Plant Propagation 101

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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

In this Presentation

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2. Propagation in the Past
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4. Sexual Increase of Plants
5. Vegetative Propagation
6. Tools and Equipment
7. Soils and Growing Media
8. Propagation in Different Climates
9. The Propagation Environment
10. Plant Problems

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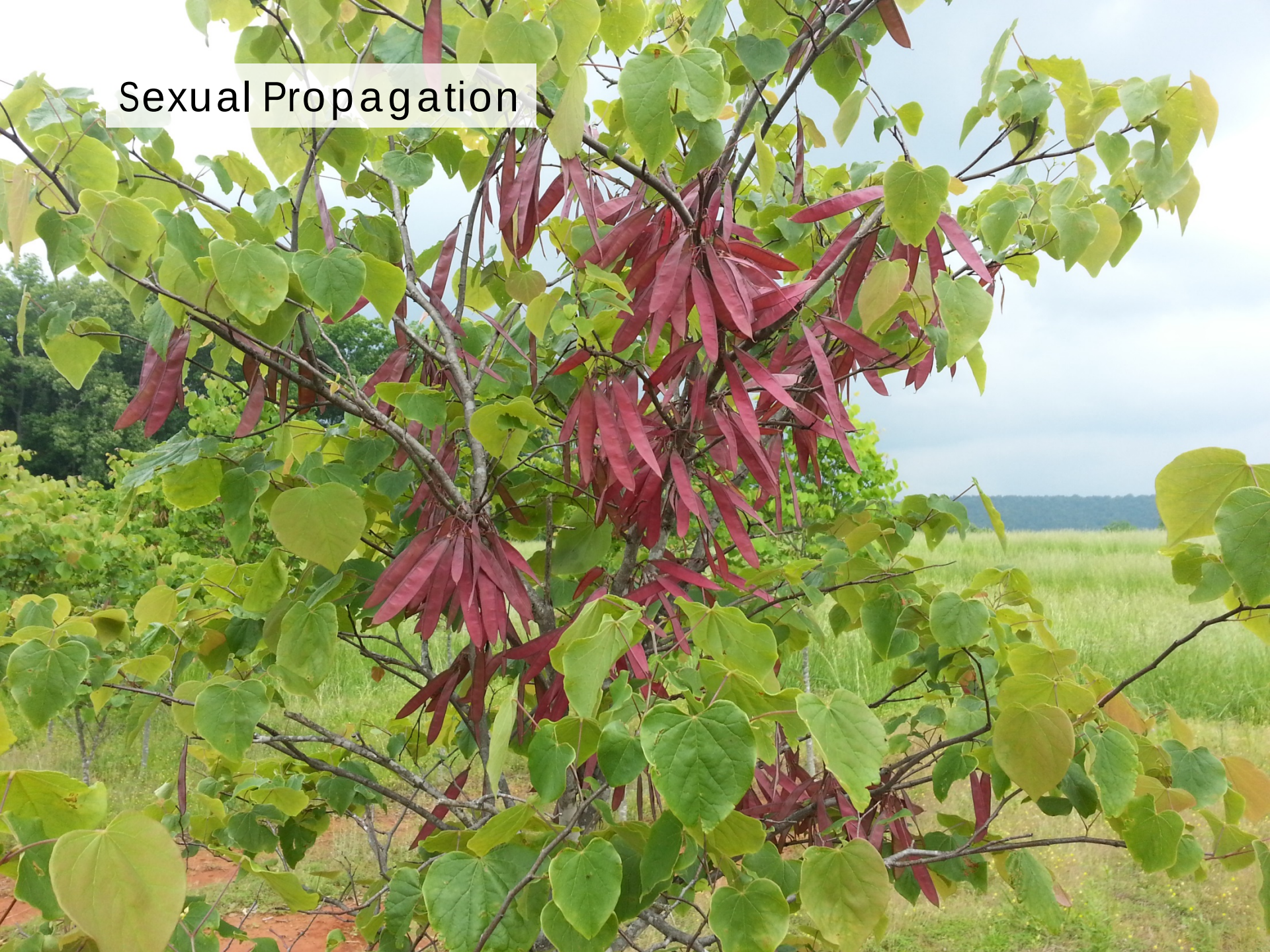
11. Taking Cuttings
12. Sowing Seeds
13. Grafting and Budding
14. Layering
15. Questions

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

http://ghardwood.com/wp-content/uploads/2011/08/26699.jpg

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

http://en.wikipedia.org/wiki/Conservatory_(greenhouse)

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

http://nrcorchids.nic.in/images/slideshow/Tissue%20Culture.jpg

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

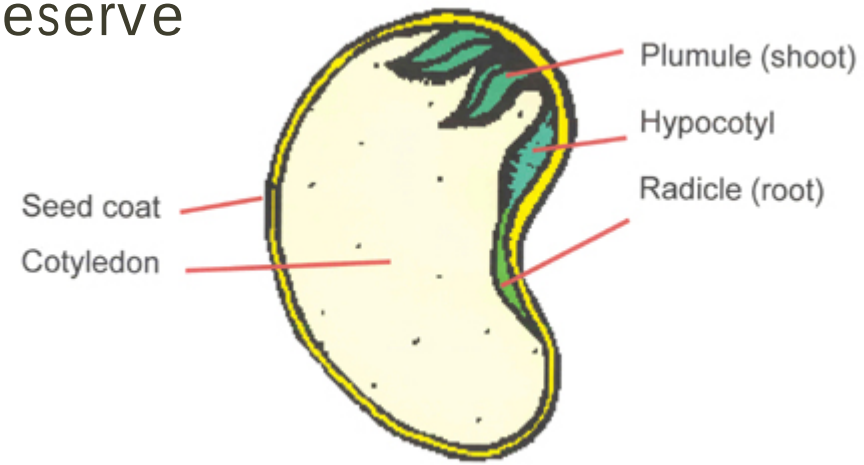
Monoecious Plant

Dioecious 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

http://www.finegardening.com/how-to/articles/dividing-

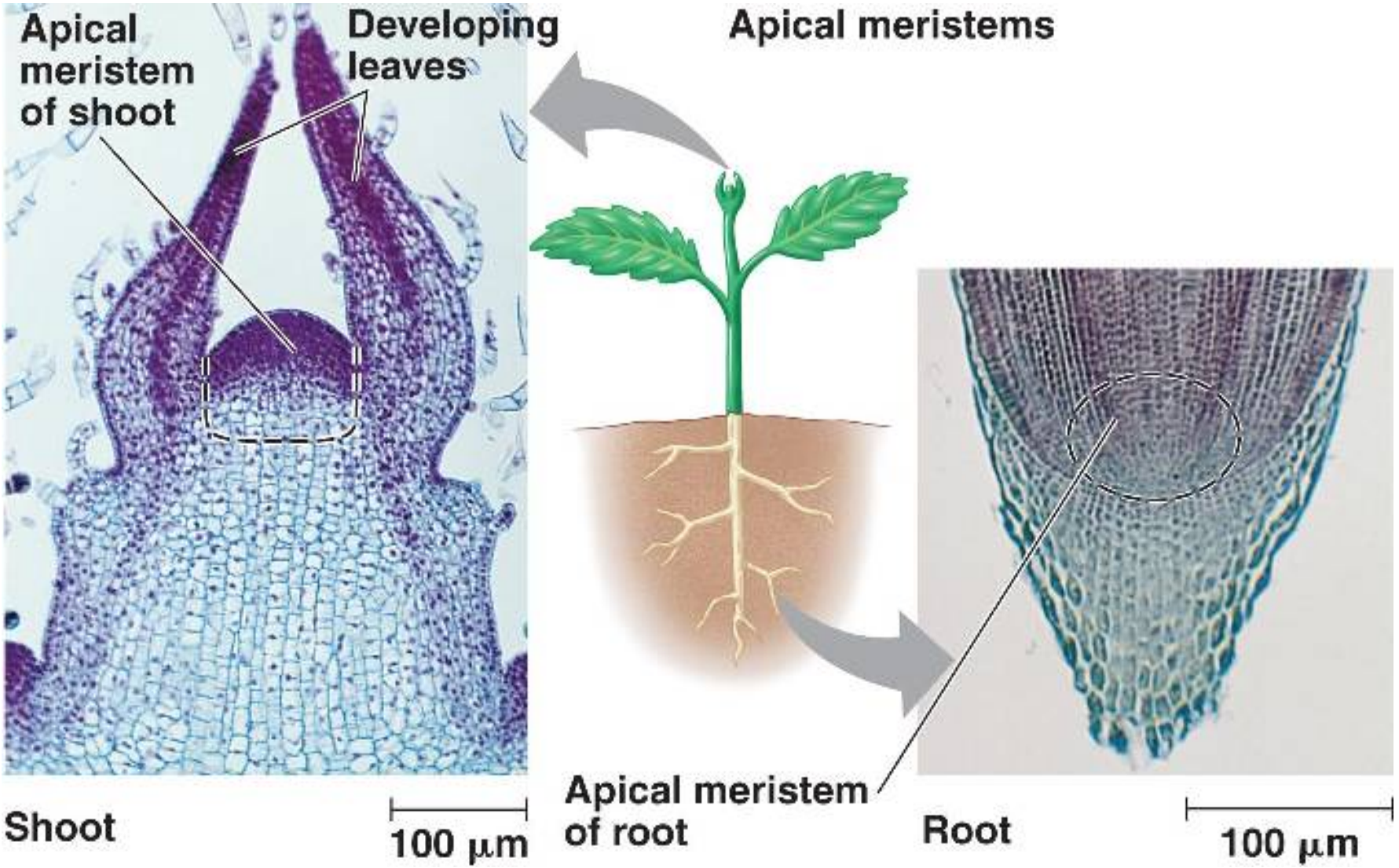
http://msucares.com/news/print/sgnews/sg11/sg110907.html

Vegetative Propagation - Cuttings

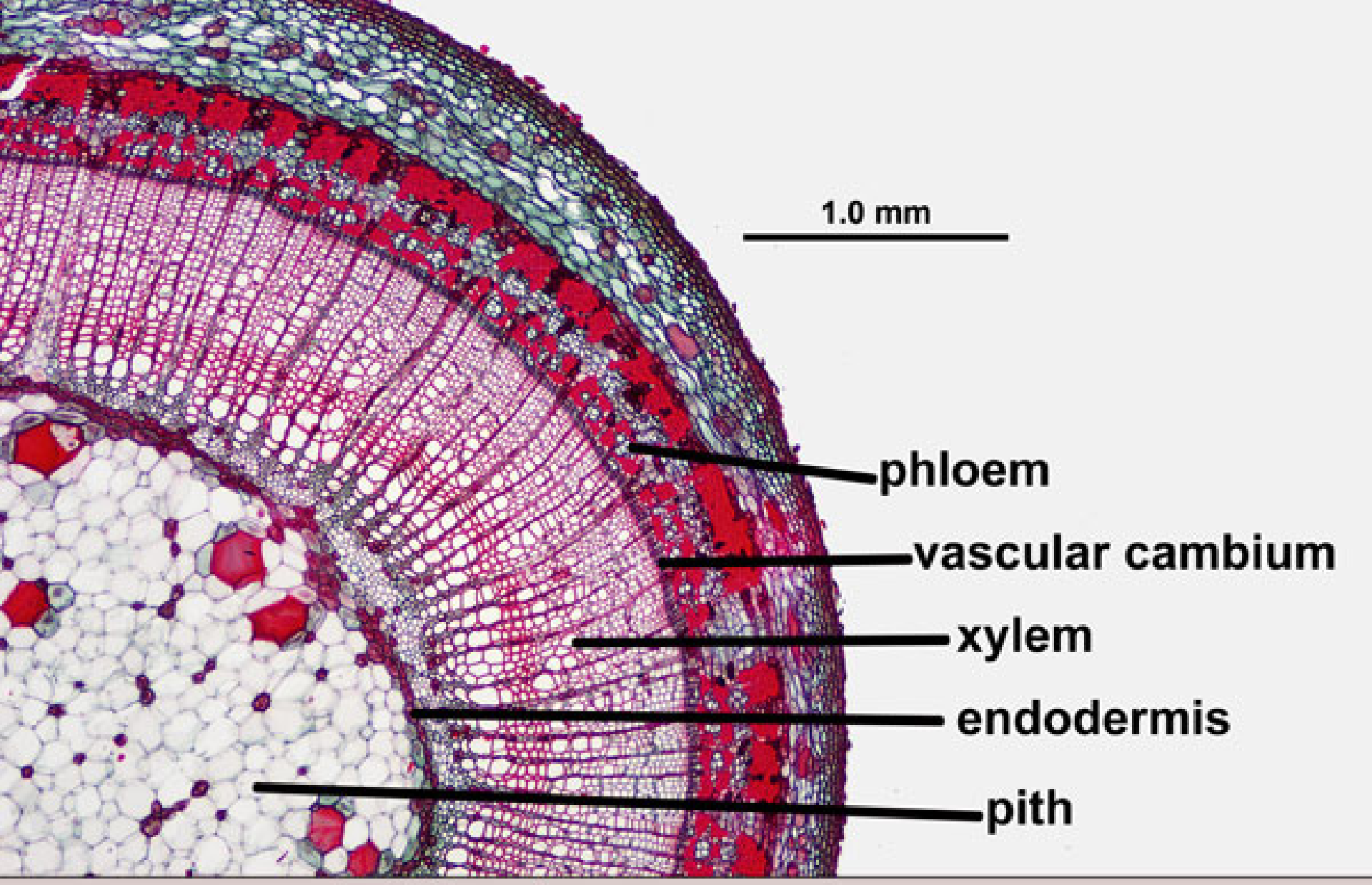
- Most plants have the ability to regenerate a whole new plant from a small piece of tissue or even one single cell!
  - This is called **totipotency** (or being totipotent)
- Plants are unique in this phenomenon (so far…)
- When you take cuttings, you exploit this phenomenon

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**



http://bio1151.nicerweb.com/Locked/media/ch29/apical.html



Tilia 1-year stem, c.s.

http://www.deanza.edu/faculty/mccauley/6a-labs-plants-05.htm

Vegetative Propagation

- Types of Cuttings

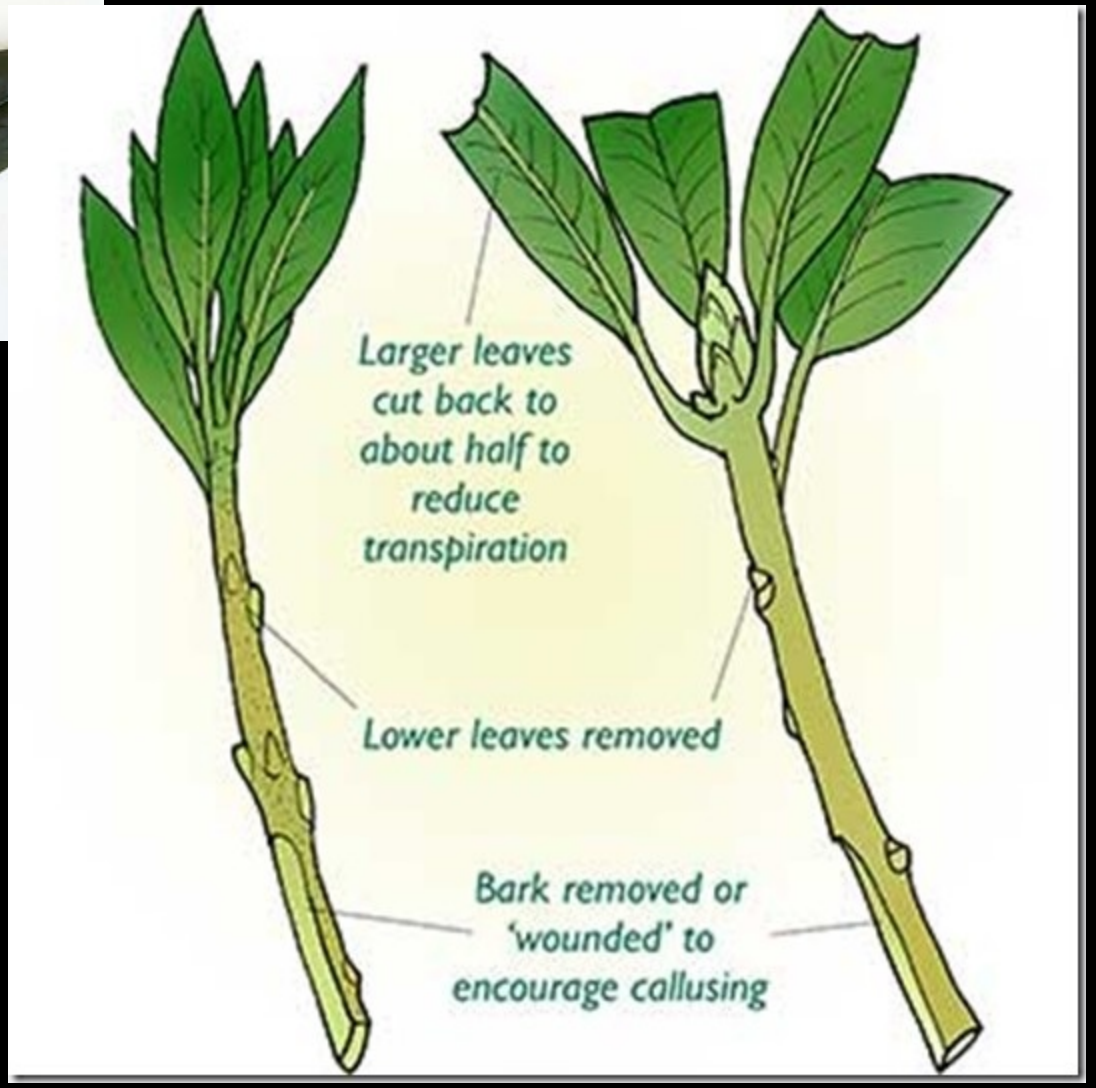
- Stems, leaves and roots can be used
  - **Softwood cuttings** – taken from the first flush of new growth
  - **Greenwood cuttings** – the stems are young but starting to firm up
  - **Semi-ripe cuttings** – when buds have developed
  - **Hardwood cuttings** – taken from dormant wood


Softwood Cuttings


Greenwood Cuttings

apps.rhs.org.uk

Semi-hardwood Cuttings



http://www.pinterest.com/pin/204350901815093350/

Hardwood Cuttings

allotmentgardens.wordpress.com

www.barkandbloom.com

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 Bud
Cuttings

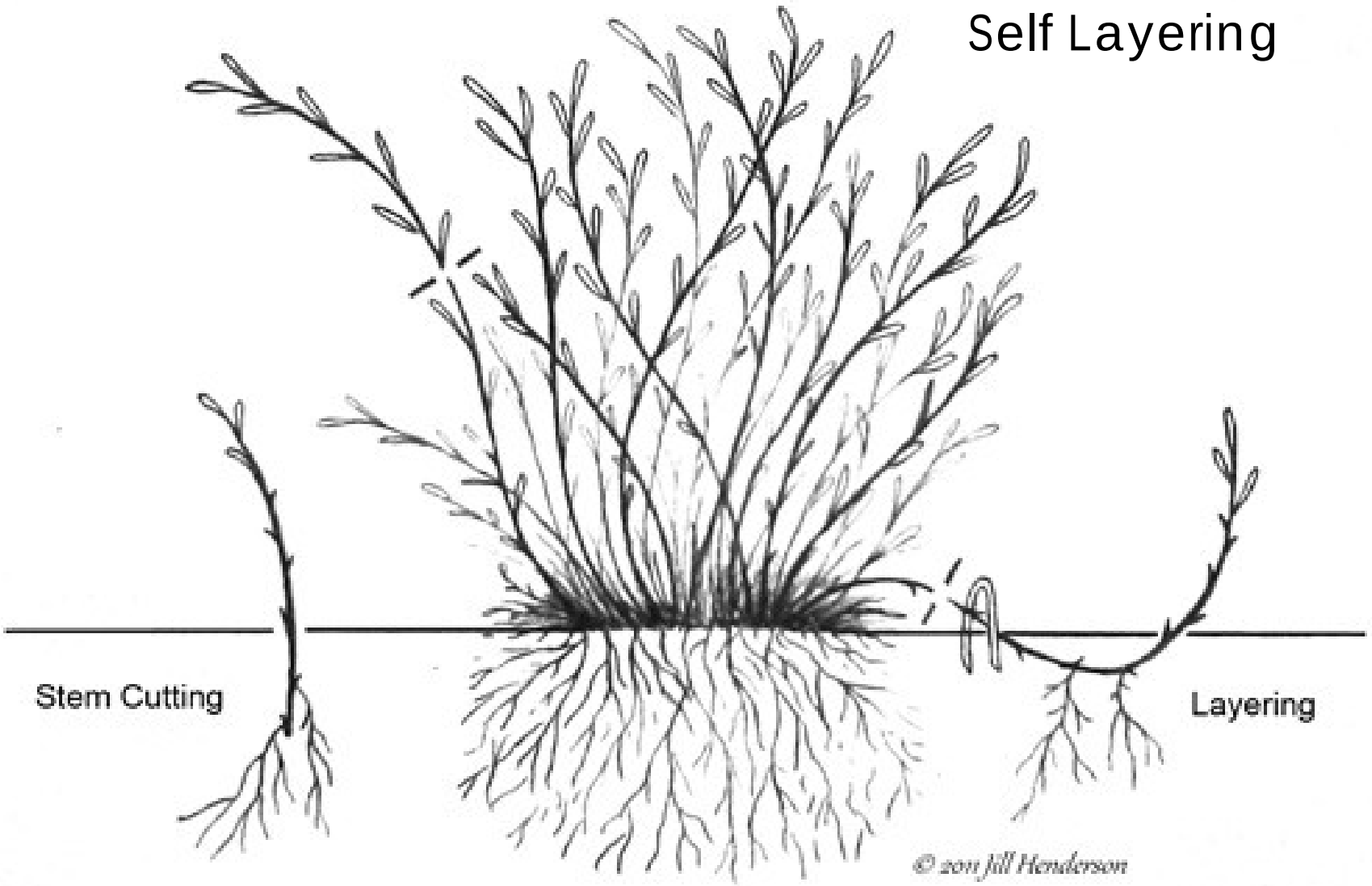
Leaf Cuttings


Root Cuttings

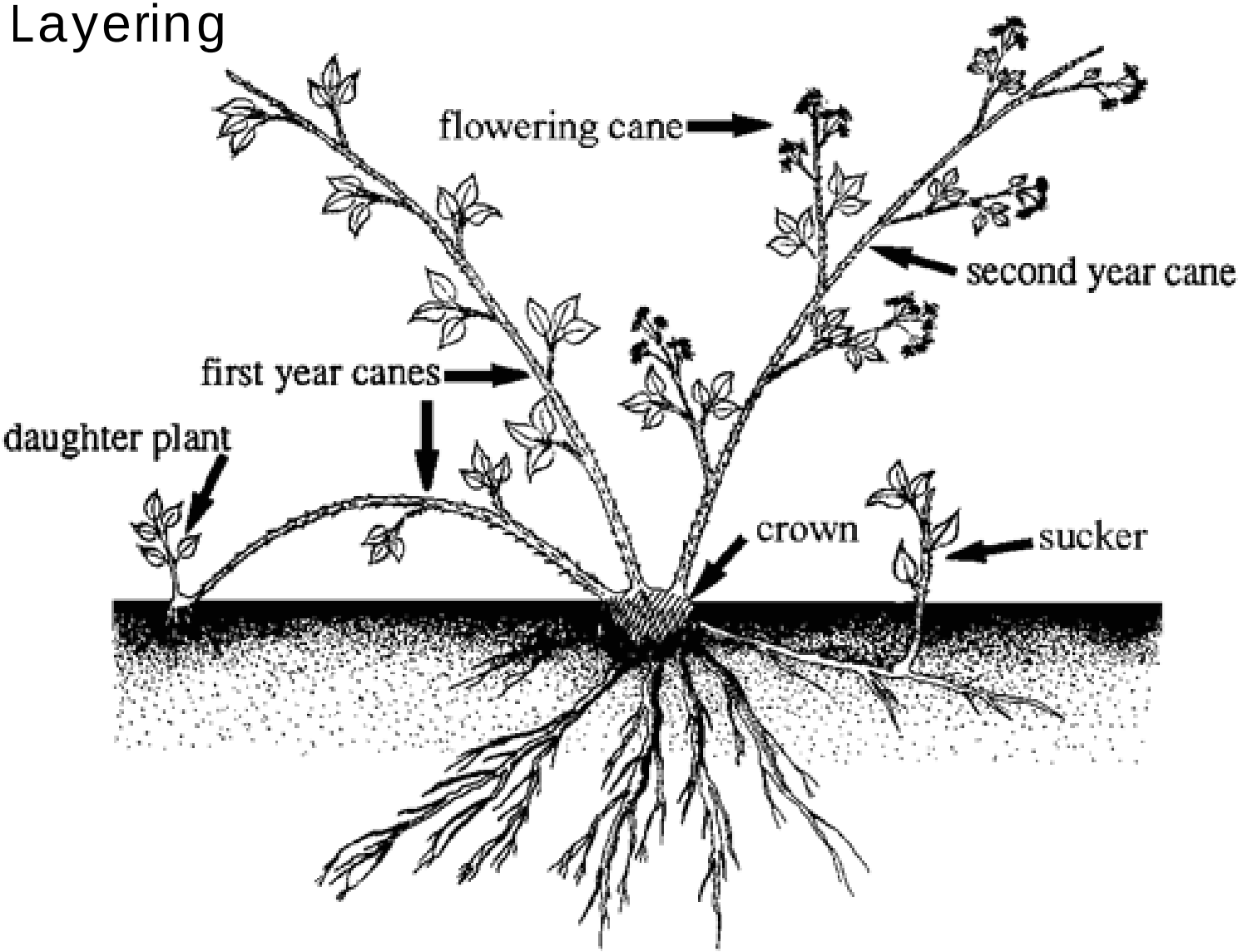
Vegetative Propagation - Layering

- 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 plants crown

Self Layering



Tip Layering



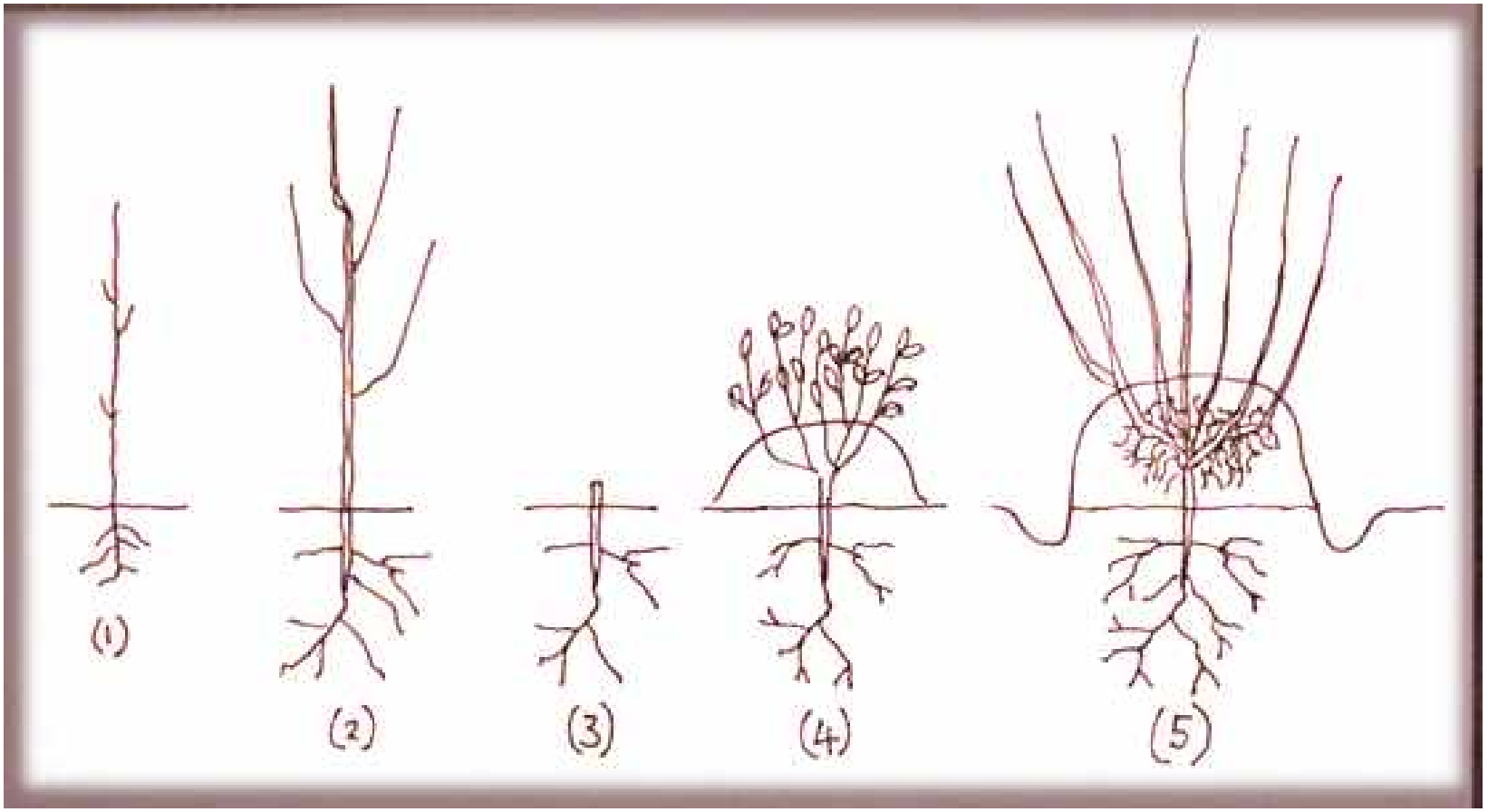
sites.google.com

Air Layering

gardenofeaden.blogspot.com

www.faroutflora.com

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

www.srgc.org.uk

Bulb Scaling of Oriental Lily

www.pacificbulbsociety.org

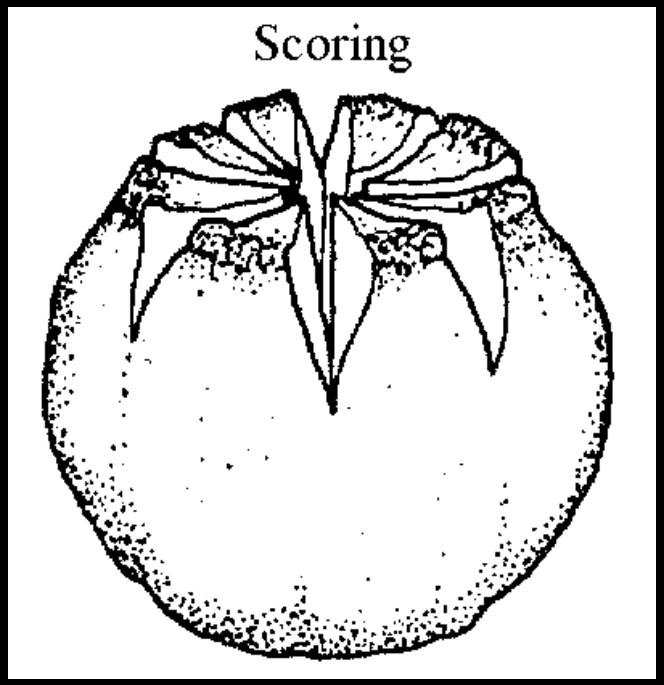
z5suburbangardener.blogspot.com

Scooping

www.gardenaction.co.uk

centralny.twcnews.com

Bulb Scoring



www.ndsu.edu

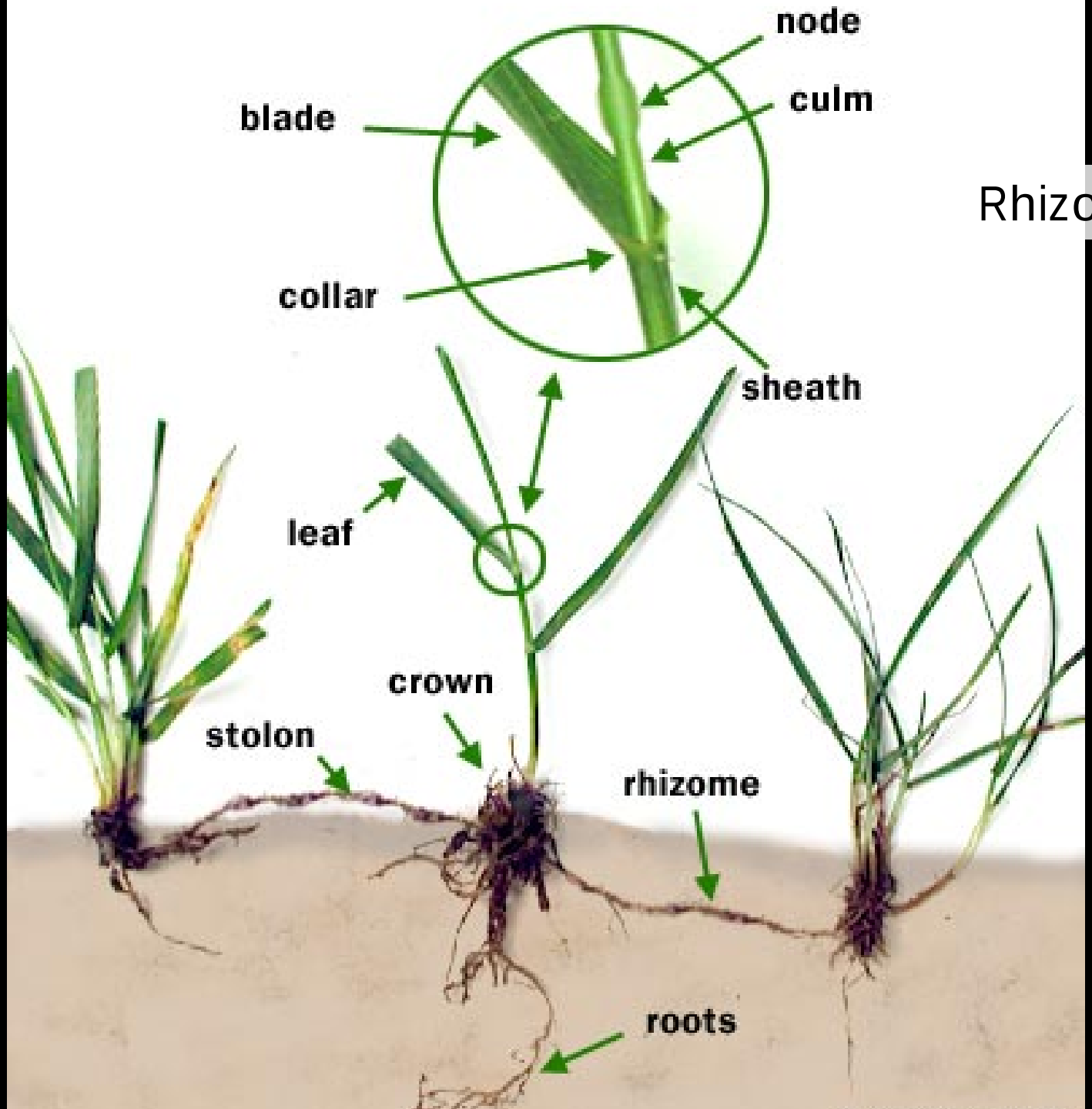
www.landspro.com

Vegetative Propagation
- Storage Organs

- Corms – 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


Cormels


Fleshy Rhizome



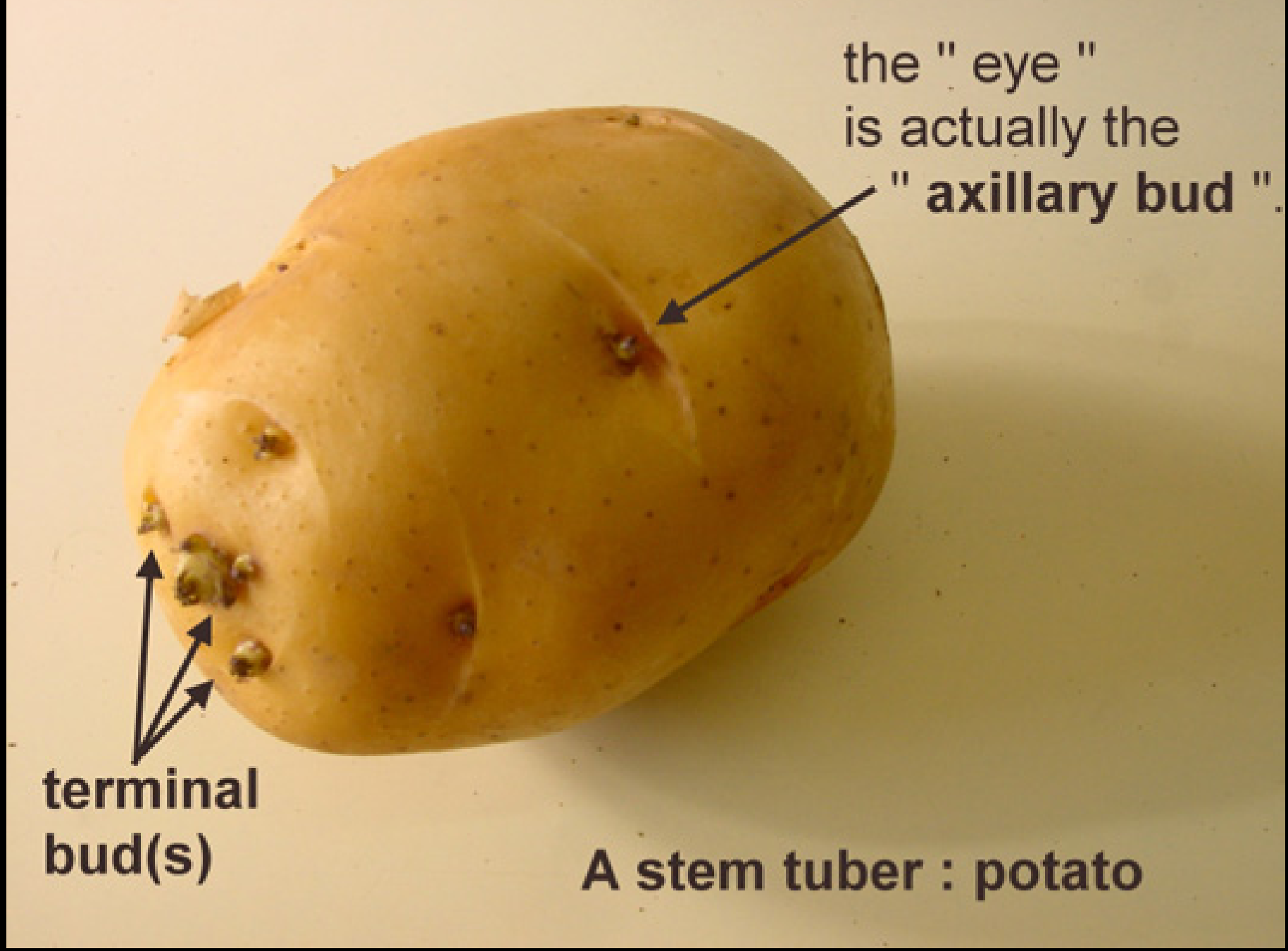
Rhizome


Root Tuber

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


the " eye "
is actually the
" axillary bud ".
terminal
bud(s)
A stem tuber : potato


Pseudobulb


Pseudobulb

Vegetative Propagation
- Grafting and Budding

- The joining of two separate pants 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

badger.uvm.edu

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 wont 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

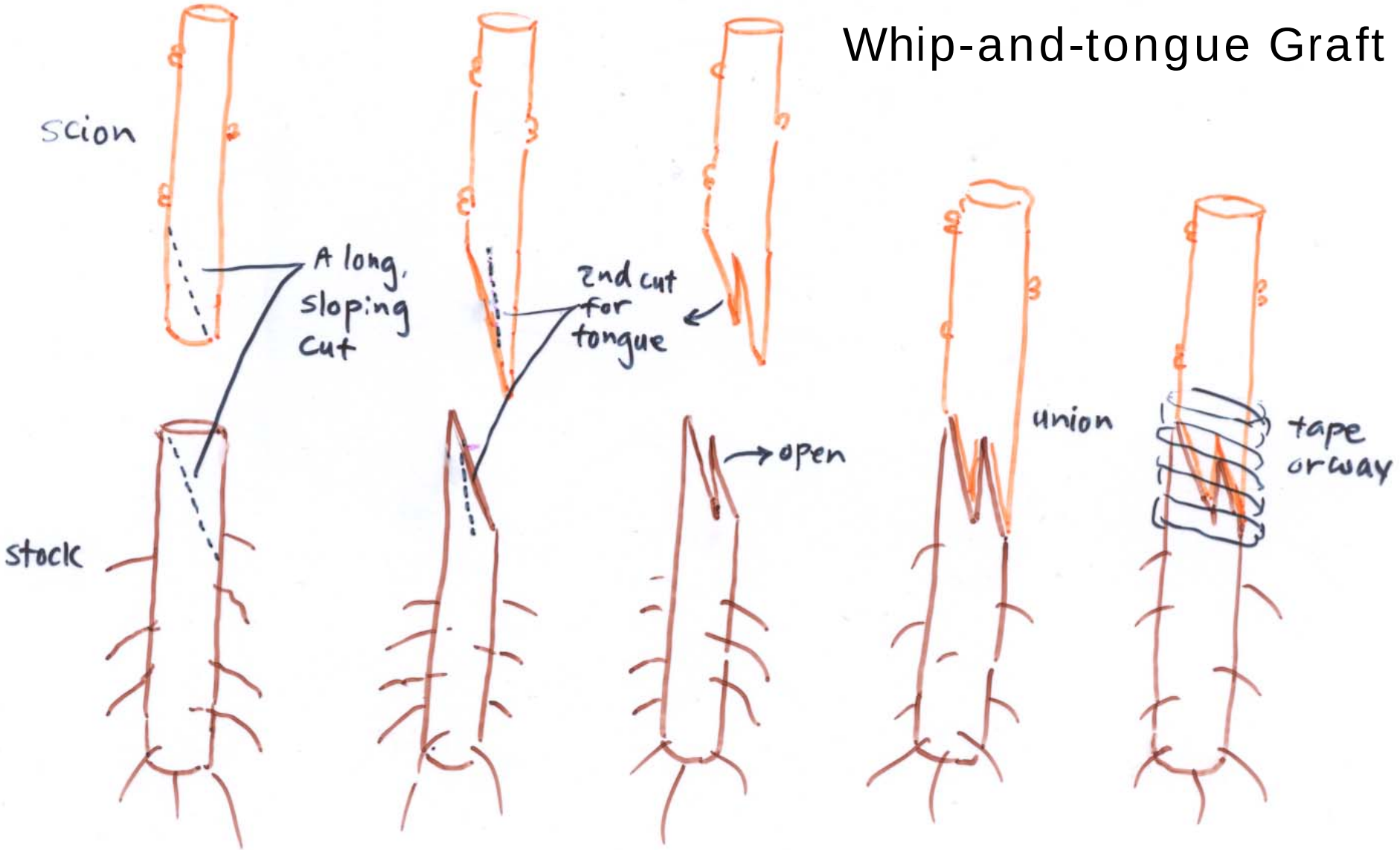
Grafting and Budding

- 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




Callusing on warm water

Grafting and Budding

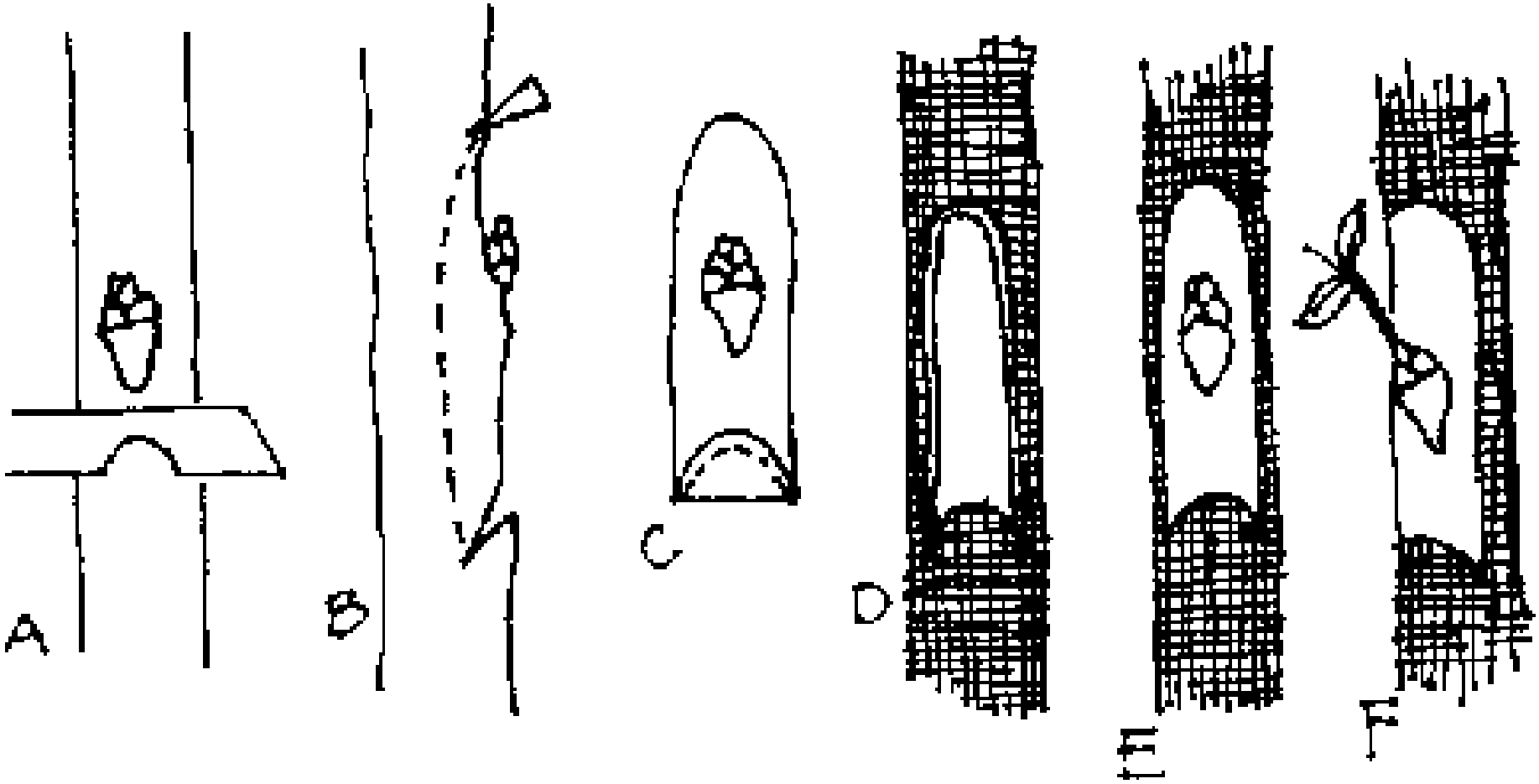
- **Budding**
  - A form of grafting where a single bud is grafted onto a rootstock
    - Chip budding
    - T-budding
    - Patch budding

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

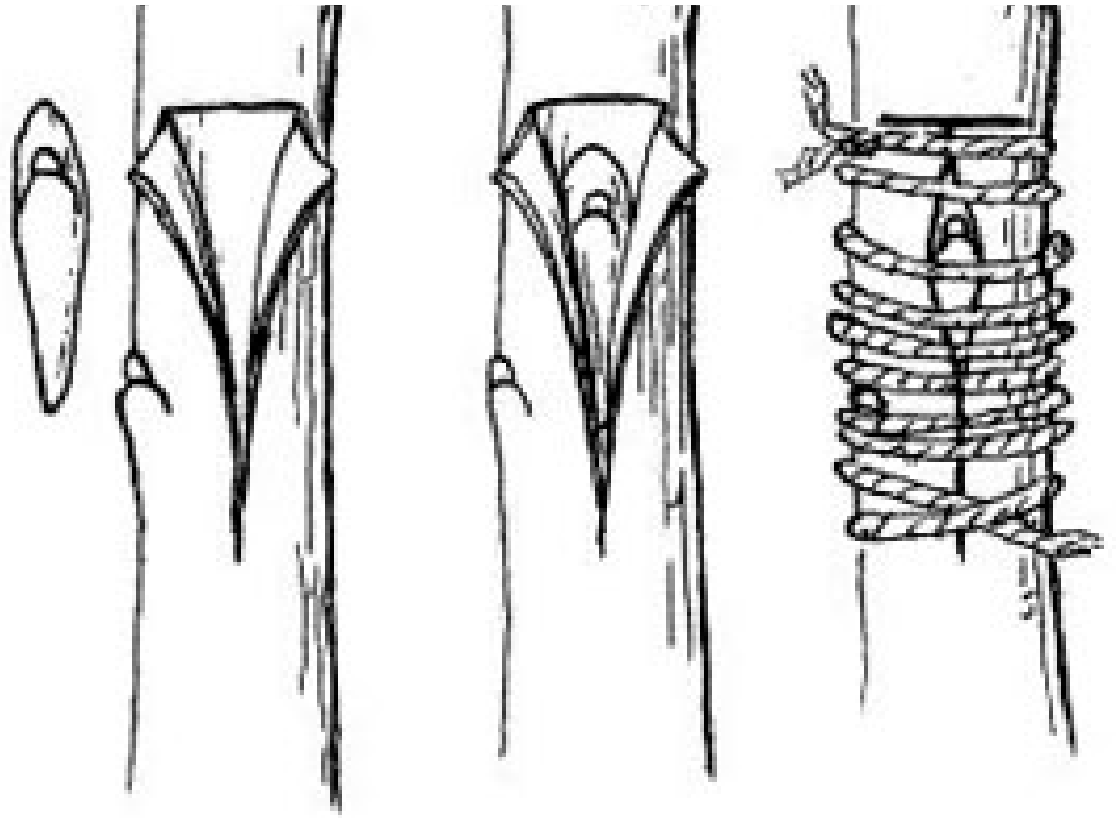


Grafting and Budding

- 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 seasons 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

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

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

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

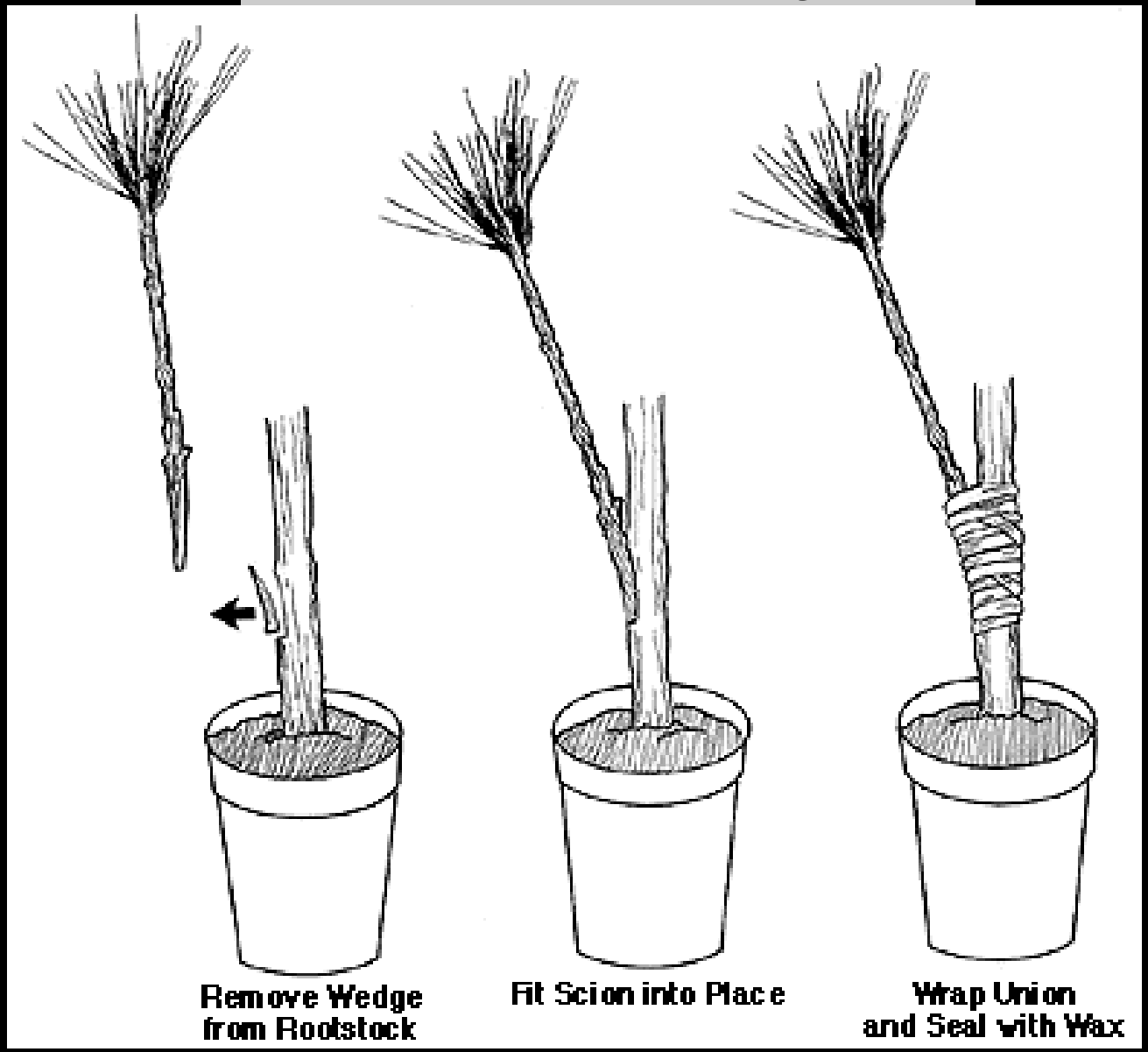
Conifers

- **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-veneer Grafting Pine



http://www.ces.ncsu.edu/depts/hort/hil/grafting.html

Side-veneer Grafting Pine

http://www.providencefarmornamentals.com/graftdemo.shtml

http://www.providencefarmornamentals.com/graftdemo.shtml

http://www.providencefarmornamentals.com/graftdemo.shtml

References

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- Plant Propagation, Principals and Practices – Hartman and Kester
- Plant Propagation, The American Horticultural Society – Alan Toogood


Happy Propagating!