

Natural History Museum:

All leaves have changed (and gotten better) to perform one simple job: get energy for the plant to make food. Leaves do this by using the sun’s light energy and converting it into glucose and producing food. The plant needs this for the same reasons we need food; to grow and repair itself. Leaves are green due to the chlorophyll in chloroplasts found in the leaves which actually convert the light into energy.

Plants have different shaped leaves as they have adjusted to live in different environments. For example, evergreen trees and cactus have lots of long, thin, needle-like leaves to reduce the loss of water in their habitats (homes/places where things live) since it is very dry. Whereas, plants in wet environments have broader (wider) leaves to increase the amount of light energy captured (absorbed). Plants that flower must also put energy into producing the flower so therefore have broad, but fewer, leaves to catch as much sunlight as possible, without investing too much energy into the leaves. Ground dwelling plants, such as those on the forest floor, have very broad leaves to absorb the little sunlight that actually makes it through the thick canopy.

Water Retention/ Water Loss:

Plants can be different from each other in the amount of surface area and thickness of the leaf. Leaves that possess “hairs” will have larger boundary layer (thickness); the hairs serve as mini-wind breaks by increasing the layer of still air around the leaf surface and slowing transpiration (evaporation of water from leaves) rates. Some plants possess stomata that are sunken into the leaf surface allowing for the plant to control the transpiration (evaporation of water from leaves) rate. Boundary layers increase as leaf size increases, reducing rates of (evaporation of water from leaves) also. For example, plants from desert weather often have small leaves so that their small edge/border layers will help cool the leaf with higher rates of transpiration (evaporation of water from leaves).

Cuticle - The cuticle is the waxy layer present on all above-ground tissue of a plant and serves as a barrier (something that blocks or stops something) to water movement out of a leaf. Because the cuticle is made of wax, it is very hydrophobic (water-repelling) therefore, water does not move through it very easily. The thicker the cuticle layer on a leaf surface, the slower the transpiration rate. Cuticle thickness differs/changes widely among plant species. In general, plants from hot, dry environments have thicker cuticles than plants from cool, moist environments. Also, leaves that develop under direct sunlight will have much thicker cuticles than leaves that develop under shade conditions.

Energy:

**Why do tree leaves have different shapes?**

The shape of a tree's leaves is a response to the tree species' long term changes to its environment. Understanding of the "logic" behind the differences of leaves is helped by understanding the exact functions a leaf must accomplish.

1. A leaf must "capture" sunlight for photosynthesis (making food from light) and as it does this it may also absorb a great deal of heat!

2. A leaf must take in carbon dioxide from the surrounding air through pores (called "stomata"). This carbon dioxide is also needed for photosynthesis (making food from light). When these leaf stomata open and allow the intake of carbon dioxide, water from inside the leaf is lost to the atmosphere.

So your decision about a leaf’s size and shape is going to be dependent on balancing two things: **enough** sunlight and carbon dioxide to run the food making process **but not too much** heat absorption or water loss.

**How does this "balancing act" influence the ultimate expression of a leaf's shape?**

Leaves high in the tree canopy, receive a great deal of sunlight. These leaves tend to be smaller in size (resulting in less light absorbing surface area) and also tend to have complex edges and lobes (which enables them to break up and move away heat very quickly).

Leaves in the lower tree canopy are more shaded. These lower canopy leaves tend to be larger (more light absorbing surface area) and tend to have less of lobes and edges. In the white oak the smaller upper level leaves observed to allow larger amounts of light to pass through in order to keep the lower leaves supplied with enough light to photosynthesize.

Needle-shaped leaves have a very small surface area so they are not able to absorb a lot of light. Needles also have a very thick, outer cuticle coating and special "pit-like" stomata designed to prevent too much water loss. Trees with needle-shaped leaves are especially well suited to places/locations that have drier soils and where water conservation is important for survival. Needle-shaped leaves stay on a tree for three or four years compared to broad leaves that only stay on the tree for a single growing season and then fall off. These “evergreen" needled trees have a great advantage over the deciduous broad leafed trees in that the cost of making the leaf is relatively low because it is used for more than one growing season. Also, these needle leafed plants can photosynthesize in the winter when other trees can’t which means that there is more time to gather energy for the tree.

A study in Germany compared energy production in large Beech trees (which have broad, flat leaves) and Norway spruce trees (which have needles). It was found that the large Beech trees photosynthesize for 176 days in a year while the Norway spruce photosynthesize 260 days in a year! The increased time for photosynthesis of the Norway spruce was actually 58% more productive than the large Beech tree!



