Basic Botany

Instructor- John Joyce
• QUESTIONS?

• What takes place in a seed?
• What controls flowering?
• Why is light necessary?
• How does water travel?
The Major Groups of Organisms

Prokaryotes
Kingdom Monera
• Bacteria, blue green algae

Eukaryotes-
• Kingdom Protista
  • Molds
  • Algae, Plankton
  • Fungi
• Kingdom Plantae
  • Bryophytes (Mosses)
  • Vascular Plants
  • (Seedless [Ferns] and Seed Forming)
How the World Was Once Viewed

• Animals VS. Everything Else:
  Seaweeds
  Mushrooms
  Mosses
  Medicinal Plants
Taxonomy

• The science of biological classification of plants and animals.
• Putting plant and animals in the form of superior and subordinate groups.
• To develop a convenient and precise method of classifying.
Taxonomy

- KINGDOM
- PHYLUM
- CLASS
- ORDER
- FAMILY
- GENUS
- SPECIES

King Phillip came over for good sushi!
• KINGDOM
• FUNGI
• Carl Linnaeus
• 1707-1778

• Binomial system of
• Nomenclature

• Genus species

• *Phaseolus vulgaris* L.
  common bean

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Plant Classification

- morphology of flowers
- pollen characteristics
- mode of embryo development
- leaf shapes
- vein patterns

- And the list goes on
• **Everyday nomenclature**
  - genus, species
  - common name
  - variety

• **Common name** - to particular area
• **Variety** - not true species
• Cultivar - do not occur in nature and must be cultivated.
• **X** - interspecific hybrid
Common names
Don’t always identify the plant

*Liriodendron tulipifera*
- Tuliptree in the north
- Yellow Poplar in the south

*Carpinus caroliniana*
- American Hornbean
- Blue Beech
- Musclewood
- Water Beech
- Ironwood

*Nymphaea alba*
- European White Waterlily
- 15 common English names
- 44 common French names
- 105 common German names
- 81 common Dutch names
Scientific Names--Binomial Nomenclature

Names follow

- *International Code of Botanical Nomenclature*
  (for wild or naturally occurring plants)
- *International Code of Nomenclature of Cultivated Plants*
  (for cultivated plants)

Good sources

- *Hortus Third* or *Hortus Fourth*
Scientific Names--Binomial Nomenclature

“sp.” = species (singular)  Do not italicize
“spp.” = species (plural)  or underline.

For example

- *Prunus sp.* -- Refers to a definite plant in the *Prunus* genera of unidentified species.

- *Prunus spp.* -- Refers to all of the species in the *Prunus* genus.
Family

- Group of closely related genera, often sharing similar structure and appearance
- Cultural practices (i.e., the care of the plant) generally follows family lines

Examples

- **Solanaceae** -- Nightshade family including tomatoes, potatoes, and petunias
- **Rosaceae** -- Rose family including 250 common landscape plants
- **Poaceae** -- Bluegrass family
Subgroups of Cultivar

**Clone** -- cultivars propagated by vegetative methods

**Line** -- cultivars propagated by seed

**Group** -- a group of cultivars of similar plants

**Strain** -- subgroup of cultivar with specific characteristics, like resistance to a disease or better color.

- Early Girl VFN Tomato

**Form** -- selection based on shape

- Columnar Norway Maple
Subspecies Categories

**Botanical Variety** -- plant group in the wild

- *Buxus microphylla* var. *japonica*
  - Japanese Boxwood
- Cabbage and cauliflower are varieties of *Brassica oleracea*.

**Cultivar** -- plant group from a cultivated variety

- Early Girl, Big Boy, and Better Boy Tomato
Is this name for Thornless Common Honeylocust correctly written?

Gleditsia triacanthos inermis

Third name must be preceded by
- “ssp.” for sub-species
- “var.” for variety
- “cu” for cultivar

Correctly written:

Gleditsia triacanthos var. inermis
Vascular Plants

• Any plant containing water and food conducting tissues.
• Seed/Seedless
SEEDLESS PLANTS

• Considered ‘lower’ vascular plants
• Most abundant - ferns
SEED PLANTS

Two Types

- **Gymnosperms**
  - Non-flowering
  - exposed bracts
  - not in ovary

- **Angiosperms**
  - flower bearing
  - seeds exposed
  - ovary / fruit
Seed Plants: Cone-bearers
GYMNOSPERMS

- Greek *gymnos* – naked
- *sperma-* seed
- More primitive
- Economic importance
- Cone bearing, needle
- leafed
Seed plants: Flowering plants
ANGIOSPERMS-

- Greek *angeion*-vessel
- *sperma*-seed
- Most sophisticated
- best adaptations
- Most diversified
Gymnosperm           Angiosperm
Anatomy
Plant Parts and Functions
The Principal Parts

Flower
Leaf axil
Petiole
Terminal bud
Lateral bud
Leaf blade
Node
Internode
Vascular system
Primary root
Lateral root
Root hairs
Root cap
Stems

• Structures that support buds and leaves.
• Serve as conduits for water minerals and sugars.
• Xylem, phloem and cambium.
Discontinuous vascular system of a monocotyledonous stem

Continuous vascular system of a dicotyledonous stem
Stem pith
a tool for plant ID

Cross-section

- Triangulate
- Star-shaped
- Rounded

Hollow pith
Chambered pith
TISSUES

• Xylem-*(wood)* group of specialized cells transport water

• Phloem-*(tree bark)* group of specialized cells transport food molecules
Cambium

• Meristem a site of cell division and active growth located between the xylem and phloem
• Node- part of a stem where leaves are attached to the stem and buds are located in these leaf axils (angle between the stem and bud/leaf).

• Internode- stem section between nodes-
• Length depends - varies with season
• Fertility, light competition.
Modified stems

• Spurs-compresses fruiting branch
Aboveground modifications

- Node
- Runner

Spur
Branch
Stolon

Belowground modifications

- Tuber
- Rhizome
- Bulb
- Corm
- Tuberous Begonia
Stolen

- Horizontal stem that is fleshy or semi woody and lies along the top of the ground
- Spider plant
- Strawberry
Crown

- Compressed stem having leaves and flowers on short internodes.
- Located at soil level so that roots support them upright and the central growing point is never covered with soil.
Rhizome

- Rhizomes are thickened, swollen stems that grow horizontally.
- Grown at or just below the surface.
- Divide after flowering and discard central portion.
- Examples
  - Iris
  - Canna
  - Solomon’s Seal
Bulb

- A true bulb is an underground modified leaf bud, which consists of a short, thick stem and fleshy scales.
- Serves as a storage organ.
- Examples
  - Tulip
  - Hyacinth
  - Daffodil
Corm

- A corm is a solid, swollen stem base that grows vertically.
- A corm has a distinct basal plate with the growing point at the top.
- Divided by off sets called cormels.
- Examples
  - Liatris
  - Gladiolus
  - Crocus
Tuber

- Tubers are underground stems used for food storage.
- Tubers have no basal plate and no dry covering.
- They can be divided by cutting into sections that have growing buds, or eyes. Each bud can produce a new plant.

Examples
- Caladium
- Tuberous Begonia
- Cyclamen
- Potato
Tuberous Roots

- Real roots.
- Food supply is kept in root tissue, not in stem or leaf tissue as in other bulbs.
- These roots do not have buds that are capable of producing new plants.
- Example
  - Dahlias
  - Sweet Potato
**Stem types**

- **Shoot** -- young stem with leaves
- **Twig** -- woody stem <1 year old
- **Branch** -- woody stem > 1 year old
- **Trunk** -- main support stem(s)
- **Water sprout** -- adventitious shoot from branches or trunk
- **Sucker** -- adventitious shoot from roots
- **Cane** -- stem with large pith, usually living only 1-2 years
Texture and Growth of Stems

- Woody
- Herbaceous or succulent
- Annuals
- Perennials
- Biennials

- Stems as food-potato
- Asparagus, broccoli
- cauliflower
Leaves
Parts of a Leaf

- Stem
- Petiole
- Midrib
- Blade

Broadleaf

Conifer Leaves

Sheath

Noodles
Leaf structure

- Tip
- Blade
- Base
- Petiole (leaf stalk)
- Bud
- Lateral vein
- Margin
- Midrib
- Stipules
Leaf Parts

Leaf cross section
designed to maximize photosynthesis

- Upper epidermis
- Palisade layer
- Vascular bundle
- Spongy mesophyll
- Lower epidermis
- Guard cells
- Stoma
- Intercellular chamber
Stoma
Terminal leaflets modified into Tendrils

Sweet Pea
The Leaf: Arrangement

- Active

- Dormant
The Leaf: Shape and Venation

- Simple
- Palmate compound
- Pinnate compound
- Double pinnate compound
- Parallel
- Pinnate
- Palmate
  - Not veined
Leaf arrangement, a tool for plant ID

Leaflets

Simple
Pinnately Compound
Palmately Compound
Doubly Compound

Leaf or Leaflet?
A bud is found at the base of a leaf, but not a leaflet.
Leaf type (venation), a tool for plant ID

**Conifers (Coniferophyta)**

Evergreens, with needle-like leaves

- scale-like
- awl shaped
- linear shaped
- single needles
- bundled needles
- clustered needles
Leaf shape, a tool for plant ID

**Tip shape**

- acuminate
- acute
- cuspidate
- emarginate
- Mucronate
- obcordate
- obtuse
- truncate
Margin patterns and leaf shapes. Margins: a. entire, b. sinuate, c. crenate, d. serrate, e. dentate, f. lobed, g. double serrate. Shapes: h. linear, i. oblong, j. ovate, k. hastate, l. sagittate, m. deltoid, n. spatulate, o. peltate.
The Stem: Buds, Scales and Scars
External features of twigs

The *leaf scar* and *bundle scars* are used in plant identification.

Leaf scar

Bundle scars
Bud type

a tool for plant ID

accessory conical narrowly conical one-scales

scale over leaf scar ovoid rounded scales in two ranks

stalked striate scales superposed valvate
Changes in length of annual growth indicates general vigor of trees.
Compare twig length between annual growth rings
Which tree is under stress?

1st year
3”
2nd year
2”
3rd year
1”
4th year
6”

1st year
3”
2nd year
2”
3rd year
3”
4th year
6”
Root function

- Absorb and conduct water and minerals.
- Anchor and support plant
- Storage and winter survival

80% of all plant problems begin with root/soil disorders.
Fibrous root vs. Tap root
Root structure

- Epidermis
- Cortex
- Endodermis
- Pericycle
- Phloem
- Xylem
The Plant Root

Diagram showing the structure of a plant root, including:
- Zone of maturation
- Root hair
- Zone of elongation
- Meristematic zone
- Endodermis (casparian strip)
- Pericycle
- Phloem
- Cambium
- Xylem
- Primary xylem
- Cortex
- Epidermis
- Primary xylem and phloem
- Cortex cells (food storage)
- Cell division (mitosis)
- Root tip
- Root cap
- Lateral root
- Emerging lateral root
- Root hairs
- Root cap

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Flowers

- Sole purpose is sexual reproduction
- Continuation of species
- Fragrance and color to attract pollinators
- Importance of insects
Taxonomy is based on flower structure.

- **Stamen**
  - Anther
  - Filament

- **Pistil**
  - Stigma
  - Style
  - Ovary

- **Calyx**
  - Sepals

- **Corolla**
  - Petals

- **Receptacle**

- **Pedicel** (flower stem)
Monocot or Dicot?

Monocot
Parts in 3s

Dicot
Parts in 4s or 5s
• Tepals
Pollination & Fertilization

Events leading to the fertilization of a flower’s eggs.

1. Pollen grains land on the stigma and germinate.

2. Pollen tubes, through which the sperm move, grow through the style. A tube nucleus precedes the sperm in each pollen tube.

3. A pollen tube enters each ovule to deliver the sperm to an awaiting egg.
Pollen grains on lilies stigma
Pollination

- **Self-pollinated** - Not common in nature. Cultivated crops such as tomatoes, peppers, eggplants, beans, and most cereal crops.

- **Cross-pollinated** - Pollen from one plant pollinates the stigma of another. Flowers of the majority of plant species have features that favor and ensure cross-pollination.
Germination

• Occurs when the pollen tube pushes through a pore of the pollen grain and starts growing down the style.
Cross Pollination

• Monoecious species - both male and female
• Dioecious species - separate (holly)
• Timing of maturation of stigma
• Self-incompatibility - can be either structural or physiological*

• More common - self pollination can occur, but self fertilization does not
Salvia flowers (sage)

Specialized structures

- tubular corolla
- stamen attached to hinge bearing basal projection
Types of Inflorescence

- Spike
- Raceme
- Corymb
- Umbel
- Head
- Dischasia cyme
- Helicoid cyme
- Scarpoid cyme
Inflorescence, the arrangement of flowers, is used for plant ID.

- Single spike
- Raceme
- Corymb
- Umbel
- Cyme
- Panicle
- Spadix
- Composite

Floret, ray flowers, and disk flowers are also important in plant identification.
Fruit

- A ripened ovary
- Fertilized mature ovules (seeds),
- ovary wall
- Fleshy (melons)
- Dry (pecan)
In apples, the ovary wall becomes the fleshy part of the fruit.
Simple Fruits

- Develop from a single ovary.
- Cherries, peaches (drupes)
- Apples, Pears (pomes)
- Tomato (berries)
- Dry-Peanut, maple (samara), Walnut (nuts)
Aggregate Fruit

- Single flower with many ovaries.
- One corolla, calyx and one stem.
- Many pistils or ovaries.
- Fertilized separately.
- Edible enlarged receptacle.
Multiple Fruits

- Tight clusters of separate independent flowers borne on a single structure.
- Own calyx and corolla.
- Pineapple, fig
The Seed

- Mature ovule
- No sign of “life”
- Dormancy - period of inactivity.
- Viable--------Dormant
- Capable of germination.
Parts of the Seed

- **Embryo** - miniature plant – dormant state
- **Endosperm** - food source.
- **Seat coat** - hard covering, protection
Germination

Protective Mechanisms that must be overcome during seed propagation:

- seed dormancy
- acid pretreatment requirements
- germination inhibitors in seed coat
- tough seed coats that have to be mechanically opened
- Need for scarification - seed surface etching
- Need for stratification - Moistenened and given extended Period of low temperature
Monocot seed
One cotyledons

Seed coat
Endosperm
Cotyledon
Plumule (shoot)
Radicle (root)
Dicot seed

Two cotyledons

- Plumule (shoot)
- Hypocotyl
- Radicle (root)

- Seed coat
- Cotyledon
Dicot emergence

- Trifoliate leaf
- Primary leaf
- Cotyledon
- Hypocotyl
- Hypocotyl
<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>DICOTS</th>
<th>MONOCOTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flower parts</td>
<td>In fours or fives (usually)</td>
<td>In threes (usually)</td>
</tr>
<tr>
<td>Pollen</td>
<td>Basically tricolpate (having three furrows or pores)</td>
<td>Basically monocolpate (having one furrow or pore)</td>
</tr>
<tr>
<td>Cotyledons</td>
<td>Two</td>
<td>One</td>
</tr>
<tr>
<td>Leaf venation</td>
<td>Usually netlike</td>
<td>Usually parallel</td>
</tr>
<tr>
<td>Primary vascular bundles in stem</td>
<td>In a ring</td>
<td>Complex arrangement</td>
</tr>
<tr>
<td>True secondary growth, with vascular cambium</td>
<td>Commonly present</td>
<td>Absent</td>
</tr>
</tbody>
</table>
Plant Physiology - Growth and Development

- Photosynthesis
- Respiration
- Transpiration
- Absorption
- Translocation
Photosynthesis

The combining of carbon dioxide and water to form carbohydrates and oxygen.

This process is essential to life on earth. Basis of all food chains.

Dependent on light availability, water, CO2 Temperature- 65 to 85 degrees
Photosynthesis (to put together with light)

Carbon dioxide
+ Water
+ energy

  carbohydrates  
  (starches and sugars)
+ Oxygen

6 CO₂ + 6 H₂O + energy

C₆H₁₂O₆ + 6 O₂
Photosynthesis occurs in the **chloroplasts** located in the mesophyll layers of plant leaves (and in some instances, in mesophyll cells in the stem).

- Chloroplasts are incredibly small. One square millimeter, about the size of a period on a page would contain 400,000 chloroplasts.

- Chlorophyll, the pigment that makes leaves green, is found in the chloroplasts. It is responsible for trapping light energy from the sun.
Respiration

• The release of chemical energy by plant and animal cells.
• Reverse of photosynthesis.
Photosynthesis  ↔  Respiration

- Produces: food
- Stores: energy
- Uses: water and carbon dioxide
- Releases: oxygen

- Sunlight: occurrence
- Light & dark

- Uses: Light & dark
- Releases: Light & dark

- Produces: food
- Stores: energy
- Uses: water and carbon dioxide
- Releases: oxygen

- Sunlight: occurrence
- Light & dark
Transpiration

• The process by which a plant loses water, primarily from leaf stomata.

• Involved in water absorption by roots.
Transpiration accounts for 90% of the water use by plants

Functions of transpiration

- Transporting minerals from soil throughout the plant
- Moving sugars and plant chemicals
- Cooling via evaporation
- Maintaining cell firmness (turgor pressure)
Transpiration

- Dependant on:
  - **temperature** - increases will cause transpiration to increase.
  - **humidity** - increases will cause transpiration to decrease.
  - **air movement** - increases will cause transpiration to increase.

Transpiration accounts for 90% of the water use by plants.

$\text{H}_2\text{O}$ $\text{CO}_2$
Adsorption

• Process where water and minerals are moved into the plant.
• Occurs through roots and root hairs.
Translocation

• Movement of water, minerals and food through a plant's vascular system.
• Move from root to upper plant parts.
• Active process requiring respiration energy to move upward and downward in the plant.
Environmental Factors affecting Plant Growth

- Light - quantity, quality and duration.
- Temperature
- Water - photosynthesis
- Nutrition
Light

- Quantity - intensity or concentration of light and varies with season.
- Quality - color or wavelength.
- Duration - photoperiod - amount of time that a plant is exposed to sunlight.

**Light duration: photoperiod**

<table>
<thead>
<tr>
<th>Short-Day Plants</th>
<th>Long-day Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>(long-night plants)</td>
<td>(short-night plants)</td>
</tr>
<tr>
<td>vegetative</td>
<td>flowering</td>
</tr>
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- Poinsettias
- Christmas cactus
- Chrysanthemums

- Spinach
- Onions
Temperature

• Productivity and growth of plants
• Warm season /cool season
• Low temps=decrease in photosynthesis= lower yields.
Temperature effects

- Photosynthesis- increase with temperature
- Respiration- rapidly increase with temperature.
- Transpiration- increase with temperature
- Flowering- partially triggered by.
- Sugar Storage- low temps reduce energy use- store sugar.
- Dormancy- warmth after a low period will break dormancy- active growth.
Nutrition

- Refers to the needs and uses of the basic chemical elements in the plant.
- 16 elements for growth.
- Macronutrients- Carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, magnesium, calcium, sulfur.
- Micronutrients- iron, zinc, molybdenum, manganese, boron, copper and chlorine.
• CONGRATULATIONS!!!!
• YOU HAVE SURVIVED BASIC BOTANY!!!!!