

# Understanding Leaf Anatomy and Morphology

**T**HE IMPACT of leaves on our lives is amazing. Leaves provide shade in the summer. They display beautiful colors in the fall. They sway in the breeze. Children jump in piles of leaves and collect them in the fall. More important, leaves harness the sun's energy and enable our life on Earth.



## Objective:



Examine the parts, organization, and types of leaves.

## Key Terms:



alternate	midrib	pinnately compound
compound leaf	netted veins	pinnately netted
cuticle	opposite	simple leaf
dichotomous venation	palisade mesophyll	spongy mesophyll
epidermis	palmately compound	stomata
guard cells	palmately netted	subopposite
leaf blade	parallel veins	whorled
leaflets	petiole	

## Leaves

Leaves are the primary food-producing organs of a plant. They are designed to be efficient in collecting light and using that light energy to produce food.

## PARTS OF A LEAF

The main light-collecting structure on a leaf is a large, broad, flat surface called the **leaf blade**. The blade has many layers that not only help the plant move but also help it store materials and byproducts of photosynthesis. The blade is held away from the stem and supported by the **petiole**. The petiole is not exactly like a stem, but it does have xylem and phloem that transport water and sugar.

The blade is supported by a system of veins that also contain both xylem and phloem. These veins prevent the blade from collapsing under its own weight. A leaf is often organized with one main vein running down the middle of the blade. This vein is called the **midrib**. All of the veins, the petiole, and the midrib help position the blade so that it is facing the light source.

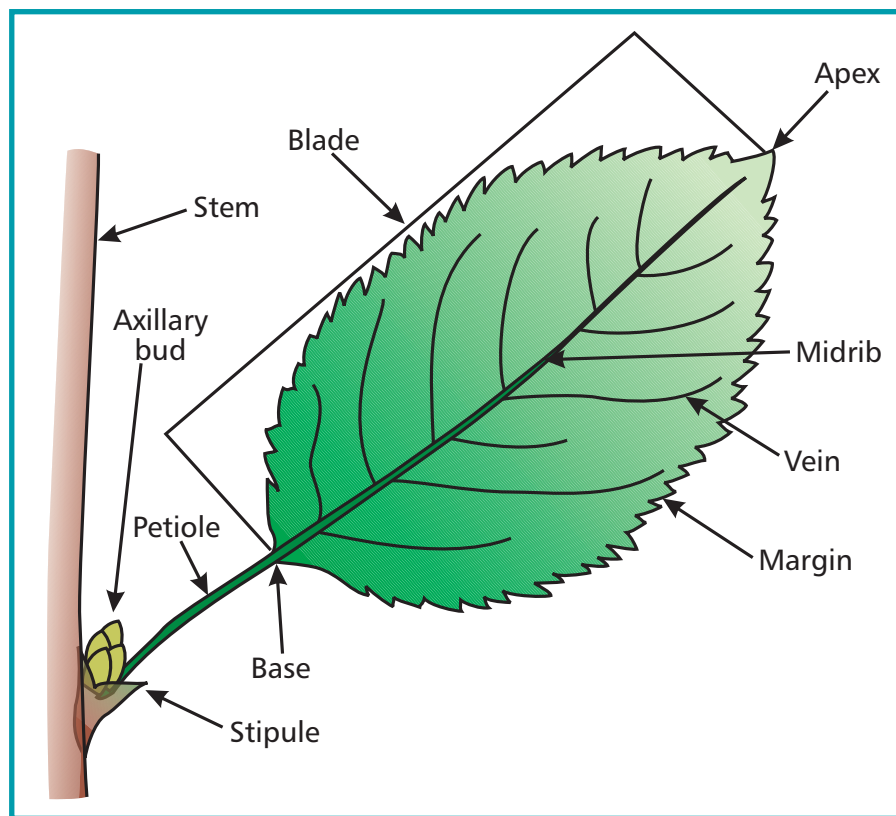


FIGURE 1. The major parts of a leaf.

### Veins

Veins of flowering plants are found in several patterns. Monocots and dicots have differing patterns.

Monocots have leaves with **parallel veins**. While the veins may not be parallel in a strict mathematical sense, none of the veins on a monocot leaf cross. They may look as if they are fused together at the top or bottom of the blade. Corn and grass plants are good examples of monocots.

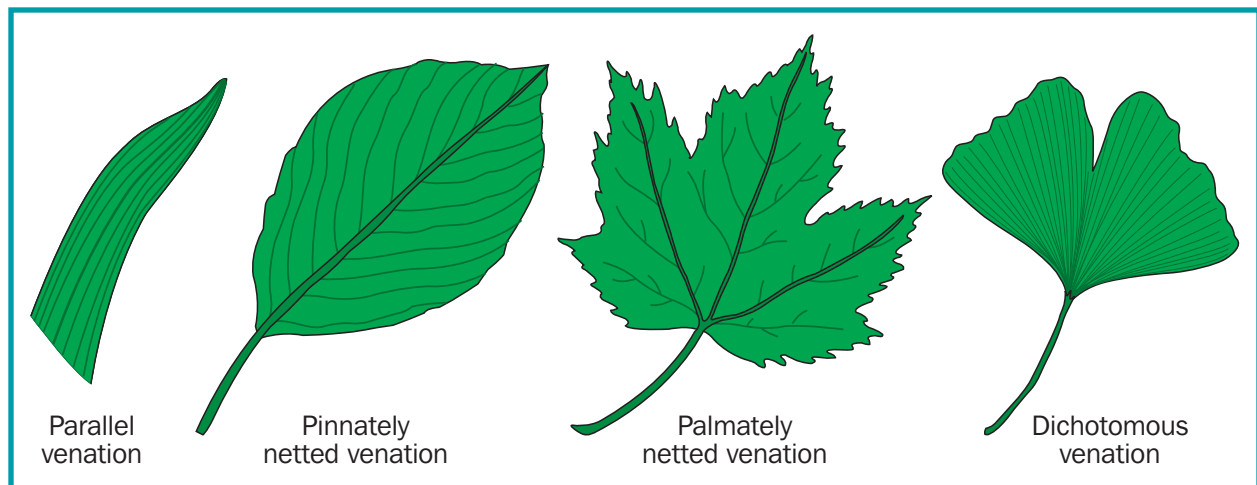


FIGURE 2. Leaf venation patterns.

Dicots have leaves with veins that connect and branch from each other. Veins in a branching pattern are called **netted veins**. A leaf with netted veins sometimes has several smaller veins branching out of a dominant midrib, a condition known as **pinnately netted**. Elms and oaks have pinnate netting. A leaf may sometimes have several dominant veins branching out from the petiole. This condition, known as **palmately netted**, is common with maples and redbud.

A few plants have a spreading vein pattern called **dichotomous venation**. A ginkgo leaf has veins of this type.

## LEAF ORGANIZATION

A leaf is organized to collect sunlight. The leaf blade is constructed of many layers that make this happen.

On top of the leaf is a waxy, noncellular layer called the **cuticle**. The cuticle is on the leaf to prevent water from escaping. Generally speaking, plants that live in bright, arid conditions have very thick cuticle layers.

The next layer on the leaf is also there for protection. The **epidermis** is the skinlike layer of cells found on both the top and bottom surfaces of the leaf. The epidermis may be one or many layers thick.

Directly beneath the upper epidermis is a layer of cells that are standing on end and packed very tightly. These standing cells

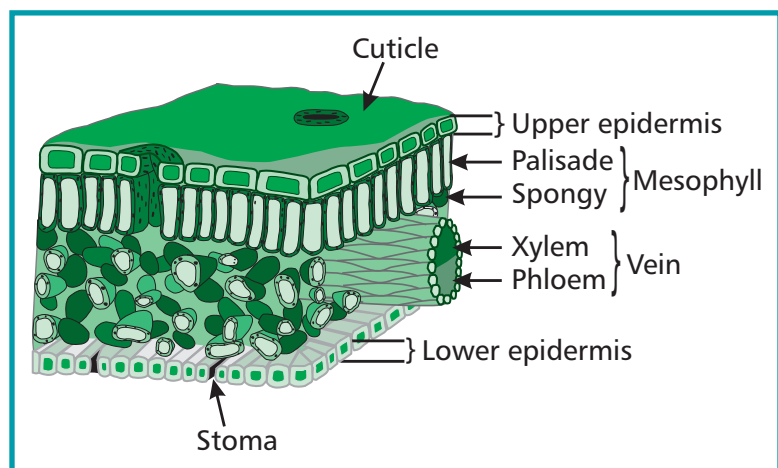


FIGURE 3. A cross section of a leaf.

are responsible for most of the photosynthesis in the leaf and are called the **palisade mesophyll**.

Located under the palisade mesophyll are loosely packed cells called the spongy mesophyll. The **spongy mesophyll** forms air spaces that hold raw materials to be used and products of photosynthesis.

The lower epidermis on the bottom of the leaf has holes in it for gas exchange. The holes are called **stomata** (singular: stoma), and they can open and close. The opening and closing is controlled by a pair of **guard cells**, which surround each stoma.

## TYPES OF LEAVES

There are many different types of leaves. Some leaves are adapted to hot, dry climates by being able to store water or being smaller. Some leaves have very large blades to collect the maximum light in a shady location. The blades of some leaves are broken into three or more sections.

A leaf that has only one blade on its petiole is called a **simple leaf**. Most plants have simple leaves.

A leaf that has multiple blades, or **leaflets**, is called a **compound leaf**. There are different kinds of compound leaves. Two common types are the palmately compound leaf and the pinnately compound leaf. A **palmately compound** leaf has all its leaflets attached to a common point. A **pinnately compound** leaf has multiple leaflets attached along a rachis, or axis.

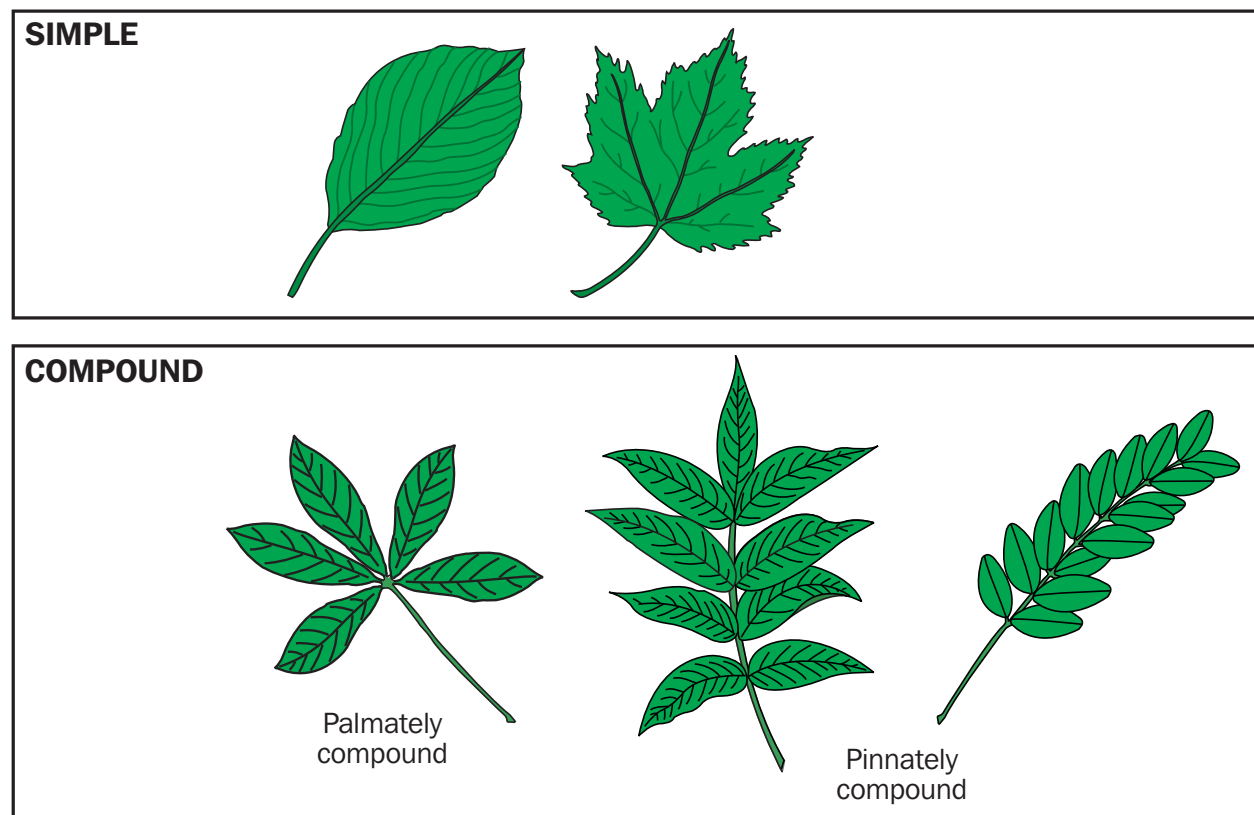


FIGURE 4. Types of leaves.

## LEAF ARRANGEMENT

Leaves are arranged along a stem in one of four major ways. When leaves and buds are directly across from each other on a stem, they are said to be **opposite**. Leaves and buds spaced along a stem in an alternating fashion are termed **alternate**. Another arrangement is **subopposite**, in which leaves and buds are not spaced far enough apart to be called alternate, but neither are they perfectly opposite. When three or more leaves and buds are attached at a node, the arrangement is called **whorled**.

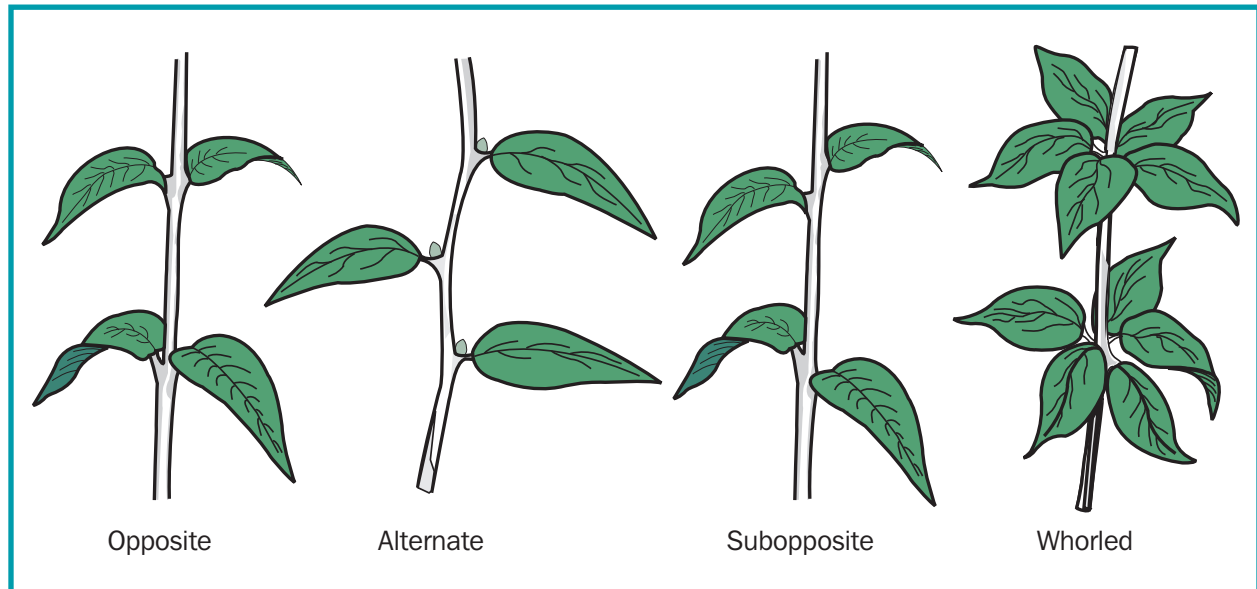


FIGURE 5. Types of leaf arrangements on stems.

### Summary:



Leaves are the primary food-producing organs of a plant. The main light-collecting structure on a leaf is a large, broad, flat surface called the leaf blade. The blade is held away from the stem and supported by the petiole.

Monocots have leaves with parallel veins. Dicots have leaves with veins that connect and branch from each other. Veins in a branching pattern are called netted veins.

A cross section of a leaf blade reveals a layer of cuticle covering a layer of epidermal cells. Beneath the upper epidermis are a layer of standing cells called the palisade mesophyll and a layer of loosely packed cells called the spongy mesophyll. The lower epidermis is on the bottom of the leaf. It has holes called stomata that can open and close. The opening and closing is controlled by a pair of guard cells.

A leaf that has only one blade on its petiole is called a simple leaf. A leaf that has multiple blades is called a compound leaf. Two common types of compound leaves are the palmately compound leaf and the pinnately compound leaf.

Leaves are arranged along a stem in one of four major ways. They may be opposite, alternate, subopposite, or whorled.

### Checking Your Knowledge:

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1. What are the main parts of a leaf?
2. How do vein patterns on leaves differ?
3. How is a leaf organized?
4. What are the types of leaves?
5. What are the four major leaf arrangements?

### Expanding Your Knowledge:

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Collect specimens from trees and shrubs in your area. For each, determine the type of leaf and the arrangement of the leaves on the stem. Use this knowledge to identify each plant. Use a dichotomous key if it is helpful.

### Web Links:

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#### Plant Leaves

[http://facweb.furman.edu/~lthompson/bgy34/plantanatomy/plant\\_leaf.htm](http://facweb.furman.edu/~lthompson/bgy34/plantanatomy/plant_leaf.htm)

#### Leaves

<http://extension.oregonstate.edu/mg/botany/leaves.html>

#### Agricultural Career Profiles

<http://www.mycart.com/career-profiles>