MASTER GARDENER
COLORADO STATE UNIVERSITY
EXTENSION

CMG GardenNotes #133

Plant Structures: Stems

Stems are the part of a plant that bears leaves and flowers, and they are the continuation of the vascular system pipeline that starts in the roots. Stems can grow in *length* at the tips and in *girth* in older stems that have developed a vascular cambium.

Functions

- Framework for leaves, flowers, and seeds.
- Continuation of vascular system carrying water and minerals from the soil, and sugars manufactured in leaves throughout the plant.
- Green stems also manufacture food.
- Food storage.
- Horticultural uses.
    - Aesthetic (winter interest in the landscape, appealing bark, etc.).
    - Feed and food.
    - Fuel.
    - Plant identification.
    - Propagation (cuttings and layering).
    - Wildlife habitat.
    - Wood industry and construction.

Stems in Common Parlance

Shoot – Young, typically pliable stem.

Twig – Slender woody stems growing from a branch or trunk.

Branch – A woody stem growing from a trunk or bough. Branches are usually considered to be larger than twigs but smaller than boughs.

Bough – Larger or main limbs of a tree, though sometimes applied to smaller branches.

Trunk – Main support stem(s) of woody plants.

Water Sprouts – Adventitious shoots arising on a branch vertically, generally growing very rapidly. Because they are adventitious, they are poorly attached to the main limb. Also called **epicormic shoots**.

Suckers – Adventitious shoots arising from the roots, generally rapidly growing.

Canes – Stems with relatively large pith and that usually live (or are allowed to grow) for only one to two years (roses, grapes, blackberries, and raspberries).

Structure

Internal Features

Shoot Apical Meristem – "Immortal" cells at the tips of stems that generate new cells for differentiation and growth in stem length.

Epidermis – Outer layer of wax-coated cells that provides protection and covering.

Cortex – Primary structural and storage tissues of a stem.

Vascular Tissues

Vascular Bundle – grouped phloem, xylem, and associated cells in primary stems. Vascular bundles give rise to the Vascular Cambium in plants that are capable of secondary growth (stem thickening).

Vascular Cambium – the layer of meristematic (dividing) tissues that forms in some plants to generate **secondary growth** (growth in girth). The cambium divides to form phloem tissues toward the outside of the stem and xylem tissues toward the inside. Cell division of the cambium tissues adds width to the stem. [**Figure 1**]

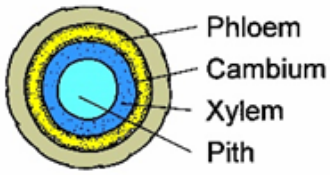


Figure 1. Cross section of stem in secondary growth.

Secondary Phloem (inner bark) – In plants with secondary growth (woody plants), the phloem is located to the outside of the vascular cambium and just beneath the bark. If the stem is damaged or girdled so as to disrupt or block the phloem, it can enlarge just above the blockage due to the sugars moving down from the leaves for distribution throughout the plant. Tissues below the blockage slowly starve. Roots die back, eventually leading to death of the plant.

Secondary Xylem (wood) – distributes water and minerals from the roots up through the plant. Typically only the xylem tissue nearest the vascular cambium (the youngest xylem) functions for water transmission; older xylem provides structural support.

Pith – the soft center of dicot plant stems, consisting of parenchyma cells. In some plants the pith breaks down forming a hollow stem. [**Figure 2**]

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

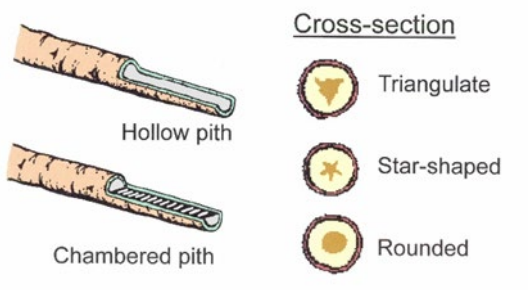


Figure 2. Stem pith is used in plant identification. It may be solid, hollow, or chambered. In a cross section, the pith may be rounded, triangulate, or star-shaped.

Tree Rings

In trees and shrubs, xylem growth makes the “annual rings” used to tell a tree’s age (phloem, being to the outside the vascular cambium, is continually sloughed off and renewed and does not accumulate in rings). Water and mineral movement occur in the more recent years of xylem rings, that is, those closest to the outside of the tree. Because water is critical in supporting cell growth and expansion, drought reduces both the width of the annual rings and the size of xylem vessels in the rings, and thus the potential for water and nutrient movement. Multi-year droughts, with their corresponding reduction in xylem size, have long-term impacts on plant growth potential. [**Figure 3**]

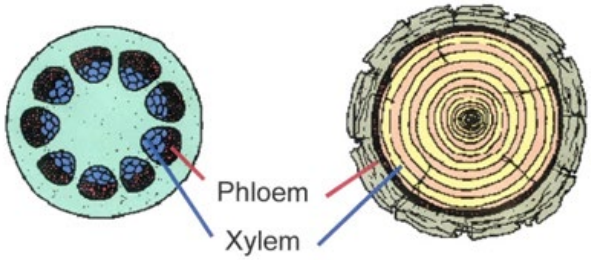


Figure 3. Cross section of dicot stems in primary growth (left) and secondary growth (right).

External Features

Bud – A stem's primary growing point. Buds can be either leaf buds (vegetative) or flower buds (reproductive). These buds can be remarkably 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. [**Figure 4**]

Lateral Buds – They grow from the leaf axils on the side of a stem.

Leaf Scar – Mark left on stem where leaf was attached. Often used in woody plant identification.

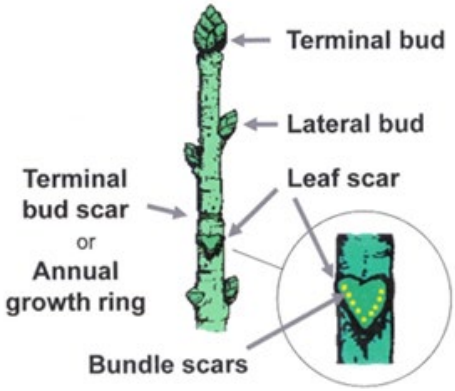


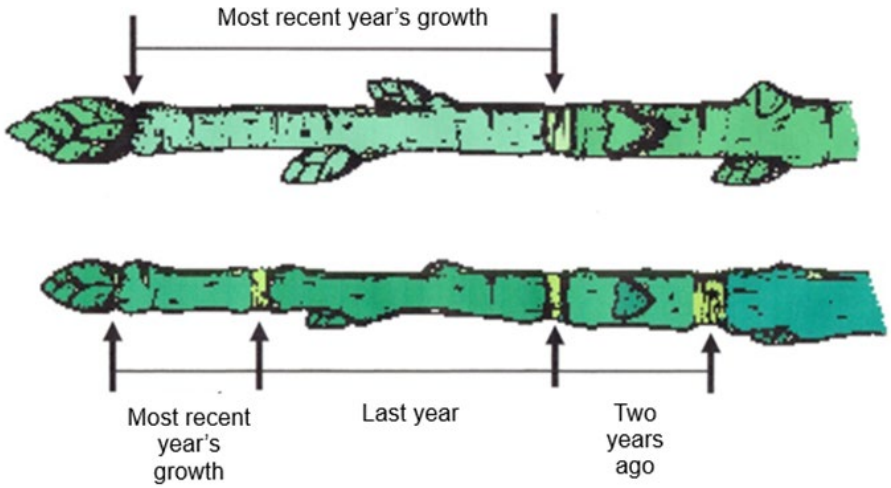
Figure 4. External features of a stem.

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** – Marks left on stem from the terminal bud scales in previous years. Terminal bud scale scars can be used to measure annual growth. Therefore, they are important in assessing plant vigor. [**Figure 5**]

Figure 5. Terminal Bud Scars and Annual Growth Increments



Node – Segment of stem where leaves and lateral buds are attached. [**Figure 6**] 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.

Close examination of stems can tell you a great deal about a plant pertinent to its identification and health.

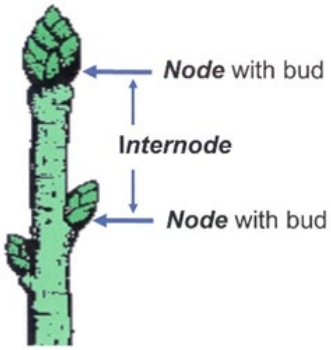


Figure 6. Node and Internode

Modified Stems

Corm – Short, thickened, underground monocot stem. [**Figure 7**]

Figure 7. Corm

Crown – Compressed stem having leaves and flowers growing above and roots beneath (strawberry plant, dandelion, African violet). [**Figure 8**]

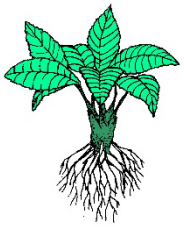
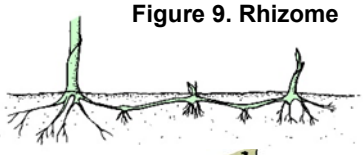


Figure 8. Crown

Rhizome – Horizontal, underground stem, typically forms roots and plantlets at tips or nodes (iris, bentgrass, cannas). [**Figure 9**]

Figure 9. Rhizome



Spur – Very compressed (shortened), fruiting twig found on some apples, pears, cherries, and ginkgo. [**Figure 10**]

Stolon (or runner) – Horizontal, above-ground stems often forming roots and/or plantlets at their tips or nodes (strawberry runners, spider plants). [**Figure 11**]

Figure 10. Spur

Figure 11. Stolon

Thorn – A stem modified for plant defense. Thorns maintain cell types and morphology of stems, whereas prickles are superficial outgrowths of the epidermis. Hawthorns have thorns, roses have prickles.

Twining stems – Modified stems used for climbing. Some twist clockwise (hops, honeysuckle); others twist counterclockwise (pole beans, Dutchman's pipe).

Tuber – A solid thickened portion or outgrowth of an underground stem containing stored food (e.g., potato, the eyes of the potato are axillary buds). [**Figure 12**]

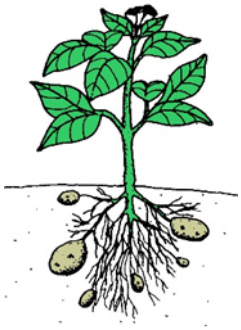


Figure 12. Tuber

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 June 2016 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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