Cheat Sheet

▼ Figure 35.7 Evolutionary adaptations of leaves.

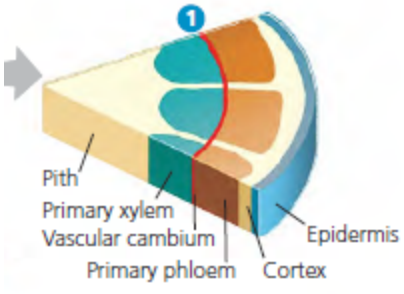
► **Tendrils.** The tendrils by which this pea plant clings to a support are modified leaves. After it has "lassoed" a support, a tendril forms a coil that brings the plant closer to the support. Tendrils are typically modified leaves, but some tendrils are modified stems, as in grapevines.

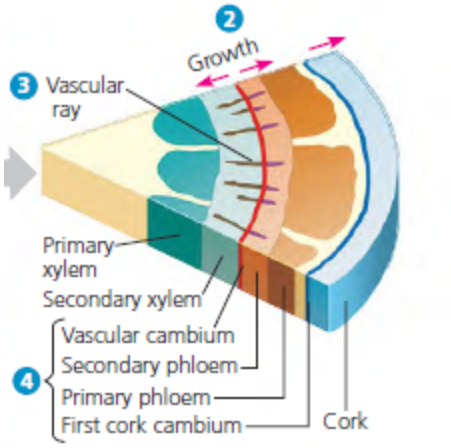
◄ **Spines.** The spines of cacti, such as this prickly pear, are actually leaves; photosynthesis is carried out by the fleshy green stems.

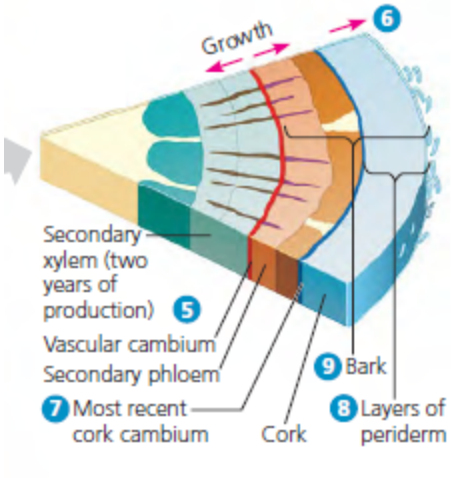
◄ **Storage leaves.** Most succulents, such as this ice plant, have leaves adapted for storing water.

◄ **Reproductive leaves.** The leaves of some succulents, such as *Kalanchoë daigremontiana*, produce adventitious plantlets, which fall off the leaf and take root in the soil.

► **Bracts.** Often mistaken for petals, the red parts of the poinsettia are actually modified leaves called bracts that surround a group of flowers. Such brightly colored leaves attract pollinators.


1
Pith
Primary xylem
Vascular cambium
Primary phloem
Cortex
Epidermis


2
Growth
3
Vascular ray
Primary xylem
Secondary xylem
4
Vascular cambium
Secondary phloem
Primary phloem
First cork cambium
Cork


Growth
6
Secondary xylem (two years of production)
5
Vascular cambium
Secondary phloem
9
Bark
7
Most recent cork cambium
Cork
8
Layers of periderm

Chapter 35 Questions

1. **What is romanesco?**
2. **What are the two organ systems of a plant?**
3. **What are photosynthates?**
4. **What is a root?**
5. **What is the first root to emerge from a germinating seed called?**
6. **What are lateral roots?**
7. **What is a taproot system?**
8. **What is a fibrous root system?**
9. **What are root hairs?**
10. **What are pneumatophores?**
11. **What are prop roots?**
12. **What is a stem?**
13. **What are nodes?**
14. **What are internodes?**
15. **What is the apical bud?**
16. **What is an axillary bud?**
17. **What are rhizomes, stolons, and tubers?**
18. **What is a leaf?**
19. **What are blades and petioles?**
20. **What are veins?**
21. **What are the differences between simple and compound leaves?**
22. **Describe 5 evolutionary adaptations of leaves.**
23. **What is a tissue system?**
24. **What is the dermal tissue system?**
25. **What are guard cells?**
26. **What are trichomes?**
27. **What are vascular tissue system?**
28. **What is xylem?**
29. **What is phloem?**
30. **What is a stele?**
31. **Describe the steles in angiosperms.**
32. **What is the ground tissue system?**
33. **What is pith?**
34. **What is cortex?**
35. **What are parenchyma cells?**
36. **What are collenchyma cells?**
37. **What are sclerenchyma cells?**
38. **What are sclereids and fibers?**
39. **What are tracheids and vessel elements?**
40. **Describe the phloem of seedless vascular plants and gymnosperms.**

41. What are sieve-tube elements?
42. What is a companion cell?
43. What is indeterminate growth?
44. What are meristems?
45. What is determinate growth?
46. What are apical meristems?
47. What is secondary growth?
48. What are lateral meristems?
49. What are primary meristems?
50. What are annuals, biennials, and perennials?
51. Describe the order of cells in a stem.
52. What is a root cap?
53. What is the zone of cell division?
54. What is the zone of elongation?
55. What is the zone of differentiation (zone of maturation)?
56. What does the protoderm give rise to in roots?
57. Describe the ground meristem?
58. What is the innermost layer of the cortex?
59. What is the procambium?
60. How do lateral roots form?
61. What is the shoot apical meristem?
62. What is apical dominance?
63. What cells make up much of ground tissue?
64. How does the emergence of lateral shoots differ from that of lateral roots?
65. What are leaf primordia?
66. What are stomata?
67. What is mesophyll?
68. What are the two types of mesophyll in eudicots?
69. What is a bundle sheath?
70. What are vascular rays?
71. What is spring wood?
72. What is dendrochronology?
73. What is xylem sap?
74. What is heartwood?
75. What is sapwood?
76. Why is heartwood darker than sapwood?
77. Why doesn't secondary phloem accumulate like secondary xylem?
78. Describe the process by which cork cambium produces periderm.
79. What is bark in plant biology?
80. What are lenticels?
81. What is development?
82. What is developmental plasticity?
83. What is growth?

84. **What is morphogenesis?**
85. **What is cell differentiation?**
86. **Why is *Arabidopsis thaliana* used as a model organism?**
87. **What is the preprophase band?**
88. **What is *tangled-1*?**
89. **What is asymmetrical cell division?**
90. **What is polarity?**
91. **What is auxin?**
92. **What is the *gnom* mutant of *Arabidopsis?***
93. **How do plant cells grow?**
94. **What is pattern formation?**
95. **What are the two types of hypotheses on how the fate of plant cells is determined during pattern formation?**
96. **What is *KNOTTED-1*?**
97. **What two cell types arise in root epidermis of *Arabidopsis*?**
98. **What is *GLABRA-2*?**
99. **What are phases?**
100. **What are meristem identity genes?**
101. **What are organ identity genes?**
102. **What is the ABC hypothesis?**

Chapter 35 Answers

1. Edible relative of broccoli that forms fractals.
2. Root system, shoot system (stems and leaves)
3. Sugars/carbs produced during photosynthesis (imported from shoots to roots)
4. an organ that anchors a vascular plant in the soil, absorbs minerals and water, stores carbs, and other reserves
5. primary root, originates from seed embryo
6. Branches from primary root that enhance ability of root system to anchor plant and acquire resources
7. Found in tall, erect plants with large shoot masses, consists of main vertical root (taproot, develops from primary root), absorption restricted to tips of lateral roots, taproot facilitates anchorage
8. Found in small vascular plants/ those that have trailing growth habit, is thick mat of slender roots spreading out below soil surface, in most monocots, primary root dies early on, many small roots emerge from stem (called adventitious = organ that grows in unusual location)
9. thin, finger-like extensions of root epidermal cells, increase surface area
10. Air roots that project above the water's surface, obtain oxygen
11. Aerial, adventitious roots that support tall, top-heavy plants
12. Plant organ bearing leaves and buds, elongates and orients shoot so that photosynthesis by leaves is maximized and facilitates dispersal of pollen and fruit. Green ones may perform limited amount of photosynthesis
13. Points at which leaves are attached
14. Stem segments between nodes
15. Growing shoot tip
16. In upper angle (axil) formed by each leaf and stem, can form lateral branch, thorn, flower
17. Horizontal shoot that grows just below the surface, vertical shoots emerge from axillary buds on rhizome
    Horizontal shoots that grow along the surface, enable plant to reproduce asexually
    Enlarged ends of rhizomes or stolons, specialized for storing food
18. The main photosynthetic organ in most vascular plants.
19. Flat part, stalk that joins leaf to stem at node (grasses/many monocots lack petioles, base of leaf forms sheath that envelops stem
20. Vascular tissues of leaves (parallel in monocots, branched network arising from major vein (midrib, runs down center) in eudicots)
21. Single undivided blade, sometimes deeply lobed
    Blade consists of multiple leaflets with no axillary buds at their base (leaflet may be divided into leaflets, resists tearing and confines pathogens to one leaflet
22. see picture
23. Continuous throughout plant, connect all organs (dermal, vascular, ground)

24. Serves as outer protective covering of plant (in nonwoody plants is single tissue called epidermis (layer of tightly packed cells), cuticle (waxy epidermal coating) prevents water loss in leaves and stems. in woody, protective tissues (periderm) replace epidermis in older regions of stems/roots)
25. Specialized epidermal cells involved in gaseous exchange.
26. Specialized epidermal cells, spikes, found in shoots (outgrowths that reduce water loss and reflect excess light, defend against insects by secreting toxins or hindering movement)
27. Facilitate transport of materials through the plant and to provide mechanical support
28. Conducts water/dissolved minerals upward from roots to shoots
29. Transports sugars from leaves to roots/sites of growth
30. Vascular tissue of a root or stem
31. Solid central vascular cylinder of xylem and phloem in roots, vascular bundles (separate strands containing xylem and phloem) in leaves and stems.
32. Tissues that are neither dermal nor vascular
33. ground tissue internal to vascular tissue
34. ground tissue external to vascular tissue
35. Have relatively thin and flexible primary walls and most lack secondary walls.Generally have large central vacuole. Perform most of metabolic functions of plant. (some in stems and roots have amyloplasts (colorless, store starch)). Fleshy tissue of fruits composed of these. Retain ability to divide/differentiate (can grow plant from single one of these)
36. Grouped in strands, help support young parts of plant shoot, generally elongated, have thicker primary walls (unevenly thickened) than parenchyma, provide flexible support, don't restrain growth (elongate with stems and leaves they support). Found below epidermis of stems and petioles
37. Function as supporting elements, more rigid than collenchyma. Secondary cell wall produced after cell elongation (thick, contains a lot of lignin (indigestible strengthening polymer, 25% of wood mass, present in all vascular plants, not in bryophytes)). Cannot elongate after maturity. Many are dead at functional maturity, produce secondary walls before protoplast (living part of cell) dies.
38. Sclerenchyma cells, specialized entirely for support
    Boxier than other, irregular in shape, very thick, lignified secondary walls
    Grouped in strands, long, slender, tapered
39. Tubular, elongated cells that are dead/lignified at functional maturity, part of xylem, walls remain after death, secondary walls interrupted by pits (only primary walls present, water can migrate laterally)
    Occur in xylem of all vascular plants, long, thin, tapered ends, water moves mainly through pits
    In few gymnosperms, most angiosperms, few seedless vascular plants, wider, shorter, thinner walled, less tapered, aligned end to end, end walls have perforation plates
40. Sugars/other nutrients transported through living, long, narrow cells called sieve cells

41. Chains of alive cells that form sieve tubes, found phloem of angiosperms. Lack nucleus, ribosomes, vacuole, and cytoskeletal elements. End walls between elements (sieve plates) have pore that facilitate flow of fluid from cell to cell
42. Nonconducting cell alongside each sieve tube element, connected to sieve tube element by plasmodesmata, have nucleus that serves sieve tube element, can help load sugar into sieve-tube elements
43. Process where growth occurs throughout the plants life.
44. Undifferentiated tissues, contain cells that can divide into cells that can differentiate
45. Process where growth stops after a certain size
46. Meristems located at root and shoot tips, enables primary growth (growth in length)
47. Growth in thickness, present in woody plants
48. Vascular cambium (adds vascular tissue called secondary xylem(wood, most of secondary growth) and secondary phloem) and cork cambium (replaces epidermis with thicker, tougher periderm), enables secondary growth.
49. Tissues that form during primary growth (protoderm, ground meristem, and procambium, produce dermal, ground, and vascular tissues respectively)
50. Complete life cycle in single year or less
    Require two growing seasons to complete life cycle
    Live many years
51. Xylem on inside, phloem on outside (vascular cambium between the two, cork outside of phloem) see picture
52. Thimble-like, protects apical meristem as root pushes through soil. Root cap secretes polysaccharide slime that lubricates soil around tip of root.
53. Includes stem cells of root apical meristem and immediate products, new cells produced
54. Typically a few mm behind root tip, most of growth occurs as root cells elongate
55. Where cells complete their differentiation and become distinct cell type
56. OUtermost primary meristem, gives rise to epidermis (single layer of cuticle-free cells covering the root, root hairs are most prominent epidermis (live only few weeks)
57. Between protoderm and procambium, gives rise to mature ground tissue (in roots consists mostly of parenchyma cells), found in cortex, stores carbs, transport water and salts from root hairs to center of root
58. Endodermis, cylinder one cell thick, forms boundary with vascular cylinder, regulates passage of substances into cylinder
59. Gives rise to vascular cylinder, consists of solid core of xylem and phloem tissues surrounded by pericycle (cell layer). Xylem has starlike appearance in eudicots. In monocots, vascular tissue = core of undifferentiated parenchyma cells surrounded by ring of alternating xylem/phloem tissue
60. Destructively push through outer tissues until they emerge from established root, emerge from meristematically active region of pericycle
61. Dome-shaped mass of dividing cells at shoot tip, delicate structure protected by the leaves of the apical bud (leaf primordia)

62. Closer an axillary bud is to active apical bud, the more inhibited it is, if animal eats end of shoot or shading causes one side of shoot to have more intense light, dominance is disrupted and axillary bud begins to grow
63. Parenchyma
64. Shoots develop from axillary bud meristems (do not disrupt other tissues)
65. Projections shaped like a cow's horns, emerge along sides of shoot apical meristem, develop into leaves, lack secondary growth
66. Allow exchange of CO_2 and O_2 between air and cells, avenues for loss of water
67. The leaf's ground tissue, sandwiched between upper/lower epidermal layers, mainly of parenchyma cells specialized for photosynthesis
68. Palisade - one or more layers of elongated parenchyma cells on upper part of leaf
    Spongy - below palisade, loosely arranged, air spaces for CO_2 and O_2 to circulate around cells and up to palisade
69. Layer of cells that regulate movement of substances between vascular tissue and mesophyll, prominent in plants with C_4 photosynthesis
70. Radial files of mostly parenchyma cells, connect the secondary xylem and phloem, move water and nutrients between the two, store carbs, aid in wound repair
71. In temperate regions, wood that develops early in spring, usually has secondary xylem with large diameters, thin cell walls (maximizes deliver of water). Wood produced later called summer wood (thick-walled cells that do not transport as much water but provide support
72. Science of analyzing tree growth ring patterns
73. Water and minerals
74. Older secondary xylem, do not transport xylem sap
75. Newest, outer layer of secondary xylem, transport xylem sap
76. Has resins that permeate cell cavities and help protect core of tree from fungi/wood-boring insects
77. Older secondary phloem sloughed off, only youngest secondary phloem functions in sugar transport
78. In outer cortex of stems, pericycle in roots, gives rise to cork cells (outside, deposit waxy, hydrophobic material called suberin in their walls before dying, so periderm is impermeable to water and gases). Old periderm is sloughed off
79. All tissues external to vascular cambium (includes secondary phloem and most recent periderm and all older layers.
80. Small, raised areas where there is space between cork cells, allows living cells in woody stem to exchange gases with outside air (often appear as horizontal slits)
81. Specific series of changes by which cells form tissues, organs, and organisms.
82. Ability to alter form in response to local environment conditions, more common in plants
83. Irreversible increase in size
84. Process that gives a tissue, organ, or organism its shape, determines positions of cell types
85. Process by which cells with same genes become different from one another

86. Tiny weed in mustard family, small so thousands of plants can be cultivated in little space. Has short generation time (6 wks for seed to grow), one plant makes many seeds, genome has 27,000 genes (smallest among plants). Has only 5 pairs of chromosomes. Can be transformed with transgenes easily.
87. Ring of concentrated microtubules in cytoplasm, predicts future plane of cell division (usually corresponds to shortest path that will halve volume of parent cell)
88. Maize mutant, normally leaf cells divide traversely (for leaf elongation) or longitudinally (leaf broadening). Mutant longitudinal divisions are abnormally oriented (crooked/curved cells, overall shapes remain normal although take longer to grow)
89. One daughter cell receives more cytoplasm than other during mitosis (formation of guard cells, epidermal cell divides asymmetrically, small cell becomes guard cell “mother cell”. Guard cells form when mother cell divides again perpendicularly to first plane)
90. Condition of having structural or chemical differences at opposite ends of an organism. Plants have root end and shoot end determined by first division of zygote (normally asymmetrical).
91. plant hormone that moves in single direction
92. First division is symmetrical, results in plant without roots or leaves, inability to transport auxin in a polar manner
93. Water uptake = 90% of expansion, stored in large central vacuole (solution called vacuolar sap, very dilute), greatest expansion usually oriented along plant’s main axis (caused by orientation of microfibrils bc they do not stretch)
94. Development of specific structures in specific locations.
95. Lineage-based mechanisms - propose that cell fate determined early in development, cells pass destiny on to progeny.

    Position-based mechanisms - Cell’s final position in emerging organ determines what kind of cell it will become
96. Homolog of *Hox* genes in maize, does not affect number or placement of plant organs, important in development of leaf morphology
97. Root hair cells and hairless epidermal cells
98. Homeotic gene needed for proper distribution of root hairs (root hair cells form if on 2 underlying cells, otherwise becomes hairless epidermal), expressed only in epidermal cells that will not develop root hairs
99. plant developmental stages, occur within shoot apical meristem, morphological changes that arise from transitions in SAM activity = phase changes
100. Switching on associated with transition from vegetative growth to flowering
101. Belong to *MADS-box* family, encode transcription factors that regulate development of characteristic floral pattern
102. 3 classes of genes direct formation of four types of floral organs. Each class of genes switched on in two specific whorls (A in outer two, B in middle two, C in inner two), sepals arise only where A are active, petals where A and B, stamens where B and C, carpels where C. Where A present, C is inhibited and vice versa (if one suppressed other activated)