

The Root:  
Structure and Development  
Chapter 24

Chapter Outline

- Root systems
- Origin and growth of primary tissues
- Primary structure
- Effect of secondary growth on the primary body of the root
- Origin of lateral roots
- Aerial roots and air roots
- Adaptations for food storage: fleshy roots

Root Introduction

- primary functions
  - anchorage
  - absorption
  - storage
  - conduction
  - synthesis of some hormones and secondary metabolites

Root Systems

- primary root
- taproot and lateral roots
  - gymnosperms
  - magnoliids
  - eudicots
- short-lived taproot
  - monocots
- root system extent
  - dependent on
    - soil moisture
    - soil temperature
    - soil composition
  - feeder roots usually in upper portions of soil
  - depth varies among species
  - lateral spread usually greater than crown of tree
- balance between shoot and root system
  - balancing area for photosynthesis with area for absorbing water and minerals
  - root-to-shoot ratio

- root population dynamic

### Origin and Growth of Primary Tissues

- root growth continuous process
- rootcap
  - parenchyma cells
  - protects root apical meristem
  - aids in root penetration in soil
  - responds to gravity
  - peripheral cells slough off as root grows
  - mucigel
- apical meristem
  - small, many-sided cells (initials)
  - active division in early root development
- region of cell division
- region of elongation
- region of maturation (differentiation)

### Primary Structure

- relatively simple
  - no leaves, nodes, internodes
  - similar among species
- three tissue systems
  - dermal tissue system
    - epidermis
  - ground tissue system
    - cortex
  - vascular tissue system
    - vascular tissues
- epidermis
  - root hairs
    - tubular extensions of epidermal cells
    - increase absorptive surface
    - relatively short-lived
  - epidermal cell walls usually allow water and minerals easy passage
  - mycorrhizae also increase surface area
- cortex
  - occupies most of the area of roots
  - plastids usually store starch
  - contains numerous intercellular air spaces
  - substances move via plasmodesmata between cells or along cell walls or both
  - innermost layer compact without spaces

- endodermis
- Casparian strips
- exodermis
- vascular cylinder
  - primary vascular tissues
  - pericycle
  - center is solid core of primary xylem
  - primary phloem in between xylem ridges

#### Effect of Secondary Growth on the Primary Body of the Root

- secondary growth
  - secondary vascular tissues from vascular cambium
  - periderm from cork cambium
- roots of monocots and many herbaceous eudicots usually lack secondary growth
- vascular cambium arises from procambial cells between primary xylem and primary phloem
- periderm replaces epidermis in woody roots
  - usually follows initiation of secondary xylem and phloem
  - pericycle divides to produce complete cylinder of cork cambium
    - cork towards outer surface
    - phelloderm towards inner surface
  - may have lenticels
- periderm replaces epidermis in woody roots

#### Origin of Lateral Roots

- usually originate in pericycle
- divisions occur some distance behind region of elongation
- root primordium

#### Aerial Roots and Air Roots

- adventitious roots
- aerial roots
- air roots
- epiphyte adaptations

#### Adaptations for Food Storage: Fleshy Roots

- storage parenchyma permeated by vascular tissue
- some species (e.g., carrot) have more parenchyma in secondary xylem and phloem
- others develop additional cambia that produce more storage parenchyma (e.g., sweet potato)

## Summary

- root function
- root tip
- root epidermis and cortex
- vascular cylinder
- secondary growth
- root modifications