Rodale's Encyclopedia of Indoor Gardening

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VEGETATIVE PROPAGATION

Sexual propagation (seeds or spores) produces offspring with varying characteristics. But in asexual propagation the parent plant is duplicated exactly. Asexual or vegetative propagation occurs naturally and has been of immense importance in horticulture. Many plants in the wild reproduce asexually from vegetative parts. Roots growing and creeping underground on an aloe *(Aloe barbadensis)* produce buds (suckers) which grow into new plants. Branches of blackberry bend down to the ground in the autumn and grow roots where they touch the soil, forming separate plants. Boston ferns and airplane plants send out runners which establish new plants at their tips. *Cereus,* a cactus, will drop some of its branches to the ground, and these will root when the growing conditions are favorable. The fallen leaves of the succulent jade plant *(Crassula argentea)* form tiny shoots and roots when they touch the ground. All of these new plants are separate individuals, but are genetically identical to the original plant.

The foregoing natural methods of vegetative propagation have been exploited by horticulturists as ways of circumventing the disadvantages of seed propagation. Seedlings may take too long to grow into mature plants, or the genetics of a plant may be too complicated to produce hybrid seeds. Seeds from some plants are slow to germinate or germinate over a long period of time, making the regular and uniform production of such plants very costly and difficult. Besides, it often requires as long as five to eight years to create a worthwhile hybrid line. So when uniformity of plant material is necessary and seed propagation is not practical, horticulturists turn to vegetative methods of propagation. Commercial growers often do likewise to produce large numbers of uniform plants to sell.

The word clone is used to describe a group of individual plants which are genetically identical, being propagated vegetatively from a particular selected plant and its vegetatively propagated offspring. Roses, florists' chrysanthemums, fruit trees, grapes, foliage plants, and many species of trees are often cloned and propagated exclusively by asexual means. Most of the plants you grow indoors probably have been propagated this way, and you can learn how to multiply your plants using many techniques of vegetative propagation.

UNDERSTANDING PLANT GROWTH AND DEVELOPMENT

In order to use asexual propagation techniques most effectively, it will be helpful to understand how plants grow. Plants increase in size in two ways, either by producing more cells (cell division) or by enlarging existing cells (cell elongation and enlargement). Most

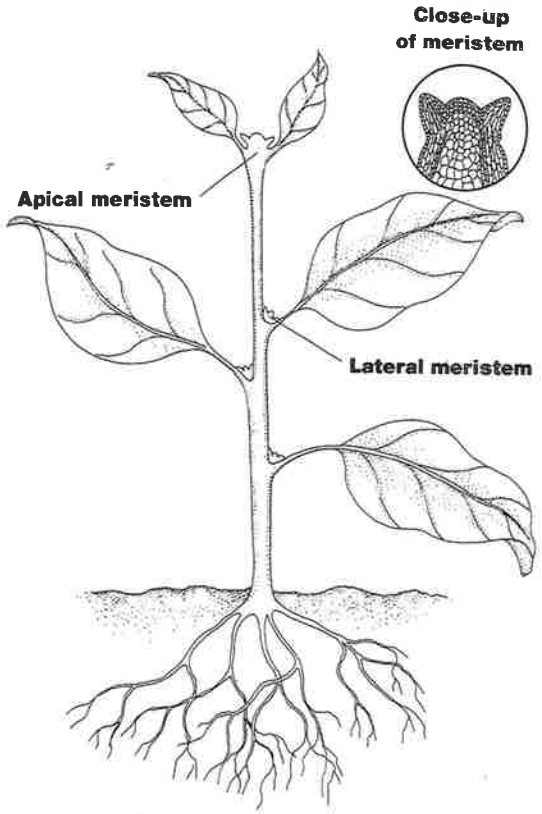
cell division occurs in meristematic cells. Groups of these — called meristems — are located in several places in the body of a plant.

Cells located at the tip of each stem and branch are constantly and rapidly dividing to form the new leaf and stem cells. These groups of specialized cells, called apical meristems, also produce auxin, a plant hormone. Auxin travels down the stem and influences how the rest of the plant grows. Lateral meristems are present in the dormant buds located in the axil of each leaf. These are identical to apical meristems except that they are dormant and will not become active and divide until they receive the proper hormonal signal. It is the auxin produced by the apical meristem which keeps the lateral meristems dormant, but when the apical meristem is removed (by pinching back the plant, for instance) the cessation of auxin flow allows the dormant lateral buds to "break" and grow into new branches and leaves.

Meristems also are present at the tips of each root, and divide and elongate to produce longer roots. The cambium is a group of meristematic cells located in the stem which divides to produce more cells which add to the girth of the stem.

Vegetative propagation of a plant usually is most successful if the piece of plant being used for propagation contains some meristematic cells. When you are rooting a cutting, the apical meristem gives rise to the new shoot and leaves. Less specialized cells (called parenchymal cells) from other parts of the plant undergo a change which causes them to become similar to meristem tissue, and these cells then begin dividing to form root tissue.

The cutting grows into an identical plant because it still has the same genes that the original plant had. The genes inside each cell function rather like blueprints, for they carry all the genetic information necessary to make a complete plant. Each cell retains that total information throughout the life of the plant,



Meristems Responsible for Plant Growth: During the course of normal growth, the apical meristems at stem and branch tips are responsible for the formation of new leaves and the lengthening of stems. The lateral meristems, found in dormant buds nestled in leaf axils, have the same capability as apical meristems, but need a special hormonal signal to trigger their action. When you pinch the growing tip of a plant, this sets up the proper signal, causing the lateral buds to burst forth with new leaves and branches. Inset shows the grouping of cells in a meristem; the rapid cellular division, invisible to the naked eye, accounts for the readily visible signs of plant growth.

regardless of whether that cell is present in a leaf, a flower, or a root. In a leaf cell, for instance, every gene necessary to make a complete plant is present but only those needed to make that cell a leaf cell are active; other genes are turned off. When we propagate that leaf by removing it from the plant and placing it in moist sand, some genes previously

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turned off will be reactivated to supply the information for cells to make new shoots and roots.

Since every cell in a plant has the blueprints for an entire plant, it is theoretically possible to propagate a plant from just a single cell. Scientists have actually done this with a few plant species using a method called tissue culture. Tissue culture requires a sterilized blend of the nutrients, hormones, and vitamins necessary for plant growth. A form of cloning, tissue culture has been a great benefit to scientists who study plant growth, but it is also an exciting way to propagate plants commercially. In recent years, many nurseries have set up tissue culture laboratories to propagate orchids, Boston ferns, African violets, gerberas, philodendrons, strawberry begonias, and other foliage plants. (See Visit to a Brave New World for a closer look at one such commercial operation.)

Recent breakthroughs in cell biology suggest that in the future tissue culture will be the basis for a revolution in plant breeding. Researchers have discovered that individual cells not only can regenerate whole plants, but with the help of certain biochemicals they can be fused first so the resulting plant is a genetically new one. Evolved through the pioneering work of Dr. Peter Carlson, who teaches at Michigan State University, the techniques of cell fusion are seen as the key to overcoming the natural incompatibility that has so far limited the varieties of plants obtainable through hybridization.

GENERAL NEEDS OF PLANTS BEING PROPAGATED VEGETATIVELY

House plants are most frequently propagated by cutting off and rooting small vegetative portions of the plant. Whether you are propagating a leaf cutting from a rex begonia *(Begonia ×rex-cultorum),* a softwood stem cutting from an English ivy *(Hedera helix),* or a sucker from a cast-iron plant *(Aspidistra elatior),* the severed part of the plant undergoes a shock because its supply of water and nutrients suddenly has been removed. You must nurse these cuttings through that shock by providing high humidity until complete plants are formed again. Many cuttings also benefit from or require light and extra warmth. Regardless of the plant part you are propagating, the methods you will be using to provide these essentials will be the same.

HUMIDITY

It may take some cuttings many weeks to regenerate new roots. Until that time, you must keep the atmosphere very humid to prevent dehydration of the plant until it can absorb water through its new root system. You can help by watering stock plants especially well about a day before taking cuttings. This will assure that cuttings are filled with water when severed from the parent plant. To keep cuttings from losing this water through transpiration (the natural loss of a plant's internal water through its stomates, or pores), raise the humidity around them immediately and maintain it at a high level. Commercial greenhouse growers usually propagate cuttings under conditions of 100 percent humidity by using intermittent misting systems. Cuttings are rooted in benches with water pipes running overhead or rising vertically in the form of towers several feet or meters high. This piping is fitted with fine spray nozzles, often controlled by automatic timers. The cuttings are sprayed for several seconds every few minutes (exact intervals are determined by solar radiation and ambient humidity) to keep a film of water on the surface of the leaves. This water film acts to slow transpiration, keeping the cutting turgid and fresh until roots are formed.

If you have a greenhouse, you may be able to design an automatic misting system similar to those used commercially by pur-

chasing the specialized pipes and nozzles. Or you can build your own mist chamber, as described in chapter 29. But even without elaborate equipment, there are easy ways to supply ample humidity for cuttings.

The most common method is to enclose the propagating container. This assures 100 percent humidity inside, but can increase disease problems due to lack of fresh air. Plastic bags or sheets are excellent for enclosing propagating containers. (Polyethylene or polypropylene is best since either of these plastics is permeable to the respiration gases, oxygen and carbon dioxide.) One plastic sandwich bag will cover a single pot and a single cutting, while glass plates are more convenient for flats of small cuttings. See Build Your Own Propagation Bed, earlier in this chapter, for instructions on how to construct a plastic-covered bed.

PROPAGATION CONTAINERS

You will not need anything fancy or special in which to propagate your cuttings as long as the unit can be enclosed to keep in moisture. Individual cuttings may be rooted in small clay or plastic pots, or you may recycle yogurt or cottage cheese containers and Styrofoam cups, punching holes in the bottoms for drainage. Groups of cuttings may be placed in plastic shoe or bread boxes and you can punch drainage holes in these with a heated ice pick. Pyrex casserole dishes or fish tanks are also useful, but since these provide no drainage, you will need to take care with the watering can to avoid overwatering your young plants.

Place the individual pots inside plastic bags and tie each one shut. The plastic should not touch the leaves, for beads of water will form on the inside of the plastic and rot any plant parts that come in contact with them. You may find it useful to use one or more plant labels or pencils as supports to keep the plastic away from the plant.

The drops of water you see forming on the inside of the plastic cover indicate that there is enough water inside to keep the atmosphere at 100 percent humidity. But you do not want this moisture to be excessive, and a little fresh air is important, too. A few holes punched in the plastic will solve both problems. As long as there are small water beads forming on the plastic, the cuttings are moist enough. When the little droplets are no longer visible on the cover, add water to the growing medium. To help new plants under plastic make a gradual adjustment to less humid conditions, keep a pin nearby and perforate the bag once or twice several times a day when you are passing by. In a week or two the cover will be ragged and the plant beneath will have adjusted to the surrounding environment.

If you are using a hard plastic container as a propagating box, you can punch holes in the top with a heated ice pick to provide air. Or you can tilt the lid slightly to create a crack for air. Casserole dishes and glass-covered fish tanks should have their lids tipped a little, too, to allow some air movement. You can regulate the air exchange by the size of the opening you leave. Always try to keep a film of small water beads on the surface of the top, opening it a bit more if the beads look very large and closing it and watering if they fail to appear at all.

For another ready-made propagating case, consider using one of the glass or plastic domes made to keep baked goods or cheese moist and fresh. A cover large enough to fit over a three-layer cake can accommodate 30 cuttings housed in two-inch (5 cm) pots. Prop up the lid slightly for aeration as needed.

Be sure to provide a layer of gravel for drainage inside a fish tank or other container with no holes in the bottom. Since the sides of the glass containers are clear, you can prevent overwatering if you closely observe the propagating medium through the sides.

A wooden or plastic flat also makes a good propagating container, but trying to enclose it may pose an obstacle. You can always

make the plastic-covered wooden frame described earlier, or a sheet of plastic alone may be used successfully as a cover if you construct supports for it (see Build Your Own Plastic-Enclosed Flat for directions).

PROPAGATION MEDIA

Even though the cut surface of the cutting can absorb only a small amount of water until roots form, a good propagating medium still should hold lots of water. It is the water evaporating from the propagating medium that keeps the humidity high around the cutting. A good propagating medium also should hold lots of air, since oxygen is needed for the conversion of the plant's sugar into the energy needed to grow new roots. It may seem impossible for a medium to hold large quantities of both water and air, but there are simple ways you can create such a medium for your cuttings.

Perlite is a very lightweight substance containing many pores that provide excellent water-holding capacity. Because it will not compact, the spaces between the particles have a good air-holding capacity. Vermiculite, another man-made mineral product, is also lightweight but tends to compact. Sand, which also provides adequate aeration, has fewer water-holding pores than either perlite or vermiculite. All three substances often are used alone for propagating plants. Because they provide no nutrients, a cutting should not be left in them after roots begin to form.

Peat or sphagnum moss occasionally are used alone for rooting cuttings. These materials have a tremendous capacity for holding water, but they also have a tendency to compact, depriving the plant of air. Peat and sphagnum are also notorious for being difficult to wet when dry. It takes about 24 hours for these products to thoroughly absorb water, so wet them the day before you plan to use them. Though peat and sphagnum are plant products, they are low in nutrients because they are only partly decomposed. Both are highly acidic, which is a deterrent to damping-off, and sphagnum has a natural ability to inhibit the growth of bacteria and fungi. This fungistatic quality makes it especially useful in combating rot problems in the rooting medium. Rotting can occur in overwatered media at higher temperatures, and afflicted cuttings develop blackening of the stem.

Using soil alone for a propagating medium is a poor choice. Soil will compact and remain soggy after watering. There are few air spaces and the cuttings are very prone to rot. Although soil will supply nutrients, nutrients are not really necessary for rooting. However, cuttings should be transplanted out of a soilless propagating medium as quickly as possible after they root.

Often a mixture of various ingredients is made for propagating plants. A blend that contains one part each of peat, perlite or vermiculite, and soil will offer the positive qualities of each and minimize the negative ones. The soil is necessary only if cuttings will be left in the propagating mixture after they have rooted, as it will keep them from starving from lack of nutrients. If you plan to pot up cuttings as soon as they are rooted, you may use a half-and-half mixture of peat and perlite. Any combination you create with whatever ingredients are at hand will work if it drains quickly while still holding water. Be sure that you pasteurize any medium that includes soil or sand (see chapter 6 for instructions), and that you sterilize any containers that have held diseased or dead plants (directions are included under Sexual Propagation, earlier in this chapter). Use only healthy-looking cuttings, and cut them with tools sterilized in rubbing alcohol or in a solution of 9 parts water and 1 part household bleach.

ROOTING IN WATER

Sometimes the easiest way to root a cutting seems to be to drop it in a glass of water, ignore it, and be rewarded with roots in a few

weeks or a month. Though this method often works, it is rarely advisable. Most plants, even if they root in the water, are under a hardship when propagated this way. There is very little air in the water, so the cutting may be slow to root. And the roots that are formed are different from those formed in soil. They are coarse and less branched, have fewer root hairs, and are more brittle. When you transplant that cutting to soil, it undergoes another shock because its roots are not adapted to absorb water from soil.

However, if you are tempted occasionally to propagate plants this way, there are a few tricks to make success more likely. Let any tapwater you plan to use for cuttings sit for 24 hours so it reaches room temperature and the chlorine in it evaporates. From time to time change the water in which cuttings are rooting to give them more oxygen and forestall the growth of algae. To keep cuttings in water vigorous and to speed early rooting, you might try adding a pinch each of rooting hormone and house plant fertilizer. After you transplant the rooted cutting into soil, pinch it back if you want the plant to branch thickly. You also should cover the pot with a plastic bag for a week or so to give the cutting high humidity while finer roots are being formed. If a cutting started in water has developed a welter of tangled roots, you can improve its chances of surviving the transition to soil by adding a potting medium around the roots while they are floating freely underwater. Just place the pot you are going to use under water up to its rim and hold the cutting so its roots are positioned properly in the pot. Then slowly drop soil into the pot and let it settle around the spread-out roots. When the roots are well covered, remove the newly potted plant from the water and allow it to drain.

It is also helpful to keep the newly potted plant for at least two weeks in the same place where it rooted in water. That way it will not have to adjust to different levels of light and warmth right away.

A few plants will not suffer from being propagated in water and may even prosper if grown indefinitely in water and never potted in soil. You might find this true of arrowhead vine *(Syngonium podophyllum),* pothos *(Epipremnum aureum),* Chinese evergreen, and the familiar heart-leaf philodendron *(Philodendron scandens* subsp. *oxycardium)* — all of which can live in water, though they should be fed occasionally to thrive.

LIGHT

Light is necessary to keep cuttings healthy and producing the energy needed to grow new roots. Very bright but indirect sunlight is best. Direct sunlight must be avoided since the heat from the rays will be trapped inside the plastic or glass cover and literally cook the unfortunate cuttings. Fluorescent lights do not give off much heat and are ideal for use in propagating plants. If you place the cuttings six to ten inches (15 to 25 cm) away from the tubes you need not worry that they will be overheated.

Cuttings are often propagated in full sun in greenhouses where intermittent mist is used. The evaporation of water film on the leaves cools them so the full sunlight does not burn or overheat the cuttings. Rooting is faster in bright light, so intermittent mist is a great aid to a commercial grower, who is usually in a greater hurry than you are. If you are using an enclosed chamber or polyethylene tent in the greenhouse, you will have to place it under the bench or shade it with cheesecloth or the cuttings will overheat.

WARMTH

New cuttings are in a state of shock. They need warmth to stay healthy and aid in regenerating new roots. This may be the most difficult requirement to meet, since the ideal temperature is 70° to 75°F (21° to 24°C) and many of us do not keep our homes this warm. If you place your cuttings in a window where

they receive good light, they also may get cold drafts.

For rooting, the soil temperature is usually more important than the air temperature. Commercial plant propagators provide "bottom heat" for their cuttings by laying heating cables in the propagating medium, or by rooting the cuttings over steam heating pipes. Bottom heat which keeps the soil temperature at 70° to 75°F (21° to 24°C) can be provided at home by using heating cables with or without attached thermostats. These are sold at garden centers. If installed properly, a cable should maintain the promised temperature but a built-in thermostat can help. You also can buy specially heated mats, trays, and propagating boxes, but these often are not worth the money.

With a little electrical knowledge and mechanical skill, you can build your own wooden flat complete with bottom heat. Such a homemade unit is very practical and sturdy, and cheaper than those small plastic units sold by garden centers. You can build the flat described in Build Your Own Basic Flat, earlier in this chapter, and simply install a heating cable in the bottom of the flat before adding the propagation medium. If you do work with electrical heating cable, remember not to shorten it since the thickness and length of the wire were both precalculated to provide the proper heat. Be sure to purchase a cable that has a built-in, preset soil thermostat which maintains a uniform soil temperature.

Bottom heat provided by heating cables is reliable and accurate but expensive, since you will be drawing electricity 24 hours a day for several weeks. With a little imagination perhaps you can find free heat. For instance, you could locate your plastic-enclosed cuttings on a board on top of a radiator or near a hot air duct. Other warm spots are the top of the refrigerator or the top of the furnace or hot water heater. Some people place their cuttings on the top of a fluorescent lighting fixture, which transmits a suitably gentle warmth. Use a thermometer to precheck all these places, remembering that roots grow best from 63° to 77°F (17° to 25°C). And be sure to provide enough light.

WHAT YOU NEED TO KNOW ABOUT ROOTING HORMONES

Although you may want to use rooting hormones just to speed up rooting, you will find that they are actually necessary for certain cuttings to root at all. Hormone powders are available at garden centers or through seed catalogs and should be used judiciously. They come in varying strengths, some of which are good for most house plants, others of which are recommended for woody material that is harder to root.

Rooting hormones contain talc as a carrying agent, and one or two kinds of synthetic auxins, usually NAA (naphthalene acetic acid) and/or IBA (indolebutyric acid). The natural hormone equivalent is the auxin called IAA (indoleacetic acid). Nature designed IAA to be unstable in the presence of light and high temperatures as a natural way of controlling its activity. However, because of this instability, IAA is rarely included in rooting preparations.

NAA and IBA are more stable than IAA but begin to lose effectiveness after six to eight months. Purchase only small quantities at a time and store the powder in a tightly closed container in a refrigerator or other cool place.

To use the powders, remove a small portion from the container onto a dish or piece of paper. Dip the cut end of the cutting into the powder to a depth of two inches (5 cm) and tap off the excess. Do not let frugality influence you here; throw away any leftover powder, since the cutting has contaminated the hormone with moisture and bacteria which will speed up the compound's deterioration.

You may wish to experiment with a method used by old-time English gardeners, who would embed a germinating grain seed

in the base of a cutting as a rooting aid. A germinating seed contains a rich supply of auxins and will provide these to the cutting. Soak the grain seed and treat it just as you would if you were sprouting seeds for your salads or Chinese dishes. When it just begins to germinate, the proper time to use it has arrived. Push it gently into the bottom of a succulent cutting, or place it into a slit cut into the bottom of hard woody cuttings.

It is easy to tell when your cuttings are rooted and ready to be transplanted to their permanent homes. You will notice that new growth has begun on the top of the cutting. A slight tug on the cutting should meet with resistance at this time since roots will have formed before top growth resumed. Do not tug too vigorously, or you may injure delicate new roots.

Gently lift the cuttings from the propagating medium with a wooden plant label or spoon so as to avoid injuring roots. Choose a pot that is not too large for the small cutting or it may become waterlogged. Spread the roots apart gently and add soil appropriate for the plant. Give the pot a thump to settle the soil around the roots, and water. Watch the cutting carefully the first week or so for signs of stress such as wilting or yellowing. Provide extra humidity if wilting occurs.

Remember to label cuttings that can be easily confused, African violet leaf cuttings, for instance. Write the name of the plant on a square of masking tape and stick it around the stem of the cutting or on the pot.