Why Do Leaves Change Color?

Reference: DNR and Seattle Times Brain Storm

While you were playing in the hot sun during summer vacation, the leaves on the broadleaf trees in Washington's forests were working hard to make food in the form of sugar and starch. Tree leaves provide much more than shade, leaves are an essential part of the tree. Leaves use Sunlight to convert water (H_2O) and Carbon Dioxide (CO_2) into simple sugars and starches and Oxygen (O_2). The tree uses the sugar as its main energy source and starches for building material. Oxygen, on the other hand, is given off as a waste product. This process is called photosynthesis. Photosynthesis actually occurs inside the leaf in little ball shaped organelles called chloroplasts.

As autumn approaches, the hardworking broadleaf trees have to stop working. Broadleaf trees, like maples, have leaves that can't photosynthesize in freezing weather. In fact, if broadleaf trees kept their leaves on, frost could get inside the branches and damage the tree. To avoid this, the trees shed their leaves. In contrast, almost all conifer trees, or evergreens, keep their needles year around. Before the broadleaf leaves are shed, the trees try to absorb all the nutrients (sugar and starches) from their leaves. When this process starts to happen a magic time occurs… the annual color change of the leaves.

In the past, our autumns in Western Washington used to be marked with displays of yellow and gold as our native cottonwoods, alders, and big leaf maples changed color. Nowadays reds and oranges colors are seen often. These colors are mainly form non native trees introduced by local nurseries over the years. So how do these colors get into the leaves?

All leaves have their different color pigments inside. But one can't usually see the pigments. That's because most pigments are masked by the green pigment chlorophyll; the leaf's primary pigment. Color pigments serve different functions in leaves. Chlorophyll, for one, captures light and starts the photosynthetic process. Chlorophyll is able to capture and use light energy in only the blue-green and red parts of the light spectrum. So leaves use non green pigments to capture more types of light energy to help the tree make even more food. These accessory pigments, called 'accessory pigments" come in a couple different types. They are the carotenoids,

Carotenoids, like carotenes and xanthophylls, pick up additional light energy and transfer it to the chlorophyll. When visible, carotenoids look bright yellow, gold, and orange. (Carotenoids also give color to familiar fruits and vegetables like corn, carrots, and bananas.)

Flavinoids, like anthocyanins, perform a vital function. Flavinoids help block ultraviolet radiation from damaging the leaves. Flavinoids produce vivid shades of red, purple, and blue. Flavinoids are famous as antioxidants. Flavinoids cause Aspirin, dark chocolate and green tea to be rich in antioxidants. Flavinoids also give color to cranberries, blueberries, red apples, cherries, etc. Researchers have discovered that anthocyanins are also produced as a form of protection. These flavinoids help the plant recover nutrients in the leaves before they fall off, so the tree will have nutrients for the next growing season.

Phytochrome is a pigment plants use to detect light. Phytochrome are sensitive to light in the red and far-red region of the visible spectrum. Plants use phytochromes to detect light and trigger events, like sprouting of seeds, creating chlorophyll, and to begin growth for the year. As nights grow longer, a tree's phytochrome senses the dwindling amounts of light. It sends a signal to the tree to slow food production and begin storing sugars deep in the tree so the tree is protected from the winter cold.

So how and why do leaves change color? Once phytochrome sends the "winter coming" signal, the trees respond by producing less chlorophyll in their leaves. Eventually, the tree stops producing chlorophyll. When that happens, the carotenoids and flavinoids begin to show through. The leaves become a bright rainbow of glowing yellows, sparkling oranges, warm browns and reds. But not always! Read on.

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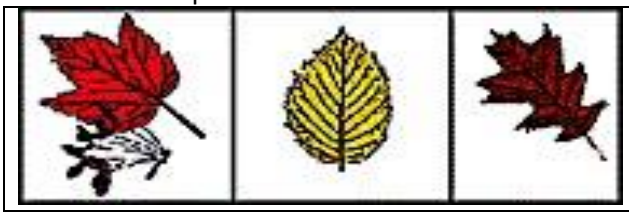
Do leaves change because of weather? Perhaps you've noticed that in some years, the fall colors seem brighter and more spectacular than in other years. That's because day / night temperature and cloud cover make a big difference in a tree's colors. A warm spring, followed by a cloudy, cool late summer and early fall will produce much duller colors.

But when a number of warm, sunny autumn days and cool but not freezing nights come one after the other, there will be brighter fall colors. That's because in the daytime during warm sunny autumn days leaves produce lots of sugar and starch. Then the cool night temperatures prevent the sugar sap from flowing through the leaf veins and down into the branches and trunk. The sugar, trapped in the leaves, increases the amount of color pigments, giving the leaves brighter, more vivid colors.

The amount of rain in a year also affects autumn leaf color. A severe drought can delay the arrival of fall colors by a few weeks. A warm, wet period during fall lowers the intensity, or brightness, of autumn leaf colors. Severe frosts kill the leaves, turning them brown and causing them to drop early. So hope for warm, sunny days and chilly nights this year!

How can you tell a tree from its fall leaf colors? You can use fall leaf color to help identify different tree species. Look for these leaf colors on the trees nearby: (click on the tree species to see information about the tree & leaf shape.



Oaks	Red Brown or Russet
Pacific Dogwood	Purple Red
Birch	Bright Yellow
Big Leaf Maple	Glowing Yellow
Vine Maple	Bright Scarlet

Why do leaves fall? If things work out on schedule, a broadleaf tree's roots, branches, and twigs can endure freezing temperatures. However, leaves are not so tough, so they have to be shed. It happens like this:

As sunlight decreases in autumn, the phytochrome in the leaves sends a chemical signal to tell the tree to get ready for winter. In response the tree's veins, which carry sap in and out of a leaf, gradually close. A layer of cells, called the separation layer, forms at the base of the leaf stem. When this layer is complete, the leaf is separated from the tissue that connected it to the branch, and it falls. Oak leaves are the exception. The separation layer never fully detaches the dead oak leaves, and they remain on the tree throughout winter until winter winds blow them off.

Most Coniferous trees -- pines, spruces, cedars and firs -- don't lose their leaves, or needles, in winter. (One Washington conifer, the Alpine Larch does.) The needles are covered with a heavy waxy coating and the fluids inside the needle's cells contain substances that resist freezing. So evergreen needles (leaves) live for several years before they fall and are replaced by new growth.

In the end, all the fallen leaves are broken down by bacteria, fungi, earthworms and other organisms. Thus, the decomposed leaves return their nutrients from the tree back to the soil. Eventually the leaves become part of the nutrient rich, spongy forest floor, called humus. This layer absorbs and holds water for the trees and many other forest organisms.

Nothing goes to waste in nature!

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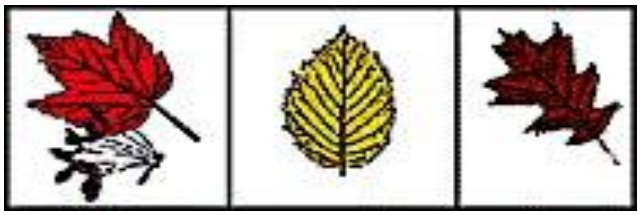

Today we are starting the soil unit out with some research on leaves. That's because healthy soil and healthy plant and animal life are linked. We can't get one without the other.one without the other.

Healthy soil is formed, in part, by decomposed plant material. In turn plants can't grow without the nutrients soil provides.

In 1949 the famous conservationist, Aldo Leopold, said: *"Land, then, is not merely soil; it is a fountain of energy flowing through a circuit of soils, plants, and animals."*

Please read the article, "Why do leaves change color?" watch this simpler video http://www.untamedscience.com/biology/plants/why-leaves-change-color/ **then answer these questions in complete, quality and correct sentences reflecting the questions.**

1. Explain 3 things a leaf needs to do photosynthesis **AND** the 2 products of photosynthesis.
2.

2. Tell the four types of pigments found in leaves.

3. Describe the function of <u>each</u> of the four different leaf pigments.

4. Explain what happens to cause the leaves to appear to "change" color.

5. Describe the conditions that need to be present to make dull fall leaf colors.

6. What conditions need to be present to make bright, vivid fall leaf colors?

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7. Use the Data Table **and** tell what color the fall leaves are for

    a. Oak,

    b. Alder,

    c. Birch

    d. Big Leaf Maple

    e. Vine Maple

8. Describe the process broadleaf trees undergo when their leaves fall off.

9. Tell <u>two</u> special adaptations that keep a conifer's needles safe through the winter.

    a.

    b.

10. Tell <u>two</u> important benefits the forest receives when bacteria, fungus and worms decompose fallen leaves

    a.

    b.

Extra Credit for ALL: Look up “How to Compost”. Then write up the basics.