The University of Georgia

College of Agricultural & Environmental Sciences

http://www.caes.uga.edu/extension/

The University of Georgia

Master Gardener

College of Agricultural & Environmental Sciences and Cooperative Extension Service

Propagation of Ornamental Plants

Learning objectives

- Basic principles of sexual plant propagation
- How plants are asexually propagated
- Techniques for stem, leaf and root cutting propagation

Learning objectives

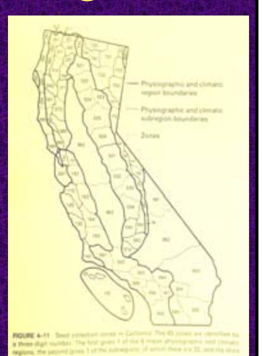
- Basics of seed germination
- Layering, grafting and budding as methods for plant propagation

Seed Propagation

No Two Seeds Are Alike

Seed Collecting

Provenance: A seed's origin, in terms of climate and geographic location. This can have profound effects on seed germination and plant survival.
Example: Hemlocks grown from southern North Carolina seed sources are more heat tolerant than Hemlocks grown from Pennsylvania seed sources.



Seed Collecting

Seeds collected from hybrids rarely look like the parent plant due to the random re-assortment of genetic material, and the random sources of pollen.
Native species tend to be more stable, but also have variation between generations.

To get a clone, try vegetative propagation!

Three Types of Seed Sources

Fleshy Fruits:
Berries, Figs

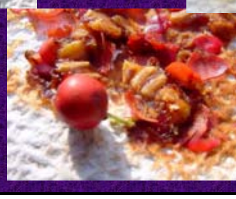
Dry Fruits:
Grains, Grasses

Dry Seeds /
Dehiscent Pods:
Cones/Pods

Extraction Methods

- **Fermentation**
- **Flotation**
- **Blender Separation**
- **Gravity Separators**
- **Hand Separation**
- **Sifting**

Fleshy Berry Seed



Seed Cleaning / Separation

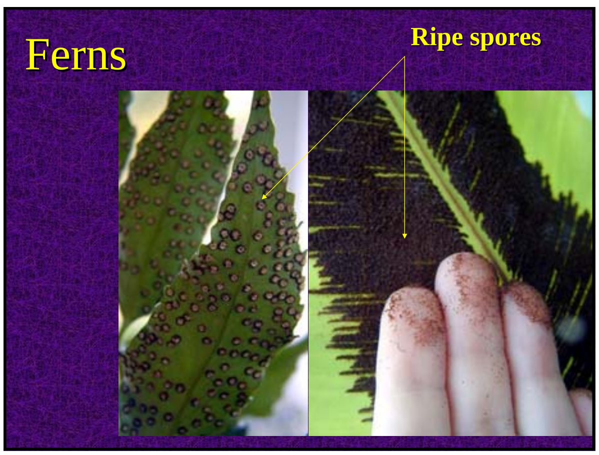
Cleaning seed reduces disease and weed seed from growing along with your selection.

For many dry seed, simply crush dried material and blow gently, transferring the seed from hand to hand.

Handling Tiny Seeds

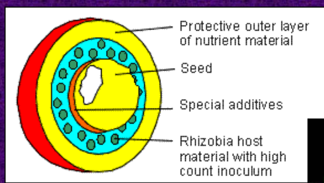
Some seeds can be smaller than the head of a pin. They can also be very expensive. A very careful approach is often needed to be efficient and successful when planting tiny seeds.

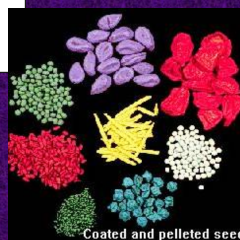

Handling Tiny Seeds
Mix Seed with Sand


Ferns
Ripe spores


Enhanced Seed
Park's Seed
Raw
Pelleted
Raw
Multi-Pellted
Raw
Coated
Raw
Detailed
Raw
Primed

Seed Coatings





- **Fungicides / Rhyzobia**
- **Polycoating**
- **Pre-germinated**

Seed Deterioration

Seeds lose half their storage life for every 1% increase in seed moisture between 5 and 14%.

Seeds lose half their storage life for every 5 degrees C increase in storage temperature between 0°and 50°C.

SEED STORAGE

Recalcitrant Seed

Tropical – Store warm and moist (ASAP)
Coffee, Cocoa, Mango

Subtropical – Store cool and moist (ASAP)
Maple, Oak, Elm, Poplar

Orthodox Seed

Short-Lived – Store dry and cold (Under 1 yr)
Vinca, Pansy, Begonia

Medium - Lived -- Store dry and cold (2-5 years)
Marigold, Petunia, Coleus

Long - Lived – Store dry and cold (5-200 years)
Morning Glory, Zinnia, Hollyhock

Seed Storage

1 Year or Less	5 – 10 Years	10-20 Years
Iberis	Cosmos	Albizzia
Phlox	Dianthus	Robinia
Delphinium	Calendula	Tilia
Parsley	Petunia	Elaeagnus
Onion	Viola	Koelreuteria

Important Information

Directions

Planting Depth

Expiration Date

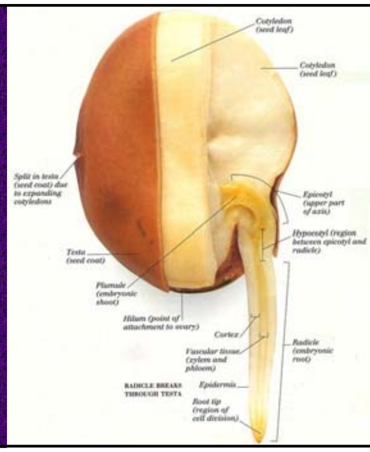
Source

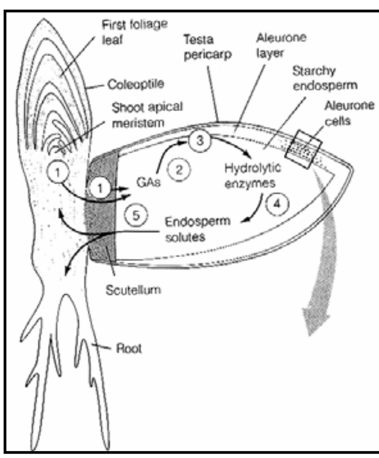
More Information

Lot Number

Germination Percentage

Scientific Name





1. **Imbibed water stimulates Gibberellin synthesis.**

2-3. **Gibberellins diffuse to the aleurone layer and stimulate the synthesis of enzymes.**

4-5. **Enzymes break down the starch and the sugars are transported to the developing embryo.**

Seed and Plant Dormancy

Dormancy is the condition in which seeds will not germinate even when most of the environmental conditions are favorable for germination.

There are many types of dormancy!

Terms To Know

Recalcitrant Seed – seeds are able to germinate without desiccating. They lose viability after drying and must be planted quickly. Oak, Maple, Coffee

Orthodox Seed –seeds desiccate after reaching full development to allow the seed to be quiescent or dormant until conditions are right to germinate. Beans

Advantages of Seed Dormancy

- Favors seedling survival
- Creates a seed bank
- Seed dispersal (birds)
- Synchronizes germination with seasons

Types of Dormancy in Seed

Quiescent – seeds are able to germinate upon imbibition of water at permissive temperatures.

Primary Dormancy – seeds cannot germinate even if immediate conditions are right. This form of dormancy delays germination until season, or other macro-environmental issues are right for survival.

Secondary Dormancy – an additional level of protection to prevent germination. Can be induced under very unfavorable conditions such as drought or cold, etc.

Primary Dormancy in Seed

Exogenous Dormancy - imposed by factors outside the embryo
Seed coat

Endogenous Dormancy - imposed by factors within the embryo
Underdeveloped embryo

Double (Combinational) Dormancy – two kinds of dormancy
Seed coat and underdeveloped embryo

Exogenous Dormancy

- **Physical** – Impermeable seed coat:
  Scarification
- **Mechanical** – Seed covering restricts radicle:
  Removal
- **Chemical** – Inhibitors in seed coat:
  Removal / Leaching

Endogenous Dormancy

Morphological - Underdeveloped embryo:

Warm Stratification

Physiological

- Non-Deep – After Ripening: Dry storage

  Photo-dormant: Exposure to red light
- Intermediate – Embryo/coat separation:

  Cold Stratification
- Deep – embryo dormant:

  Cold Stratification

Double Dormancy

Morpho-physiological – Some combination of underdeveloped embryo and physiological dormancy

Cycles of warm and cold stratification.

Exo-Endodormancy – Combination of exogenous and endogenous dormancy conditions

Sequential combinations of dormancy releasing treatments, e.g. scarification followed by cold stratification.

Secondary Dormancy

- **Thermodormancy** - High temperatures induce dormancy

  Growth regulators or Cold stratification
- **Conditional** – Change in ability to germinate is related to time of year

  Chilling or Warm stratification

Photodormancy

Photodormancy: A type of dormancy where the ability of the seed to germinate is controlled by the wavelength and duration of light received by the embryo.

Lettuce,
Butterfly weed,
Tobacco

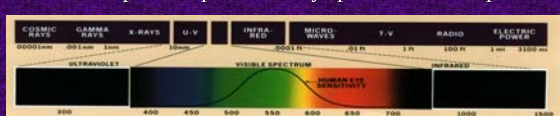
Photoperiodism:

Response to the duration and timing of day and night

Photodormancy and Photoperiodism Are Under the Control of a Pigment - Phytochrome

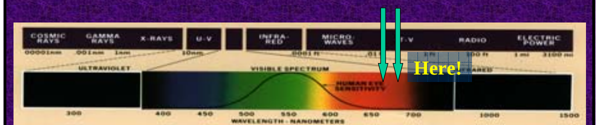
What Is Phytochrome?

- Phytochrome is a pigment found in some plant cells that controls plant development. This pigment has two forms or "phases" it can exist in; P-red light sensitive (Pr) and P-far red light sensitive (Pfr) forms.
- If a photoperiodic plant is exposed to light at the 740 nm wavelength, Pfr is converted to Pr.
- If a photoperiodic plant is exposed to light at the 660 nm wavelength, Pfr is converted to Pr.
- The actual plant response is very specific to each species!



Which Wavelengths Are Photoperiodic?

- The length of the night period plays a major role in determining which wavelength will be effective, as the phytochrome pigment tends to revert to Pr during long periods of darkness.
- Thus the length of exposure to light in a building, or if outdoors, the seasonal light changes, affect how long the plant perceives each form of phytochrome.



phytochrome

Bright Sun
660 nm

Pr — Red Light (Fast) → Pfr
Pfr — Far Red Light → Pr

740 nm

Dark Reversion (Slow)

Quiescence

Germination

Long hours of bright spring sun stimulate formation of Pfr and germination begins.

phytochrome

660 nm

Far Red Light
740 nm

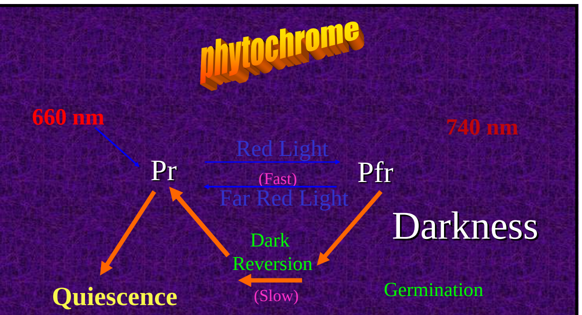
Pr — Red Light → Pfr
Pfr — (Fast) Far Red Light → Pr

Dark Reversion (Slow)

Quiescence

Germination

Far-red light, such as is found under a vegetative canopy, prevents germination.
Seeds wait for sun.



Darkness maintains Pr and quiescence. Buried seed won't germinate until brought to the surface.

Light Requirements for Germination

Species	Light/Dark	Species	Light/Dark
Ageratum	Light	Marigold	Either
Aster	Either	Nicotiana	Light
Begonia	Light	Pansy	Dark
Centaurea	Dark	Petunia	Light
Cosmos	Either	Phlox	Dark
Dahlia	Either	Portulaca	Dark
Dianthus	Either	Snapdragon	Light
Geranium	Light	Verbena	Dark
Impatiens	Light	Vinca	Either
Larkspur	Dark	Zinnia	Either

Preconditioning Seeds

(for more uniform germination)

Methods:

Mechanical Scarification

Soaking in water

Acid Scarification

Moist Chilling / Freezing

Mechanical Scarification

Acid Scarification

An alternative to scraping the seed coat is to use acid to etch through the coat. There are many reference books that advise which acid and how long to treat.

Tip: use vinegar as a safer alternative to acid.

Hot Water Scarification

Water temperature should be over 110^{O}F

Let soak for a few hours. Stir often.

Do not re-heat the water.

Plant ASAP.

Moist Stratification

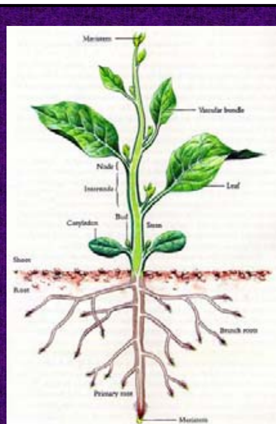
Cold or Warm

Vegetative Propagation

Why Vegetative Propagation?

- Maintain specific characteristics (cloning)
  - true-to-type plants
- Cost
  - break-even point for cuttings is 50-60% (90% or higher for grafting)
- Avoid graft/bud incompatibilities

What is a ‘cutting’?



any vegetative portion of the plant

apical bud

stem

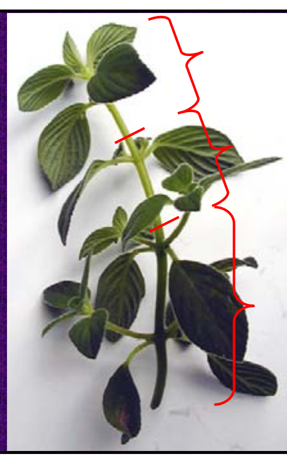
node

leaf

axillary buds

herbaceous plants

Types of Cuttings



tip cutting

one-node cutting

stem cutting

herbaceous plants


woody plants
softwood cuttings
taken early in the growing season


semi-hardwood (greenwood) cuttings
taken in the summer (mid-July to early September)


woody plants
taken in the dormant season
hardwood cuttings

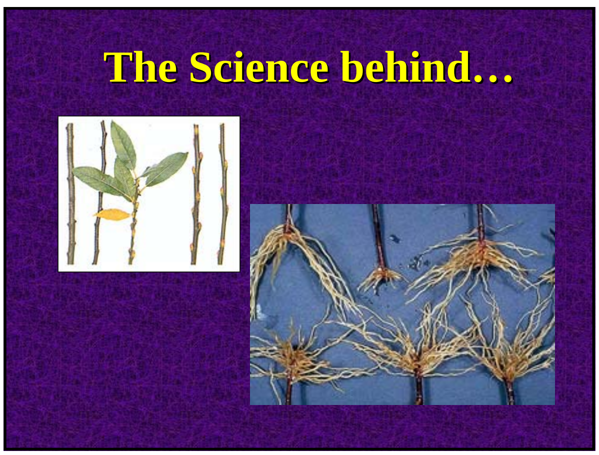
Taking & Treating Cuttings

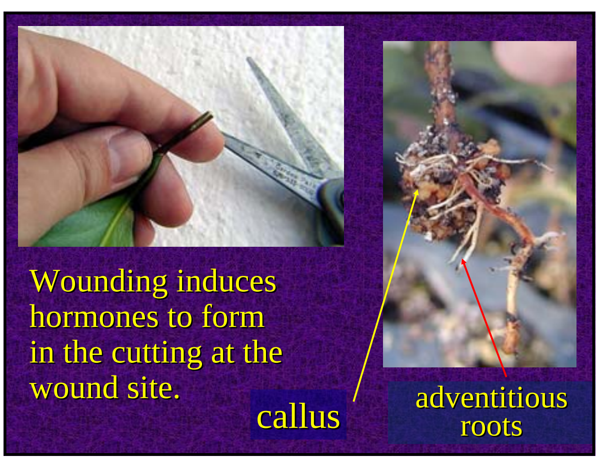
Cut the woody stem at an angle

Make the angled cut on the side of the closest bud.

Scratch/scrape the stem on the other side.


Remove bottom leaves and/or cut bottom leaves in half to reduce transpiration.


The Science behind…


Wounding induces hormones to form in the cutting at the wound site.
callus
adventitious roots

Adventitious Roots Are Two Types

Preformed & wound-induced

Plant Growth Substances (Hormones)

- Adventitious root formation involves plant hormones.
- Hormones occur naturally within plants.
- Root-promoting hormones are present in buds.
- Rooting hormones are synthetic chemicals that stimulate adventitious root formation.

Plant Rooting Response to Growth Regulators

Three classes:

1. Plants that have all essential endogenous root substances plus auxins. *Cuttings rapidly form roots.*
2. Plants that have all essential endogenous root substances but no auxins. *When cuttings are treated with auxins they rapidly form roots.*
3. Plants that lack an endogenous root substance(s) and/or lack the sensitivity to respond to this substance(s), even though natural auxins may or may not be present in abundance. *External application of auxins has little or no effect.*

- Auxins such as indole-3-acetic acid (IAA), indolebutyric acid (IBA), and naphtaleneacetic acid (NAA) have greatest effect on initiating roots in cuttings
- Not a universal response across plant species:
  - difficult-to-root species
  - mixtures of root-promoting substances are sometimes more effective than either component alone
    - IBA + NAA are better than either one alone

For general use in rooting stem cuttings of the majority of plants, IBA and /or NAA are recommended.

Rooting Hormones Concentrations

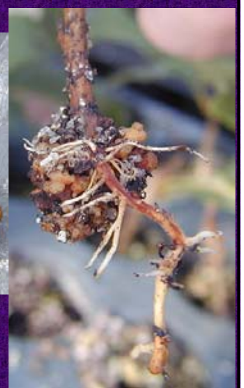
Generally

- auxin concentrations of *500 to 1,250 ppm* are used to root the majority of softwood and herbaceous cuttings
- auxin concentrations of *1,000 to 3,000 ppm* with a maximum of 5,000 ppm are used to root semi-hardwood cuttings
- auxin concentrations of *1,00 0 to 3,000 ppm* with a maximum of 10,000 ppm are used to root hardwood cuttings

Rooting Hormones

Powder Formulations

Liquid Formulations



excessive hormones,
only callus formed

Methods of Vegetative Propagation

- Plantlets
- Divisions
- Layering
- Root cuttings
- Shoot cuttings

Strawberry begonia
Saxifraga

Plantlets

Kalanchoe

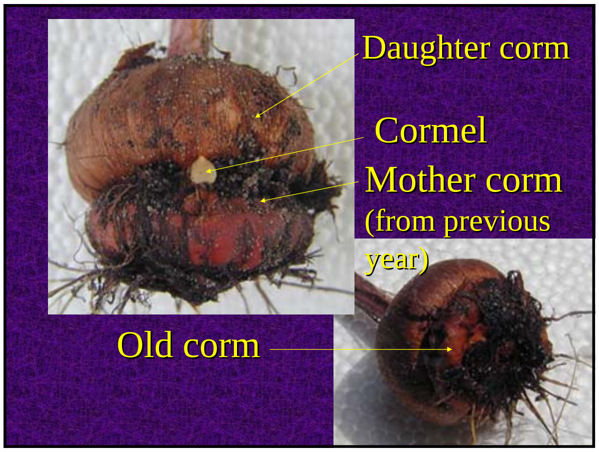
Yarrow, *Achillea*

Divisions

Bulbs, Corms, Tubers, Rhizomes, Rootstocks


Iris
Rhizome


Gladiolus


Daughter corm
Cormel
Mother corm
(from previous year)
Old corm


Cross vine, *Bignonia*
Shoot Cuttings


Dianthus


Salvia


Creeping
Raspberry
Rubus
Stem Cuttings


Leaf Cuttings

adventitious buds

Woody Plants

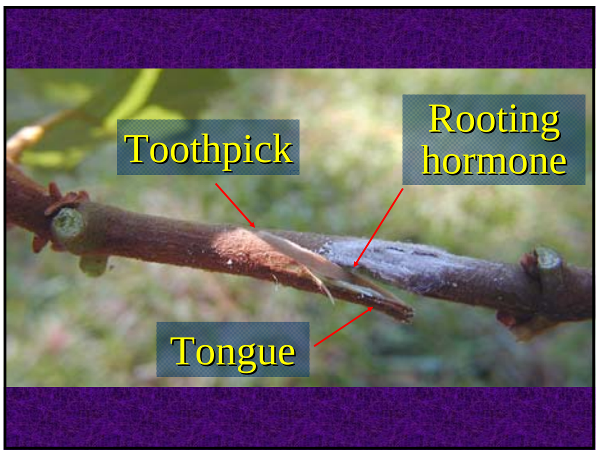
Loropetalum


Azalea


Holly


Juniper
heel


Ground-Layering


Toothpick
Rooting hormone
Tongue

Soils and Growing Media For Propagation

- Any substance providing air/water relationships (25 to 40% air space)
  - Soil, sand, pumice, bark

Soils

Garden soil (homemade mixes)

- Sterilize before use
- Sieve moist soil through a ¼-inch sieve, place a layer up to 3-inch deep in a baking tray, bake for 30 min @ 400 ^{0}F
- In a microwave (seal in a pierced roasting bag) heat on high for 10 min

Media components -- Sand

Sharp builders sand (particle diameter 0.5–2 mm)

- Sterilize before use
- No buffering capacity, pH varies with source and can change with the water, no nutrients, no water-holding capacity
- Suitable with peat, perlite, and other components

Media components -- Perlite

Crushed aluminum-silica volcanic rock, heated rapidly to 1800 ^{0}F

- Sterile, lightweight & chemically inert
- No nutrients, low water-holding capacity, pH 7-7.5
- Horticultural grade (#2) best

Media components -- Vermiculite

Clay mineral w/ high potassium and magnesium, heated to 1400 ^{0}F

- Sterile & lightweight
- High water– and nutrient holding capacity; pH 7-7.5
- Use coarser grades

Media components – Scoria & Pumice

Scoria is a naturally occurring volcanic rock, crushed and screened for size.
Pumice is a white, natural glass.

- Similar qualities to perlite

Scoria

Pumice

Media components -- Peat

Sphagnum moss peat, hypnaceous moss, reed and sedge peats, and humus or muck peat

- Relatively sterile & lightweight (when dry)
- High water– and nutrient holding capacity; pH 3-4.5
- Different sizes used (fine – seed, shredded form is most common)
- Excellent when mixed w/ sand and perlite

Media components -- Bark

Hardwood and pine bark

- Milled, w/ 70-80% of the particles in the 1/40 to 3/8-inch size, and 20-30% of the particles less than 1/40-inch size
- High nutrient holding capacity; pH 3.5-4.0
- Alone or mixed w/ others 3 Bark: 2 Peat: 2 Perlite

For most plants:

2 coarse perlite: 1 peat (by volume)

Propagation Systems

Mist Systems – Purpose and Components

- Mist keeps the leaves wet to maintain a favorable water status and cools leaves
- *The objective is NOT to water the cuttings*

- Cutoff valve
- Pressure regulator(s)
- Filter
- Solenoid valve
- Mist nozzles

Mist Control Systems

Timer (install away from mist)

- Simple, malfunctions are obvious
- Use a timer designed for mist systems
- Turn the system off at night (some have a photocell built-in, or you can use a second timer)

Bottom Heat

Why?

- Temperature controls development
- Cool tops, warm roots

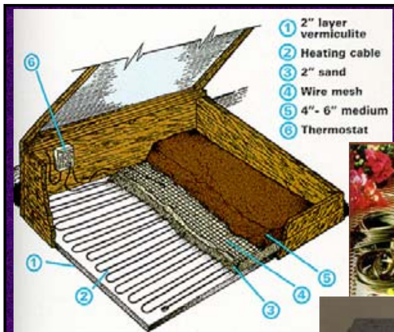
  Optimal root zone temperature: 65 - 75 °F (depending on species)

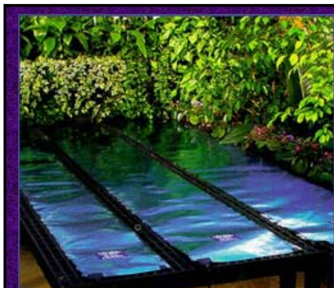
  Thermostat placement is crucial!

How?

- Commercially available propagating mats
- Heat tape (soil heat cable) and thermostat
- Warm water pipes (can be buried)

Soil heat cable





Propagation mat

Propagation mat

Tips For Success

Maintain
Clean & Organized Environment

Use Healthy, Pest-Free Plants

Use Healthy, Disease-Free Plants

Questions?

Bodie V. Pennisi, Paul A. Thomas, Melvin R. Hall, and John M. Ruter

Horticulturists