

NATURE'S LABORATORY

*"A society grows great when old men plant trees
whose shade they know they shall never sit in"*

-- Greek Proverb

As the year draws to a close the woods erupt in a firestorm of colors, the landscape ablaze with yellows, reds, and oranges like crayons left to the sun. Spring's greens run for cover and a chill sets in. It's autumn, the season when leaves fall to earth one by one, then in a rush, at last the stragglers. And it is this falling of leaves that gives the season its more familiar title — fall.

Leaves make the tree. As they unfurl every spring, leaves set in motion a process known as photosynthesis. The basic ingredients needed to fuel photosynthesis are water, gathered through the roots, carbon dioxide gas, taken in through pores lining the surface of each leaf, and sunlight.

Sandwiched inside each leaf, in a region of cells known as the mesophyll, are cellular structures called chloroplasts where photosynthesis occurs. Each chloroplast contains chlorophyll, a type of pigment molecule. Absorbing sunlight as an energy source, chlorophyll breaks down the carbon dioxide and water and turns it into oxygen and glucose, a type of sugar plants need to grow.

Loaded with food, the tree sends glucose every which way to prepare for next year's growth — to new buds protecting future leaves, twigs and flowers, and to seeds and fruits essential to reproduction. So much glucose is manufactured, a tree can convert the excess food into starch and store it in chloroplasts to be tapped into later at night in the absence of the sunlight essential to photosynthesis.

Come fall, however, trees begin to shut down and go dormant. With the onset of cold and fewer daylight hours, trees are ready to rely on their food stores. To do so, they cut back on unnecessary processes like photosynthesis. As a result, chlorophyll begins to disappear from the leaves, marking a change in fall foliage. Rather than *changing* colors, the absence of a leaf's chlorophyll reveals other pigments masked until now by the greenness. Carotene and xanthophyll, two pigments responsible for fall's yellows and oranges, show through in all their glory.

Autumn's rich reds arise in a different fashion under special conditions. They develop when, in shutting down, a tree blocks off its connection to any leaves by abscission,

cutting off the leaf from the tree. This abscission causes leaves to break off of branches and fall to earth. Prior to falling, however, if exposed to bright sunlight and cool night air, glucose trapped in the severed leaves can be converted to a red pigment — anthocyanin.

Leaves come in a variety of shapes and sizes. Imagine the hand-shaped maple leaf. Every finger-like point of a maple leaf is known as a lobe, while the recession between each lobe is known as a sinus. Leaves like a maple are simple palmate leaves because the lobes radiate from a central point. An oak leaf, however, is a pinnate since the lobes extend feather-like on either side of the leaf's axis. Serrations or jagged leaf margins are known as teeth. Altogether, each tree species' leaf has it's own characteristic shape, tip, base and margin, making each unique.

Trees that shed their leaves at the year's end are known as deciduous — trees like elms, ginkgos and maples. Those whose leaves don't jump ship every autumn are called evergreens. As their name implies, evergreens are trees that are always green. Their needle-like leaves are designed to endure the cold and dry of winter. These needleleaf trees still lose their leaves, but they are spent throughout the year. Pine, fir, cedar and spruce trees are exemplary evergreens.

Hands On: To help identify different leaves, start a pressed leaf collection. On a blustery day, take to the woods with a notebook and collect some leaves, taking special care to note the description of the tree each leaf belongs to. When you get home, compare your leaves and notes to a field guide, identifying and labeling each leaf. To preserve them, place each leaf between the pages of an unwanted book (ask first!) and stack some heavy books on top. Check every week or so until the leaves are fully dried and pressed.

An alternative to pressing leaves is making leaf rubbings. Place a sheet of paper over a leaf and rub all over with the side of a crayon. As you rub, the outline of the leaf and its veins will show through. Switch leaves and crayon colors, and soon your sheet of paper will look like a collage of the fall forest floor.

To extract chlorophyll from a leaf, simply soak it in boiling water (with parental supervision), then submerge it in a beaker of alcohol set in a glass of warm water. Inspect the beaker after an hour — the chlorophyll should have bled from the leaf into the alcohol.

It's easy to see how the red pigment anthocyanin develops. While leaves are changing colors, place a strip of nontransparent tape across an exposed leaf to block that portion of the leaf from the elements. If the days are bright enough and the nights cold enough, the uncovered portion of leaf should bear hints of red, proof that glucose was converted into anthocyanin. Peel off the tape — beneath, the leaf will be yellow. Without sunlight, the leaf's glucose didn't undergo a chemical change. All that are visible are the naturally present pigments carotene and xanthophyll.

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