Botany for Gardeners
Heather Sloven

Why Botany?
- Botany = study of plants!
- Background for many principles you will be learning
  - Plant ID
  - Pruning
  - Propagation
  - Plant growth and processes
  - It is fun to learn!

Today’s Topics
- Survey of plants and relevant non-plants
- Anatomy of plants
  - Leaves
  - Stems
  - Flowers
  - Vascular system
  - Photosynthesis, respiration and transpiration
  - Plant hormones

What is a plant?
- In the kingdom Plantae
- Generally...
  - Make their own food
  - Chlorophyll a & b
  - Multicellular
  - Cell walls made of cellulose
  - Limited motility

Variation in plants

Kingdom Classification
Photos: Linda McMahan

Indian pipe
Volvox
A tour of the plant kingdom...

- Separated into monocots and eudicots

Not Shown: Fungi, certain algae

Algae

- Some types of algae (green algae) are classified as plants others are not

Cyanobacteria (not a plant)

Photo: Linda McMahan

Not Plants but important...

- Slime Molds
  - Slime molds are primitive single cell organisms that travel together as a crowd
  - Occur on moist soil, lawns, stumps and mulch
  - Not deleterious to plants

Slime Molds

Fungi

- Often see the fruiting body above ground
- Hyphae are strands of fungus
- Most of fungal organism is underground and unseen

Fungi

- Form spores
- Fungi are decomposers and some are pathogens
- Many have positive associations with plants

Photos: Linda McMahan

OSU disease clinic

Fungi

ucanr.edu
cals.ncsu.edu
Symbiosis
- relationships between species
- Mycorrhizae – between plants and fungus
- Lichen – between fungi and algae

Lichens
- Can live in extreme environments as epiphytes – arctic, deserts, rocky areas
- Long lived, slow growing, many 1mm/yr
- Vulnerable to environmental disturbance

Mosses
- Reproduce via spores
- Lack an extensive vascular system

Liverwort
- A lot like mosses except more differentiated leaves or lobes

Back to Plants...

Horsetail
- Ancient plants – relatives were thick as forests and tall as trees
- Hollow stems and jointed
- Produce spores
- Have vascular system
- Stiff due to retention of silica

Ferns
- Reproduce via spores
- Have a vascular transport system
- Can be tree size
- Most need moist sites
Conifers
- Classified as gymnosperms — “naked seed”
- Produce cones
- Foliage is needles or scales
- In junipers, “berries” are female cones
- Most are evergreen, but some are deciduous
- Non-deciduous also shed needles each year

Flowering Plants
- Angiosperms – seeds enclosed
- Principle group of plants on earth
- Identifying structures
  - Leaves
  - Stems
  - Flowers
  - Fruits

Plant identification
- Monocot vs. eudicot
- Leaf arrangement
- # petals
- Flower type
- Flower parts
- Fruit type
- Other
  - Hairs
  - Thorns
  - Sap

Eudicots vs. Monocots
- Monocots
  - Flower parts are in 3’s, leaf veination parallel, one cotyledon
- Eudicots
  - Flowering parts typically multiples of 2, 4 or 5
  - Two cotyledons
  - Vein patterns palmate or pinnate

Monocots and Eudicots
- Plant families will be either monocots or eudicots
  - Monocot family examples:
    - Liliaceae
    - Vidiaceae
    - Poaceae
  - Eudicot family examples:
    - Asteraceae
    - Brassicaceae
    - Roseaceae

Monocot or Eudicot
- Flowering parts?
- Veination?
Monocot or Eudicot
- Flowering parts?
- Veination?

Leaf structure
- Arrangement
  - Opposite/alternate/whorled

Note: Leaves have an opposite arrangement

Leaf Parts
- Leaf blade
- Petiole

Leaf structure
- Shape
  - Chordate
  - Linear
  - Ovate

Leaf structure
- Adaptations to the environment
  - Hairs
  - Wax
  - Trichomes
Leaf structure
- Leaf margins
  - Lobed
  - Dentate
  - Entire

Leaf structure
- Simple

Leaf structure
- Compound

Leaf structure
- Compound leaves
  - Pinnate
  - Bipinnate
  - Palmate
Stems
- Provide structure
- Parts of the stem: nodes and internodes

Bark
- Protects the tree's vital growing areas
- Can be beautiful

Roots
- Anchor plants
- Absorb water and mineral nutrients
- Often stores food
- Can be reproductive
- Types of roots
  - Tap – anchorage, storage
  - Fibrous – shallow, cover large area

Flowers
- Contain reproductive structures

Exercise – Look at the Parts of a Twig
- Terminal bud
- Auxiliary buds
- Leaf scars
- Bud scale scars

Roots
- Many "roots" are specialized stems
  - Tubers
  - Bulbs
  - Corms
  - Rhizomes

StudyPage.in
Flowers
- Petal number
- Regular (radial) vs. irregular (bilateral)
- Flower parts
- Inflorescences

Flowers
- Perfect
  - Has male and female parts
- Imperfect
  - Lacking parts
  - Called staminate or pistillate flowers

Flowers – an example
- Flowers can be complete (has sepals, petals, stamens, and pistils) or incomplete (missing one of above)
- Hydrangeas
  - An example of incomplete flowers
  - Contains sterile and fertile flowers
  - “petals” are really sepals (calyx)
  - Cluster of flowers called corymb (top photo)

Flowers
- Imperfect flowers
  - Monoecious
    - Male (staminate) and female (pistillate) flowers on same plant
  - Dioecious
    - Male and female flowers not on same plant

Flowers – an example
- Corn
  - An example of incomplete flowers
  - Plants are monoecious
  - Imperfect - Staminate and pistillate flowers
Flower parts

From wikipedia.org

Exercise – Find the Parts of a Flower

Are your examples complete or incomplete? Perfect or imperfect? Monocot or Dicot?

Pollination and fertilization

- Methods – insects/animals, wind, rain, human
- Pollination vs. fertilization
- Incompatibility
- Timing and genetics

Pollination - an Example

- Hazelnuts
  - Pollination occurs in Jan-Feb
  - Fertilization takes place 4-5 mo. later
  - Hazelnuts are not self-compatible – need pollinizers
  - Wind pollinated

Fruits and berries

- Seeds are found in fruits
- Fruits provide protection and sometimes incentives for animal seed dispensers
- Seed dispersal is very important for the plant!

Fruits

- Types of fruits
  - Simple – one ovary
  - True berry
  - Pome
  - Aggregate – many ovaries
    - Blackberries, strawberries
    - Multiple- fusion of many flowers
  - Pineapples
  - Fruits can be dry or fleshy

Physiology

- Leaves
- Stems
- Roots
- Photosynthesis
- Transpiration
- Respiration
- Plant hormones
Leaf structure
- Cellular structure and physiology
- Epidermis
  - Adaptations - hairs, waxy cuticle
- Mesophyll
  - Most photosynthesis takes place here

Vascular Systems
- Xylem - water conducting tissue
- Phloem - photosynthate transport
- Cambium - divides to produce xylem and phloem in eudicots

Stems
- Cross section
- Only eudicots produce woody tissue, why?

Stems: wood
- Vascular structure also important for pest management and propagation

Exercise: look for vascular bundles
- Xylem - water conducting tissue
- Phloem - photosynthate transport
- Cambium - divides to produce xylem and phloem

Root Structure
- Epidermis
- Cortex
- Phloem
- Xylem
- Vascular cambium
- Negative water potential draws water into roots, transpiration helps move water through xylem
Roots – Nutrient movement

Most nutrients diffuse into roots, is also some active transport.

Organic matter and many clays have high CEC and hold nutrients well.

Photosynthesis

Key to our life on earth!
Plants make their own food
Only plants do this

Photosynthesis

Factors affecting rate of photosynthesis
- Water availability
- Temperature
- Light
  - Plants able to use ≈ 40% of sunlight
  - Plants are green because they reflect green wavelengths
  - Blue light = vegetative (fluorescent lights for seedlings)
  - Red & blue = flowering

What is Respiration?

A process that all living things go through
The process occurs during both day and night
It is a “breaking down process”

Food made during photosynthesis (photosynthates) is broken down to generate energy
This energy is used for plant growth and development
For growth to occur photosynthesis must be greater than respiration
**A Comparison**

**Photosynthesis**
- produces food
- stores energy
- uses water
- uses carbon dioxide
- releases oxygen
- occurs in sunlight

**Respiration**
- uses food
- releases energy
- produces water
- produces carbon dioxide
- uses oxygen
- occurs in dark and light

**An “Ahaaa Moment”**
- Why roots need air and do not like waterlogged soils
- Respiration requires oxygen
- Without oxygen, root cells cannot convert glucose and maintain cell processes and root tissue dies

**What is Transpiration?**
- Water loss (in vapor form) from a plant
- Transpiration rate is controlled by stomatal aperture, which is influenced by:
  - relative humidity
  - temperature
  - light
- 95% of water lost through stomates
- Open when guard cells are turgid, closed when flaccid

**The Process...**
- Water is taken up by roots, moved through the plant and then lost as vapor through stomata on the leaves
- Helps cool plants
- Helps move minerals through

**To consider...**
- Stomates need to be open for photosynthesis and releasing heat
- Transpiration is related to the environment
- Plants can be stressed and damaged especially:
  - Hot, windy
  - If ground is frozen (winter desiccation)
- Plants can adapt – smaller leaves, waxy cuticles, dormancy, different metabolic processes

**Water vapor**

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\text{Water enters through root hairs} \quad \text{Transpiration} \quad \text{Below ground} = \text{Respiration, no photosynthesis} \
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\text{Above ground} = \text{Photosynthesis respiration} \quad \text{CO}_2 \quad \text{O}_2 \\
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\[
\text{Light energy} \
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Plant hormones

- Auxin
- Gibberellic Acid (GA)
- Cytokinin
- Ethylene
- Abscisic Acid (ABA)

Auxin

- Apical dominance
- High concentration in terminal bud
- Phototropism
- Geotropism
- Synthetic auxins
  - IBA rooting hormones
  - 2,4-D herbicides

Gibberellic Acid

- Stimulates cell division and elongation - bolting
- Speeds germination
- Breaks seed dormancy

Cytokinin

- Stimulates cell division
- Important in callus formation – used in tissue culture
- Delays senescence

Ethylene

- Stress responses
  - Epinasty (leaves drooping downward)
  - Abscission (leaf drop)
- Promotes ripening and senescence
Abscisic Acid
- Considered the "stress hormone"
- Induces stomatal closure
- Abscission of leaves, fruits and flowers
- Induces dormancy
- Prevents seeds from germinating

Conclusions
- Plants are very diverse, shaped by their adaptations to their environment
- Plants are our key to life on the planet
- Understanding how plants work is important for gardeners
- Characteristics for identifying plants
- Plant physiology for propagation, pruning, growing plants
- Use your new trained eyes to view the botanical world!

Resources
- OSU Woody plant ID system
  http://oregonstate.edu/dept/ldplants/plant_ident/
- Botany in a Day - Elpel
- Botany for Gardeners - Capon
- Oregon Flora Project app
- Science News Daily: Botany

Questions?