

CUTTINGS - Anatomy

Cuttings are a relatively low-cost, low tech way of clonal plant production. Cuttings can be made from a large number of parts of the plant, main ones being stems, leaves and roots. Species of plants differ in the ability of different organs to form cuttings. The most widely used and most amenable organ used as a cutting is a shoot. In these cases roots form on shoots to produce a complete plant. In some plants leaves are the primary organ used as a cutting. Roots are first formed on leaves at the junction of the petiole and lamina. New shoots form either at this position (African violet) or on other parts of the lamina. These shoots must then form roots to produce a complete plant. The initial roots formed by the leaves are not connected to the new shoots. Other organs used for cuttings include roots, leaves with buds, and stems without leaves (but requiring buds). Specialized structures such as rhizomes can also be used as cuttings.

ROOT FORMATION

Concept of **adventitious** formation

Adventitious roots and shoots do not arise from the same organs on the original embryo axis. Thus non-adventitious shoots arise from axillary buds of the stem, and roots arise from the original radicle. When roots and shoots arise from any other source they are considered adventitious. In some cases such as corn, *Pandanus* etc. adventitious roots form naturally during development of the plant.

Major categories of root formation - preformed and wound

1. PREFORMED

A. In stem. Are latent or preformed **ROOT** initials that are present during stem formation. Preformed root initials lie dormant and develop under the proper environmental conditions. Examples include: salix (willow), hydrangea, poplar, jasmine,

currant. Often the roots initials are established at the end of the season in the present year's wood and will grow when the shoot is separated from the plant the following season. In some cases the shoot does not have to be separated and may root when the tree falls over.

B. In stem. Can also get preformed **SHOOT** initials. When these shoot grow they are termed 'water sprouts'. Water sprouts are originally lateral buds, NOT adventitious buds. They do not usually grow because they are inhibited by apical dominance. Anything that can disturb normal apical dominance can also cause the suckers to grow, such as topping of a plant, cutting back of shoots, disease of upper part of plant etc.

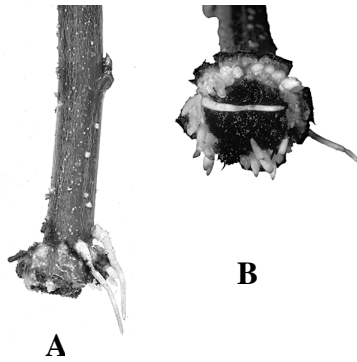
2. WOUND ROOTS

Wound roots are the major kind of adventitious roots that are formed to produce clonal plants for propagation. The shoot or root or leaf must be excised from the plant. At the wounded site on the cutting a series of steps occur in the formation of roots. Common to all wounded sites sealing off of the wound and production of suberized, protective cells are first produced. Callus then grows at the wound site. Callus is a natural growth of dedifferentiated cells. The use of hormones during adventitious rooting enhances the formation of callus in addition to inducing the formation of roots.

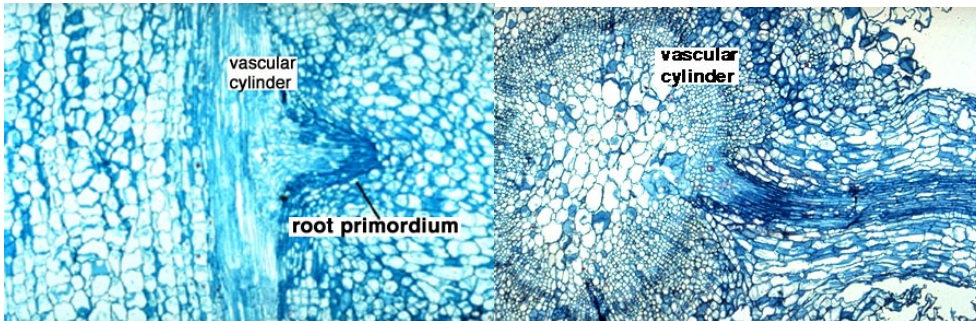
Two major sites of root formation are exogenous and endogenous.

A. Endogenous

Roots that form within the stem are usually near vascular bundles. This is a good site since it is near the source of hormones, carbohydrates, etc. The area where the root forms acts as a sink and continues to draw more nutrients towards itself. This area is also near the cambium which is meristematic and a source of cells.

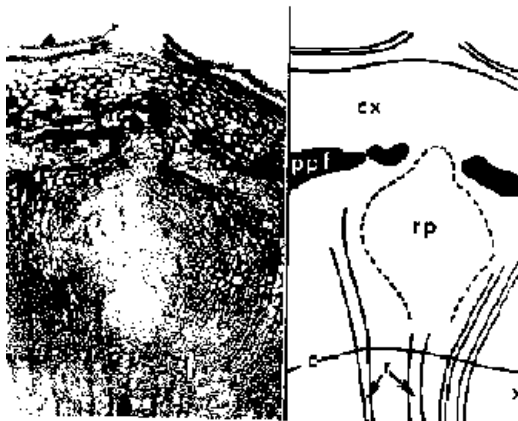


Adventitious root formation in Marianna 2624 plum, a rootstock used in the production of fruit trees. Note that the roots appear both at the very base of the cutting (A) and higher up on the stem where no callus has formed. One of the roots appears to be coming from the callus. Closer examination shows that the roots are emerging from an area near the vascular ring and not from the callus itself (B).



Longitudinal section of a stem with a root primordium. Note the proximity to the vascular cylinder.

Cross section through a stem with an adventitious root. Note origin of root at vascular cylinder.



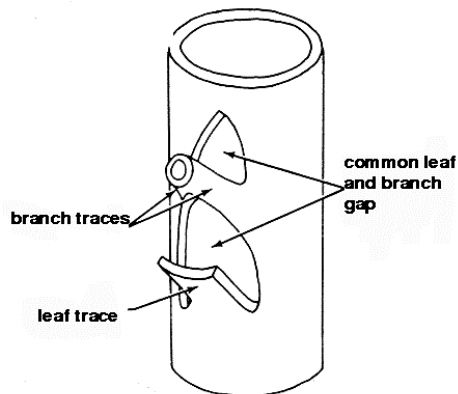
Root primordium originating near the vasculature.
 rp=root primordium
 cx=cortex; x=xylem; c=cambium

B. Exogenous

Roots are initiated within callus that forms at the wound site. Generally this is at the base of the stem, cut portion of the root etc. Exogenous root formation occurs mostly in difficult-to-root plants (ex. adult ivy) and in many conifers. Root initials start *in the callus* and then vascular elements form and eventually join with the vasculature of the stem.

C. General process

1. Initiative phase - meristemoids forms. Cells form from divisions of a few cells - either in callus area or near vascular bundles. Is a meristematic locus -source of cells. These are the ROOT INITIALS.
2. The root initials then differentiate into ROOT PRIMORDIA which are organized structures characteristic of root. Have a root cap, apical meristem, and central cylinder.
3. Root elongate and emerge through the side of the stem or base of the stem.



Leaf gaps- region of parenchyma in vascular cylinder of a stem located above the level where a leaf trace diverges toward the leaf. Roots often emerge from this area. There is no actual interruption of vasculature.

Wounding

One reason that wounding is useful is that it enables roots to emerge through areas with cells with lignified walls that would otherwise impede the growth of the roots.

The same pattern of root formation is found in leaf cuttings and root cuttings. Can arise within the leaf or within the root. Is generally near the vasculature. These are endogenous.

When roots arise in callus at the base of roots or leaves have exogenous formation.

3. SPHAEROBLASTS

Seen as small bumps in the bark. Are composed of meristematic tissue and conductive tissues. When trees are cut back, shoot will grow from these growths. Are juvenile shoots.

Leaf cuttings

Leaves must form adventitious shoots and roots. As with stem cuttings, new shoots and roots can be formed from preformed, primary meristems or wounded-induced, secondary meristems. The primary meristems have never ceased to be meristematic. Bryophyllum or Kalanchoe diagestemma are examples. “Mother of thousands”

Leaf cuttings of other plants such as African violet, rex begonia, Crassula species – arise from newly formed meristems. Roots often form first followed by shoots. But the shoots themselves often have to be rooted separately. The roots that form first on the original leaf are often not directly connected to the shoots that form.

Root cuttings

The use of roots as cuttings requires that adventitious shoot buds be formed. One can take roots from plants such as some apple and obtain shoots from them. These shoots are then removed from the root, treated with auxin and rooted.

In other cases roots form at the base of the new shoots while still attached to the original root. Some plants that can be propagated from root cuttings include quince, California poppy, Ficus carica (fig), Liriope, poplar, aspen, some rose as well as many others.