

Propagation

Sexual Propagation from seed

Fertilization: pollen + egg = new individual.

- **Self-pollinating**-pollen loosens from the male stamen sticking to the pistil of the same flower resulting in offspring identical to parents
- **Monoecious**- plants that have male and female flowers on the same plant
- **Cross pollination**- (natural hybridization) pollen from a different plant within the same species pollinates the egg from another plant. The resulting hybrid offspring have characteristics from each parent ie) most of the offspring will look different
 - hybrid seed generated is known as the **F1 generation**
- **Dioecious**- plants that have male and female sex organs on different individuals
 - need a male and a female plant to generate seed/fruit

Harvesting Seed

- helps maintain: heirloom varieties, plants no longer commercially available and genetic diversity
- only collect seed from strong, healthy, pest free plants
- if collecting from the wild take only a few seeds from a number of different plants
- ensure the seeds are labeled with variety and date of collection
- collect just before seeds are naturally dispersed
 - dry fruit**-seeds ripen and disperse within a dry structure
 - can collect seed heads and allow to finish drying in a paper bag, seeds will fall into bag ex) poppies
 - fleshy fruit**- seeds need to be released from inside the fruit, may need to be fermented (tomatoes)

Storing Seed

- keep dry in dark, airtight containers or bags in a consistently cool (4C)
- seed life varies ex) calendula and onions 1 year, snapdragons and tomatoes 10 years under optimal conditions, some even longer under ideal conditions
 - seed packets or catalogs often contain this information

Seed Germination

- are held in suspended animation awaiting favourable conditions to germinate
- viable seeds will germinate with:
 - sufficient moisture and oxygen
 - favourable temperature
 - dark or in some cases light
- **Quiescence**-state where a viable seed is ready to germinate once favourable conditions arrive
- **True dormancy**-seeds require additional environmental conditions or cues for seed to enter quiescence
 - ex) scarification and stratification

Breaking Dormancy

External Dormancy-is an adaptive strategy to keep seeds dormant until favourable conditions for germination and growth are available ex) spring, wet season

- seeds have thick hard outer coats that needs to be worn away in order for moisture to enter, prevents moisture from entering too early
- **Scarification**- process of etching minute openings into seed coat
 - occurs naturally through freezing and thawing, microbial activity over the winter, acid exposure in mammal stomachs or scratching in bird crops
 - seed coat then becomes permeable to water and gases
 - gardeners can mimic these processes artificially:

- **mechanical**- nicking with a file, sandpaper, hammer
- **hot water**- soak in hot water for 24 hours
- **acid** -soak in sulfuric acid, rinse thoroughly afterwards
- **fire**- needed to etch very thick seed coats ex. eucalyptus
- scarified seeds must be planted immediately after treatment

Internal Dormancy- is another adaptive strategy to ensure timely germination

- regulated by inner seed tissues, have growth inhibitors or other barriers that prevent germination
- **after-ripening**-a period when the embryo continues to mature and all systems get ready for germination
- **staggered germination**- an adaptive strategy to ensure some plants make it
- **allelopathy**- chemical inhibitors secreted by seed coats and plants to prevent other seeds and plants from developing and competing for resources
- **Stratification**-a period of moist/cold/warm that ensures seeds germinate at the optimum time of year, required by plants in temperate zones that experience winter
 - gardeners can mimic this process artificially:
 - **Moist chilling**-mix seeds with moist medium and store in fridge (mimics fall sowing)
 - **Warm stratification**-seeds mixed with moist medium and kept at 20-30 C
-(mostly plants of tropical origins)
 - **Red light**-mechanism that allows seeds to respond only to increased levels of red light (early spring before leaves come out)
 - ensures adequate sunlight before trees leaf out and create too much shade, ex) seeds of plants in deciduous or tropical forests
- Some seeds require both scarification and stratification to germinate. This serves to wash away all chemical inhibitors and soften the seed coat.

Moving out of quiescence

- when conditions are optimal the seed breaks dormancy and enters quiescence
- this is followed by a period of intense activity that is never again repeated in a plant's life
 - requirements for germination include: optimum light, moisture, temperature, and oxygen
 - some plants have specific requirements (temp, light) which need to be determined
 - can be found on seed packets, catalogues and books

Water

- when water is absorbed through the seed coat it causes the cells to expand, allowing the endosperm to swell cracking the seed coat

Light

- can either inhibit or stimulate germination ex) red light

Oxygen

- even when seed is dormant some oxygen is required for metabolic processes
- oxygen aids in the break down of large food molecules into smaller easily transportable units

Temperature

- seeds have a minimum, optimal and maximum temperature to germinate
- 18-24 C is the best range for most plants but consider area where plants grow to determine optimal range
- after seeds have germinated most prefer to be grown on in cooler conditions
- most appreciate temperature differences between night and day

Germination

- first sign of germination is the root radicle emerging from the seed
- soon a plumule (the young shoot or stem) starts to emerge

Dicots- plants have two cotyledons (seed leaves) in their seeds

- dicots emerge from the seed in two different ways
 - **epigeal germination**- seed leaves (cotyledons) emerge from the seed coat and start to

- photosynthesize supplying energy until the first set of true leaves forms
- **hypogeal germination**-cotyledons stay inside the seed coat under the soil surface supplying food to the young plant until leaves develop for photosynthesis

Monocots- have only one cotyledon in their seeds

- monocots' seeds stay below ground and a single blade emerges

Starting Seeds Indoors

- **Growing Media**
 - soil needs to hold moisture, drain well and fine particles
 - soilless mixes are best for seeding (coir or peat base)
- **Containers**
 - must have drainage holes and be at least 5 cm deep (deeper for transplanted seedlings)
 - clay and plastic are the most commonly available
 - if reusing should be washed out with 10% bleach solution and rinsed well
 - young seedlings are usually transplanted into larger pots before planting out
 - amend soil with worm castings, compost, etc
 - peat or coir pots/disc and newspaper pots can be used for plants that dislike root disturbance

Sowing Seeds

- timing is critical as seeds started too early will become weak and leggy by planting time
- check seed packets for cultural data and sowing time, can add an extra week for Calgary
- to determine if seeds need to be started early look at days to maturity
- journals help keep track of start and transplanting dates
- **To start:**
 - moisten seed mix with warm water and prefill clean containers
 - plant seeds on surface two per cell or loosely scattered over top
 - most seeds require a light covering with fine sand or seed mix
 - tiny seeds should not be covered but ensure have good contact with soil
 - spritz with warm water to ensure good contact between seed and soil
 - cover with clear hood and place somewhere warm

Damping Off is a fungal disease that attacks newly emerged stem tissue at soil level, will kill seedlings very quickly

- prevention is key- good air circulation, clean equipment
- **Cinnamon, chamomile tea** also have antifungal properties

Emergence:

- once seedlings emerge gradually remove hood
- water seedlings from below, ensure all cells draw up water
- once seedlings have two sets of true leaves can transplant into larger containers
 - fill containers with fresh amended soil, poke hole in the soil
 - holding **leaves** gently scoop out roots and replant into new pot filling in with soil
 - spritz to firm soil, hold off watering for a day
 - keep seedlings sheltered until settled in
- There will be some initial plant shock but with care will recover.

Growing on Seedlings

- most seedlings prefer to grow on in cooler conditions with a lower night time temperature
- to encourage bushy, compact plants seedlings need adequate light, good air circulation and fertilization
 - **light**- south facing window, fluorescent lights, etc
 - light should be about 10 cm above seedlings at all times, 14-16 hours per day
 - **air circulation**- a small fan creates gentle movement ensuring good air circulation
 - **fertilizer**-feed every other watering with very dilute fertilizer
 - never fertilize dry soil

Hardening Off

- seedlings grown indoors are tender, acclimate gradually to outdoor conditions
- start in a shady protected spot and gradually expose them to more sun and wind over 3-5 days

Planting

- prior to planting acclimatized seedlings water well the day before.
- water planting bed the day before. This allows the soil to warm back up.
- Remove carefully from pots, gently loosen tangled roots, place in pre-dug hole and gently fill in.
- Water in gently the next day, decreases transplant shock.
- Follow the same procedure with biodegradable pots, ensure the rim of the pot is buried below soil
- best to plant when cloudy or in the cool of the evening
- can protect new seedlings with a light cover such as Remay for a few days

Direct Sowing

- cool season vegetables and annual flowers can be direct seeded into the garden, many prefer it
- root vegetables and herbs must be direct seeded
- spinach, lettuce, peas and greens can be sown in the fall, will come up earlier (self seeders do this)
- remove weeds first, water soil well prior to planting and keep well watered until germination occurs and seedlings are established
- only varieties with short maturity lengths are suitable for direct seeding
- soil temperature determines appropriate seeding time, some can be planted well before the last frost (onions, lettuce, chard, radishes, spinach), others need warmer soil (cukes, carrots, beans, squash)
- thin seedling out to desired spacing once they have a couple sets of true leaves
- cut off or pull out unwanted seedlings, can eat the baby plants in most cases

Asexual Propagation

- involves the vegetative parts of a plant so are genetic clones of the parent
- pieces from the parent plant (**stock plant**) such as stems or roots are removed and under favourable conditions will form roots and become new plants
- many plants can be propagated numerous ways others are more particular so do some research
- only propagate healthy and vigorous plants

Mediums: can use perlite, damp sand, potting mixes to start cuttings

Underground Shoots or Stems

- are modified stems that can be removed or cut from the parent and rooted to create new identical plants
 - **rhizomes**-stem tissue that can produce buds and shoots (iris and many perennials)
 - **runners or stolons**-above ground shoots that form roots at the nodes that can be removed and planted (strawberries, mint)
 - **suckers**-shoots arising from ground level that when rooted can be dug up during dormancy and replanted (raspberries, roses)

Divisions

- dividing perennials is done to rejuvenate an older plant with declining vigour
- dead center, decrease in flowering, crowded stems and decreased vigour are signs that a plant needs rejuvenation
- involves lifting the root ball and splitting it into several pieces
 - dispose of old inner growth while maintaining young outer growth
 - ensure each new piece has a good chunk of roots
- water soil, replant pieces, mulch with compost and **water in well the next day**
- replant asap or pot up, keep divisions moist and shaded until ready for planting
- when dividing perennials: spring bloomers after flowering, summer bloomers in spring

Crowns

- plants that have several buds or shoots around the base of the parent (rhubarb)
- divisions must have a 2-3 shoots or buds and some roots for new plant to take

Offset or Offshoots

- are similar to crowns but arise from dormant buds on the stem above ground
- remove with a clean sharp knife, buds readily form roots (succulents)

Tubers and Tuberous Roots

- **stem tubers** have **nodes and buds** (eyes on a potato), tuber can be cut up into pieces containing a least one eye, new roots will develop below and eventually produce more tubers
 - parent tuber is exhausted during the process and dies
- **tuberous roots** have only **nodes** (dahlias, begonias)
 - tuberous roots must have a small section of stem attached to the tuber where new shoots will develop and grow

SEPARATION - commonly used with bulbs and corms

Bulbs

- over time, new bulbs grow beside original bulb; may cause overcrowding
- every 3-5 years bulbs can be dug up, usually after growing is finished; leaves have died back
- old bulbs are removed; largest and most viable of the new bulbs are re-planted

Corms

- corms are annuals; new corms form on top of the old depleted one
- cormels or cormlets can be removed and grown on until large enough to flower

CUTTINGS - many plants are propagated by cuttings

- Piece of parent plant is removed, rooted to create an identical plant
- Cuttings require high humidity, indirect light and soil temperatures of 20-25°C

Stem Cuttings

- When a cutting is made, xylem and phloem cells are injured, a callus is formed allowing root growth
- Use a clean sharp knife or razor blade, can dip cut end in rooting hormone to assist root growth
- Place rooting medium in sterile container, moisten and tamp down firmly
- Poke a hole in medium, insert cutting with node below the surface and tamp gently in place
- Cover with plastic bag or clear cover to maintain humidity
- Place in indirect light in a warm place; monitor moisture level
- After a few weeks, test cutting for roots by gently tugging at the cutting, can take several weeks
- If there is resistance, roots have begun to form, and the cover may be gradually removed.

Hardwood cuttings

- Use dormant 1-2 year old woody material collected in fall after leaves have fallen
- Cutting needs two to three buds about 6-12 mm in diameter, cut bottom on angle, top level
- Bury lower node with bud below ground level, can be buried over winter and planted in spring
- Used for deciduous shrubs such as willows, roses, aspen, dogwoods

Semi-hardwood cuttings

- Cuttings collected from partially mature wood of the current season's growth
 - usually mid-July to early fall
- Cuttings should have 2-3 nodes, 3-4 leaves, a firm stem and the start of woody tissue
- Plant up asap and keep moist
- Used for many broadleaf evergreen shrubs and conifers (*Thuja*, *Juniperus* species)

Softwood cuttings

- Use current year's growth, not yet woody just as it begins to harden (May, June, July)
- Make cut just below a leaf node, will root quicker
- Water stock plants in well prior to taking cuttings
- Place in moist soil and keep humid until roots begin to grow
- Good for Clematis, Apple, Maple, woody herbs- rosemary, lavender

Herbaceous cuttings - e.g. coleus, chrysanthemums, dahlias

- Choose vigorous, new growth with no flower buds
- Cut 7.5 - 12.5 cm piece of stem, 2-4 leaf nodes, remove leaves on bottom half
- Place in moist soil, keep humid, tug gently after a week

Leaf Cuttings- only works with a limited number of plants as most plants will produce roots, but no new plant

Whole leaf

- Remove leaf with 2.5 cm of petiole, push petiole into rooting medium until leaf blade touches medium
- Cover for humidity, one or more new plants will form at base of petiole
- Leaf may be removed from new plants when they have their own roots; petiole may be reused
- Works with African violet family members

Leaf blade

- Used for plants with sessile or petiole-less leaves
- Gently tear leaves away from stem, must have piece of stem tissue; allow to dry then lay on soil surface
- Roots form first then new leaves (these leaf cuttings don't need humidity, can cause rot)
- Works well for succulents (*Echeveria*, *Crassula*, *Sedum* etc.)

Split veins

- Take leaf, slit veins on the lower surface, place cutting slit side down on growing medium, ensure contact
- New plants will form at each cut, will root and produce young plantlets, keep humid until new plants appear
- Good for Begonia family members

Leaf sections - used with Sanseveria and begonias

- Cut leaves into 2.5 cm square sections; must include at least one vein, place sections flat on medium
- Roots are produced; new plant grows at end of leaf section, keep humid until new plants appear

Leaf-bud

- Remove a leaf, petiole and short piece of stem with a leaf bud attached
- Plant up with stem in rooting medium, keep humid and moist and expose bud to light

Root Cuttings

- Some plants have the ability to produce above ground shoots from a piece of root
- Some develop root systems before producing new shoots
- Best taken from 2-3 year old plants during dormant season when they have a large carbohydrate supply
- Select new, vigorously growing roots (often pale coloured), take cutting 2.5 – 10 cm long
- Essential to ensure orientation: make slanted cut on the bottom and straight cut on the top
- Place cutting vertically into the growing medium level with top of medium
- If roots are **dormant** when the cutting is made, a period of artificial 'winter' is needed
 - place the cutting in a plastic bag with moist rooting medium, store in a fridge for 3 weeks
 - remove and plant root upright in growing medium
 - provide bright light and moisture (tent it in a plastic bag) until it begins to grow
- If plant is **growing** when the cutting is made, simply place cuttings into rooting medium and keep humid and moist in protected spot until growth appears
- Hardening them off and planting outside can then occur in the same growing season

LAYERING

Layering happens naturally when a branch comes into contact with the soil promoting root formation.

Tip layering – commonly used with raspberries, vines and shrubs

- Bend stem or branch over to touch the soil; peg in place, cover with soil, leaving tip exposed
- Make a small cut in the stem where it is covered to encourage roots to grow more quickly
- Rooting can take most of a growing season so don't separate from parent until next season
- Best done toward the beginning of the growing season in order to ensure root good formation

Simple layering - involves rooting one stem in one place

Compound layering - uses a longer, flexible stem (such as a vine) with the goal of producing several new plants; the stem is pinned down and covered in several spots

Air layering

- Girdle or slit stem just below where roots are desired, remove outer tissue; wrap in moist sphagnum moss held in place by plastic film
- Roots will be stimulated to form here; branch is then removed and planted
- Used with rubber plants, with monocots (tropicals) it is enough to just wrap the stem

Tissue Culture

- Uses small piece of tissue from a plant, cells separated and grown in a nutrient media
- Requires sterile conditions
- Enables propagation of plants difficult to multiply in more traditional ways

Grafting and budding

- Used to join two or more parts of related plants to create one plant
- Done to create plants with better disease and pest resistance, to modify growth habits and shapes
- Roots and branches occasionally may graft together naturally when they cross
- Are a variety of ways to do this

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March 2018