

The Shoot:
Primary Structure and Development
Chapter 25

Shoot Introduction

- definition
- more complex than root
- stem functions

Chapter Outline

- Origin and growth of primary tissues of the stem
- Primary structure of the stem
- Relation between the vascular tissues of the stem and leaf
- Morphology and structure of the leaf
- Grass leaves
- Development of the leaf
- Leaf abscission
- Transition between the vascular systems of the root and shoot
- Development of the flower
- Stem and leaf modifications

Origin and Growth of the Primary Tissues of the Stem

- apical meristem
 - adds cells to primary plant body
 - produces
 - leaf primordia
 - bud primordia
 - phytomeres
 - may be protected by young leaves
- vegetative shoot apex
 - tunica-carpus organization
 - tunica
 - corpus
 - peripheral meristem
 - pith meristem
 - cannot be divided into zones like root
 - leaf primordia originate too quickly to distinguish nodes and internodes
 - elongation occurs primarily when internodes elongate
- stem thickness
 - periclinal divisions
 - cell enlargement
 - in monocots
 - meristematic cap

Primary Structure of the Stem

- three basic organizations
 - vascular system of internode is more or less continuous cylinder within ground tissue
 - primary vascular tissues develop as bundles separated by ground tissue
 - more complex
- almost continuous vascular cylinder
 - *Tilia* (basswood, linden)
 - vascular bundles separated by very narrow area of ground parenchyma (interfascicular parenchyma)
 - epidermis
 - single layer of cells covered by cuticle
 - usually few stomata
 - cortex
 - collenchyma
 - parenchyma
 - vascular tissue
 - primary phloem develops from outer cells of procambium
 - primary xylem from inner cells
 - one layer of cells in between becomes vascular cambium
 - pith
 - parenchyma cells with large canals full of mucilage
 - intercellular air spaces
- vascular system of discrete strands
 - *Sambucus* (elderberry)
 - epidermis, cortex, pith similar to *Tilia*
 - interfascicular regions (pith rays) relatively wide
 - portion of vascular cambium develops from interfascicular parenchyma
 - *Medicago* (alfalfa)
 - herbaceous eudicot with some secondary growth
 - similar to *Sambucus*
 - *Ranunculus* (buttercup)
 - resembles monocots
 - no procambium after primary vascular tissues mature
- scattered vascular bundles
 - *Zea* (maize)
 - closed vascular bundles
 - similar to eudicot stems
 - protoxylem lacuna
 - mature bundle

Relation between the Vascular Tissues of the Stem and the Leaf

- procambial system of leaf is continuous with stem

- bundles diverge at each node
- leaf traces
- leaf trace gaps
- pattern of vascular system in stem reflects arrangement of leaves
- branch trace
- leaf arrangement
 - phyllotaxy
 - helical (spiral)
 - distichous
 - opposite
 - decussate
 - whorled

Morphology of the Leaf

- highly variable
- parts of leaf
 - blade (lamina)
 - petiole
 - sheath
- morphology
 - simple
 - compound
 - pinnately
 - palmately
 - distinguish leaflets from leaves
 - buds are in axils of leaves not of leaflets
 - leaves extend in various planes; leaflets in one

Structure of the Leaf

- variation
 - habitat
 - availability of water
- characterize plants by water availability
 - mesophytes
 - hydrophytes
 - xerophytes
- specialized for photosynthesis
 - all three tissue systems like roots and stems
- epidermis
 - compactly arranged
 - covered with cuticle
 - stomata may occur on one or both sides
 - xerophytes

- mesophyll
 - large volume of intercellular spaces
 - numerous chloroplasts
 - mesophytes
- vascular bundles
 - netted (reticulate) venation
 - parallel venation
 - veins contain xylem and phloem
 - minor and major veins

Grass Leaves

Development of the Leaf

- clonal analysis
 - chimeral meristems
 - genetic mosaics
- leaf development
 - founder cells
 - leaf buttress
 - leaf primordium
- magnoliid and eudicot leaves
- monocot leaves

Sun and Shade Leaves

- environment can affect leaf size and thickness
- sun leaves
 - smaller, thicker than shade leaves
 - more extensive vascular system
 - epidermal cell walls thicker

Leaf Abscission

- definition
- abscission zone
 - formed by structural and chemical changes near base of petiole
 - woody angiosperms
- retranslocation
- leaf scar

Transition between Vascular Systems of the Root and Shoot

- distinctions between plant organs
 - in eudicots
- transition region

Development of the Flower

- sequence of physiological and structural changes
- initiation of flowers similar to initiation of leaves
- homeotic mutations
 - horticulturists
 - plant geneticists
 - *Arabidopsis thaliana*
 - three classes of genes essential to normal floral development
 - Class A: *apetala2*
 - Class B: *apetala3* and *pistillata*
 - Class C: *agamous*

Stem and Leaf Modifications

- tendrils
 - aid in support
 - some modified stems
 - Boston ivy (*Parthenocissus tricuspidata*)
 - Virginia creeper (*Parthenocissus quinquefolia*)
 - grape (*Vitis*)
 - most modified leaves
 - garden pea (*Pisum sativum*)
- cladophylls
 - modified stems that appear to be leaves
 - do not have buds in axils
 - asparagus (*Asparagus officinalis*)
 - some cacti
- spines
- thorns
- prickles
- carnivorous plants
- tubers
- bulb
- corm
- petiole
- succulent plants

Summary

- shoot apical meristem
- three types of organization of primary structure of stems
- relationship between leaves and stems

- variations in leaf structure
- development of flowers
- modification of stems and leaves