

Why do the leaves change color?

French author Albert Camus wrote: *“Autumn is a second spring when every leaf is a flower.”* But why and how the fascinating autumn change happens?

During spring and summer, roots of trees absorb water and nutrients from the soil and transport them to other parts of the plant, including buds, shoots or leaves. When a tree has enough water and sunlight, the leaves create chlorophyll, which captures light energy, photosynthesizes, and creates food in the form of glucose.

With the advancing autumn, the number of hours of sunlight and the temperature decreases. **Trees feel the loss of light** due to chemical light receptors. They **respond to the change by preparing for dormancy** (a state of suspended growth and metabolism). For so called deciduous trees, the most visible manifestation of this change is **leaf color change and green-down**.



The change in color is not the only one that occurs in the leaves before the winter. Other changes are less noticeable, but are very important for plants. The **leaves contain many important substances** – sugars, proteins and minerals (phosphorus, nitrogen) that would be lost in falling leaves. This is why, before the leaf falls off, at least a portion of these substances is removed from the leaves to the branches, trunk and roots where they are **stored during the winter rest period**. In spring, when the trees are growing, these stocks are reused to create new leaves and flowers.

What causes beautiful autumn colors?

The green color of spring and summer leaves is caused by chlorophyll. As daylight declines, trees slow down chlorophyll production until they eventually stop. As the green pigment in the leaf disappears, other colors that have been masked by chlorophyll begin to appear.

The first colors that appear on the autumn leaves are yellow caused by pigments carotenoids (carotenes and xanthophylls). **Carotenoids cause yellow and orange color** and can be found for example, in carrot roots or yellow flowers.



The red and violet color of the leaves consists of pigments anthocyanins. These pigments color red and violet for example blueberries, red apples, plums or violets. Their presence is likely to help reduce the freezing point of the

leaf, providing protection from the cold and allowing the leaves to remain in place longer, giving the trees more time to absorb nutrients. Some trees have anthocyanins in the leaves all year round, but many do not produce this chemical until autumn.

The timing and color intensity of the leaves depends on the species of the tree and the elevation and climatic conditions of its location. However, it is also affected by the amount of rainfall and soil moisture.

ACTIVITY

Try to investigate pigments in leaves using chromatography with GLOBE learning activity [Investigating Leaf Pigments](#).

Why do trees lose leaves?

There are several reasons why deciduous trees get rid of leaves in autumn. Deciduous trees usually have **thin leaves that are sensitive to low temperatures**. As the water expands in the frozen state, there is a risk of cracking and damage to the leaf cells. Moreover, photosynthesis slows down in cold conditions and leaves do not perform their main function – the conversion of solar energy into glucose.

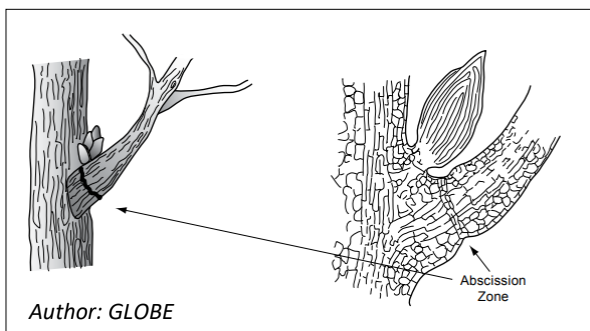
In winter, water supply is very limited so **trees must reduce their water loss to survive**. Leaf fall significantly reduces the surface through which a tree loses water, making them more resistant. The large surface area of the leaves increases also the **risk of mechanical damage to the tree** in the cold and windy winter months. Keeping the leaves would be dangerous for trees not only because of the wind but also because of the weight of the snow that would get caught by leaves.

Leaves are often damaged at the end of summer, for example, eaten by insects. Green-down gives a tree a **fresh start in spring** and allows it to use nutrients from decaying leaves. In spring, the absence of leaves facilitates the **transmission of pollen by wind**. Pollen can travel longer distances to reach more trees.

ACTIVITY: What would it look like if the leaves did not fall?

Ask students think about why the green-down happens and what would happen if the leaves remained green throughout the year. Let the students discuss their ideas in groups. You can also motivate students to take on the role of their tree and describe autumn and winter from its perspective.

How do the leaves separate from the tree?



Interestingly, the leaves are not simply blown out of the tree in autumn, but are separated from the tree by a **highly controlled process**. At the point where the stem of the leaves meets the branch, there is a **special layer of cells called the abscission layer**. Through this layer, small tubes transport in spring and summer water to leaves and food from leaves to the trunk. In the autumn, the cells of the abscission layer begin to swell and form a cork-like material, which limits

and finally disrupts the flow between leaves and trees.

The hormones inside the plant are activated to initiate the process of abscission as the length of the day becomes shorter and the temperatures cool. Chlorophyll production is stopped and the pigment begins to degrade. The transfer of water and glucose is also stopped. When the cells of the separation layer form a seal between the leaf and the tree, the cells at the top of the separation layer begin to disintegrate. They create a tear line that makes the leaf vulnerable to tearing off the branch and eventually falls off.

Why do conifers keep their leaves?

Majority of conifers are evergreens. As the name implies, their leaves are still green and do not fall. This is because **they have a thick wax layer to protect their leaves**. This means that they do not freeze and tear like the leaves of deciduous trees and therefore do not need to lose leaves in autumn and grow back in spring.



Why are leaves good for litter?

The nature does not waste any material, so also the leaves that drop off have an **important ecological role**. Nutrients resulting from their decomposition penetrate the soil and are a **source of food** for a vast number of plants and animals.

Source:

- *The GLOBE Program – www.globe.gov*
- *Australian Academy of Sciences: Why do the leaves of so many trees change in the fall and fall to the ground? <https://www.science.org.au/curious/earth-environment/autumn-leaves>*
- *RNDr. Jiří Jakl, Priroda.cz: Proč na podzim žloutne a opadává listí?, <https://www.priroda.cz/clanky.php?detail=468>*
- *Roger di Silvestro, National Wildlife Federation: Why leaves fall from trees in autumn, <https://blog.nwf.org/2014/09/why-leaves-fall-from-trees-in-autumn/>*
- *Melissa Petruzzello, Encyclopædia Britannica: Why do the leaves fall in the fall?, <https://www.britannica.com/story/why-do-leaves-fall-in-autumn>*
- *Deanna Conners, EarthSky: Why trees shed leaves, <https://earthsky.org/earth/why-do-trees-shed-their-leaves>*
- *Australian Academy of Science: Autumn leaves, article reviewed by Professor Susanne von Caemmerer, www.science.org.au/curious/earth-environment/autumn-leaves*
- *Veronika Podešvová, Masarykova Univerzita: Rostlinna barviva (Bachelor thesis)*