Plant Structure and Growth: Growth Overview

• Determinate vs. indeterminate growth

• Meristems- the key to indeterminate growth
  – apical meristem is responsible for primary growth
  – lateral meristems are responsible for secondary growth

Plant Structure and Growth: Primary Growth

• Apical meristem
  – zone of active cell division near tip of root or shoot
  – lays down 3 primary meristems
    • Protoderm —» dermal tissue
    • Ground meristem —» ground tissue
    • Procambium —» vascular tissue
  – 3 growth zones (division, elongation, maturation)
Plant Structure and Growth: Primary Growth

- Growth of dicot primary root
  - epidermis
  - cortex (ground tissues just inside epidermis)
    - active in nutrient uptake & food storage
    - innermost layer = endodermis
  - Stele (vascular bundle in center of root)
    - Xylem & phloem
    - pericycle (outermost layer)
Organization of primary root tissues of a dicot.

Stele = central vascular bundle

Endodermis (= inside skin):
innermost layer of cortex cell walls coated with suberin
stele = tissue inside endodermis

Endodermis
Passage cell
Primary xylem
Pericycle
Primary phloem

Prim. Xylem

4 pockets of phloem

Pericycle:
first layer of stele
may give rise to lateral roots

Lateral roots develop from pericycle

**FIGURE 14.14**
A lateral root. A lateral root growing out through the cortex of black willow, *Salix nigra*. Lateral roots arise in the pericycle beneath the surface of the main root, while lateral stems arise from buds located in the axils of the leaves.
**Plant Structure and Growth**: Primary Growth

- Growth of dicot primary stem
  - apical meristem → 3 primary meristems
    - epidermis covering stems & leaves formed by protoderm
    - vascular bundles formed by procambium
    - split ground tissue formed by ground meristem
      - pith
      - cortex (external to vascular bundles)
**Plant Structure and Growth:** Secondary Growth

- Growth produced by two lateral meristems
  - vascular cambium —» secondary xylem & phloem
  - cork cambium —» thick covering over roots and stems
- Vascular cambium
  - layer of parenchyma cells between primary xylem & phloem becomes meristematic
  - soon forms continuous ring
  - xylem to the inside, phloem to the outside
  - tree rings
  - sapwood vs. heartwood
Cross section of dicot stem- early secondary growth

Vascular Cambium forms solid ring

Pith gets squashed!

Cross section of dicot stem- well-developed secondary growth

Annual growth layers
**Plant Structure and Growth:** Secondary Growth

- **Cork Cambium** (woody plants)
  - single layer epidermis replaced by multi-layer “bark”
  - a layer of cells in cortex becomes meristematic and produces cork cells & phelloderm
  - cork cells deposit wax in cell walls & then die

- “Bark” = more than tissues produced by cork cambium
  - outer bark = cork cambium and all tissues it produced (cork & phelloderm)
  - inner bark = phloem
  - “Bark” = everything outside the vascular cambium

**Monocot Stem:**
vascular bundles do NOT form concentric ring
do not have Vascular Cambium (no secondary growth)
Modified Stems

- **Rhizomes** - thick underground stems w/ new plant produced at each node (ferns, irisis, grasses)
- **Runners and Stolons** - horizontal stems with long internodes (strawberries)
- **Bulbs** - very large underground bud- composed of a short stem and highly modified leaves (e.g. onion)
- **Tubers** - not a root… enlarged tip of a stolon (potato)
- **Tendrils** - stems modified for climbing (ivy)
- **Cladophylls** - flattened stems which look and function like leaves.

“Sticky” plant parts

- **Spines** - modified leaves (e.g. cactus)
- **Thorns** - modified stems (e.g. honey locust)
- **Prickle** - outgrowth of epidermis (e.g. rose)