

Activity 2: Why do leaves change color in the fall?

Note: for best results, use leaves that are green but have JUST started changing colors in the fall.

Note 2: Only do this with an adult. This activity uses hot water.

Materials

- 3-4 leaves from the same **deciduous** tree (this means a tree whose leaves change color and fall off in the autumn)
- Isopropyl (rubbing) alcohol: ½ cup to 1 cup
- Glass jar
- Plastic/saran wrap
- Paper coffee filter
- Heat-safe bowl or pan
- Something to mash the leaves with (spoon or pestle)
- Scissors
- Rubber band
- Tape
- Water

Instructions

- (1) Break the leaves into small pieces and put them into the glass jar
- (2) Pour the isopropyl alcohol over the leaves until they are **just** covered. Don't add too much!
- (3) Mash the leaves and stir them into the alcohol. Really mush them and mix them around, but be careful not to break the jar. Watch and see what happens as you mix. **Does the color of the alcohol change?**
- (4) Cover the top of the jar with saran wrap and rubber band it in place.

- (5) Put the jar into your heat safe bowl or pan
- (6) Heat 1-2 cups of water (in a different microwave or heat-safe container/pan) in the microwave or over the stove till it's almost boiling. **Only do this with an adult! Be careful, and make sure you don't splash yourself.**
- (7) Pour the hot water into your heat safe bowl or pan until it surrounds your glass jar.
- (8) Keep the jar in the hot water for 1 hour. Swirl it around to stir up the leaves every 5-10 minutes. **What happens to the alcohol?**
- (9) Remove the jar from the hot water and take off the plastic wrap
- (10) Cut a strip from the filter paper and put one end in the alcohol. Tape the other end of the filter paper to the top of the glass jar.
- (11) Leave the filter in place for an hour, then remove it. **What do you see on the filter? Is everything the same color, or do you see different colors?**

Bonus: Try picking 2-3 groups of leaves from the SAME tree that are at DIFFERENT stages of changing color (each group gets its own jar). Or, you can try picking just-starting-to-change-color leaves from 2-3 DIFFERENT trees (each tree gets its own jar).

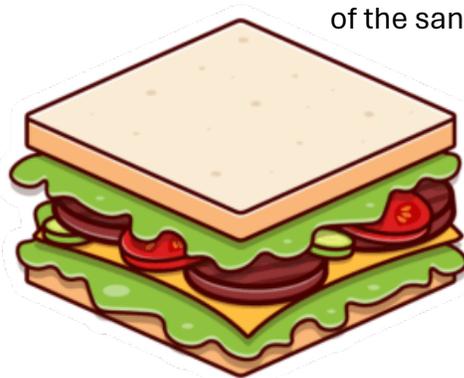
What you learned:

Explanation:

Leaves are made up of many layers, kind of like a sandwich.
(images courtesy of sciencewithme.com)

Sandwich

Bread (the "skin"
of the sandwich)

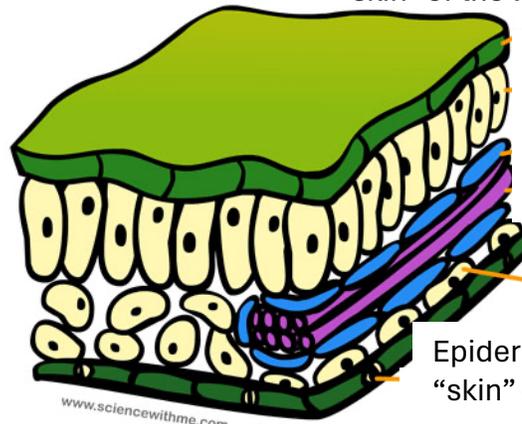


Delicious
fillings (full
of nutrients
and energy)

Bread (the "skin"
of the sandwich)

Leaf

Epidermis (the
"skin" of the leaf)

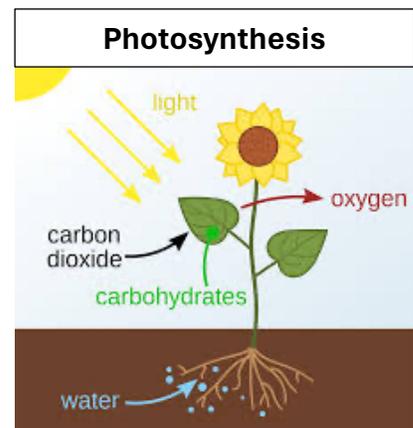
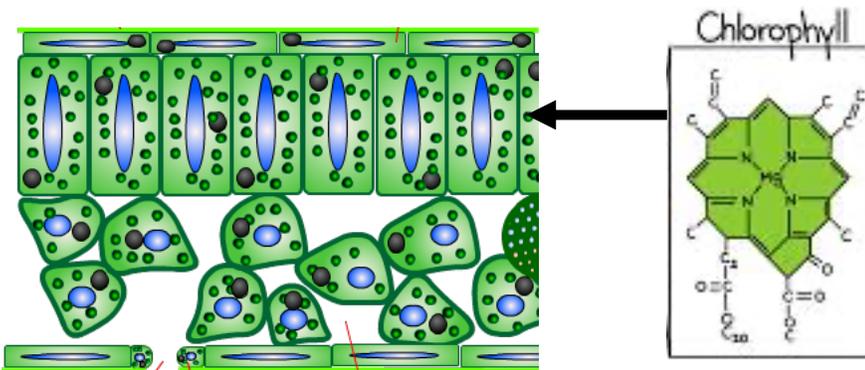


Mesophyll (the
"factory" of the
leaf, full of
nutrients and
energy)

Epidermis (the
"skin" of the leaf)

Between the two layers of epidermis (like the leaf's "skin") there's an energy factory full of little green molecules called **chlorophyll** that harvest light to make energy. This is called **photosynthesis**.

Chlorophyll is so bright that it acts like dropping a big green mask over all the leaf's other colors. (images from expii.com and wikimedia)



Over the winter, there's less sunlight, so plants stop harvesting light to make energy. That means they don't need their chlorophyll over the winter! So, they get rid of it, and the green color disappears. This lets you see all the other colors in the leaf: yellow, orange, and red.



A leaf loses its color as the chlorophyll fades.

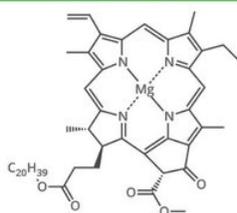
So what about our experiment? We used a filter paper to separate out all the different colored molecules (green chlorophyll and all the other red and yellow molecules) in the leaf. Over time, the different colored molecules move along the paper from bottom to top, like they are in a race with each other. So you should be able to see the **chlorophyll** on one part of the filter paper, while the red molecules (**anthocyanin**) and yellow molecules (**carotenoids**) are on another part of the filter paper.

If you are interested in more information, see below: (courtesy of compoundchem.com)

THE CHEMISTRY OF THE COLOURS OF AUTUMN LEAVES



CHLOROPHYLL

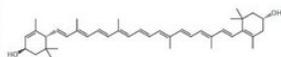


CHLOROPHYLL A

A type of porphyrin

Chlorophyll is the chemical that gives plant leaves their green colour. Plants require warm temperatures and sunlight to produce chlorophyll - in autumn, the amount produced begins to decrease, and the existing chlorophyll is slowly broken down, diminishing the green colour of the leaves.

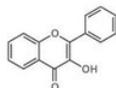
CAROTENOIDS & FLAVONOIDS



LUTEIN

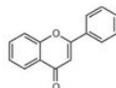
A type of carotenoid

Carotenoids and flavonoid pigments are always present in leaves, but as chlorophyll is broken down in the autumn their colours come to the fore. Xanthophylls, a subclass of carotenoids, are responsible for the yellows of autumn leaves. One of the major xanthophylls, lutein, is also the compound that contributes towards the yellow colour of egg yolks.



FLAVONOL

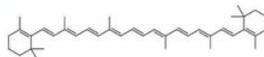
(general structure)



FLAVONE

(general structure)

CAROTENOIDS

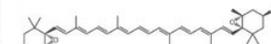


β-CAROTENE

A type of carotenoid

Carotenoids can also contribute orange colours. Beta-carotene is one of the most common carotenoids in plants, and absorbs green and blue light strongly, reflecting red and yellow light and causing its orange appearance. It is also responsible for the orange colouration of carrots.

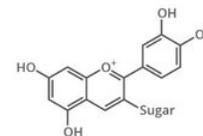
Carotenoids in leaves start degrading at the same time as chlorophyll, but they do so at a much slower rate; beta-carotene is amongst the most stable, and some fallen leaves can still contain measurable amounts.



VIOLAXANTHIN

A type of carotenoid

ANTHOCYANINS & CAROTENOIDS



ANTHOCYANINS

(general structure)

Unlike the carotenoids, anthocyanin synthesis is kick-started by the onset of autumn - as sugar concentration in the leaves increases, sunlight initiates anthocyanin production. The purpose they serve isn't clear, but it's been suggested that they help protect the leaves from excess light, prolonging the amount of time before they fall.



LYCOPENE

A type of carotenoid



You can also obtain much more detailed scientific information at:
<https://sciencenotes.org/leaf-chromatography-experiment-easy-paper-chromatography/>