Propagation

"to cause an organism to multiply by any process of natural reproduction from the parent stock"

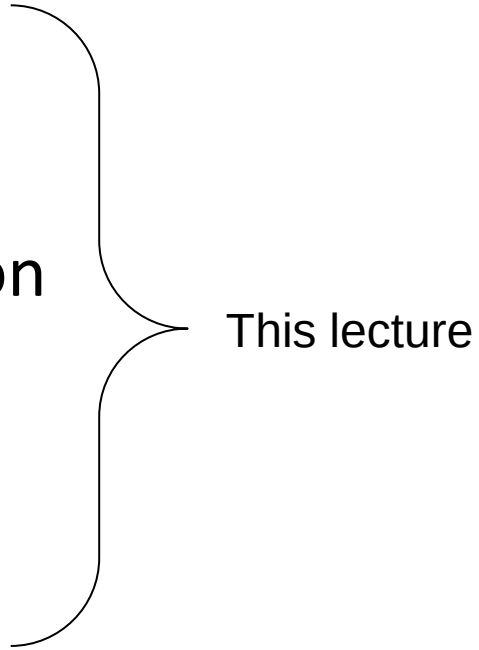
Gretel Anspach
Lifetime Master Gardener
Massachusetts Master Gardener Association

Plant Life Cycles

- Annuals
  - Bloom all summer
  - But need to be replanted every year
  - Grown from seed, cuttings
- Tender Perennials
  - Bloom all summer
  - But need to be replanted every year
  - Tender perennials can be overwintered inside
  - Grown from seed (if not sterile), cuttings, division
- Biennials
  - Bloom most of the summer
  - Need to plant every year unless it reseeds
  - Some biennials live 3 years (some foxgloves)
  - Grown from seed, cuttings
- Perennials
  - Bloom 2-6 weeks – conserving energy to grow roots
  - Will die eventually – 3-100 years
  - Grown from seed (if not sterile), cuttings, division

Types of Propagation

- Seeds (sexual)
- Vegetative (asexual)
  - Division and Separation
  - Runners and Suckers
  - Layering
  - Cuttings
  - Grafting & Budding
- Micropropagation (tissue culture, etc.)



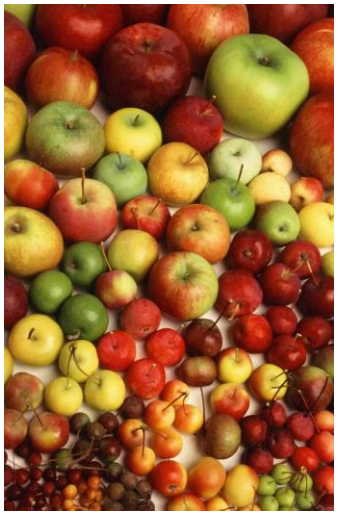
Propagation

Sexual – Genetic mix of 2 individuals

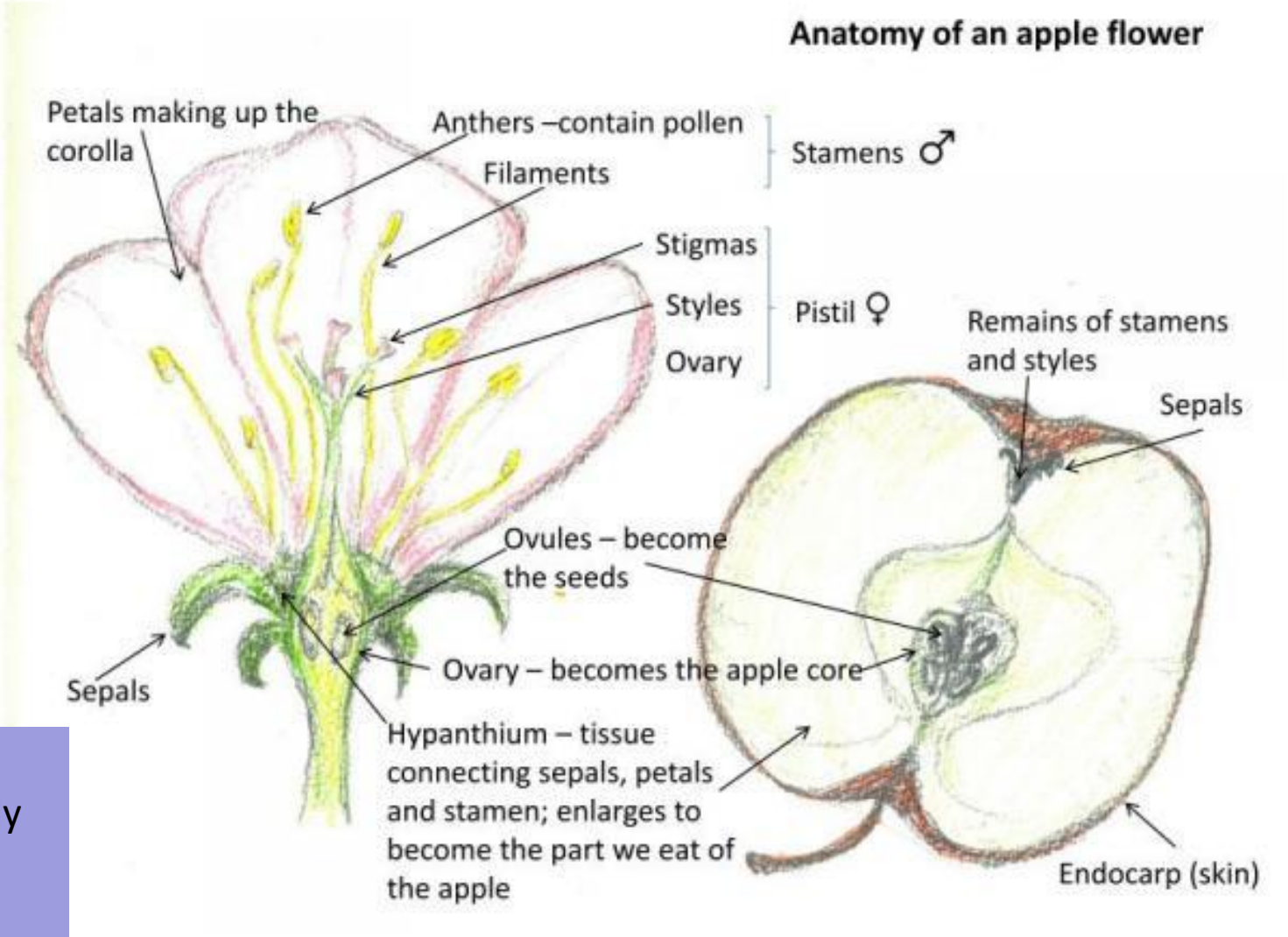
- Even in-bred lines show variety
- Evolution to different forms, hardiness, etc.
- Slow, random

Asexual – Clone of 1 individual

- Exact duplicate
- Strengths & weaknesses retained
- Faster (generally)



Flowers into Fruit



Seeds are the only part that genetically combines both parents.

https://www.theorchardproject.org.uk/blog/blossoming-cities/

Terms – Open Pollinated vs Hybrid

Open pollinated

AA

x

aa

First generation hybrid (F1)

Aa

2nd generation hybrid (F2)

AA

Aa

Aa

aa

Four O'Clock (Mirabilis

Terms – Open Pollinated vs Hybrid

- Open-pollinated (OP or blank)
  - The only option if you need it to breed true
- Hybrid (F1, F2, etc.)
  - May need to cull out about up to half the plants, which isn't practical if you're growing for fruit
  - Often have "hybrid vigor"

Terms – Heirloom

- Definition: A cultivar that originated at least 50 years ago
  - Or else at least 100 years ago
  - Or else before 1945
  - Or maybe it's 1951
  - Or maybe it was just handed down in a family
  - Or maybe it's just not a hybrid
- For sure:
  - Implication that it has more old-fashioned goodness and less commercial viability
  - Guaranteed it's open pollinated (not hybrid)

Seed Saving

Buy seeds because:

- You can grow new things every year
- You don't have to think about cross-pollination
- You don't have to think about storing the seeds

Save seeds because:

- Heirlooms can be interesting
- You know those worked here
- Some varieties can no longer be obtained
- It's free!

Getting started

- To get viable seeds, you need
  - A plant that can produce fertile seeds
  - That plant to be pollinated
  - Ripe fruit
- To get seeds that breed true, you need
  - Open pollinated plants
  - Sufficient separation
  - A large enough population

Seeds

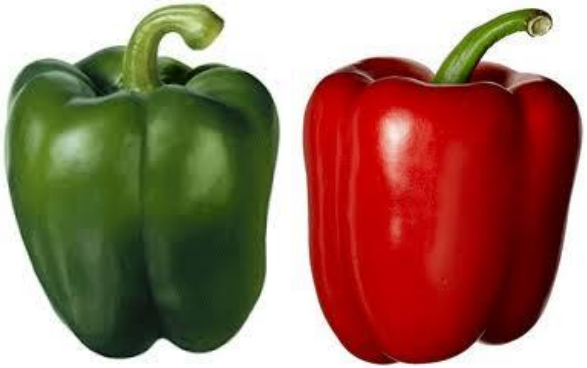
- Most garden plants can make seeds, but
- Some plants are seedless
  - Ferns, mosses, etc. reproduce with spores
  - Seedless cultivars
    - Watermelons, grapes, oranges, bananas
    - Many double flowers
- Some plants only (mostly) make sterile seeds
  - Some Japanese spirea, butterfly bush, burning bush, lantana, etc.

Fertile seeds

- Some flowers are self-pollinating
  - Dandelions, peanuts, peas, beans, violets
- Some flowers can be self-pollinating, but need help for complete pollination
  - Tomatoes, blueberries, shooting stars
- Some plants have male and female flowers on the same plant and can be self-pollinating
  - Squash, birch
- Some plants have “perfect” flowers (both male and female) but need 2 separate varieties for best pollination
  - Apples, blueberries
- Some plants are have male and female flowers on separate plants – need both, and only the female can make seeds
  - Hollies, Jack-in-the-Pulpit, gingkoes, pollenless sunflowers (female only)

And to make matters more complicated, some plants can generate fruit without being fertilized, but these fruits won’t have seeds (some tomatoes, cucumbers, pineapples)

Ripe fruit…












To get seeds that breed true…

- Open pollinated plants
  - Not hybrids
  - Not clones
- Sufficient separation
- A large enough population to prevent "inbreeding depression"
  - Corn needs at least 200 plants of the same cultivar
  - Most plants can survive "a few" generations of inbreeding without negative effect

Separation from what?

- Family – Plantae
- Division – Magnoliophyta (flowering plants, also called Angiosperms)
- Class – Eudicots (also called Dicots)
- Order: e.g. Violales (includes squash), Primulales (includes primroses).
- Family: e.g. Cucurbitaceae (includes squash), Violaceae (includes violets).
- Genus: e.g. Cucurbita (includes squash), Cucumis (includes cucumbers, melons)
- Species: e.g.
  - C. maxima (some winter squash, some pumpkins),
  - C. mixta (some pumpkins),
  - C. moschata (some winter squash, some pumpkins),
  - C. pepo (summer squash, some winter squash, some pumpkins)

Plants in the same species will interbreed if they bloom at the same time
The fruit will taste like the 'mom', but the seeds will be a cross of both parents

Cucurbita pepo













- Acorn squash
- Delicata squash
- Dodi marrow
- Gem squash
- Heart of gold squash
- Kamo Kamo
- Pattypan squash
- Some gourds
- Some pumpkins
- Spaghetti squash
- Sweet dumpling squash
- Yellow crookneck squash
- Yellow summer squash
- Zucchini

Different species

"Big Max"
C. pepo

"Jack O Lantern"
C. maxima

"Musquee de Provence"
C. moschata

"Rouge d'Etamp"
C. mixta

What is “sufficient” separation?

						Population Size (Number of plants)		
Crops	Species	Family	Life Cycle	Primary Pollination Method	Recommended Isolation Distance for Seed Saving	Viable Seeds	Variety Maintenance	Genetic Preservation
bean	Phaseolus vulgaris	Fabaceae	annual	self or insect	10–20 feet	1	5–10	20+
carrot	Daucus carota	Apiaceae	biennial	insect	800 feet–1/2 mile	5	20–50	80+
cauliflower	Brassica oleracea	Brassicaceae	biennial	insect	800 feet–1/2 mile	5	20–50	80+
collards	Brassica oleracea	Brassicaceae	biennial	insect	800 feet–1/2 mile	5	20–50	80+
corn	Zea mays	Poaceae	annual	wind	800 feet–1/2 mile	10	50–120	200+
cucumber	Cucumis sativus	Cucurbitaceae	annual	insect	800 feet–1/2 mile	1	5–10	25+
eggplant	Solanum melongena	Solanaceae	annual	self or insect	300–1,600 feet	1	5–20	50+
kale	Brassica oleracea	Brassicaceae	biennial	insect	800 feet–1/2 mile	5	20–50	80+
lettuce	Lactuca sativa	Asteraceae	annual	self	10–20 feet	1	5–10	20+
melon	Cucumis melo	Cucurbitaceae	annual	insect	800 feet–1/2 mile	1	5–10	25+
pea	Pisum sativum	Fabaceae	annual	self	10–20 feet	1	5–10	20+
pepper	Capsicumspp.	Solanaceae	annual	self or insect	300–1,600 feet	1	5–20	50+
pumpkin	Cucurbita spp.	Cucurbitaceae	annual	insect	800 feet–1/2 mile	1	5–10	25+
radish	Raphanus sativus	Brassicaceae	annual	insect	800 feet–1/2 mile	5	20–50	80+
spinach	Spinacia oleracea	Amaranthaceae	annual	wind	800 feet–1 mile	10	20–50	80+
squash	Cucurbita spp.	Cucurbitaceae	annual	insect	800 feet–1/2 mile	1	5–10	25+
tomatillo	Physalis philadelphica	Solanaceae	annual	insect	800 feet–1/2 mile	5	20–50	80+
tomato	Solanum lycopersicum	Solanaceae	annual	self or insect	10–50 feet	1	5–10	20+
watermelon	Citrullus lanatus	Cucurbitaceae	annual	insect	800 feet–1/2 mile	1	5–10	25+

Extracted from https://www.seedsavers.org/site/pdf/Seed%20Saving%20Guide_2017.pdf

Does this matter?

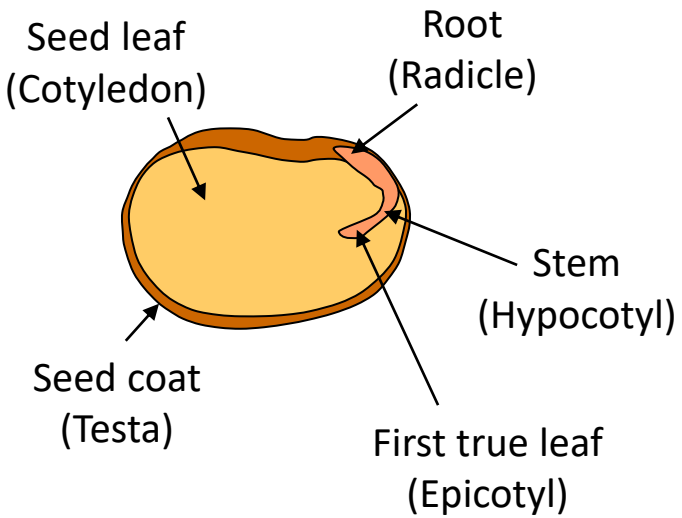



- Yes:
  - If you are marketing the seeds as a particular cultivar (e.g. Tomato “Brandywine”)
  - If there is significant variation in taste (edibles) or appearance (ornamentals) within the species (e.g. squash, pepper, Brassicas)
- No:
  - If you are marketing the seeds more generally (e.g. Tomato)
  - If there is relatively little variation in taste or appearance within the species (e.g. tomato, lettuce, cucumber, bean)

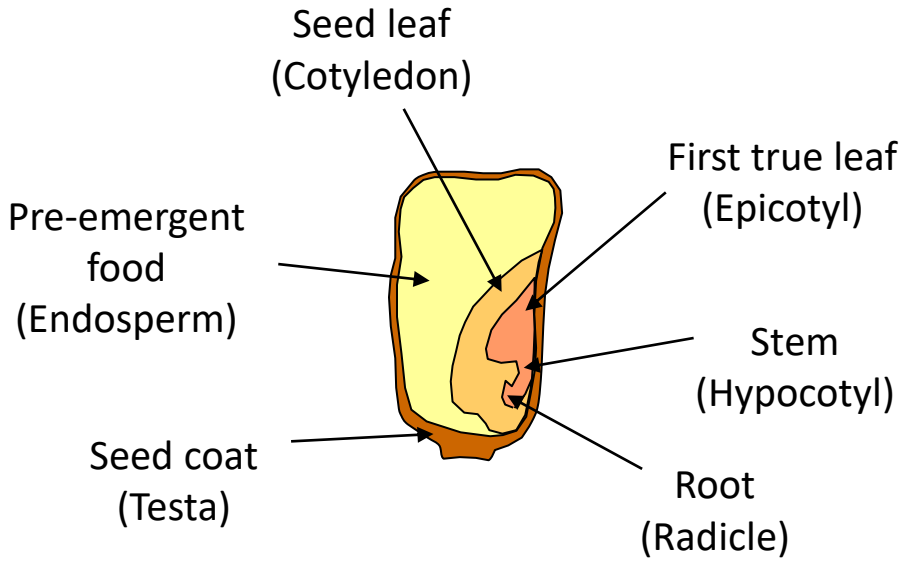


Brassica oleracea

What's in a seed?



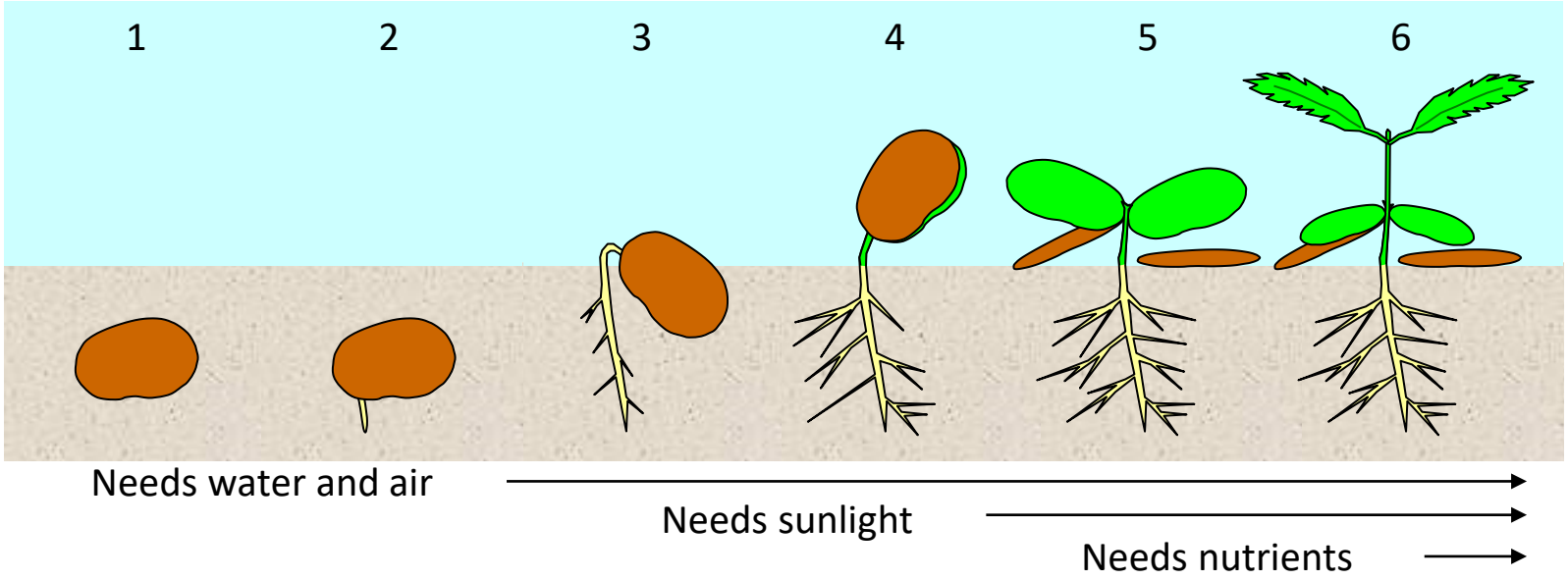
Bean Seed



Corn Seed

How seeds sprout

1) The seed is planted. The seed coat begins to absorb water.
2) The root pushes through the seed coat into the soil.
3) More roots begin to develop. The stem forms a hook pulling the seed through the surface of the soil.
4) The stem straightens out, pulling the rest of the seed above ground.
5) The seed opens and the seed leaves deploy. The seed coat may drop off.
6) The stem gets longer and the first true leaves emerge. The seed leaves eventually fall off.



Cost

4” plastic pot

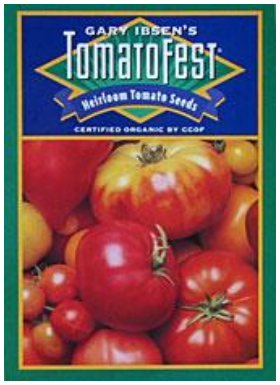
68c each

+

Seed starting mix

$6.98/8 quart bag

+



Tomato seeds

$5.95/pack

(35-40 seeds)

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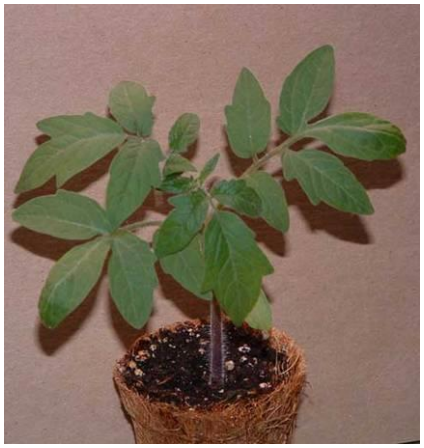


Number of plants	Pots	Seed starting mix	Seeds	Total cost	Cost per plant
1	$0.68	$6.98	$5.95	$13.61	$13.61
20	$13.60	$6.98	$5.95	$26.53	$1.33

Required Equipment – “Dirt”

- Seed Starting Mix a.k.a. Soil-less mix
  - Sterile – no fungus, no bugs
  - Very light – easy for seedlings to push through
  - Generally peat moss, perlite, vermiculite
- You can use potting mix
  - Generally heavier, a bit harder for seedlings to deal with
- DO NOT USE garden soil

Required Equipment - Pots

Jiffy-7

Peat pots

Newspaper pots

Seed starting One plant per pot

Plastic flower pot

20 row seedling flat

Seed starting Many plants per pot

Flower pot

Large flat

Final stage
One plant per pot

Required Equipment – Fertilizer

- Any balanced liquid fertilizer will do
  - Balanced means that the three numbers (Nitrogen, Phosphorus, Potassium) are about the same (e.g. 5-5-5)

Required Equipment – Misc.

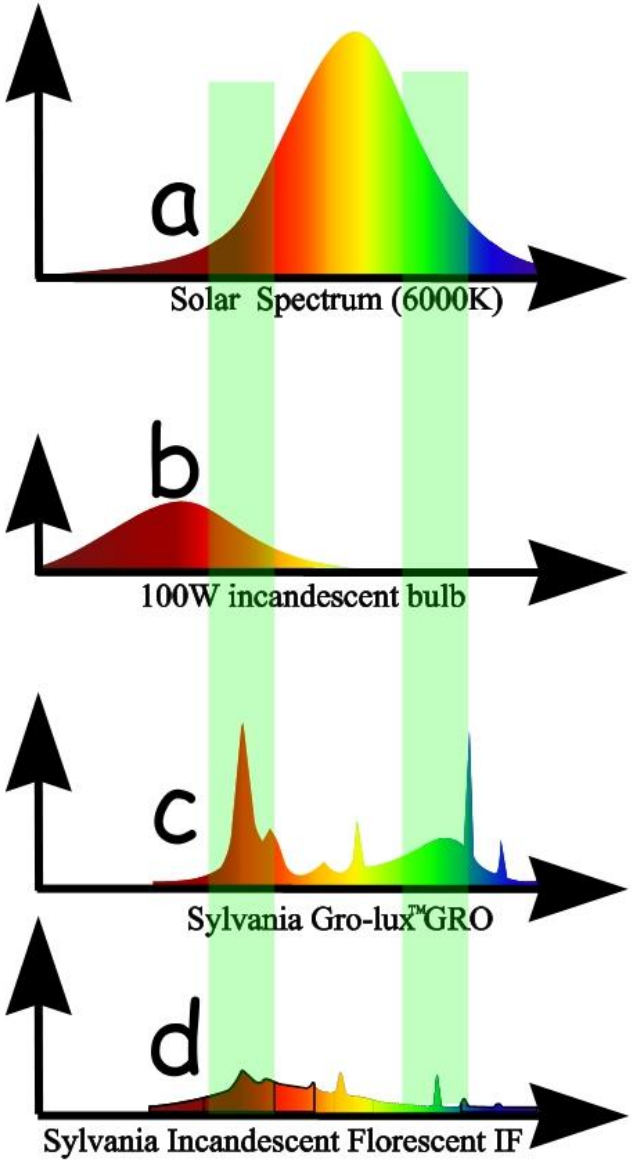
Labels

- Label when you plant, not the next day, because
- You will not remember which seeds you planted where, and
- All seedlings look alike

Watering tray

- Seedlings need to be watered a lot
- Bottom watering is best

Equipment you probably need – Light



If you have a sunny window or a greenhouse, you may not need supplemental light

Otherwise get a 4’ shop light

- Cool white bulbs
- Each light handles an area about 1’ wide x 3.5’ long
- Light is cool so it can be adjusted to almost touch the plants

http://resources.yesican-science.ca/tomatosphere/final/trans_absorption_band1.html

Mount lights within an inch of plants

Optional Equipment – Heat

- Seeds germinate fastest if soil temperature is about 75 degrees
- Options:
  - Radiator, refrigerator with heating element on top
  - Seedling heat mat (~$15)
  - Don't bother (they'll germinate soon enough)

Plant	Advertised germination time	Actual w/ heat mat
Alyssum	7 days	2 days
Calendula	10-14 days	2 days
Chamomile	7-14 days	3 days
Geranium	14 days	3 days
Kale	5-10 days	2 days
Lettuce	2-14 days	2 days
Marigold	7 days	2 days

Growing 1 Pepper – planting

- Start in late March or early April
- Pour hot water on a Jiffy-7 pot till the pot puffs out and looks dark
- Make sure the pot is right-side up.
- Scratch a shallow hole in the top of the pot
- Drop in 2 seeds
- Shove the dirt over the seeds and squeeze a bit to make sure there is good soil-seed contact.

Growing 1 Pepper – germinating

- Put the pot in a very bright window and rotate the pot every few days to keep the seedlings growing up. OR
- Put a fluorescent light directly above the seedlings (1 inch away)
- Keep an eye on the pot, looking for a bit of green poking up from where the seeds went in
- If you put the pot over a heat source (~ 70 degrees) the seeds will germinate quicker.
- Add water (bottom-water) if the pot doesn't feel cool.

Growing 1 Pepper – early growth

- Keep the light on 16-18 hours per day, off the rest of the time
- Water the pot when it feels warm.
- When the true leaves appear, add liquid fertilizer every time you water.

Fertilizer concentration should be adjusted as needed to apply fertilizer every time you water. For example, if label says:

"2-3 teaspoons (10-15 mL) per gallon (4 L) of water every other watering."

then apply 1-1.5 teaspoons per gallon of water every time you water

Growing 1 Pepper – the tough part

- With scissors, cut off the weaker of the two seedlings at the base.
- The alternative is to plant only one seed per pot, and throw out the pots where no seed germinated.

Growing 1 Pepper – transplanting

- When the roots grow through the side of the pot, it's time to put the seedling in a larger pot.
- Put about 1" of potting mix or seedling mix in the bottom of a 4" pot and firm it down.
- Strip the plastic mesh off the outside of the peat pot and set in the larger pot.
- Add more potting mix to fill the pot. The seedling should be planted at the same depth as before, and there should be ¼" to ½" space at the top of the pot for watering.
- Water the pot till the water runs out the bottom.

Growing 1 Pepper – more growing

- Put the pot in a very bright window and rotate the pot every few days to keep the seedling growing up. OR
- Put a fluorescent light directly above the seedling (1 inch away)
- Water the pot when the soil feels dry or warm. Add liquid fertilizer every time you water.

Growing 1 Pepper – hardening off

- About 1 week before you want to plant the outside, start hardening the plant off.
- Place the plant outside in the shade (tree shade, house shade, shade-cloth, etc.)
- Remove the plant from the watering tray, or else remember to empty it every time it rains.
- Water the pot when the soil feels warm or dry. Stop fertilizing

Growing 1 Pepper – planting out

- Dump the seedling out of the pot. If any roots are wrapping around the inside of the pot, pull them loose.
- Plant the plant in moist garden soil, preferably on a cloudy day.
- Water the plant in after planting to eliminate air pockets.
- Water weekly unless it rains.

Growing 25 Peppers – planting

- Start in late March or early April
- Fill a 4” pot with moist seedling mix.
- Scatter the seeds over the top of the soil.
- Cover the seeds with ¼” of seedling mix and firm it down to make sure there is good soil-seed contact.

Growing 25 Peppers – germinating

- Put the pot in a very bright window and rotate the pot every few days to keep the seedlings growing up. OR
- Put a fluorescent light directly above the seedlings (1 inch away)
- Keep an eye on the pot, looking for a bit of green poking up from where the seeds went in
- If you put the pot over a heat source (~ 70 degrees) the seeds will germinate quicker.
- Add water (bottom-water) if the pot doesn't feel cool.

Growing 25 Peppers – early growth

- Keep the light on 16-18 hours per day, off the rest of the time
- Water the pot when it feels warm.
- When the true leaves appear, add liquid fertilizer every time you water.

Growing 25 Peppers – transplant

- When the seedlings in the pot look crowded, it's time to separate them.
- Slide the root ball out of the pot and drop it gently on its side. This will loosen the root ball.
- Grab each seedling by a seed leaf and tease it out of the clump.
- Plant the seedling at the same depth it was growing in seed starting mix or potting mix in a larger pot
- If you put each seedling in a 2" pot, you will need to repot them again. If you put them in a 4" pot, it will take up a lot of space for a much longer time.

Cold Stratification

- Late fall / early winter plant seeds in damp sand or peat or 50-50 blend
- Store pot in fridge for at least 2.5 months
- Remove from fridge, add light, and start growing
- Or else plant outside in fall

<u>Recommended for</u>

Milkweed (*Asclepias*)

Lupine (*Lupinus*)

Pincushion Flower (*Scabiosa*)

Perennial sunflowers (*Helianthus*)

Spider Flower (*Cleome*)

…and many more

Soaking or Scarring

- Soak seeds overnight just before planting, or
- Scratch seed coating with sandpaper or knife

<u>Recommended for</u>

Joe Pye Weed

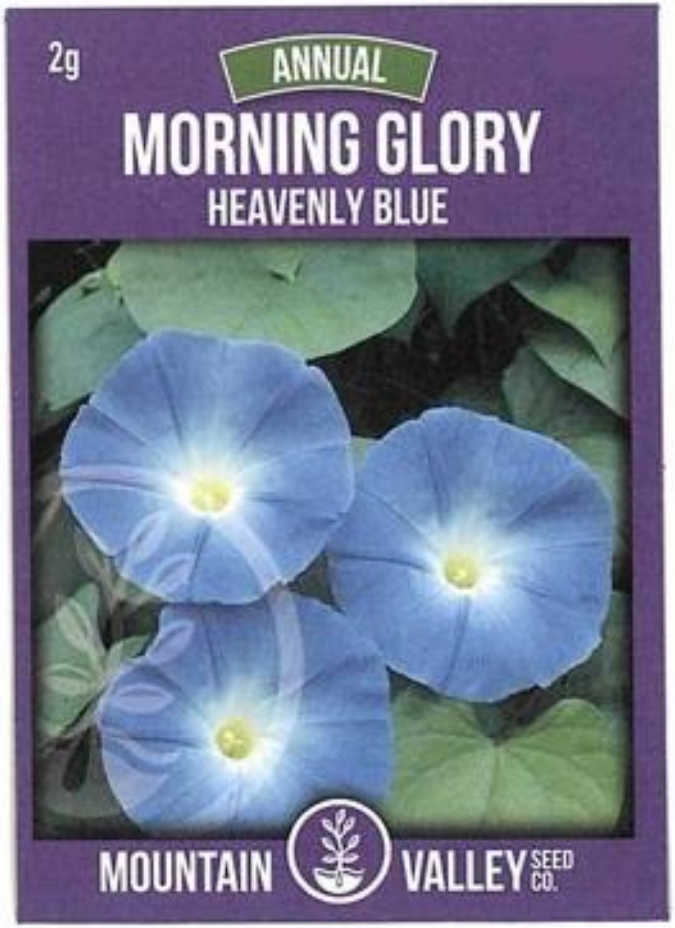
Lupine

Milkweed

Morning Glories

Nasturtiums

…and many more



To cover, or not to cover

- Some seeds require light to germinate
- Some seeds require dark to germinate
- Some are somewhat flexible

	Light (1)	Germination Temperature (2)	Growing Temperature (2)	Crop Time (3)
Annuals				
Snapdragon	L	70-75	60-65	8-10
Wax Begonia	L	70-75	60-65	10-12
Periwinkle (Vinca)	C	75-80	70-75	8-10
Celosia	C	75-80	70-75	7-9
New Guinea Impatiens	LC	75-80	70-75	8-10
Geranium	C	70-75	65-70	10-12
Petunia	L	75-80	65-70	8-10
Scarlet Sage (Salvia)	L	75-80	70-75	8
Coleus	L	70-75	65-70	8-10
Marigold	C	70-75	65-70	6-8
Pansy	LC	65-70	60-65	8-10
Zinnia	C	70-75	65-70	4-6

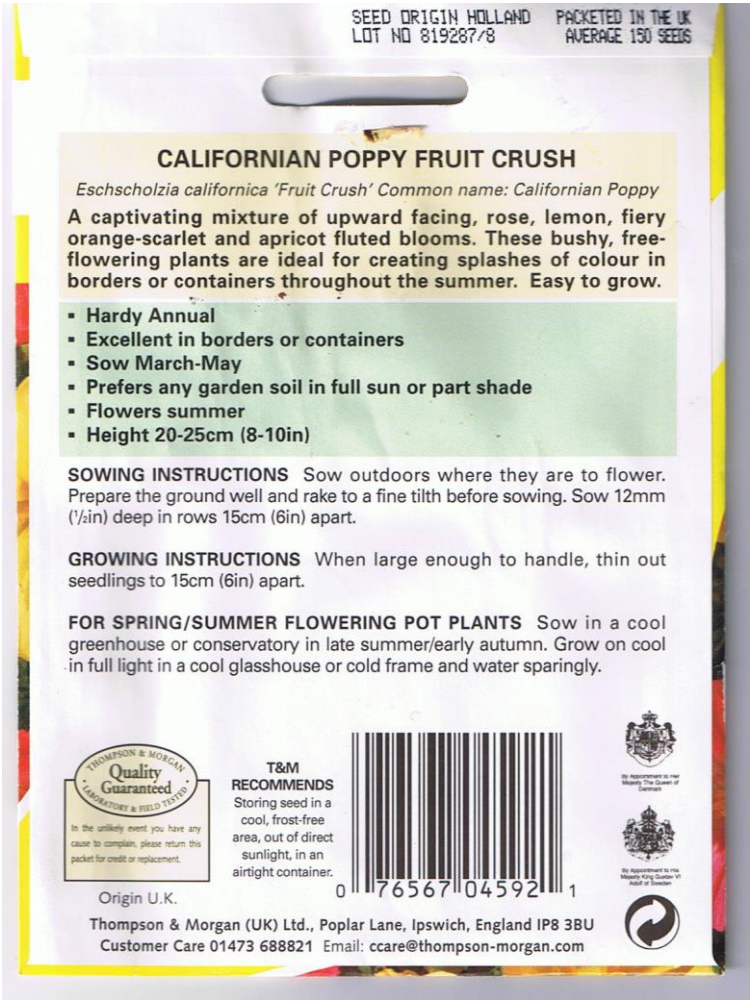
L = requires light
C – cover
LC – lightly cover

https://hortnews.extension.iastate.edu/2017/01/seed-germination-guide

Marigolds

"Sow in average soil after danger of frost" means time from seed to bloom is relatively short (6-8 weeks)

Poppies



"Sow outdoors where they are to flower" means they hate to have their roots disturbed. The "growing 1 …" approach will work. The "growing 25…" will not.

What can go wrong

- Dry seedling mix / potting soil will shed water. If you start seeds in dry mix, get a mister and keep misting the soil with warm water till it finally starts absorbing the water
- If you get the seeds wet and then let them dry out, they will die. They are very vulnerable from the time growth starts till when the first 2 true leave appear.
- If you don't give the plants enough light, they will get very gangly. You can mitigate this somewhat when the plant is bigger by pinching the plant to encourage branching, but it is better to avoid.
- If you let the plant get root bound, it will never be as strong as if you can let it grow unbound.
- If you cover the seeds with a clear dome, it increases the chances of damping-off disease.

Resources

- How to start seeds
  - https://extension.umn.edu/planting-and-growing-guides/starting-seeds-indoors#watering-and-fertilizing-1179613
- How long do seeds last
  - https://www.johnnyseeds.com/on/demandware.static/-/Library-Sites-JSSSharedLibrary/default/dw913ac4d0/assets/information/seed-storage-guide.pdf
  - https://extension.colostate.edu/topic-areas/yard-garden/storing-vegetable-and-flower-seeds-7-221/
- Which seeds to get:
  - Seed Savers Exchange (9,153 tomato listings versus 134 in Johnny's)
  - Cornell Vegetable Varieties (http://vegvariety.cce.cornell.edu/main/login.php)
  - All American Selections
  - Beecology project (https://gegearlab.weebly.com/plant-list.html)
  - Missouri Botanical Garden plant finder

Division and Separation

- Creates more plants
- Rejuvenates older plants
- Controls spread of plants

Division / Separation – Timing

- Ideally
  - Divide spring and summer bloomers in fall
  - Divide fall bloomers in summer
- In reality
  - Avoid mid-summer (unless you water)
  - Give time for roots to establish themselves before ground freezes
  - Divide when you see there's a problem – generally lack of flowers

Root systems

- Spreading root systems (e.g. bee balm)
- Clumping root systems (e.g. daylilies)
- Stolons (e.g. strawberries)
- Rhizomes (e.g. irises)
- Tubers (e.g. dahlias)
- Bulbs / Corms (e.g. daffodils, lilies)

Spreading / Clumping Root Systems

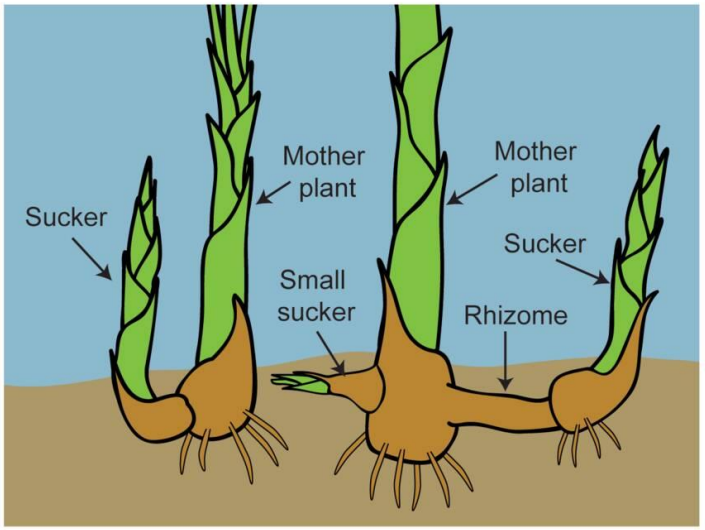
- Ideally
  - Water the plant a day or two before dividing
  - Pick a cloudy day to divide the plant
  - Dig the plant up
  - Shake or wash the soil off the roots
  - Separate the plant by hand, knife, shovel, or fork
    - At least one growing point per division
  - Replant immediately
- In reality
  - Can just cut out a portion of a plant in the ground

Spreading / Clumping Root Systems

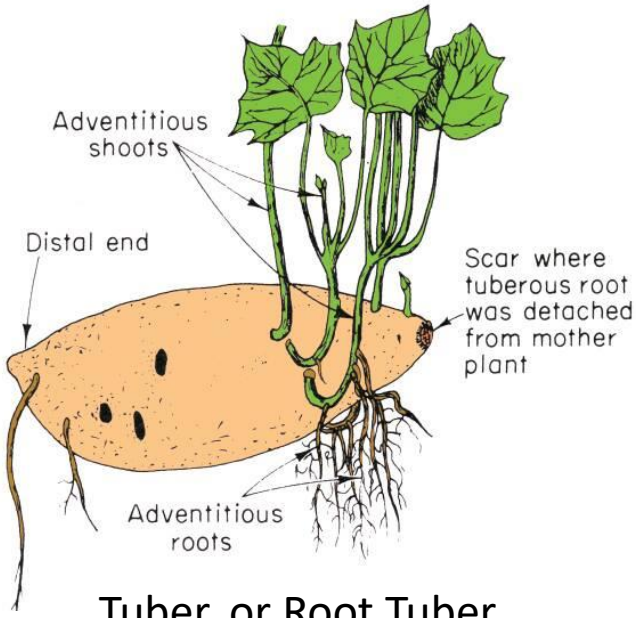
Stolons

- Check that the daughter plant is well rooted by tugging on it gently
- Cut off the stolon at both ends

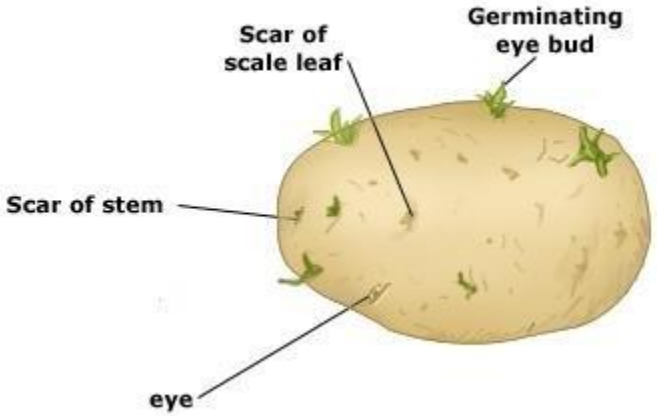
Rhizome, Stem Tuber, Tuber



Rhizome



Tuber, or Root Tuber



Stem Tuber

https://propg.ifas.ufl.edu/terms.html

Rhizomes

Leptomorph

- Literally “thin thing”
- May generate several new shoots in a year.
- Examples:
  - Pachysandra
  - Lily of the Valley
  - Running bamboo
- Divide like spreading/ clumping root systems

Pachymorph

- Literally “thick thing”
- Generates one flowering bud at end of growing season
- Examples:
  - Iris
  - Trillium
  - Clumping bamboo
- Divide as follows:

Rhizomes

- Water the plant a day or two before dividing
- Pick a cloudy day to divide the plant
- Dig the plant up
- Shake or wash the soil off the roots
- Cut off and discard any shriveled rhizomes
- Cut off and discard any rhizomes that do not have leaves
- Separate the remaining rhizomes into sections with one fan of leaves each
- Replant immediately; take care to plant at the same depth as before you dug it up

Rhizomes

Spotted Trilliums
(*Trillium maculatum*)

Dig up the clump

Remove the clump from the hole

Get some of the soil off

Start breaking them apart

Keep breaking them apart

Until they’re all separated

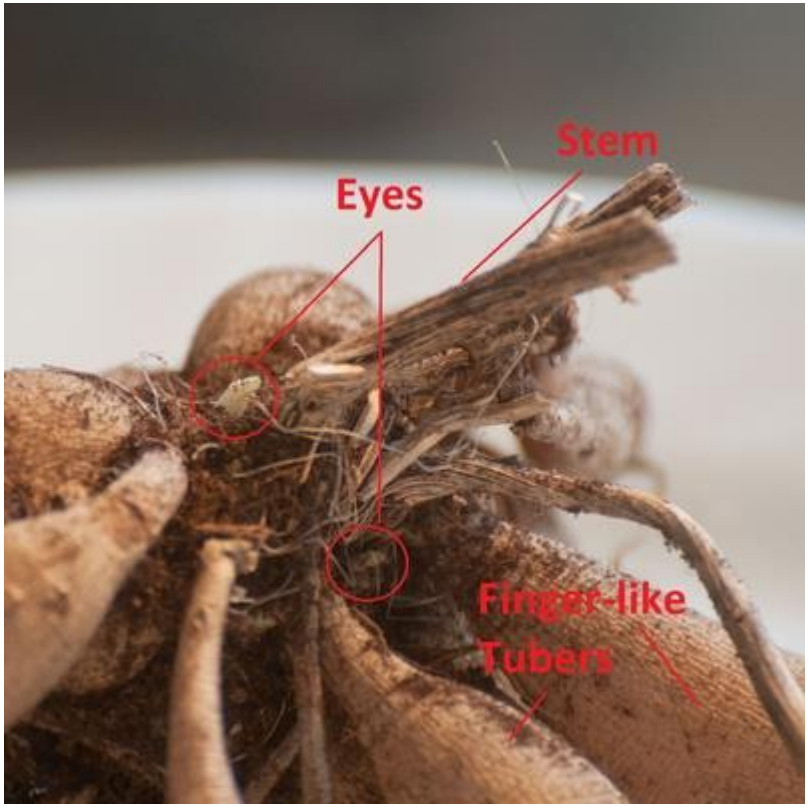
Trim the roots

And replant

Tubers

- Lift the clump of tubers out of the ground and brush off the soil
- Cut away the thin roots so it's easier to see what you're doing
- Divide the clump with pruning shears or a sharp knife
  - Make sure each division has a tuber with an eye
  - It's ok (and easier) to include part of the old stem
- Discard any tubers that don't have eyes or are soft
- Advice varies on whether to divide in spring or fall
  - Professionals divide tubers in the fall (easier to store)

Tubers



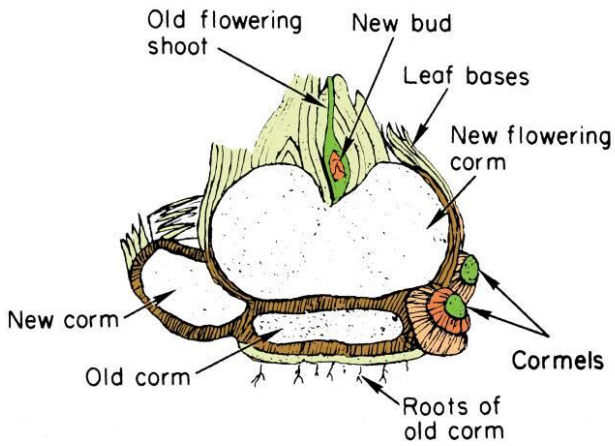
Potatoes (Stem Tubers)

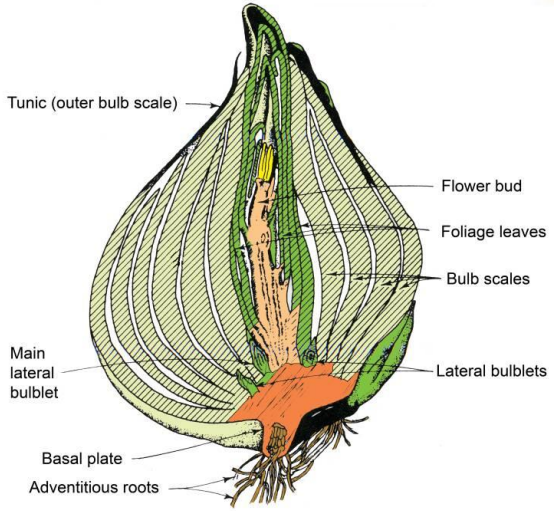
1) Cut potato apart so each piece has 2-4 eyes (buds)

2) Set them to dry somewhere out of the sun for a few days till the cut scabs over.

3) Plant cut side down in a trench

Corm versus Bulb





https://propg.ifas.ufl.edu/07-geophytes/02-othergeophytes/02-geophytes-corms.html

https://propg.ifas.ufl.edu/07-geophytes/01-bulbs/02-geophytes-bulbs.html

Bulbs and Corms

Overgrown patch of daffodils – lots of leaves, no flowers

Dig the patch up with spade or fork

Replant individual bulbs

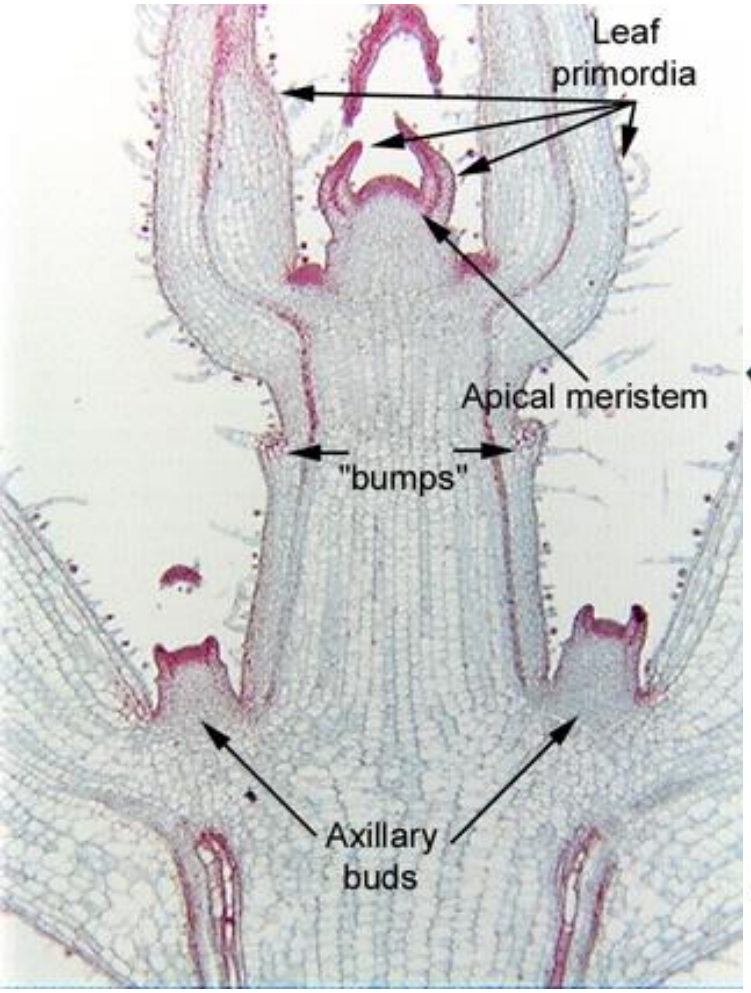
Should all bloom next year

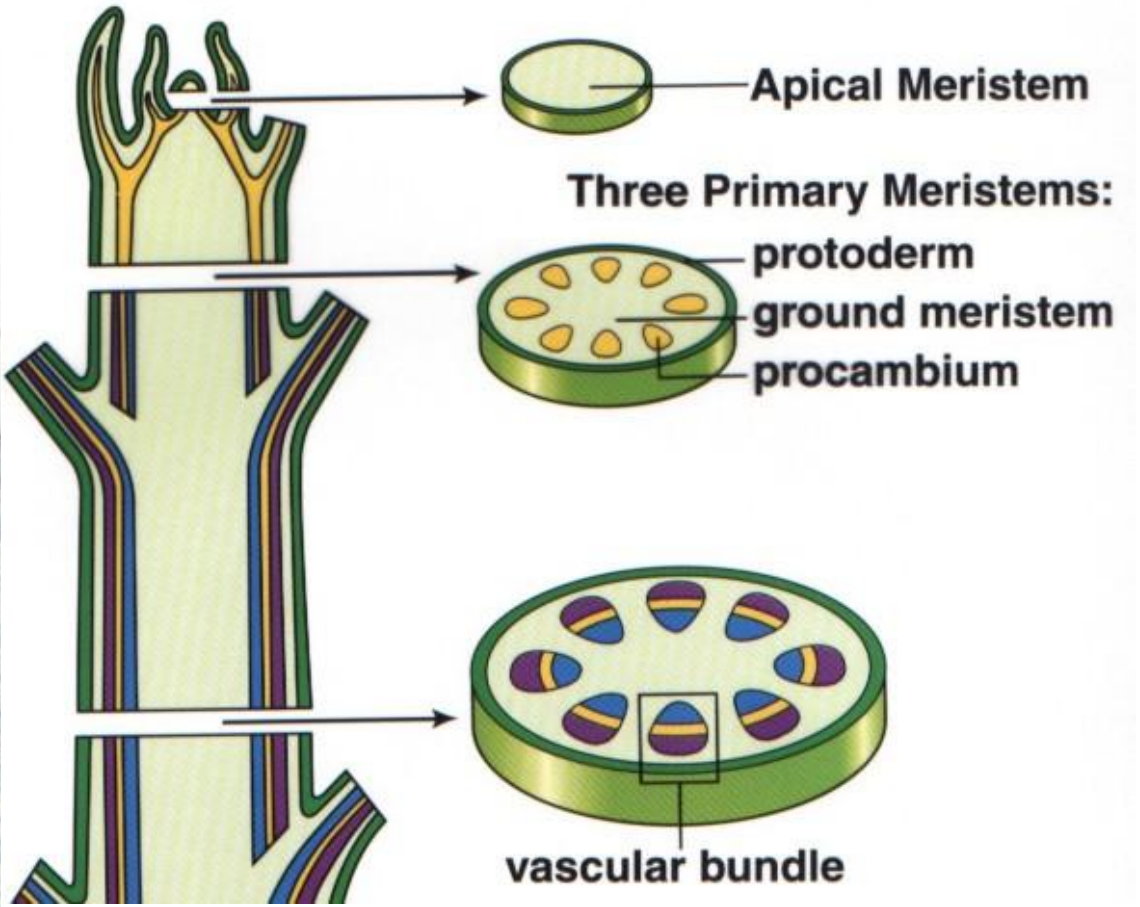
“Sports”

Cuttings

- Kinds of cuttings
  - Stem
  - Root
  - Leaf
- Vocabulary
  - Totipotency – the ability of any individual cell to produce all the other cells in an organism
  - Differentiation – the process where a meristem cell generates specialized cells, such as xylem, phloem, bark, epidermis, etc.
  - Dedifferentiation – the process where a specialized cell turns back into a meristem cell

Stems

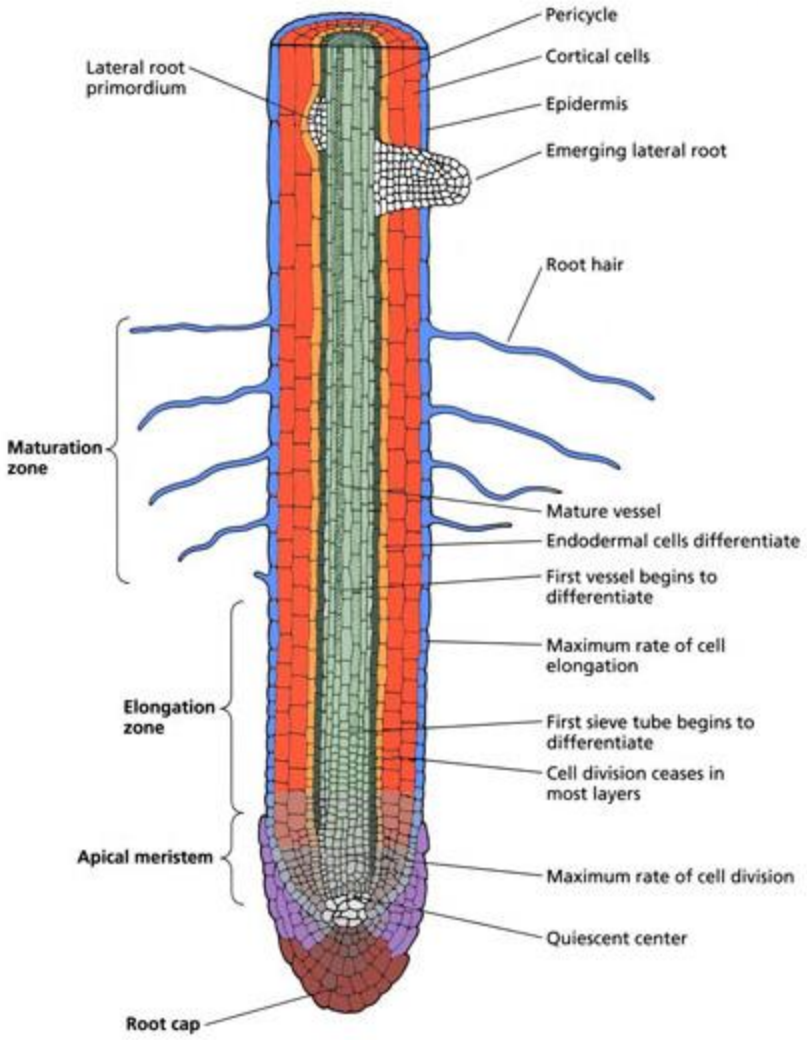




http://www.sbs.utexas.edu/mauseth/weblab/webchap6apmer/6.1-1.htm

http://www.bio.miami.edu/dana/226/226F09_5.html

Roots



Mature zone
- Most cells are mature
- Root hairs have sheared off
- Lateral roots may form

Maturing zone
- Root epidermis form root hairs to maximize surface area for absorbing nutrients
- Some cell lengthening

Elongation zone
- Cells differentiate (take on different functions)
- Cells grow longer – this is primary mechanism for root growth

Cell Division zone
- Makes more cells

Root Cap
- Perceives gravity
- Protects growing tip of root
- Excretes lubricant (mucilage)

http://vannocke.hrt.msu.edu/plb865/29oct/structuredevel.html

Stem Cuttings – in general

After a plant is cut or wounded:

- The cut scabs over to protect against drying out and disease
- Buds in the cut piece generate phytohormones
  - Auxins: promotes root development
  - Cytokinins: promotes shoot development
- The phytohormones cause cells behind the scab to dedifferentiate and become meristems
  - Which cells dedifferentiate is different for different species
- The meristems generate roots

The trick in rooting cuttings is to take the cutting when the plant generates the best combination of phytohormones.

Stem Cuttings

- Softwood cuttings
  - Taken from woody plants during spring and early summer
  - Stem is still green but not too succulent
- Semi-hardwood cuttings
  - Taken from woody plants during late summer and early fall
  - Stem is brownish
- Hardwood cuttings
  - Taken from woody plants in winter when the plant is dormant
- Herbaceous cuttings
  - Taken from herbaceous plants (not trees and shrubs)

Softwood Cuttings - Hydrangea

Butterfly cutting (top)

Double-eye single node cutting (middle)

Single-eye single node cuttings (bottom)

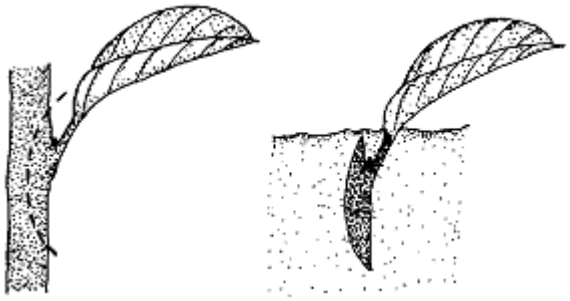
From NDSU PLSC 368 Plant Propagation lecture

Stem cuttings – Process

- Research the right time of year to do the cutting
- Cut off the stem with a sharp knife or by-pass pruners. Select a very healthy looking stem.
- Keep the end moist (wrap in damp paper towel till ready to proceed)
- Cut the stem into sections – at least one bud per section, ideally 2”-8” long
- Consider moistening the root end of the cutting and dipping it in rooting hormone (IBA – synthetic auxin). Knock off the excess.
- Poke a hole larger than the stem end in dampened growing medium (sand, vermiculite, perlite, coir, etc.). Put the stem in the hole and firm the medium around it.
- If the cutting has large leaves, consider cutting them in half.
- Consider placing the pot in a baggy to increase humidity.
- Place the pot in shade and keep it moist.
- After 2-4 weeks, tug gently on a cutting. If it resists, it has rooted and can be transplanted into soil.

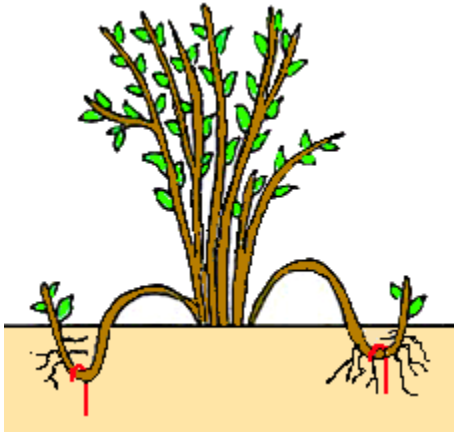
Stem cuttings – helpful hints

- Stem cuttings have polarity – they know which end should develop roots
  - If you put the cutting in upside down, roots will form on the top
  - Some people cut the root end at an angle and the top end flat to tell the difference.
- If the root zone is 10 degrees warmer than the air, the cutting will root faster
- Double-eye cuttings seem to have higher success rate than single-eye cuttings
- Can also try leaf-bud cuttings

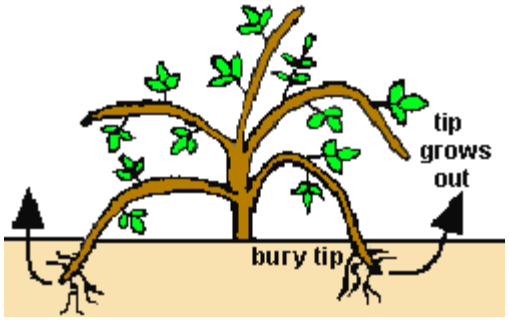


Layering – Easy Stem Cuttings

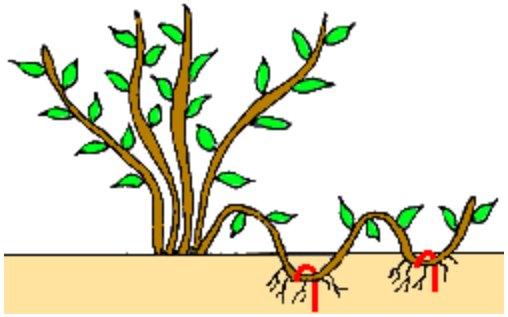
Notch stem and place in contact with moist growing medium



Simple layer

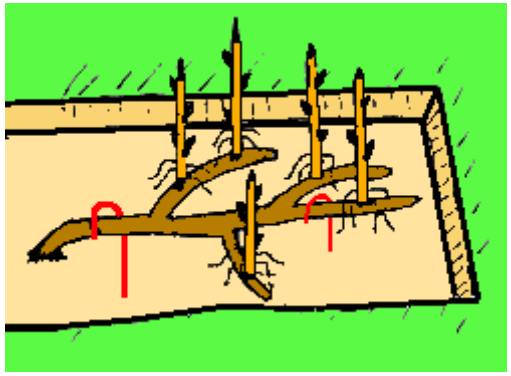


Tip layer

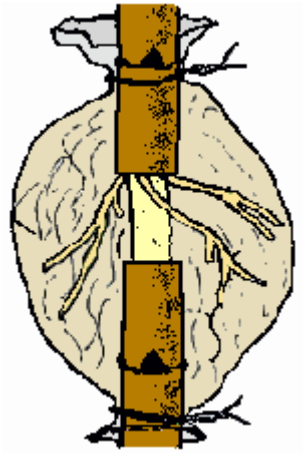


Serpentine layer

Mound layer



Trench layer



Air layer

From http://hort201.tamu.edu/YouthAdventureProgram/AsexualPropagation/AsexaulPropagation.html

Root cuttings

- Timing
  - Generally done in very early spring just before plant breaks dormancy – when the plant has the most energy stored in the roots
  - Can try it any time
- Plants with large roots
  - Cut pieces of root 2” – 6” long.
  - Store at 40 degrees for 3 weeks in moist sawdust, peat moss or sand
  - Plant horizontal about 2-3” below soil surface
- Plants with small roots
  - Cut pieces of root 1” – 2” long
  - Plant horizontal about ½” below soil surface
  - Keep evenly moist till shoots emerge

Leaf cuttings

Mostly for house plants and tropicals (e.g. African violet, begonia)

Leaf-petiole
(African violet)

Leaf blade
(Jade plant)

Leaf vein
(Rex begonia)

From http://www.hort.purdue.edu/ext/ho-37web.html

Tools

Garden spade
- Dig plants out of the ground without disturbing their neighbors
- Divide plants

Pull-stroke pruning saw, blade length 4”-7”
- Divide plants
- Trim root-bound plants
- Dig up stumps

Bypass pruners
- Trim broken roots and stems
- Take cuttings

Garden fork
- Pry plants out of the ground with most of their roots
- Divide plants (need 2)

Reciprocating saw
- Divide plants in ground or out

Sources

- Propagation lecture series
  - http://www.ndsu.edu/pubweb/chiwonlee/plsc368/lecture/chap1.htm
  - http://www.ces.ncsu.edu/hil/hil-8700.html
  - https://propg.ifas.ufl.edu/index.html
- Michael Dirr, The Reference Manual of Woody Plant Propagation
- Dr. Leonard Perry, Herbaceous Perennials Production: A Guide from Propagation to Marketing
- Dividing perennials
  - http://www.clemson.edu/extension/hgic/plants/landscape/flowers/hgic1150.html
- List of what cuttings work for trees and shrubs
  - Debbie Lonnee, Nancy Ross, Don Selinger, and John Whitman, Growing Shrubs and Small Trees in Cold Climates
  - https://content.ces.ncsu.edu/plant-propagation-by-stem-cuttings-instructions-for-the-home-gardener#:~:text=Herbaceous%20cuttings%20are%20made%20from,and%20they%20do%20so%20quickly.
- List of propagation techniques for perennials
  - https://s3.wp.wsu.edu/uploads/sites/2076/2017/07/C101-Propagating-Perennials-15a.pdf

Questions?