What is Plant Propagation?

- The science and art of re-producing plants
- The act of producing offspring or multiplying plants
- The act of multiplication of a plant by any process of reproduction from the parent stock
- Increasing the number of plants by sexual or asexual means
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Learning from Nature

- Most plants have the ability to reproduce sexually and asexually.
- Sexual propagation allows plants to evolve and adapt.
- Asexual propagation can allow plants to colonize and dominate new territory quickly.
- Asexual propagation is very common in nature!
Sexual Propagation
Asexual Propagation - Natural Division
Asexual Propagation
- Natural Graft
Propagation in the Past

- Humans first started propagating plants around 10,000 years ago when they abandoned their hunter-gatherer lifestyle.
- Onions, sugar cane, bananas, potatoes and pineapples were probably the first asexually propagated plants.
- The Romans first started grafting woody plants around 4,000 years ago using approach grafting.
Propagation in the Past

- In the 18th and 19th century during the Victorian era, asexual plant propagation and methods exploded from the many plant exploration discoveries between China, Japan, Australia and the tropics.
- The construction and invention of walk in greenhouses enabled new propagation methods to be developed.
Modern Propagation

- The modern intermittent mist system was designed in the 1950s
- Plastic film was also developed in the 1950s
- Fog systems developed in the 1980s
- Micropropagation and tissue culture methods
- Other advancements in IGRs, bottom heat, sanitation, materials and methods has increased the success of propagation
Tools and Equipment

- LABELS!
- Pruners
- Seives
- Various sharp knives and razor blades
- Potting bench
- Varying containers
- Hormone rooting compound
- Heating pad
- Protected and controlled environment
Sexual Increase of Plants

- The combination of male and female genes
- The offspring are genetically variant from either parent
- The species can preserve its identity yet be constantly changing
- The exchange of genetic information within a species allows the plant to adapt and survive in the changing environment
Sexual Increase of Plants

- Pollination

- Before seeds are produced, pollination must occur
- Most wild plants resist self-pollination which encourages genetic variation and species adaptability

- Monoecious plants - separate male and female flowers
- Dioecious plants - separate male and female plants
Monoecious Plant
Sexual Increase of Plants

- **Seed Structure**

  - **Embryo** – a tiny plant
    - Plumule – shoot
    - Radicle – root
    - Cotyledons – seed leaves
    - Endosperm – food reserve
  - **Seed coat**

http://www.ext.colostate.edu/mg/gardennotes/137.html
Sexual Increase of Plants

- **Seed Dormancy**
  - Inability to germinate when conditions are favorable
  - Most plant species from temperate climates have some form of dormancy
    - **Seed coat dormancy** - hard outer seed coat prevents water infiltration
    - **Embryo dormancy** - embryo is not fully ripe upon seed maturation
    - **Chemical dormancy** - chemicals in or surrounding seeds prevents germination
Sexual Increase of Plants

- Seed Germination

- Absorption of water
- Exposure to Oxygen
- Warm temperatures (species specific)
- Light (species specific)
- Broken dormancy (from previous exposure)
Vegetative Propagation (Aka. Asexual Propagation)

- Division
- Cuttings
- Layering
- Storage organs
- Grafting
Vegetative Propagation

- Divisions

- Separation of one plant into several self-supporting ones

- Generally, division is confined to herbaceous perennial plants but some woody shrubs can be divided
Vegetative Propagation

- Cuttings

- Most plants have the ability to regenerate a whole new plant from a small piece of tissue or even one single cell!
  - This is called **totipotency** (or being totipotent)
  - Plants are unique in this phenomenon (so far...)
  - When you take cuttings, you exploit this phenomenon
Vegetative Propagation

- **Cuttings**
  - It is difficult to change an already mature and differentiated plant cell
  - **Meristematic** cells are undifferentiated cells found in specific areas of the plant
  - These “stem-cell-like” plant cells can differentiate into new plant parts (roots and shoots!)
    - Shoot tips
    - Root tips
    - **Vascular cambium**
Vegetative Propagation

- Types of Cuttings

- Stems, leaves and roots can be used
  - **Softwood cuttings** - taken from the first flush of new growth
  - **Greenwood cuttings** - the stems are young but starting to firm up
  - **Semi-ripe cuttings** - when buds have developed
  - **Hardwood cuttings** - taken from dormant wood
Greenwood Cuttings
Semi-hardwood Cuttings

Larger leaves cut back to about half to reduce transpiration

Lower leaves removed

Bark removed or ‘wounded’ to encourage callusing

http://www.pinterest.com/pin/204350901815093350/
Hardwood Cuttings
Vegetative Propagation
- **Types of Cuttings**

  - **Leaf bud cutting** – semi-ripe stems with a leaf and an axillary bud
  - **Leaf cuttings** – whole leaves or leaf sections
  - **Root cuttings** – lengths of strong healthy roots are taken
Leaf Cuttings

www.cassidytuttle.com
Root Cuttings
Vegetative Propagation

- **Layering**

- Layering is when plants form new roots (and eventually stems) where stems touch the soil
  - **Self-layering** – natural contact with soil
  - **Tip-layering** – arching stem is buried
  - **French (trench)-layering** – bury whole stem which is later dug and divided
  - **Air-layering** – wrap moist media around a wounded stem
  - **Traditional stooling** – Mounding soil around the plant's crown
Tip Layering

- flowering cane
- second year cane
- first year canes
- daughter plant
- crown
- sucker
Common Stooling

www.waldeneffect.org
Layering

- Simple layering
  - For **deciduous** trees and shrubs
    - Wound and bury in mid to late autumn
    - Adding hormone can help initiate rooting
  
  - For **evergreen** trees and shrubs
    - Wound and bury in early spring
    - Adding hormone can help initiate rooting
Vegetative Propagation
- Storage Organs

- Bulbs – compressed stems
  - **Offsets** – usually are removed and planted
  - **Scaling** – removing one scale (species specific)
  - **Twin-scaling** – removing 2 scales as one (species specific)
  - **Scooping** – scoop out middle of bulb (hyacinths)
  - **Scoring** – making a cross cut on bottom of bulb (species specific)
Bulb Offsets
Bulb Scaling of Oriental Lily

www.pacificbulbsociety.org

z5suburbangardener.blogspot.com
Scooping

www.gardenaction.co.uk

centralny.twcnews.com
Bulb Scoring

www.ndsu.edu

www.landspro.com
Vegetative Propagation

- **Storage Organs**

- **Coms** – thickened stem base
  - Cormels – tiny dormant offsets around the base of the corm

- **Rhizomes** – underground stems
  - Just like above ground, stem cuttings, rhizomes have axillary buds and vascular cambium

- **Root tubers** – swollen sections of root
  - Unable to form shoots except at the crown
Comets
Fleshy Rhizome
Rhizome
Root Tuber Displaying polarity
Vegetative Propagation

- **Storage Organs**

- **Stem tubers** – modified stems with the same function as root tubers (ex: potato)

- **Pseudobulbs** – thickened lower stems only found on sympodial orchids
A stem tuber: potato

the "eye" is actually the "axillary bud".

terminal bud(s)
Pseudobulb
Pseudobulb
Vegetative Propagation
- Grafting and Budding

- The joining of two separate plants so they function as one
- Grafting is a skill, a science and an art.
- Labor intensive and generally reserved for plants that do not root from cuttings.
- Grafting can bring plants to flowering and fruiting maturity faster
- Grafting can offer disease resistance and control the scions (top growth) size
Vegetative Propagation

- Grafting and Budding

- Types of grafting:
  - Approach grafting – Roots remain attached
  - Detached grafting – Roots cut off
    - Whip and tongue grafting
    - Wedge grafting/saddle grafting
    - Spliced side grafting
  - Budding
    - Chip budding
    - T-Budding
    - Patch budding
Soils and Media

- Use high quality soil-less media
- For cuttings you want a media that:
  - Drains rapidly
  - Holds some moisture
  - Allows for excellent air flow
- A good place to start is 3 parts peat, 2 parts perlite to 3 parts perlite to 2 parts peat.
Propagation in Different Climates

- Propagation and gardening is easier if plants are suited to the climate
- We live in Plant Hardiness zone 7 (although some would argue otherwise)
- Heat and humidity can play a significant role in plant success in middle Tennessee
The Propagation Environment

- Until the plant can regenerate roots and shoots it is at the mercy of the environment
- Most plants will require a controlled environment
  - Greenhouses
  - Cold frames
  - Quonset huts
The Propagation Environment

- Humidity

- Critical component
- 98-100% constantly
- Leaves can also absorb water so a gentle intermittent mist is advantageous
- Mist systems are preferred for any large scale propagating
The Propagation Environment

- **Light**

  - Light drives photosynthesis which is the plants source of energy
  - Too much light will burn and dry out plants because they don’t have any roots yet
  - Some sort of shade is need
The Propagation Environment

- Temperature

- Temperature is not generally as critical as humidity
- Sometimes bottom heat can speed up the rooting process
- Best to maintain a warmer soil and a cooler air
- Sometimes in grafting, the union is placed on a warm water pipe to speed up callusing but delay bud break
Plant Problems

- Diseases from constant moisture
- Insect pests can explode in controlled and confined environment
- Weeds and algae can become a problem
- Enclosed and sealed environments can get hot very fast
Taking Cuttings

- **Hardwood cuttings** – dormant mature stems
  - Take before spring growth begins or just after the last leaves fall
  - Cut at the junction of 1 and 2 year old wood
  - Stick in the ground!
  - Lengths vary from at ground level to 6 feet
  - Willows, poplars, figs and some vines are easy!
Taking Cuttings

- **Semi-ripe Cuttings** – axillary buds have formed
  - Cut just below a node
  - Trim leaves down to reduce moisture loss through transpiration
  - Wounding may or may not be necessary (consult with the literature)
  - Dip in hormone and tap/shake off extra
  - Poke hole in media first, then insert cutting.
  - Quickly place in ideal environment
Taking Cuttings

- **Softwood Cuttings** – first flush of new growth
  - Prepare trays and materials before taking cuttings
  - Take cuttings in the morning
  - Put cuttings in plastic bag
  - Immerse them in a bucket of water upon retuning
  - Dip in hormone, stick and place in ideal environment
What if your cuttings won't root?
Grafting and Budding

- **Spliced side-veneer grafting**
  - Used on trees that are difficult to unite with a stock or have thin bark (Japanese maples)
  - The stock is headed (cut) back only after the graft has taken... usually
  - Conifers are also grafted this way
Side-veneer Graft

Double Side-veneer Graft
Side-veneer Graft
Grafting and Budding

- Show video of grafting Japanese maples
Grafting and Budding

- **Whip-and tongue grafting**
  - Used in fruit trees and some ornamentals where budding has failed
  - Best when stock and scion is similar in size
  - Scions are gathered during the winter when hormone levels are highest and stored in a cool area
  - In early spring as the rootstock “wakes up”, take the dormant scion sticks out of the refrigerator and make the graft
Whip-and-tongue Graft

scion

A long, sloping cut

2nd cut for tongue

stock

open

union

tape or way
Callusing on warm water
Grafting and Budding

**Budding**
- A form of grafting where a single bud is grafted onto a rootstock
  - Chip budding
  - T-budding
  - Patch budding
Grafting and Budding

- Chip Budding

- The most successful technique for grafting fruit trees
  - (T-budding is the most common)
- Performed in late summer to early autumn... usually
- In 2 to 3 weeks the chip should have callused and fused with the rootstock
- Remove the tape anytime after this
Chip Budding
Grafting and Budding

- **T-Budding**

- Preferred when grafting dogwoods and peaches
- Is still popular but research and experience show that chip budding is more successful
- Performed in late summer... generally
- Peaches are T-budded in June
T-budding
T-budding on Dogwood
Conifers

- **Cuttings**
  - Usually taken from the current season's growth in mid-autumn and mid-winter.
  - Select the terminal tip for reliable growth characteristics.
  - Side shoots can yield different growth habits especially in yews.
  - Including a small amount of 2-year-old wood can help initiate rooting.
  - Junipers are usually rooted.
Heel Cut of Juniper

http://www.bonsaiforbeginners.com/bonsai_cuttings.html
Conifers

**Grafting**
- Rootstock is two years old and is a species compatible with the scion
- All conifers can be grafted in late winter but blue spruce are usually grafted in late summer
- Spliced side-veneer graft is usually used
Conifers

- Generally grafted in the winter
  - *Side-veneer grafting*
  - Collect scions in late winter when fully dormant and store in plastic at 39 deg.
  - At the same time, bring potted stock plants indoors to warm up for several weeks before grafting
  - It is critical that the cambium layers line up!
Side-veen Grafting Pine

1. Remove Wedge from Rootstock
2. Fit Scion into Place
3. Wrap Union and Seal with Wax

http://www.ces.ncsu.edu/depts/hort/hil/grafting.html
Side-veneer Grafting Pine
References

- Manual of Woody Landscape Plants – Michael A. Dirr
- Plant Propagation, Principals and Practices – Hartman and Kester
- Plant Propagation, The American Horticultural Society – Alan Toogood
Happy Propagating!