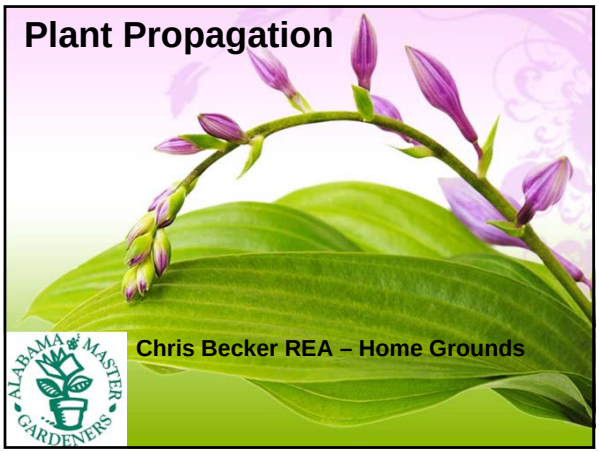
Plant Propagation



Chris Becker REA – Home Grounds

What is Plant Propagation?

- Purposeful multiplication and production of plants using propagules to retain their unique qualities and genetic characteristics (genotype)

What is Plant Propagation?

- Sexual Propagation (propagation by seeds)
  - Mixing of genetic material of parents
  - Seeds are cheap
- Asexual Propagation (vegetative propagation)
  - Production of clones (genetically identical to mother plant)
  - Quick
  - More expensive than seeds

What is Plant Propagation?

- Propagule: Any part of the plant used to produce a new plant or a population, i.e.; seeds, cuttings, layers, scions, explants, bulbs, corms, and tubers)
- What is plant breeding? How does it relate to Plant Propagation?

What is Plant Propagation?

- Plant Breeding introduces variability to create new and improved cultivars.
- Plant Propagation tries to control genetic variation and maintain a plant's genetic potential intact.

Plant Propagation evolves in Human History…

- Agriculture had it's beginnings some 10,000 years ago…
- Where hunter and gathers transitioned to cultivators and domesticators.
- Eventually this became site oriented which is resulted in centers of activity or cities.

Plant Propagation evolves in Human History…

- Agriculture involves four types of activities:
  - Selecting and (or) developing specific kinds of plants (Plant Breeding)
  - Multiplying those plants and preserving their unique qualities (Plant Propagation)
  - Growing them under controlled conditions for maximum yield (Crop Production)
  - Crop handling and storage
  - Transforming and preserving the products of those plants for food or other uses for example… making bread, pressing oil, preparing wine, etc. (Food Technology)

Plant Propagation evolves in Human History…

- Plant Selection provides for us the plants which are most useful
- Plant Propagation – Multiplies these in ways that preserves their unique and valuable characteristics

Biology of Plant Propagation

What's in a Name…

- Species: natural occurring plants that have maintained themselves from generations to generations. These plants have common characteristics in appearance (phenotype), adaptation, and breeding behavior (genotype) (can interbreed)

What's in a Name…

- *Cultivars (Varieties)*: Populations of plants that are unique and only exist in cultivation, and whose essential characteristics are maintained during propagation

Plant Hormones & Plant Development

- *Auxins: Indole-3-acetic acid (IAA), it is involved in phototropism, apical dominance, formation of abscission layer of leaves and fruit, and activation of cambial growth.*
- *Mostly used to induce adventitious rooting in cuttings.*

Plant Hormones & Plant Development

- *Cytokinins: Kinetin, often used in conjunction with auxins to induce rooting, shoot formation, and callus formation in micropropagation techniques. It promotes cell division, shoot initiation, and can control seed dormancy.*

Plant Hormones & Plant Development

- *Gibberellins: (GA_3), Found in high concentrations in developing seeds and function in the germination and control of dormancy. Also occur in stem apices, roots, fruits, and tubers. Promotes shoot elongation through the increase of both cell division and elongation.*

Plant Hormones & Plant Development

- *Abscisic Acid: (ABA) Plays a role in plant stress, controlling water relations, dormancy of buds and seeds, leaf senescence and abscission, embryogenesis, and seed production.*

Plant Hormones & Plant Development

- *Ethylene: Is the only hormone that exists as a gas. Stimulates epinasty, senescence and abscission in leaves and fruit, flowering, lateral bud stimulation. In propagation, it can stimulate adventitious roots.*

Plant Hormones & Plant Development

- *Ethylene: Is the only hormone that exists as a gas. Stimulates epinasty, senescence and abscission in leavces and fruit, flowering, lateral bud stimulation. In propagation, it can stimulate adventitious roots.*

Media and Fertilizers

The *Ideal* rooting medium must have…

- Good air/water relationship
- Reasonable cost
- Ease of handling
- Readily availabile
- reproducible results

Fertilizers…

- There is usually no benefit to adding fertilizers…
- There is no benefit until after cuttings have rooted since limited uptake occurs through the cut stem.

Factors Affecting Rooting

Nutrition/Carbohydrates/Nitrogen

- Stock plants should not be water stressed, and should have decent N and CHO reserves. There is an old concept that high CHO to N ratio promotes rooting. Typically stockier cuttings produce better rooting than thinner ones (fewer CHO reserves).

Juvenility

- Cutting taken from young plants, root more readily than those from mature plants, e.g. Leyland Cypress, 5 year old rooted 94%, 20 year old only 34%, 50 year old only 5%.

Juvenility

- Why does juvenility exert such a strong effect?
  - As plants age, increase in rooting inhibitors? Nurserymen try to maintain juvenile state
  - Frequent pruning

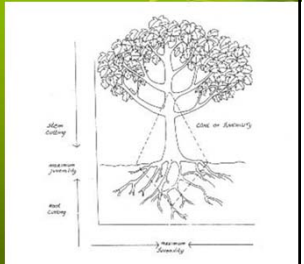


Figure 13. Juvenility, in practical terms, can be gauged by proximity to trunk/root interface. For stem cuttings the best area to collect material is within the cone of juvenility (above ground). This same effect applies to root cuttings. Generally, the closer the root cuttings are to the crown the better the regeneration potential.

Timing

- Timing is species specific!
  - Some plants can be rooted year round (Photinia)
  - Some have narrow windows for rootability (lilac, wax myrtle, native azaleas)

Hormones

- Intro
- About 10,000 different chemicals show root promoting activity. In 1935, Zimmerman and Wilcox discovered that IBA and NAA promoted rooting even better that the natural auxin IAA. These are now the widely used growth regulators to induce rooting. IAA is not used because it is broken down too quickly and is destroyed by light and bacteria.

Hormones

- Commercial Rooting Formulations
  - The most popular are:
    - Hormodin - IBA in talc
    - Hormo-Root-thiram (Fungicide) IBA in talc
    - Hormex - IBA in talc
    - Rootone - NAA, 2-methyl NAA
    - Dip'N Grow -IBA, NAA, in alcohol
    - Wood's – IBA, NAA in alcohol

TABLE 10–5 Partial List of Commercial Rooting Compounds, Sources, Formulations, and Ingredients

Trade name	Source	Formulation	Ingredient
Chrysopon	Rhizopon b.v., Hazerswoude, Holland (www.rhizopon.com)	Powder (talc)	0.1 to 8.0% IBA
C-mone	Coor Farm Supply Services, Inc., Smithfield, NC	Liquid (isopropyl alcohol)	1% and 2% IBA
Dip 'N Grow	Dip 'N Grow, Inc., (Astoria-Pacific, Inc.) Clackamas, OR (www.dipngrow.com)	Liquid (alcohol—ethanol and isopropyl)	1% IBA + 0.5% NAA + boron
Hormex	Brooker Chemical Corp., North Hollywood, CA	Powder (talc) Liquid	Rooting Powder—0.1 to 4.5% IBA Hormex Concentrate—0.13% IBA + 0.24% NAA + Vitamin B-1
Hormodin	MSD-Agvet (Merck & Co.) Rahway, NJ	Powder (talc)	0.1 and 0.8% IBA
Hormo-Root	Rockland Chemical Co. Newfoundland, NJ	Powder (talc)	1, 2, 3, or 4.5% IBA
Rhizopon	Rhizopon b.v., Hazerswoudle, Holland (www.rhizopon.com); Hortus USA Corp. Inc. New York, NY (www.rooting-hormones.com)	Powder and water-soluble tablet forms	0.5 to 1.0% IAA or 0.1 to 0.2% NAA or 0.5 to 0.8% IBA (series)
Rootone	Dragon Chemical Corp. Roanoke, VA (www.dragoncorp.com)	Powder (talc)	0.2% 1-naphthaleneacetamide 4% Thiram (fungicide)
Roots	Wilson Laboratories, Inc. Dundas, Ontario, Canada	Liquid	0.4% IBA + ethanol (fungicide)
Synergol	Silvaperl Products Ltd., Harrogate, North Yorkshire, Great Britain	Liquid	0.5% K-IBA + 0.5% K-NAA + fungicides and other additives
Woods Rooting Compound	Earth Science Products Corp., Wilsonville, OR	Liquid (ethanol)	1.03% IBA + 0.56% NAA

Note: The EPA registration number is on the finished formulation container. If no number is present, the product has not been registered and/or is being sold illegally (42).

Hormones

- Quick dips compared to talcs
  - Quick dips are usually superior over talc formulations
  - Dips are performed fro 5 seconds
  - Quick dip cuttings may burn at higher concentrations but sometimes roots still form above the burned end.
  - Sometimes a 24 hour more dilute soak is as effective as the concentrated quick drip method. Cuttings should be dipped about 1" in depth.

The History of Grafting

The History of Grafting

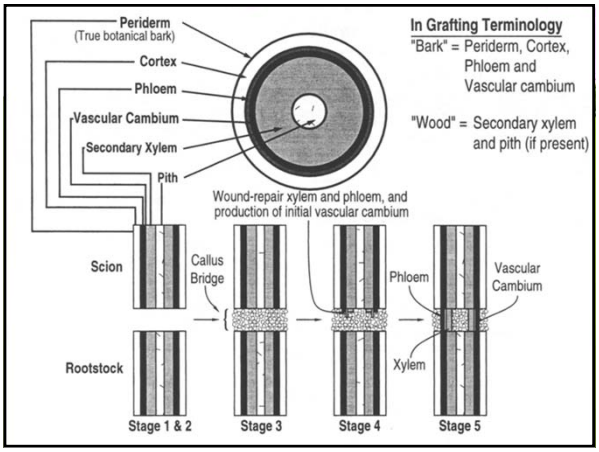
- Since the beginning of civilization, fruit and nut trees have been grafted because of the difficulty in propagation by cuttings.
- Grafting is expensive. Budding is 3x more expensive than cuttings and 12x more than seed propagation.
- But in many cases it is the only thing that will work or it confers special advantages.

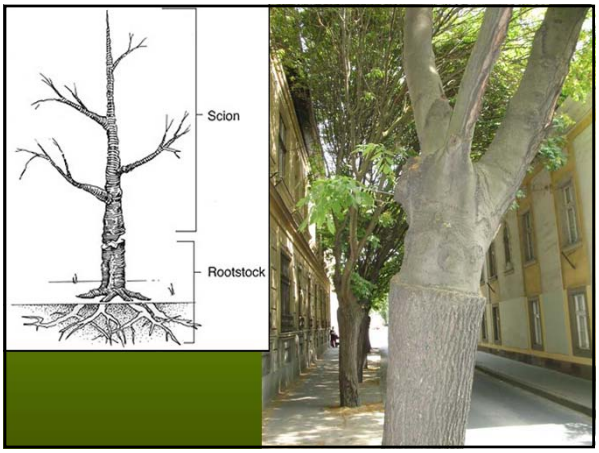
Terminology

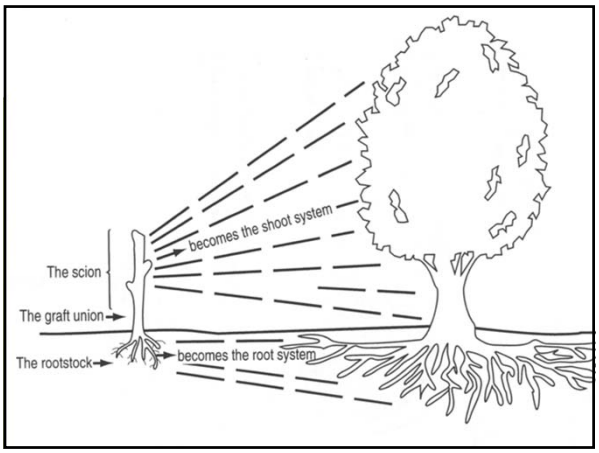
- ❖Grafting – Connecting two pieces of living plant tissue together so they will unite and grow as a composite plant.
- ❖Budding – Grafting but scion is only the size of one bud or a cluster of buds at one axil.
- ❖Scion – Short piece of shoot containing several buds (will become the upper piece of the graft and ultimately the shoot system)

Terminology

- Rootstock – Lower portion of the graft which develops into the root system (may be seedling, clonal rootstock, micro propagated plant).
- Interstock – Piece of stem inserted between the scion and the rootstock by means of two graft unions.
- Vascular Cambium – Thin tissue located between the bark (periderm, phloem, cortex) and the xylem wood which is capable of dividing and forming new cells.
- Callus – Mass of parenchyma cells which forms in response to wounding.







Reasons for Grafting and Budding

- Perpetuating clones that cannot be readily maintained or economically propagated by cuttings, layering, division or other asexual methods.

Reasons for Grafting and Budding

- Obtaining the benefits of certain rootstocks
- Tolerance of heavy wet soils
- Size control
- Disease resistance/tolerance
- Insect resistance/tolerance
- Fruit bearing
- Some cuttings make poor root systems
- Avoid root diseases

Reasons for Grafting and Budding

- Obtaining the benefits of certain interstocks (double working)
  - Done by interstem or by double budding
    - Bartlett on Old Home on Quince

Reasons for Double Working

- Interstock may avoid incompatibility
- Interstock may have traits such as disease resistance of cold hardiness
- May give disease resistance to relevant area such as leaf blight in rubber
- May reduce vegetative growth ad push reproductive growth

Reasons for Grafting and Budding

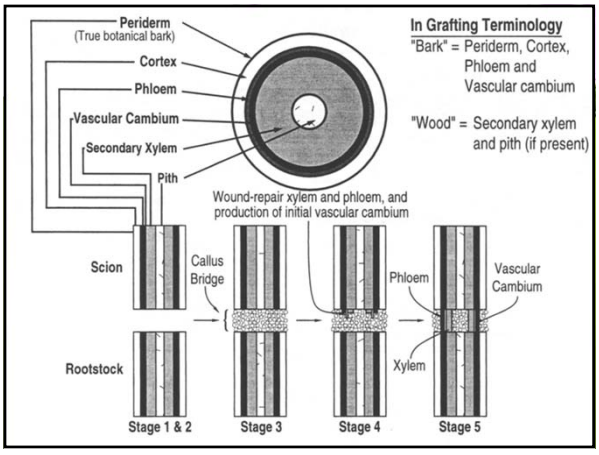
- Changing cultivars of established plants (topworking)
- Done by California growers for peaches, plums, and nectarines every 2-3 years.
- May be used to introduce a pollinator in a solid block of one cultivar or a branch of staminate flowering in a pistillate shrub (ilex).
- May be used to make a multi-cultivar tree for the home gardener (one citrus tree growing oranges, lemons, grapefruit, mandarins, and limes)

Reasons for Grafting and Budding

- Hastening reproductive maturity of seedling selections. Takes 5-10 years to grow out of juvenile phase, less time if grafted.
- Hastening plant growth rate and reducing nursery production time. In nursery production, budded or grafted trees grow faster than seedling or cutting produced trees.
- Obtaining special forms of growth – tree roses, weeping cherries, mulberries, and birches.

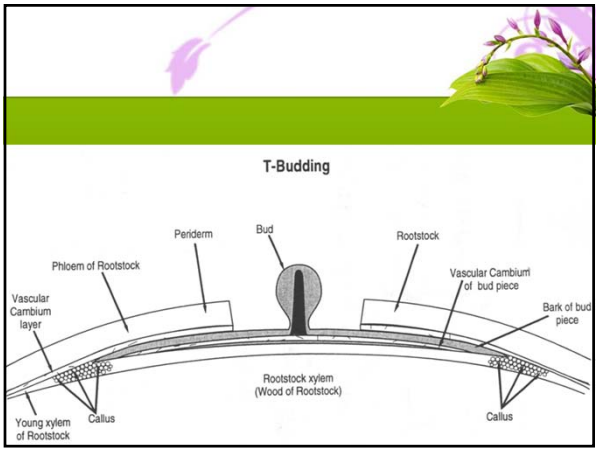
Natural Grafting

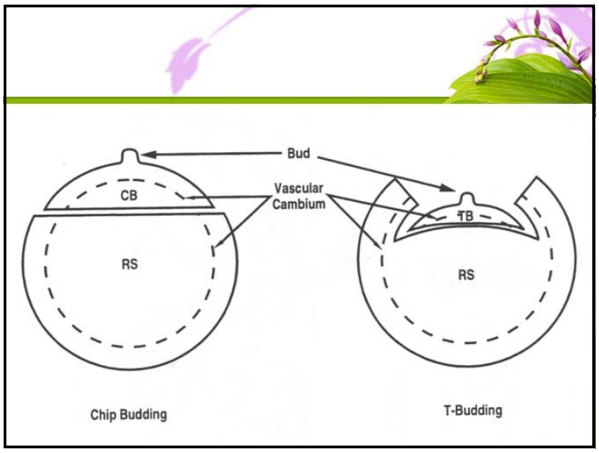
- Sometimes occur after two limbs are pressed together for a long time. May also occur with roots. However, can be a route for transmission of viruses or root diseases.
- Used by orchardists to strengthen trees to support scaffold system.



Graft Union Formation in T-Budding and Chip Budding

- Chip budding results in a more rapid and complete union – due to closer match of scion tissue to rootstock.
- Chip budding can be done over a longer period. T-budding requires the rootstock to be active (Bark slipping)

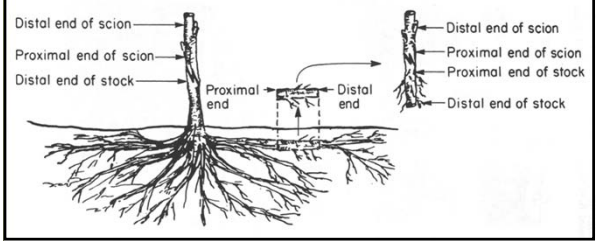




Polarity In Grafting

- Proximal end (end nearest root-stem junction) of the scion is stuck into the Distal end (nearest the tip of root or shoot) of the rootstock.
- Maintain polarity. Inverse budding produces wide branch angles. Inverse bridge graft does not increase in size.

Polarity in Grafting



Vegetative Propagation

- Using cuttings as a type of vegetative propagation which enables the development and maintenance of *clones*.
- Cloning - producing plants (clones) identical in genotype to a single source plant.
- Advantages - enables the immediate selection of a superior type and its indefinite multiplication.

Vegetative Propagation

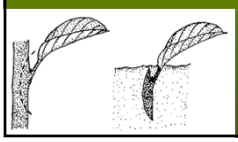
- Cuttings - Moist coarse sand, vermiculite, perlite or a mixture is best material.
  - stem tip (terminal)
  - sub terminal stem
  - root
  - leaf cuttings

Stem Cuttings

- Cut 3 to 5 inches from the tip just below a node.
- Take off the bottom leaves that would be covered by the rooting medium and place them upright in your pot or tray.
- Water, cover with clear plastic and put them in a warm place with bright light; after a few days, remove the plastic
- When cuttings have good roots, transplant into pots using a standard soil mix.

Leaf Bud Cuttings

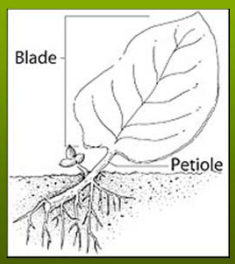
- Treated like stem-tip cuttings, and can be used on the same plants.
- Can get more plants from one parent plant with this method; just cut between every two nodes.



Leaf Petiole Cuttings

- Jade plant, peperomia, piggy-back plant and African violet
- A new plant is generated from just a leaf and its stalk (the petiole).
- Use young, healthy, medium-sized leaves
- Cut from the plant, leaving the petiole about one inch long
- Place in rooting medium deep enough to cover the petiole and firm medium around it
- Treat like stem tip cuttings

Leaf Petiole Cutting



Leaf Section Cuttings

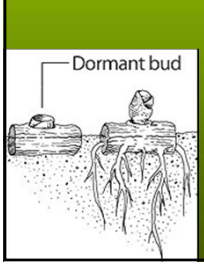
- Snake Plant
- Cut a leaf into two-inch sections.
- Stick them halfway into rooting medium, right side up.
- Roots are produced in approximately one month.
- Young plants develop in a month

Leaf Section Cutting

Stem Section Cuttings

- Chinese evergreen, dracaena and dumb cane
- Some plants are grown from stem-section cuttings so that each has one or more nodes.
- Sections are laid flat on sand or vermiculite, and bottom half covered.

Stem Cuttings



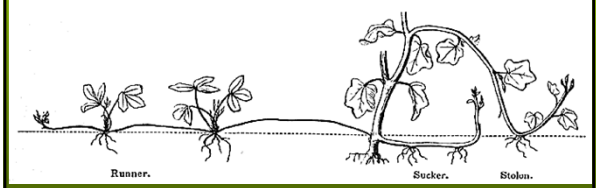
Root Cuttings

- Should be one to three inches long, about 1/4- to 1/2-inch across for trees and shrubs.
- Plant cuttings right side up in moist rooting medium with the tops just above the surface.

Runner or Stolon

- Above ground stem that produces new plants at its nodes
- Runners are removed with its small plant intact under plastic or
- A small pot containing good soil is set up near the parent plant and runner fastened to the soil
- Runner plant is cut free once rooted.

Runner or Stolon



Suckers

- Some trees and shrubs send up suckers from their roots. These are shoots that can be dug up and cut free and planted.

Bulbs

- Separate bulbs (tulip, narcissus, hyacinth, amaryllis) or ***corms*** (gladiolus, crocus) by breaking off the small bulbs or corms that form around the parent. Each of these can then be planted.

Corm

- A short, thickened, vertical rhizome that stores starch

Rhizomes

- Underground stems; examples are lily-of-the-valley and bearded iris.

Tubers

- Swollen, underground stems that store food.

Layering

- Method of making roots develop on a stem while still attached to the parent plant.
- After roots form, it is cut free and planted. Layering works best in spring or late summer.

Simple Layering

- A low branch is bent to the ground and buried, except for the tip.
- Wounding the branch by cutting part-way through the part that will be buried helps rooting.

Air Layering

- Used on rubber plants and other indoor woody plants.
- Wound the stem, or remove a ring of bark about a foot from a branch tip.
- Wrap the area with damp sphagnum moss and secure it in place by using plastic tape; keep the moss moist.
- Roots form in a few weeks to several months. Once rooted, cut off the stem below the roots and plant.

Air Layering

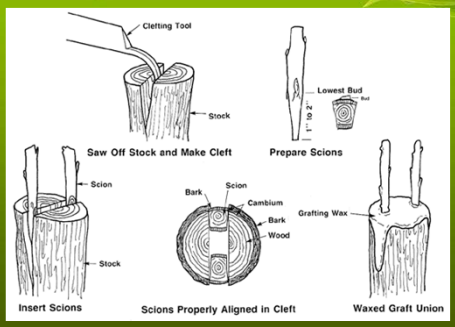
Grafting

- Cleft graft
- Bark Graft
- Side-Veneer Graft
- Splice Graft
- Whip and Tongue Graft
- Saddle Graft
- Bridge Graft
- Inarch Graft

Cleft Graf

- One of the simplest and most popular forms of grafting, cleft grafting, is a method for top working both flowering and fruiting trees (apples, cherries, pears, and peaches) in order to change varieties.
- Cleft grafting is also used to propagate varieties of camellias that are difficult to root. This type of grafting is usually done during the winter and early spring while both scion and rootstock are still dormant.
- Cleft grafting may be performed on main stems or on lateral or scaffold branches.
- The rootstock used for cleft grafting should range from 1 to 4 inches in diameter and should be straight grained. The scion should be about 1/4 inch in diameter, straight, and long enough to have at least three buds. Scions that are between 6 and 8 inches long are usually the easiest to use.

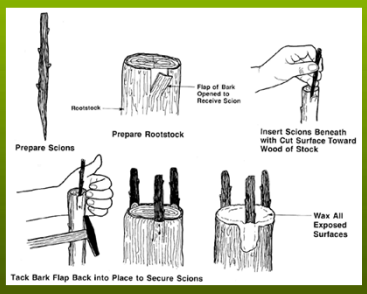
Cleft Graft



Bark Graft

- Bark grafting is used primarily to top work flowering and fruiting trees.
- In contrast to cleft grafting, this technique can be applied to rootstock of larger diameter and is done during early spring when the bark slips easily from the wood but before major sap flow.
- The rootstock is severed with a sharp saw, leaving a clean cut as with cleft grafting.

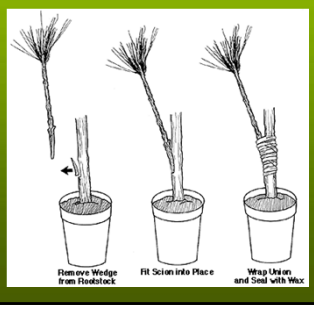
Bark Graft



Side-Veneer Graft

- At one time the side-veneer graft was a popular technique for grafting varieties of camellias and rhododendrons that are difficult to root.
- Currently, it is the most popular way to graft conifers, especially those having a compact or dwarf form.
- Side-veneer grafting is usually done on potted rootstock.

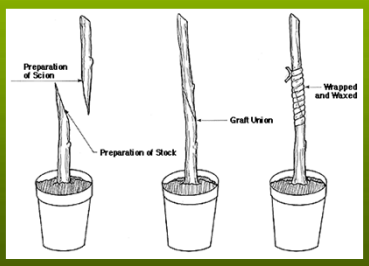
Side-Veneer Graft



Splice Graft

- Splice grafting is used to join a scion onto the stem of a rootstock or onto an intact root piece.
- This simple method is usually applied to herbaceous materials that callus or "knit" easily, or it is used on plants with a stem diameter of 1/2 inch or less.
- In splice grafting, both the stock and scion must be of the same diameter.

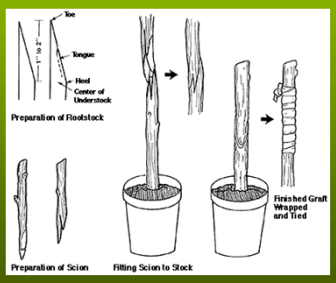
Splice Graft



Whip and Tongue Graft

- The whip and tongue technique is most commonly used to graft nursery crops or woody ornamentals. Both the rootstock and scion should be of equal size and preferably no more than 1/2 inch in diameter.
- The technique is similar to splice grafting except that the whip on the rootstock holds the tongue of the scion in place (and vice versa). This leaves both hands free to wrap the joint.
- For the whip and tongue graft, make similar cuts on both the stock and scion. These cuts should be made with a single draw of the knife and should have a smooth surface so that the two can develop a good graft union. Up to this point, rootstock and scion are cut the same as for a splice graft.

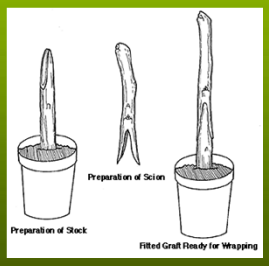
Whip and Tongue Graft



Saddle Graft

- Saddle grafting is a relatively easy technique to learn and once mastered can be performed quite rapidly.
- The stock may be either field-grown or potted. Both rootstock and scion should be the same diameter.
- For best results, use saddle grafting on dormant stock in mid- to late winter. Stock should not be more than 1 inch in diameter.

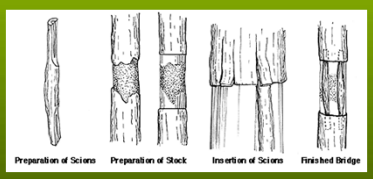
Saddle Graft



Bridge Graft

- Bridge grafting is used to "bridge" a diseased or damaged area of a plant, usually at or near the base of the trunk.
- Such damage commonly results from contact with grading or lawn maintenance equipment, or it may be caused by rodents, cold temperatures, or disease organisms.
- The bridge graft provides support as well as a pipeline that allows water and nutrients to move across the damaged area.
- Bridge grafts are usually done in early spring just before active plant growth begins. They may be performed any time the bark on the injured plant "slips."

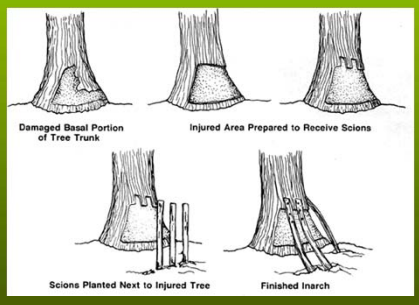
Bridge Graft



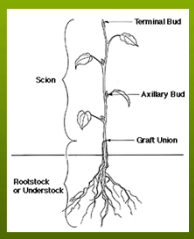
Inarch Graft

- Inarching, like bridge grafting, is used to bypass or support a damaged or weakened area of a plant stem.
- Unlike bridge grafting, the scion can be an existing shoot, sucker, or watersprout that is already growing below and extending above the injury.
- The scion may also be a shoot of the same species as the injured plant growing on its own root system next to the main trunk of the damaged tree.
- With the inarching technique, the tip of the scion is grafted in above the injury using the same method as for bark or bridge grafting.

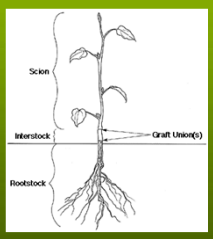
Inarch Graft



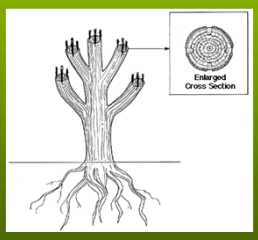
Single Work Graft



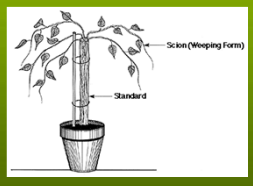
Double Work Graft



Top Work Graft



Graft for Form



Propagation Tools

1. Budding knife
2. Grafting Knife
3. A fine-tooth saw for cleft grafting
4. Pruning
5. Grafting material
6. Tying material such as grafting tape, adhesive tape, electrician's tape or rubber strips
7. Grafting wax
8. A light hammer for bridge grafting
9. A cleft-grafting chisel and mallet, or a heavy knife or hatchet can be used for a small job