



# Colorado MASTER GARDENER

## Plant Structures: Stems

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### Thought question:

- My trees were under severe drought stress for the past few years. But why are they still showing stress when we had good moisture this year?
- Over the winter, rabbits girdled my tree all the way around down to the wood. My neighbor said it would die, but it leafed out nicely. Will it be okay?
- I planted several new trees the past few years. How can I evaluate how they are growing? How can I tell if roots are established so I can begin structural pruning?



Stems are the part of a plant that bear leaves and flowers. Stems are also the continuation of the vascular system pipeline that starts in the roots.

### Functions

- Stems provide a framework for leaves, flowers and seeds.
- They are a continuation of the vascular system carrying water and minerals from the soil, and sugars manufactured in leaves throughout the plant.
- Green stems also manufacture food (photosynthesis).
- Stems provide food storage.
- They also have horticultural uses including:
  - aesthetic (winter interest in the landscape, appealing bark, etc.),
  - feed and food,
  - fuel,
  - plant identification,
  - propagation (cuttings and layering),
  - wildlife habitat, and
  - wood industry and construction.

### Structure

#### Internal Features

**Apical meristem** – tissues at the tip of a stem capable of cell division, give rise to stem elongation.

**Epidermis** – outer layer of wax-coated cells that provide protection and covering.

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**Cortex** – primary tissues of a stem externally bound by the epidermis and internally by the phloem.

### Vascular Bundle

**Xylem tissues** – distribute water and minerals from the roots up through the plant. Xylem provides the structural support in plants, and becomes the woody tissue.

**Cambium tissues** – the single-celled layer of meristematic (dividing) tissues that continually divide to form phloem tissues toward the outside and xylem tissues towards the inside. Cell division of the cambium adds width to the stem.

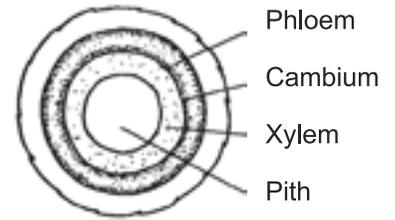


Figure 1. Vascular bundle.

**Phloem tissues** – distribute sugars (products of photosynthesis) throughout the plant. It is important to understand what happens when the phloem is blocked, as when a tree is girdled with a tie or rope. The stem often enlarges just above the blockage due to the sugars moving down from the leaves. Tissues below the blockage slowly starve. Roots die back, eventually leading to death of the plant.

**Pith** – center of dicot plant stems. In some plants the pith breaks down forming a hollow stem. In older woody plants, the pith is filled with rigid xylem wood fiber.

### Monocot or Dicot

Monocot and dicot stems differ in the arrangement of the vascular system. In monocot stems, the xylem and phloem are paired in bundles. These bundles are dispersed throughout the stem.

In herbaceous dicot stems, the vascular system makes a ring, with the phloem to the exterior and xylem to the interior.

In woody dicot plants, the rings grow to make a complete ring around the stem. Xylem growth makes the **annual rings** used to tell a tree's age. In woody dicot plants, water and mineral movement occurs in the more recent years of xylem rings (approximately 5 years). Drought reduces the size of the annual rings (size of xylem tubes) and thus the potential for water and nutrient movement. Multi-year droughts, with their corresponding reduction in xylem size, have long-term impact on plant growth potential.

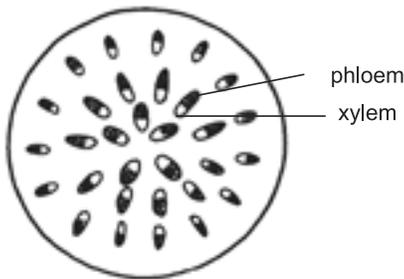


Figure 2. Monocot stem cross-section.

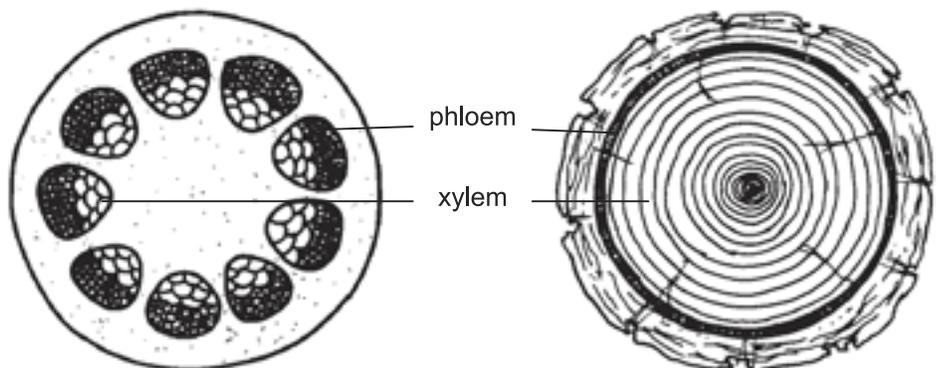


Figure 3. Herbaceous dicot stem (left). Woody dicot stem (right).

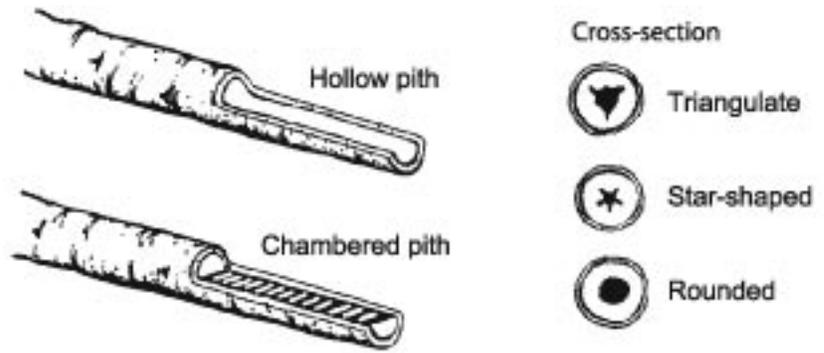


Figure 4. Cross-section of the pith of a woody dicot stem.

Woody dicot stems are used in tree and shrub identification. Features to look at include the cross section shape of the pith (rounded, star, or triangular) and whether the pith is solid, hollow, or chambered.

### External Features

**Bud** – a stem’s primary growing point. Buds can be either leaf buds (vegetative) or flower buds (reproductive). These buds can be very similar in appearance, but flower buds tend to be plumper than leaf buds.

**Terminal bud** – bud at the tip of a stem. In many plants, auxin (a plant hormone) released from the terminal bud suppresses development of lateral buds, thereby focusing the growth of the plant upward rather than outward. If the terminal bud is removed during pruning (or natural events) the lateral buds will develop and the stem becomes bushy.

**Lateral buds** grow from the leaf axil on the side of a stem.

**Bud scales** – a modified leaf protecting and covering a bud.

**Naked bud** – buds without a protective bud scale; characteristic of the Viburnum Family.

**Leaf scar** – a mark left on the stem where a leaf was attached. Often used in woody plant identification.

**Bundle scar** – marks left in the leaf scar from the vascular tissue attachment. Used in woody plant identification.

**Lenticel** – pores that allow for gas exchange

**Terminal bud scale scars or annual growth rings** – mark left on stem from the terminal bud scales in previous years. Terminal bud scale scars are an external measure of annual growth. Therefore they are important in assessing plant vigor.

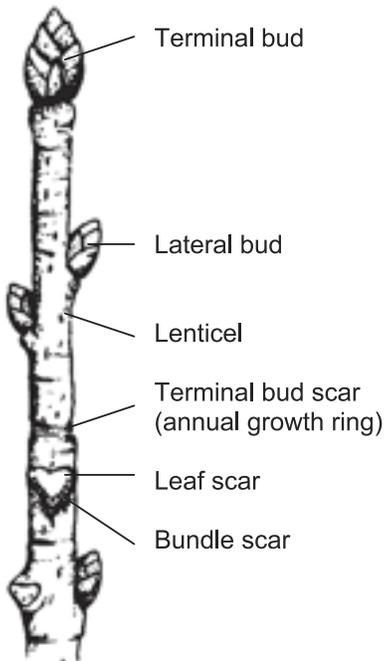


Figure 5. External features of a stem.

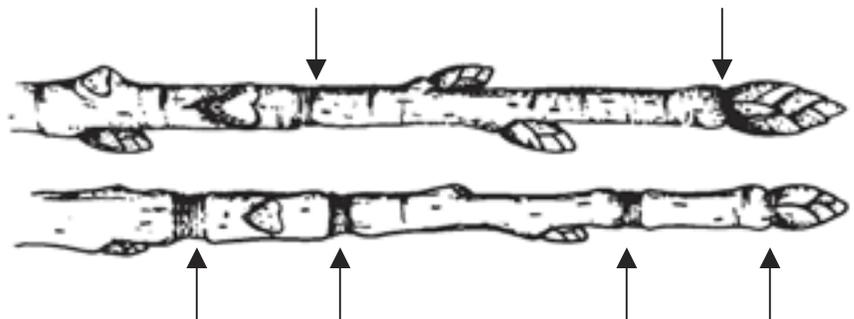
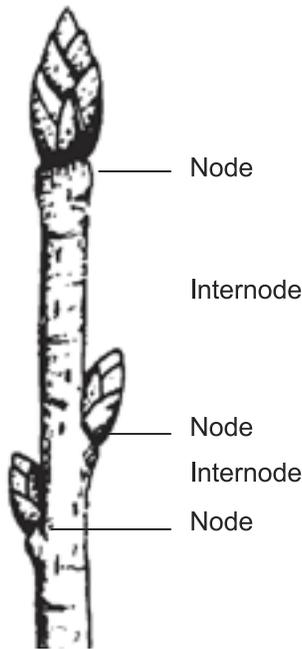


Figure 6. Terminal bud scars or annual growth rings.



**Node** – segment of stem where leaves and lateral buds are attached.  
 Note: Roots do not have nodes.

**Internode** – section of a stem between two nodes

**Bark** – protective outer tissue that develops with age. Used in woody plant identification.

All the features described above can tell the knowledgeable horticulturist a great deal about a plant pertinent to its identification and health. These are common terms that frequently appear in literature.

The type of bud is also used in plant identification. Figure 8 (below) illustrates bud types used in the *Manual of Woody Landscape Plants*.

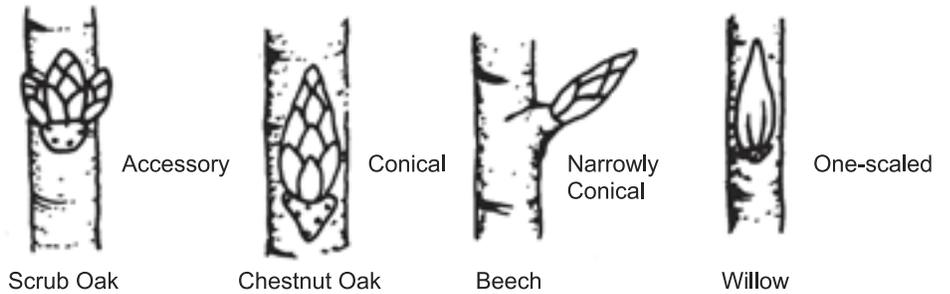


Figure 7. Nodes formation on a stem.

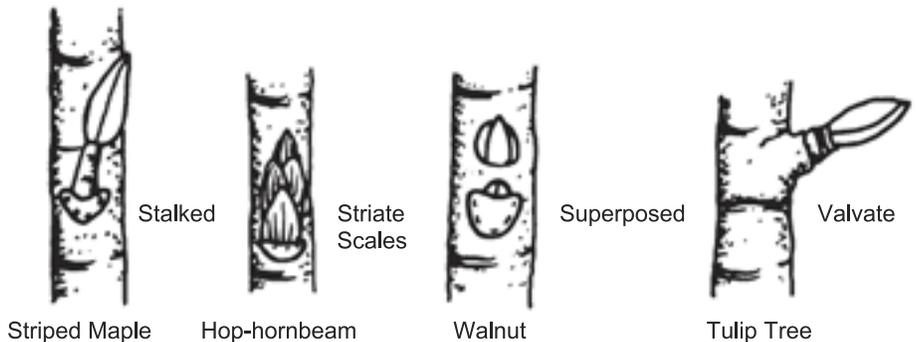
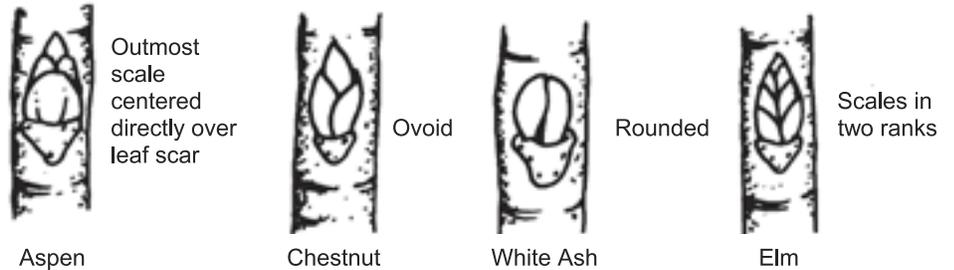


Figure 8. Types of buds often used in plant identification.

## Common Types of Stems

### Woody Plants

**Shoot** – first year growth on a woody or herbaceous plant.

**Twig** – woody stem less than one year old.

**Branch** – woody stem more than one year old.

**Trunk** – main support stem(s) of woody plants

**Water sprouts** – juvenile adventitious shoots arising on a branch.

Generally very rapid, upright growing, and poorly attached to the main limb.

**Suckers** – juvenile adventitious shoots arising from the roots, generally rapid, upright growing

**Canes** – stems with relatively large pith and usually living for only one to two years (roses, grapes, blackberries, and raspberries).

## Modified Stems

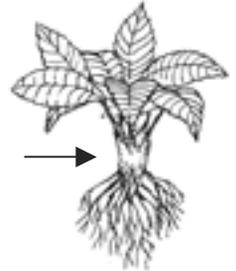
**Bulb** – thickened, underground stem with fleshy storage leaves attached at base (tulips, lilies, onions).



**Corm** – short thickened underground stem with reduced scaly leaves (gladiolus).



**Crown** – compressed stem having leaves and flowers growing above and roots beneath (strawberry plant, dandelion, African violet).



**Stolon** (or runner) – horizontal above-ground stems often forming roots and/or plantlets at their tips or nodes (strawberry runners, spider plants).



**Rhizome** – horizontal underground stem, typically forms roots and plantlets at tips or nodes (iris, bentgrass, cannas).



**Spur** – very compressed fruiting twig found on some apples, pears, cherries, and ginkgo.



**Twining stems** – modified stems used for climbing. Some twist clockwise (hops, honeysuckle); others twist counter-clockwise (pole beans, Dutchman's pipe).

**Tuber** – enlarged rhizome containing stored food (Irish potato, the eyes of the potato are the modified buds.).



**Tuberous stem** – short, flattened, modified storage stem (tuberous begonias, dahlias). Unlike tubers, which have buds scattered all over, tuberous stems only have leaf buds on the up end.

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