Tree Reproduction: Discovery Learning Fieldtrip:

Once you've watched the 3 videos on tree reproduction in Alberta, it's time to head outside and find some living examples to study!

Field Trip Overview:

- **Step 1:** Locate examples of spruce, pine and poplar trees in your area
    - This can be done at any time of year
    - If you need further help identifying examples from these groups, download the free PDF of "Guide to Common Native Trees & Shrubs of Alberta" http://www.insideeducation.ca/learning-resources/elementary-school/#guide-to-common-native-trees-shrubs-of-alberta
    - Also, check out the identification cards for trembling aspen, lodgepole pine and white spruce with lots of colour photos of all the reproductive steps!

- **Step 2:** Return to these trees every few days (or as frequently as possible) once spring begins (aim to start in late-April to mid-May)
    - Remember that the start of spring varies drastically from Medicine Hat (early) to High Level (late). Spring is defined by the bud development (phenotypic expression) of plants in your area. This depends on climate and latitude as well as the genotype of that specific tree for that trait. It's highly variable so keep visiting!
    - Watch for the bud development in each of the trees and reference the tree reproduction videos to identify male, female and vegetative buds as they become more clearly differentiated and emerge into catkins or conelets, needles or leaves.

- **A Story About Genotypes, Phenotypes & the Environment**
    - Understanding the relationship between the 3 factors
    - *Case Study*...Why does it matter where the seed falls?

- **General Rules**
    - Native species that follow these rules: White Spruce, Black Spruce, Lodgepole Pine, Jack Pine, Balsam Fir, Trembling Aspen, Balsam Poplar, Plains Cottonwood
- **Exceptions**
    - Native exceptions: Larch, Birch
    - Non-native exceptions: Cedar, Gingko
- **Some Definitions**
    - Serotinous cones
    - Resinous bonds
    - Native species
    - Non-native species
    - Hybridization
    - Ecological succession

Things to think about when identifying your trees!

- What are some ways to tell spruce and pine apart?
    - Needles, Bark, Cones, Size & Form, Buds
- What are some things to be aware of when identifying a tree on <u>private land</u> (within city limits)?
    - It could be any species or even a hybrid of two or more species. Trees do not have to be native to be planted on private land.
- What species should we expect to find in forests on <u>public land</u> (Crown land)?
    - Native species or hybrids of native species
- What are the <u>most common native species</u> of spruce, pine and poplar found in Alberta's forest?
    - Lodgepole pine, Jack pine and their hybrids
    - White spruce, Black spruce
    - Trembling aspen, Balsam Poplar, Plains cottonwood and their hybrids

Although any species of pine or spruce will work perfectly for this,

Do you know how to tell them apart? This can be very difficult…

Which one is it?

Jack Pine OR **Lodgepole Pine??**

Did you know?

The cones on **Jack Pine** point <u>toward the tip</u> of the branch while the cones on **Lodgepole Pine** point <u>away from the tip</u> of the branch! Both have similar needles that occur in bunches of 2.

Which one is it?

White Spruce OR **Black Spruce??**

Did you know?

White Spruce generally have wider crowns than **Black Spruce**. They also have slightly longer needles and bigger cones. Black Spruce is easily distinguished by the long hairs on their buds.

Step 1:

- Identify the **coniferous trees (pine and spruce):**
  - Try to identify conifer trees based on their needles. If you can't see the needles clearly, try to find cones on the ground underneath the tree.
    - **Pine:** cones are hard and round, needles are long, soft, light green and attached in groups (could be groups of 2's or even 5's if exotic)
    - **Spruce:** cones are soft and cylindrical, needles are short, pointy, dark green and attached singly

- Take home activity! Cone Collection

Find cones and needles from a spruce and a pine tree. Bring the cones home and try to find and extract any remaining seeds. Compare the sizes of the needles, the seeds and the characteristics of the cones themselves. If you can find mature, closed pine cones still attached to branches, bring them back to school and put them in a pot of simmering water for a few minutes. Listen to them POP! Then, give them to your teacher to put in an oven or a dehydrator at a very low temperature for 8 hours. This should help break the resinous bonds and open the scales, revealing the winged seeds! This is an artificial way to mimic the role of fire in pine reproduction. In fact, when collecting seeds for growing seedlings in nurseries, this is exactly how they extract the seed! You could even try planting some of them!

Make sure a parent or teacher is present for this!

- Identify the **deciduous trees (aspen, poplar or cottonwood –** any one of those is fine):
  - Try venturing into a forest or ravine where trees are growing more naturally.
    - Look for white, smooth bark with black patches.
    - Leaves are light green, heart-shaped and some have finely rounded teeth along the edges. They turn yellow and fall off in the fall.

- Take home activity! Branch Collection

Alberta's deciduous trees are dioecious (each tree is male OR female). But how do we tell which one is which! If you visit in the winter (November to March), it's very hard to tell. Cut off some branches (a few feet long) from a few candidate trees and bring them inside. Put them in a bucket of water and wait for them to flush (buds open and develop into catkins) in the warm air. Try to identify which branches (and therefore trees) are male or female. There will also be vegetative buds on each branch. Watch the leaves sprout from these as well once pollination is complete. You can also wait until springtime (late-April to mid-May) and identify male and female trees as they flush naturally. The fluffy cotton we all see in spring is attached to the mature seeds and helps them disperse.

Step 2:

After you've watched the 3 videos, and once SPRING has SPRUNG (aim for late-April to mid-May), go out and visit your favourite spruce, pine or poplar tree every few days to watch the bud development! This will help the information you've learned CLICK into place.

> **Note:** Larger trees are older and therefore more likely to produce significant numbers of reproductive buds, however, you'll be more likely to reach the female cones at the top if the tree is shorter. If you have time, find one young (short) and one older (tall) tree in each group to study. You might want to bring binoculars to get a closer look of the top!

Keep visiting until you can tell the male, female and vegetative buds apart

- **Spruce and Pine:**
  - Watch the male buds as the pollen grains inside them mature.
    - If they feel wet and hard, they aren't ready yet
    - When they turn yellow and a slight touch creates a cloud of pollen, it's time!
  - Over the summer, track the conelets as they develop into mature seed-bearing cones.
  - You'll known that pollination is more or less done when the vegetative buds burst open with new needles.

- **Aspen, Poplar and Cottonwood:**
  - Watch the male and female trees start to look "fuzzy" as their catkins develop.
    - The male catkins will lose their red colour as the pollen is dispersed
    - The female catkins are green
  - Once pollinated, the catkins on the female trees will develop for several weeks, producing seeds in bright green pods
    - The females will then burst open and light, white "fluff" will disperse the seeds. Collect some and observe how tiny they are, especially compared to spruce and pine seeds!

> ➢ Something to think about – Who's the father???
>
> As you stand near your chosen trees and watch their cones or catkins develop, think about which trees could have possibly pollinated the female cones. The fathers are probably very close by and it's probably more than one tree!
>
> - For **spruce and pine**, the pollen could have come from males on the same tree or any nearby tree.
>   - ***List two ways that conifers prevent self- fertilization.***
> - For **poplar, aspen and cottonwood**, females couldn't have fertilized themselves (each tree is only male OR female) so the males are likely nearby.
>
> Although likely from nearby trees, pollen is very small and light and the wind can carry it from farther away as well.

➢ A Story about Genotypes, Phenotypes and the Environment

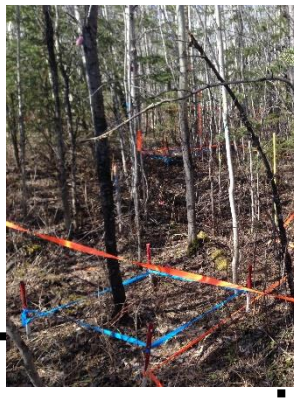
We've learned that **trees generally reproduce sexually**. In a nutshell:

- Male pollen fertilizes female ovules.
- The ovules develop into seeds within a cone or fruit
- When mature, the seeds are dispersed in the wind.
- If the seed lands in a good spot and conditions are right, the seed may one day become a seedling and then a tree that can make more seed!

An organism's **genotype** is the set of genes that it carries. Each seed is genetically distinct. It contains a unique combination of genes from the mother and father. Like a computer code, and hidden within the seed, it is not obvious what each gene codes for.

Phenotypes are the observable and measurable characteristics or traits. Some traits are **qualitative,** meaning that they are coded by one gene. Other traits are **quantitative,** meaning that they are coded by more than one gene. Eye colour is a qualitative (coded by one gene) trait while tree height (most other tree characteristics) is quantitative trait (coded by multiple genes).

So, what? Well, quantitative traits generally have very high levels of **environmental plasticity**. The phenotype that is displayed is a combination of both the genotype that codes for it and the environment in which it occurs. Different genotypes respond to environmental variation in different ways. A seed that grows in beautiful soil with the perfect amounts of light, nutrients and water will ultimately look different than if the same seed grew in a shaded bog.



Phenotype = Genetic effect + Environmental effect + (Genotype x Environment interaction)

P = G + E + (GxE)

Case Study...Why does it matter where the seed falls?

Using sticks to mark the boundary, create two 1m by 1m squares in different environments in the forest. They don't have to be perfect squares! Similar will do! Now take a look at what is in the squares. **Imagine that a seed was released from a spruce cone nearby and fell in each of those squares.**

- How much vegetation is there? This is competition for the seed and one day, the seedling.
- How thick is the duff layer (sticks and dead leaves)? This will make it harder for the seed to take root
- Dig under the duff. What does the soil look like? Is it a rich black colour and well decomposed? Is it mostly sticks and dry, light brown dirt? Soil is an indication of nutrient and moisture content.
- Look up! Are there lots of trees overhead? Will the seedling get enough light and access to rain? Will the canopy intercept it all?

Think about which square the seedling would do best in. Genetics aren't everything! Most seeds could grow into beautiful trees if they are lucky enough to fall in the perfect spot! Unfortunately, this is not the case. **How do trees deal with this uncertainty and lack of control?**

➢ General Rules:

Tree Type #1 – Native Alberta examples: White Spruce, Black Spruce, Lodgepole Pine, Jack Pine, Balsam Fir	**Tree Type #2** Native Alberta examples: Balsam Poplar, Trembling Aspen, Plains Cottonwood
Coniferous – has needles	**Broadleaf** – has leaves
Evergreen – holds green foliage all year	**Deciduous –** loses all foliage in the cold season
Softwood – lower density, faster growth rate	**Hardwood –** higher density, slower growth rate
Gymnosperm – no true seeds (often cone-bearing)	**Angiosperm –** true seed or flower bearing
Monoecious – male and female buds on separate trees (each tree is either male OR female)	**Dioecious –** male and female buds on the same tree (each tree is both male AND female)

➢ Examples of exceptions to the general rules:

Rule: Most native **monoecious trees are coniferous**

Exception: **Birch is native, monoecious and deciduous** – it has male and female buds on the same tree and it loses its leaves in the fall (broadleaved and deciduous). Birch is native to Alberta and can be found on both private and public land.

Rule: Most native **conifers are evergreen**

Exception: **Larch native, a conifer and it is also deciduous –** it has needles that fall off every fall. Larch is native to Alberta and can be found on both private and public land. It has needles attached in clusters of 10-20.

Rule: Most **dioecious trees are deciduous**

Exception: **Cedar is non-native, dioecious and a conifer** – it has male and female buds on separate trees and it is also an evergreen conifer. Cedar is not native to Alberta but is often found in cities in a bush-like form.

Rule: Most **gymnosperms are coniferous**

Exception: **Gingko is non-native, deciduous, broadleaf and a gymnosperm-** It has leaves that it loses in the fall but it also has naked seeds like conifers. Gingko is not native to Alberta or North America but it is common in cities for its tolerance to pollution.

➢ Some Definitions:

- **Serotinous cones:**
  - Lodgepole pine and jack pine have serotinous cones that are sealed shut by resinous bonds. They have evolved cones that do not open at maturity but instead stay on the tree for years until a fire passes through with temperatures great enough to break the bonds and release the seeds. Fire helps clear the area of competition and debris so that the abundance of newly released seed have lots of perfect spots to take root! Evolution at its finest!
- **Resinous bonds:**
  - The scales of pine cones are sealed shut by a strong resin (imagine a strong candle wax coating). When a fire passes through (or sunlight temperatures are great enough), the resin melts which allows the scales to open and the seeds to be released.
- **Native ("endemic" or "indigenous") species:**
  - Species that occur naturally in the environment where they are found. They thrive in this environment because they are adapted to the climate and soil conditions. They are also part of the local ecosystem. In Alberta, only native tree species can be planted on public (Crown) land because they are locally adapted. Foresters also want to avoid introducing exotic species which could potentially have catastrophic effects on the environment.
  - In Alberta, our native tree species include lodgepole pine, jack pine, white spruce, black spruce, balsam fir, larch tamarack, paper birch, trembling aspen, balsam poplar and plains cottonwood.
- **Non-native ("exotic") species:**
  - Species that have been introduced to the area by humans. They do NOT occur here naturally. Non-native species such as Gingko (from Asia) and American Elm (from the East Coast of North America) are often seem in cities as street trees. Non-native species can only be planted on private land (such as in cities) to avoid them becoming invasive because they have no natural predators.
- **Hybridization:**
  - In the wild, if two or more species are similar enough and their geographic ranges overlap, they are capable of interbreeding. This results in a hybrid offspring that contains qualities from both parental species. Lodgepole pine and Jack pine, White spruce and Black spruce, Trembling aspen and Balsam poplar are all capable of doing this naturally. Humans can also make this happen artificially in hopes of combining desirable traits from two species into one. Remember, human-made hybrids cannot be planted on public land unless they occurred there naturally.
- **Ecological Succession:**
  - A series of predictable community structure changes that occur following a disturbance. A wildfire is a type of secondary succession. In general, if a severe fire passes through a mature forest, it will leave a wide-open area with lots of exposed soil in its wake.
  - **Early successional (pioneer species)** such as grasses, mosses, pine and aspen are the first species to arrive and colonize the area. They are fast growing and love the abundance of sunlight. These species are usually short-lived and will eventually be replaced with l**ate successional (climax species)**. These species are slower growing and tend to not mind growing in the understory where there is lots of shade. These species were usually part of the initial mature forest that was burned. The forest is now back to its natural state.