division at the root tips
- Root hairs absorb most of the water and are concentrated in the maturation zone
- Roots transport water & nutrients in their vascular system

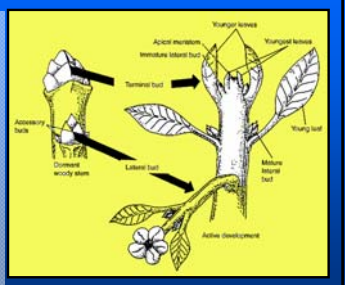
## ascular Tissue Form & Function



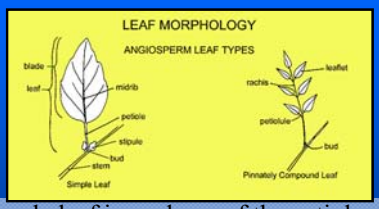

- Vascular tissue in monocots (grasses) are scattered in the stem (A), on left.
- Vascular tissue in dicots (broad leafed plants) are arranged in a circle inside the stem (B), on right
- The xylem tissue conducts water upward while the pholem conducts food from the leaves downward.

## Bud Form & Function

- Terminal buds develop into terminal shoots, leaves & buds
- Lateral buds develop into lateral shoots, leaves & buds
- Flowers may be produced by both

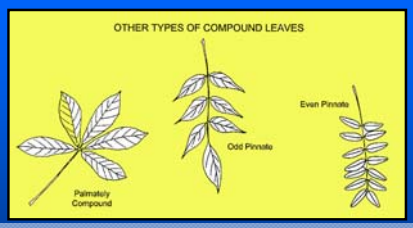



## Leaf Form & Function




- A simple leaf is made up of the petiole and blade. Stipules are leafy appendages at the base of the petiole
- A compound leaf has many leaflets & a central rachis. Each leaflet can have a short petiolule

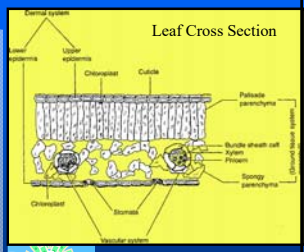
## Leaf Form & Function




- Pinnately compound leaves have opposite leaflets, they are even or odd in number
- Palmately compound leaves have leaflets meeting at the top of the petiole

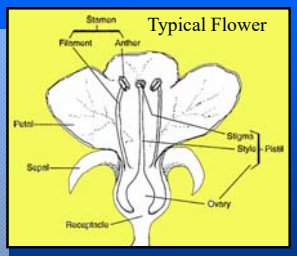
## Leaf Form & Function

- Cuticle is waxy & holds moisture in
- Chloroplasts intercept light and make plant food
- Stomata open to let oxygen out and $CO_2$ in
- Vascular system moves food & water




## Flower Form & Function

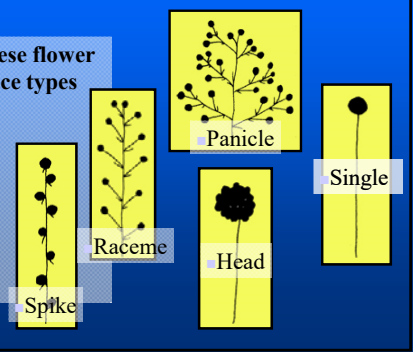
- The male stamen is made up of the anther and filament
- The female pistil is made up of the stigma, style and ovary
- A perfect flower has both, a functional pistil and stamens




## Flower Form & Function

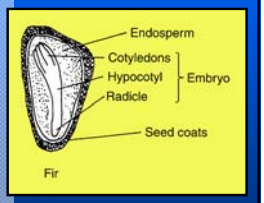
- **Identify these flower inflorescence types**

- Single
- Head
- Spike
- Raceme
- Panicle



## Seed Form & Function

- Seeds develop to allow reproduction
- Identify the function of these seed parts
  - Endosperm – Energy
  - Embryo - New Plant
  - Cotyledons - Seed Leaves
  - Hypocotyl - Transition
  - Radicle - Root
  - Seed Coat - Protection



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## Review Basic Botany

- Plant Taxonomy deals with (1) identification, (2) naming & (3) classification
- Problems with common names - not precise and no rules for naming
- Botanical names are precise and reflect classification
- Inter-specific and inter-generic hybrids are designated with a multiplication sign ( × )

## Review Basic Botany

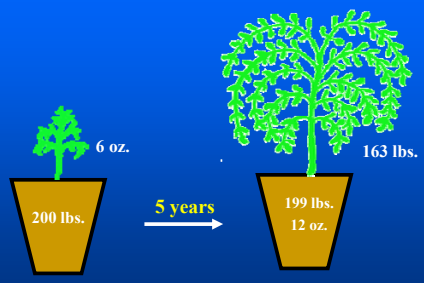
- Cultivars are selected, named and maintained by man
- The chloroplasts in the leaves make the food necessary for plant cell survival
- The vascular tissues move the water, nutrients and plant food through out the entire plant
- A perfect flower contains a pistil & stamens
- The embryo of the seed grows to produce an entirely new plant



## Plant Physiology

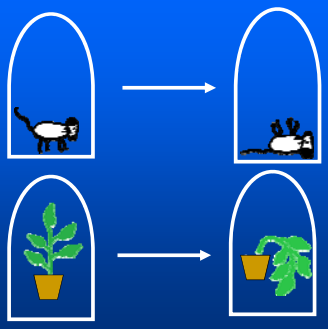
- Definition
- The Early Years
- Environmental Effects on Plant Growth
  - Light
    - Photosynthesis/Respiration
    - Phototropism/Photoperiodism
    - Other

## Van Helmont Experiment

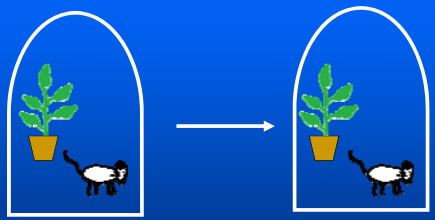



**Conclusion**: Plants don't consume soil

## Joseph Priestly Experiment



## Joseph Priestly Experiment



Photosynthesis

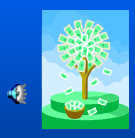
$$6Co_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + O_2 + \text{energy}$$

$6\ Co_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{light}} C_6H_{12}O_6 + O_2 + \text{energy}$ (ATP)

Photosynthesis → Glucose

Respiration: Glucose → ATP

Glucose
Sucrose
Starch
Amino Acids
Oils



**Photosynthesis**: A Building Up Process

**Respiration**: A Break-down Process

## Photosynthesis vs. Respiration

| Photosynthesis | Respiration |
|---|---|
| • Occurs only in light | • Occurs in light or dark |
| • Occurs only in cells containing chlorophyll | • Occurs in all living cells |
| • Increases dry weight | • Decreases dry weight |

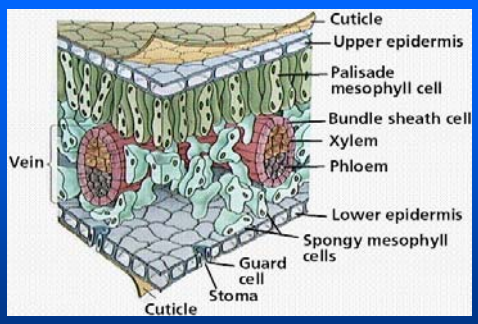
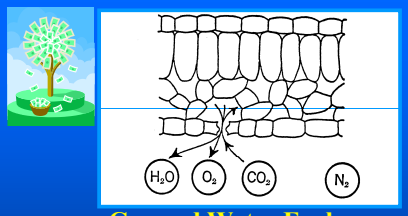
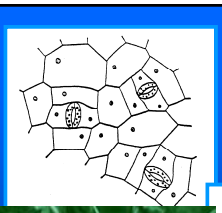



Image from Purves et al., Life: The Science of Biology, 4th Edition, by Sinauer Associates (www.sinauer.com) and WH Freeman (www.whfreeman.com).

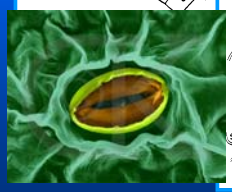


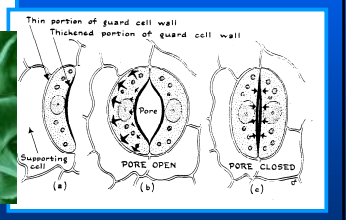

**Gas and Water Exchange Through Stomata (Stomate, singular)**

**Atmospheric elements (carbon, hydrogen, and oxygen) and water vapor move in and out of leaf through the STOMATA**



## Stomata on the Leaf Surface



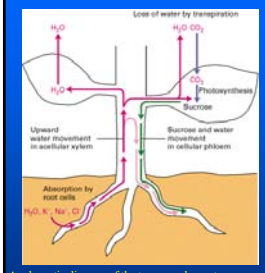



Pea Leaf Stoma, *Vicea* sp. (SEM x3,520). This image is copyright Dennis Kunkel at www.DennisKunkel.com.

## POP QUIZ!

- **Turn your handout over** and on a separate sheet of paper, write a sentence using all of the following words that describes the process of photosynthesis:
- Oxygen
- Energy
- Light
- Carbon Dioxide
- Chlorophyll
- Water
- Carbohydrates

## Plant Tissues that Conduct Water and Food




A schematic diagram of the two vascular systems, xylem and phloem, in higher plants, showing the transport of water (red) and sucrose (green). Image from Lodish et al. Molecular Cell Biology, 4th Edition by W.H Freeman www.whfreeman.com.

**Water and nutrients (N, P, K, Ca, Mg, Fe etc.) move upward in the plant to areas undergoing respiration and food manufacture via the XYLEM**

**Carbohydrates, starch, water, proteins, amino acids, oils etc. move to areas where needed for growth or to the root for storage via the PHLOEM**

## Plant Tissues that Conduct Water and Food


Stem structures, including xylem, phloem, pith, cortex and epidermis. This image is copyright by Karen Carr Media: Digital at www.karencarr.com

## Light

## The Electromagnetic Spectrum

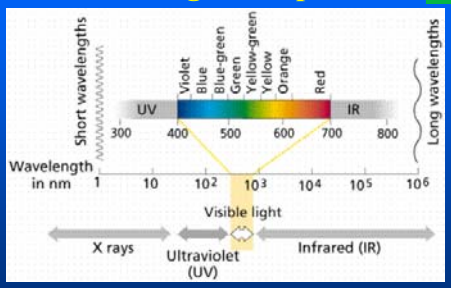



Image from Purves et al., Life: The Science of Biology, 4th Edition, by Sinauer Associates (www.sinauer.com) and WH Freeman (www.whfreeman.com).

## Light Adaptability of Woody Ornamentals

| Adapted to Shade | Flower Well in Shade | Flower Poorly in Shade |
|---|---|---|
| ▪ Aucuba | ▪ Azalea | ▪ Rose |
| ▪ Azalea | ▪ Hosta | ▪ Clematis |
| ▪ Camellia | ▪ Camellia | ▪ Forsythia |
| ▪ Cleyera | ▪ Dogwood | ▪ Hydrangea |
| ▪ Gardenia | ▪ Gardenia | ▪ Hibiscus |
| ▪ Hosta | | ▪ Flowering Cherry |
| ▪ Nandina | | |
| ▪ Yew | | |

## Effects of Light on Plants

**Very High Light:**

Leaves smaller/thicker

Chlorosis (overall yellowing)

Brown Spots

**Very Low Light:**

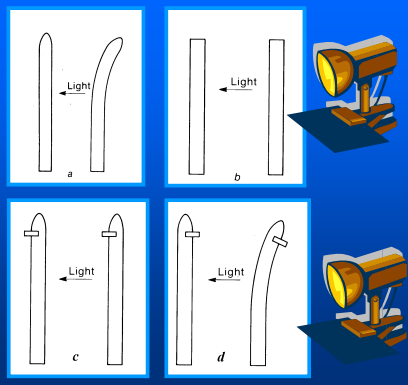
Leaves larger/thinner

Greater internode length - stretching

## Phototropism

A change in the manner of growth of a plant in response to non-uniform illumination. An auxin-related response causing bending toward the strongest light.

## Phototropism: F.W. Went Expt. - 1928






Auxin produced in the tip moves downward on the side of the stem opposite the illuminance, causing cell elongation

## Photoperiodism

The response of plants to the lengths of day or night

Discovered 1906: Garner and Allard Maryland Mammoth Tobacco

In the field: Grew 10 to 15 feet tall – would not flower until late fall or winter

## Three Photoperiodic Responses

**Short Day Plants:** Initiate flower buds when day length is shorter than the critical day length or when the dark period is longer than the critical night length.

- Poinsettia
- Chrysanthemum
- Aster
- Goldenrod
- Ragweed
- Christmas Cactus
- Variegated Spider Plant

## Three Photoperiodic Responses

**Long Day Plants:** Initiate flower buds when the day length is longer than the critical day length or when the dark period is shorter than the critical night length.

Hollyhock
Radish
Beets
Spinach
Iris
Red Clover

## Three Photoperiodic Responses

**Day Neutral:** Flower over a wide range of photoperiods.

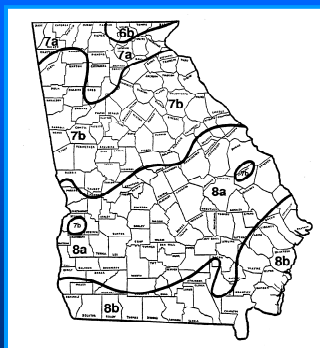
| | |
|---|---|
| Cabbage | Hyacinths |
| Carrots | Daffodils |
| Tulips | Tomatoes |

**Most woody ornamentals are day neutral**

## Temperature

- Governs the rate of photosynthesis and respiration.
- Influences fall color - sugars to starch, chlorophyll ceases function and carotenoids (orange) and anthocyanins (red) become evident.
- Influences leaf fall and dormancy.
- Influences fruiting plants. Many horticultural plants have a cold or chilling requirement. (peaches 350-1200 hours below 45 degrees F).
- Influences hardiness (flowers<roots<leaves<stems).

## Plant Hardiness Zones



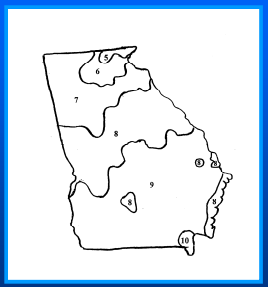

Range of Average Annual Minimum Temperatures for Each Zone

| Zone | Range in Degrees F |
|---|---|
| 6b | 0 to –5 |
| 7a | 5 to 0 |
| 7b | 10 to 5 |
| 8a | 15 to 10 |
| 8b | 20 to 15 |

## Root Killing Temp. of Selected Landscape Plants

| Species | °F |
|---|---|
| Southern Magnolia | 23 |
| Flowering Dogwood | 20 |
| Boxwood | 15 |
| Japanese Andromeda | 10 |
| Horizontal Juniper | 0 |

## Heat Zone Map For Georgia




Ave. no. of days per year above 86 degrees F

| Zone | Ave. No. Days |
|---|---|
| 5 | 30 – 45 |
| 6 | 45 – 60 |
| 7 | 69 – 90 |
| 8 | 90 – 120 |
| 9 | 120 - 150 |

# Water

**The lifeblood of plants**

**Water is essential for:**

**Chemical reactions in the plant**

**Translocation of nutrients**

**Transpiration**

# Water Movement in Plants

**How does water reach the top of our tallest trees?**

**Root pressure – not found in many species. In those species where it has been found, only enough pressure has been measured to push water to a height of 64 feet.**

# Water Movement in Plants

**Water is pulled up in the xylem by a transpiration-cohesion-tension mechanism.**

**Transpirational loss of water causes additional water to be pulled up through the xylem to replace the water lost.**

## Sixteen Essential Nutrients for Plant Growth

**Atmospheric Nutrients**
C - Carbon H – Hydrogen
O - Oxygen

**Primary Nutrients**
N – Nitrogen P – Phosphorus
K - Potassium

**Secondary Nutrients**
Ca – Calcium Mg - Magnesium
S - Sulphur

**Micro Nutrients**
Fe – Iron Cu – Copper Zn – Zinc B – Boron
Mn – Manganese Mo – Molybdenum Cl - Chlorine

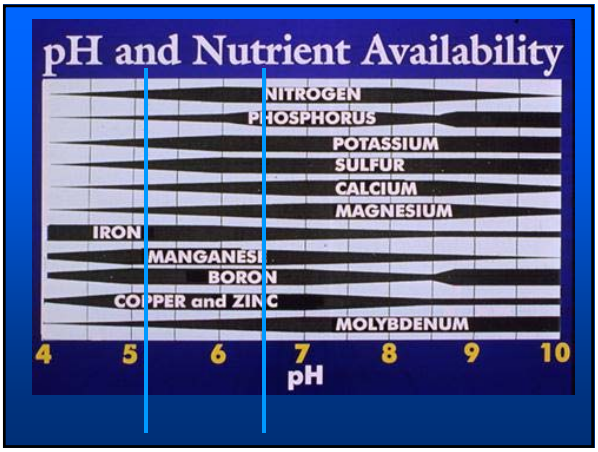
## Each Nutrient Has An Important Function In Plants

- Nitrogen
  - An essential component of proteins, amino acids, chlorophyll and many other organic compounds
- Phosphorus
  - A component of phosphorylated sugars (ATP, DPM, DNA)
- Sulphur
  - A component of proteins and many other substances

## Each Nutrient Has An Important Function In Plants

- Calcium
  - Necessary in calcium pectate in cell walls
- Iron
  - A constituent of important enzymes
- Magnesium
  - A part of the chlorophyll molecule

Trace or minor elements are essential in many chemical reactions



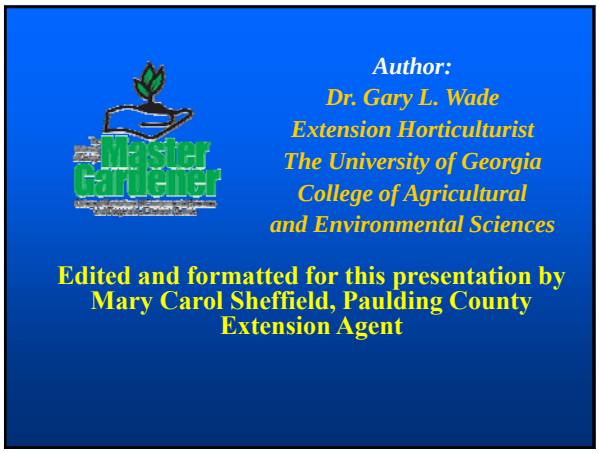

- Water and nutrients move into the plant primarily through the intercellular spaces between the root cells. They move into the internal vascular system called the xylem and are pulled upward in the plant via cohesion and tension resulting from transpirational water loss through the stomata.

- Water and nutrients take part in the food manufacturing process during photosynthesis. Respiration then breaks down the food manufactured in order to produce energy.

- Growth substances, such as amino acids, proteins and oils, are transported to other areas of the plant (ie. developing fruit, flowers, leaves or roots) via the phloem.

- Carbon dioxide, oxygen and water vapor move in and out of the plant via the stomata or breathing structures on the leaves.

- Light and temperature have a pronounced effect on the rate of photosynthesis and respiration.

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