

Chapter 35

Introduction to Plants

Kingdom Plantae

- We will primarily be discussing the angiosperms
 - Phylum Anthophyta
- Flowers and fruits
 - Only group that does/has these things
- Advanced traits
 - Seeds
 - Advanced vascular tissues

From seed to seed

The life of a flowering plant

- Seeds
 - reproductive structures produced by angiosperms and other seed plants
 - usually the result of sexual reproduction
 - contains embryos that develop into seedlings upon germination
 - has survival value

Alternation of Generations

- Exhibited by all plants (and plant-like organisms) that have sexual reproduction
- There is an alternation between a diploid (2N) form [sporophyte] and a haploid (1N) form [gametophyte]

Gametophyte (haploid)

- Gamete-producing plant form
- multicellular
- microscopic in flowering plants
 - female
 - embryo sac with egg
 - male
 - pollen grain

- grow and develop within flowers of angiosperms
- produces gametes by mitosis/cytokineses

Sporophyte (diploid)

- multicellular
- large "plant" in flowering plant
- produces haploid spores by meiosis (reduction)
 - called meiospores

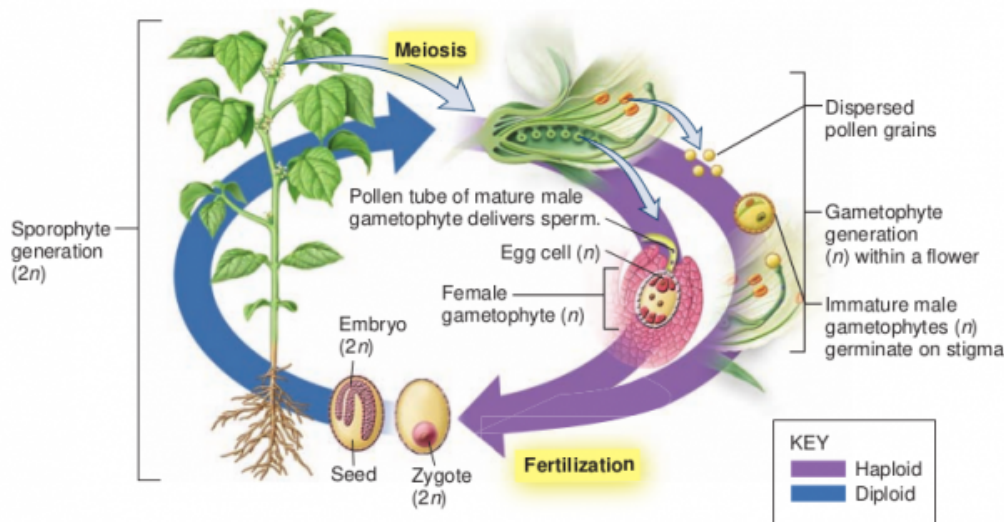
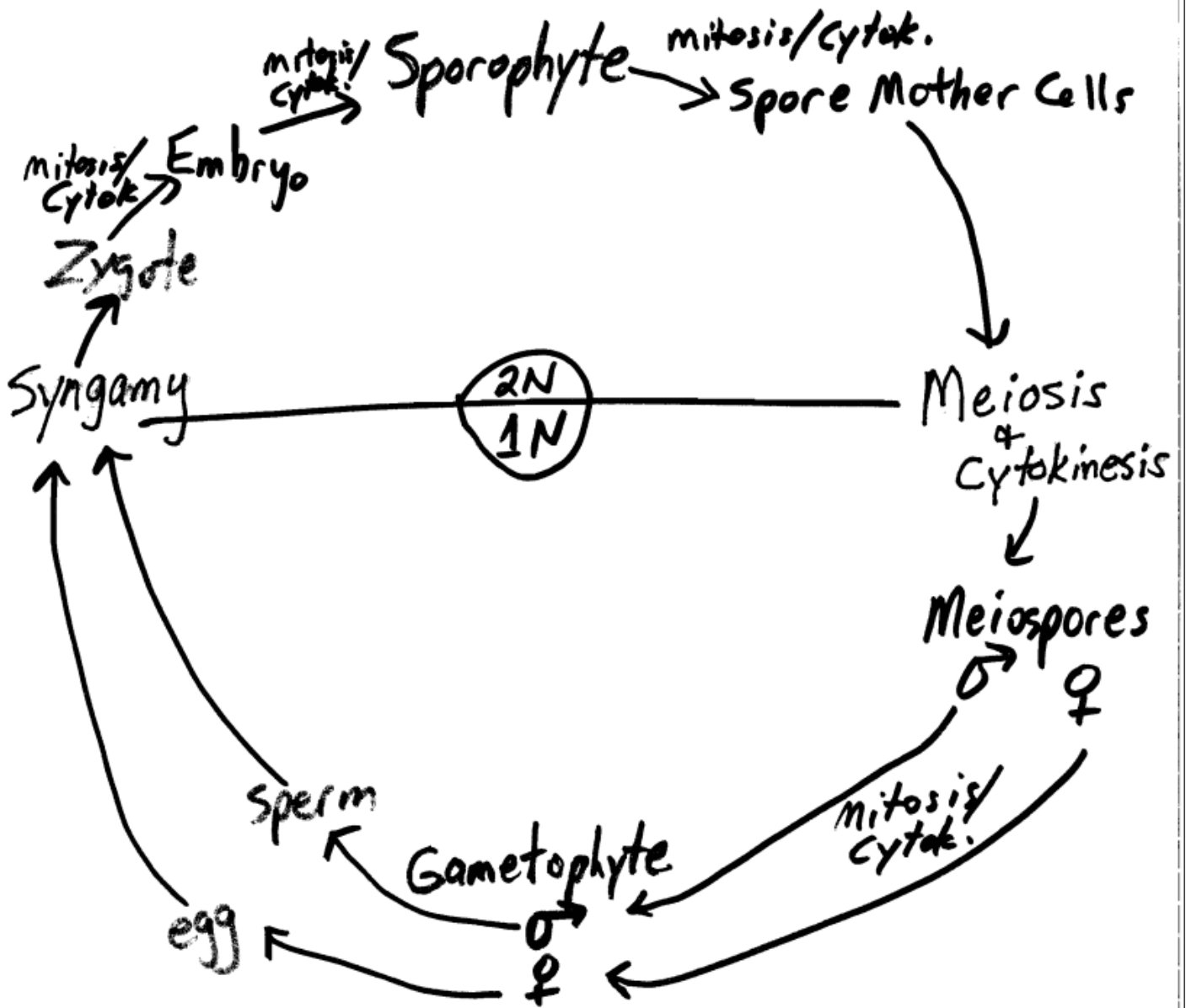


Figure 35.1 The plant sexual cycle. The sexual cycle of flowering plants involves alternation of sporophyte and gametophyte generations. In flowering plants, the sporophyte is the dominant, conspicuous generation, whereas the tiny gametophytes are mostly hidden within flowers. The bean plant shown here produces both male and female gametophytes. Embryos form when eggs produced by female gametophytes are fertilized by sperm produced by male gametophytes. Embryos, which are the young sporophytes of the next generation, are dispersed from plants within seeds.



The plant embryo

- Fertilization (syngamy) results in the formation of a diploid zygote, which undergoes mitosis to form an embryo (multicellular)
- the embryo is a sporophyte that lies dormant in the seed with a supply of stored food and a seed coat
- may lay dormant for long periods until conditions are favorable

The plant body

Composed of three organ types

- stems

- leaves
- roots

Shoot system

- stem
 - produce leaves and branches and bear the reproductive structures
- leaves
 - flattened structure specialized for photosynthesis

Root system

- roots
 - Provide anchorage in the soil and foster efficient uptake of water and minerals
 - can store food

Growth

- Indeterminate growth
 - increasing in size as long as the plant is alive
- grows into a seedling and then a mature plant
- Plant growth occurs by 3 means
 - Increase in number of cells
 - cellular reproduction
 - (mitosis/cytokineses)
 - increase in cell size
 - elongation
 - increase in weight/mass

Development

- Mature plants produce reproductive structures
 - flowers
 - seeds
 - fruits
- flowers and floral buds are reproductive shoots that develop when shoot apical (tip) meristems produce flower parts instead of new tissues and leaves
- flowers are produced by determinate growth

Seed coats

- Flower tissues enclose and protect tiny male and female gametophytes
 - sperm in pollen fertilizes the egg, triggering ovules to develop into seed and flower parts to develop into fruit
- fruits enclose seeds and function in seed dispersal
 - Angiosperms

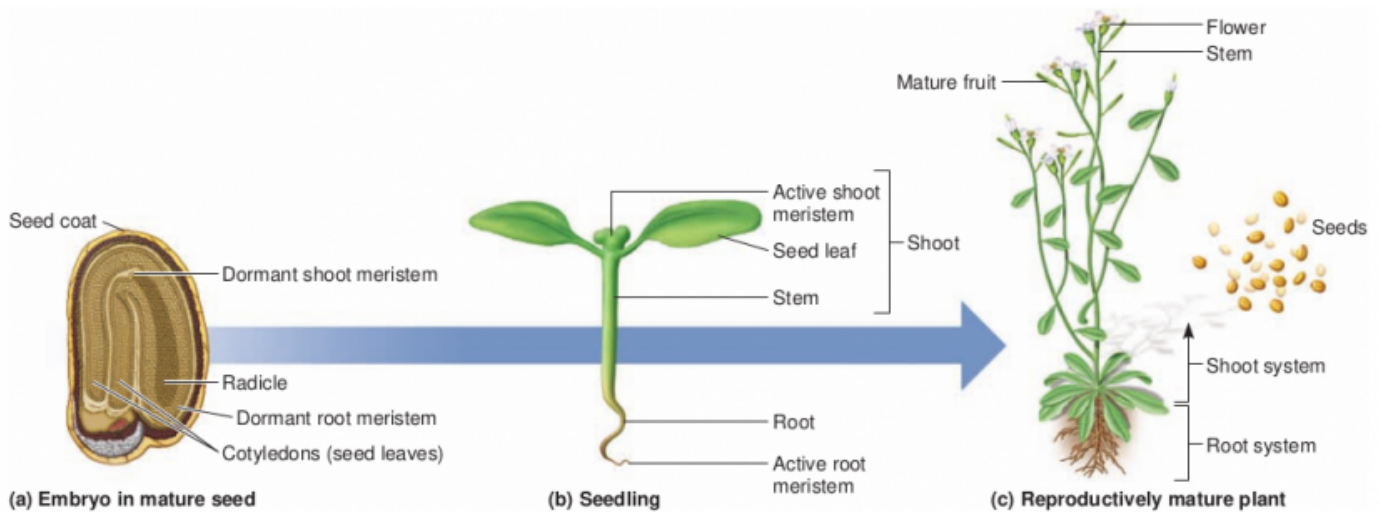


Figure 35.2 The seed-to-seed life of flowering plants. This example depicts the life of the eudicot *Arabidopsis thaliana*, widely used as a model organism for understanding the genetics of plant structure and development. (a) Seed embryos possess embryonic leaves, known as cotyledons; a dormant shoot meristem; an embryonic root, known as a radicle; and a dormant root meristem. (b) When seeds germinate, the shoot and root meristems become active. Meristem activity allows the radicle to produce the seedling root and the young shoot of the seedling to grow and produce leaves. (c) Reproductively mature plants have branched shoot and root systems and bear flowers and fruits that disperse seeds.

Meristems

- Seedlings and mature plants produce new tissue from meristems
 - cell factories
- meristem is a region of undifferentiated cells that produce new tissue by cell division
- A dormant meristem occurs at the shoot and root of seed embryos
 - activate in seedlings
- mature plants have shoot apical meristems (SAM) and root apical meristems (RAM)

Mature sporophyte develop from seedlings

- photosynthesis powers the transformation of seedlings into mature plants
- provides the ability to produce organic food
- plants undergo both vegetative growth and reproductive development

Hierarchy of structures in a mature plant

- Specialized cells
- tissues

- organs
- organ systems
 - branches, buds, flowers, seeds, fruits
- root and shoot systems
- plant (the organism itself)

Primary Growth

- Elongation of plant organs
- roots, stems, and leaves
- Occurs in ALL plants
- Produces primary tissues from apical meristems (SAM and RAM)

Primary Tissues

- Primary xylem
 - vascular/conducting tissue
 - water and minerals
- Primary phloem
 - vascular/conducting tissue
 - food and solutes
- Epidermis
 - dermal
 - Outer-most tissue
 - protection
 - holds water in plant
- Support ground tissues
 - Parenchyma
 - most abundant type
 - storage
 - water and food
 - part of cortex/pith
 - Collenchyma
 - Protection/support of growing plant organs
 - cortex
 - Sclerenchyma
 - protection/support of non-elongating organs
 - cortex

Secondary Growth

- Expansion of plant organs
 - lateral meristems
- roots and stems only

- does not occur in leaves
- does not occur in all plants
- Produces secondary tissues
 - woody tissues

Major groups of Angiosperms

Eudicots

- >240,000 species
- all have primary growth
- most have secondary growth
 - for this class we are saying they all have secondary growth

Monocots

- >60,000 species
- all have primary growth
- very few have secondary growth
 - for this class we are saying that non have secondary growth
- grasses, corn, tulips, lilies

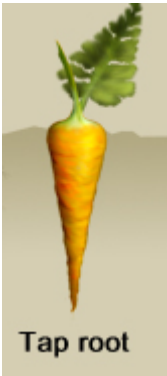
Root system adaptations

Major functions

- absorbing water and minerals
- anchoring the plant in the soil
- storing nutrients and water

Eudicots

Taproots



Monocots

fibrous roots



Three zones of root growth

1. Region of cell division
 - RAM and root cap
 - RAM contains cells that are dividing
 - Quiescent center keeps nearby cells undifferentiated
 - Root cap embedded in mucigel
 - Mucigel is a slimy substance that covers the root cap of the roots of plants.
2. Region of elongation
 - cells extend by uptake of water
3. Region of maturation
 - root cell differentiation and tissue specialization
 - identified by presence of root hair
 - water and mineral uptake

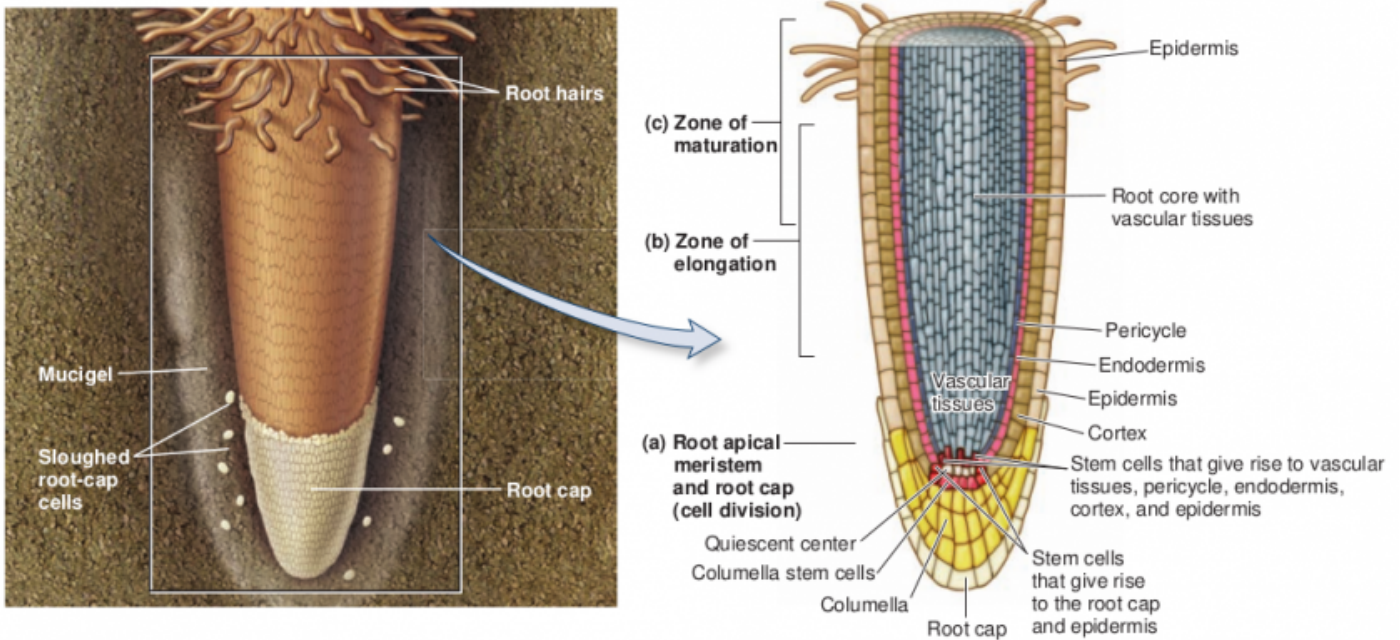
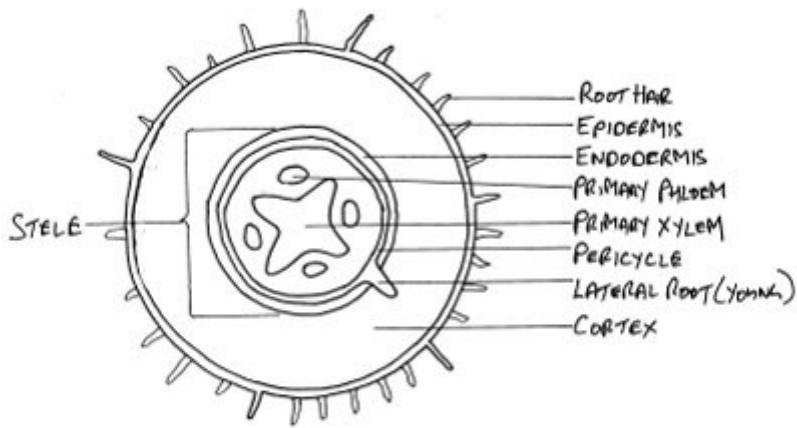


Figure 35.24 Three zones of root growth. A longitudinal view of a typical root reveals three major zones: (a) a root apical meristem region that includes stem cells, a quiescent zone, columella, and a root cap; (b) a zone of elongation; and (c) a zone of maturation, characterized by specialized cells and tissues including epidermal root hairs, cylinders of endodermis and pericycle tissue, and a core of vascular tissue.

Root Internal Structure

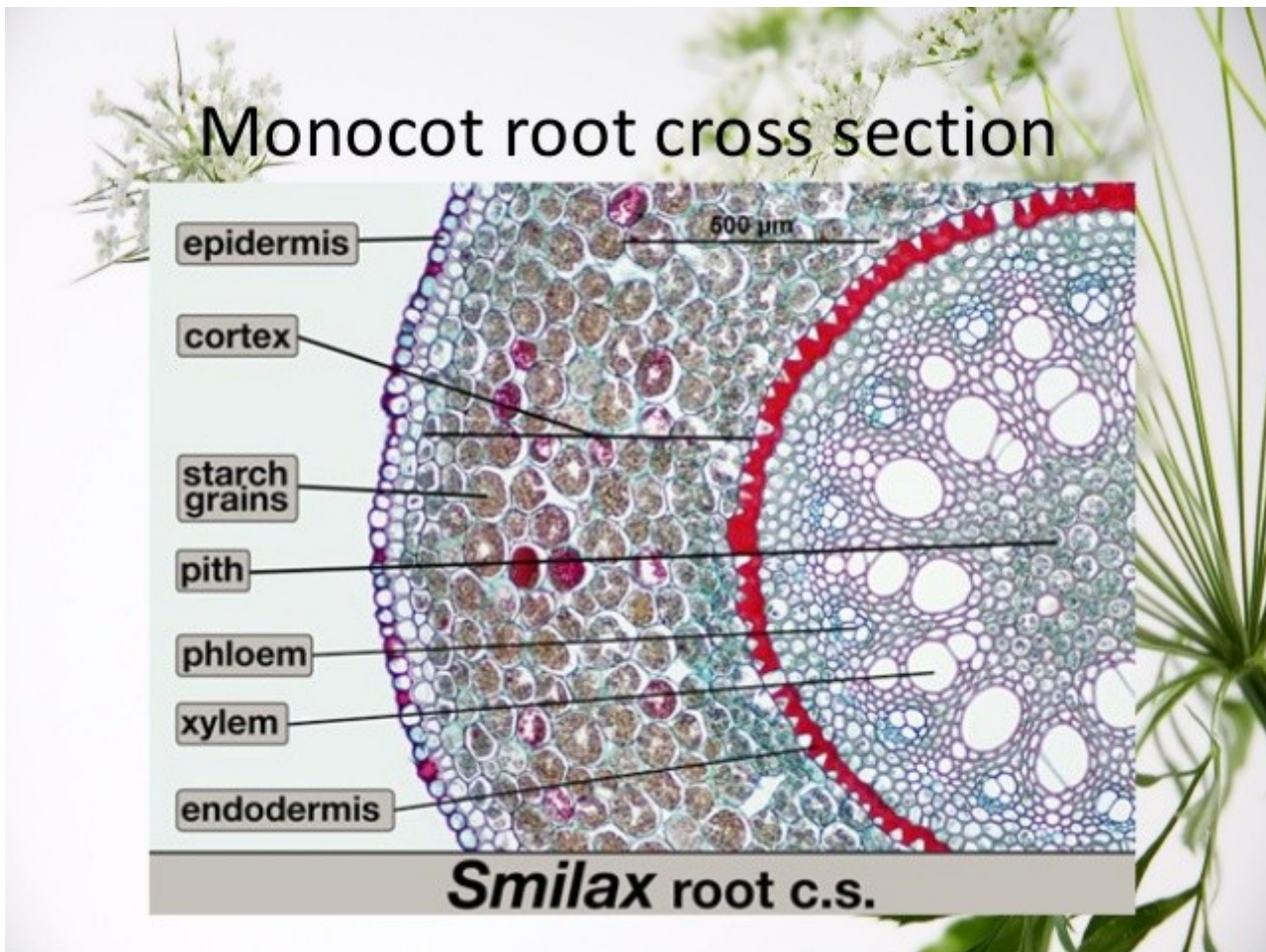
- Epidermis of mature roots encloses a cylinder of parenchyma called the root cortex
 - One cell thick
 - often rich in starch
 - functions as food storage
 - many contain inter-cellular air spaces
- Endodermis
 - selective absorption of minerals
 - one cell thick
- Meristematic pericycle
 - encloses root in vascular tissues
 - provides lateral branches
- woody roots produce primary vascular tissues followed by secondary vascular tissues

Eudicot root



T.S. YOUNG DICOT ROOT

Monocot Root



The shoot system

Stem and leaf adaptations

Shoots are modular with 4 parts

1. Stem node
 - leaves or branches emerge
2. Internode
 - stem between adjacent nodes
 - elongation
3. Leaf
4. Axillary Meristem
 - generate axillary buds
 - can produce flowers or branches
 - Lateral shoots
 - New branches bear SAM at their tips

Shoot Tip

- Terminal bud
 - at the end of each shoot
 - includes the SAM and other parts
 - scales

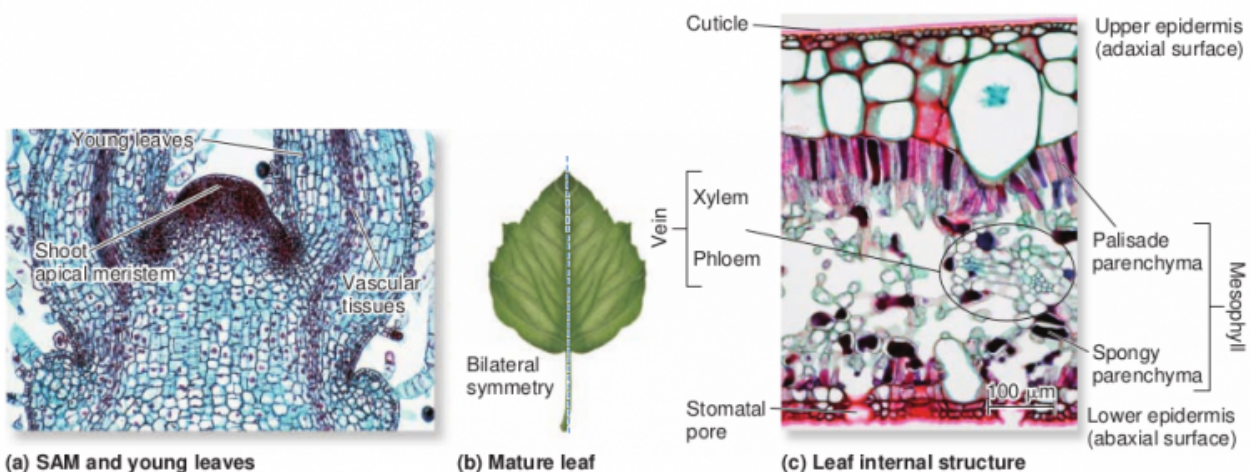
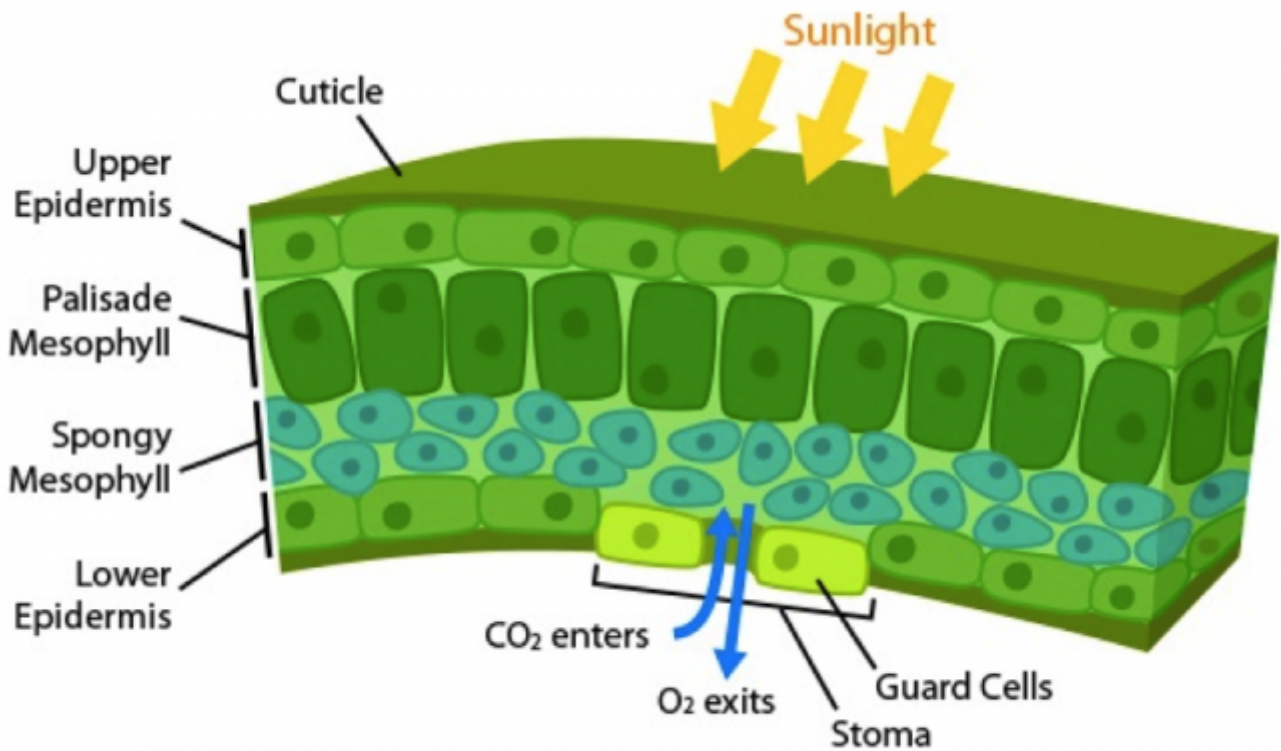


Figure 35.8 Leaf development and structure. (a) Young leaves develop at the sides of SAMs, as shown in this thinly sliced, stained shoot tip. Note that the darkly stained vascular tissues of young leaves are connected to those of the stem. (b) Mature leaves are typically thin and flat and show bilateral symmetry. (c) An internal view of a thinly sliced and stained leaf reveals top to bottom (adaxial to abaxial) tissue differentiation. A layer of palisade parenchyma lies just beneath the upper epidermis capped with a waxy cuticle. Veins of conducting tissue (xylem and phloem) are embedded in the photosynthetic mesophyll. Spongy parenchyma lies above the lower epidermis, which displays stomatal pores. These structural features of mature foliage leaves facilitate photosynthesis.

Concept check: What advantage do plant leaves obtain by having stomatal pores on the lower epidermal surface?

Leaf anatomy



Most carbon dioxide enters plants through stomata that are tiny openings guarded by cells. Most stomata are found in the leaves of plants. [Click for more detail.](#)

Leaf adaptation

Leaf venation

Eudicot

- Pinate (feathery)
- Palmate (palm)
- Netted
 - provides more support for the leaves

Monocot

- Parallel

Stem

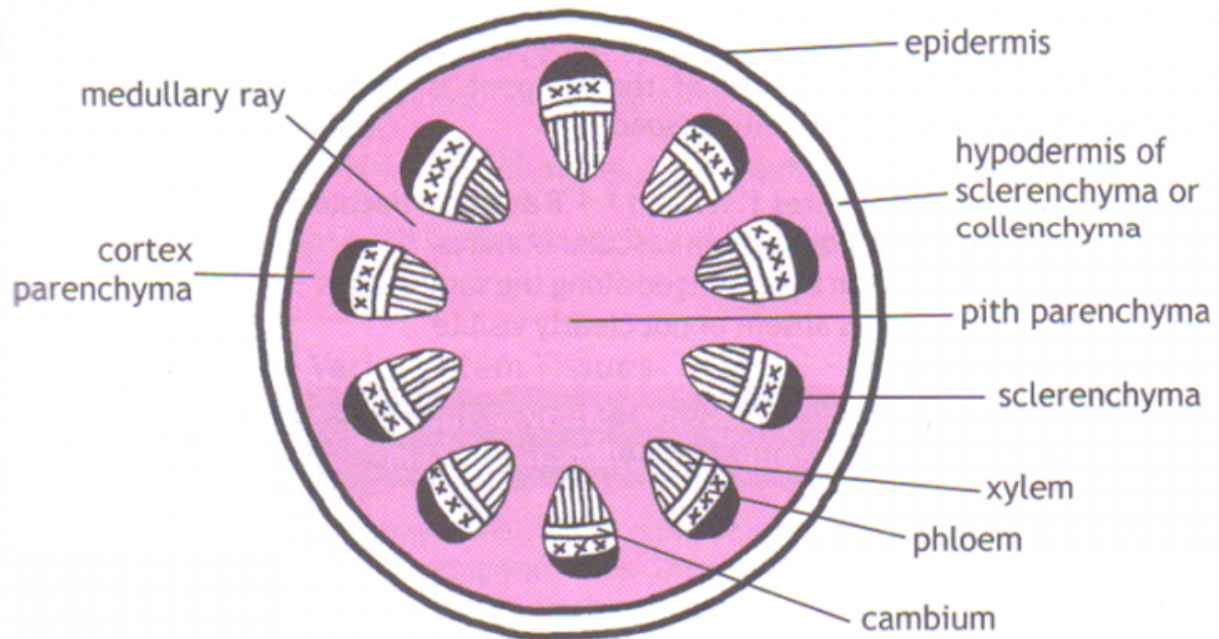
Primary growth

- mostly above ground organs, but some modified stems are below ground
 - Irish potato
 - underground stem

Eudicot Stem

- ALC
- Primary (elongation) and secondary (expansion) growth
- vascular bundles (xylem and phloem) form a ring pattern
- exhibit both a pith and a cortex
- cambium ring produce cells
 - provide secondary growth

Transverse section of a young dicot stem in plan



T/S of a young dicotyledonous stem, in plan

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Lateral Meristems

- Produces secondary growth
- 2 lateral meristems
 - both are rings that retain cell division properties and produce secondary tissues to the inside and outside of the cambium ring
- Vascular cambium
 - produces ring of **secondary xylem (wood)** to the inside and a ring of **secondary phloem (inner bark)** to the outside
- Cork cambium
 - Produces ring of **periderm (outer bark)** that replaces the epidermis and cortex for external protection

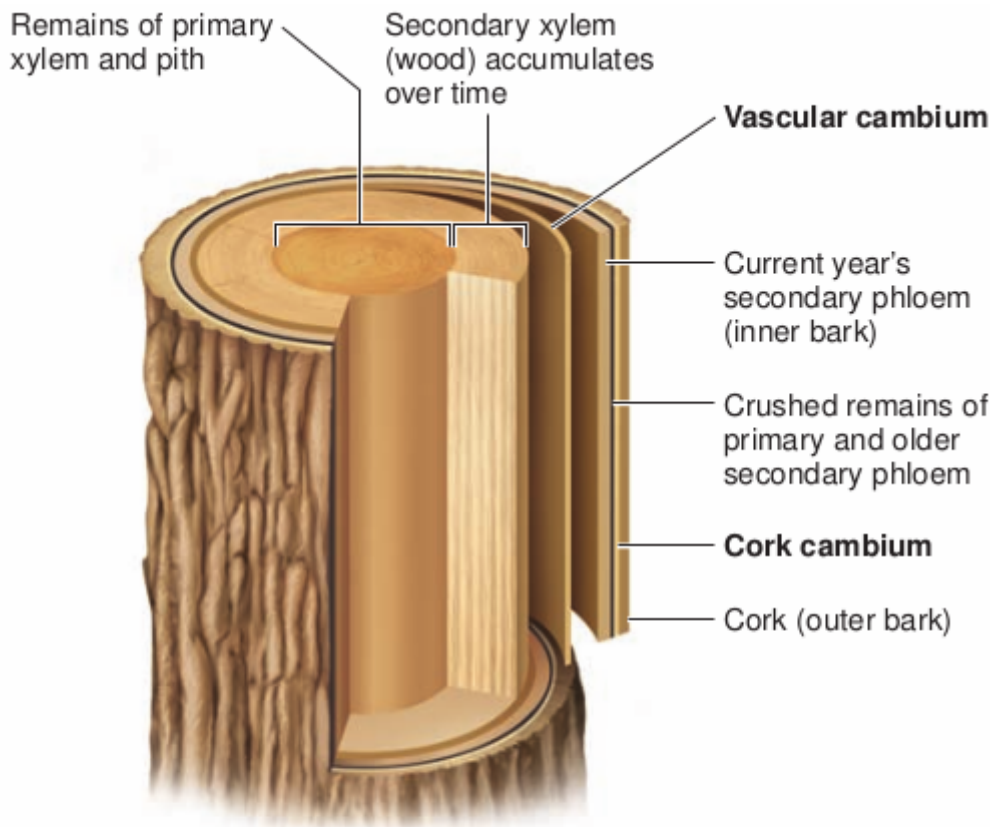


Figure 35.20 Formation of wood and bark by secondary (lateral) meristems. The vascular cambium is a thin cylinder of tissue that produces a thick cylinder of wood (secondary xylem) toward the inside of the stem and a thinner cylinder of inner bark (secondary phloem) toward the outside of the stem. The cork cambium forms an outer coating of protective cork (outer bark).

- Secondary vascular tissue
 - woody plants begin life with only primary vascular systems
 - produces secondary tissues and bark as they mature
 - secondary xylem
 - wood
 - Secondary phloem
 - inner part
 - bark has both outer bark (mostly dead cork cells) and inner bark (secondary phloem)
- Secondary growth
 - begins late in first year of growth
 - eudicot stem after 3 years of growth

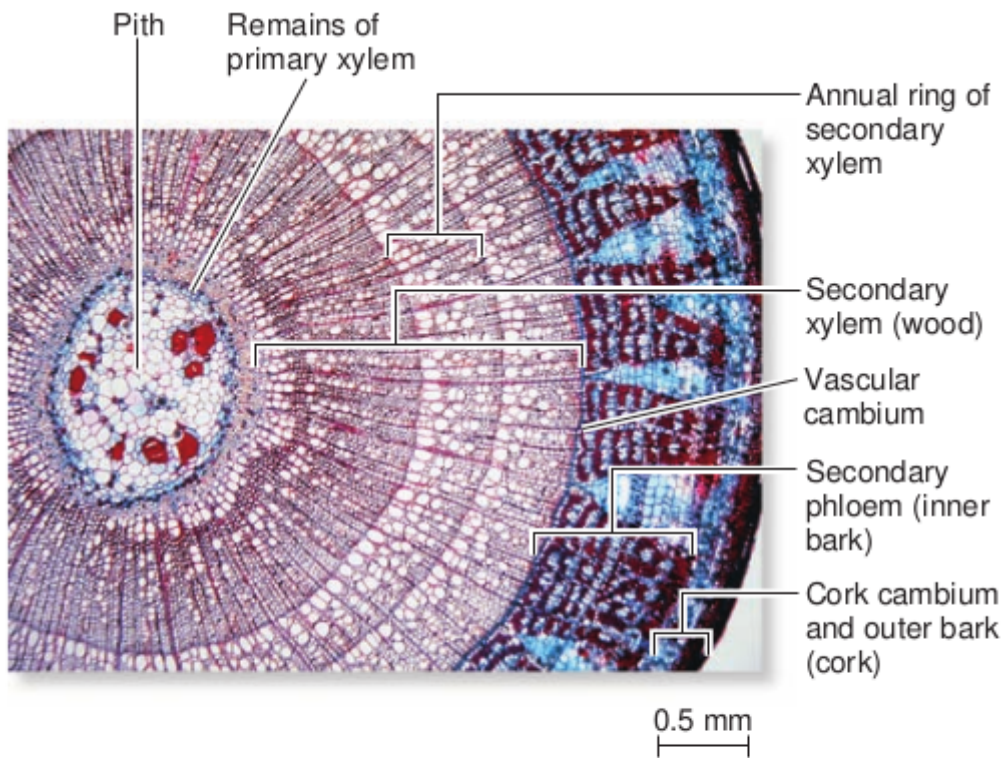
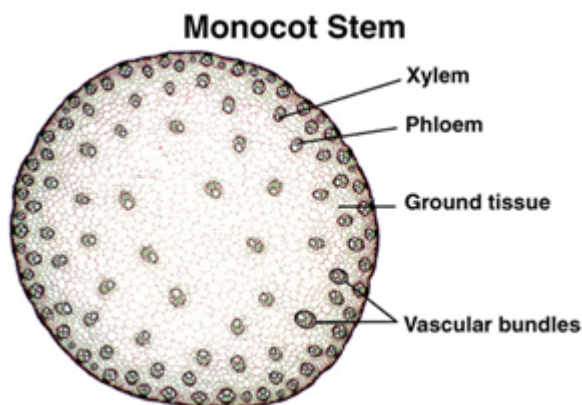


Figure 35.22 The anatomy of a tree trunk. Each year, a new cylinder of wood is produced; this yearly wood production appears as annual rings on the cut surface of a woody stem.

Concept check: Why do tree trunks have a thicker layer of wood (secondary xylem) than of inner bark (secondary phloem)?

Monocot stem

- Primary growth (elongation)
- vascular bundles (xylem and phloem) are scattered
- lacks both pith and cortex



Comparison between Plant types

Leaves

Eudicot

- net venation

Monocot

- parallel venation

Roots

Eudicot

- primary and secondary growth (mostly)
- cortex
- no pith
- core of xylem in the root

Monocot

- Primary growth only
- both cortex and pith

Stems

Eudicot

- primary and secondary growth (mostly)
- vascular bundles in a ring pattern around cortex

Monocot

- Primary growth only
- vascular bundles scattered around
- no pith or cortex

Primary Growth

- Due to activities of Apical Meristems
 - RAM and SAM
- Results in production of primary growth

Secondary Growth

- Due to activities of lateral maristems
 - vascular and cork cambiums
- Results in production of secondary tissues

Table 35.1**Distinguishing Features of Eudicots and Monocots, Two Major Groups of Flowering Plants**





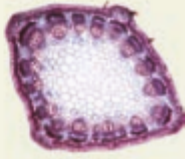

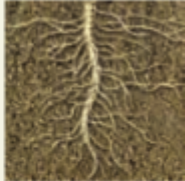





Feature	Eudicots	Monocots
Number of seed leaves (cotyledons)	Two 	One 
Number of flower parts	Usually four, five, or multiples of these 	Usually three or multiple of three 
Stem vascular bundles	Arranged in a ring 	Scattered 
Root system	Branched taproot 	Fibrous; adventitious 
Leaf venation	Netted or branched 	Often parallel 
Pollen	Three pores or slits 	One pore or slit 

Table 35.2**Examples of Tissues and Specialized Cells Found in Flowering Plants***

Simple primary tissues
(composed of one or two cell types)

Parenchyma

Plant cell types found
in those tissues

Parenchyma cells

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