# How Trees Grow

**Nº. 53**

**INTERMEDIATE**

Science | Geography

## LESSON SUMMARY

To understand some of the factors that affect tree growth by observing changes in dormant twigs.

FORESTS ONTARIO

Focus on Forests



Focus on Forests is a program of Forests Ontario.

# Activity Information

**Grade Level:** Intermediate

**Estimated Duration:** Up to 2 weeks

**Materials:** Three or four freshly cut dormant twigs of local shrubs or trees (about 30 cm long), large glass jar, 50 mL of sugar, 1 L beaker, glass stirring rod, large clear plastic bag, water, copies of experiment sheet for Activity #1 (one per student or group)

**Setting:** Indoors and outdoors

**Key Vocabulary:** Terminal buds, lateral buds, terminal bud scar, cambium, crown, dominant crown, suppressed trees, shade-tolerant, conical, round

**Background**

How does a small, hard seed become a 30 m tall tree? In the competitive world of the forest, the vast majority of seeds do not in fact ever produce mature trees. Only the fortunate few that land on suitable ground, get enough exposure to sunlight and water, and avoid being devoured or damaged by animals and diseases eventually grow up to become adult trees in the forest. In this lesson, you will look at how trees grow upwards and reach their final heights and shapes, and in the next lesson you will learn how they grow thicker and build up wood.

Look at the trees on your local streets and in parks. Every tree has a different size and shape, depending on the rate and pattern in which new cells are added to it each year. You can think of tree growth in two ways. First, the trunks grow outwards and upwards from their tips, carrying their leaves towards the sun. This growth produces extra height and spread. Second, the trunk and branches grow thicker and sturdier, allowing them to support the added weight of the larger branches.

Despite their variations in appearance, all trees have essentially the same basic structure. They have a central column — the trunk — supporting a framework of branches. The branches in turn bear an outside covering layer of leaves. Anchoring the tree in the ground is a network of roots, which spreads and grows thicker in proportion to the growth of the tree above the ground. In a mature tree, most of the cells of the trunk, roots. and branches are dead or inactive. All growth of new tissue takes place at only a few points on the tree, by the division of specialized cells. These actively growing areas are located at the tips of branches and roots and in a thin layer just inside the bark.

If you look at a branch on a deciduous tree during the winter when the leaves are gone, you can see **terminal buds** at the very ends of the twigs. These are the points from which the next spring's growth will take place. Twigs also have side or **lateral buds**, from which side branches develop. Buds are formed in the summer and fall and remain dormant over winter. Dormancy is broken when suitable growing conditions return, usually in the spring.

If you look further back along a twig, you will come to a ring of thickened bark. This scar tissue marks the place where the terminal bud grew the previous year and is called the terminal bud scar. The distance between the scar and the new terminal bud is therefore the amount of growth that took place in one year. Knowing this, you can find the age of several branches of different sizes on your tree.

As the main trunk of the tree grows taller, it also grows thicker. Its structure can be thought of as an extremely elongated cone shape, with the base of the trunk, being the oldest part, slightly thicker than the rest of the trunk. You can visualize this growth pattern by inverting and stacking a number of paper cups on one another. Each cup in the column represents a year's growth. The narrow bottom of' each cup (pointing upwards in the column) represents the terminal bud. Each year's growth fits tightly around the previous years and increases the height of the tree. While the growth in height comes from the terminal buds, the

growth in girth comes from a thin layer of cells called the **cambium**, found between the inner bark and the wood of the trunk and branches. In the paper cup model, the cambium is represented by the outside surface of the cups.

The growth rate and the ultimate height and shape of a tree are governed partly by the growing conditions of its environment, but also by its genes. In optimal conditions of sunlight and Moisture, different species reach different maximum heights. The tallest species of trees are the coastal redwoods, which grow on the west coast of California and Oregon and reach heights up to 112 m. A tree can continue to grow for as long as it lives, so its ultimate height depends on its growth rate and its longevity. Long-lived species, like the sugar maple and white pine, tend to be taller, while short-lived species, like the poplar and white birch, are shorter.

The shape of a tree depends on many factors, such as the amount of space it has to grow in, the amount of sunshine and moisture it receives, the relative growth rate of its terminal and lateral branches, and any damage it receives from such factors as lightning, fires, prevailing winds, snow, animals, and disease. The part of the tree above the trunk, called the **crown**, is built up bit by bit and year by year in order to maximize the leaves' exposure to the sun's energy. The direction of growth of the branches is towards the light. Trees that can reach above their neighbours get the most sunshine and are said to have **dominant crowns**. Those that are shaded by other trees may be slower growing and are called **suppressed trees.** In some species, such as poplar, continued shading over several years will eventually lead to their death. Other species, however, called **shade-tolerant**, can survive long periods in low levels of light. Species such as sugar maple, for example, can remain suppressed for years, but will shoot up in height as soon as the death or removal of their taller neighbours, opens up the forest canopy and lets in more light.

While a great height and large crown give a tree more exposure to sunlight, they make the branches more vulnerable to damage from severe winds or heavy snow. To balance the spread of its branches, a tree tends to grow deeper roots to anchor it firmly against toppling by storms. In general, the crowns of trees growing in Ontario take on two basic forms: **conical** and round. In conical forms —such as the familiar - Christmas tree*'— the terminal bud grows much faster than the lateral branches. The resulting conical form helps the tree shed snow and ice, and its compact shape resists wind pressure. For this reason, the conical form is most common in trees growing farther north. In the milder, moister conditions of southern Ontario, the predominant form is that of the spreading, more rounded crown, typical of oaks and maples.

Besides its branches, roots, and leaves, a mature tree grows one other important structure — the flower (or cone, in the case of evergreens). These are the reproductive structures from which the seeds are produced. Fast-growing species may mature and produce seeds after as little as five to 10 years' growth, while other species take 30 to 40 years to mature. A certain size is needed before flowering takes place, and suppressed trees may not flower even at an age of 50 to 100 years or more. With the growth of flowers, fruit, and seeds, the life cycle of the tree comes full circle. The seeds are dispersed by wind, water, or animals and the few that find a suitable spot will germinate and begin their journeys of growth toward the sun.

**Advance Preparation**

1. In the spring, before buds have flushed, collect twigs as part of a field trip activity. Cuttings can be kept frozen in plastic bags until needed, then slowly thawed. Stress that permission should be asked before cutting twigs from trees or shrubs on private or public property. Cut twigs with a sharp knife blade or snipping shears. Remove twigs that won't noticeably affect the general appearance of the tree, and don't take all the twigs from the same spot or side.
2. Make copies of the experiment sheet and activity sheets as required.

# ACTIVITY #1

Begin this activity by asking your students: Have you ever noticed how much trees grow from year to year in your neighbourhood? Encourage students to describe changes they have noticed as a result of tree growth in their communities. Then ask:

- How can you tell if a tree is growing? (The stems grow outwards and upwards from their tips producing extra height and branch spread, and the trunk and branches grow sturdier).
- Where does growth occur in a tree? (At the tips of branches and roots and in the cambium — the thin layer just inside the bark.)

Have students create their own experiments that demonstrate either the actual growing parts of a tree or that demonstrate some of the factors that affect the growth of a tree (e.g., water, amount of light, location. environment). Ask how they could test their ideas and ensure that their tests are fair. Help them think through each step of their experiments and encourage them to predict what might happen. Assist them in conducting their experiments and in reaching conclusions. Alternatively, have them try the experiment on the experiment sheet or use it as a model for their experiments.

# ACTIVITY #2

1. Sketch the outlines of trees near your school or on a field trip, including as many different forms as you can. Add labels to your sketches to indicate the type of crown on each tree and to identify the species. If you find any uprooted trees or trees with roots exposed by erosion, note the form of the roots.
2. Which of the trees you have drawn has an advantage in the following conditions? Explain your answer in each of the following cases:

- heavy snowfall.
- strong winds. summer drought,
- shaded location.

# ACTIVITY #3

Distribute one copy of the Factors Affecting Growth Rate of Trees Activity Sheet to each student and assist students in reading the graphs and answering the questions.

**Extension**

Make models of trees using wooden rods for trunks and cardboard cones, cylinders, cubes, and spheres to represent differently shaped crowns. "Plant" the trees in soil to different depths and subject them to wind stress using a hair drier or vacuum cleaner. What is the effect of crown shape and depth planted on the model's ability to stand up in wind? Use crushed soap flakes to simulate snow. Drop equal amounts of "snow" directly onto each model from the same height and observe the pattern of snow accumulation both on and beneath the crown.

# Activity #1

Experiment Sheet

**Purpose**

To observe and measure twig growth and to observe the effects of a sucrose solution on the buds.

**Materials**

Three or four freshly cut dormant twigs of local shrubs or trees (about 30 cm long), two large glass jars, 50mL of sugar, 1L beaker, glass stirring rod, two large clear plastic bags, water.

**Method**

1. Pick one twig from each species available. Sketch the twigs and label the different parts (terminal bud, lateral bud, and terminal bud scar).
2. Measure and record the length of the twigs, the length and diameter of the buds, and the colour of the bud scales. Measure the length from the terminal bud to the terminal bud scar.
3. Make up a dilute solution of sucrose by mixing sugar in water in a beaker and stirring until the sugar is dissolved. Place twigs in a jar of water and add a few milliliters of the sucrose solution. As a control, place several twigs in a jar of water with no sucrose solution.
4. Place the jars of twigs in a warm, sunny location in the lab. Cover the twigs in both jars with the clear plastic bags.
5. Observe and measure the twigs every few days, and record your data in a suitable data table. Add more sucrose solution every other day. Attempt to identify the species after leaves and flowers form- usually after about two weeks.

**Questions**

Encourage students to generate their own questions about the experiment and to draw conclusions about what conditions are required to break the dormancy of buds. Some sample questions follow.

1. What might the sucrose solution represent in the growth of a tree?
2. What affect does covering the twigs with plastic bags have on the twigs?
3. Did the buds produce anything other than leaves? If so, could you have predicted what the bud would produce from its appearance?
4. What would happen to the twig if the terminal bud were snipped off?
5. Did different species grow at different rates? If so, which were fastest and which slowest?
6. How did the final length grown by your twig compare with the length it grew the previous year?

# Some Factors Affecting Growth Rates of Trees

Activity Sheet

1. The graph below compares the growth rates of two stands of yellow birch from different locations in Ontario. Study the graph and answer the following questions.

   a) Describe the patterns of growth in height of yellow birch.

   b) What effect does location have on the growth pattern and ultimate height of these trees?

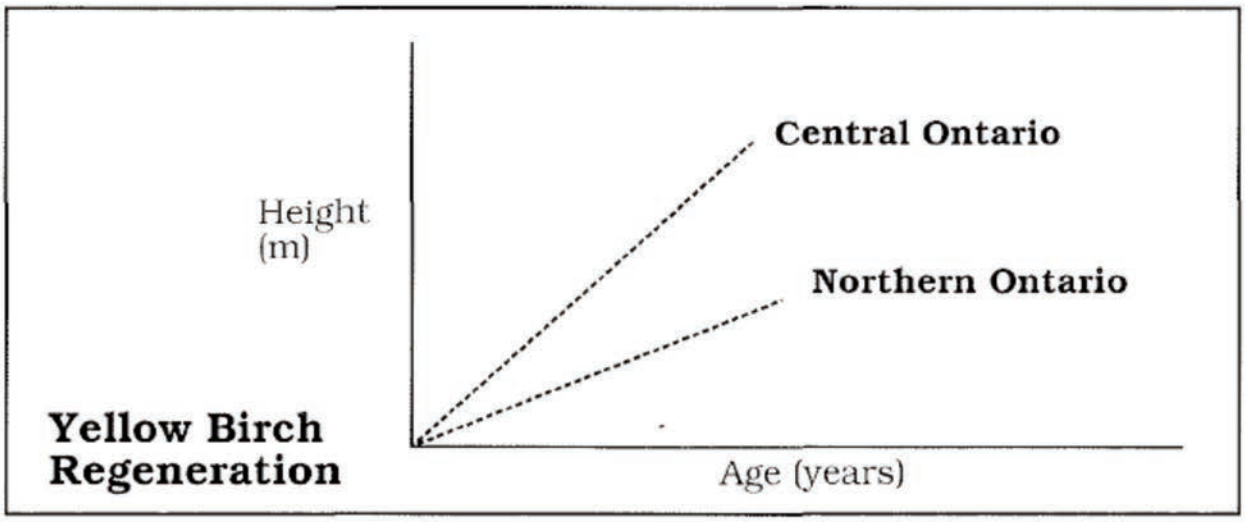
**Regeneration**

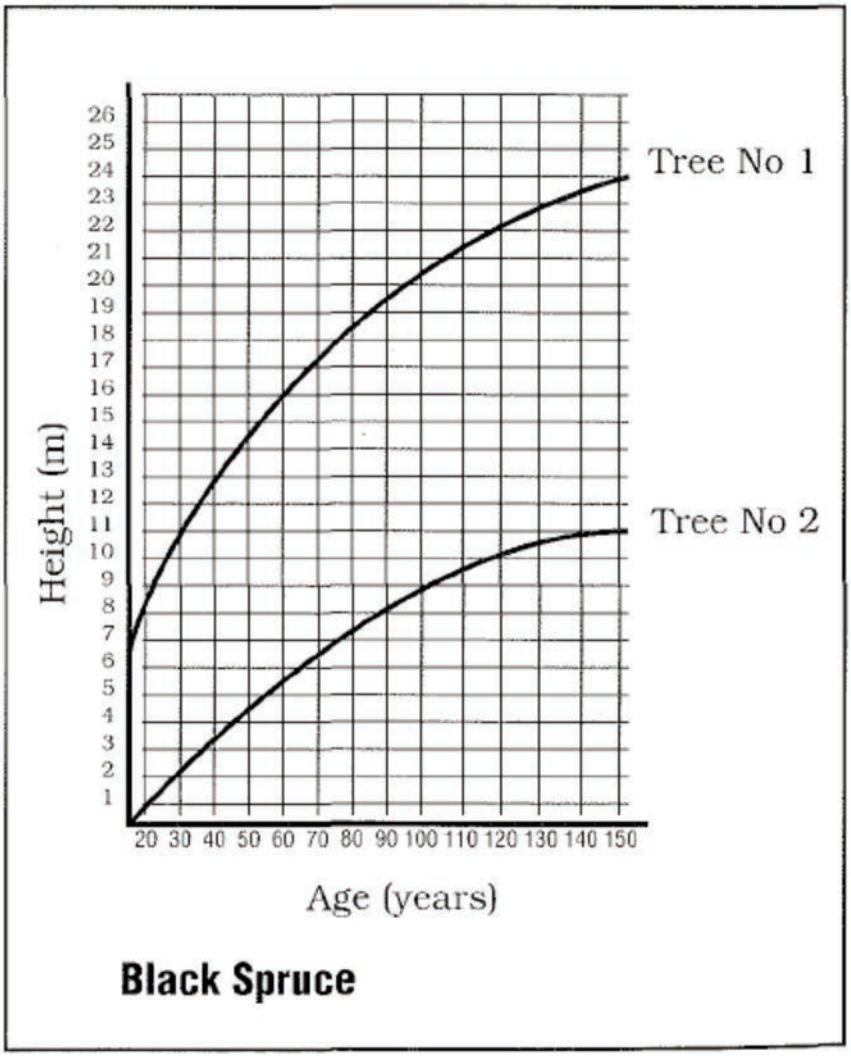
2. The graph below shows the growth rates of two different samples of black spruce that are growing in different environments. Study the graph and answer the following questions.

   a) What is the effect of age on growth rate?

   b) How does the growth pattern of black spruce suggest there may be competition for resources among these trees?

   c) What effect does the growing environment have on the height of these trees?




Height (m)
26
25
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13
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11
10
9
8
7
6
5
4
3
2
1
Tree No 1
Tree No 2
20 30 40 50 60 70 80 90 100 110 120 130 140 150
Age (years)
Black Spruce