



## CMG GardenNotes #134

# Plant Structures: Leaves

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Leaves, produced on stems, are the principle structure where photosynthesis takes place.

## Functions

- Capture light for photosynthesis (the manufacture of sugars).
- Transpiration from the leaves moves water and nutrients up from the roots.
- Water, gas exchange for photosynthesis and respiration, and temperature are regulated through small openings on the leaf, known as **stomata**.
- Horticultural uses:
  - Aesthetic qualities.
  - Feed and food.
  - Mulch and compost.
  - Plant identification.
  - Propagation from cuttings.
  - Summer cooling. (Evaporative cooling accounts for 70-80% of the shading impact of a tree.)
  - Wildlife habitat.
  - Wind, dust, and noise reduction.

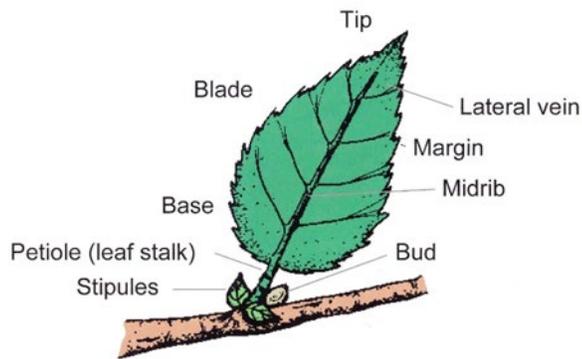
## External Structure Features

[Figure 1]

**Leaf Blade** – Flattened part of the leaf.

**Petiole** – Leaf stalk.

**Stipules** – Appendages at the base of the leaf, which may be leaf-like, spines, or reduced/absent.



**Figure 1.**  
External features of a leaf.

For plant identification purposes, the shape of the leaf margin, leaf tip, and leaf base are key features to note. Remember, a leaf begins at the lateral or auxiliary bud.

### Leaf Arrangement on Stems [Figure 2]

**Alternate** – Arranged in staggered fashion along stem (willow).

**Opposite** – Pair of leaves arranged across from each other on stem (maple).

**Whorled** – Arranged in a ring (catalpa).

**Rosette** – Leaves arranged tightly at the plant crown (dandelion).



**Figure 2.**  
Leaf arrangement on stem.

### Leaf Types [Figure 3]

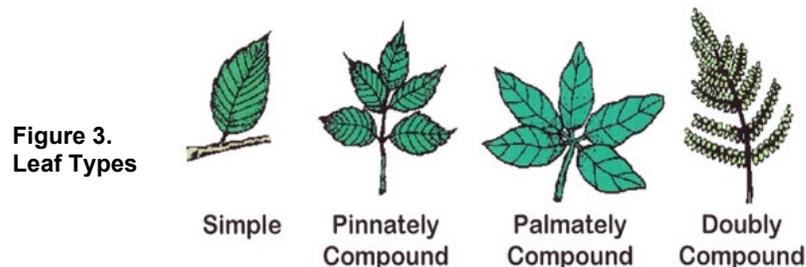
**Simple** – Leaf blade is one continuous unit (cherry, maple, and elm).

**Compound** – Several **leaflets** arise from the same petiole.

**Palmately Compound** – Leaflets radiate from one central point, like fingers from a palm. (Ohio buckeye and horse chestnut).

**Pinnately Compound** – Leaflets arranged on both sides of a common rachis (leaf petiole), like a feather (mountain ash).

**Bi-pinnately (Doubly) Compound** – Leaflets are themselves compound, with smaller leaflets on a secondary rachis.



**Figure 3.**  
Leaf Types

Note: Sometimes identifying a "leaf" or "leaflet" can be confusing. Look at the petiole attachment. A leaf petiole attaches to the stem at a bud node. There is no bud node where leaflets attach to the petiole.

## Overall Leaf Shape

Leaf shape is a primary tool in plant identification. Descriptions often go into minute detail about leaf shapes and margins. **Figure 4** illustrates common overall leaf shapes.

### Leaf Shape Descriptions

**Cordate** – Heart-shaped.

**Cuneate** – Leaves with small width at base, widening near the top (think wedge).

**Elliptical** – Leaves widest in the middle, tapering on both ends.

**Hastate** – Arrowhead shaped leaves.

**Lanceolate** – Leaf is three times or longer than width and broadest below the middle.

**Linear** – Leaves narrow, four times longer than width and have the same width.

**Obcordate** – Reverse appearance of cordate leaves. (The heart shape is upside down).

**Ob lanceolate** – Leaf is three times longer than wide and broadest above the middle.

**Oblong** – Leaf is two to three times as long as it is wide and has parallel sides.

**Obovate** – Leaf is broadest above the middle and about two times as long as the width.

**Ovate** – Leaf is broadest below the middle and about two times as long as the width, also called oval (egg shaped).

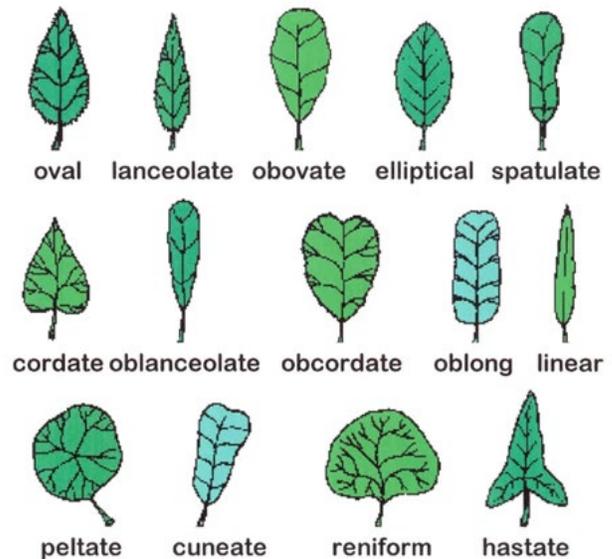
**Peltate** – Leaves rounded with petiole attached under the leaf base.

**Reniform** – Leaves wider than they are high.

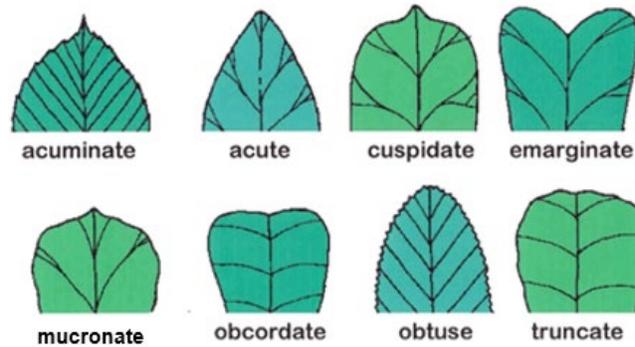
**Spatulate** – Generally narrow leaves widening to a rounded shape at the tip.

### Shape of Leaf or Leaflet Apex

The shape of the leaf apex (tip) and base is another tool in plant identification. **Figures 4** and **5** illustrate common tip and base styles.



**Figure 4. Leaf Shapes**



**Figure 5.**  
Common leaf tips  
shapes.

### Leaf Apex Descriptions

**Acuminate** – Leaf margins forming a terminal angle of less than 45 degrees.

**Acute** – Leaf margins forming a terminal angle of 45 to 90 degrees.

**Cuspidate** – Tip is sharp; looks like two curves meeting at the tip.

**Emarginate** – Tip is slightly indented.

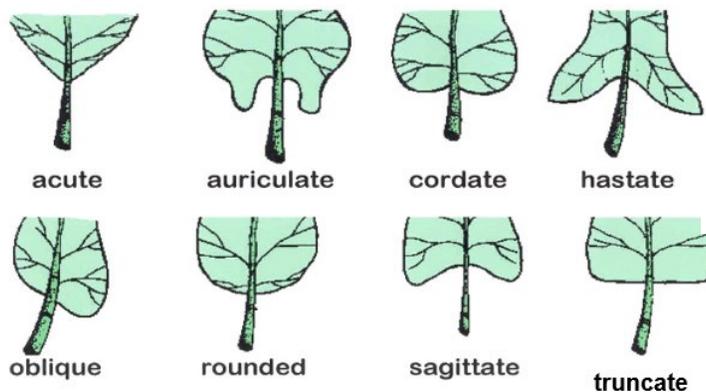
**Mucronate** – Tip ends in a small sharp point that is actually continuation of leaf midrib.

**Obcordate** – Upside down heart shape.

**Obtuse** – Leaf tip is blunt with an angle greater than 90 degrees.

**Truncate** – Leaf tip appears to be squared off, as though cut, or truncated.

### Shape of Leaf Base [Figure 6]



**Figure 6.**  
Common leaf base shapes.

### Leaf Base Descriptions

**Acute** – Base is pointed toward the stem, with leaf edges forming an angle of less than 90 degrees to one another.

**Auriculate** – Base has ear-shaped appendages near the petiole.

**Cordate** – Base is heart-shaped.

**Hastate** – Base has pointed, flaring lobes, making a triangular leaf that resembles a spearhead.

**Oblique** – Base has one side lower than the other.

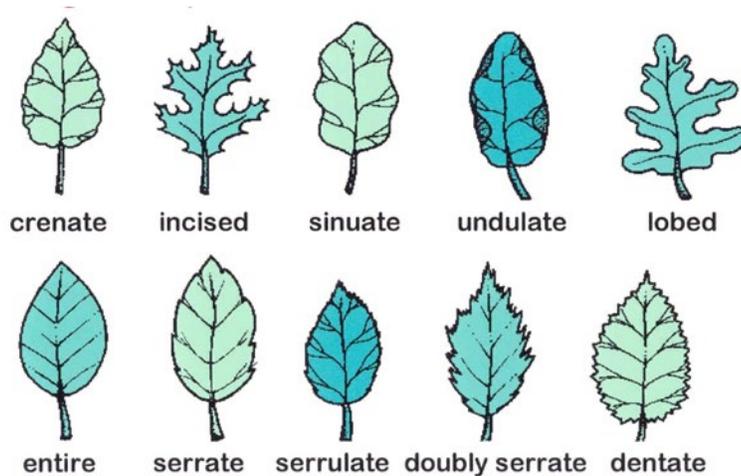
**Rounded** – Circular with no point.

**Sagittate** – Lower lobes of leaf are folded or pointed down, like an arrowhead.

**Truncate** – Leaf base is roughly squared, perpendicular to the petiole.

### Leaf Margins

The leaf margin is another tool in plant identification. **Figure 7** illustrates common margin types.



**Figure 7.**  
Common leaf margins.

### Leaf Margin Descriptions

**Crenate** – Leaf edge has blunt, rounded teeth.

**Dentate** – Leaf has triangular or tooth-like edges.

**Doubly Serrate** – Edges with saw like teeth that have even smaller teeth within the larger ones.

**Entire** – Leaf edge is smooth.

**Incised** – Leaf margins have deep, irregular teeth.

**Lobed** – Leaf edges are deep and rounded.

**Serrate** – Leaf edges are sharp and saw-like (think serrated knife).

**Serrulate** – Leaf edges with smaller, more evenly spaced serrations than a serrated leaf.

**Sinuate** – Margins are slightly wavy.

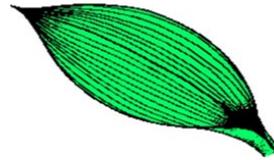
**Undulate** – Very wavy margins.

## Leaf Venation

### Monocots

**Parallel Venation** – Veins run in parallel lines (common in monocots, e.g., grasses, lilies, tulips). [Figure 8]

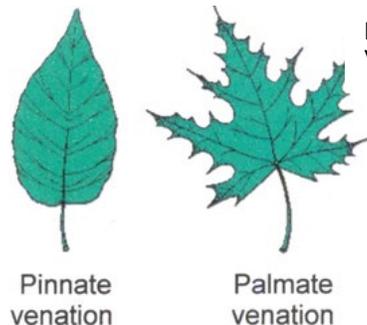
**Figure 8.**  
Parallel veined monocot leaf.



### Dicots [Figure 9]

**Pinnate Venation** – Veins extend from a midrib toward the edge, resembling a feather. (elm, peach, apple, cherry).

**Palmate Venation** – Veins radiate from a central point in a fan-shape from the petiole, like fingers on a palm (maple, grapes).



**Figure 9.**  
Venation of dicot leaves.

## Modified Leaves

**Adhesive Disc** – Modified leaf used as an attachment mechanism. Sometimes referred to as a holdfast (Boston ivy).

**Bract** – Specialized, often highly colored leaf below flower that often serves to lure pollinators (poinsettia, dogwood).

**Tendrils** – Modified leaf, stipule, or other plant part used for climbing or as an attachment mechanism (Virginia creeper, peas, grapes). Distinguished from twining stems by the absence of leaves along their length (since they are themselves leaves).

## Internal Structural Features

The leaf blade is composed of several layers. [Figure 10]

**Epidermis** – Outer layer of cells

**Cuticle** – Waxy protective outer layer of epidermis that prevents water loss from leaves, green stems, and fruits. The amount of cutin or wax increases with light intensity.

**Leaf Hairs/Trichomes** – Uni- or multicellular projections that can provide physical defense or excrete chemical compounds.

**Stomates (Stomata)** – Natural openings in leaves and herbaceous stems that allow for gas exchange (water vapor, carbon dioxide and oxygen) and plant cooling. Most stomates are found on the underside of leaves.

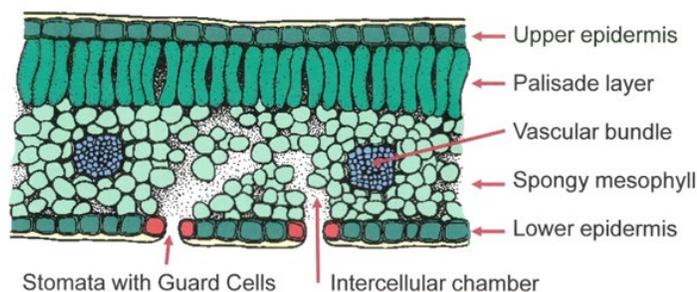
**Guard Cells** – Specialized kidney-shaped cells that open and close the stomata.

**Vascular bundle** – Xylem and phloem tissues comprising the leaf veins.

**Mesophyll** – Cells within the leaf directly involved with photosynthesis, storage, and other metabolic processes. Mesophyll organization is variable within the leaves of different plant species.

**Palisade Layer** – Closely ranked cells directly beneath the epidermis, very photosynthetically active. Not all plants have a well differentiated palisade layer.

**Spongy Mesophyll** – Loosely organized ground tissue (mostly parenchyma cells) that are involved with photosynthesis, water and nutrient exchange, and metabolism.



**Figure 10.**  
Cross sectional view of a leaf.

Figures 4, 5, and 7, drawn after by D. Whiting, inspired from the book *Manual of Woody Landscape Plants*, Michael A. Dirr. Stipes Pub LLC, fifth edition, 1998. ISBN: 0-87563-795-7.

Authors: David Whiting, CSU Extension, retired; Michael Roll, former CSU Extension employee; and Larry Vickerman, former CSU Extension employee. Artwork by Scott Johnson and David Whiting. Used with permission. Revised October 2017 by Patti O'Neal, CSU Extension, retired; Roberta Tolan, CSU Extension, retired; and Mary Small, CSU Extension, retired. Reviewed March 2023 by John Murgel, CSU Extension and Sherie Shaffer, CSU Extension.

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