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SEXUAL Vs. ASEXUAL PROPAGATION

SEXUAL OR SEED PROPAGATION

Advantages:

1) produces large numbers in a short period of time
2) can handle large numbers easily
3) produces **hybrids**

Disadvantages:

1) some plants produce no viable seeds
2) some seeds are very difficult or slow to germinate
3) causes **genetic variability** (due to production of hybrids)

ASEXUAL OR VEGETATIVE PROPAGATION

totipotency - the concept that every cell in a plant has the inherent genetic ability to reproduce the entire plant.

Advantages:

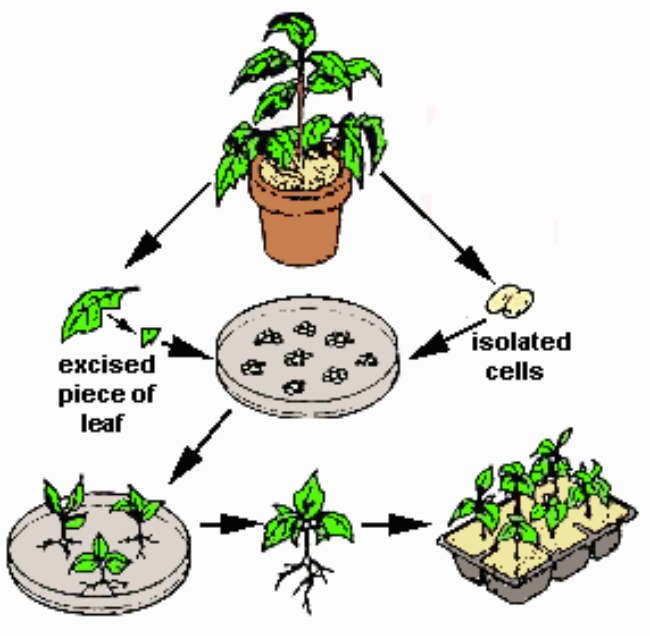
1) All off-spring are **true-to-type** (identical to the parent) and produce a **clone** .
clone - a group of plants, cultivar or variety derived from the same parent plant by asexual (vegetative) propagation.
2) for plants that are hard or impossible to propagate from seeds
3) decrease time to flowering (esp. grafting & budding); by-passes juvenile phase

Disadvantages:

1) can only propagate a few from each parent (except tissue culture).
2) requires a lot of labor

Tissue Culture

An asexual propagation technique where small pieces of excised tissue or individual cells are placed in sterile *in vitro* culture containing all the nutrients, carbohydrates and hormones needed for growth. The tissue grows rapidly and can be induced to produce large numbers of new plants. Hormones are used to cause the tissue to grow into callus masses, roots or shoots. Sometimes called **micropropagation**.



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SEXUAL (SEED) PROPAGATION

TERMINOLOGY

pollination - deposition of pollen on the stigma of the pistil.
ploidy - the number of sets of chromosomes present in the nucleus of the cell.

haploid = 1N = 1 of each chromosome
diploid = 2N = 2 of each chromosome
triploid= 3N = 3 of each chromosome
tetraploid = 4N = 4 of each chromosome

Normally, the regular cells of the plant (called vegetative cells) are 2N, and the reproductive cells (called the gametes) are 1N.

gamete - a haploid (1N) reproductive cell.
- the male gamete is the sperm cell with its 1N nucleus
- the female gamete is the egg cell with its 1N nucleus.

fertilization - the union of one male gamete (1N sperm nucleus) and one female gamete (1N egg nucleus) to produce a zygote (2N).
double fertilization - union of one male gamete (1N) with one female gamete (1N) to produce a zygote (2N), plus the union of one male gamete (1N) with two polar nuclei (1N each) to produce an endosperm (3N); occurs in higher plants only (angiosperms).
apomixis - development of an embryo without fertilization; hence, it is not true sexual propagation even though it produces a seed.
parthenocarpy - development of fruit without seeds.
vivipary - germination of seeds inside the fruit while still attached to the parent plant.

STAGES OF SEED GERMINATION

1st Stage
a) **imbibition** - initial absorption of water to hydrate seed
b) **activation of metabolism** - increased respiration and protein synthesis
2nd Stage
a) **digestion of stored food**- for example, starch to sugars in cotyledon or endosperm
b) **translocation to embryo**- sugars move to embryo for growth
3rd Stage
a) **cell division and growth** - development of seedling

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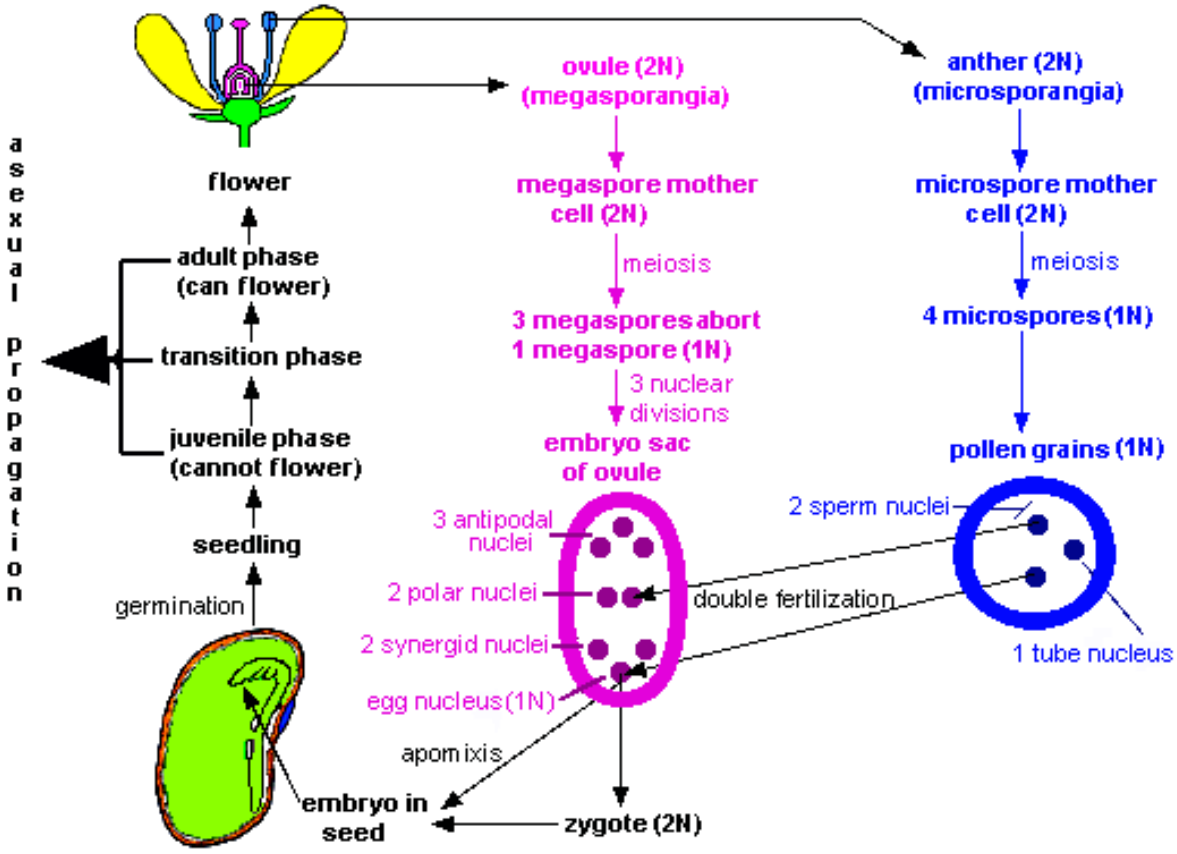
SEXUAL LIFE CYCLE OF HIGHER PLANTS
(Angiosperms: Monocots and Dicots - the flowering plants)



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SEED DORMANCY

Caused By	Type Dormancy	How Overcome?
1) Dry Seeds: dehydration of seed	quiescence	sow in moist environment
2) Seed Coat Dormancy or Hardseededness: hard seed coat impermeable to water and gases	quiescence	**scarification** - physical or chemical abrasion of seed coat.
3) Embryo Rest: low growth promoters and/or high growth inhibitors in embryo	rest (physiological dormancy)	**stratification** - cold (35-40 ºF), moist storage for 4-12 weeks.
4) Double Dormancy: hard seed coat plus embryo rest	both quiescence and rest	scarification then stratification
5) Chemical Inhibitors: inhibitors in pericarp (fruit wall) or testa (seed coat)	correlated inhibition	**I)** if fleshy, remove fleshy pericarp (fruit wall) or testa (seed coat). **2)** if pericarp or testa is dry, leach in running watery.

6) Immature Embryo: underdeveloped or rudimentary embryo	developmental dormancy	**1) after ripening** - store for 4-6 weeks under ambient conditions. **2) warm stratification** - warm moist storage. **3) embryo culture -** excise embryo and put in tissue culture.
7) Light Requirement phytochrome in Pr form	secondary dormancy	**I)** expose to any white light **2)** expose to red light **3)** sow shallow or on surface

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CUTTINGS

Cutting - a plant part that when removed from the parent plant and placed under the proper environmental conditions forms adventitious roots and/or shoots.

HOW TO MINIMIZE WATER LOSS OF CUTTINGS?

1) Place cuttings in **cool, humid area** - for leafless cuttings
2) Spray cuttings with **antitranspirants**.
antitranspirants - chemicals that decrease transpiration by forming a film on the leaf surface or by physiologically closing stomata.
3) Place cuttings in a **humidity chamber** - enclosed chamber with very high humidity.
4) Place cuttings under an **intermittent mist system.**

Intermittent Mist System
A propagation system that periodically (every 5 to 30 minutes) sprays a fine mist of water on the cuttings to keep the foliage moist and minimize water loss.

Effective due to:
a) high relative humidity
b) cooler temperature
c) allows use of higher light intensity
d) increases endogenous root promoting substances
e) may decrease disease

Disadvantage:
leaching - the loss of nutrients and other compounds from inside leaves and stems.
During intermittent mist propagation up to half of some of the nutrients in the leaf can be leached out. This causes the cuttings to be nutrient deficient. The problem can be corrected with **nutrient mist.**

nutrient mist - addition of dilute fertilizers to the mist; replaces nutrients lost to leaching. Use 2-6 oz. of a 20-20-20 or equivalent soluble fertilizer per 100 gallons of water.

HORMONES USED ON CUTTINGS

1) auxin - stimulates adventitious root formation on stem cuttings.
- IBA (most commonly used), NAA (frequently used), 2, 4-D (less used).

2) cytokinin - stimulates adventitious shoot formation on leaf or root cuttings.
- kinetin (commonly used), benzyladenine (BA) (commonly used), zeatin (seldom used), pyranylbenzyladenine(PBA) (used in research).

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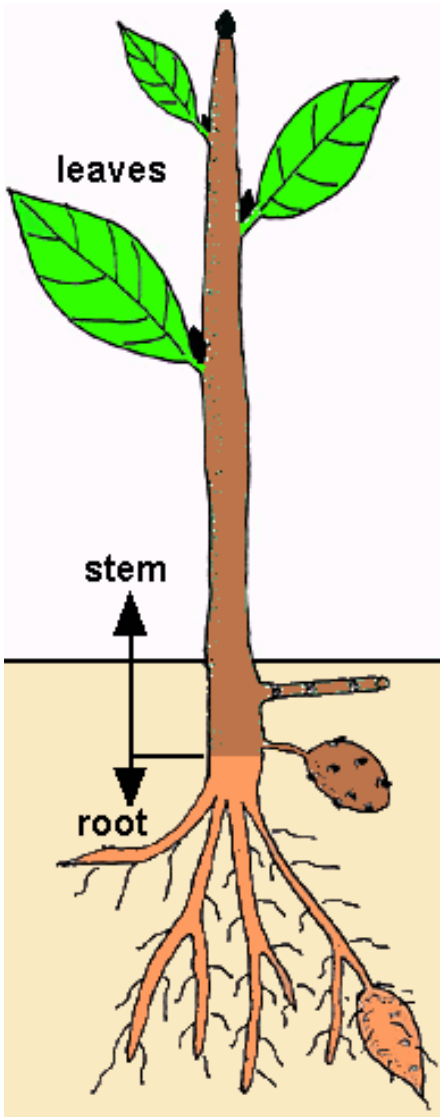
TYPES OF CUTTINGS

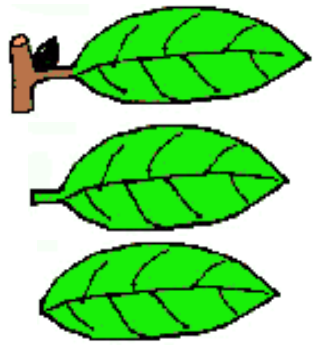


LEAF CUTTINGS - must form both adventitious shoots and roots (except leaf bud).

a) leaf bud

b) leaf petiole

c) leaf blade



d) leaf section

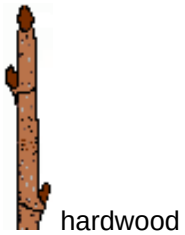
STEM CUTTINGS - must form adventitious roots

a) hardwood

b) semi-hardwood

c) soft or greenwood

d) herbaceous


hardwood


semi-hardwood, softwood or herbaceous

e) cane
leafless stem

f) rhizome
underground stem

g) tuber
underground storage stem


cane


rhizome


tuber

ROOT CUTTINGS
must form adventitious shoots


root section


tuberous root

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CHIMERA
(ki mer' a)

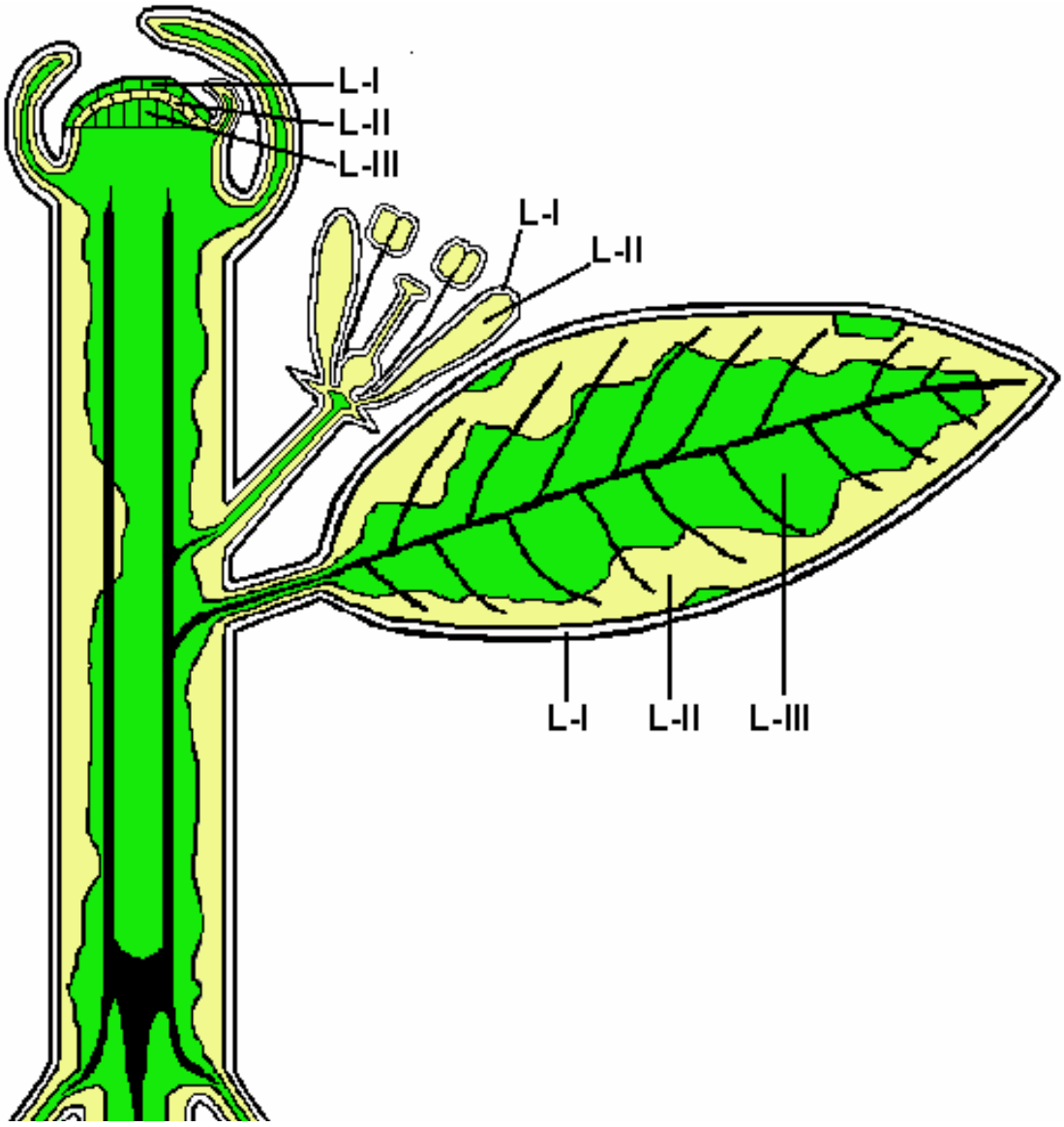
Chimera - a plant or plant part composed of genetically different layers.

The most common example is a "variegated" plant where different regions or layers of the leaf are yellow or white due to no chlorophyll development, i.e. these are chlorophyll mutants.

GROWING POINT OR APEX - can be subdivided into 3 different layers called L-I, L-II and L-III.

Layer	Gives rise to:
L-I	epidermis of all organs; monocot leaves - L-I contributes to the outermost region of the leaf mesophyll giving rise to a strip along the leaf margin. dicot leaves - L-I usually gives rise to only the colorless epidermis, thus cannot be seen; sometimes L-I gives rise to small islands of tissue along the margin.
L-II	stem and roots: outer and inner cortex and some of vascular cylinder leaves: mesophyll in outer region of leaf
L-III	stem and roots: inner cortex, vascular cylinder and pith leaves: mesophyll in central region of leaf

LOCATION OF LAYERS IN A TYPICAL DICOT



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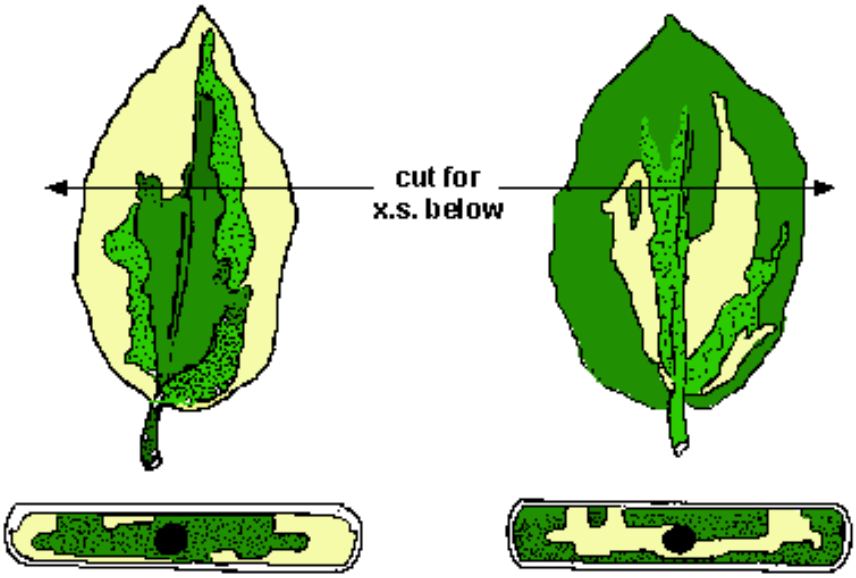
NEVER PROPAGATE CHIMERAS BY LEAF CUTTINGS - WHY?

(for the same reasons - never use root cuttings)

(Modified from: R.A.E. Tilney-Bassett. 1986. *Plant Chimeras*. Edward Arnold Ltd., Baltimore, MD)

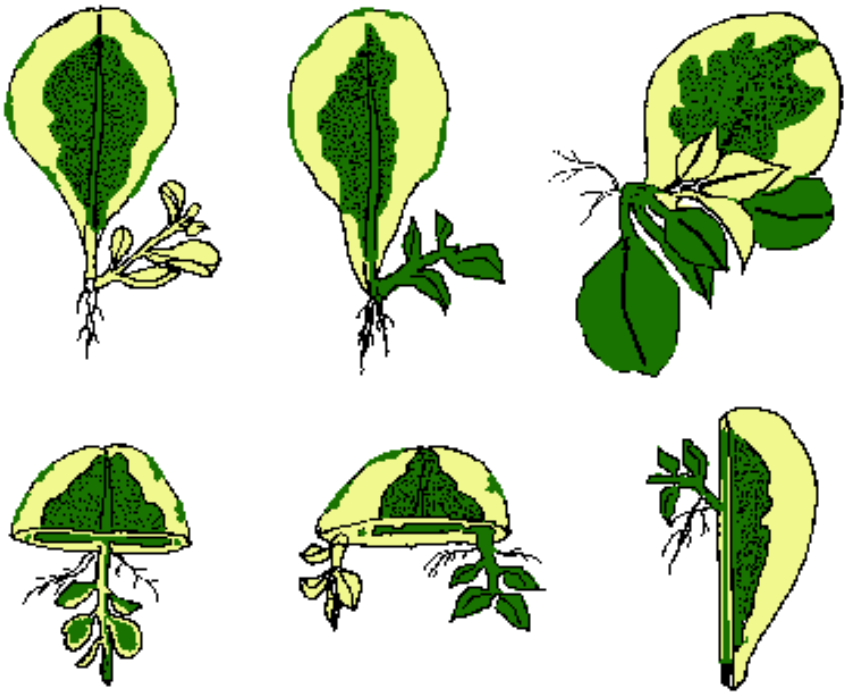
VARIEGATED LEAF PATTERNS OF CHIMERAS

The leaves below demonstrate two types of variegated *Elaeagnus*. The cultivar on the left is a L-II chimera (i.e. GWG), and the cultivar on the right is a L-III chimera (i.e. GGW). These are chimeras where the yellow or albino regions cannot make chlorophyll. A cross-section of the leaf shows the regions of albino cells in the mesophyll. The different shades of green and yellow are determined by the depth of the cell layers..



ADVENTITIOUS SHOOT FORMATION ON LEAF CUTTINGS OF CHIMERAS

If you take leaf cuttings from variegated plants, such as these variegated *Peperomia (GWG)*, the plantlets that form are never true-to-type to the parent variegation. The reason is simple. The adventitious shoots that form will have the properties of the region of the leaf from which they regenerate. The same would happen with a root cutting. For this reason, chimeras are never propagated true-to-type by cutting types or methods that require adventitious shoot formation.



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LAYERING

Layering - a propagation technique where roots are formed prior to the stem being removed from the parent plant.

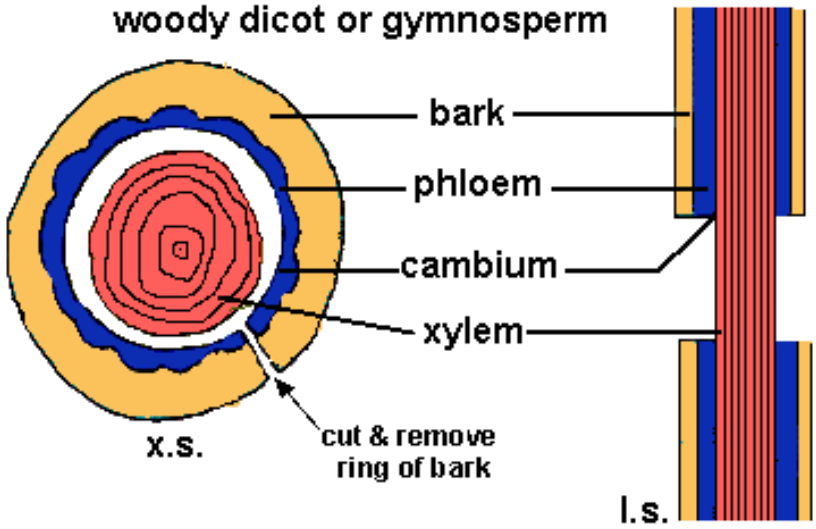
PRINCIPLE OF LAYERING

In layering, one must wound the stem such that phloem, but not xylem, translocation is disrupted. The internal anatomy of dicot, gymnosperm and monocot stems dictates the "ideal" type cut that is made to get maximum disruption of translocation in the phloem, while causing minimum disruption of translocation in the xylem. If done properly, roots form on the stem at the wounded site. The stem is then cut-off with the attached roots.

ANATOMICAL BASIS FOR THE TYPE CUTS USED IN LAYERING

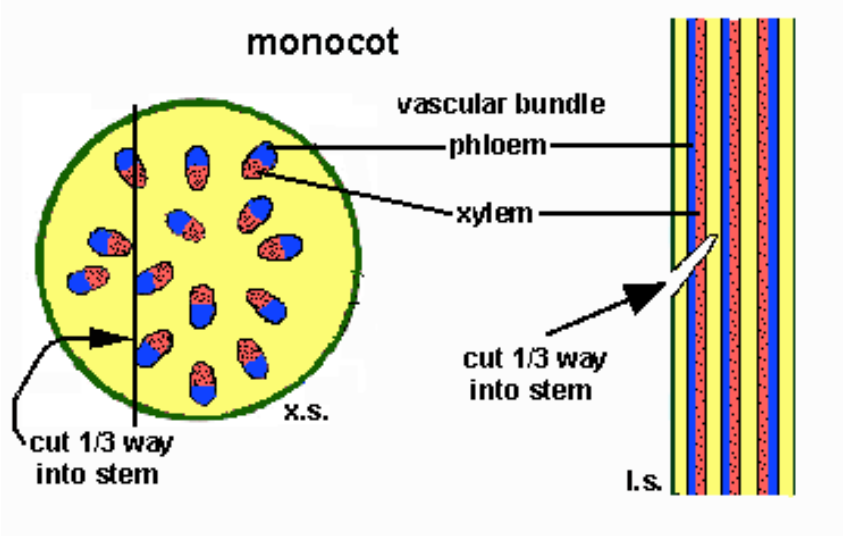
Woody Dicots and Gymnosperms

A ring of bark is removed from around the stem. The phloem and cambium are attached to the inside of the bark, so when the bark is removed the phloem is also removed. This leaves the central cylinder of xylem and upward water flow unaffected.



Monocots

Monocots have scattered vascular bundles, therefore, it is not possible to cut the phloem and not the xylem. As a compromise, a slit is cut about 1/3 way into the stem. This cuts enough of the vascular bundles to disrupt sufficient phloem translocation while still allowing sufficient water flow in the xylem.



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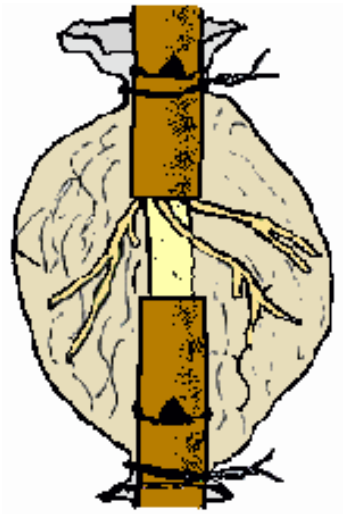
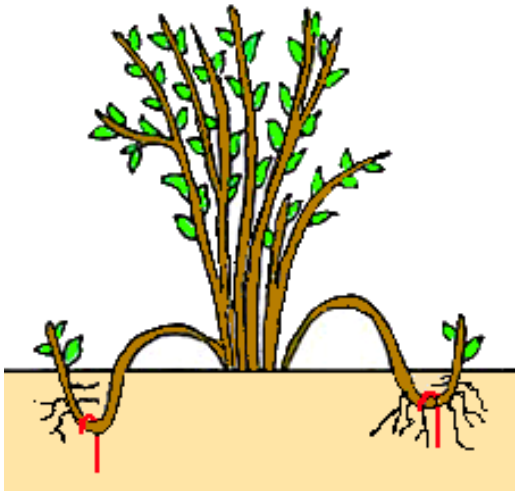
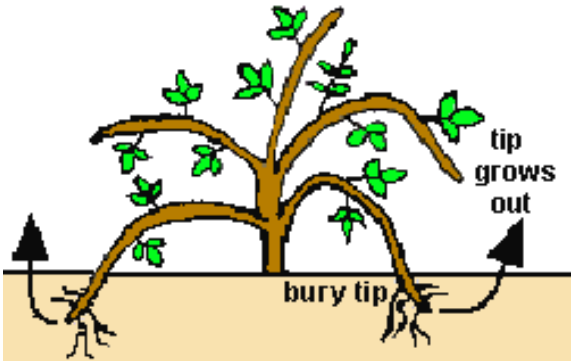
TYPES OF LAYERING



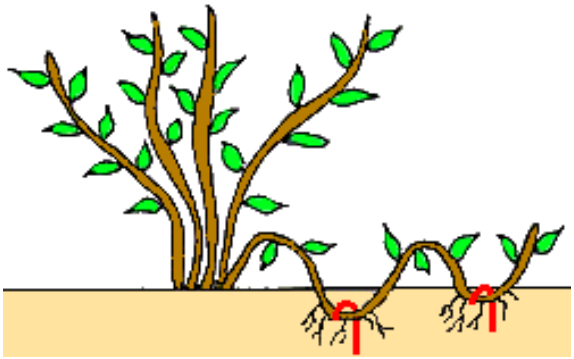
air layer



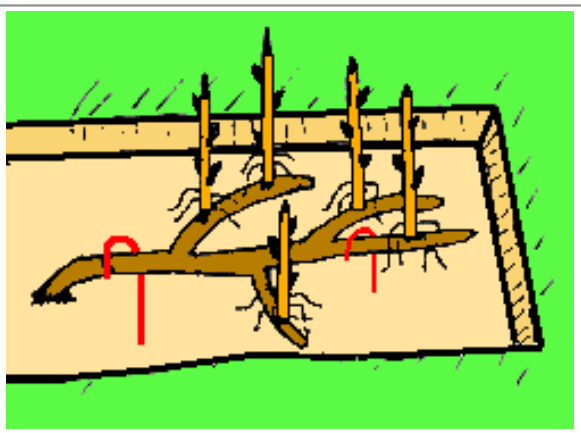
simple layer



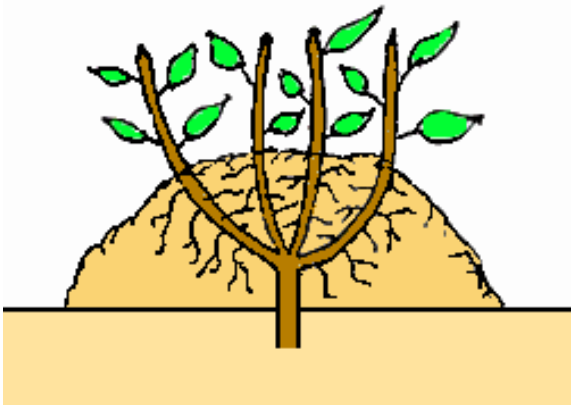
tip layer



serpentine layer



trench layer



mound or stool layer

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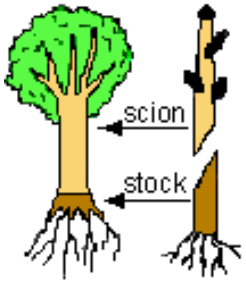
GRAFTING AND BUDDING

Grafting - the joining of separate plant parts together, such that they form a union and grow as one plant.



scion or cion - the upper part of the graft that becomes the shoot system of the new plant.

stock, rootstock or understock - the lower part of the graft that becomes the root system of the new plant.

Budding - a type of grafting where the scion is just a bud piece or small chip of wood with a bud attached.

REASONS FOR GRAFTING OR BUDDING

1) Plants cannot be propagated by other means, ex. plants in adult phase
2) Decrease time to flowering and fruiting, especially fruit and nut trees
3) Obtain desirable characteristics of rootstock, such as:
  a) disease resistance
  b) adapted to soils or climate in various regions
  c) dwarfing
4) Change variety, topwork mature trees
5) Special forms, usually for ornamental purposes, ex. tree roses
6) Repair damage (inarching, brace graft, bridge graft)
7) Virus indexing, used for diagnosing virus diseases

STAGES OF GRAFT AND BUD UNION FORMATION

Prerequisite- must **match cambium** of stock with cambium of scion
1) Callus formation by both stock and scion
2) Intermingling of callus from stock and scion
3) New cambium forms in callus between stock and scion
4) New secondary xylem and phloem from new cambium to connect stock and scion

FACTORS AFFECTING SUCCESS OF GRAFTING AND BUDDING

1) Plant type - can only graft dicots and gymnosperms; not monocots (lack a cambium)
2) Plant Relationship - within species is most successful

3) Incompatibility - sometimes graft or bud is rejected, even if within species
4) Season and growth state - best when cambium is active, but without leaf growth
5) Environment - must supply proper temperature, humidity, etc.

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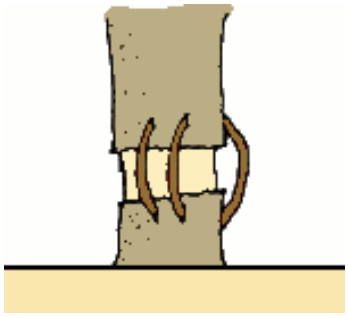
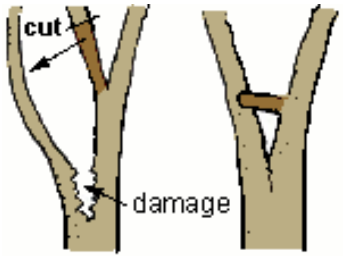
TYPES OF GRAFTING

TYPES USED TO REPAIR DAMAGE

inarching
(to replace damaged root system)

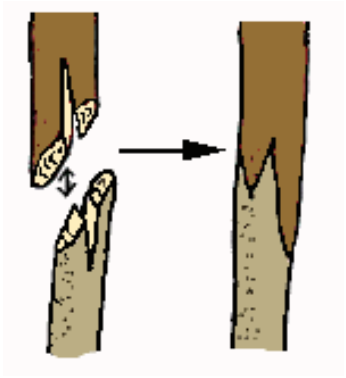


bridge graft
(to repair damaged trunk)

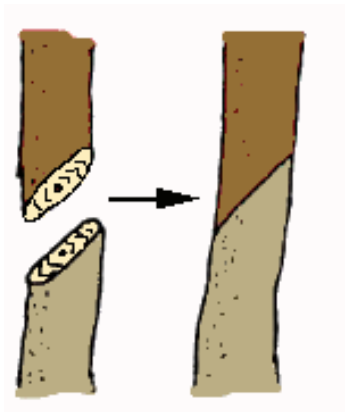


brace graft
(to support weak branches)

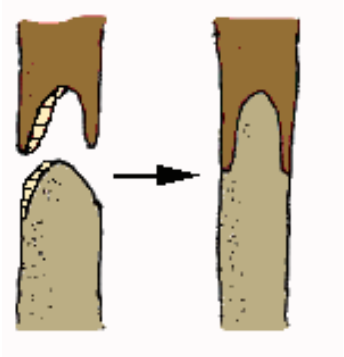
TYPES USED WHEN SCION AND STOCK ARE APPROXIMATELY EQUAL IN SIZE



whip or tongue graft
(click image for animated version)

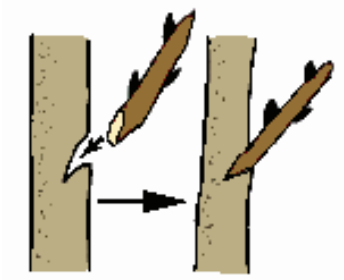


splice graft

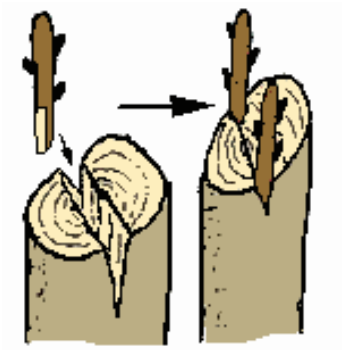


saddle graft

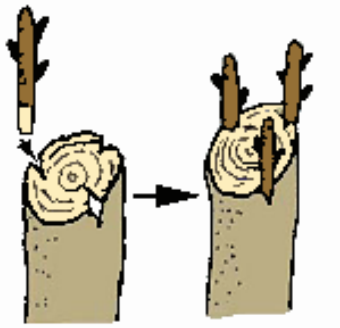
TYPES USED WHEN SCION IS SMALLER THAN STOCK



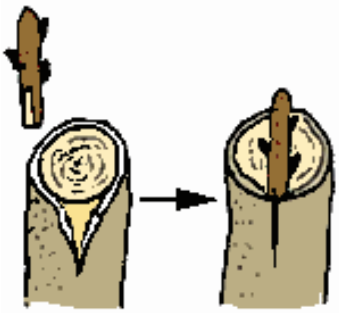
side graft



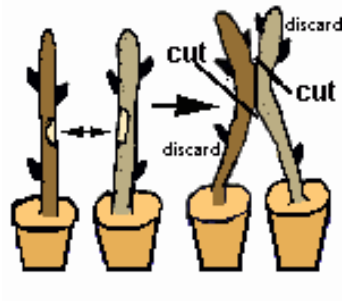
cleft graft



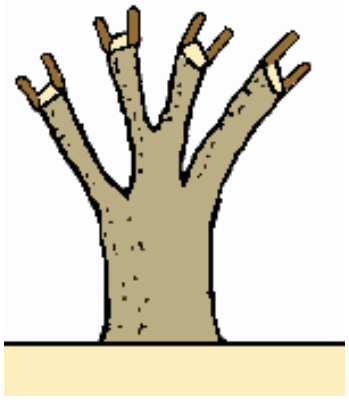
wedge, notch or saw-kerf graft



bark or bark inlay graft



approach graft



topworking

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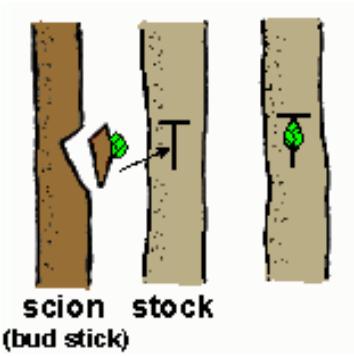
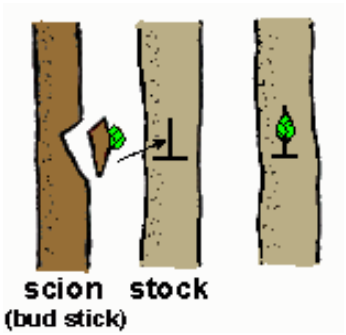
TYPES OF BUDDING

TYPES USED WHEN BARK IS SLIPPING

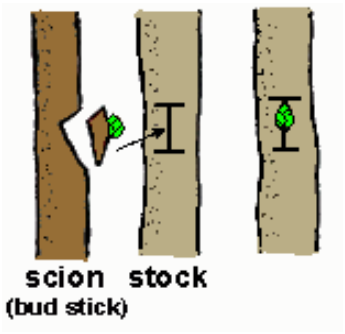
(click on image to view animated version)



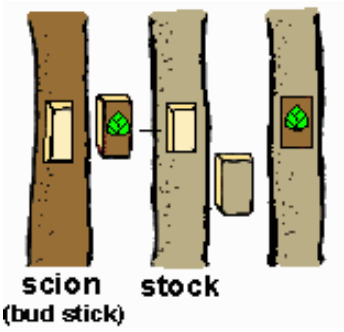
T-bud



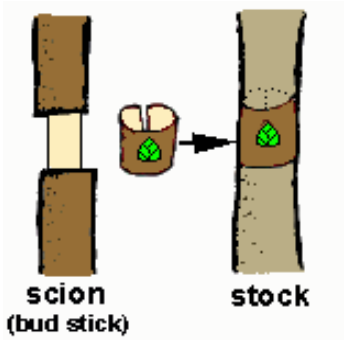
inverted T- bud



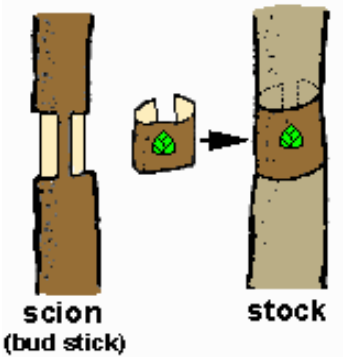
I-bud



patch bud



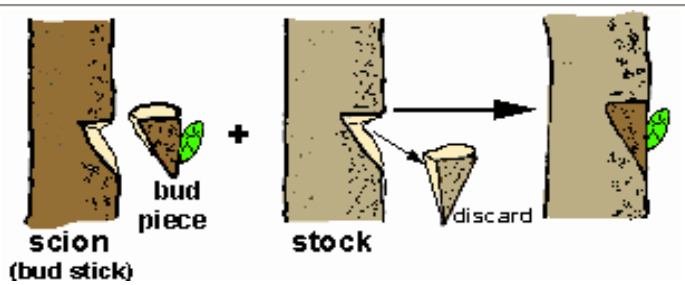
ring bud



flute bud

TYPE USED WHEN BARK IS NOT SLIPPING

(click on image to view animated version)



chip bud

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