Chapter 6

Plant Propagation

Learning Objectives
1. Explain the main differences between sexual and asexual propagation
2. Identify the three parts of a seed
3. Define the external and internal factors that affect the germination of a seed
4. Explain the different methods of breaking dormancy
5. Relate the fundamentals of starting and planting seeds
6. Demonstrate the major methods of asexual propagation
the purposes of plant propagation are to multiply a species, to spread a species or to maintain the youthfulness of a plant. There are two types of propagation: sexual and asexual. Sexual reproduction is the union of the pollen and egg. It draws from the genes of two parents to create a new individual. Sexual propagation involves the floral parts of a plant. Asexual propagation involves taking a part of one parent plant and causing it to regenerate itself into a new plant. Genetically, the new plant is identical to its one parent. Asexual propagation involves the vegetative parts of a plant, which are the stems, roots and leaves.

Sexual propagation is advantageous because it can be cheaper and quicker than asexual propagation and it can be the only way to obtain new varieties and hybrid vigor. Additionally, in certain species, it is the only viable method for propagation and it can avoid transmission of certain diseases. On the other hand, asexual propagation is advantageous because it can be used to bypass the juvenile characteristics of certain species; it can be an easier and faster form of reproduction and it may be the only way to perpetuate some cultivars.

Sexual Propagation
Sexual propagation is the union of the pollen from the male with the egg of the female to produce a seed. Even the smallest seed holds the complete genetic make-up of the plant. Sexual propagation can occur naturally or artificially. It can result in the genetic alteration of future plants. These alterations, for example, have created plants that can grow under specific conditions or express specific traits. Most of the planet’s vegetation is the result of natural sexual reproduction from seeds.

The seed is made up of three parts: the outer seed coat that protects the seed, the endosperm that is a food reserve, and the embryo, which is the young plant itself. When a seed is mature and put in a favorable environment, it will germinate. This means that it will begin active growth.

Acquiring and Storing Seed
To obtain quality plants, it is necessary to start with good quality seeds from a reliable dealer. Varieties should be selected based on the size, color and growth habit desired. The adaptability to the area in which they will be planted should also be considered. It is important that the variety selected can reach maturity before an early frost.

Although some seeds will keep for several years if stored properly, it is advisable to purchase only enough seed for the current year’s use. Good seed will have little debris, will not contain weed seed and will not contain seed of any other crop. The printing on the seed packet usually indicates essential information such as the variety, the year the seeds were packaged, the expected percentage of germination and any notes of chemical seed treatment. If the seeds are obtained well in advance of the actual sowing date or are stored as surplus, they should be kept in a cool, dry place.

Storing Seeds
Laminated foil packets will help ensure dry storage. Paper packets are best kept in tightly closed jars or in containers and maintained with low humidity at around 40 degrees F.

Although most seed companies take great care in handling seeds properly, generally only about 65 to 80 percent of the seeds sown will germinate. From those seeds germinating, about 60 to 75 percent will produce satisfactory, vigorous and sturdy seedlings. An alternative to purchasing seeds is to save them from the garden. However, garden seed is the result of random pollination by insects or other natural agents and may not produce plants typical of the parents. This is especially true of the many hybrid vegetable varieties. See Chapter 14, Vegetables for more information.
Factors Affecting Germination

Germination begins when certain internal requirements have been met: a mature embryo, a large enough endosperm to sustain the embryo during the germination process, and sufficient hormones to initiate the process. There are four environmental factors that affect germination: water, oxygen, light and heat.

Water

The first step in the germination process is the imbibition, or the absorption, of water. Even though seeds have great absorbing power due to the nature of the seed coat, the amount of available water in the germination medium affects the uptake of water. Therefore, an adequate, continuous supply of water is important to ensure germination. Once the germination process has begun, a dry period will cause the death of the embryo.

Light

Light is known to either stimulate or inhibit germination of seed. Some crops that need light to assist in seed germination are ageratum, begonia, browallia, impatiens, lettuce and petunia. Conversely, calendula, centaurea, annual phlox, verbena and vinca have seed that will germinate best in the dark. Other plants are not specific at all. Seed catalogs and seed packets list germination tips for individual varieties of plants.

Oxygen

In all viable seeds, respiration takes place. The respiration in the non-germinating seed is low. The respiration rate increases during germination; therefore, the medium in which the seeds are placed should be loose and well aerated. If the oxygen supply during germination is limited or reduced, germination can be severely retarded or inhibited.

Heat

A favorable temperature is another important requirement of germination. It not only affects the germination percentage, but it also affects the rate of germination. Some seeds will germinate over a wide range of temperatures, whereas others require a narrow range. Many seeds have minimum, maximum and optimum temperatures at which they germinate. For example, tomato seed has a minimum germination temperature of 50 degrees F, a maximum temperature of 95 degrees F, but an optimum germination temperature of about 80 degrees F. Where germination temperatures are listed, they are usually the optimum temperatures unless otherwise specified. Generally, 65 to 75 degrees F is the optimum for most plants. This often means that germination flats may have to be placed in special chambers or on radiators, heating cables or heating mats to maintain optimum temperature. The importance of maintaining proper medium temperature to achieve maximum germination percentages cannot be over emphasized.

Hybrids

Many new vegetable and flower varieties are hybrids that cost a little more than open pollinated types. However, hybrid plants usually have more vigor, more uniformity and better production than non-hybrids. Sometimes, hybrid plants will have specific disease resistance or other unique cultural characteristics as well.

Sowing Light Requiring Seed

When sowing light requiring seed, seeds should be left on the soil surface with little or no cover. If gardeners need to cover the seed, it should be lightly with fine peat moss or fine vermiculite. These two materials, if not applied too heavily, will permit some light to reach the seed and will not limit germination. When starting seed in the home, supplemental light can be provided by fluorescent lights suspended 6 to 12 inches above the seeds for 16 hours a day.
Methods of Breaking Dormancy

One of the functions of dormancy is to prevent a seed from germinating before a favorable environment surrounds it. In some trees and shrubs dormancy is difficult to break, even when the environment is ideal. Various treatments are performed on the seed to break dormancy and begin germination. The three discussed in this chapter are seed scarification, seed stratification and using sphagnum moss.

Seed Scarification
Seed scarification involves breaking, scratching or softening the seed coat so that water can enter and begin the germination process. There are several methods of scarifying seeds: acid scarification, mechanical scarification, hot water scarification and warm, moist scarification. In acid scarification, seeds are put in a glass container and covered with concentrated sulfuric acid at about twice the volume of the seed. The seeds are gently stirred and allowed to soak from 10 minutes to several hours, depending on the hardness of the seed coat. When the seed coat has become thin, the seeds can be removed, washed and planted. Another scarification method is mechanical scarification. In mechanical scarification, seeds are filed with a metal file and then either rubbed with sandpaper or cracked with a hammer to weaken the seed coat. A third method of scarification is hot water scarification. In hot water scarification, the seeds are put into hot water (170-212 degrees F), soaked in the water as it cools—about 12 to 24 hours, and then planted. Finally, in warm, moist scarification, seeds are stored in non-sterile, warm and damp containers until the seed coat is broken down by decay. This process usually takes at least several months.

Seed Stratification
Seeds of some fall ripening trees and shrubs of the temperate zone will not germinate unless chilled underground as they overwinter. This so-called “after ripening” may be accomplished artificially by a practice called stratification. The following procedure is usually successful for stratification:

- Place sand or vermiculite in a clay pot until it is about 1 inch from the top
- Wet the medium thoroughly and allow excess water to drain through the hole in the pot
- Place the pot containing the moist medium and seeds in a plastic bag and tie the bag using a twist tie or rubber band
- Place the bag in a refrigerator
- Periodically check to see if the medium is moist but not wet. Additional water will probably not be necessary
- After 10 to 12 weeks, remove the bag from the refrigerator
- Take the pot out and set it in a warm place in the house
- Water often enough to keep the medium moist
- Soon the seedlings should emerge
- When the young plants are about 3 inches tall, transplant them into pots to grow until time for setting outside

Sphagnum Moss
Another procedure that is usually successful in breaking dormancy involves the use of sphagnum or peat moss. The following instructions detail how to break dormancy using this method.

- Wet moss thoroughly and squeeze out excess water with your hands
- Mix seed with the sphagnum or peat and place in a plastic bag
- Use a twist tie or rubber band to secure the top
- Place the bag in a refrigerator at a temperature of 35 to 45 degrees F
- Check periodically to see if there is condensation on the inside of the bag—condensation indicates that the process will probably be successful
- After 10 to 12 weeks, remove the bag from the refrigerator
- Plant the seeds in pots to germinate and grow
- Handle seeds carefully because often small roots and shoots are emerging at the end of the stratification period

**Starting Seeds**

**Media**

A wide range of materials can be used to start seeds: straight vermiculite, mixtures of soilless artificial media and various amended soil mixes. With experience, it becomes easier to determine what works best under specific conditions. Regardless of which germinating medium is used, it is important that it is fine and uniform, yet well aerated and loose. The medium should also be free of insects, disease organisms and weed seeds. It should be low in fertility and total soluble salts and capable of holding and moving moisture by capillary action. A combination of 1/3 sterilized soil; 1/3 sand, vermiculite or perlite; and 1/3 peat moss contains these features.

The importance of using a sterile medium, container and tools cannot be over emphasized. Fortunately, a small quantity of soil medium can be treated in a home oven. Treating soil at home should prevent damping-off and other plant diseases as well as eliminate potential plant pests; however, this procedure produces unpleasant odors.

To sterilize plant medium in the home, slightly moist soil should be placed in a heat resistant, covered container in a 250 degree F oven. A candy or meat thermometer can be used to ensure that the mix reaches a temperature of 180 degrees F for at least ½ an hour. Over heating should be avoided because this can be extremely damaging to the soil. If wood or plastic growing containers and/or tools are used, they should be washed to remove any debris then rinsed in a solution of 1 part chlorine bleach to 10 parts water.

An artificial, soilless mix will also provide the qualities of a good germination medium. The basic ingredients of such a mix are sphagnum peat moss and vermiculite, both of which are generally free of diseases, weed seeds and insects. The ingredients are readily available, easy to handle, light-weight and produce uniform plant growth.

Ready made “peat-lite” mixes or similar products are commercially available or can be made at home using one of the recipes in the Tip Box entitled “Home-made Peat-lite.”

### Home-Made Peat-lite

Mix together:

- 4 quarts of shredded sphagnum peat moss
- 4 quarts of a fine grade vermiculite
- 1 tablespoon of superphosphate
- 2 tablespoons of ground limestone

**OR**

Mix together and with fertilizer:

- 50 percent vermiculite or perlite and
- 50 percent milled sphagnum moss

These mixes have little fertility so seedlings must be watered with a diluted fertilizer solution soon after they emerge. Do not use garden soil by itself to start seedlings as it is not sterile, it is heavy, it will not drain well and it will shrink from the sides of containers if allowed to dry out.

### Containers

Containers can be made from many different materials such as wood, plastic, clay and compressed peat. If wood or plastic flats and trays are used, a convenient size to handle is about 12 to 18 inches long by 12 inches wide by 2 inches deep. To ensure drainage, cracks or about 1/8 of an inch should be left between the bottom boards or a series of holes should be drilled into the bottom boards. Wood or plastic flats or trays can either be purchased or made from scrap lumber.

If flowerpots are used, they can be made from clay, plastic or recycled from things such as cottage cheese containers, the bottoms of milk cartons and pie pans. If these items are used, it is important to ensure holes are made in the bottom for good drainage.

Additionally, numerous types of pots and strips made of compressed peat can be utilized to start seeds. Plant bands and plastic cell packs are also available. Each cell or minipot holds a single plant. This reduces the risk of root injury when transplanting. Peat pellets, peat or fiber based blocks and expanded plastic foam cubes can also be used for seeding. Here,
the growing medium itself forms the container unit.

Seeding

The proper time for sowing seeds for transplants depends upon when plants may be safely moved outdoors. This period may range from 4 to 12 weeks depending upon the speed of germination, the rate of growth and the cultural conditions provided. A common mistake is to sow the seeds too early and then attempt to hold the seedlings back under poor light or improper temperature ranges. This usually results in tall, weak and spindly plants that do not perform well in the garden.

To begin seeding, a container should be selected and filled to within ¾ of an inch from the top with the moistened medium of choice. For very small seeds, at least the top ¼ inch should be of a fine, screened mix or a layer of vermiculite. The medium should be firmed at the corners and edges with fingers or a block of wood. This will provide a uniform, flat surface.

For medium-to-large seeds, furrows about 1 to 2 inches apart and 1/8 to ¼ of an inch deep should be made across the surface of the container using a narrow board or pot label. By sowing in rows, good light and air movement results and, if damping off fungus does appear, there is less chance of it spreading. Seedlings in rows are easier to label and to handle at transplanting than seedlings that have been sown in a broadcast manner. Gently tapping the packet of seed as it is moved along the row will help ensure that the seeds are sown in thin, uniform rows. Once the seeds are in the container, they should be lightly covered with dry vermiculite or sifted medium if they require darkness for germination. A suitable planting depth is usually about twice the diameter of the seed.

Seeds should not be planted too deeply. Extremely fine seed such as petunia, begonia and snapdragon should not be covered; however, they should be lightly pressed into the medium or watered in with a fine mist spray. If these seeds are broadcast, a uniform stand can be achieved by sowing half the seeds in one direction and the other half in the other direction.

Large seeds are frequently sown into some sort of a small container or cell pack. This eliminates the need for early transplanting. Usually 2 or 3 seeds are sown per unit and later thinned to allow the strongest seedling to grow.

Seed Tape

Most garden stores and seed catalogs offer indoor and outdoor seed tapes. Seed tape has precisely spaced seeds enclosed in an organic, water soluble material. When planted, the tape dissolves and the seeds germinate normally. Seed tapes are especially convenient for tiny, hard-to-handle seeds. However, tapes are much more expensive per seed. Seed tapes allow uniform emergence of seedlings, eliminate overcrowding of seedlings and permit sowing in perfectly straight rows. The tapes can be cut at any point for multiple row plantings; thinning is rarely necessary.

Pre-germination

Another method of starting seeds is pregermination. This method involves sprouting the seeds before they are planted. Pregermination reduces the time to germination because the temperature and moisture are easy to control. Therefore, a high percentage of germination is guaranteed because no seed will be lost due to environmental factors. Pregermination is done by laying seeds on a pan between folds of cotton cloth on a layer of vermiculite or similar material. After the seeds are laid out, they should be kept moist in a warm place; watering is critical to the survival of the seedlings. Once the roots begin to show, the seedlings should be placed into containers or planted directly into the garden. Special care needs to be taken while transplanting seedlings because the roots are tender and easy to break.

When planting seeds into a container that will eventually be set out in the garden, one seed should be planted to ½ the recom-

Figure 1. Seeding

![Figure 1. Seeding](image-url)
mended depth into a 2- to 3- inch container. A little soil should be gently pressed over the sprouted seed and then about ¼ inch of milled sphagnum or sand should be added to the soil surface. These materials will keep the surface uniformly moist and are easy for the shoot to push through. Pots should be kept in a warm place and cared for just as any other newly transplanted seedlings.

A convenient way to plant small, delicate, pregerminated seeds is to suspend them in a gel. A gel can be made by blending cornstarch with boiling water to a consistency that is thick enough for the seeds to stay suspended. Once the gel is cooled, it can be placed into a plastic bag with the seedlings. A small hole should be made in the bag and then the gel can be squeezed through the hole along a pre-marked garden row. The number of seeds in the gel determines the spacing of seeds. If the spacing is too dense, more gel can be added; if too wide, more seeds can be added. The gel will keep the germinating seeds moist until they establish themselves in the garden soil.

Watering
After the seed has been sown, the planting mix should be thoroughly moistened by using a fine mist spray or by placing the containers in a pan that has about 1 inch of warm water in the bottom. Splashing or excessive flooding should be avoided because this might displace small seeds. Once the planting mix is saturated, the container should be set aside to drain. The soil should be moist but not wet.

Ideally, seed flats should remain sufficiently moist during the germination period without having to add water. One way to maintain moisture is to slip the whole flat or pot into a clear plastic bag after the initial watering. The plastic should be at least 11 ½ inches from the soil. The container should be kept out of direct sunlight; otherwise the temperature may rise to the point where the seeds will be harmed. Many home gardeners cover their flats with panes of glass instead of using a plastic sleeve. If this is done, the plastic bag or glass cover should be removed as soon as the first seedlings appear. At this point, surface watering is appropriate if care and good judgment are used.

Lack of uniformity, over-watering and drying-out are problems related to hand watering. Excellent germination and moisture uniformity can be obtained with a low pressure misting system. Four seconds of mist every 6 minutes or 10 seconds of mist every 16 minutes during the daytime in the spring seems to be satisfactory. Bottom heat is an asset with a mist system. Sub-irrigation or watering from below may also work well at keeping the flats moist. However, as the flats or pots must sit in a constant water level, the soil may absorb too much water and the seeds may rot due to lack of oxygen.

Temperature and Light
Several factors assuring good germination have already been mentioned. The last items, and by no means the least important, are temperature and light. Since most seeds will germinate best at an optimum temperature that is usually higher than most home night temperatures, special warm areas must often be provided. The use of thermostatically controlled heating cables is an excellent method of providing constant heat.

After germination and seedling establishment, flats should be moved to a light, airy, cooler location, with a 55 to 60 degree F night temperature and a 65 to 70 degree F day temperature. This will prevent soft, leggy growth and minimize disease troubles. Some crops, of course, may germinate or grow best at a different constant temperature and must be handled separately from the bulk of the plants.

Because seedlings must receive bright light after germination, they should be placed in a window facing south. However, if a large,
bright window is not available, the seedlings should be placed under two 40-watt, cool-white fluorescent tubes or under special plant growth lamps. Plants should be positioned 6 inches from the tubes, and the lights should be kept on about 16 hours each day. As the seedlings grow, the lights should be raised.

**Transplanting and Handling**

If the plants have not been seeded in individualized containers, they must be transplanted to give them proper growing space. One of the most common mistakes made by plant growers is leaving the seedlings in the seed flat too long. The ideal time to transplant young seedlings is when they are small and there is little danger from setback. This is usually about the time the first true leaves appear above or between the cotyledon leaves. Transplanting should always be done before the plants get hard and stunted or too tall and leggy.

**Seed Leaves**

The cotyledons or seed leaves are the first leaves the seedling produces.

Once the plants are ready to be transplanted, they should be carefully dug up with a knife or wooden plant label. The group of seedlings should be allowed to fall apart and then individual plants can be carefully picked out. Small seedlings should be handled by their leaves, not their delicate stems. Next, a hole should be punched in the growing medium. The hole should be deep enough so that the seedling can be put at the same depth it was growing in the seed flat. Small plants or slow growers should be placed 1 inch apart and rapidly growing, large seedlings should be placed about 2 inches apart. After planting, the soil should be firmed and the plants watered gently. Newly transplanted seedlings should be kept in the shade for a few days or placed under fluorescent lights. They should also be kept away from direct heat sources. Watering and fertilizing should be continued as was done in the seed flats.

Most plants transplant well and can be started indoors, but a few plants are difficult to transplant. Generally, these plants are directly seeded outdoors or sown directly into individual containers indoors. Examples include zinnias and cucurbits such as melons and squash.

**Growing Seedlings**

Seedling growing mixes and containers can be purchased or prepared. These mixes and containers are similar to those mentioned for germinating seed. However, the medium should contain more plant nutrients than a germination mix. Some commercial soilless mixes have fertilizers already added. If fertilizer is to be added, a soluble houseplant fertilizer should be used at the dilution recommended by the manufacturer about every 2 weeks after the seedlings are established. Remember that too much fertilizer easily damages young seedlings, especially if they are under any moisture stress.

**Containers for Transplanting**

A wide variety of containers can be used for transplanting seedlings. The container selected should be economical, durable and make good use of space. The type selected will depend on the type of plant to be transplanted and individual growing conditions. Standard pots may be used; however, they waste a great deal of space and may not dry out rapidly enough for the seedlings to have sufficient oxygen for proper development.

There are many types of containers available commercially. Those made out of pressed peat can be purchased in varying sizes. Individual pots or strips of connected pots that fit closely together are inexpensive and can be planted directly into the garden. When setting out plants grown in peat pots, care should be used to cover the pot completely. If the top edge of the peat pot extends above the soil level, it may act as a wick and draw water away from the soil and into the pot. To avoid this, the top lip of the pot should be torn off and the plants should be planted flush with the soil level.
Compressed peat pellets may also be used. When soaked in water, they expand to form little compact individual pots. They waste no space, do not fall apart as badly as peat pots, and can be set directly out in the garden. Compressed peat pellets are excellent for direct sowing if transplanting seedlings is to be avoided completely.

Community packs are containers in which there is room to plant several plants. These are generally made of pressed paper or fiber and are inexpensive. The main disadvantage of a community pack is that the roots of the individual plants must be separated when putting the plants into the garden. Community packs and cell packs, which are strips of connected individual pots, are also available in plastic and are frequently used by commercial bedding plant growers as they withstand frequent handling.

In addition to the aforementioned commercial containers, many homeowners find a variety of materials from around the house useful for containers. These homemade containers should be deep enough to provide adequate soil and have plenty of drainage holes in the bottom.

**Hardening Plants**

Hardening is the process of altering the quality of plant growth to withstand the change in environmental conditions that occurs when plants are transferred from a greenhouse or home to the garden. Hardening is important because a severe check in growth may occur if plants produced in the home are planted outdoors without a transition period. Even cold hardy plants will be hurt if exposed to freezing temperatures before they are hardened. However, after proper hardening, plants can be planted outdoors and light frosts will not damage them. Hardening is more critical with early crops when adverse climatic conditions can be expected than it is for crops planted later in the season.

Gradually lowering temperatures, relative humidity and water can accomplish hardening. Hardening results in an accumulation of carbohydrates and a thickening of cell walls. Plant growth changes from being soft and succulent to a firm and hard.

Hardening should be started at least 2 weeks before moving plants to the garden. If possible, plants should be moved to a shady location that is 45 to 50 degrees F. This location can either be indoor or outdoor. A cold-frame is excellent for this purpose. Once put outdoors, plants should be shaded and then gradually moved into sunlight. Each day, the length of sun exposure should be gradually increased. However, tender seedlings should not be put outdoors on windy days or when temperatures are below 45 degrees F. Also, although the frequency of watering should be reduced to slow growth, plants should not be allowed to wilt.

The hardening process is intended to slow plant growth. If carried to the extreme of actually stopping plant growth, significant damage can be done to certain crops. For example, cauliflower will make thumb size heads and fail to develop further if hardened too severely. Also, cucumbers and melons will stop growth and not resume growth if hardened to a severely.

**Propagation of Ferns by Spores**

Though ferns are more easily propagated by other methods, some gardeners like the challenge of raising ferns from spores. Ferns can be propagated from spores that develop in clusters on the underside of fronds. Germinating spores takes more time and care than germinating seeds. Growing ferns from spores involves two generations of ferns. Spores first produce an asexual plant called a gametophyte. This plant is very small and has none of the usual plant parts. It resembles a moss-like growth and is about 1/8 inch thick. The gametophyte reproduces sexually and forms sporophytes that have visible roots, stems and leaves.

In order to propagate via spores, fronds that have produced spores should be collected and stored in an envelope until they are dry. Once dry, the dust-like spores should be separated from the cases by screening and the spores should be stored in an airtight container in a cool, dry place until ready to plant.

When ready to plant, a solid, sterilized brick should be put in a pan with enough water to cover the brick. The brick can be sterilized by baking it at 250 degrees F for 30 minutes. When the brick is wet throughout, a thin layer of moist soil and peat (1:1) should be squeezed onto the top of the brick. Then, a second layer that is about 1-inch deep should be packed...
added. Next, spores should be sprinkled over the second layer and covered with plastic. Care should be taken to not touch the spores with the plastic. Finally spores should be placed in a warm place in indirect light and kept moist at all times. It may take at least a month for the spores to germinate.

A prothallus, one generation of the fern, will develop first from each spore, forming a light green mat. Once the prothallus develops, it should be misted lightly once a week to maintain high surface moisture; the sperm must be able to swim to the archegonia—the female parts. After about 3 weeks, fertilization should have occurred. At this point, the mat should be pulled apart with tweezers into ¼-inch squares and spaced ½ inch apart in a flat containing a 2-inch layer of sand, a ¼-inch layer of charcoal and about a 2-inch layer of soil/peat mix. The flat should be covered with plastic and kept moist. When fern fronds appear and become crowded, they should be transplanted to small pots. At this time, humidity should be gradually reduced, by lifting plastic slightly, until the plants can survive outside the plastic and light exposure can be increased.

**Asexual Propagation**

Asexual propagation is the best way to maintain some species, particularly an individual that best represents that species. Clones are groups of plants that are identical to their one parent and that can only be propagated asexually. The Bartlett pear and the delicious apple are two examples of clones that have been asexually propagated for many years. The major methods of asexual propagation are cuttings, layering, budding and grafting. The sections below detail how to perform each of these propagation methods.

**Cutting**

A cutting is a vegetative plant part that is severed from the parent plant and then regenerated, thereby forming a whole new plant. Cuttings are frequently used to propagate both woody and herbaceous plants. To propagate a plant by cutting, use a sharp knife or razor blade to reduce injury to the parent plant. Dip the cutting tool in rubbing alcohol or a mixture of one part bleach and nine parts water to prevent transmitting diseases from infected plant parts to healthy ones. Flowerers and flower buds should be removed from cuttings to allow the cuttings to use the energy and stored carbohydrates for root and shoot formation rather than fruit and seed production. To obtain uniform rooting, except on soft fleshy stems, use a rooting hormone—preferably one containing a fungicide. To prevent possible contamination of the entire supply of cuttings with rooting hormone, put the rooting hormone in a separate container and then dip the desired cuttings into that container.

Rooting Hormones

These chemicals are primarily composed of synthetic auxins (plant hormones); most commonly, IBA (indolebutyric acid) and/or NAA (naphthaleneacetic acid) are used. Commercially prepared talc formulations in various concentrations, suited for easy-, moderate-, or difficult-to-root plants, are available at most garden centers. Some talc formulations of auxins also contain a fungicide to help prevent disease during rooting. Be careful; if you apply the talc powder too heavily, it may burn off the base of some cuttings.

When using these products, remove a small amount of the talc powder from its container and place it into a smaller container. Then dip or dust your cuttings from that portion. This protects future cuttings by preventing any potential disease contamination from the cutting to the hormone formulation.
Stem Cuttings

Stem cuttings propagate numerous plant species. Some cuttings can be taken at any time of the year, but stem cuttings of many woody plants must be taken in the fall or in the dormant season. To do a stem cutting, choose a healthy stem and snip it with a sterilized, sharp knife or a razor. The size of the cutting can vary depending on the type of plant; however, for herbaceous plants, the cutting should be about 3 to 5 inches. Once cut, remove all leaves that are within at least an inch of the bottom of the cutting and then place the cutting into growing media.

Tip Cuttings

Detach a 2- to 6-inch piece of stem, including the terminal bud. Make the cut just below a node. Remove lower leaves that would either touch or be below the medium. Dip the stem in rooting hormone if desired. Gently tap the end of the cutting to remove excess hormone. Insert the cutting deeply enough into the media to support itself. At least one node must be below the surface.

Medial Cuttings

Make the first cut just above a node and the second cut just above a node 2 to 6 inches down the stem. Prepare and insert the cutting as you would a tip cutting. Be sure to position right side up. Remember: axial buds are always above the leaves.

Cane Cuttings

Cut cane-like stems into sections containing one or two eyes, or nodes. Dust ends with fungicide or activated charcoal. Allow to dry several hours. Lay horizontally with about half of the cutting below the media surface, eye facing upward. Cane cuttings are usually potted when roots and new shoots appear. However, new shoots from dracaena and croton are often cut off and re-rooted in sand.

Single Eye

Single eye cutting is used for plants with alternate leaves when space or stock material is limited—the eye refers to the node. Cut the stem about ½ inch above and below a node. Insert the cutting vertically into the medium with the node just touching the surface.

Heel Cutting

Heel cutting uses stock material with woody stems. Make a shield-shaped cut about halfway through the wood around a leaf and axial bud. Insert the shield horizontally into the medium.

Leaf Cuttings

Leaf cuttings are rarely used for plant propagation. When they are used, it is almost exclusively for a few indoor plants. This is because the leaves of most plants will either produce a few roots but no plant, or just decay.

Whole Leaf With Petiole

Detach the leaf and ½ to 1½ inches of petiole. Insert the lower end of the petiole into the medium. One or more new plants will form at the base of the petiole. The leaf may be severed from the new plants when they have their own roots. The petiole can be reused.

Whole Leaf Without Petiole

This is used for plants with sessile or petiole-less leaves. Detach a whole leaf and insert the cutting vertically into the medium. A new plant will form from the axillary bud. The leaf may be removed when the new plant has its own roots.
Figure 4. Woody Cutting with a Minimum of Four Nodes

Softwood Cuttings

Cuttings taken from succulent spring growth from deciduous or evergreen species are called softwood cuttings. These greenwood cuttings are available during flushes of new growth and may only be around once a year. Depending where one lives, the timing for different softwood cuttings can vary. Taking softwood cuttings is often the only way to root some of the more finicky and hard to propagate woody plants.

Generally, softwood cuttings root faster than other types of cuttings. Therefore, when choosing a piece to take off the mother plant, material that is extremely fast growing or tender is not desirable. However, material that is not vigorous might be slow to root. Thus, rooting material that is flexible and will break when bent sharply should be chosen. Cuttings should be between 3 and 5 inches long, have two or more nodes and have the bottom leaves removed. Cuttings should be placed in a well-drained potting mix and kept as moist and cool as possible. To slow drying, cuttings can be covered with a clear plastic tent for short periods. However, if this is done, temperature must be frequently monitored to ensure that the cuttings are not getting too hot.

Hardwood, Semi-hardwood and Softwood Cuttings

Hardwood Cuttings (Deciduous Species)

One of the most durable and dependable types of cuttings that can be taken is a hardwood cutting. Hardwood cuttings are made of dormant mature wood after the leaves have dropped. These cuttings are taken and prepared during the fall, winter or very early spring. Most commonly, wood from the last season’s growth is used. This type of cutting is often used to propagate deciduous woody plants. However, some broad-leaved evergreens are also propagated in this manner.

Hardwood cuttings should come from healthy plants that have not experienced a large amount of stress in the landscape. The stems should be about the size of a pencil in diameter and 5 to 7 inches long. Each cutting should have a minimum of four nodes. Any remaining dry or withered leaves should be removed from the cutting. To enhance rooting, a commercial rooting hormone can be used.

Many home gardeners who have mild winters or reliable snow cover can generally place cuttings directly into the soil in the late fall; rooting will happen during the dormant season. Once hardwood cuttings are planted, it is imperative to ensure that the soil around them remains moist.

Split Vein

Detach a leaf from the stock plant. Split its veins on the lower leaf surface. Lay the cutting, lower side down, on the medium. New plants will form at each cut. If the leaf tends to curl up, hold it in place by covering the margins with the rooting medium.
Leaf Sections
This method is frequently used with fibrous rooted begonias and snake plants. Cut begonia leaves into wedges with at least one vein. Lay leaves flat on the medium. A new plant will arise at the vein. Cut snake plant leaves into 2-inch sections. Consistently make the lower cut slanted and the upper cut straight so you can tell which is the top. Insert the cutting vertically. Roots will form fairly soon, and eventually a new plant will appear at the base of the cutting. These and other succulent cuttings will rot if kept too moist.

Root Cuttings
Root cuttings are usually taken from 2- to 3-year-old plants during their dormant season when they have a large carbohydrate supply. Root cuttings of some species produce new shoots, which then form their own root systems. Root cuttings of other plants develop root systems before producing new shoots.

Semi-hardwood Cuttings
Cuttings taken from either leafy summer or early fall hardy deciduous plants with partially matured wood are referred to as semi-hardwood cuttings. Often times these cuttings can also include broad-leaved evergreens. These cuttings are very similar to hardwood cuttings in size. However, with semi-hardwood cuttings it is important to keep the leaves on the top nodes of the plant attached. If the leaves are large, it can be beneficial to cut them in half to reduce water loss from transpiration.

Similar to hardwood cuttings, using a rooting hormone to enhance root growth can be beneficial. Commercial growers utilize mist, fog and/or bottom heat systems to keep their cuttings happy. However, for the homeowner, planting in a well drained potting mix and tenting with a clear plastic bag is often the best way to insure that cuttings do not dry out.

Plants With Large Roots
Make a straight top cut. Make a slanted cut 2 to 6 inches below the first cut. Store about 3 weeks in moist sawdust, peat moss or sand at 40 degrees F. Remove from storage. Insert the cutting vertically with the top approximately level with the surface of the rooting medium. This method is often done outdoors.

Plants With Small Roots
Take 1 to 2 inch sections of roots. Insert the cuttings horizontally about ½ inch below the medium surface. This method is usually done indoors or in a hotbed.

Layering
Stems still attached to their parent plants may form roots where they touch a rooting medium. Severed from the parent plant, the rooted stem becomes a new plant. This method of vegetative propagation, called layering, promotes a high success rate because it prevents
the water stress and carbohydrate shortage that plague cuttings.

Some plants layer themselves naturally, but sometimes plant propagators assist the process. Layering is enhanced in several ways: girdling the stem where it is bent, wounding one side of the stem or bending the stem very sharply. The rooting medium should always provide aeration and a constant supply of moisture.

**Tip Layering**

Dig a 3- to 4-inch deep hole. Insert the shoot tip and cover it with soil. The tip will grow downward first, then bend sharply and grow upward. Roots form at the bend and the recurved tip becomes a new plant. Remove the tip layer and plant it in the early spring or late fall. Some examples are purple raspberries, black raspberries and trailing blackberries.

**Simple Layering**

Bend the stem to the ground. Cover part of it with soil, leaving the last 6 to 12 inches exposed. Bend the tip into a vertical position and stake in place. The sharp bend will often induce rooting, but wounding the lower side of the branch or loosening the bark by twisting the stem may help. Some examples are rhododendron and honeysuckle.

**Compound Layering**

This method works for plants with flexible stems. Bend the stem to the rooting medium as for simple layering, but alternately cover and expose stem sections. Wound the lower side of the stem sections to be covered. Some examples are heart-leaf philodendron and pothos.

**Mound (Stool) Layering**

Cut the plant back to 1 inch above the ground in the dormant season. Mound soil over the emerging shoots in the spring to enhance their rooting. Some examples are gooseberries and apple rootstocks.

**Air Layering**

Air layering is used to propagate some indoor plants with thick stems or to rejuvenate them when they become leggy. Slit the stem just below a node. Pry the slit open with a toothpick. Surround the wound with wet, unmilled sphagnum moss. Wrap plastic or foil around the sphagnum moss and tie in place. When roots pervade the moss, cut the plant off below the root ball. Some examples are dumbcane and rubber tree.

The following propagation methods may be considered types of layering, as the new plants form before they are detached from their parent plants.

**Stolons and Runners**

A stolon is a horizontal and often fleshy stem that roots and produces new shoots when in contact with growing medium. A runner is a slender stem that originates in a leaf axil and then grows along the ground, or downward if in a hanging basket, producing a new plant at its tip. Severing the new plants from their parent stems propagates plants that produce stolons or runners. Plantlets at the tips of runners may be rooted while still attached to the parent, or they may be detached and placed in a rooting medium. Some examples are strawberry and spider plant.

**Offsets**

Plants with a rosetted stem often reproduce by forming new shoots at their base or in leaf axils. To asexually propagate this type of plant, sever the new shoots from the parent plant after they have developed their own root system. Unrooted offsets of some species may be removed and placed in a rooting medium. Some must be cut off, while others may be simply lifted off of the parent stem. Some examples are date palm, haworthia, bromeliads and many cacti.

**Separation**

Separation is a form of propagation for plants that produce multiple bulbs or corms. See descriptions for each directly below.

**Bulbs**

New bulbs form beside the originally planted bulb. Separate these bulb clumps every 3 to 5 years for the largest blooms and to increase bulb population. Dig up the clump after the leaves have withered. Gently pull the bulbs apart and replant them immediately so their roots can begin to develop. Small new bulbs may not flower for 2 or 3 years, but large ones should bloom the first year. Examples include tulip and narcissus.
Corms
A large new corm forms on top of the old corm, and tiny cormels form around it. After the leaves whither, dig up the corms and allow them to dry in indirect light for 2 to 3 weeks. Remove the cormels and then gently separate the new corm from the old corm. Dust all new corms with a fungicide and store in a cool place until planting time. Some examples include crocus and gladiolus.

Division
Plants with more than one rooted crown may be divided and the crowns planted separately. If the stems are not joined, gently pull the plants apart. If horizontal stems unite the crowns, cut the stems and roots with a sharp knife to minimize injury. Divisions of some outdoor plants should be dusted with a fungicide before they are replanted. Some examples include snake plant, iris, prayer plant and day lilies.

Grafting
Grafting and budding are methods of asexual plant propagation that join plant parts so they will grow as one plant. These techniques are used to propagate cultivars that will not root well as cuttings or whose own root systems are inadequate. One or more new cultivars can be added to existing fruit and nut trees by grafting or budding.

The portion of the cultivar that is to be propagated is called the scion. It consists of a piece of shoot with dormant buds that will produce the stem and branches. The rootstock, or stock, provides the new plant’s root system and sometimes the lower part of the stem. The cambium is a layer of cells located between the wood and bark of a stem from which new bark and wood cells originate.

Four conditions must be met for grafting to be successful: the scion and the rootstock must be compatible, both the scion and the rootstock must be at the proper physiological stage, the cambial layers of the scion and the rootstock must meet, and the graft union must be kept moist until the wound has healed.

Cleft Grafting
Cleft grafting is often used to change the cultivar or top growth of a shoot or a young tree—usually a seedling. It is especially successful if done in the early spring. Collect scion wood 3/8 to 5/8 inches in diameter. Cut the limb or small tree trunk perpendicular to its length. Make a 2-inch vertical cut through the center of the previous cut. Be careful not to tear the bark. Keep this cut wedged apart. Cut the lower end of each scion piece into a wedge. Prepare two scion pieces 3 to 4 inches long. Insert the scions at the outer edges of the cut in the stock. Tilt the top of the scion slightly outward and the bottom slightly inward to be sure the cambial layers of the scion and stock touch. Remove the wedge propping the slit open and cover all cut surfaces with grafting wax.

Bark Grafting
Unlike most grafting methods, bark grafting can be used on large limbs—although these are often infected before the wound can completely heal. To do a bark graft, collect scion wood 3/8 to ½ inch in diameter when the plant is dormant. Store the wood wrapped in moist paper in a plastic bag in the refrigerator. Saw off the limb or trunk of the rootstock at a right angle to itself. In the spring when the bark is easy to separate from the wood, make a ½ inch diagonal cut on one side of the scion and a 1½-inch diagonal cut on the other side. Leave two buds above the longer cut. Cut through the bark of the stock a little wider than the scion. Remove the top third of the bark from this cut. Insert the scion with the longer cut against the wood. Nail the graft in place with flat-headed wire nails. Cover all wounds with grafting wax.

Whip or Tongue Grafting
This method is often used for material ¼ to ½ inch in diameter. The scion and rootstock are usually of the same diameter, but the scion may be narrower than the stock. This strong graft heals quickly and provides excellent cambial contact. Make one 2½-inch-long sloping cut at the top of the rootstock and a matching cut on the bottom of the scion. On the cut surface, slice downward into the stock and up into the scion so the pieces will interlock. Fit the pieces together, then tie and wax the union.
Care of the Graft
Very little success in grafting will be obtained unless proper care is maintained for the year or two following the graft. If a binding material, such as strong cord or nursery tape, is used on the graft, it must be cut shortly after growth starts. This will help prevent girdling and death of the graft. Also, grafts should be inspected after a 2- to 3-week period to see if the wax has cracked. If necessary, exposed areas can be re-waxed. After this, the union will probably be strong enough and no more waxing will be necessary.

Limbs of the old variety that are not selected for grafting should be cut back at the time of grafting. The total leaf surface of the old variety should be gradually reduced as the leaves of the new variety increases. However, all of the limbs of the old variety should not be removed at the time of grafting because this will increase the shock to the tree and cause excessive suckering. Also, the scions may grow too fast, making them susceptible to wind damage. The new variety should take over in about 1 to 2 years.

Budding
Budding, or bud grafting, is the union of one bud and a small piece of bark from the scion with a rootstock. It is especially useful when scion material is limited. It is also faster and forms a stronger union than grafting.

Patch Budding
Plants with thick bark should be patch budded. This is done while the plants are actively growing so their bark slips easily. Remove a rectangular piece of bark from the rootstock. Cover this wound with a bud and a matching piece of bark from the scion. If the rootstock’s bark is thicker than that of the scion, pare it down to meet the thinner bark so that when the union is wrapped, the patch will be held firmly in place.

Chip Budding
This budding method can be used when the bark is not slipping. Slice downward into the rootstock at a 45-degree angle through ¼ of the wood. Make a second cut upward from the first cut, about one inch. Remove a bud, an attending chip of bark and wood from the scion. Shape this so that it fits the rootstock wound. Fit the bud chip to the stock and wrap the union.

T-Budding
This is the most commonly used budding technique. When the bark is slipping, make a vertical cut that is the same axis as the rootstock through the bark of the rootstock, avoiding any buds on the stock. Make a horizontal cut at the top of the vertical cut—making a T shape— and loosen the bark by twisting the knife at the intersection. Remove a shield-shaped piece of the scion including a bud, some bark and a thin section of wood. Push the shield under the loosened stock bark. Wrap the union, leaving the bud exposed.

Rubber Budding Strips
Using rubber budding strips for grafting has some advantages over other materials. They expand with growth, they usually do not need to be cut as they deteriorate, and they break after a short time.

Care of Buds
The bud should be placed in the stock storage in August. For the bud to develop the following spring, the stock should be cut 3 to 4 inches above the bud. The new shoot may be tied to the resulting stub to prevent damage from the wind. After the shoot has made a strong union with the stock, the stub should be cut close to the budded area.

Plant Tissue Culture for the Home
Although technical procedures for aseptic culture of plant cells, tissues and organs are as diverse as the plant material on which they are practiced, a simplified general procedure can be followed in the home. All that is needed are a few basic supplies that can easily be obtained at the local grocery store. The procedures outlined below can be used in the home to propagate various species of plants that are either easy or difficult to propagate.
Medium Preparation

- 1/8 cup sugar
- 1 tsp all-purpose soluble fertilizer mixture, check the label to make sure that it has all of the major and minor elements, especially ammonium nitrate. If the latter is lacking, add 1/3 tsp. of a 35-0-0 soluble fertilizer
- 1 (100 mg) tablet of inositol (myo-inositol), this can be obtained at most health food stores
- 1/4 of a pulverized vitamin tablet with 1 to 2 mg of thiamine
- 4 Tbsp. coconut milk (cytokinin source) drained from a fresh coconut
- 3 to 4 grains (1/400 tsp.) of a commercial rooting compound that has 0.1 active ingredient IBA
- Distilled or de-ionized water

Mix the first six ingredients into a 1-quart home canning jar. Fill up the jar with distilled or de-ionized water. If purified water is not available, water that has been boiled for several minutes can be substituted. Shake the mixture and make sure all materials have dissolved. This will make 2 pints of medium.

Choosing a Culture Jar

Baby food jars with lids, or other heat resistant glass receptacles with lids can be used as individual culture jars. They should be half filled with cotton or paper to support the plant material. The medium should be poured into each culture bottle to the point where the support material is just above the solution.

Sterilization

Once the growing medium is sterilized and cooled, plant material can be prepared for culture. Because plants usually harbor bacterial and fungal spores, they must be disinfested before placement on the sterile medium. Otherwise, bacteria and fungi may grow faster than the plants and dominate the culture.

To disinfect a plant, leaves attached to the tip can be removed and discarded. Then, all remaining plant tissue can be submerged into a solution of 1 part commercial bleach to 9 parts water for 8 to 10 minutes. Next, excess bleach can be rinsed off by dropping the plant tissue into sterile water. Once the plant material has been in the bleach, it has been disinfested and should only be touched with sterile tweezers.

After the plant material has been rinsed, any bleach-damaged tissue can be removed with a sterile razor blade. Next, the cap of a culture bottle containing sterile medium can be removed and the plant part can be placed onto the support material in the bottle. Finally, the container should be quickly recapped.

Culturing Plants

Various plant parts can be cultured, but small, actively growing portions usually result in the most vigorous plantlets. For example, using only a ½ inch of the tip of a rhizome most readily propagates ferns. For other species, ½ to 1 inch of the shoot tip is sufficient.

Plant Disinfestation and Culture

Once the growing medium is sterilized and cooled, plant material can be prepared for culture. Because plants usually harbor bacterial and fungal spores, they must be disinfested before placement on the sterile medium. Otherwise, bacteria and fungi may grow faster than the plants and dominate the culture.

After all plants have been cultured, they should be placed in a warm, well-lit environment to encourage growth. However, plants should not be placed in direct sunlight. If contamination of the medium has occurred, it

water, tweezers and razor blades, which will be needed later, can be prepared in the same manner.
should be obvious within 3 to 4 days. Contaminated culture bottles should be removed and washed as quickly as possible to prevent the spread to uncontaminated cultures.

When plantlets have grown to sufficient size, they should be transplanted into soil. The plantlets should be handled as gently as possible because the plants are leaving a warm, humid environment and entering a cool, dry one. After transplanting, the plants should be thoroughly watered and placed in a clear plastic bag for several days. Gradually, the bag should be removed to acclimate the plants to their new environment. This is done by removing the bag one hour per day and gradually increasing the time out of the bag over a two week period until the plants are strong enough to dispense with the bag altogether.
<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Methods of Propagation</th>
<th>Time Period</th>
<th>Comments/Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achillea spp.</td>
<td>Yarrow</td>
<td>S</td>
<td>Late Spring</td>
<td>Sometimes produce inferior plants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SC</td>
<td>Mid-summer</td>
<td>Divide mature plants every 3-4 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Fall or Spring</td>
<td></td>
</tr>
<tr>
<td>Agapanthus spp.</td>
<td>Lily-of-the-Nile</td>
<td>D</td>
<td>Fall or Spring</td>
<td>Thick rhizomes can be divided</td>
</tr>
<tr>
<td>Aquilegia spp.</td>
<td>Columbine</td>
<td>S</td>
<td>Early Spring</td>
<td>Respond to chilling period of 3-4 weeks</td>
</tr>
<tr>
<td>Astilbe spp.</td>
<td>Astilbe</td>
<td>D</td>
<td>Early Spring</td>
<td>Seed germination can take up to 16 weeks</td>
</tr>
<tr>
<td>Begonia spp.</td>
<td>Wax Begonia</td>
<td>S</td>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tuberous Begonia</td>
<td>SC/LC</td>
<td>Indoors anytime</td>
<td>Readily rots if stem, leaf and leaf bud are attached.</td>
</tr>
<tr>
<td></td>
<td>Fibrous-Rooted Begonia</td>
<td>SC</td>
<td>Spring or Summer</td>
<td>Softwood cutting taken form young shoots</td>
</tr>
<tr>
<td>Canna spp.</td>
<td>Canna</td>
<td>D</td>
<td>Fall or Winter</td>
<td>Cultivars do not come true from seed, divide when shoots die down to the ground</td>
</tr>
<tr>
<td>Cleome spinosa</td>
<td>Spiderflower</td>
<td>S</td>
<td>Summer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Late Summer</td>
<td></td>
</tr>
<tr>
<td>Digitalis spp.</td>
<td>Foxglove</td>
<td>S</td>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td>Gaillardia spp.</td>
<td>Blanketflower</td>
<td>S</td>
<td>Spring</td>
<td>Seeds will bloom the following year</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RC</td>
<td>Spring or Fall</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Spring or Fall</td>
<td></td>
</tr>
<tr>
<td>Helleborous spp.</td>
<td>Hellebore or Christmas Rose</td>
<td>S</td>
<td>Spring</td>
<td>Seed may take up to 2 years to germinate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Spring</td>
<td>Careful separating crown, roots and leaves are poisonous.</td>
</tr>
<tr>
<td>Hemerocallis spp.</td>
<td>Daylily</td>
<td>S</td>
<td>Summer</td>
<td>Used to develop new cultivars</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Fall or Spring</td>
<td>Separate roots sections to have 3-4 offshoots.</td>
</tr>
<tr>
<td>Heuchera spp.</td>
<td>Coralbells</td>
<td>S</td>
<td>Spring</td>
<td>Germinate in 3-4 weeks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Spring of Fall</td>
<td>Need to maintain humidity best done in a greenhouse</td>
</tr>
</tbody>
</table>
Table 1. Propagation of Select Ornamental Herbaceous Perennials (continued)

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Methods of Propagation</th>
<th>Time Period</th>
<th>Comments/Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hosta spp.</td>
<td>Hosta</td>
<td>D</td>
<td>Spring</td>
<td>Clump division of the crown (divide in quarters)</td>
</tr>
<tr>
<td>Iberis spp.</td>
<td>Candytuft</td>
<td>S</td>
<td>Spring</td>
<td>Root soft wood cuttings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RC</td>
<td>Summer</td>
<td>Divide after bloom, discard older portion of rhizome, only keep vigorous side shoots. Trim leaves to 6 inches</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Fall</td>
<td></td>
</tr>
<tr>
<td>Iris spp.</td>
<td>Iris</td>
<td>RC</td>
<td>Late Spring, Early Summer</td>
<td>Plant as soon as ripened after a moist chilling period, germination may be slow and depend on species</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S</td>
<td>Summer</td>
<td></td>
</tr>
<tr>
<td>Lavandula spp.</td>
<td>Lavender</td>
<td>S</td>
<td>Winter, indoors</td>
<td>Take cutting from side shoots</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SC</td>
<td>Summer or Fall</td>
<td>Lay side shoot on soil and hold in place weigh</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>Summer or Fall</td>
<td></td>
</tr>
<tr>
<td>Nymphaea spp.</td>
<td>Water lily</td>
<td>D</td>
<td>Spring</td>
<td>Clumps of rhizomes are divided in Spring</td>
</tr>
<tr>
<td>Pelargonium x hortorum</td>
<td>Geranium</td>
<td>S</td>
<td>Winter, indoors</td>
<td>Use clean stock, cuttings are susceptible to root diseases</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SC</td>
<td>Summer</td>
<td></td>
</tr>
<tr>
<td>Pennisetum spp.</td>
<td>Fountain Grass</td>
<td>D</td>
<td>Fall or Winter</td>
<td>Divide clumps</td>
</tr>
<tr>
<td>Phlox paniculata</td>
<td>Garden phlox</td>
<td>SC</td>
<td>Spring or Summer</td>
<td>Softwood cuttings root easily but are susceptible to root diseases</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RC</td>
<td>Fall</td>
<td>Dig crown and cut roots into 2” lengths and place in sandy flats to be planted next Spring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Fall</td>
<td>Divide clumps</td>
</tr>
<tr>
<td>Rudbeckia spp.</td>
<td>Black-eyed Susan</td>
<td>S</td>
<td>Spring</td>
<td>2-3 weeks to germinate, will reseed naturally</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Fall</td>
<td>Divide clump</td>
</tr>
<tr>
<td>Salvia spp.</td>
<td>Sage</td>
<td>S</td>
<td>Spring Indoors</td>
<td>May benefit form some hormone (IBA) on semi-hardwood cuttings taken in the fall</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SC</td>
<td>Spring or Fall</td>
<td></td>
</tr>
<tr>
<td>Thymus spp.</td>
<td>Thyme</td>
<td>S</td>
<td>Spring</td>
<td>2 weeks to germinate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Summer</td>
<td>Softwood cuttings</td>
</tr>
</tbody>
</table>
### Table 1. Propagation of Select Ornamental Herbaceous Perennials (continued)

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<tr>
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<th>Methods of Propagation</th>
<th>Time Period</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Verbena canadensis</td>
<td>Clump Verbena</td>
<td>S</td>
<td>Spring Summer</td>
<td>2-4 weeks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Summer</td>
<td>Divide clump</td>
</tr>
<tr>
<td>Veronica spp.</td>
<td>Speedwell</td>
<td>S</td>
<td>Spring</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SC</td>
<td>Spring or Summer</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Spring or Fall</td>
<td>Divide clump</td>
</tr>
</tbody>
</table>

S = Seed  
SC = Stem Cutting  
LC = Leaf Cutting  
D = Division  
TC = Tissue Culture or Micropropagation

### Table 2. Propagation of Select Ornamental Woody Plants

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Methods of Propagation</th>
<th>Time Period</th>
<th>Comments/Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abelia x grandiflora</td>
<td>Glossy Abelia</td>
<td>SH</td>
<td>Summer and Fall</td>
<td>May require mist irrigation</td>
</tr>
<tr>
<td>Acer spp.</td>
<td>Maple</td>
<td>S</td>
<td>Fall or Spring</td>
<td>Gather seeds promptly before drying, some seeds may require soaking before planting. Pencil sized cutting (Japanese maple and sugar maple) may need IBA.</td>
</tr>
<tr>
<td>Buxus spp.</td>
<td>Boxwood</td>
<td>SW</td>
<td>Spring or Summer</td>
<td>Mist in shaded poly frame</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SH</td>
<td>Fall</td>
<td>Cuttings are rooted in a poly frame</td>
</tr>
<tr>
<td>Buddleia</td>
<td>Butterfly Bush</td>
<td>SW, L</td>
<td>Summer or Fall</td>
<td>Place under mist or in high humidity</td>
</tr>
<tr>
<td>Calycanthus spp.</td>
<td>Sweetshrub</td>
<td>S</td>
<td>Summer</td>
<td>Collect seeds when they turn from green to brown and stratify for 3 months</td>
</tr>
<tr>
<td>Chamaecyparis spp.</td>
<td>False Cypress</td>
<td>SH</td>
<td>Fall</td>
<td>Cuttings are difficult to root and may require IBA</td>
</tr>
<tr>
<td>Clematis spp.</td>
<td>Clematis</td>
<td>S</td>
<td>Spring</td>
<td>40 degree stratification may help</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SW</td>
<td>Spring</td>
<td>Choose cutting with short internodes and place under mist</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SH</td>
<td>Spring</td>
<td>Use IBA</td>
</tr>
<tr>
<td>Cotoneaster spp.</td>
<td>Cotonester</td>
<td>SW</td>
<td>Spring and Summer</td>
<td>Use IBA</td>
</tr>
<tr>
<td>Scientific Name</td>
<td>Common Name</td>
<td>Methods of Propagation</td>
<td>Time Period</td>
<td>Comments/Requirements</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------</td>
<td>------------------------</td>
<td>----------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><em>Cornus</em> spp.</td>
<td>Dogwood</td>
<td>S</td>
<td>Fall</td>
<td>Gather as seeds start to turn red and stratification 4 months at 40 degrees (outdoors)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>Summer</td>
<td>Wound one side of the stem and treat with IBA place under mist</td>
</tr>
<tr>
<td><em>Forsythia</em> spp.</td>
<td>Forsythia</td>
<td>H</td>
<td>Early Spring</td>
<td>Place under mist</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SW</td>
<td>Late Spring</td>
<td>Place under mist</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>Anytime</td>
<td>Lay branch and wound where soil contact is made</td>
</tr>
<tr>
<td><em>Hydrangea</em> spp.</td>
<td>Hydrangea</td>
<td>SW, SH, H</td>
<td>Spring and Summer</td>
<td>Easily root, may add some IBA Oak Leaf Hydrangea may need more mist and IBA</td>
</tr>
<tr>
<td><em>Juniper</em> spp.</td>
<td>Juniper</td>
<td>H</td>
<td>Fall</td>
<td>Take terminal cuttings form this year's growth. Upright species are more difficult than prostrate.</td>
</tr>
<tr>
<td><em>Lagerstroemia</em> spp.</td>
<td>Crape Myrtle</td>
<td>SW</td>
<td>Summer or Fall</td>
<td>Use IBA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>Winter</td>
<td>Gather after first frost, use IBA</td>
</tr>
<tr>
<td><em>Lonicera</em> spp.</td>
<td>Honey Suckle Vine</td>
<td>H</td>
<td>Spring or Summer</td>
<td>Place in moist soil</td>
</tr>
<tr>
<td><em>Magnolia</em> spp.</td>
<td>Magnolia</td>
<td>S</td>
<td>Fall</td>
<td>Gather as soon as fruit is ripe, clean and plant immediately</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SH</td>
<td>Late Spring or Late Summer</td>
<td>Wound base before sticking in course sand</td>
</tr>
<tr>
<td><em>Mahonia</em> spp.</td>
<td>Grape Holly</td>
<td>S</td>
<td>Summer</td>
<td>Separate seed form pulp and stratify for 3 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>Fall or Winter</td>
<td>Difficult to propagate use IBA</td>
</tr>
<tr>
<td><em>Rhododendron</em> spp.</td>
<td>Rhododendron and Azalea</td>
<td>RC</td>
<td>Mid Summer or Fall</td>
<td>Plant roots in similar soil to parent plant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SH</td>
<td>Mid Winter</td>
<td>Use IBA and place in a well drained soil (1 peat:1 perlite)</td>
</tr>
<tr>
<td><em>Rose</em> spp.</td>
<td>Rose</td>
<td>SW</td>
<td>Early Spring</td>
<td>Current seasons growth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>Late Fall or Early Winter</td>
<td>Place in sand and allow healing, plant in spring.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>Anytime</td>
<td>Wound stem that comes in contact with soil</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S</td>
<td>Summer</td>
<td>For breeding, requires stratification</td>
</tr>
<tr>
<td>Scientific Name</td>
<td>Common Name</td>
<td>Methods of Propagation</td>
<td>Time Period</td>
<td>Comments/Requirements</td>
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<tr>
<td>----------------------</td>
<td>-------------</td>
<td>------------------------</td>
<td>--------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>Rosmarinus</td>
<td>Rosemary</td>
<td>SW</td>
<td>Summer</td>
<td>Under mist</td>
</tr>
<tr>
<td>Spiraea spp.</td>
<td>Spirea</td>
<td>SW HW</td>
<td>Mid Summer, Early Spring</td>
<td>Use IBA, Use IBA</td>
</tr>
<tr>
<td>Thuja spp.</td>
<td>Arborvitae</td>
<td>HW</td>
<td>Mid winter or Mid Summer</td>
<td>Winter: 6 inches of succulent terminal growth placed under mist</td>
</tr>
<tr>
<td>Viburnum spp.</td>
<td>Viburnum</td>
<td>H SW</td>
<td>Mid Summer, Late Spring</td>
<td>Place in sand or perlite, Using IBA, Place in sand or perlite, use IBA</td>
</tr>
</tbody>
</table>

* S = Seed
* SC = Stem Cutting
* LC = Leaf Cutting
* L = Layering
* RC = Root Cutting
* D = Division
* TC = Tissue Culture or Micropropagation
Summary
Plant propagation is challenging and can be quite rewarding. Knowledge from science and experience can be used to create or reproduce desired plants. There are few things as rewarding as tending to plants that would not live or thrive without a gardener’s hands.

Terms To Know
Dormancy
Embryo
Endosperm
Fronds
Gametophyte
Germinate
Hardening
Layering
Medium
Peat moss
Pregeneration
Propagation
Scarification
Scion
Seed Tape
Sexual propagation
Sphagnum moss
Spores
Sporophytes
Stratification
Vermiculite

Test Your Knowledge
1. What are the advantages of asexual propagation?
2. What are the three parts of a seed?
3. What are the environmental factors and internal factors that affect germination?
4. Briefly describe the difference between ending seed dormancy via scarification and stratification?
5. After growing plants in medium, how should one transplant the plantlets that have grown to sufficient size?

Resources
Alan Toogood. American Horticultural Society
Plant Propagation: The Fully Illustrated
Plant-by-plant Manual of Practical
Geoff Bryant. Plant Propagation A to Z:
2003.
Dirr and Heuser. The Reference Manual of
Woody Plant Propagation: From Tissue to
University of Tennessee Gardens
utgardens.tennessee.edu
University of Vermont Extension
pss.uvm.edu/ppp/proptabA.htm
University of North Carolina Extension
ces.ncsu.edu/depts/hort/hil/hil-8702.html