

# Reproducing Fruit Trees by Graftage: Budding and Grafting

Leonard P. Stoltz and John Strang

**G**raftage includes both budding and grafting. Knowledge of graftage is necessary for nurserymen and fruit tree producers. It is also a source of pleasure, satisfaction, and usefulness to the hobbyist.

The graftage methods described here are the ones most often used by fruit growers to increase plant populations, change the cultivar of a tree, or preserve a cultivar or mutation not found in nurseries. Since most fruit trees do not come true from seed, vegetative or asexual propagation must be used. Cuttings from the majority of fruit trees are usually difficult to root; therefore, graftage is the most efficient means of reproducing them.

Basically, graftage is the joining of a scion (bud or shoot) of the desired cultivar to a plant with an established root system (rootstock). Grafting is done in winter or early spring with dormant scion wood. Budding is accomplished by inserting a single bud of the desired cultivar into the stock in contact with the cambium. This procedure is usually done during the late growing season (July, August, or early September), although it may be done at other times.

The tree resulting from grafting or budding is essentially the same, only the procedure differs. Which graftage method is correct is determined by the kind of plant, environmental conditions, and the plant materials at hand. Under Kentucky conditions peaches, plums, cherries, apples, and pears are commonly propagated by budding, although apples and pears are also commonly grafted.

Although grafting is still used, budding is becoming the method of choice in fruit tree production. Budding requires: (1) less proficiency in handling a knife, thus making it easier; (2) much less time, making it more economical; and (3) a much smaller scion resource. However, a major disadvantage is that budding is mostly limited to active growth periods of the year when labor demands may be high for other growing operations.

## Budding

The budding operation begins when one-year-old whips of the appropriate rootstock are planted in early spring. Roots should be pruned to 6 or 8 inches to facilitate planting. Any sideshoots on the lower 4 to 5 inches of the trunk should be cleanly pruned off.

In mid-July, before starting the actual budding operation, check the bark on the stocks to see if it peels easily. (Irrigate if

dry; bark will then slip in a few days.) If it does not slip and the cambium layer appears dry, the budding will not be successful.

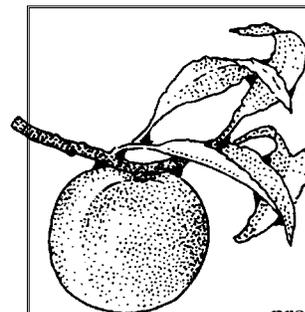
At budding time, remove all sideshoots up to 4 to 6 inches above the ground to give a clear trunk area for inserting the bud. Place the bud about 2 to 3 inches above the ground on the shady side of the stem. If a dwarfing rootstock is being budded, place the bud higher on the stem, usually 4 to 6 inches above the ground.

Collect "budsticks" of the cultivar to be propagated from vigorous current season growth. The middle buds generally are the best to use since the tip buds are too immature, and those near the base may be a cluster of buds or weak buds. The budsticks are prepared by removing the leaves but leaving  $\frac{1}{4}$  to  $\frac{1}{2}$  inch of leaf petiole on the stem (Figure 1a). Long budsticks are usually cut to a convenient 8 to 12 inches in length.

The buds should be used as soon as practical but may be stored for three to four days. To store budsticks:

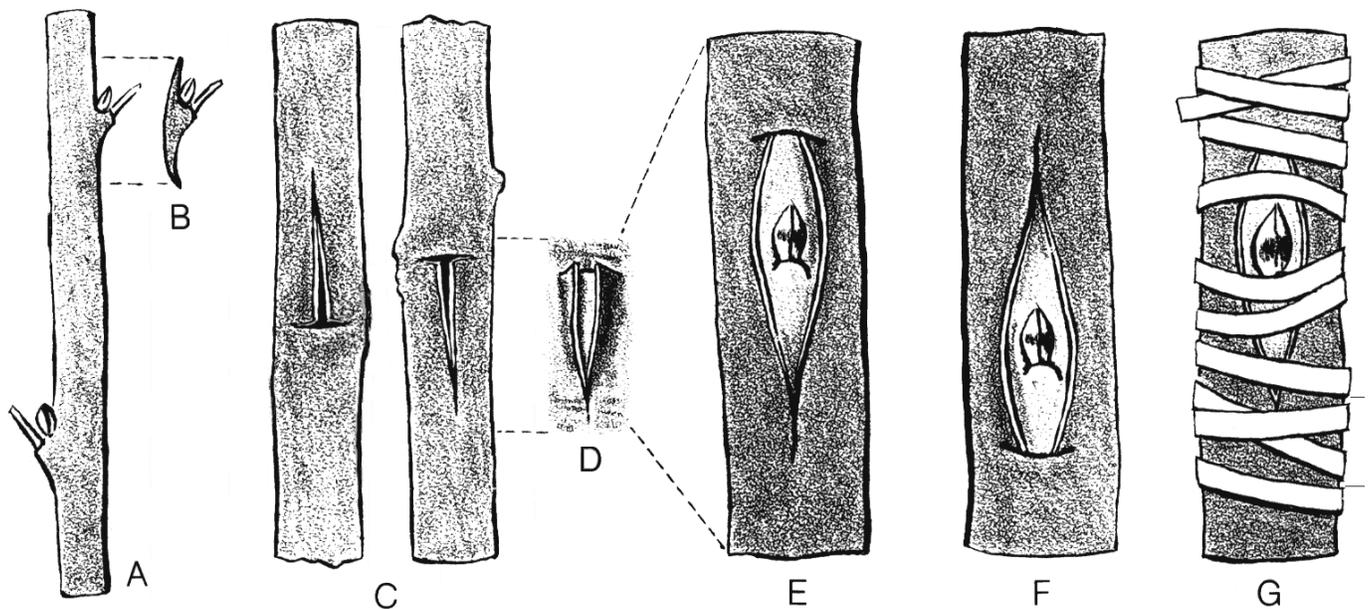
- wrap them in damp paper toweling,
- attach a label for positive identification,
- place in a polyethylene bag,
- seal tightly, and
- place in a refrigerator (40° to 45°F).

When working with the budsticks in the field, keep them moist and out of the sun as much as possible.



### Peach

Peach rootstocks are best grown from seed planted in the fall. Seed from peaches that ripen after August 1 germinate better than those from early-maturing cultivars. Peach seed commonly used for rootstock production include Lovell, Halford, Elberta, and Rutgers Red Leaf. Nemaguard is sometimes used for nematode resistance, and Siberian C is *occasionally* used to provide winterhardiness and moderate dwarfing of the scion cultivar, but it does not survive well in Kentucky.



**Figure 1.** (a) Bud stick with short leaf stems. (b) Shield bud. (c) Inverted “T” and standard “T” cut in stock. (d) Bark opened and ready for bud. (e) Bud inserted and flaps closed. (f) Bud inserted for inverted “T” budding. (g) Rubber budding strip holding flaps and bud firmly in place.

# How to Bud

## “T”-Budding and Inverted “T”-Budding

For “T”-budding, the “T” cut on the stock is made in a clear area of the stem away from buds as much as possible. A vertical slit 1 to 1½ inches long and a top slit to ½ inch long are made by inserting the knife into the trunk until it meets resistance of the wood layer of the stem. Open the slit enough to insert the bud shield to be cut from the budstick (Figures 1c and 1d).

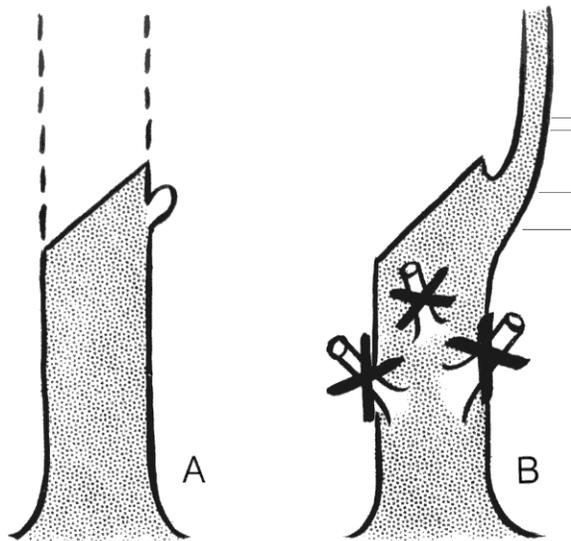
The bud is cut from the stick by starting the cut 1 inch below the bud, coming up underneath, and exiting about ½ inch above it. The depth of the cut is such that only a very small amount of wood appears directly under the bud (Figure 1b). Wood underneath the bud need not be removed. Hold the top part of the shield between the blade and thumb, and insert the bud into the “T” cut on the stock. If part of the bud sticks out above the “T,” it should be cut off so the flaps can be closed tightly. A rubber budding strip or polyethylene budding tape is wrapped firmly around the stem to close the incision (Figure 1g). Tying may begin at the top or bottom of the incision, depending on the preference of the operator. Take care not to injure or cover the bud (Figure 1g).

Although “T”-budding is more commonly used, the inverted “T” method almost always gives better results. There are only two

differences in the methods: (1) the “T” on the stock is inverted (Figure 1c), and (2) the bud is cut from the bud stick by starting ½ inch above the bud and exiting ¾ inch below. The advantage of the inverted “T” is that the downward flow of hormones and metabolic products is interrupted below the bud rather than above it. This results in earlier healing and a stronger union the following year.

In three to five weeks, the rubber strip will loosen and possibly fall off. If this does not happen, cut the binding to prevent constriction. If the bud is alive, it will be plump and the leaf petiole will have abscised. If the bud shield is shriveled and the dried petiole is still attached, the bud is probably dead, and the job will have to be done over. Buds do not grow after they are inserted but remain dormant until the following spring. The bud placement can be marked with paint so it will be easy to see the next spring at pruning time.

The following spring, just as growth begins, all top growth is cut off with a sloping cut ½ inch above the bud (Figure 2a). At this time, any growth other than the desired bud should be rubbed off. Removing the top of the stock will force the new bud into growth; it will also force many other stock buds into growth. Every 7 to 10 days, all growth except the inserted bud must be removed (Figure 2b).



**Figure 2.** (a) The stock above the bud is removed with a sloping cut about 1/2 inch above the bud set the previous fall. (b) All other growth is removed allowing only the desired bud to develop.

## Chip-Budding

This method of budding can be used whether or not the bark is slipping. More expert knife handling is needed, but once the basics are mastered, it is nearly as easy as “T”-budding. An advantage is that chip-budding can be done when the bark is not slipping. When done at the same time as “T”-budding, it heals more quickly and gives an even stronger union than the inverted “T.”

To chip-bud, make a cut 1¼ to 1½ inches long on the stock. The depth of the cut should be one-fifth to one-fourth the diameter of the stock. Make a small back cut at the bottom of the cut to remove the chip (Figures 3a and 3b). This small back cut on the stock aids in holding the chip-bud in place and provides for added cambial contact between stock and scion. The bud is cut in a similar manner (Figure 3c).

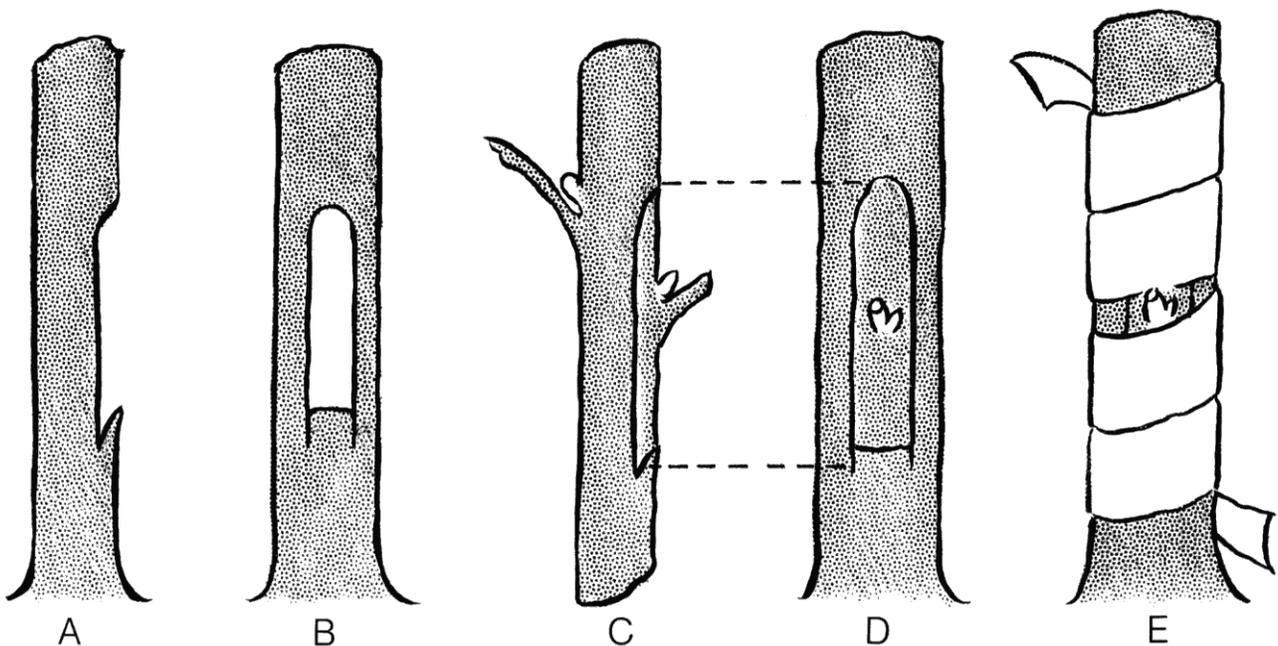
Ideally, the stock and the budstick should be the same diameter. When the budstick is smaller in diameter, the bud must be set off to one side of the stock so the cambia of the stock and scion will match as much as possible (Figure 3d). Although budding bands can be used for chip-budding, polyethylene tape is best since it does a much better job of sealing the bud and preventing desiccation (Figure 3e).

## Grafting

### The Scion Wood

Scion wood is collected during the dormant season from shoots that grew the previous year. Vigorous growth of at least a foot makes the best scions. Water sprouts from up in the tree usually make good straight scions. Do not collect scion wood while it is frozen, and avoid wood that has been damaged by cold.

After the scion wood has been cut from the tree, it should be tied in bundles, labeled, and stored under moist conditions in a temperature range of 40° to 45°F. The bundles may be stored in boxes of moist sphagnum or peat moss and placed in a cool cellar or refrigerator. Scion wood bundles wrapped with damp paper toweling, sealed in plastic bags, and placed in a refrigerator also store well. When you are ready to make scions, cut off and



**Figure 3.** (a) Side view of stock cut for chip-budding. (b) Front view of stock cut. (c) Chip-bud shield. (d) Chip-bud set in stock. Note that if the chip-bud is smaller than the cut that has been made for it, the bud should be lined up with the edge of the cut to obtain cambium contact. (e) Polyethylene tape to seal chip-bud; only bud is left uncovered.

discard the tip and base of the shoot. Buds near the tip of the shoot are often flower buds, and those near the base are often weak buds. The remaining portion of the stem is used to make scions each containing three to five buds. Scion wood should not be stored in a refrigerator that contains apples, pears, or other ethylene gas-generating fruit, as this will ruin the scion wood.

## The Rootstock

### Apple

Desirable characteristics of apple rootstocks include adaptability to local conditions, resistance to diseases and insects, vigor, and compatibility with the scion cultivar. These seedlings or trees make good stocks, in order of their vigor: Delicious (non-spur), McIntosh, Jonathan, Winesap, Wealthy, and Rome. The seeds of these varieties germinate well and have a high degree of compatibility with most apple cultivars.

If you are considering producing dwarf apple trees, it is best to purchase dwarf rootstocks from a nursery specializing in their production. A wide range of size-controlling apple rootstocks is available in the trade.

### Pear

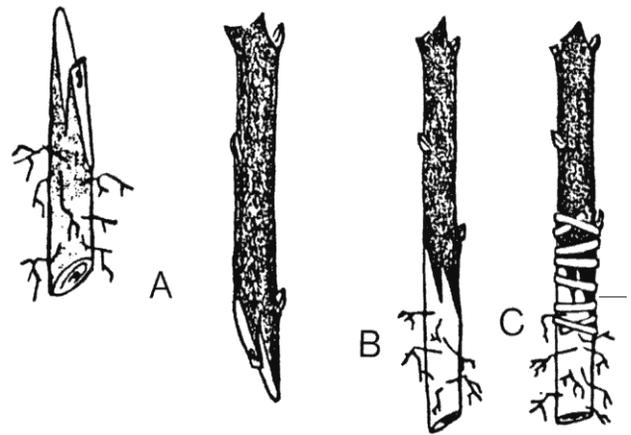
Both rootstocks and scions should be chosen for resistance to fire blight. Cold hardiness is also desirable in Kentucky. The French pear (*Pyrus communis*) is hardy but is not resistant to blight. The Chinese pear (*Pyrus calleryana*) has some resistance to blight but may be injured by sub-zero weather. There are several ways to produce trees with both cold and blight resistance:

- (1) bud the Old Home cultivar onto a French seedling (Bartlett, Anjou, or Hardy), and the following year bud or graft the desired scion cultivar. This method requires an extra year for production;
- (2) use Old Home seedlings or Old Home x Farmingdale clonal selections as the rootstock; or
- (3) use *Pyrus calleryana* seedlings as the rootstock, bud the desired scion cultivar as low as possible on the stock, and plant the finished tree so that all of the *P. calleryana* rootstock is beneath the soil.

Angers' quince (East Malling 'A') is commonly used as a rootstock for producing dwarf pear trees; however, quince rootstocks are not very hardy and are very susceptible to fire blight. The Old Home x Farmingdale 333 rootstock will produce a semi-dwarf pear tree.

## The Whip Graft

The whip graft (also known as the tongue graft) is particularly useful for species that unite easily, such as the apple and pear (Figure 4). It may be used in making a root, stem, or top graft as long as the stock and scion are near the same size. Scions and stocks from the size of a pencil to 1/2 inch in diameter are the best to use.



**Figure 4.** The whip graft showing scion and stock: (a) Prepared. (b) Joined. (c) Tied in place with waxed twine or rubber budding strip, or wrapped with grafting tape.

## Root Grafting

Root grafting is used to produce a tree on a seedling rootstock. Do not use root grafting to develop a tree on a dwarf rootstock since the scion will root and overcome the dwarfing effect. Root grafting is done when the apple rootstock and scion are dormant. (Pear is not normally root-grafted.) Either whole roots 3 or 4 inches long and as large as or slightly larger in diameter than the scion may be used (Figures 4a and 4b).

Prepare the scion by making a diagonal cut on the lower end about 1 1/2 inches long with a well-sharpened grafting knife. Hold the knife at an acute angle (Figure 5), and pull the scion through the blade with a swift, smooth stroke. Make the tongue as shown in Figure 4a; start the cut one-third of the way down from the tip of the cut surface, and end one-third of the way from the bottom on the cut surface. Prepare the top part of the root section the same way as the bottom. *Do not touch the cut surfaces with your hands.* Oil from the skin may inhibit union of the parts.

Join the two pieces as shown in Figure 4b, making sure that the cambium layers are in contact at least on one side. Grafting tape is recommended to bind the union. When it is spiraled on tightly and in such a way that the edges overlap slightly, the union will be held in place and protected from desiccation. The tape does not have to be removed. It is designed to disintegrate after the grafts are planted to the field. Rubber budding bands or light twine may be used, but these may need to be cut before planting.



**Figure 5.** Making the diagonal cut with knife held at an acute angle rather than at a 90° angle.

Bundle, label, and store the grafts before they have time to dry. Store the grafts in sphagnum or peat moss at 55° to 60°F for 10 to 14 days to initiate callus formation, then store at 40° to 45°F until they can be planted in the field. Examine the grafts from time to time and note the callus growth along the edge of the union. If mold is present, the grafts should be aired and then stored under drier conditions. If leaf growth has started, reduce the temperature to 35°F, or plant as soon as possible.

The dormant grafts should be planted into prepared, well-drained soil leaving only the top bud above the soil. Plant the grafts 12 to 16 inches apart in the row. The distance between rows is usually 30 to 36 inches and is mainly governed by the available cultivating and digging equipment.

March is a good time for field-setting grafts in Kentucky. The plants are grown for one season and then dug and stored for sale or transplanting the following spring.

### Stem or Top Grafting with the Whip Graft

Whip grafting to dwarf rootstocks follows the same procedure except the scion is placed uniformly 6 to 8 inches above the roots. This allows the dwarf tree to be set deeper in the soil at first planting for added support, and keeps the scion 2 to 3 inches above the soil line. The new plant needs to be set high because if the scion takes root, the dwarfing character of the rootstock will be lost.

Timing is important when whip grafting in the field on the stem or branches. The danger of cold injury should be past, but the graft must be made before the bark of the stock begins to slip. Usually stem grafting is done when the buds on the original stock begin to swell in the spring. The scion is then dormant. Keep all buds below the graft removed. Spurs may be left on to provide the needed leaf surface until the shoots from the scion have a sufficient number of leaves to do the job.

### Bark Graft

The bark graft is often used when the stock is too large for whip grafting. This graft is used mainly on pears, apples, and nuts such as pecans and walnuts. Dormant scion wood is used, but the stock is not ready until the bark begins to slip. Prepare the stock by cutting squarely across the trunk or branch with a fine-toothed saw at a point that is from 1 to 2 inches in diameter.

Prepare two scions 5 to 6 inches long by making a sloping cut ¼ inch above the top bud and a 2-inch-long diagonal cut on the lower end (Figure 6). Place the cut surface of the scion against the side of the stock. When viewed from the opposite side, ⅛ inch of the cut surface should be showing above the top of the stock. Hold firmly in place, and with the point of the knife, outline the scion on the bark. Finish cutting through the bark. Remove this bark and insert the scion. Use ½- to ¾-inch wire nails to hold the scion in place. Place the other scion on the opposite side. These operations should be done as rapidly as possible to limit drying of the cut surfaces. Study Figure 6.

A tree wound dressing of asphalt water emulsion is good to cover all exposed surfaces. This material is applied cold. If

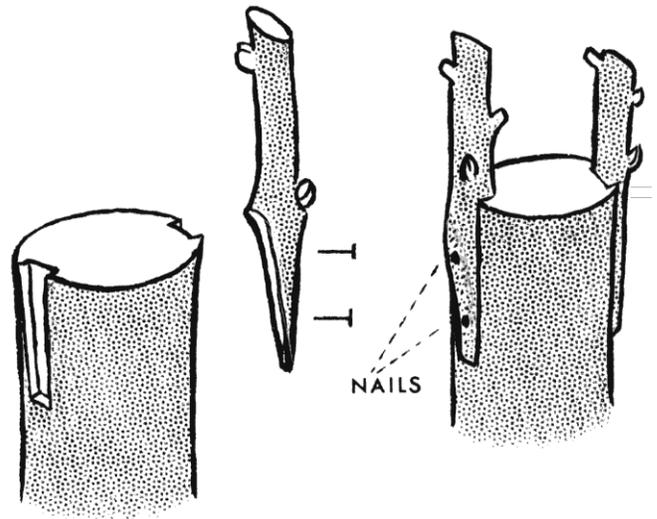


Figure 6. The bark graft.

melted grafting wax is used, take care to avoid wax hot enough to injure the tissue.

Aftercare of the graft is important. Keep shoots and sprouts below the graft removed. If both of the scions live, pinch back the shoot of the weaker one several times during the summer. Both scions should continue to grow the second summer. Gradually reduce the development of the weaker one by pruning, and in the spring of the next year, remove it completely. During the first or second summer, the strong scion may need to be topped to encourage branching.

### Cleft-Graft

The cleft-graft is one of the older grafting methods. Good technique can make it one of the most successful. It is mainly suited for top working apple and pear trees. The process simply involves fitting a scion into a split stock. The best time to perform the cleft-graft is just before the bark begins to slip in the spring.

When preparing the stock for the cleft-graft, look for:

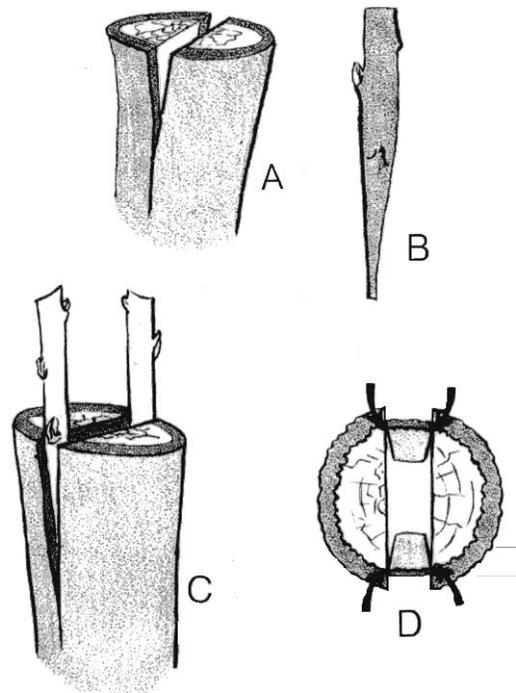
- scaffold limbs or trunks from 1 to 2 inches in diameter,
- areas on limbs that have straight grain for at least 6 inches below the amputation point (this area should also be free from spurs, knots, and cankers), and
- limbs that grow more toward the vertical than horizontal position. Grafts on horizontal limbs will likely “take” just as well, but the resulting sharp-angled upright growth is very undesirable.

After locating the point of amputation, make the cut with a fine-toothed saw. Take care to prevent the limb from splitting or the bark from peeling. Using a cleft-graft knife and a wooden mallet, split the stock across the center and to a depth of about 6 inches. After the scions are prepared, the split is held apart by driving the wedge of the cleft knife into the center of the split.

For the hobbyist, a small hatchet may be substituted and the split held open with a small cold chisel or large screwdriver.

Prepare two dormant scions by making a sloping cut on each side of the scion. The slopes on the scion and split should closely coincide (Figure 7). The cut on the scion should start slightly below the bottom bud. There is no need to bring the cuts to a point; a length of 2 inches is sufficient. The inside of the wedge should be slightly thinner than the outside (Figure 7d).

When joining the stock and the scion, remember that the bark of the stock will be thicker than the bark of the scion, so be sure to place the cambium in contact with each other. The top of the cut surface of the scion should be flush with the top of the stock, and it is most important that the cambium layers touch at this point (Figure 7). If the scion is loose in the stock, wrap the split with waxed cloth for three months. To prevent constricting the limb, cut the cloth after three months, but do not remove it. Seal all cut surfaces with asphalt water emulsion or grafting wax, including the split in the stock. Be sure there are no pinholes in the wax that will permit moisture to escape. Recheck the graft the day after grafting, and seal any pinholes that may have appeared in the asphalt water emulsion or grafting wax.



**Figure 7.** The cleft graft showing: (a) Split stock. (b) Scion with tapered lower end. (c) Scion fitted into stock. (d) Most vital points of contact are the cambium layers of stock and scion (note arrows).

## Important Points

Whichever method of graftage you use, remember these important points:

- The cambium layers of the stock and scion must be in contact with each other.
- Make smooth cuts to provide close contact.
- Work as rapidly as possible to prevent drying of the cut surfaces.
- Bind or wax the cut area to prevent drying of the tissue.
- Bindings should not be so tight or left on so long that they impair or stop the expansion growth of the stem.
- Use only properly identified and properly stored scion wood with healthy buds.
- Do the job at the proper time.
- Use sharp tools.

# Terms\*

**Budding** is a type of graftage. It consists of inserting a single leaf bud, the scion, with or without attached bark and wood piece, into the stock by specific techniques. “T”-budding is done in the latter part of the growing season from late June into September.

**Budstick** is the current season’s shoot growth from which single buds are removed for budding.

**Callus** is the mass of regenerating cells, called parenchyma cells, developing from and around wounded tissue. The union between a rootstock and scion results from the interlocking of the cells from both parts. Likewise, roots usually arise from the callus tissue at the basal ends of cuttings.

**Cambium layer** refers to a single layer of cells between the wood and bark tissues that surrounds all woody portions of a tree. This layer of cells, through cell division, produces two sets of cells that make up the growing tissues on both sides of it. On the outside, the new cells form phloem. On the inner side, the wood or xylem cells are formed. The phloem tissues eventually make up the layers of bark. The cambium is thus the source of all growth in diameter of the woody stem. In propagating trees, the cambium of the scion must line up with the cambium of the stock as perfectly as possible if good union is to result.

**Clone** denotes a specific cultivar propagated asexually or vegetatively. Specific rootstocks used in fruit tree propagation and propagated in this way are called clonal rootstocks.

**Cultivar** is the term now commonly used in place of “variety,” which was common in horticultural literature for many years. It refers to a variety that was selected or originated from a controlled cross under cultivated conditions, rather than found in the wild.

**Grafting** refers to various techniques of inserting a section of stem with leaf buds (the scion) into the stock. Since dormant scions are used, grafting is done in early spring, usually before growth begins.

**Interstem** or **interstock** is a section of trunk of the basic framework that is introduced between the rootstock and the scion cultivar. An interstem is chosen for specific vegetative characteristics or for the effect it may have on tree size. Interstems may be used to develop desirable framework characteristics, winterhardiness, or disease resistance or to make possible joining two cultivars that are incompatible if grafted directly. Thus, such trees consist of three distinct parts: the rootstock, the interstem, and the scion cultivar.

**Mound layering** is a method of vegetative propagation. Plant species and cultivars successfully layered form roots on the portion of the stem (shoot) below the soil surface. The rooted shoots are removed later and used as rootstocks for graftage.

**Rootstock** is the part of a tree that becomes the root system of a grafted or budded tree.

**Scion** denotes a short piece of twig or bud with attached section of bark inserted into the stock.

**Seedling** refers to a plant grown from a seed.

**Stock** identifies a plant or root system to which a scion cultivar is grafted or budded.

**Sucker** or **root sucker** refers to shoot growth arising from the crown or roots of a tree, generally below the graft union at or just below the soil surface.

**Top working** is the practice of changing the top of a tree from one cultivar to another through the use of graftage.

**Waterspout** indicates a vigorously growing unbranched shoot of the current season. It generally grows vertically and may arise from a primary scaffold or smaller branch, often adjacent to a pruning wound.

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\* Adapted from *Tree Fruit Propagation*, Bulletin 481, The Ohio State University.

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