Colorado Master Gardener[sm] Program
Colorado Gardener Certificate Training
Colorado State University Extension

CMG GardenNotes #134

Plant Structures: Leaves

Outline:

Thought questions:

(Explain the science behind the questions.)

- Last spring my tulips were magnificent. As blooms faded, I removed the blossoms and foliage so it wouldn't detract from other spring flowers coming into bloom. This year, most of the tulips didn't come back. Why?

Leaves are the principle structure, produced on stems, where photosynthesis takes place. Cacti are an exception. The leaves are reduced to spines, and the thick green, fleshy stems are where photosynthesis takes place.

Functions

- To compete for light for photosynthesis, i.e., the manufacture of sugars
- Evapotranspiration from the leaves is what moves water and nutrients up from the roots.
- Small openings on the leaf, known as ***stomata,*** regulate moisture and gas exchange (water and carbon dioxide) and temperature (cooling effect as water vapor escapes through 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

Structure

Internal Features

The leaf blade is composed of several layers as follows:

Epidermis – Outer layer of tissues

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

Leaf hairs – Part of the epidermis

Palisade layer – A tightly packed layer of parenchyma tissues filled with chloroplasts for photosynthesis.

Chloroplasts – Sub-cellular, photosynthetic structures in leaves and other green tissues. Chloroplasts contain chlorophyll, a green plant pigment that captures the energy in light and begins the transformation of that energy into sugars.

Vascular bundle – Xylem and phloem tissues, commonly known as leaf veins.

Spongy mesophyll – Layer of parenchyma tissues loosely arranged to facilitate movement of oxygen, carbon dioxide, and water vapor. It also may contain some chloroplasts.

Stomata – Natural openings in leaves and herbaceous stems that allow for gas exchange (water vapor, carbon dioxide, and oxygen).

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

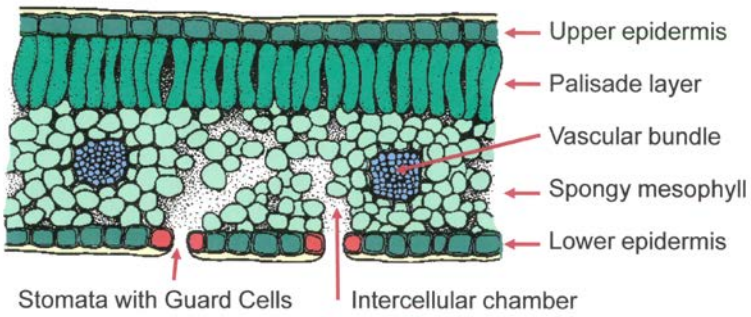
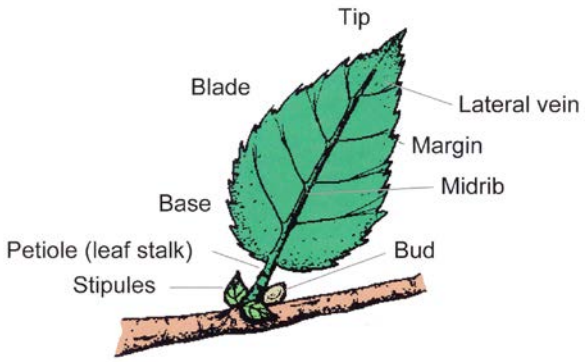


Figure 1. Leaf Cross Sectional View with Stomata.

External Features

Leaf blade – Flattened part of the leaf
Petiole – Leaf stalk
Stipules – Leaf-like appendages at the base of the leaf.

Figure 2. 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

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 – Spiral cluster of leaves arranged at the base (or crown) (dandelion)

Figure 3. Leaf Arrangement on Stem

Leaflet Arrangement on Petiole

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

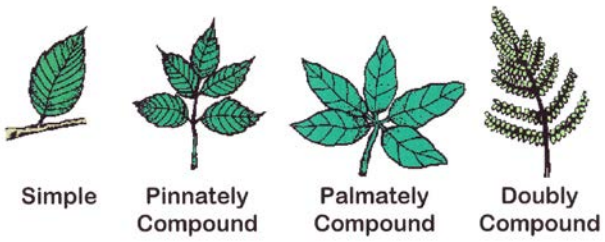
Compound – Several ***leaflets*** arise from the same petiole

Pinnately compound – Leaflets arranged on both sides of a common rachis (leaf stalk), like a feather (mountain ash)

Palmately compound – Leaflets radiate from one central point (Ohio buckeye and horse chestnut)

Double pinnately compound – Double set of compound leaflets

Figure 3. Leaf Arrangement on Petiole.

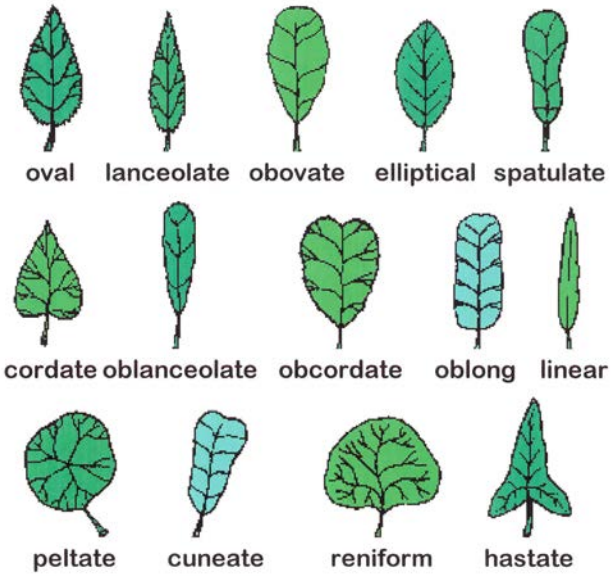


Note: Sometimes identifying a "leaf" or "leaflet" can be confusing. Look at the petiole attachment. A leaf petiole attaches to the stem at a bud node. There is no bud node where leaflets attach to the petiole.

Overall Leaf Shape

Leaf shape is a primary tool in plant identification. Descriptions often go into minute detail about general leaf shape, and the shape of the leaf apex and base. Figure 5 illustrates common shapes as used in the *Manual of Woody Landscape Plants.*

Figure 5. Leaf Shapes



Shape of Leaf Apex and Base

Shape of the leaf apex (tip) and base is another tool in plant identification. Figures 6 and 7 illustrate common tip and base styles as used in the *Manual of Woody Landscape Plants*.

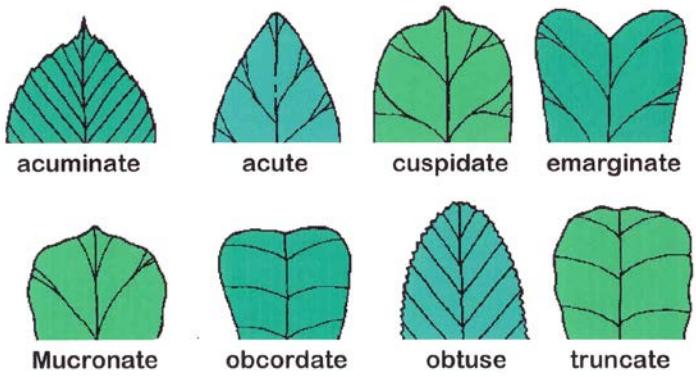


Figure 6. Leaf Tip Shapes

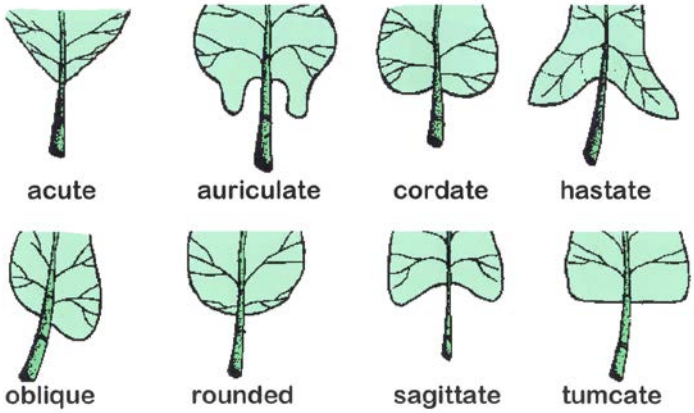


Figure 7. Leaf Base Shapes

Leaf Margin

The leaf margin is another tool in plant identification. Figure 8 illustrates common margin types as used in the *Manual of Woody Landscape Plants*.

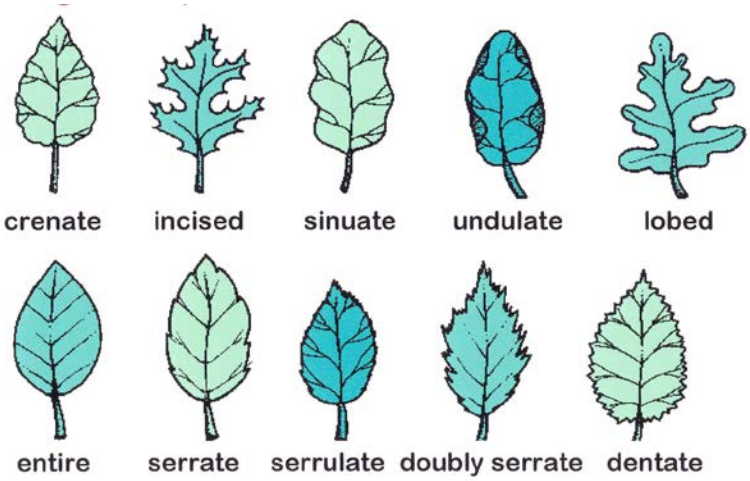


Figure 8. Leaf Margins

Leaf Types / Leaf Venation

Conifer types

Scale-like – Mature leaves common on most junipers and arborvitae
Awl-shaped – Juvenile leaves common on some junipers
Linear-shaped – Narrow flat needles of spruce, fir, and yews
Needle-like – In pine, the single, bundle**,** or cluster of needles makes a rounded shape

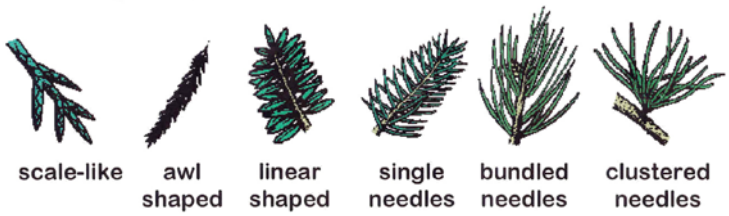


Figure 9. Conifer leaf types

Ginkgo type

Dichotomous venation – Somewhat parallel vein sections, forming a 'Y', found in Ginkgo trees. [Figure 10]

Figure 10. Dichotomous veined Ginkgo leaf

Monocot types

Parallel venation – Veins run in parallel lines. (monocot plants, e.g. grasses, lilies, tulips). [Figure 11]

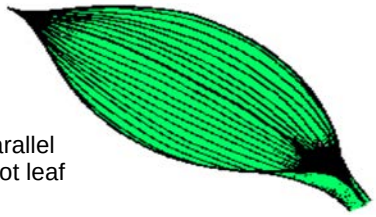


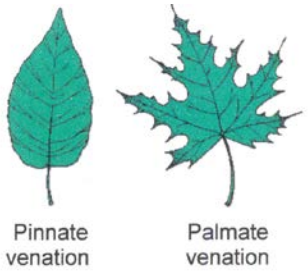
Figure 11. Parallel veined monocot leaf

Dicot types

Net-veined or reticulate-veined – Leaves with veins that branch from the main rib and then subdivide into finer veinlets. (dicot plants) [Figure 12]

Pinnate venation – Veins extend from a midrib to the edge (elm, peach, apple, cherry).
Palmate venation – Veins radiate fan-shaped from the petiole (maple, grapes).

Figure 12. Venation of dicot leaves



Modified Leaves

Adhesive disc – Modified leaf used for 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)

Thorn – Modified leaf. (barberry, pyracantha)

Tendril – Modified sinuous leaf used for climbing or as an attachment mechanism. (Virginia creeper, peas, grapes)

Figure 13. Thorns are modified leaves.

Additional Information – *CMG GardenNotes* on How Plants Grow (Botany):

#121	Horticulture Classification Terms	#136	Plant Structures: Fruit
#122	Taxonomic Classification	#137	Plant Structures: Seeds
#131	Plant Structures: Cells, Tissues, and Structures	#141	Plant Growth Factors: Photosynthesis, Respiration and Transpiration
#132	Plant Structures: Roots	#142	Plant Growth Factors: Light
#133	Plant Structures: Stems	#143	Plant Growth Factors: Temperature
#134	Plant Structures: Leaves	#144	Plant Growth Factors: Water
#135	Plant Structures: Flowers	#145	Plant Growth Factors: Hormones

---

Authors: David Whiting, Consumer Horticulture Specialist, Colorado State University Extension; with Michael Roll and Larry Vickerman (former CSU Extension employees). Line drawings by Scott Johnson.

Minor revisions, September 2014