



נפלאות הבריאה

A year in the life of a leaf

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A year in the life of a leaf

Explore a leaf's magical transformations across seasons.

By [Kasha Patel](#) and [Emily Wright](#)

Leaves on a tree are the reason we can breathe and rest in a cool spot on a sunny day. Their role is critical to our everyday lives, but it's also worth admiring the special day-to-day actions that allow them to flourish on our planet.

"The life cycle of a leaf is pretty magical," said Andy Finton, a forest ecologist with the Nature Conservancy in Massachusetts. It has allowed trees "to survive and thrive though hot summers and cold winters," he said.

Trees make adjustments depending on their location and climate. Evergreen trees, like pine, spruce and fir, are often found in cool, temperate regions; they keep their leaves and remain green throughout the year.

Trees that are deciduous — roughly translating to "falling off" in Latin — lose all of their leaves for part of the year. These broad-leafed trees are

typically found in temperate regions, such as the eastern United States and western Europe.

From bud to bloom, many leaves of deciduous trees experience a lifetime in just a year. Their shifts in shape, color and size across seasons are on display for everyone to witness. Internally, the leaves are undergoing chemical transformations.

Follow along as we illustrate the conspicuous and not-so-conspicuous annual changes in deciduous trees.

Spring

Springtime is the season of new beginnings. Baby leaves are already inside buds, which formed months ago. As daylight and temperatures increase, the waterproof scales around the buds fall off. The tiny leaves and flowers swell and join the world.

As the tender leaves grow, they produce a red pigment called anthocyanin that helps protect the leaf from receiving too much solar radiation and getting damaged, said Finton.

Each leaf also turns into a kitchen for the tree. Leaves produce a chemical called chlorophyll, which provides the green color and helps absorb energy for the plant to make food. The food-making process, called photosynthesis, turns sunlight and carbon dioxide into oxygen that we breathe. It also produces sugar, which nourishes the plant so it can become food for all — even us, sometimes.

The leaves are full-size by mid-spring, although a warmer winter can push the leaves to appear earlier. By summer, it's their time to thrive.

Summer

Leaves will be at peak green and more will flourish to soak up the sun and produce more food.

Some leaves may appear darker because they build up tannins — the chemical that makes your tea look brown — to fend off insects. The bad taste of the tannins, Finton said, wards off insects from eating the leaves.

As trees bask in the sun, they start their winter preparations. As daylight begins to decrease after the summer solstice, the trees begin to ramp down photosynthesis and absorb nitrogen back from their leaves.

Nitrogen allows the tree to produce compounds that can protect its cells from freezing. Over half of a leaf's nitrogen is sent to a tree's woody tissues by the end of September, according to the National Park Service.

Buds for the following year also start forming in the summer and over the next few months.

As summers grow hotter due to climate change, the timing of a tree's growth is changing. Research has shown that abnormally warm temperatures before the summer solstice can boost growth, but trees also stop providing nutrients to their leaves earlier in the season in northern forests.

Droughts and extreme heat events can also cause some leaves to shrivel and die before they have a chance to show off their beautiful colors in autumn. In Arizona, researchers documented how one ponderosa pine appeared to stop growing midway through the season last year after record heat.

Autumn

Trees don't need a calendar to know it's time to shed their leaves. Although temperature and rain is important, the primary trigger of the vibrant fall leaf colors is reduced sunlight.

As daylight hours decrease, the leaves have less sunlight to make food. Much like a bear preparing to hibernate for the winter, the tree continues to compile its resources to make it through the upcoming cold season. That includes breaking down compounds such as chlorophyll and sending those nutrients back to the trunk and roots to be used next spring.

"In the fall, the trees have evolved an adaptation strategy to maintain nutrients and prevent damage," said Finton.

When the leaves lose their green chlorophyll, they reveal their true colors: the natural orange and yellows (produced by pigments called carotenoids). The colors of a leaf depend on the type of pigments it contains.

Under the dwindling sunlight, the leaves produce sugars during the day that are then trapped inside by longer, cooler nights. The sugars lead to the production of pigments, such as anthocyanins, which add an extra punch of brilliant red to the newly unveiled yellow and orange leaves. Oaks, maples and dogwoods are known for their red leaves.

While the leaves are losing their green color, the tree is also physically sealing itself off from the harsh outdoor elements. New cells form what is called an abscission layer at the base of the leaf, which cuts off the leaf's attachment to the tree. These stops shuttling water into the leaf and exporting carbohydrates back to the tree. The leaves eventually completely detach from the tree and die.

Over the past few decades, scientists have found that leaves are delaying their color changes in some parts of the U.S. Northeast by a week or so because of climate change. Warmer temperatures extending longer into fall, especially at night, affect production of the red anthocyanin pigments. Warm autumns can also degrade pigments and dull the leaf colors.

Winter

Evergreen trees, such as pines, spruces and cedars, are able to withstand harsh winter conditions. The waxy coating on their needlelike leaves allows them to conserve water. Plus, fluid inside their cells can resist freezing. These trees tend to keep their leaves for a long time, losing them eventually to old age.

But for a deciduous tree, winter is a time to rest. The leaves have fallen and nutrients are safely stored inside the tree. If the leaves were to stay on during the cold season, they would become crisp and lose all of their nutrients.

“It’s a water-saving technique and a nutrient-saving technique to send those nutrients back into the stem in the roots,” said Finton.

As the leaves lie on the ground, they decompose and return nutrients back to earth. They also provide a habitat for wildlife, such as lizards, turtles, frogs and insects, looking for a place to take cover during the winter.

The buds that started to grow on the tree also take cover. Just as people need a blanket, the buds are wrapped in a tough waterproof casing to protect its valuables from the harsh elements outside. The outer casing falls off as temperatures rise in the spring, and the bud bursts open and grows.

The cycle begins again.