Grafting & Budding

Compiled from https://propg.ifas.ufl.edu/terms.html

Articles: 27

Approach Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/01-grafting-approach.html

Approach grafting is unique because both the rootstock and scion remain atached to their root systems during the grafting process. The scion is usually in a container, which is brought to the rootstock.

This graft is done while both partners are actively growing. It is a graft used when the scion is unique and the propagator does not want to remove it from the stock plant.

It is also used when standard grafts have not been successful.

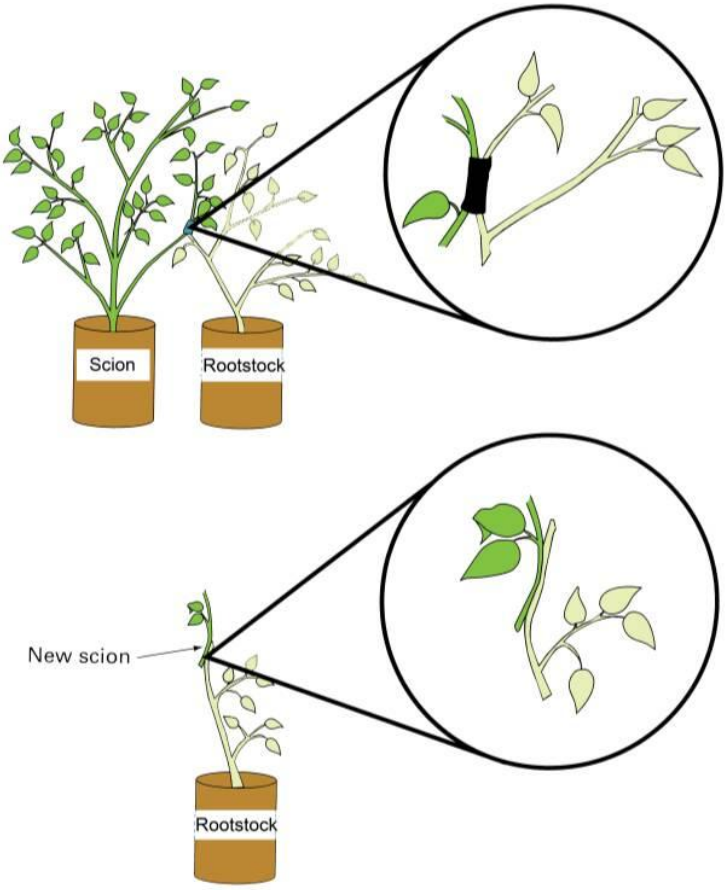


Illustration showing how approach grafting is done. First step shows scion being bound to rootstock while both plants still in their own containers. Step two shows new scion successfully grafted to rootstock, and now sepparated from original scion plant.

After the graft union forms cut the unwanted rootstock and scion away.

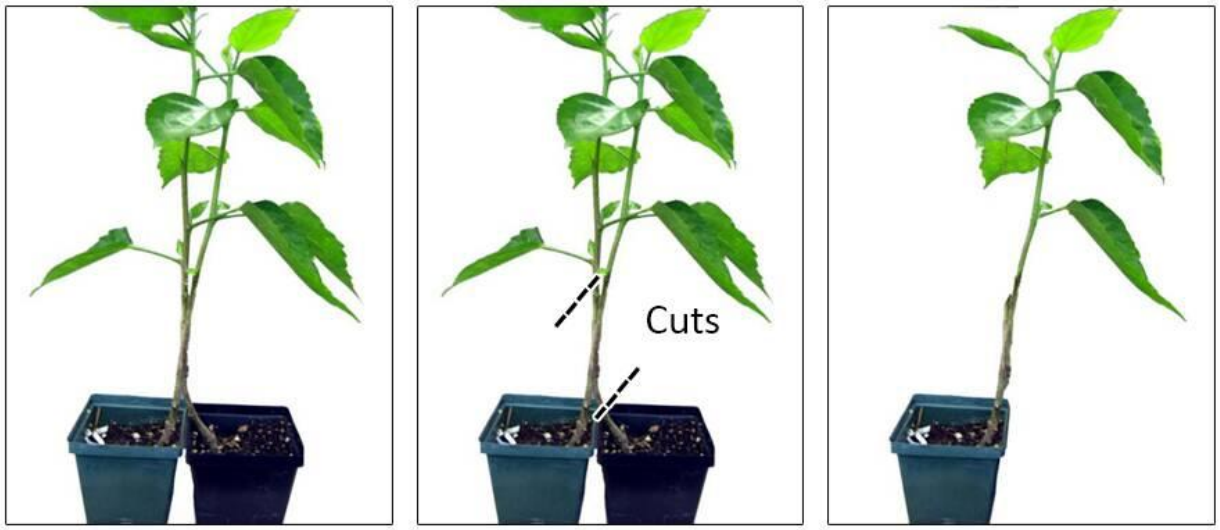


Photo showing three steps to create an approach grafting. In the first step, the scion and rootstock plants are bound together. Step two shows where cuts should be made on both plants once the graft union finishes forming. The scion should be cut from it's root source, while the top of the rootstock should be removed. Step three shows the completed graft with the scion now growing from the rootstock.

Spliced approach graft

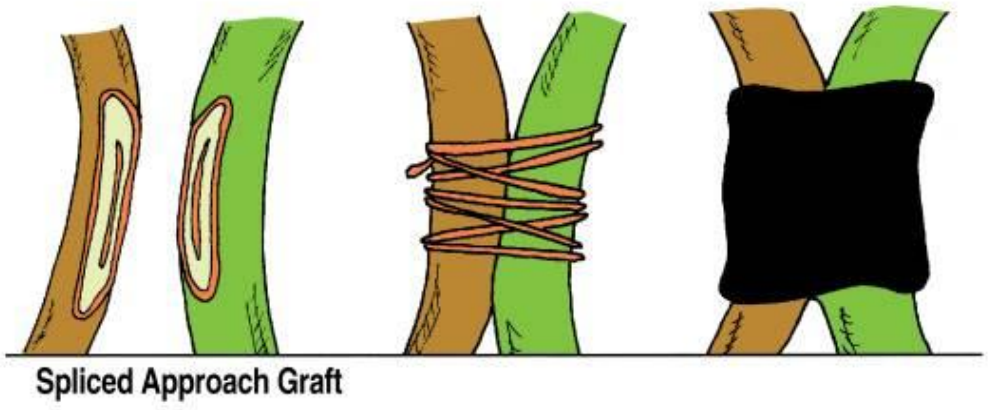


Illustration showing the spliced approach method of grafting. With this approach the two plants have had simple cuts made to remove their outer layers to bind the cambium layers to each other.

Tongued approach graft

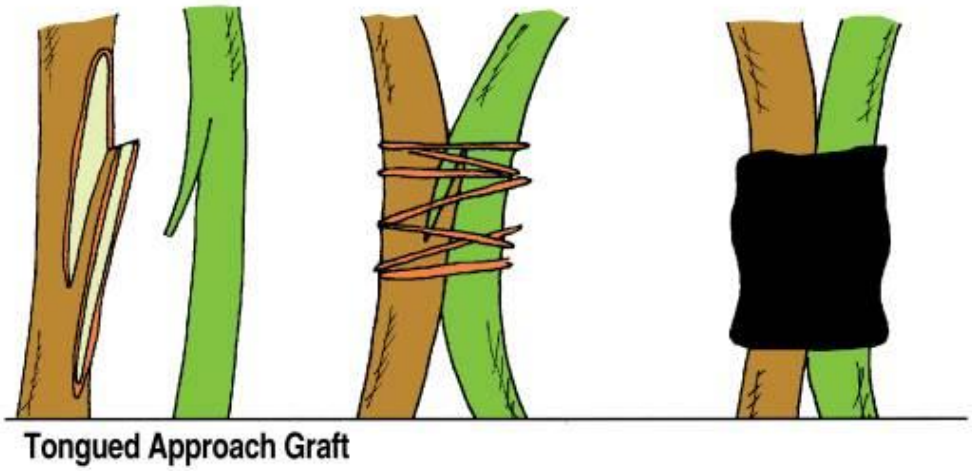


Illustration showing the tongued approach method of grafting. With this approach the two plants have had tongued cuts made to remove their outer layers to bind the cambium layers to each other, with the tongues inserted into each other.

Inlay approach graft

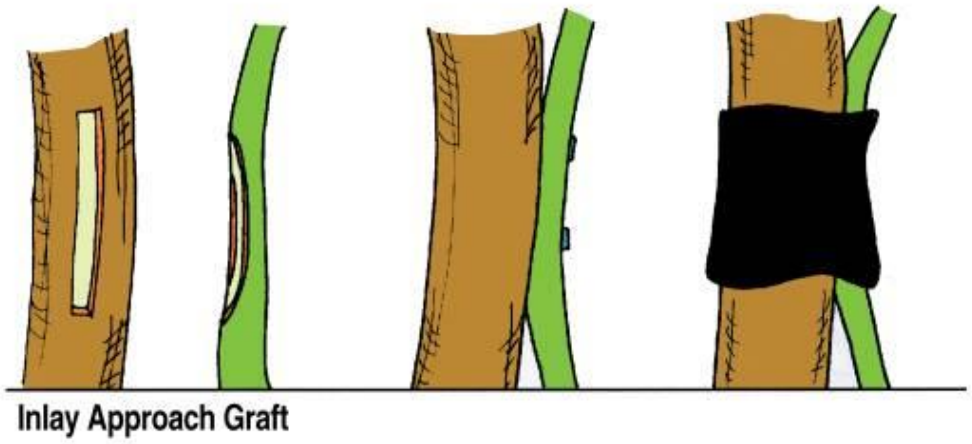


Illustration showing the inlay approach method of grafting. With this approach the two plants have had inlay cuts made to remove their outer layers to bind the cambium layers to each other. The first plant has a groove cut into it, while the second has a ridge created to fit into the groove.

Bark Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/02-grafting-bark.html

The bark graft and the inlay bark graft are types of grafts used for topworking established plants.

Topworking is a technique used in fruit orchards for changing cultivars without having to plant new trees.

Photo of an example of bark grafting showing three scions inserted into a rootstock.

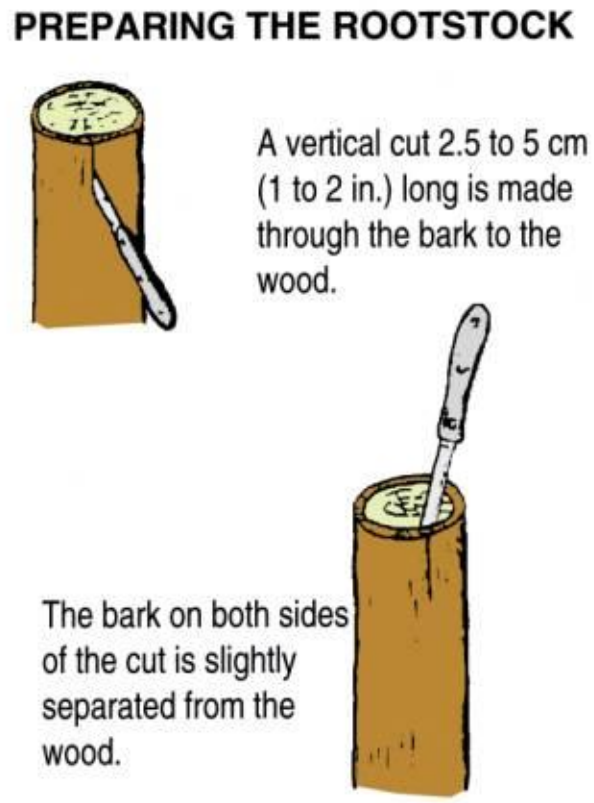


Illustration showing two steps to prepare rootstock for bark grafting. First a vertical cut 2.5 to 5 cm (1 to 2 in) long is made through the bark to the wood. Second the bark on both sides of the cut is slightly separated from the wood.

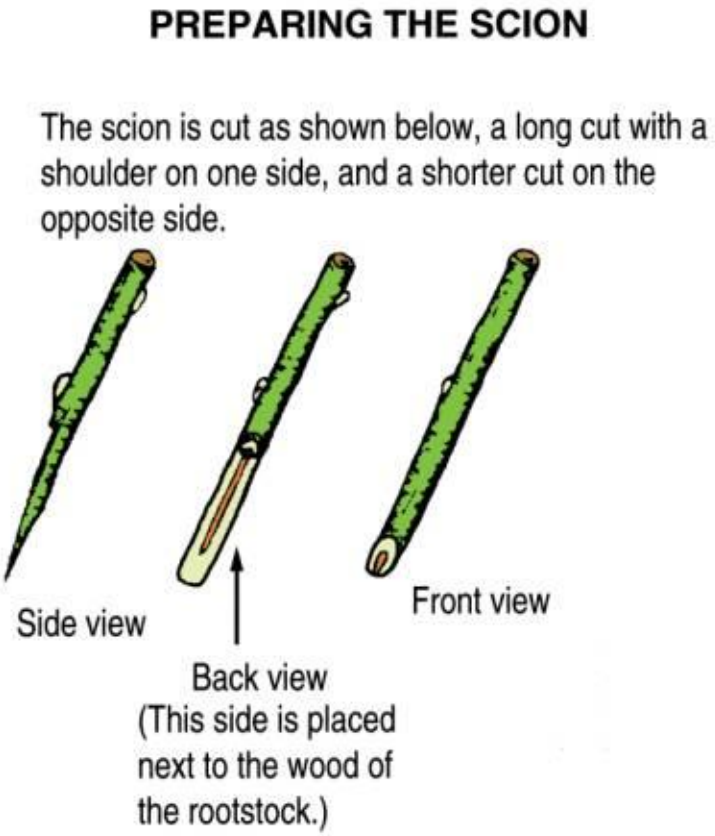


Illustration showing side, back, and front views of how to prepare a scion for bark grafting. The scion is given a long cut with a shoulder on one side, and a shorter cut on the opposite side. The long cut is placed next to the wood of the rootstock.

Photo showing a side view of a prepared scion.

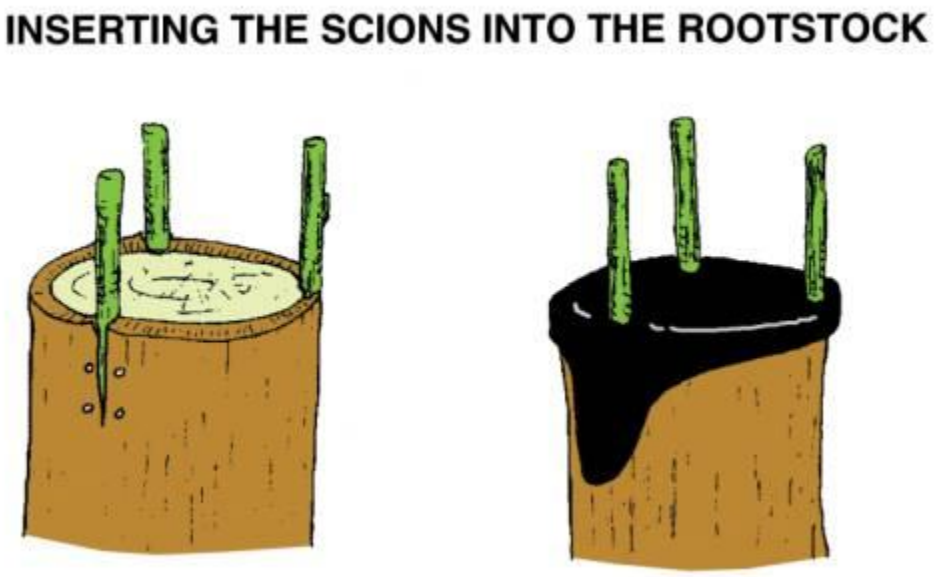


Illustration showing three scions inserted into a rootstock, and then the cut surfaces with a protective coating applied.

Photo showing four scions inserted into a rootstock with a protective coating applied.

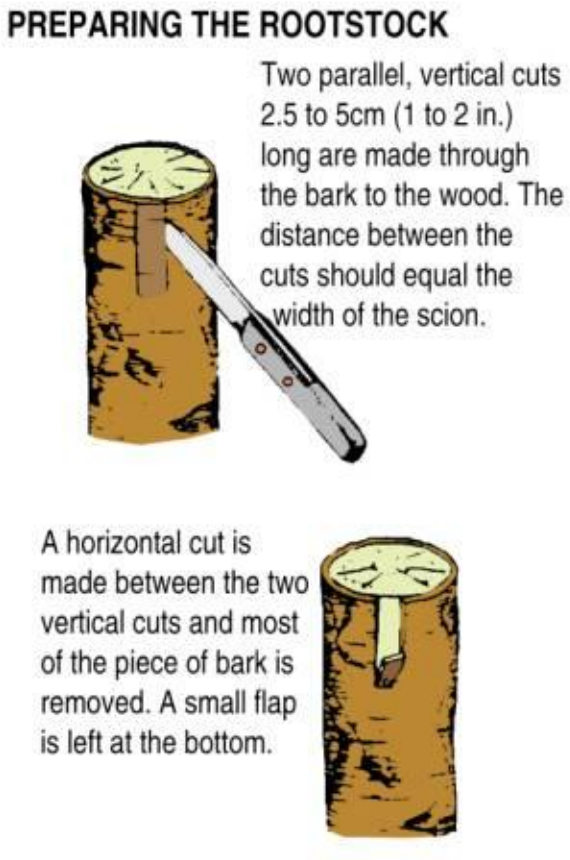
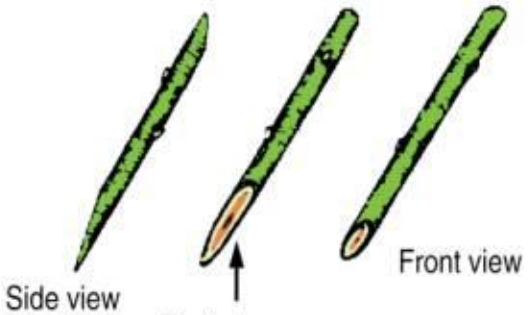


Illustration showing an alternate method for creating a bark grafting rootstock. In step one two parallel, vertical cuts 2.5 to 5 cm (1 to 2 in.) long are

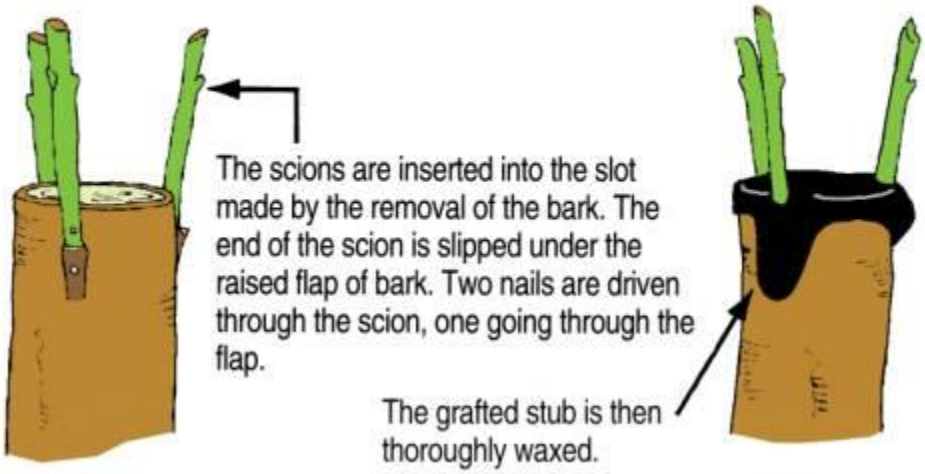
PREPARING THE SCION

The scions are made with a long sloping cut on one side and a shorter cut on the opposite side.



(This side is placed next to the wood of the rootstock.)

INSERTING THE SCION INTO THE ROOTSTOCK



The scions are inserted into the slot made by the removal of the bark. The end of the scion is slipped under the raised flap of bark. Two nails are driven through the scion, one going through the flap.

The grafted stub is then thoroughly waxed.

Click on the button below to see bark grafting video.

Bench Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/03-grafting-bench.html

Bench grafting refers to grafting operations that are performed indoors and maintained under protective covers rather than grafts performed in the field.

Bench grafting is done using bareroot or container-grown rootstocks.

Photo of technicians working with Japanese maples using bench grafting.

Side grafting Japanese maples.

Bridge Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/04-grafting-bridge.html

A bridge graft is an example of a repair graft. It is done to rescue established trees that have been girdled by mechanical damage or animals.

Bridge grafting is best done in early spring when the bark is slipping.

Scions are taken from dormant one-year old stems.

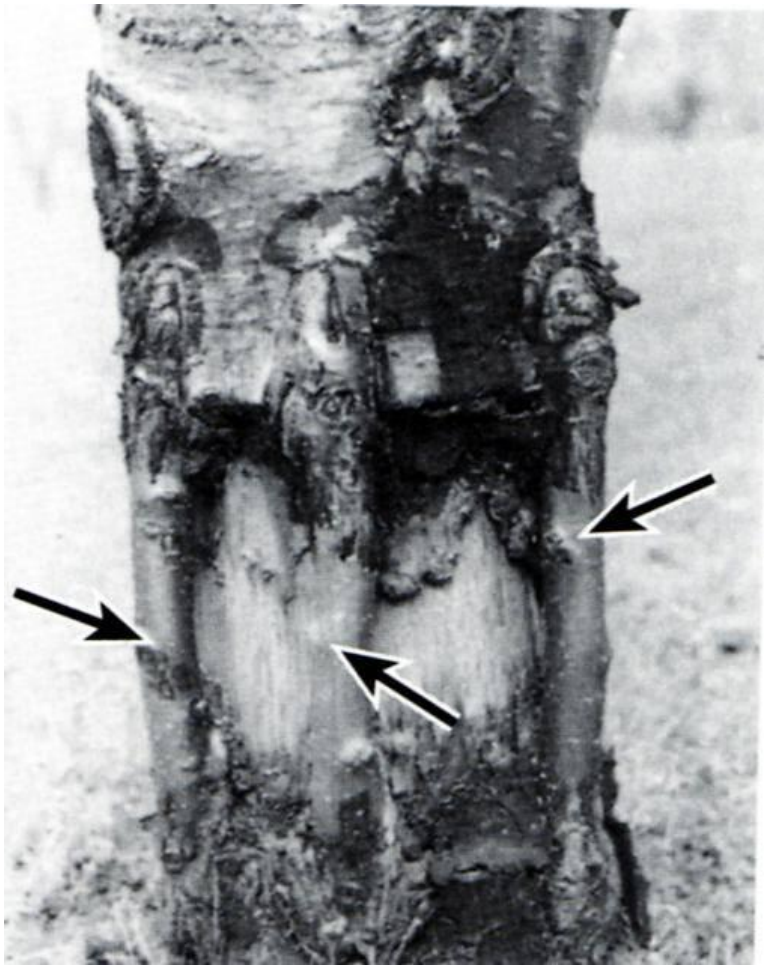


Photo example of bridge grafting with the bridging scions identified.

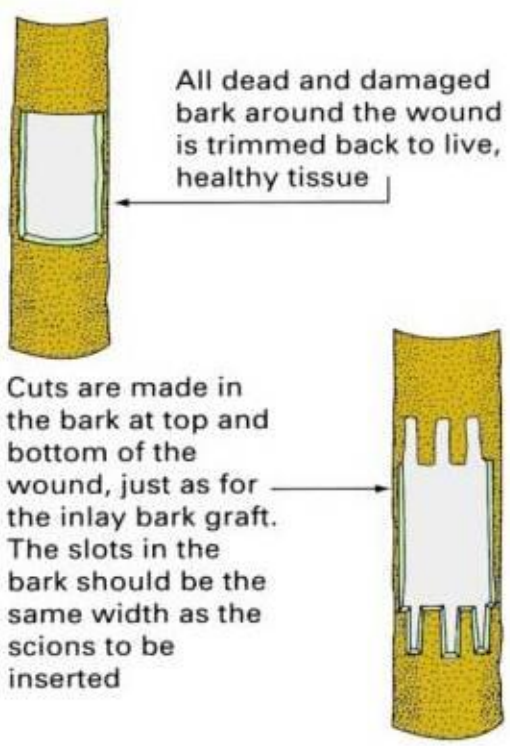


Illustration showing two steps needed to prepart the damaged plant. In step one all dead and damaged bark around the wound is trimmed back to live, healthy tissue. In steop two cuts are made in the bark at the top and bottom of the wound, just as for the inlay bark graft. The slots in the bark should be the same width as the scions to be inserted.

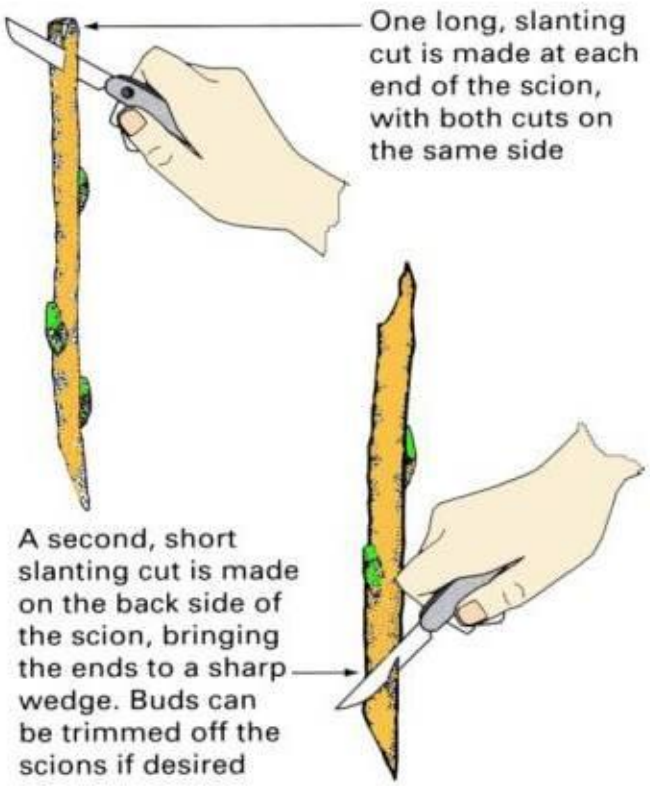


Illustration showing two steps needed to prepare a scion for bridge grafting. In step one a long, slanting cut is made at each end of the scion, with both cuts on the same side. In the second step a second, short slanting cut is made on the back side of the scion, bringing the ends to a sharp wedge. Buds can be trimmed off the scions if desired.

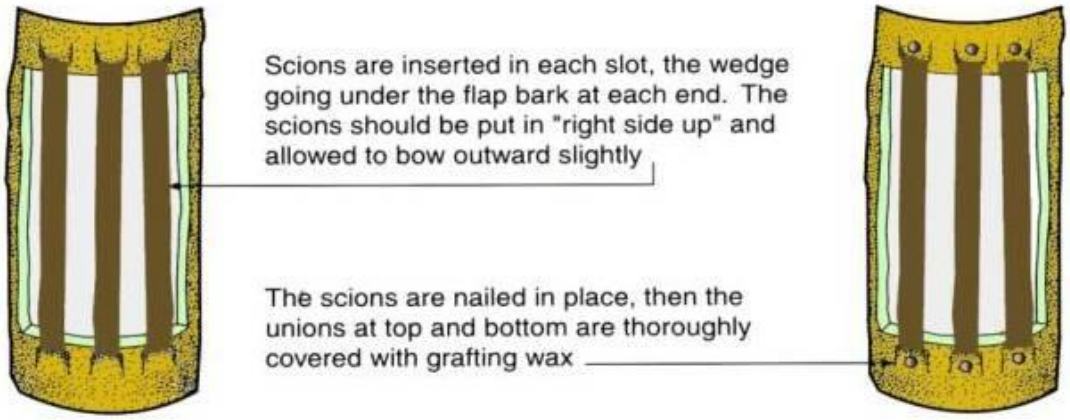


Illustration showing the bridge graft being made in two steps. In the first step the scions are inserted in each slot, the wedge going under the flap bark at each end. The scions should be put in 'right side up' and allowed to bow outward slightly. In the second step the scions are nailed in place, then the unions at top and bottom are thoroughly covered with grafting wax.

Budding

Source: https://propg.ifas.ufl.edu/06-grafting/03-buddingtypes/01-grafting-budding.html

Budding is a form of grafting where the scion is reduced to a single bud.

Types of budding include: T-budding Chip budding Patch budding I-budding Flute budding Ring budding

For additional information see various types of budding.

Photo showing a worker creating a bud graft.

Cactus Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/05-grafting-cactus.html

Cactus grafts are novelties formed by grafting scions with interesting shapes or colors on to an easy to root cactus rootstcock. Most of the colored scions do not produce chlorophyll and must be grafted to persist. These grafted cactus are most commonly done in Asia and imported into the USA.

Photo showing flats filled with a variety of cactus grafts.

Close up photo of a cactus graft.

The stem anatomy in cactus is different from most other dicots, so the scion and the rootstock must be aligned a little differently from other grafts. The central core of the scion and rootstock must be lined up to allow the vascular system to become connected.

Photo of a cactus rootstock cut to prepare it for grafting.

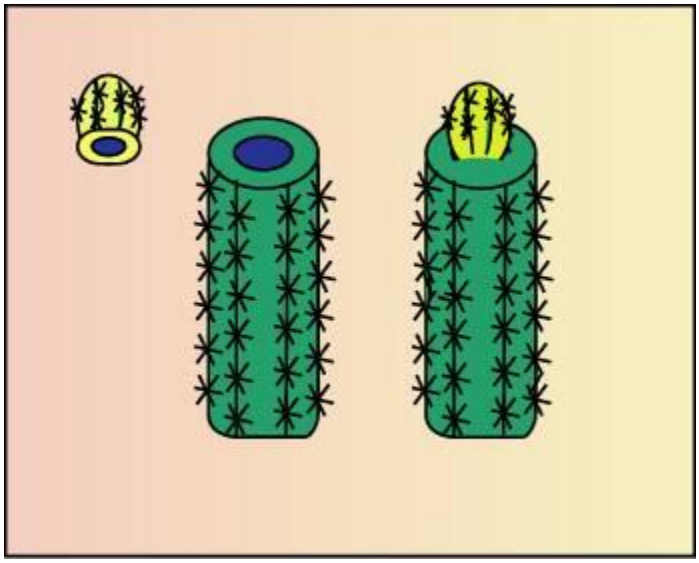


Illustration showing how the rootstock and scion must have their centers lined up, rather than the outer edges, to form a graft.

Rootstocks are removed from stock plants, placed in a rooting substrate and cut to receive the scion.

Photo of a flat of rootstocks that have been removed from stock plants.

Photo of rootstocks which have had their tops cut, and have been placed in flats of rooting substrate.

The scion is held in place with ties, pins, glue, or specialized weighted clips.

Close up photo of a cactus graft with the scion held in place with strings tying it to the rootstock.

Photo of an entire bed of cactus grafts with the scions tied in place.

Shade provides temperature control until plants have successfully grafted and rooted.

Photo of cactus grafts under shade cover cloths inside a greehouse environment.

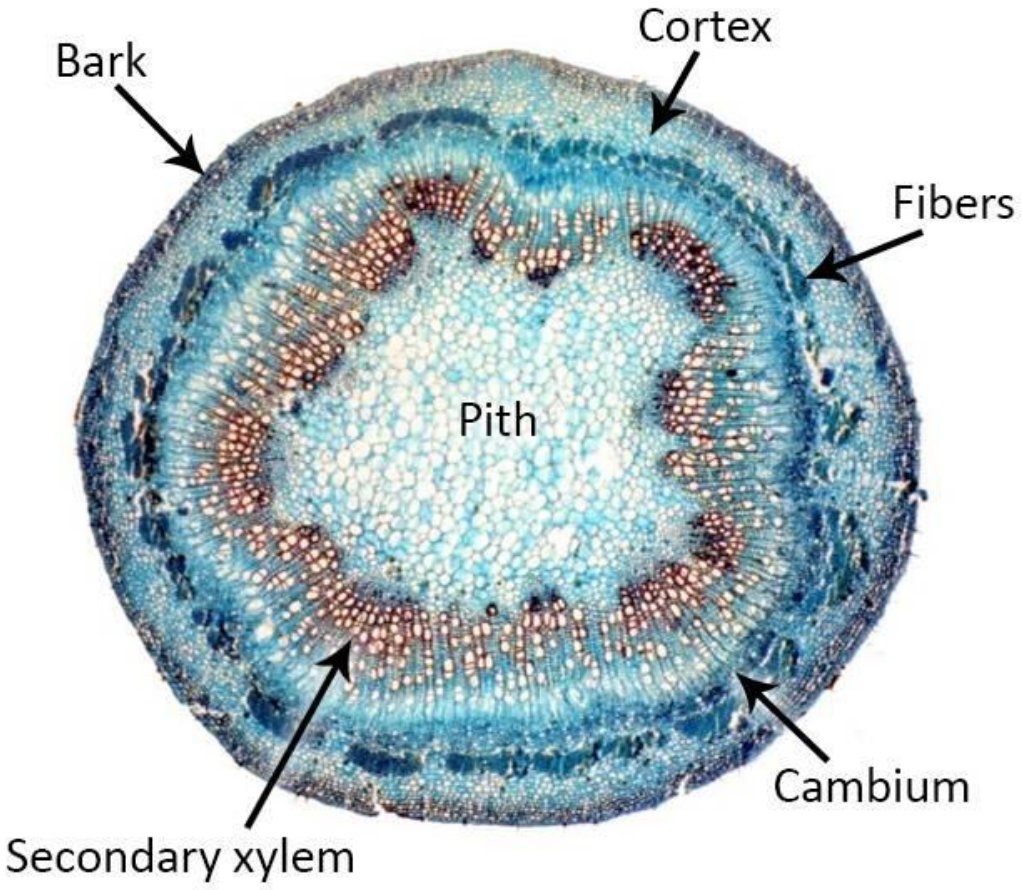
Photo of cactus grafts under shade cover cloths inside a greehouse environment.

Cambium (Grafting Types)

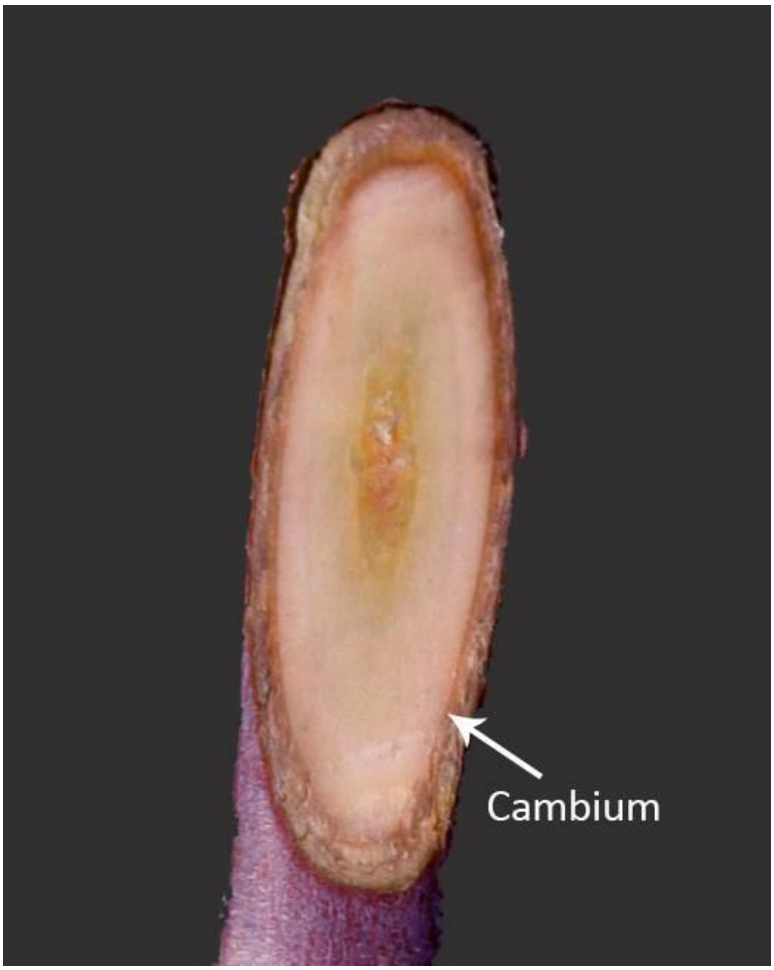
Source: https://propg.ifas.ufl.edu/06-grafting/01-terms/01-graftingterms-cambium.html

The cambium is a region of the stem where the vascular system is made.

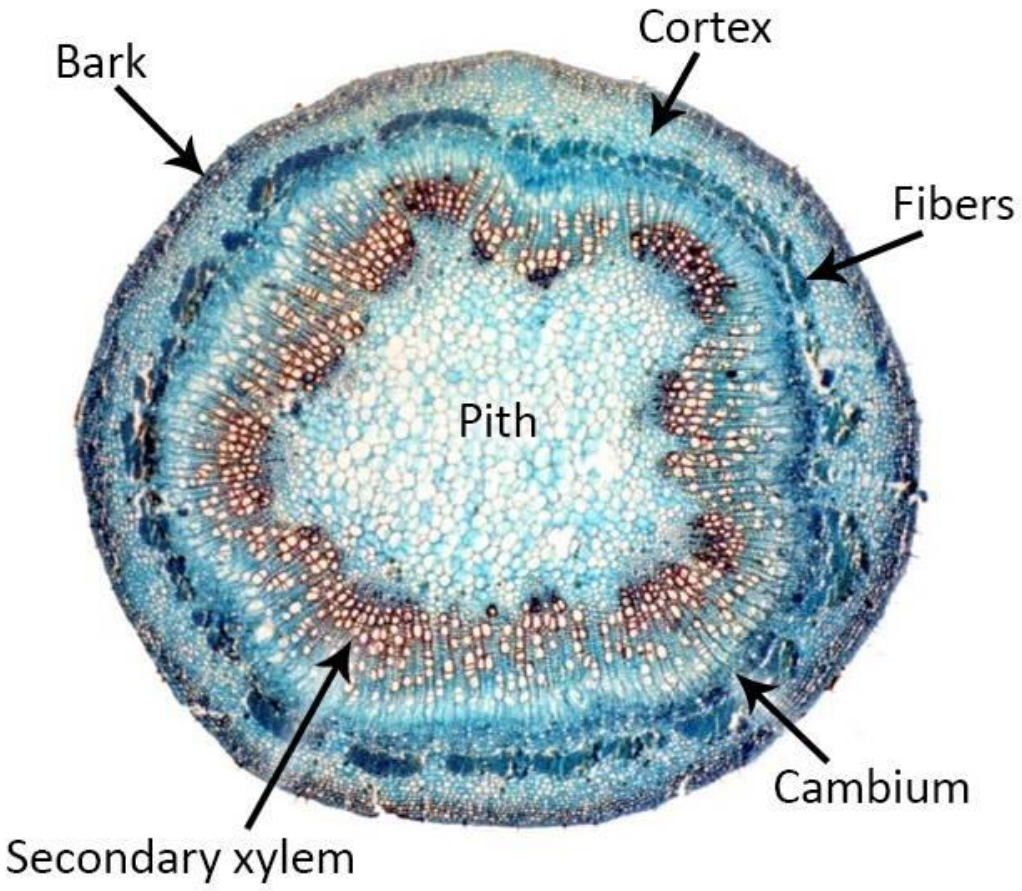
Cambial initials make phloem cells to the outer (bark) side of the stem, while xylem is made to the inner section of the stem.



Micrograph of the cross section of a stem with the following structures identified in order from outside to core: bark, cortex, fibers, cambium, secondary xylem, and pith.



Close up photo of a cutting with the cambium identified.



Micrograph of the cross section of a stem with the following structures identified in order from outside to core: bark, cortex, fibers, cambium, secondary xylem, and pith.

During grafting the cambial regions of the scion and rootstock must line up so that the vascular systems can reattach in the graft union.

Photo showing a rootstock and scion being spliced together.

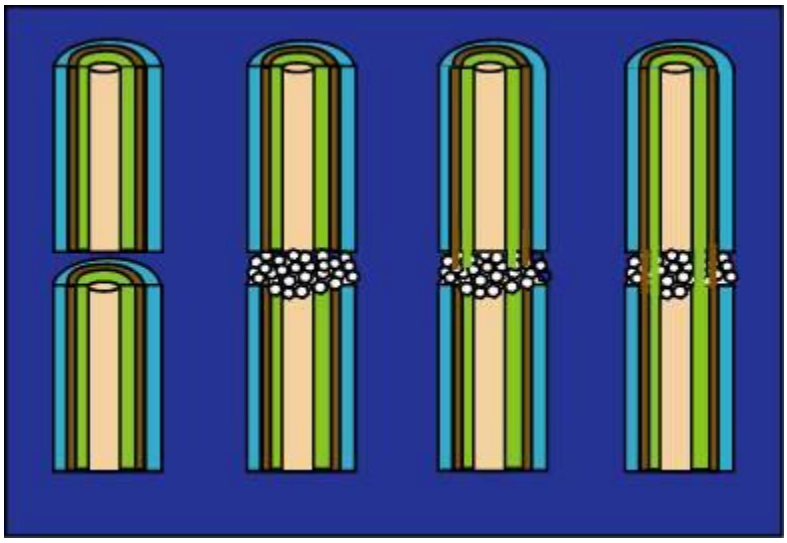


Illustration showing how the vascular systems of the scion and rootstock reattach in the graft union.

Center Wedge Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/16-grafting-centerwedge.html

In a center wedge graft, a tapered cut is made in the scion to fit into a wedge-shaped incision in the rootstock.

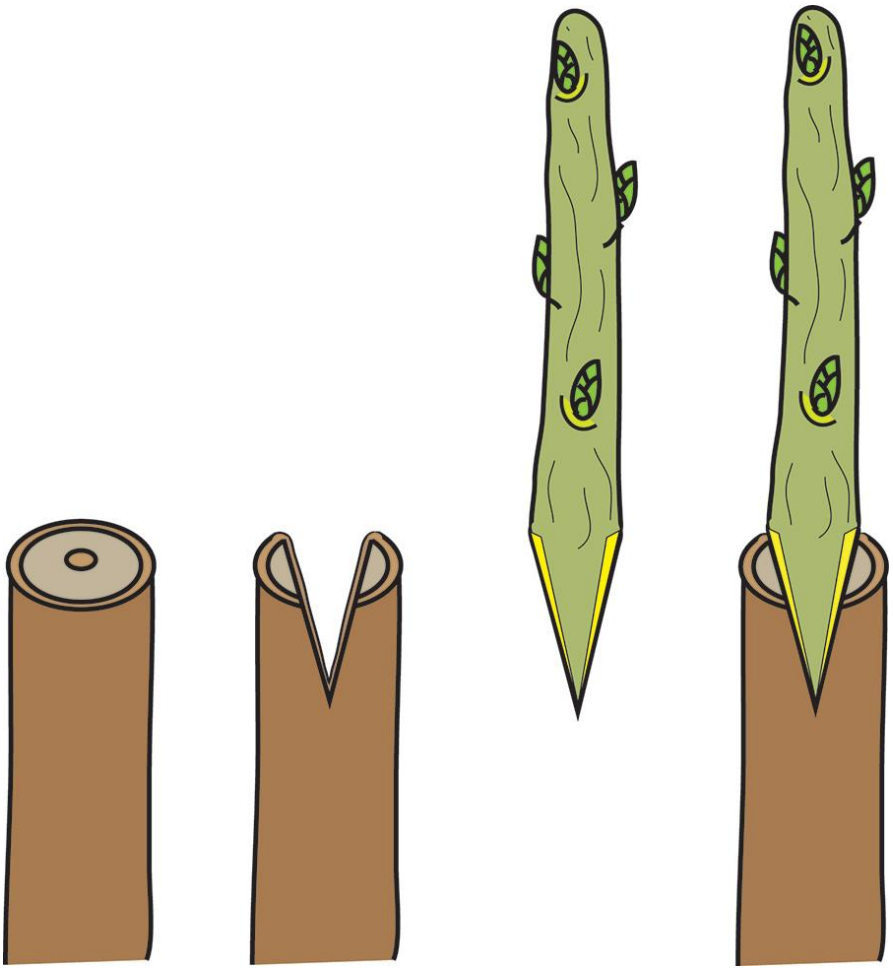


Illustration showing a scion fitting into a rootstock

Photo of an example of center wedge grafting.

After grafting, the scion and rootstock are wrapped as is illustrated in the South African native pagoda plant (Mimetes).

Photo of wrapped pagoda plant graft

Wrapped graft

Photo of pagoda plant with graft healed

Finished healed graft

Center wedge grafts are done for conventional grafting as in orange (Citrus) or specialty grafts like crested euphorbia.

Example of center wedge graft of orange.

Orange

Example of center wedge graft of euphorbia.

Euphorbia

Center wedge grafting being used to propagate avocado.

Close up photo of avocado center wedge grafting.

Photo of technician creating avocado center wedge grafts.

Click on the button below to see center wedge grafting video for avocado.

Chip Budding

Source: https://propg.ifas.ufl.edu/06-grafting/03-buddingtypes/02-grafting-budchip.html

Chip budding differs from T-budding because it can be done when the bark of the rootstock is not slipping. It has gradually become the most common form of budding for many ornamental and fruit tree species.

It is done in the summer when the buds are dormant but the rootstocks are active.

Chip budding results in greater grafting success and straighter trunks.

Photo showing an example of chip budding.

The rootstock is prepared by making a downward 45 degree cut followed by a second downward cut to form the "chip" shape.

Photo showing an example of the chip shaped piece of plant removed by the two cuts.

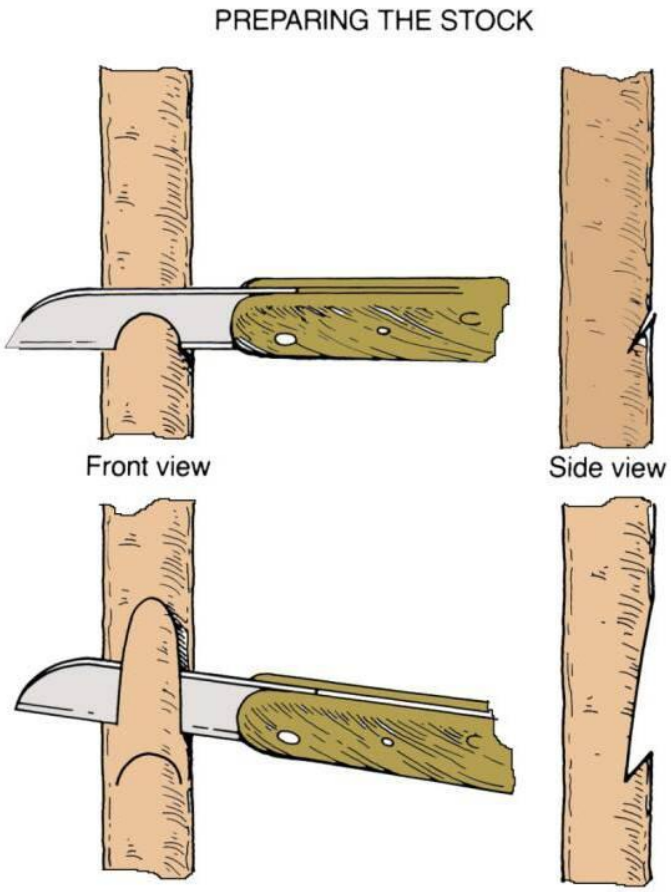


Illustration showing frontal and side views of the two cuts being made into rootstock.

Cutting the rootstock

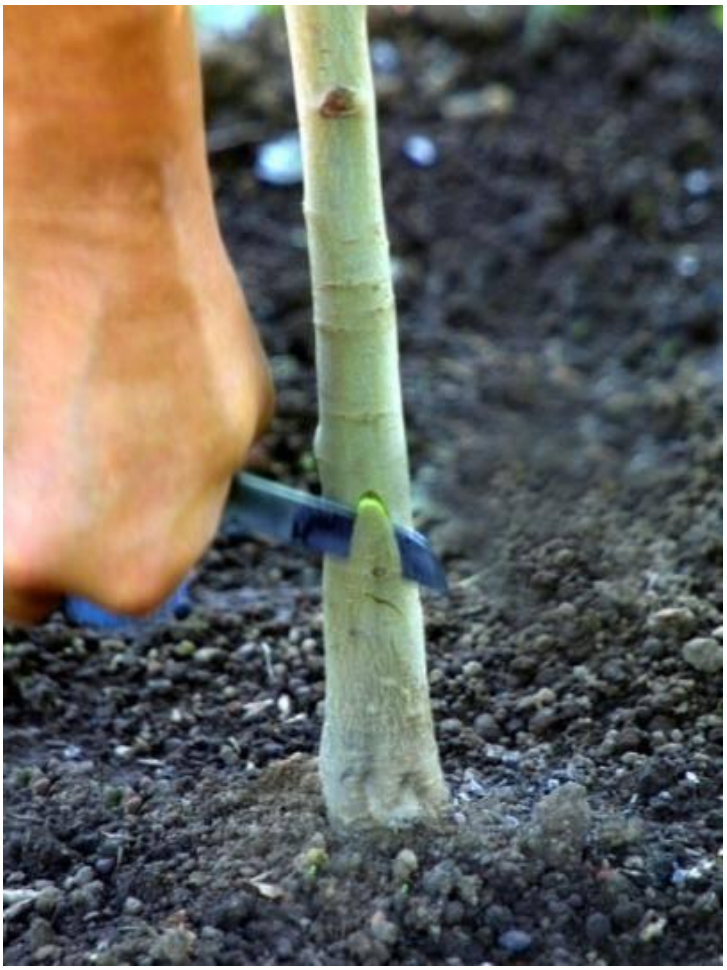


Photo showing the first downward cut in rootstock.

First downward cut in rootstock.

Photo showing the second downward cut in rootstock.

Second downward cut.

Photo showing the rootstock now ready to have bud inserted.

Rootstock ready to have bud inserted.

Cutting scion bud

Photo showing first cut being made to remove a scion bud.

Photo showing second cut being made to scion bud.

Photo showing the scion bud being removed, and ready to be inserted into rootstock.

The scion chip is made the same way and inserted into the rootstock and wrapped.

Photo showing scion chip being made.

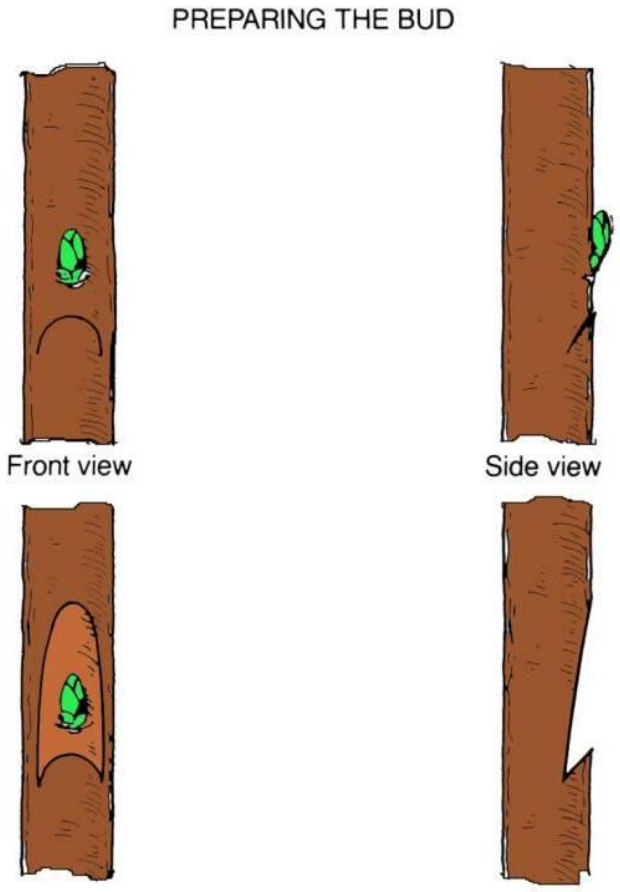
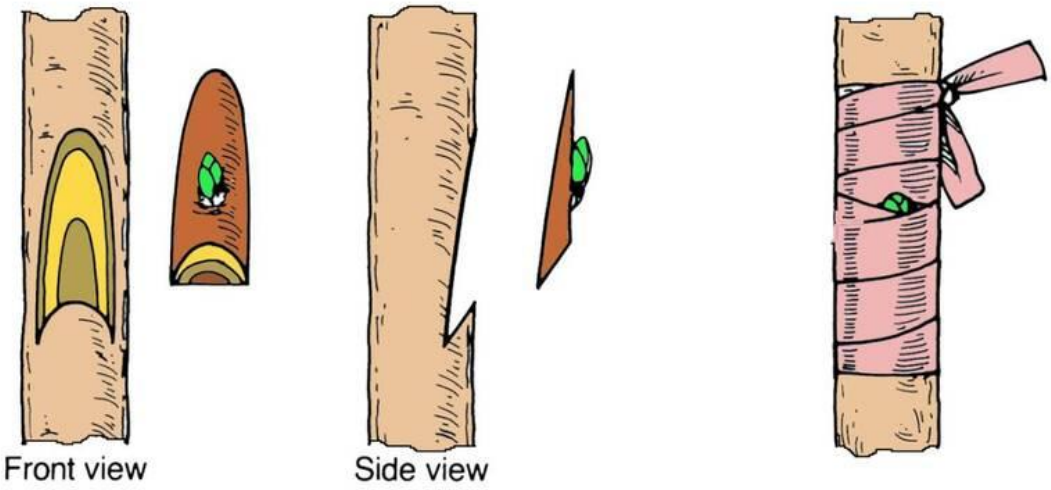


Illustration showing frontal and side views of a bud being cut into a chip to be inserted into rootstock.

The chip is wrapped completely with a rubber of plastic grafting wraps.



Illustraton showing frontal and side views of rootstock and bud chip before being brought together. Second step shows chip inserted and wrapped with plastic grafting wraps, except for the bud, which is left exposed.

Inserting the chip bud.

Photo showing a chip bud being inserted into rootstock.

Photo showing a chip bud being inserted into rootstock.

Photo showing a chip bud being inserted into rootstock.

Wrapping the chip bud.

Photo of a chip bud inserted into rootstock and being wrapped in plastic.

Photo of a chip bud inserted into rootstock and being wrapped in plastic.

Photo of a chip bud inserted into rootstock and being wrapped in plastic.

Click on the button below to see Bench Chip Budding video.

Field budding is a team effort with each group member specializing in either budding or tying.

Photo showing rootstock plants with lower leaves rubbed off.

Budding starts with rubbing off the lower leaves on the rootstock.

Photo of a field of plants with a first team member inserting chip buds to rootstock, and the second wrapping the chip buds.

The first team member buds and the second follows to wrap.

Grafting trolleys can be used to support and can be as simple as two connected wheels.

Photo showing front angle view of workers in the field using grafting trolleys.

Photo showing rear angle view of workers in the field using grafting trolleys.

More elaborate grafting trolleys have four wheels, storage capacity, and shade.

Photo showing a four wheeled grafting trolley.

Photo of a worker using a four wheel grafting trolley.

Click on the button below to see chip bud grafting video.

Rows of completed chip buds.

Photo of a field row of completed chip buds.

Close up view of completed chip buds.

After budding plants in the field, the tops of the rootstock must be taken off.

This can be accomplished in two steps. First, most of the top is removed mechanically with a field driven corn chopper in early spring.

Photo of an example field of rootstock plants with tops removed.

Photo of an example field of rootstock plants with tops removed.

Then, after the bud begins to grow, the rest of the rootstock is removed above the bud. Illustrated to the right is a hydraulic pruner that reduces the strain on workers pruning acres of trees.

Photo of a healed bud on rootstock.

Healed bud

Photo of a worker doing hand pruning of the top of rootstock.

Hand pruning

Photo showing a pneumatic pruner being used on rootstock.

Pneumatic pruner

Shoot growth begins from the inserted bud in the spring.

Photo of a field of rose rootstocks with buds beginning to grow leaves.

Roses

Close up photo of a paw paw bug beginning to sprout from rootsock.

Paw paw

The objective of producing shade trees from budding is to get a straight trunk without an obvious bend in the trunk where the chip bud was inserted. This is accomplished by training the developing bud with "grow straights" that forces the developing stem upright.

Photo showing rows of pots with buds growing straight with the aid of grow straights.

Close up photo of a grow straight.

Cleft Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/06-grafting-cleft.html

A cleft graft is one of the grafts used for topworking new cultivars on existing trees.

It is used for relatively small branches and done when the stock is dormant and cracks easily.

Photo identifying an example of cleft grafting in a field of trees.

Two scions are inserted on either side of the branch and the cambium lined up along the outer edge.

When the tool is released, the pressure of the closure holds the scions in place.

Once the graft takes, only one of the scions will be retained.

Sometimes the other scion is left for a while as a nurse branch

Photo showing an example of a cleft graft.

Photo showing a kiwi cleft graft with two scions.

Photo showing a kiwi cleft graft with two scions.

Kiwi is an exception where two vines are left per graft.

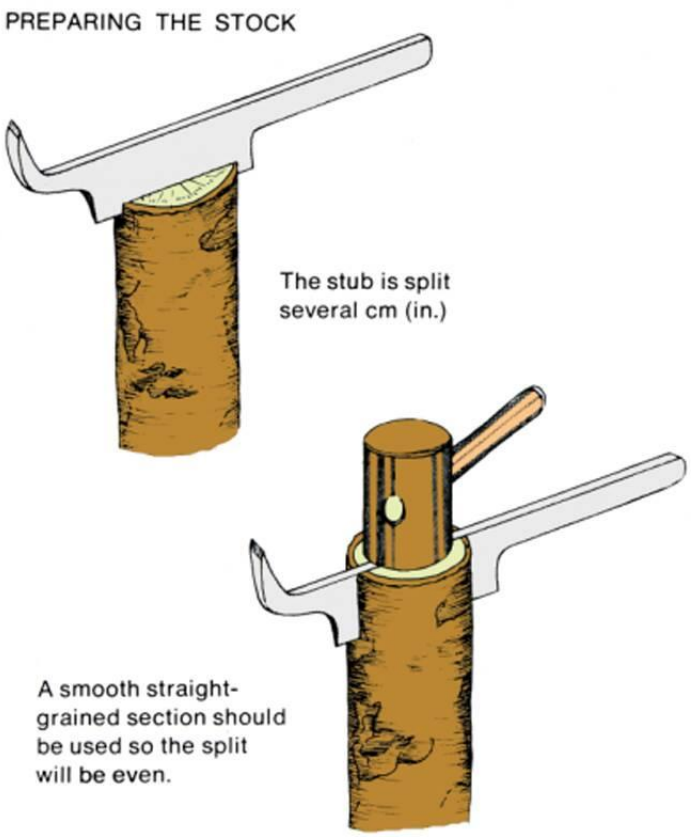
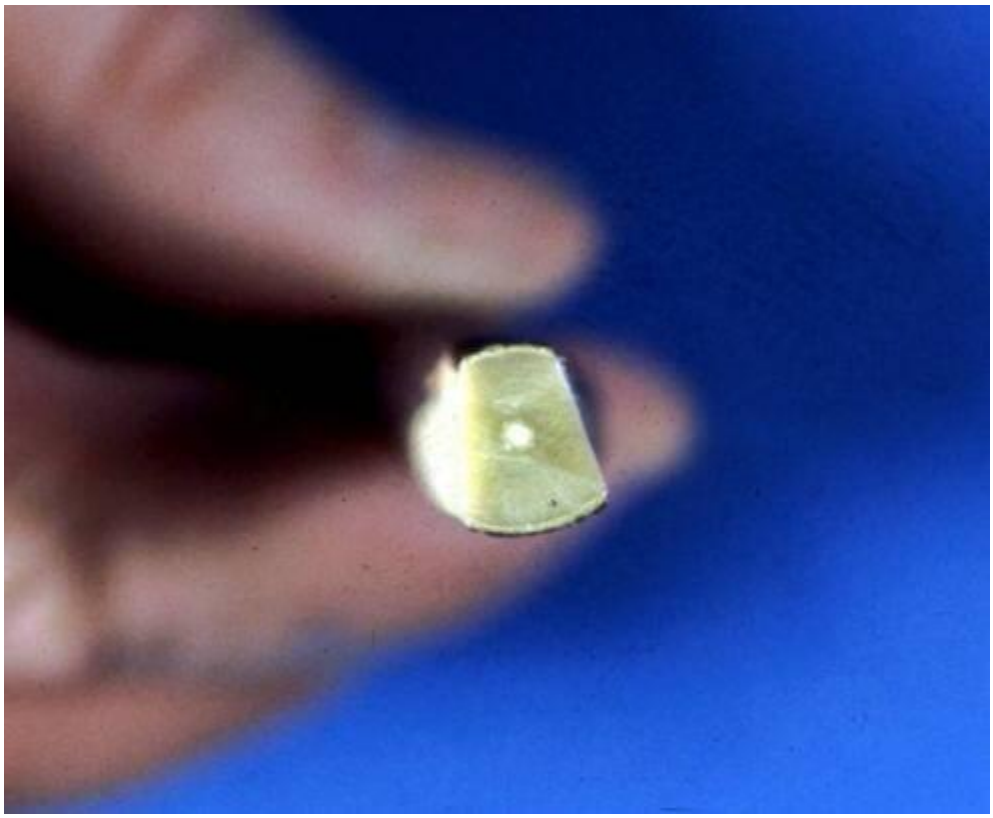


Illustration showing the preparation of rootstock in two steps. In step one the stub is split several cm (in.) using a wedge. In step two a mallot is used to drive the wedge into the stub. A smooth straight grained section should be used so the split will be even.

Close up photo showing a wedge splitting a stub.

Photo of a wedge being used to split the top of a stub.



Top view photo of a completed scion with cuts on both sides to form a wedge.

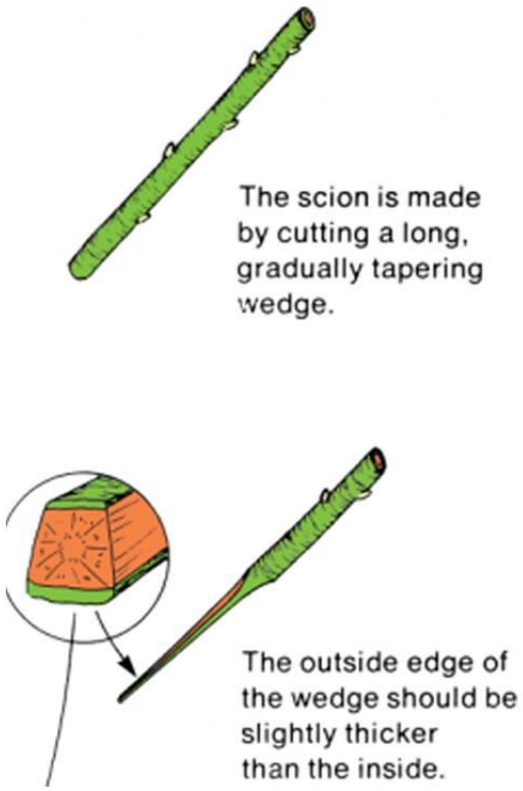


Illustration showing how to prepare a scion in two steps. In step one the scion is made by cutting a long, gradual tapering wedge. In step two the outside edge of the wedge should be slightly thicker than the inside.

Side view photo of a completed scion with cuts on both sides to form a wedge.

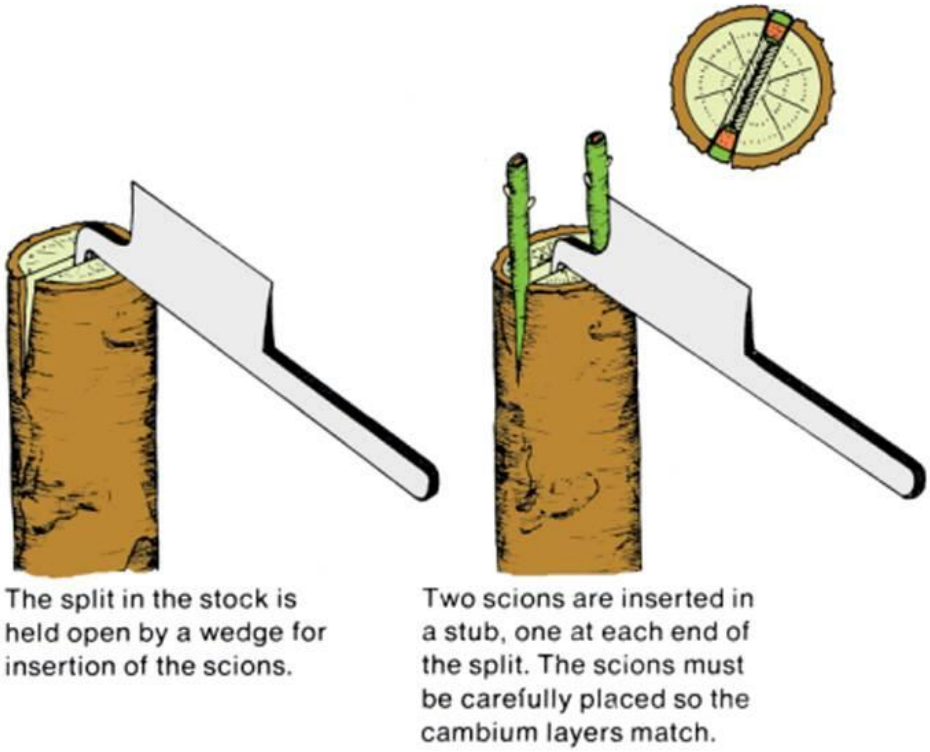


Illustration showing the insertion of the scions into the rootstock in two steps. In the first step the split in the stock is held open by a wedge for insertion of the scions. In the second step two scions are inserted in a stub, one at each end of the split. The scions must be carefully placed so the cambium layers match.

Photo of a split being held open with a wedge so that a scion can be inserted.

After the scions are properly placed, the wedge is withdrawn. The entire union, including the tips of the scions, is then thoroughly covered with grafting wax.

Illustration showing after the scions are properly placed, the wedge is withdrawn. The entire union, including the tips of the scions, is then thoroughly covered with grafting wax.

Photo of a completed cleft graft.

Click on the button below to see cleft grafting video.

Double Working by Budding

Source: https://propg.ifas.ufl.edu/06-grafting/03-buddingtypes/03-grafting-buddoubleworking.html

Double working refers to making grafts in two locations on the plant. This involves placing an interstock between the scion and the rootstock.

This may be done in certain fruit tree grafts where the scion and rootstock are incompatible, but the interstock is compatible with both the scion and rootstock.

Double working is also the way rose standards are made.

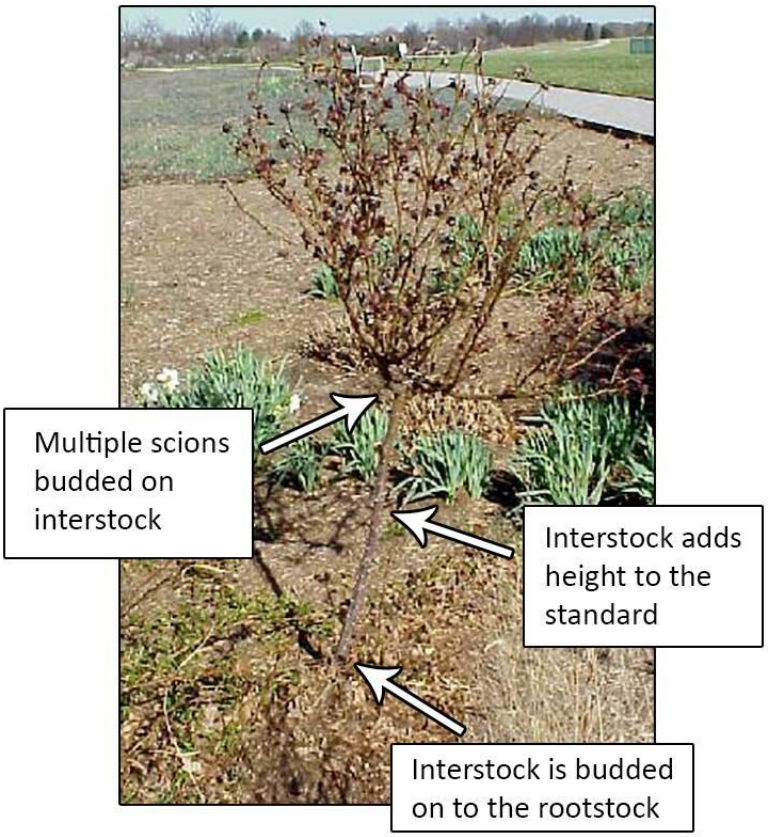


Photo showing an example of double working. Three sections are identified on the resulting plant; multiple scions budded on interstock, interstock adds height to the standard, and interstock is budded on to the rootstock.

For rose standards, the interstem is budded on the rootstock and allowed to grow for one year.

Then several scion buds (arrows) are budded onto the interstem.

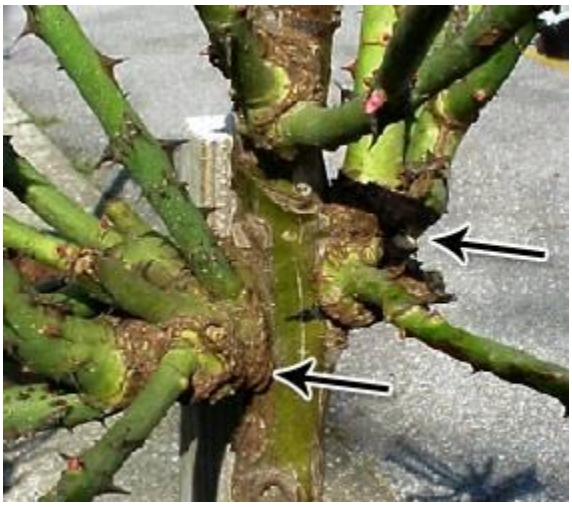


Photo showing where the scion buds are budded onto the interstem of a rose standard.

Flute, Ring and I-Budding

Source: https://propg.ifas.ufl.edu/06-grafting/03-buddingtypes/04-grafting-budflute.html

Variations on patch budding include flute, ring and I-budding. These vary by the degree the scion wraps around the rootstock.

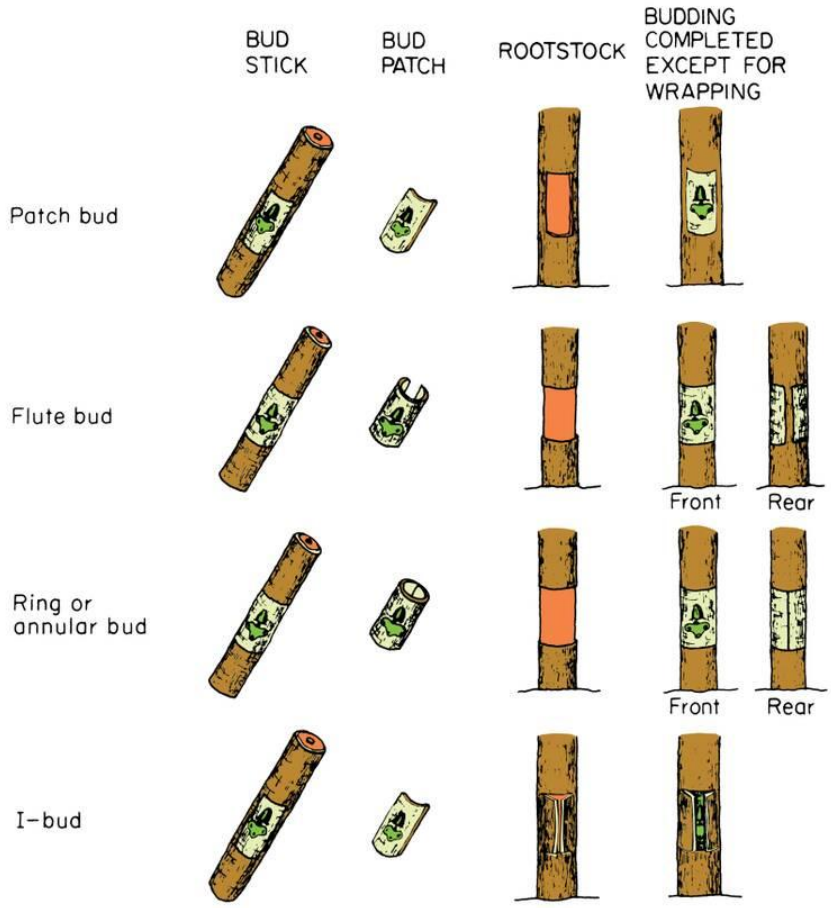


Illustration showing the differences between patch bud, flute bud, ring or annular bud, and I-bud.

Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/01-terms/05-graftingterms-grafting.html

Grafting is the art of connecting two pieces of living plant tissue together in such a manner that they will unite and subsequently grow and develop as one composite plant.

A graft consists of the scion which becomes the above ground growth and the rootstock that produces the root system.

There are many techniques for grafting, but in general grafting is done when the rootstock is active and the scion is dormant.

Photo of a graft with the scion and rootstock identified.

Grafting Knives

Source: https://propg.ifas.ufl.edu/06-grafting/01-terms/06-graftingterms-knives.html

Grafting knives have either a fixed or folding blade that is beveled on one side and flat on the other to provide a smooth, clean cut.

Therefore, there are right and left handed knives. Budding knives have a rounded tip and a blunt quill used to open the bark flap during T-budding.

Both types of knives should be sharpened regularly to insure sharp cuts.

Photo of three variations of grafting knives.

Grafting Machines and Robots

Source: https://propg.ifas.ufl.edu/06-grafting/01-terms/07-graftingterms-machines.html

Several hand held and bench top grafting machines have been developed but few are used extensively.

When the scion and rootstock are the same size, these machines make tightly fitting grafts.

Photo of a hand held grafting machine.

Photo of a saddle graft that fits together tightly.

Automated grafting robots have also been developed. These are primarily used for grafting vegetable seedlings.

Vegetables are grafted with pathogen or nematode resistant rootstocks.

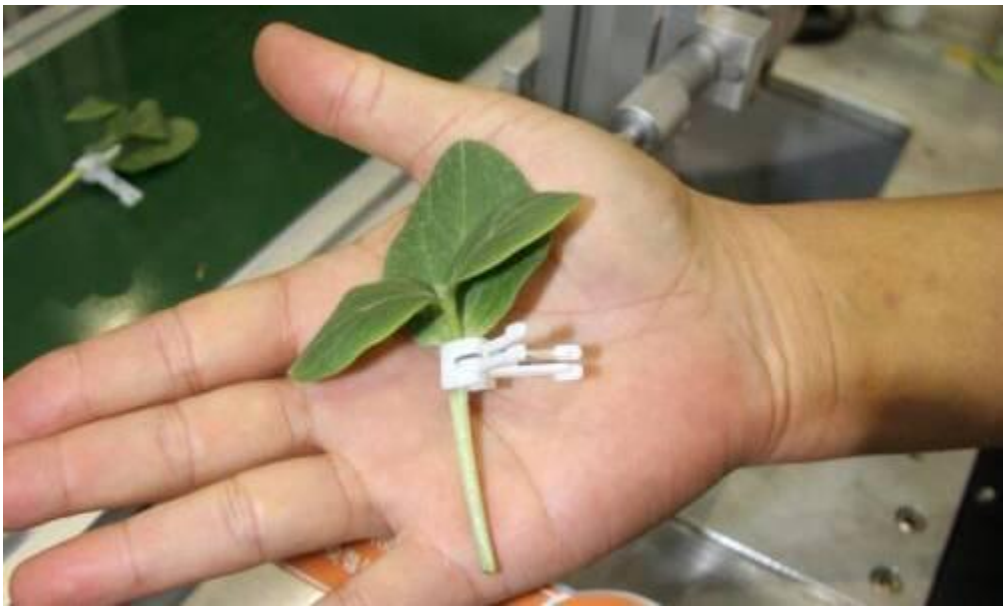


Photo of a small vegetable graft that was made using a robot.

Photo of robotic grafting machine.

Click on the button below to see grafting robot video.

Grafting Waxes

Source: https://propg.ifas.ufl.edu/06-grafting/01-terms/08-graftingterms-wax.html

Grafting waxes are used to cover graft unions to prevent them from drying out until the tissues unite. There are two types of waxes - hot or cold waxes.

Hot waxes must be heated to liquefy prior to application to the graft. They must be heated in a heating pot prior to use.

Cold waxes are liquid at room temperature because of solvents in the wax. They solidify after the solvent evaporates. In either case, the wax must adhere to the plant surfaces and be resistant to cracking and run off in rainy or hot weather.

Photo showing a graft covered with grafting wax to protect it.

Hot waxes require heating to keep the wax liquid. They are special combinations of waxes that have a low melting point.

Photo of a pot of hot grafting wax being heated in the field.

Photo of hot wax being applied to a graft.

Close up photo of a graft with hot wax applied to it.

Cold waxes contain a solvent that keeps the wax liquid until the solvent evaporates after application.

Photo of a graft bound with polyethylene wrap and sealed with cold grafting wax.

Photo of workers in a field of grafts applying cold wax.

Click on the button below to see grafting wax video.

Hot-Pipe Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/01-terms/10-graftingterms-hotpipe.html

With some difficult to graft species, a warm temperature around the graft can be beneficial.

The hot-pipe callusing system warms the graft union to about 80°F. but keeps the roots and buds on the scion cool (about 45°F.) to prevent their premature growth.

Species that benefit from this technique include various fruit crops and ornamentals like maple (Acer), hazel (Corylus) and beech (Fagus).

Photo showing a graft being kept warm using a hot-pipe callusing system.

The graft union is kept warm by a PVC or copper pipe that contains a hot wire or recirculating hot water system.

The entire system is insulated around the graft and the scion and roots are kept cool. As in all grafts, the union must be kept from drying out.

Hot-pipe callusing is performed in the late winter or early spring.

Photo of a hot-pipe system showing a heating pipe wrapped with insulation.

Top view photo of a hot-pipe system keeping rows of grafts warm.

Patch Budding

Source: https://propg.ifas.ufl.edu/06-grafting/03-buddingtypes/05-grafting-budpatch.html

Patch budding is used for species that have thick bark like pecans (Carya). The thick bark makes T- and chip budding difficult.

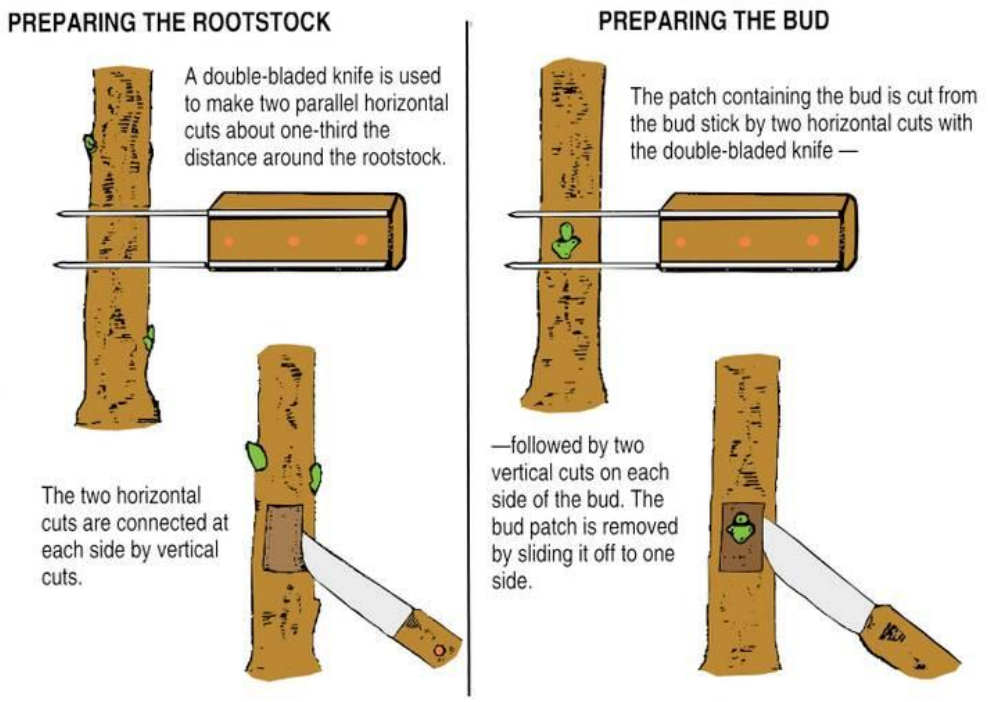
The distinguishing feature of patch budding is that a rectangular patch of bark containing a single bud is taken from the scion and placed into a similar patch taken from the rootstock.

Photo showing a rectangular patch of a scion containing a bud, and a similar patch removed from a rootstock.

Specialized tools that act as templates or double bladed knives are used to get matching sized patches from the scion and rootstock.

Photo showing a tool with two parallel knif blades to create consistently sized cuts for patch budding.

Photo showing a tool to create a template for consistently sized cuts for patch budding.



An illustration the two steps each needed for preparing the rootstock, as well as preparing the bud. Step one for preparing the rootstock requires a double-bladed knife being used to make two parallel horizontal cuts about one-third the distance around the rootstock. In step two the two horizontal cuts are connected at each size by vertical cuts. Step one for preparing the bud requires the patch containing the bud being cut from the bud stick by two horizontal cuts with the double-bladed knife. This is followed by step two where two vertical cuts are made on each side of the bud. The bud patch is removed by sliding it off to one side.

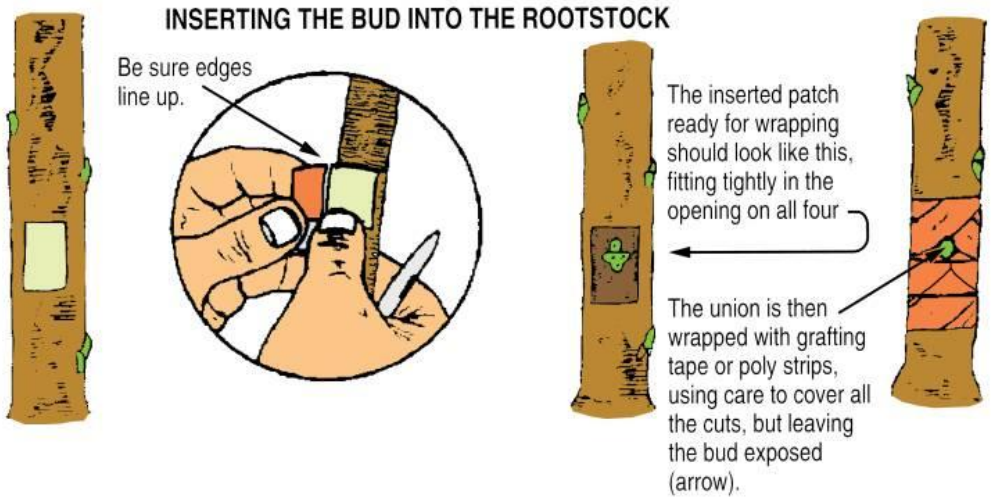


Illustration showing inserting the bud into the rootstock. The rootstock with patch is shown. Be sure edges of the bud patch match up to the rootstock patch. The inserted patch read for wrapping is shown how it should look, fitting tightly in the opening on all four sides. The final step shows the union then wrapped with grafting tape or poly strips, using care to cover all the cuts, but leaving the bud exposed.

Repair Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/09-grafting-repair.html

Repair grafts are used to correct damage done to established trees.

The two most common repair grafts are bridge grafting and inarching.

These differ because in inarching, the rootstock has its own root system. In bridge grafting a scion is inserted around the injured section and attached at both the upper and lowers ends of live, undamaged bark.

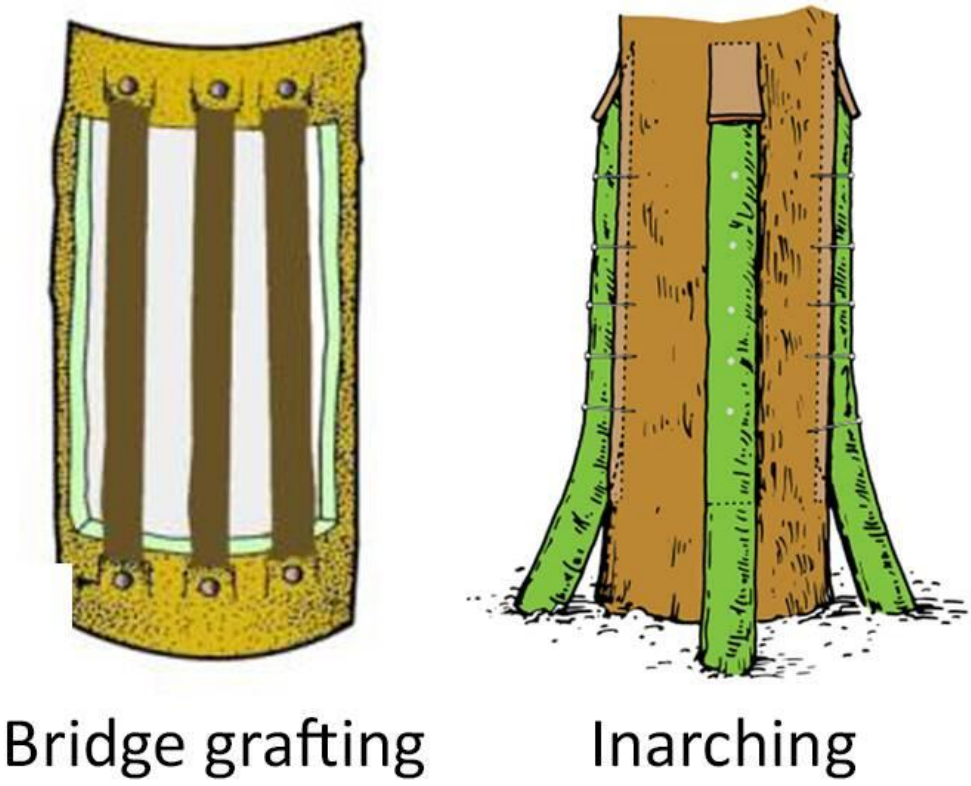


Illustration showing examples of bridge grafting and inarching.

Root Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/10-grafting-root.html

Root grafting (also called whole-root or piece-root grafting) uses only a root piece as the rootstock compared to other types of grafts where the rootstock contains both root and stem tissue.

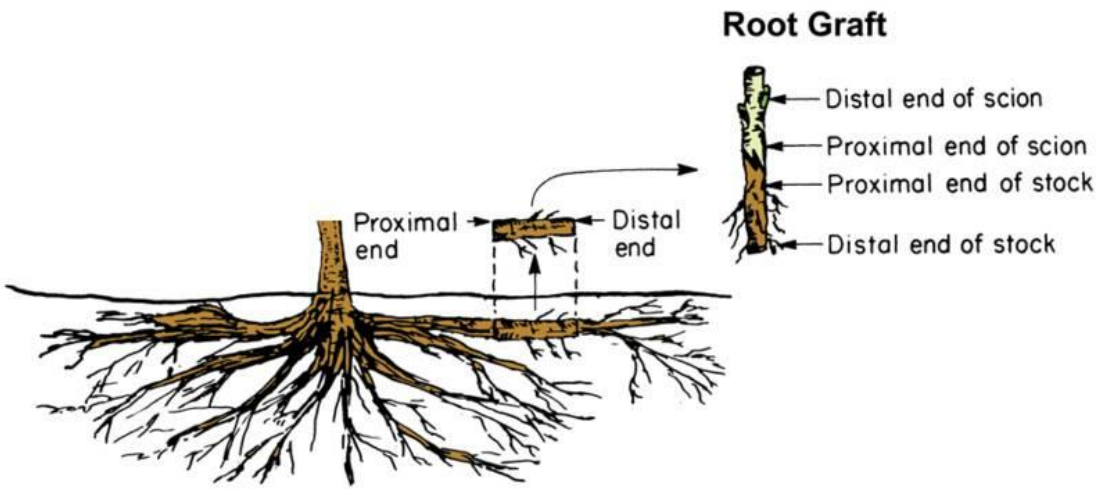


Illustration showing how a piece of root is removed from a grown plant, and then attached to a scion. Attention must be paid to making sure that the proximal end of each part are bound together to form the new graft.

At one time, this was a common graft for apples.

Root grafting is done as bench grafting when the scion is dormant.

They are commonly tied with nursery tape that decomposes naturally when the graft is planted in the soil.

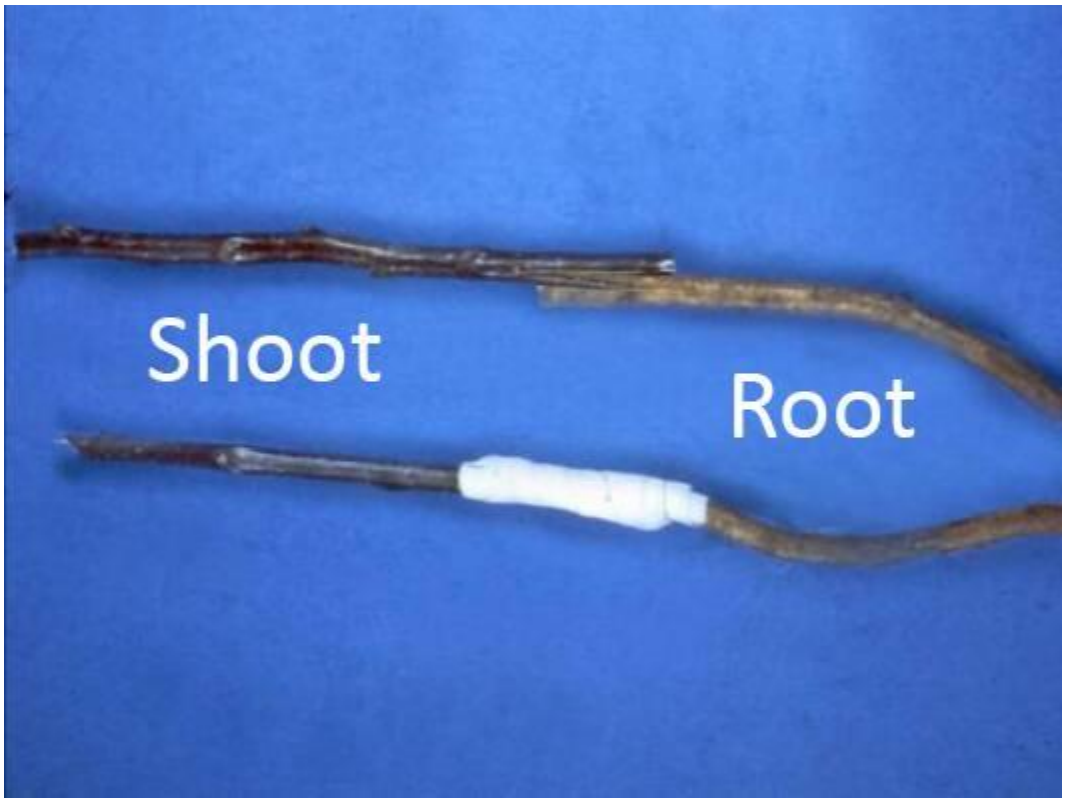


Photo showing a shoot and root of a root grafting before and after being bound with nursery tape.

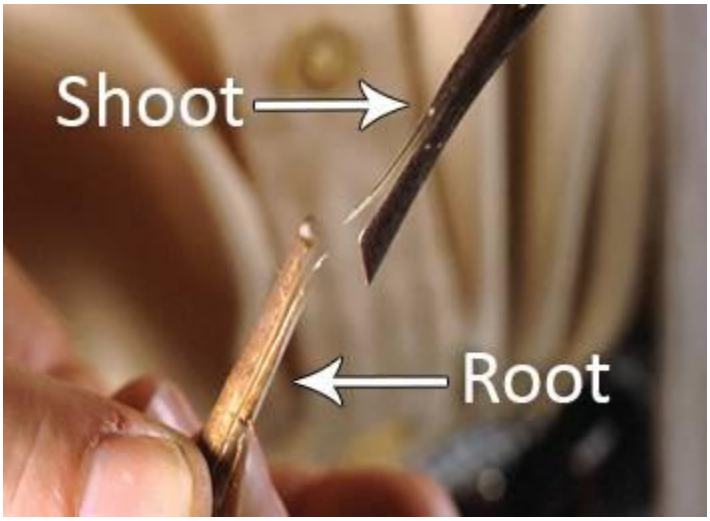


Photo shwoing a root and shoot about to be bound together in a graft.

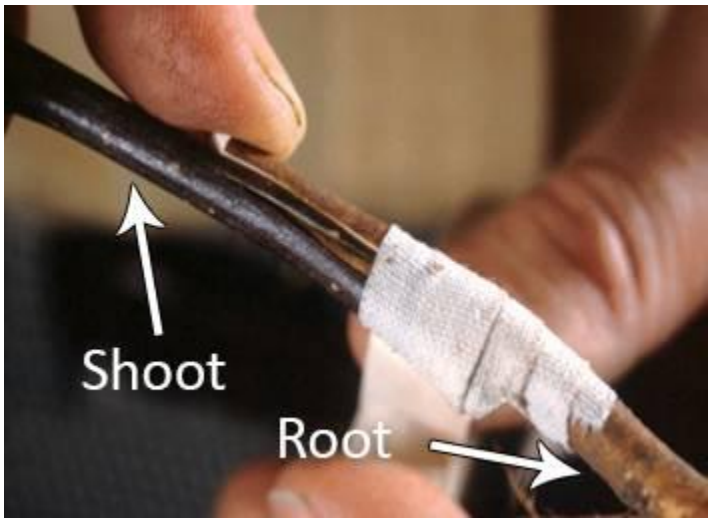


Photo now showing the shoot and root bound together with nursery tape.

Saddle grafts were once a common graft for rhododendrons using a root piece as the rootstock.

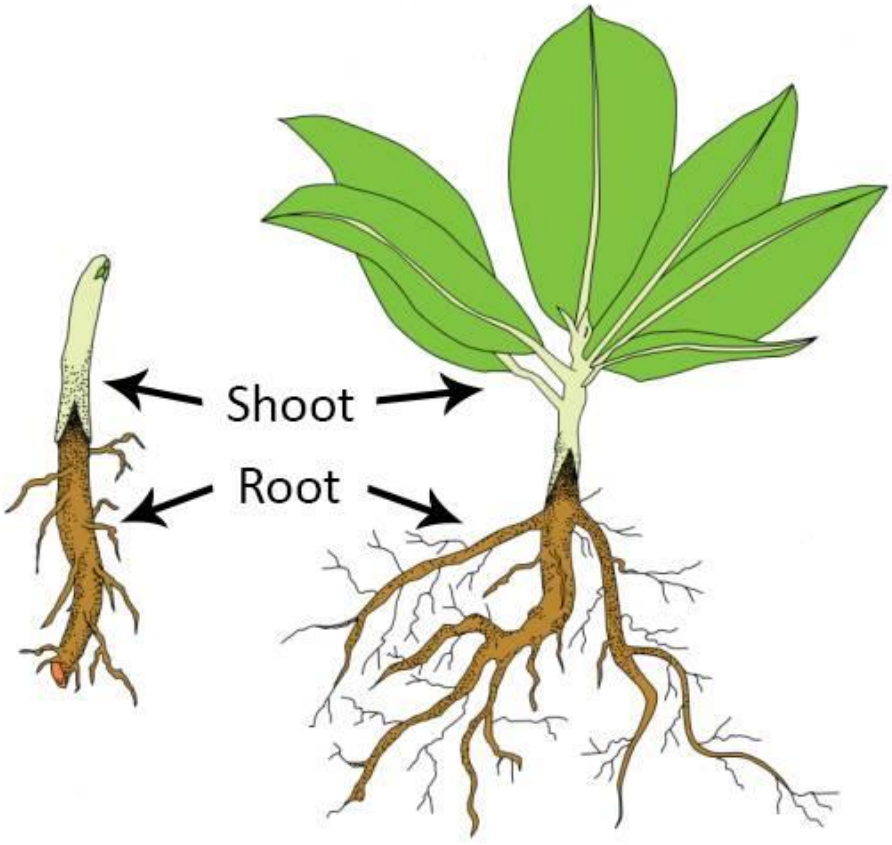


Illustration showing a saddle graft of a rhododendron as an example of using a grafting root.

Tree peonies are side wedge or cleft grafted to herbaceous peony tuberous roots.

It is an interesting graft performed between a woody and herbacous perennial.

The graft is done in the fall when herbaceous peonies are lifted from the field.

The healed graft is planted in the spring.

Photo showing a graft between a woody and herbacous perennial.

Saddle Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/11-grafting-saddle.html

Saddle grafts can be done as bench grafting or using a grafting machine.

The scion and rootstock must be the same size.

The scion is cut like a saddle and sits on top of the rootstock.

Saddle grafting is done as bench grafting when the scion is dormant.

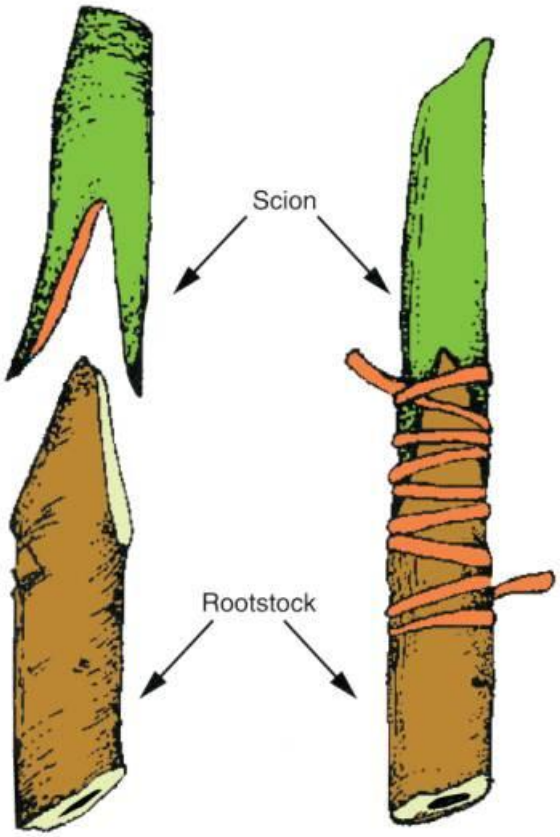


Illustration showing the scion and rootstock of a saddle graft before and after being bound together.

Saddle grafts were once a common graft for rhododendrons.

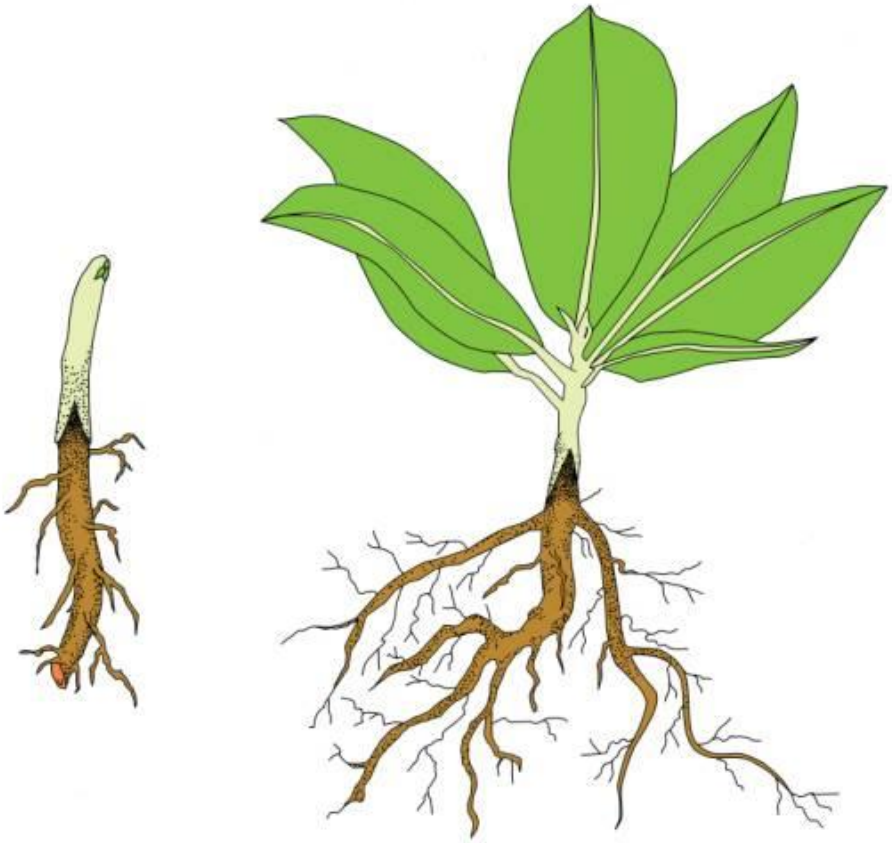


Illustration showing how rhododendron scions were attached to rootstock.

Side Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/12-grafting-side.html

There are numerous techniques for doing side grafts.

Side grafts place the scion on the side of the rootstock.

Photo example of a citrus side graft.

Citrus graft

Side grafting is usually performed as bench grafting with the rootstock potted and just coming out of dormancy.

The scion is dormant.

Photo showing an example of a birch side graft.

Birch graft

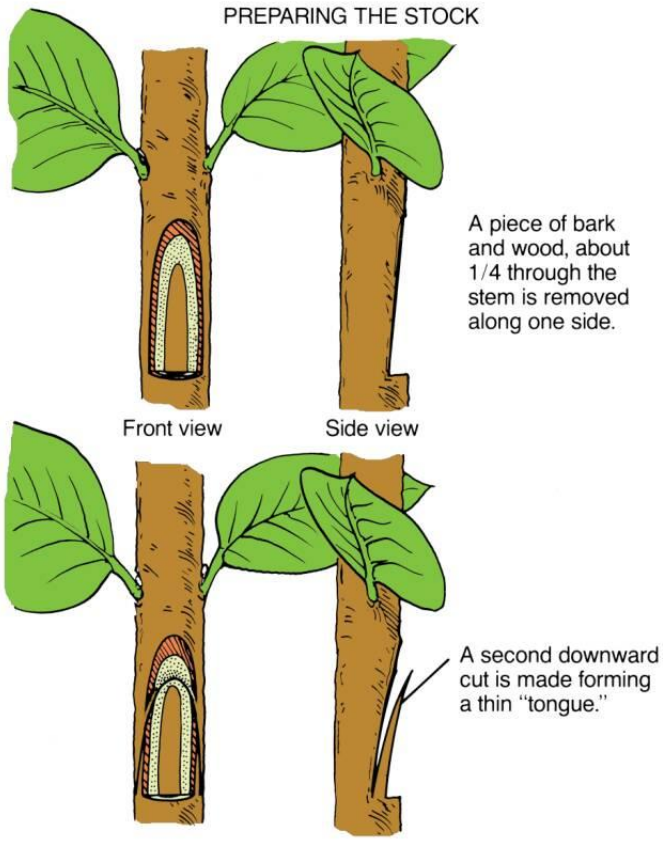


Illustration showing the preparation of the rootstock in two steps, from front and side views. In the first step a piece of bark and wood, about 1/4 through the stem is removed along one side. In the second step a second downward cut is made forming a thin 'tongue'.

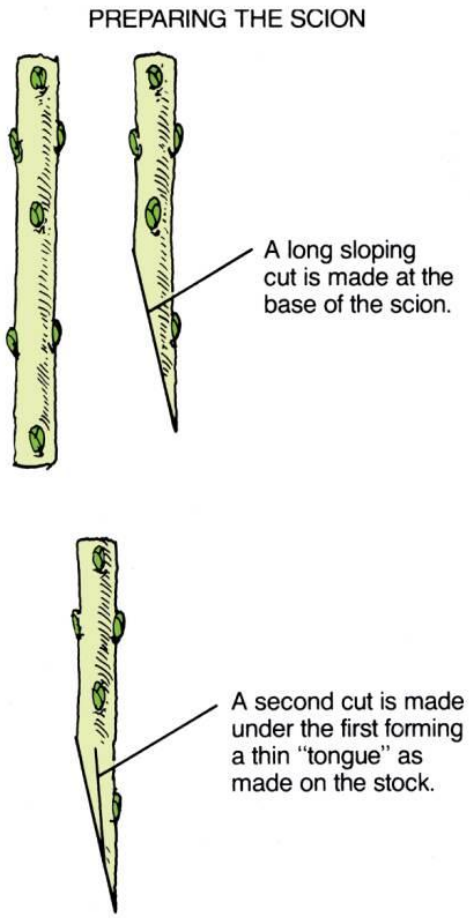


Illustration showing the preparation of the scion in two steps, from a side view. In step one a long sloping cut is made at the base of the scion. In step two a second cut is made under the first forming a thin 'tongue' as made on the rootstock.

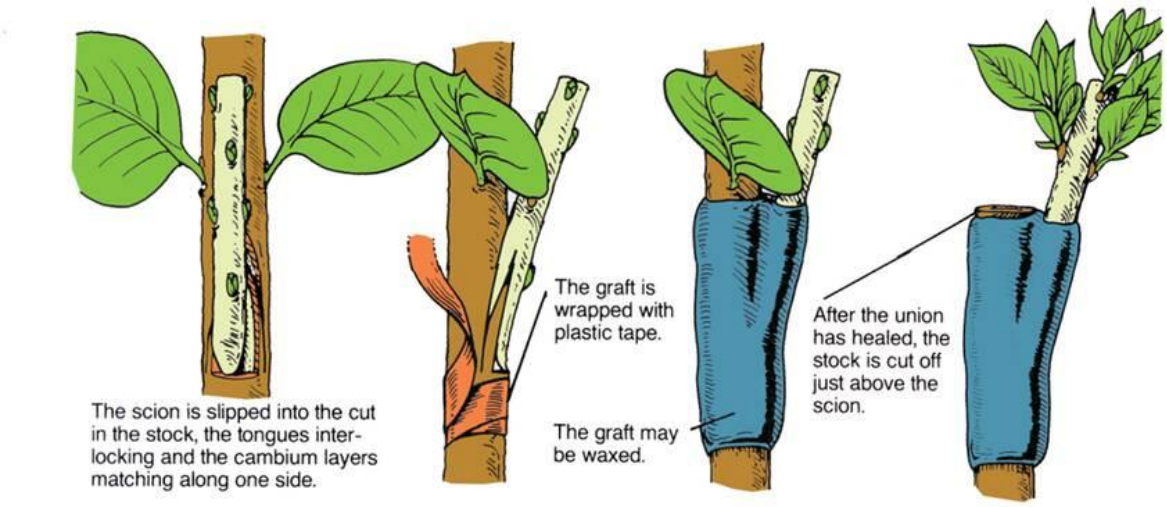


Illustration showing four steps to attach the scion and rootstock to complete the side graft. In step one the scion is slipped into the cut in the stock, the tongues interlocking and the cambium layers matching along one side. In step two the graft is wrapped with plastic tape. In step three the graft may be waxed to protect it. In step four, after the union has healed, the stock is cut off just above the scion.

A common side graft is for production of specialty Japanese maples (Acer palmatum). The next series of pages will describe side grafting in maple.

The scion is prepared by removing tissue from both sides of the scion. The scion is inserted into a downward cut in the rootstock.

Notice the buds swelling on the rootstock indicating that it is ready for grafting.

Cutting scion in Japanese maple graft.

Photo showing a Japanese maple scion being cut.

Photo showing the Japanese maple scion with cut completed.

Tying the graft starts at the top of the graft and works its way down the stem. A slip knot allows the banding rubber to be removed easily.

Photo showing a graft properly tied with a banding rubber.

Photo showing completed graft beign placed in growing medium.

The scion and rootstock must be held firmly together and the cambial regions of both lined up.

The graft union is kept from drying out and the union wil be complete within a few weeks.

Photo of a side graft tied with plastic tape.

Tied with plastic tape.

Photo of a healed side graft.

Healed graft.

It is important to keep the graft union from drying out while it heals. One approach is to cover many grafted plants at the same time with a cover that reduces moisture loss.

Shown at the right is a cover made of a spin-woven cover to reduce water loss combined with a shade cloth to reduce heating from sunlight.

Photo showing the use of a cover for grafts inside a greenhouse environment.

New scion growth needs to be supported with a stake.

Photo shwoing a greenhouse with many potted side grafts supported with stakes.

Detail photo showing how the scion is supported by the stake, with the scion bound lightly to the stake beside it.

Side-Wedge Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/17-grafting-sidewedge.html

Side wedge grafts are used for top grafts and top working.

It is used when the scion is smaller than the rootstock.

Side wedge grafts are made on one side of the rootstock.

Photo of an example of wedge grafting.

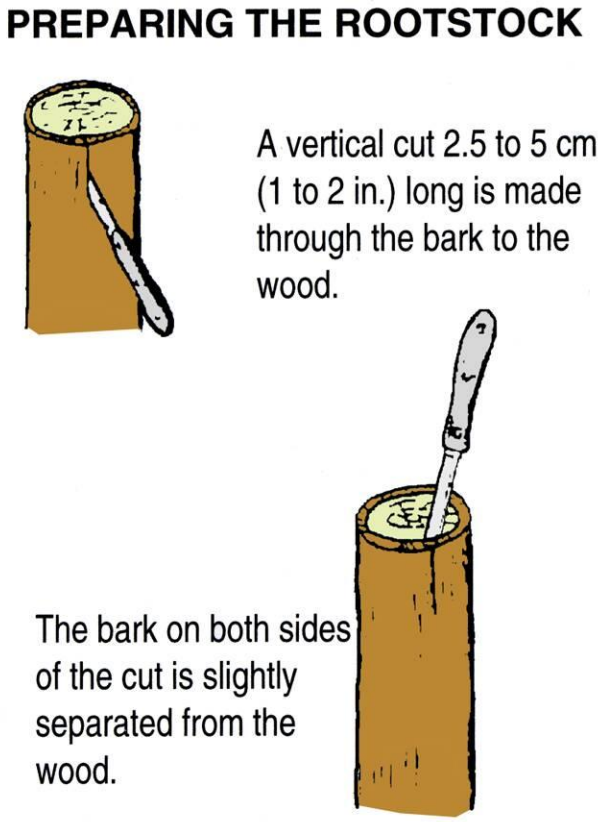


Illustration showing the preparing of the rootstock for wedge grafting. The first step shows making a vertical cut 2.5 to 5 cm (1 to 2 in.) long being made through the bark to the wood. The second step shows the bark on both sides of the cut being slightly separated from the wood.

Side wedge grafts for top working.

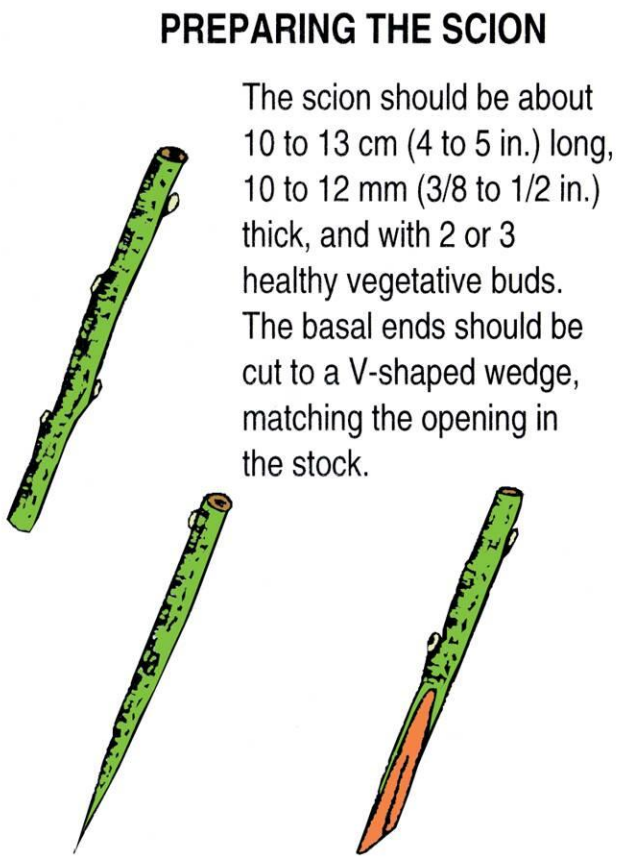


Illustration of preparing the scion. Three pictures, first of the uncut scion, then a frontal and side image of the cut scion. The scion should be about 10 to 13 cm (4 to 5 in.) long, 10 to 12 mm (3/8 to 1/2 in.) thick, and with 2 or 3 healthy vegetative buds. The basal ends should be cut to a V-shaped wedge, matching the opening in the stock.

Photo of a technician holding a finished scion.

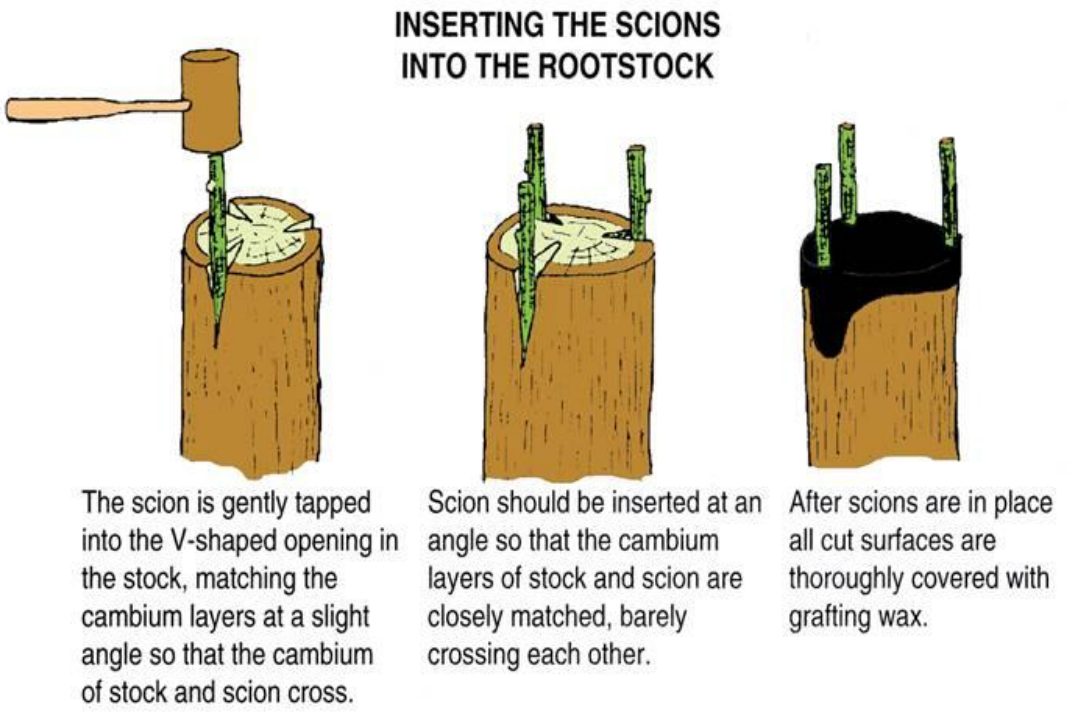


Illustration showing the inserting of scions into rootstock in three steps. In the first step, the scion is gently tapped into the V-shaped opening in the stock, matching the cambium layers at a slight angle so that the cambium of stock and scion cross. The second step shows that the scion should be inserted at an angle so that the cambium layers of the stock and scion are closely matched, barely crossing each other. The third step shows after scions are in place all cut surfaces are thoroughly covered with grafting wax.

Side wedge grafting is also used for top grafts when the scion stem diameter is less than the rootstock's stem diameter. The scion is cut with a sharp grafting knife using a single motion. It is cut on both sides of the stem to form a wedge.

Photo of a technician cutting a scion.

Photo of a technician showing the finished scion after being cut.

The scion is placed into the wedge-shaped cut at the top of the rootstock.

Photo of a technician inserting the scion into the top of the rootstock.

Photo of the finished wedge grafting, with the scion inserted into the top of the rootstock.

The graft is wrapped in plastic grafting tape and the cut and exposes surfaces of the graft are covered with grafting wax.

Photo of a technician wrapping graft with grafting tape.

Photo of a graft that has been wrapped with plastic grafting tape, and the exposed surfaces of the graft covered with grafting wax.

Click on the button below to see the side wedge grafting video.

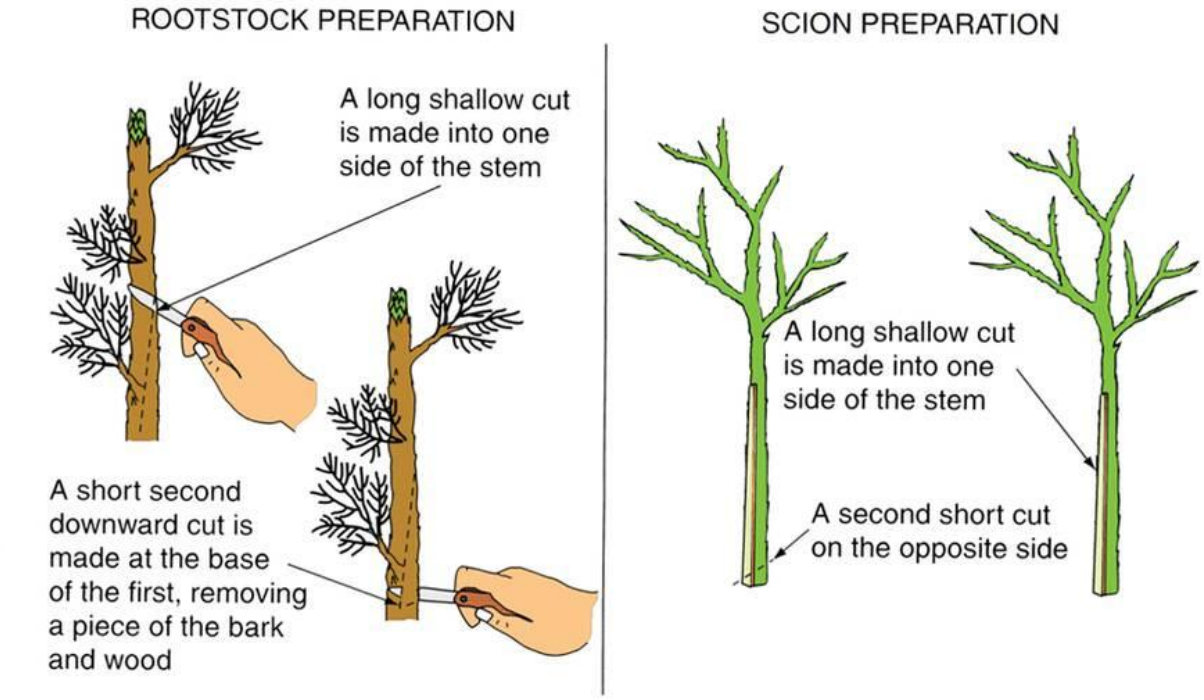
Side-Veneer Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/13-grafting-sideveneer.html

The side-veneer graft is a type of side graft and it is widely used to graft conifers. It is a common graft that uses small potted seedlings as the rootstock.

Side-veneer grafts are used to produce various types of upright juniper, and dwarf conifers like specialty pines (Pinus) and spruce (Picea).

Photo showing an example of a side-veneer graft.



Two illustrations showing rootstock and scion preparation. Rootstock in prepared by a long shallow cut being made into one side of a stem. A short second downward cut is made at the base of the first, removing a piece of the bark and wood. The scion is prepared by a long shallow cut being made into one side of the stem. A second short cut on the opposite side is then made.

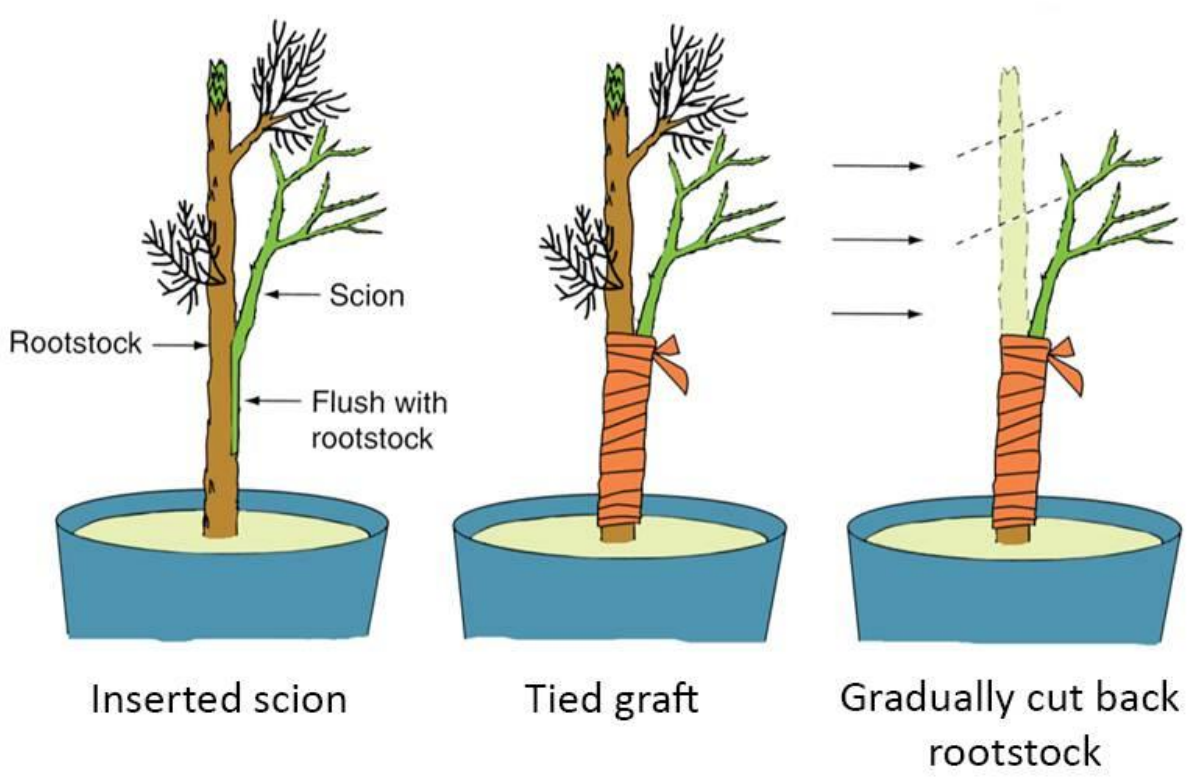


Illustration showing three steps for completing a side-veneer graft. The scion is inserted into the cut in the rootstock and made flush with it. The two parts are then tied togetehr. Afterward the rootstock is gradually cut back.

The lower needles on scions must be removed by pulling or scraping with a knife.

Photo of technicians removing lower needles from scions.

Photo of a flat of prepared scions.

Photo of completed graft covered with a grafting compound.

Completed graft covered with a grafting compound to prevent the graft union from drying.

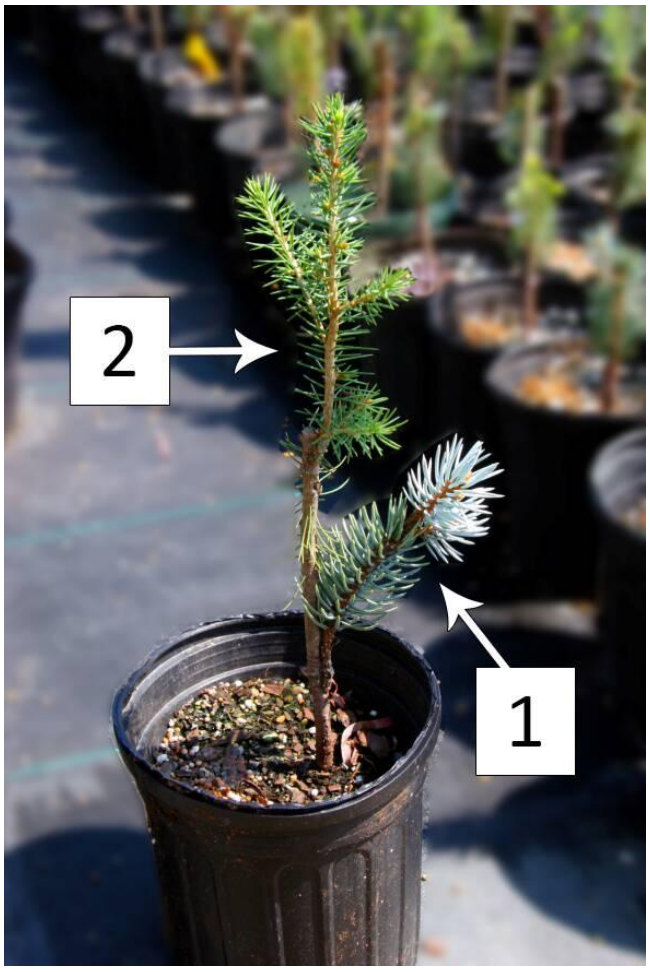


Photo showing a graft with the scion and rootstock shoots identified.

Healed blue spruce graft (arrow 1) ready to have the green rootstock (arrow 2) cut back.

Finished grafts with the rootstock's top completely removed.

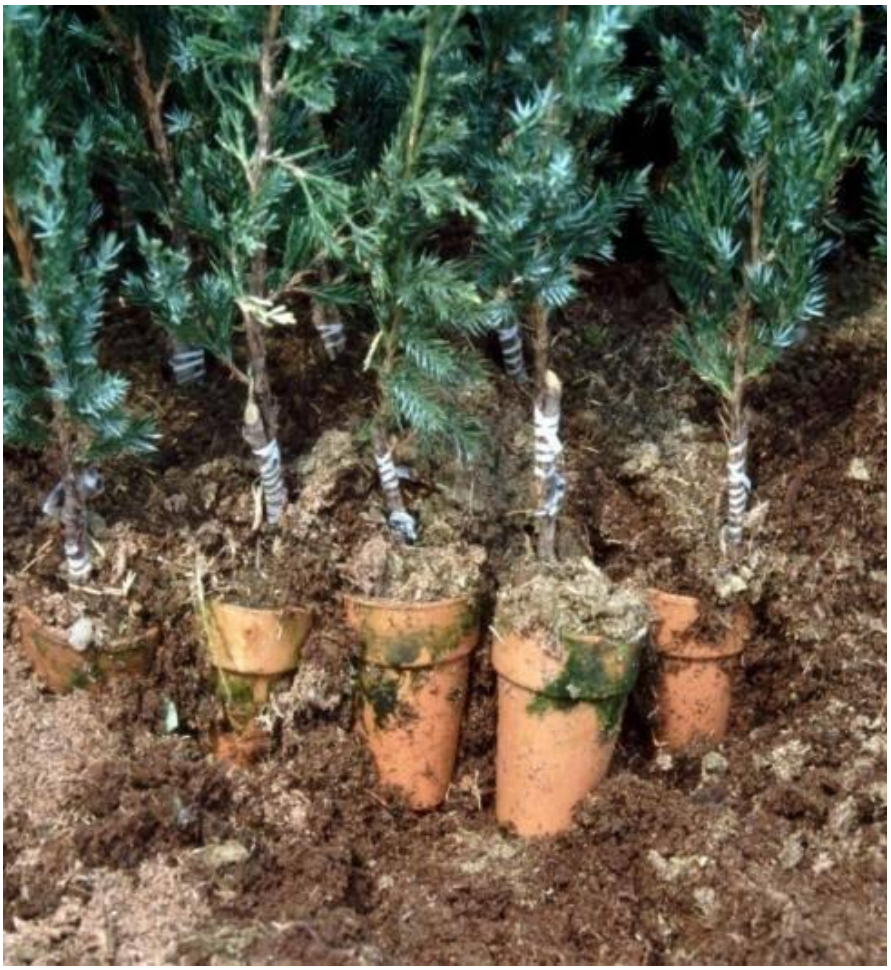
Photo of an example of a finished graft with the rootstock's top completely removed.

Photo of an example of a finished graft with the rootstock's top completely removed.

Click on the button below to see side-veneer graft video.

A common practice for small potted side-veneer grafts is to plunge the grafted plants into a slightly moist medium, such as peat moss, so that it just covers the graft union. This prevents the graft from drying until it is healed.

Photo showing a technician placing small potted side-veneer grafts into peat moss medium.



Close up photo of small potted side-veneer grafts placed into peat moss medium.

Grafts may be covered with polyethylene and shade to keep graft union from drying. The shade helps reduce heat build up under the plastic.

Photo of grafts covered with polyethylene under shade.

Photo showing grafts under polyethylene that has been partially removed to show plants underneath.

Splice Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/14-grafting-splice.html

The splice graft is similar to the whip-and-tongue graft except the second tongue cut is not made.

A simple slanting cut of the same length is made in both the scion and rootstock.

It is a common graft used for vegetable crops that use robotic grafting of a scion on a disease resistant rootstock.

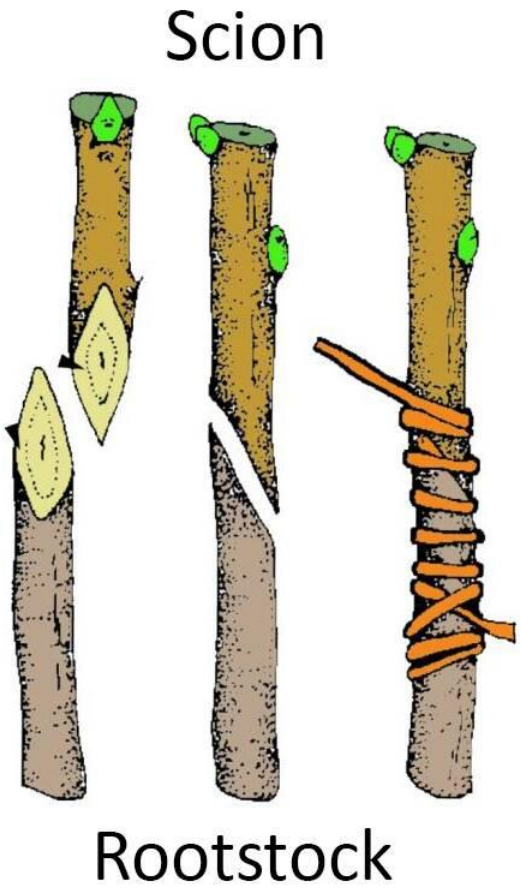


Illustration showing three steps to creating a splice graft.

Accounting for differences in size

If the scion and rootstock are not the same size, then line up both along one side to maximize cambial contact.

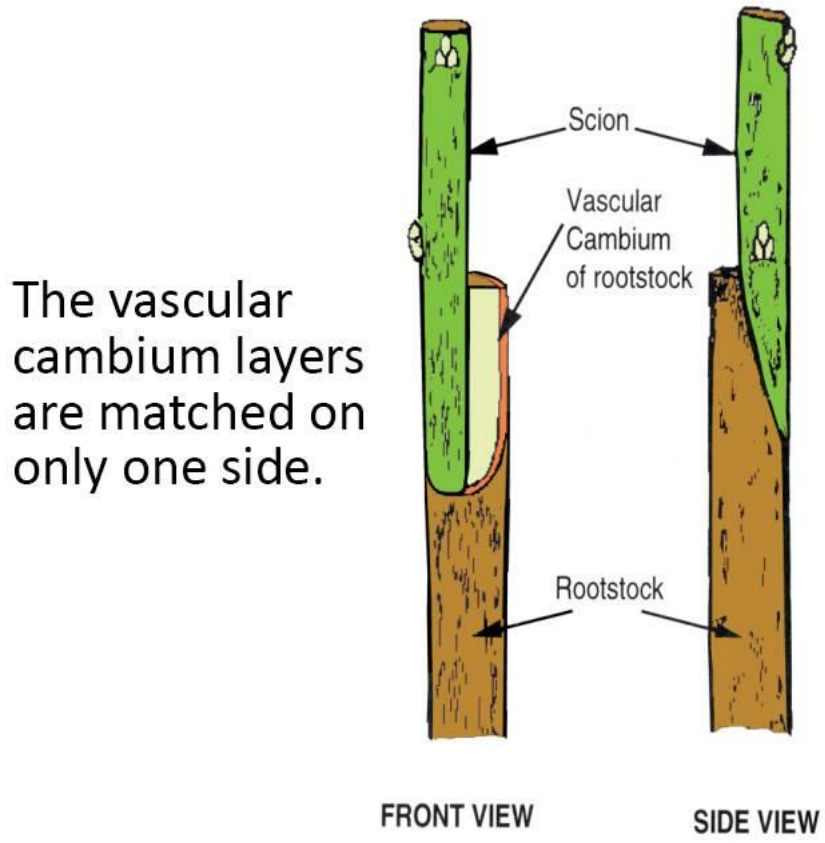


Illustration showing front and side views of how to line up a scion and rootstock of differing sizes.

Grafting vegetables on to disease resistant rootstocks can increase yield, especially in protected culture systems.

Photo showing an example of a vegetable splice graft.

Photo showing a flat of vegetable splice grafts being placed in growing medium.

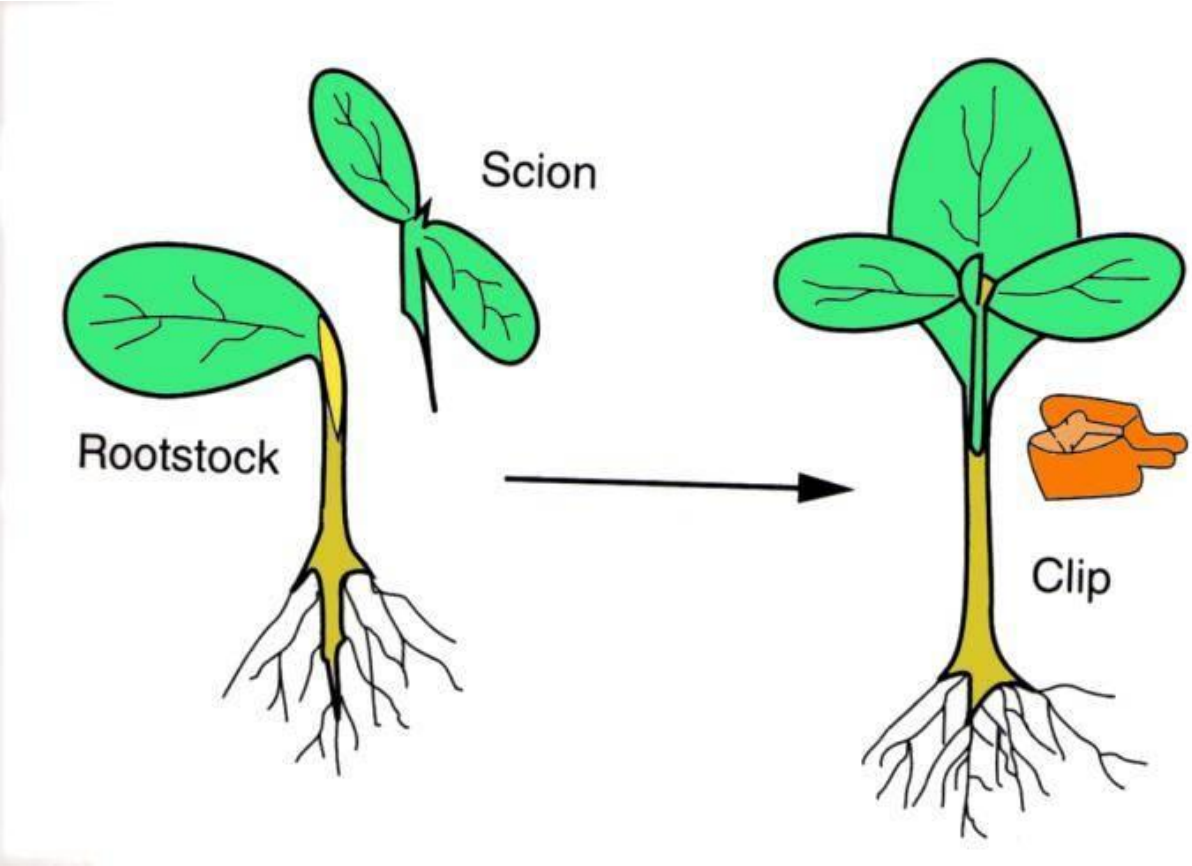


Illustration showing how a scion and rootstock are brought together and then held together using a clip.

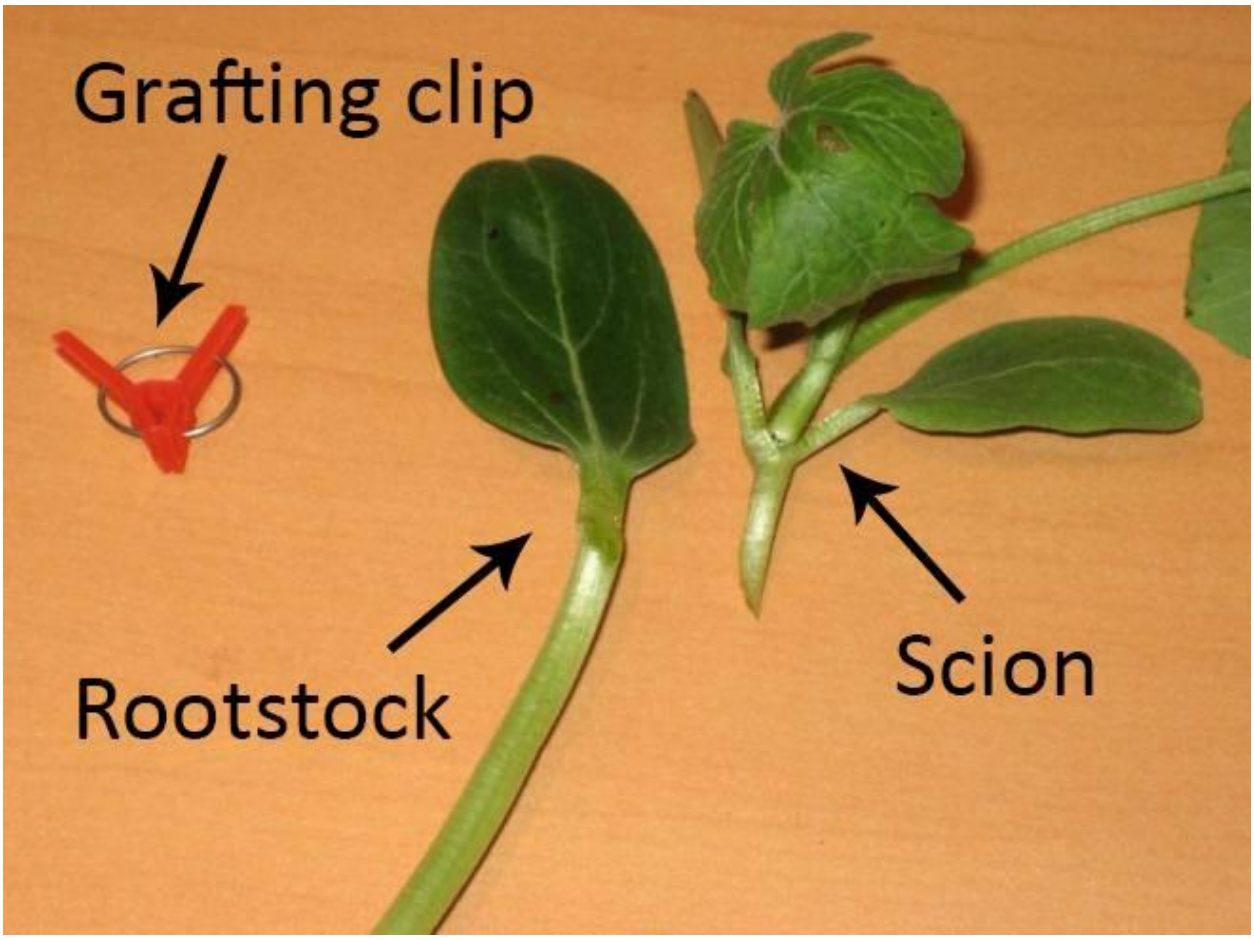


Photo showing a rootstock, scion, and a grafting clip used to hold them together.

Preparing rootstock.

Photo showing technician about to make a splice cut to rootstock with a razor blade.

Making splice cut.

Photo showing technician having completed the splice cut.

Lining up the partners

Photo showing technician lining up a scion with the rootstock.

A clip unites the graft.

Photo showing technician using a grafting clip to hold the two parts together.

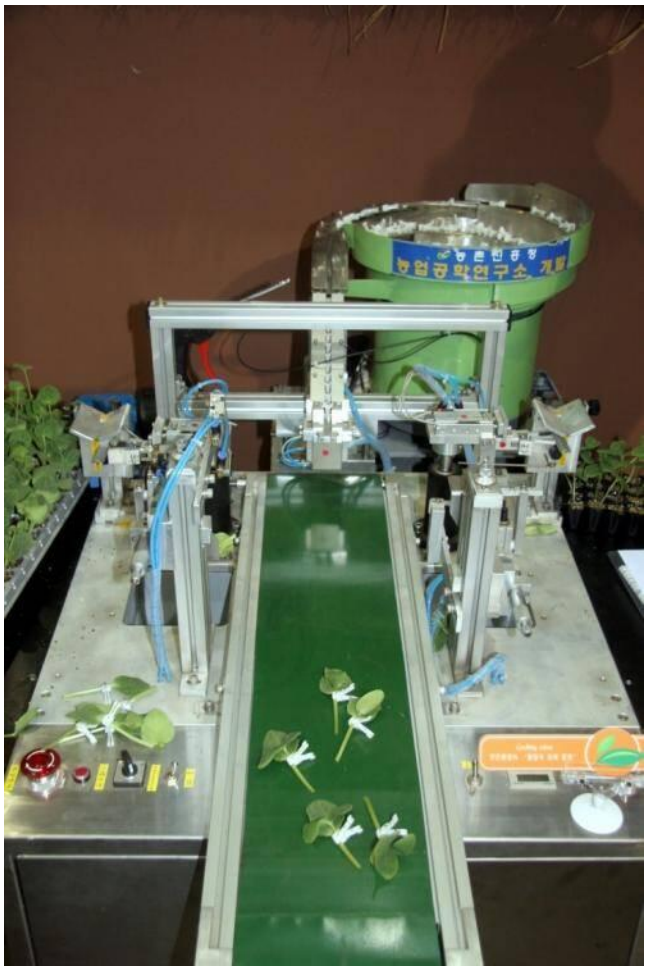
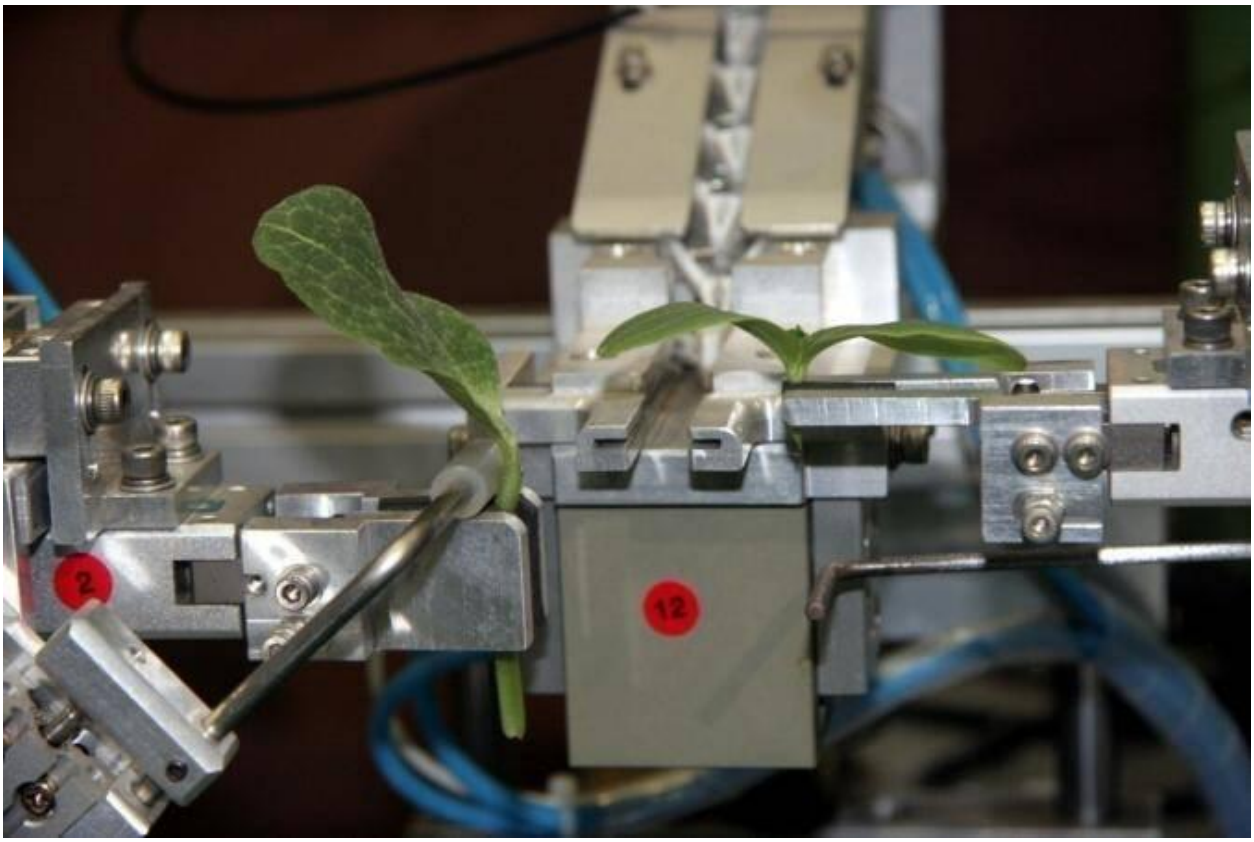


Photo of a grafting robot.



Close up photo of grafting robot.

Grafting robots have been developed to perform splice grafts for vegetables like the melon scion on gourd rootstock combination pictured here.

T-Budding

Source: https://propg.ifas.ufl.edu/06-grafting/03-buddingtypes/06-grafting-budtbud.html

T-budding is a common budding type, but must be done with dormant scions and active rootstocks.

The bark must be slipping.

The term T-budding comes from the shape of the cut made in the rootstock which is shaped like a "T".

Photo showing an example of T-budding.

Two cuts are made to form the T and the sides peeled back to allow the insertion of the scion "shield".

Because of this, the rootstock needs to be actively growing and the bark has to "slip"

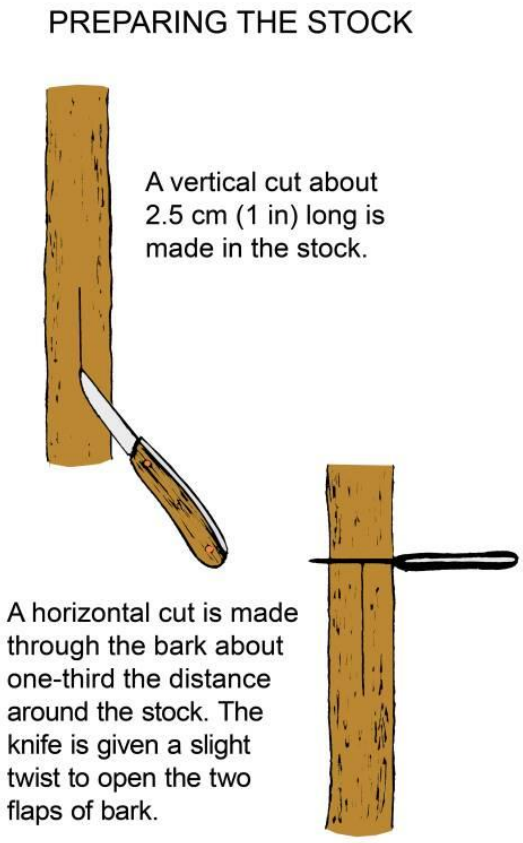


Illustration showing the preparation of stock for T-budding. Image shows two steps. The first step shows a vertical cut about 2.5cm (1 in) long is made in the stock. The second step shows a horizontal cut is made through the bark about one-third the distance around the stock. The knife is given a slight twist to open the two flaps of bark.

In contrast, the scion shield must be dormant and consists of only a single vegetative bud.

T-budding can be performed in the early spring, as June budding or in the fall.

T-budding is usually a field operation and usually has a high success rate.

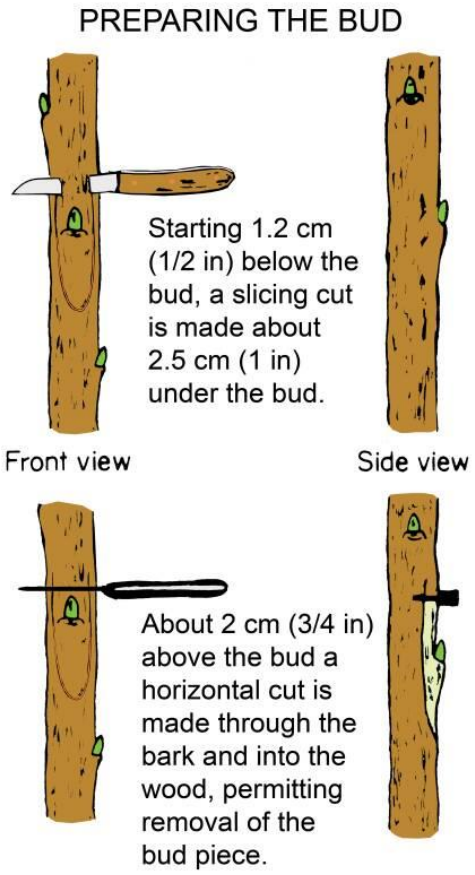


Illustration shwoing two steps for preparing the bud, from a front and side view. Step one shows starting 1.2 cm (1/2 in) below the bud, a slicing cut is made about 2.5 cm (1 in) under the bud. Step two shows about 2 cm (3/4 in) above the bud a horizontal cut is made through the bark and into the wood, permitting removal of the bud piece.

When preparing the scion, some species have a better take if the inner wood is removed from the T-bud.

Photo of inner wood being removed from a T-bud.

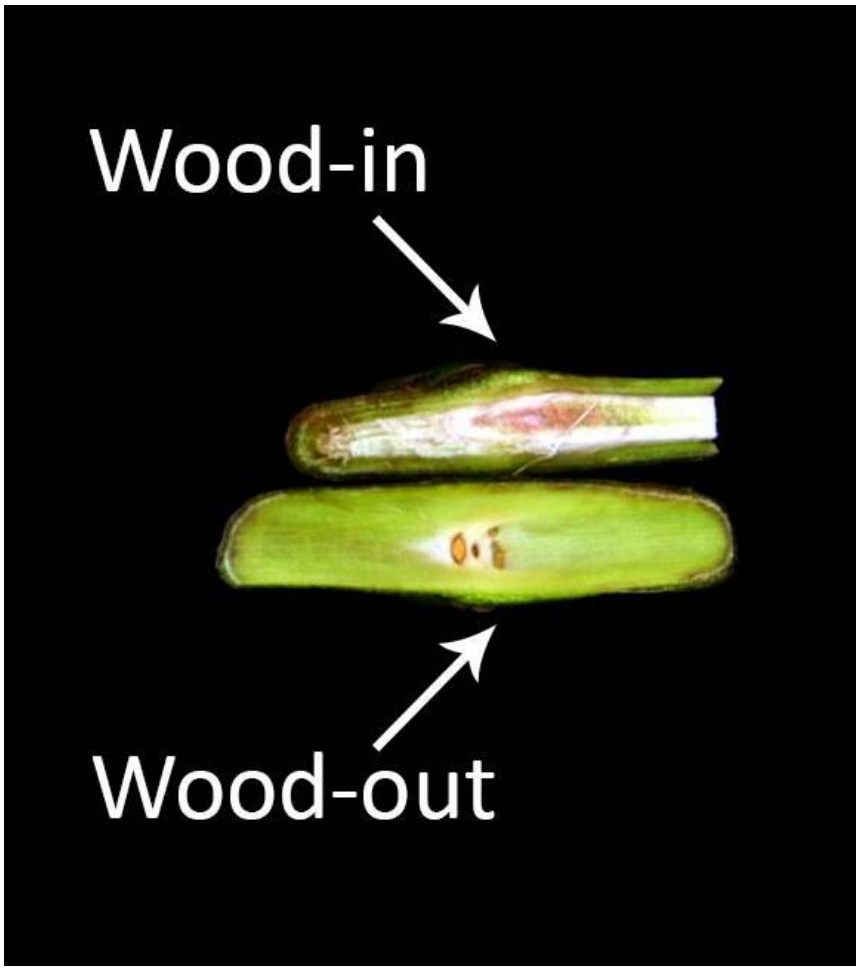


Photo showing wood-in side, and wood-out side.

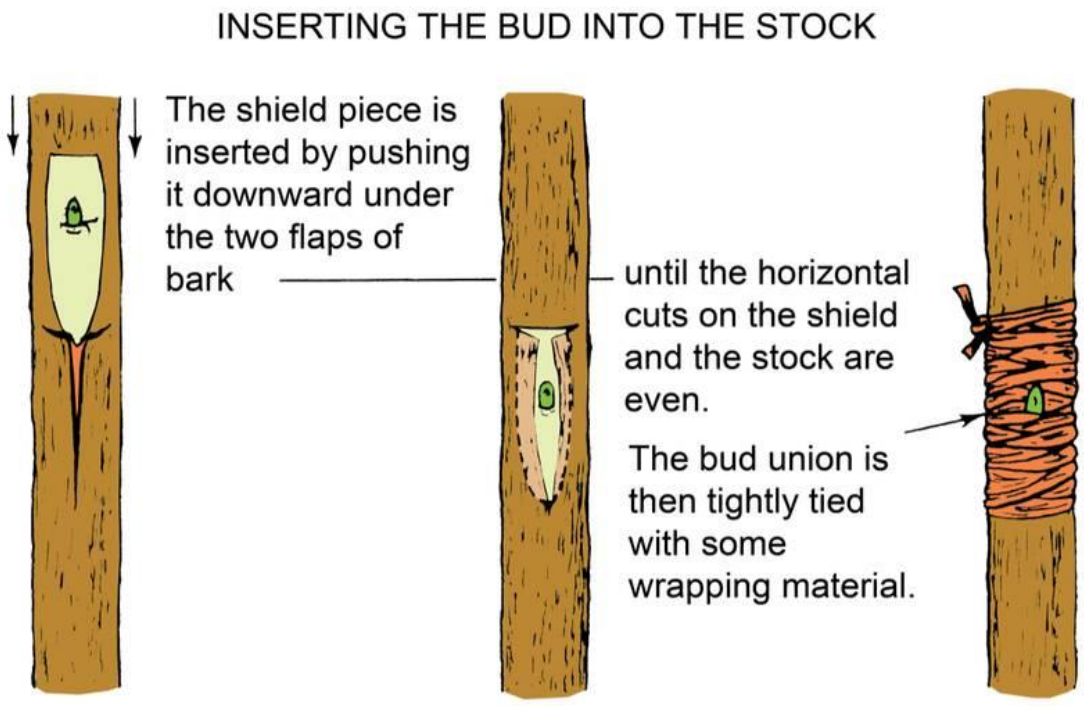


Illustration showing the insertion of the bud into the stock in three steps. The first step shows the shield piece being inserted by pushing it downward under the two flaps of bark. The second step shows step one being done until the horizontal cuts on the shield and the stock are even. Step three shows the bud union then being tightly tied with some wrapping material.

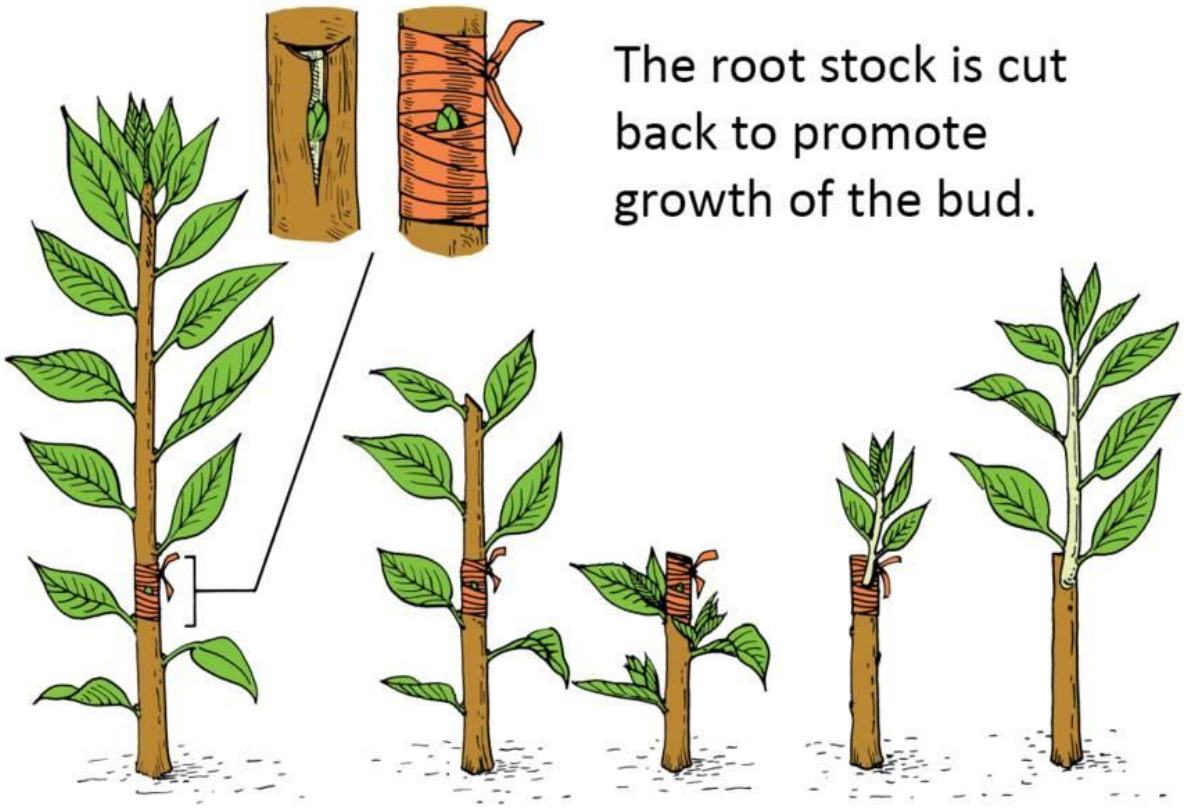


Illustration showing the rootstock being cut back to promote growth of the bud.

T-buds at various stages of healing.

Photo of a T-bud that has recently been made.

Photo of a T-bud moderately healed.

Photo of a T-bud with a good deal of healing.

T-buds are usually wrapped with rubber bands leaving the bud exposed.

Photo of a new T-bud wrapped with rubber bands and the bud exposed between them.

Photo of a T-bud moderately healed, with the rubber bands now removed.

Honeylocust and sugar maple are commonly T-budded.

Photo of a row of plants with T-buds, wrapped with rubber bands.

Close up photo of a T-bud wrapped with rubber bands.

Click on the button below to see t-bud grafting video.

Whip-and-Tongue Grafting

Source: https://propg.ifas.ufl.edu/06-grafting/02-graftingtypes/18-grafting-whipandtongue.html

The whip-and-tongue graft is a form of detached scion grafting.

When done properly, it can be a very successful graft because it lines up a large amount of cambium from the scion and rootstock. It also forms a strong graft.

This graft is similar to a splice graft, except that a second reverse "tongue" cut is made in both the scion and rootstock that allows the partners to fit tightly together.

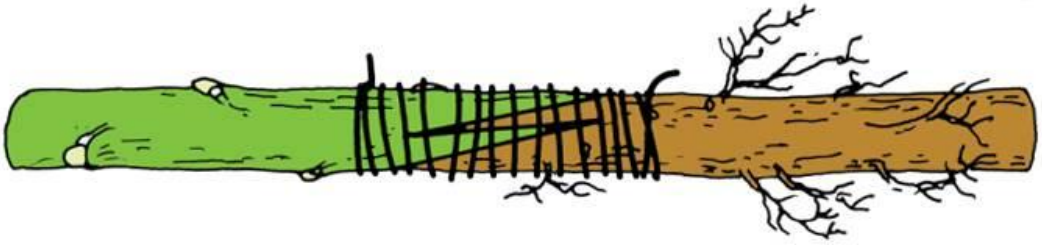


Illustration of a whip-and-tongue grafting.

Photo of a whip-and-tongue grafting.

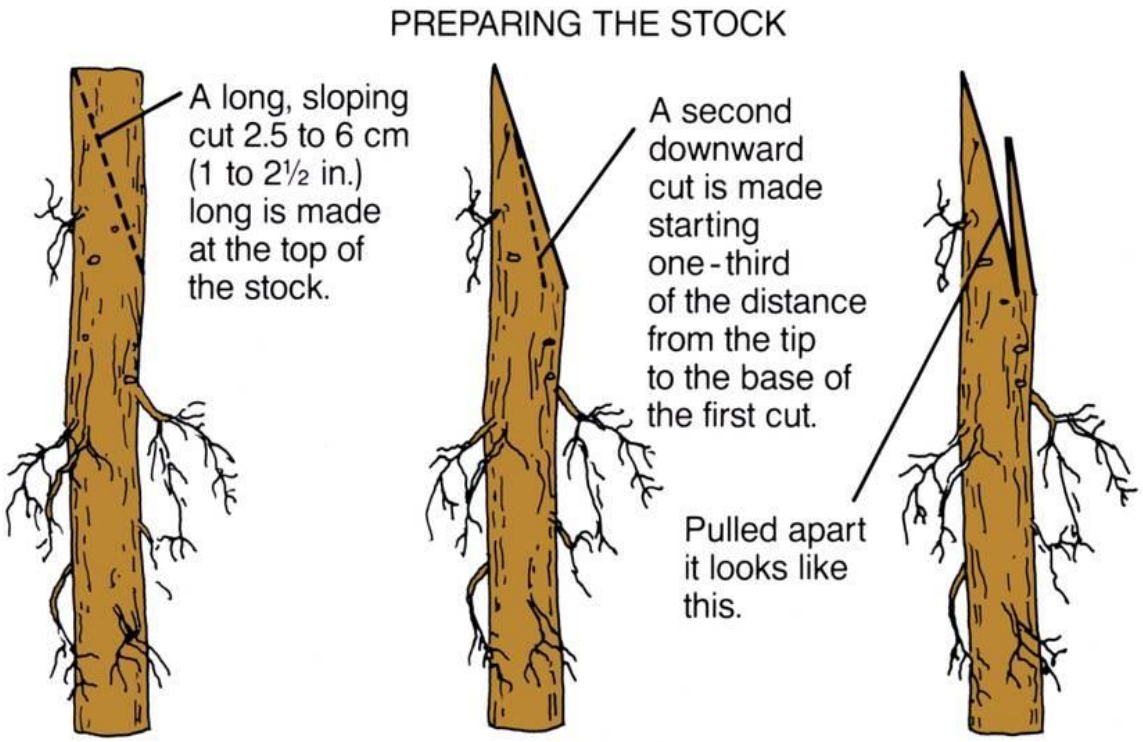


Illustration showing how to prepare a stock in three steps. Step One: A long, sloping cut 2.5 to 6 cm (1 to 3.5 in.) long is made at the top of the stock. Step Two: A second downward cut is made starting one-third of the distance from the tip to the base of the first cut. Step Three: The stock is shown with the second cut pulled open.

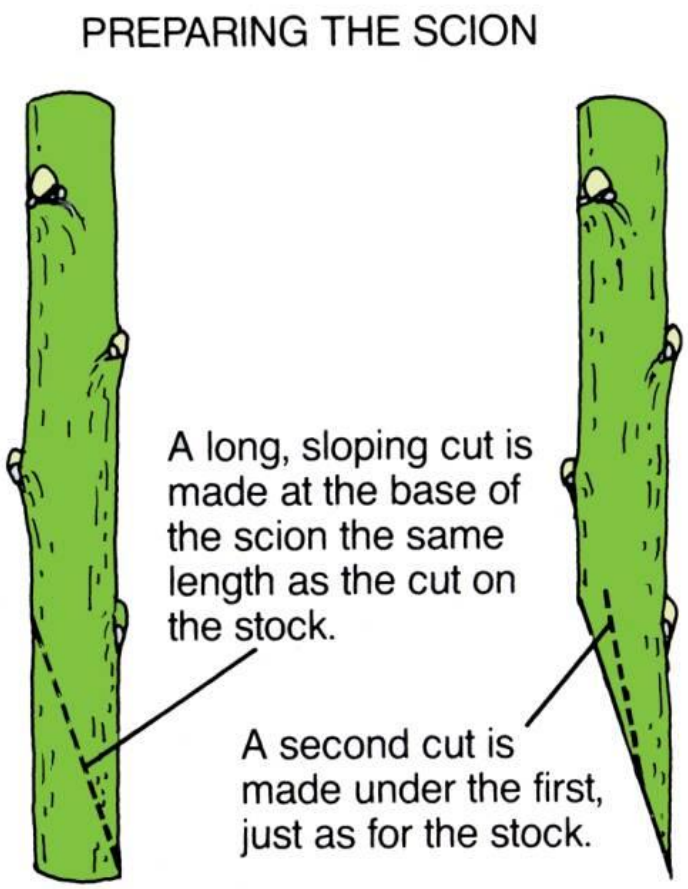


Illustration showing preparing the scion. A long, sloping cut is made at the base of the scion the same length as the cut on the stock. A second cut is made junder the first, just as for the stock.

Photograph showing how the stock and scion look after being cut, but before being joined.

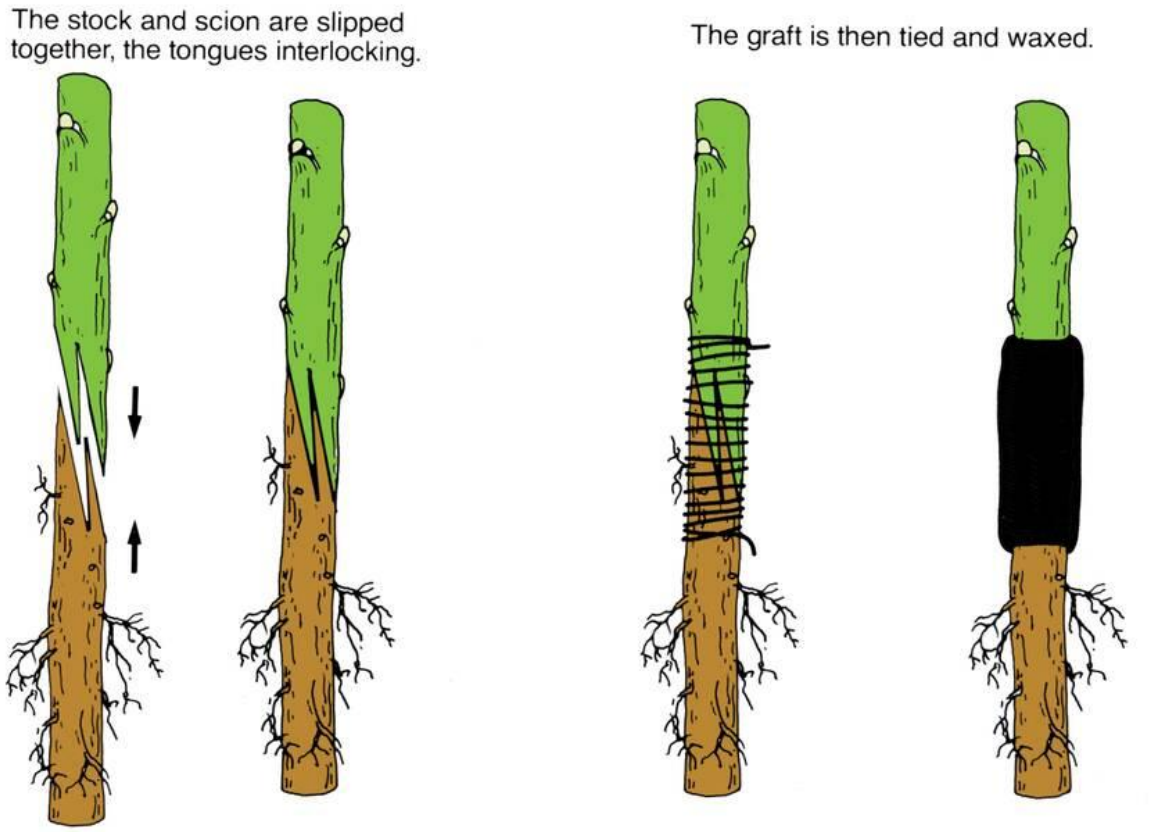
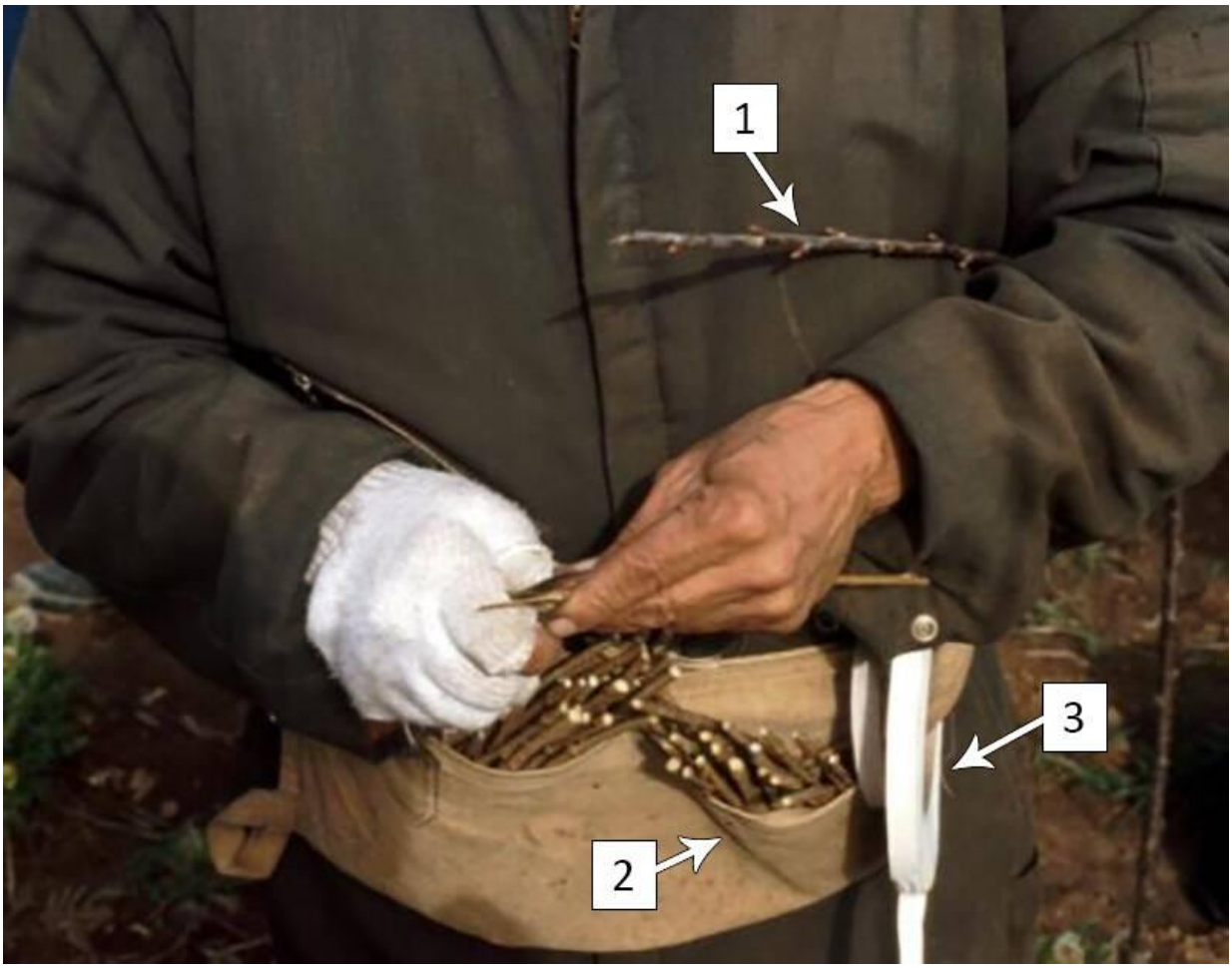


Illustration showing the stock and scion being joined in four steps. Steps one and two, the stock and scion are slipped together and the tongues interlocking. Steps three and four, the graft is then tied and waxed.

A top graft used to make weeping cherry trees is a good example of a common whip-and-tongue graft. Illustrated to the right is a grafter performing this graft in the field. He has the rootstock, which is 8 feet tall, under his arm (arrow 1). His waist pouch contains a supply of scions (arrow 2) and his grafting tape (arrow 3).



Photograph of grafter perfoming a graft in the field. The elements one through three mentioned in text are pointed out to illustrate what is being done.

The scion is cut with a sharp grafting knife using a single motion. After the first cut, a second reverse cut is made three-quarters of the way into the first cut to form the tongue.

Photograph showing the making of the first cut in the scion.

Making the first cut in the scion.

Photograph showing the second inward cut which makes the tongue.

The second inward cut makes the tongue.

After making matching cuts in both the scion and rootstock, the two are joined together and wrapped with nursery tape. If the scion is smaller in diameter than the rootstock, then one side of the scion should be matched to one side of the rootstock.

Photo showing the joining of the scion and rootstock together.

Joining the scion and rootstock together.

Second photo showing the joining of the scion and rootstock together.

Aligning the cambial regions.

The graft is held in place with grafting tape.

Photo of a roll of grafting tape.

Photo of worker taping the graft in place.

Since this is a field graft, it is important to cover the graft union with a grafting wax to prevent the cut surfaces from drying out. In this case, the propagators have chosen to use a hot wax. The wax is kept in a liquid state by using a warming pot. The wax should be hot enough to flow easily but not boiling hot which will damage the graft.

Photo of a pot of grafting wax, with wax being applied to a graft.

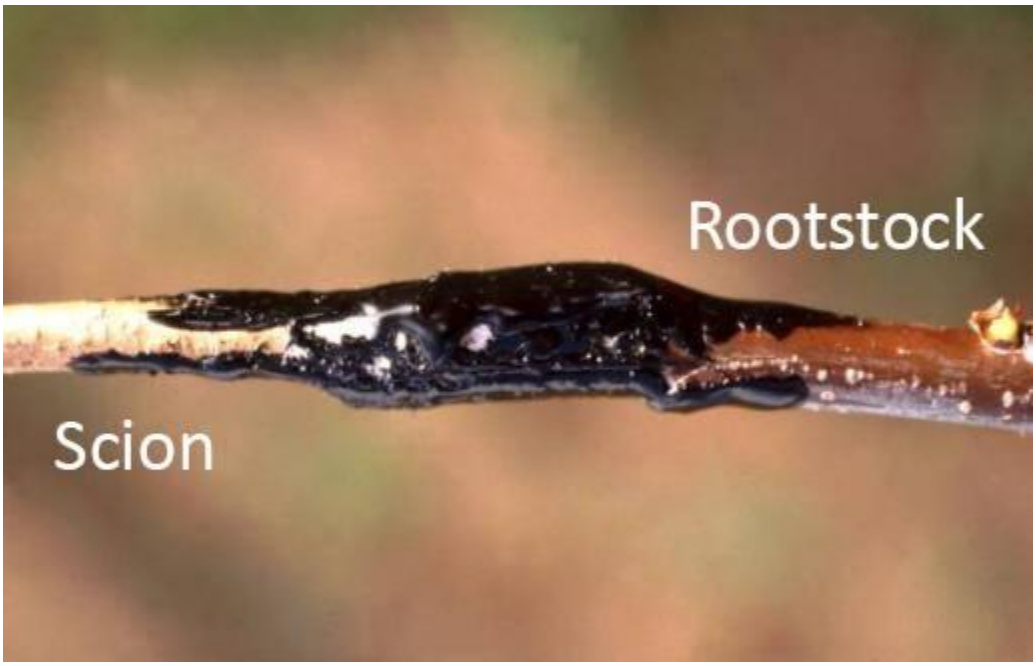


Photo of grafting wax applied to a graft, with the scion and rootstock identified.

Click on the button below to see whip-and-tongue graft on bareroot stock video.