EXERCISE 14  STEM ORGANIZATION AND STEM TYPES

Stems vary in structure and may be classified into types. This classification is artificial, however, because there is no sharp line of demarcation between types, and sometimes the differences are of a purely quantitative kind. The chief differences are determined by the spatial relation between the vascular and nonvascular tissues and by the relative amounts of secondary growth. The stems are more complex in structure than the roots mainly because of the complexity of the primary vascular system. In stems the primary vascular system differentiates in relation to leaves. In roots this system differentiates with no relation to lateral organs. During secondary growth the resemblance between roots and stems increases. The secondary xylem and secondary phloem of roots and stems show mainly quantitative differences.

Primary Structures of Stem

Tissue regions. The basic organization of stem in primary state of growth may be reviewed by the use of a young stem of Helianthus (# 11), or other plant with none or small amount of secondary growth. Observe (1) tissue regions; (2) complexity of vascular region--it consists of discrete strands of various sizes; (3) a delimitation of tissue regions that is less precise than in roots. The starch sheath, if observable, occupies the same position as the endodermis in the root; but whereas the root has a distinct pericycle beneath the endodermis, in the stem commonly the starch sheath is located next to the phloem. The vascular bundles in Helianthus are collateral. The "bundle cap" on the outer periphery of the vascular bundle is non-functioning phloem. Collenchyma may or may not be present beneath the epidermis.

Vascular bundles

(1) collateral vascular bundle - xylem on one side (toward the pith) phloem on the other (toward the cortex). Pelargonium (# 18), Triticum (# 42), Zea (# 43).

(2) Bicollateral vascular bundle - phloem on both sides of the xylem. Cucurbitaceae, Melastomaceae, certain Compositae, Solanaceae, Asclepiadaceae, Apocynaceae. Cucurbita (cucumber) is slide # 21).

(3) Concentric vascular bundle - (a) phloem surrounding the xylem (amphicribral). Ferns (e.g., Dicksonia (# 23), Pteris (# 25), axial bundles in dicotyledonous water plants (Hippuris, Myriophyllum), small bundles in floral parts of dicotyledons. (b) xylem surrounding the phloem (amphivasal). Frequent in monocotyledons in combination with collateral bundles. Acorus (# 46).

Herbaceous dicotyledon. (1) Pelargonium stem (slides 18 and 19) is a good example of onset of secondary growth in a "typical" dicot. Features to be studied are - epidermis, present in young stems, replaced by periderm (cork cambium and cork) in the older stem. The cork cambium arises in the subepidermal layer. The dead and collapsed epidermis may cling to the periderm for some time. Stomata occur in the epidermis. The cortex is composed of parenchyma with abundant intercellular spaces. Tannins accumulate in many cortical cells in older stems. Pitting
may be visible in the cortical cells. The vascular region is surrounded by several rows of phloem fibers. These fibers arise from the same part of procambium as the primary phloem. The fibers develop secondary walls. Both the compound middle lamella and the secondary walls eventually become lignified. In a young stem the procambium forms an almost continuous cylinder (ring in transection) but certain parts of it are much wider than others. The wider parts become the vascular bundles of the primary vascular system, the narrow parts the interfascicular areas. The bundles are collateral and contain primary phloem and primary xylem. Mature (with secondary walls) and immature (without secondary walls) tracheary elements may be present. The immature ones occur near the vascular meristem located between the phloem and the xylem. In young stems this meristem is procambium. Later it assumes the characteristics of vascular cambium and produces secondary xylem and secondary phloem. Vascular cambium occurs not only between the primary phloem and primary xylem, but it also develops in the interfascicular areas. The fascicular and interfascicular layers of cambium together form a continuous cylinder of secondary vascular tissues. The primary xylem appears on the inner side of the secondary xylem and has the shape of wedges projecting into the pith. The pith is composed of parenchyma cells. (2) *Hoya carnosa* (wax plant) stem on demonstration is a variant on the normal organization, with internal phloem, perivascular and medullary sclereids, and phloem fibers.

*Herbaceous monocotyledon.* (1) *Triticum* (wheat) (# 42), stems show hollow internodes and collateral vascular bundles arranged in one or two circles near the periphery of the stem. It is instructive to see the stem in combination with the leaf sheath and to study the connection of the vascular bundles of the sheath with those of the stem. If fresh material is available of the above genera or some other grass, the concept of intercalary meristems may be considered. (2) *Zea* (corn) stem (# 43), preferably in younger and older stages of development. The collateral vascular bundles appear scattered in the ground parenchyma, visible in longitudinal section at two stages of development (# 44 and # 45). Actually, they form a connected system.