Name _____ Class _____ Date _____

23.1 Specialized Tissues in Plants

Lesson Objectives

- Identify the principal organs of seed plants.
- Explain the primary functions of the main tissue systems of seed plants.
- Contrast meristems with other plant tissues.

Lesson Summary

Seed Plant Structure All seed plants have three principal organs:

- Roots anchor plants in the ground and absorb water and dissolved nutrients.
- Stems provide a support system for the plant body, a transport system that carries nutrients, and a defensive system that protects the plant.
- Leaves conduct photosynthesis and exchange gases with the air.

Plant Tissue Systems Plants have three main tissue systems:

- Dermal tissue is the protective outer covering of a plant. In young plants it consists of a single layer of cells called the **epidermis.** A waxy cuticle often covers epidermis and protects against water loss. In older plants, dermal tissue may be many cell layers deep and may be covered with bark.
- Vascular tissue supports the plant body and transports water and nutrients throughout the plant. The two kinds are xylem, a water-conducting tissue, and phloem, a tissue that carries dissolved nutrients.
  - Xylem contains cells called tracheids, which have cell walls with **lignin,** a complex molecule that resists water and gives wood much of its strength. Angiosperms have a second form of xylem tissue called **vessel elements,** which are arranged end to end on top of one another.
  - Phloem contains **sieve tube elements,** which are arranged end to end. **Companion cells** support the phloem cells and aid in the movement of substances in and out of the phloem.
- Ground tissue produces and stores sugars, and helps support the plant.
  - **Parenchyma** cells have a thin cell wall and a large central vacuole.
  - **Collenchyma** cells have strong, flexible cell walls that help support plant organs.
  - **Sclerenchyma** cells have extremely thick, rigid cell walls that make ground tissue tough and strong.

Plant Growth and Meristems **Meristems** are regions of unspecialized cells in which mitosis produces new cells that are ready for differentiation.

- **Apical meristems** are found in the tips of stems and roots.
- Floral meristems produce the tissues of flowers.

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Seed Plant Structure

1. List the three principal organs of seed plants, and state the function of each one.

_____

_____

_____

2. What adaptation helps leaves conserve water?

_____

Plant Tissue Systems

For Questions 3–6, complete each statement by writing the correct word or words.

3. The three main tissue systems of plants are _____ tissue, _____ tissue, and _____ tissue.

4. The cuticle protects against _____ loss.

5. Some epidermal cells have tiny projections known as _____, which may give a leaf a fuzzy appearance.

6. Dermal tissue in roots contains _____ cells that help absorb water.

For Questions 7–11, match the vascular-tissue elements with their descriptions.

Vascular-Tissue Elements

_____ **7.** Tracheids

_____ **8.** Lignin

_____ **9.** Vessel elements

_____ **10.** Sieve tube elements

_____ **11.** Companion cells

Description

A. The main phloem cells

B. Long, narrow xylem cells with openings in their cell walls

C. Cells that support the phloem cells and aid in the movement of substances

D. Xylem cells arranged end to end on top of one another

E. The substance in the cell walls of dead tracheids that makes wood tough

12. How can water move from one tracheid into a neighboring cell?

_____

_____

_____

13. How can materials move from one sieve tube element into the next?

_____

_____

_____

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14. Complete the table that compares ground-tissue cells.

Ground Tissue Cells		
Type of Cell	**Structure**	**Function**
		Photosynthesis in leaves
	Cells with strong, flexible cell walls	
	Cells with extremely thick, rigid cell walls	

Plant Growth and Meristems

For Questions 15–19, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

_____ **15.** Meristems are regions of the plant that produce new cells by mitosis.

_____ **16.** Apical meristems are found in the growing tip of a root or stem.

_____ **17.** The specialized cells that result from cell division in meristems have thin cell walls.

_____ **18.** Newly produced plant cells undergo fertilization as they mature into different cell types.

_____ **19.** An apical meristem changes into a floral meristem when its pattern of gene expression changes.

Apply the Big idea

20. Plants are the source of many useful fibers, such as cotton and linen. Fibers are long, thin structures that have strength and flexibility. Which plant tissue system produces fibers such as cotton and linen? Justify your answer.

Name _____ Class _____ Date _____

23.2 Roots

Lesson Objectives

- Describe the main tissues in a mature root.
- Describe the different functions of roots.

Lesson Summary

Root Structure and Growth The root is the first part of a plant to emerge from a seed.

- Plants have two main types of root systems:
  - Taproot systems are found mainly in dicots and consist of a large primary root that has many smaller branches.
  - Fibrous root systems are found mainly in monocots and consist of many equally sized branch roots. They help prevent topsoil from being washed away.
- Roots contain cells from the three tissue systems. A mature root has an outside layer, called the epidermis, and also contains vascular tissue and a large area of ground tissue. The root system is important to water and mineral transport.
  - The root's epidermis performs the dual functions of protection and absorption. Its surface is covered with thin cellular projections called **root hairs,** which produce a large surface area that allows water and minerals to enter.
  - Ground tissue called **cortex** stores products of photosynthesis, such as starch. Water and minerals move through the cortex. A layer called the **endodermis** encloses the vascular cylinder.
  - The xylem and phloem together make up a region called the **vascular cylinder** at the center of the root.
  - Apical meristems produce new cells near the root tip, which is covered by a tough **root cap** that protects the root tip as it grows into the soil.

Root Functions Roots support a plant, anchor it in the ground, store food, and absorb water and dissolved nutrients from the soil.

- Roots take in many essential inorganic nutrients, such as nitrogen and potassium.
- Active transport brings the mineral ions of dissolved nutrients from the soil into the plant.
- Cells of the root epidermis create conditions under which osmosis causes water to "follow" ions and flow into the root.
- The waterproof **Casparian strip** enables the endodermis to filter and control the water and nutrients that enter the vascular cylinder, as well as ensuring that nutrients do not leak out.
- Root pressure, produced within the vascular cylinder by active transport, forces water through the vascular cylinder and into the xylem.

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Root Structure and Growth

3. Complete the table that compares the types of root systems.

Types of Root Systems			
Type of Root	**Description**	**Mainly in Dicots or Monocots?**	**Examples**
	Long and thick primary roots that grow deep into the soil		
	Equally sized branch roots that grow separately from the base of the stem		

For Questions 2–6, complete each statement by writing the correct word or words.

2. A mature root has a large area of _____ tissue between its dermal and vascular tissues.

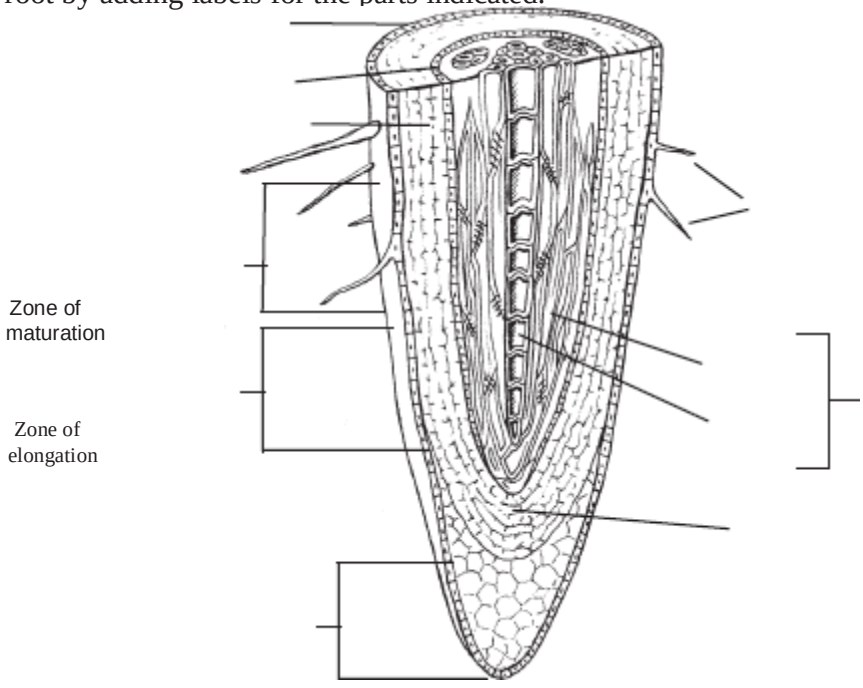
3. A root's surface area for absorption of water is increased by _____.

4. One function of the _____ is the storage of starch.

5. The _____ cylinder, made up of xylem and phloem, is found at the center of a root.

6. A root's apical meristem can be found just behind the _____.

7. **THINK VISUALLY** Complete the illustration of a cross section of a root by adding labels for the parts indicated.



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Root Functions

8. Name at least two functions, besides uptake of water and nutrients, of a plant's roots.

9. What is the role of active transport in the uptake of water by plant roots?

10. Where in roots are active transport proteins located?

11. What happens to water and dissolved minerals after they move across the epidermis of a root?

12. Why is there a one-way passage of materials into the vascular cylinder in plant roots?

13. How do water and nutrients cross the endodermis that surrounds the vascular cylinder?

14. What is root pressure?

Apply the Big idea

15. People often give potted houseplants more fertilizer than they need. As a result, the plants begin to wilt and eventually die instead of getting larger and healthier. What could be the reason for this result?

Name _____ Class _____ Date _____

23.3 Stems

Lesson Objectives

- Describe the main functions of stems.
- Contrast the processes of primary growth and secondary growth in stems.

Lesson Summary

Stem Structure and Function Aboveground stems have three main functions:

- Stems produce leaves, branches, and flowers.
- Stems hold leaves up to the sun.
  - Growing stems contain distinct **nodes,** where leaves are attached.
  - **Buds** contain apical meristems that can produce new stems and leaves.
- Stems transport substances throughout the plant.
  - Vascular tissues are arranged in clusters of xylem and phloem called **vascular bundles.** In monocots, vascular bundles are scattered throughout the stem; in dicots they are arranged a cylinder, or ring.
  - In a young dicot, the parenchyma cells inside the ring of vascular tissue are known as **pith.**

Growth of Stems One type of growth adds length to a plant's stems and roots. The other adds width, or thickens stems and roots.

- **Primary growth** of stems is the result of elongation of cells produced in the apical meristem. It takes place in all seed plants.
- **Secondary growth** is an increase in the thickness of stems and roots that is common among dicots and gymnosperms but rare in monocots. In conifers and dicots, secondary growth takes place in meristems called the vascular cambium and cork cambium.
  - The **vascular cambium** produces vascular tissues and increases the thickness of stems over time.
  - The **cork cambium** produces the outer covering of stems.
  - "Wood" is actually layers of secondary xylem produced by the vascular cambium. **Heartwood,** near the center of the stem, contains old xylem that no longer conducts liquids. **Sapwood** surrounds heartwood and is active in fluid transport.
  - In most of the temperate zone, tree growth is seasonal. Tree rings can be used to estimate a tree's age and provide information about past climate and weather conditions. In a mature stem, all of the tissues found outside the vascular cambium make up the **bark.**

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Stem Structure and Function

4. What are the three main functions of stems?

_____

_____

5. What is an example of a stem that conducts photosynthesis and stores water?

_____

6. What is a node?

_____

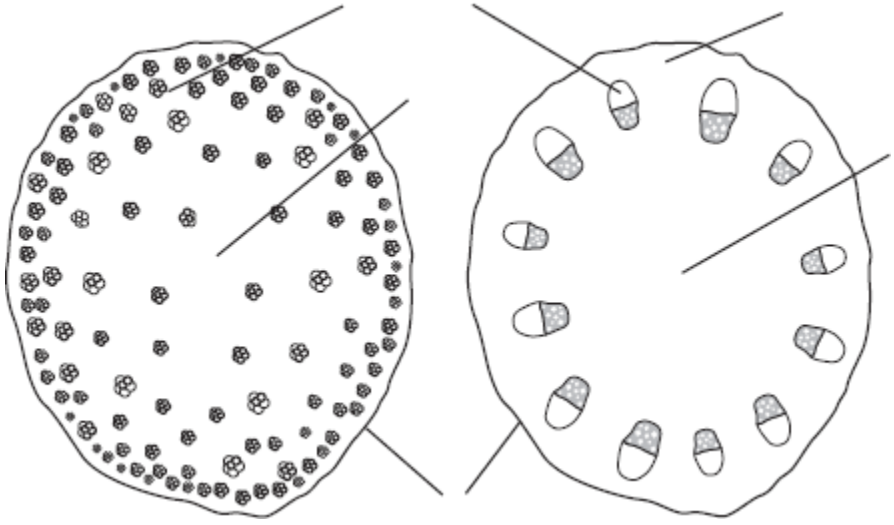
7. What kind of plant tissue does a bud contain?

_____

8. What does a vascular bundle contain?

_____

9. Complete the cross-section diagrams by writing labels for the structures indicated.



_____ _____

10. Complete the compare and contrast chart.

Structure of Monocot Stems and Dicot Stems	
Similarities	**Differences**

Name _____ Class _____ Date _____

Growth of Stems

For Questions 8–17, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

_____ **8.** Plants grow in a way that is <u>the same as</u> the way animals grow.

_____ **9.** The number of legs an animal will have is predetermined, but the number of <u>branches</u> a plant will have is not predetermined.

_____ **10.** Primary growth of stems is the result of elongation of cells produced in the <u>ground tissue.</u>

_____ **11.** The increasing thickness of stems and roots in dicots and gymnosperms is called <u>new</u> growth.

_____ **12.** Secondary growth is <u>common</u> in monocots.

_____ **13.** Dicots can grow to great heights because the increase in <u>width</u> supports the weight.

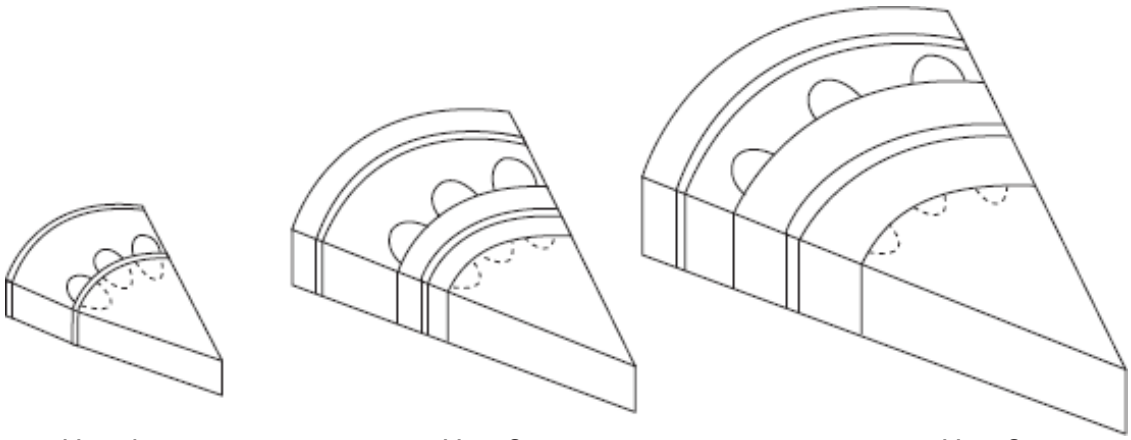
_____ **14.** Vascular cambium forms <u>between</u> the xylem and phloem of the vascular bundles.

_____ **15.** In conifers and dicots, secondary growth takes place in <u>stems and roots</u> called the vascular cambium and cork cambium.

_____ **16.** The <u>inner layers</u> of a stem are produced by the cork cambium.

_____ **17.** Stems become thicker because the cambium produces new layers of <u>vascular</u> tissue each year.

18. **THINK VISUALLY** Complete the diagram of secondary growth by identifying the structures involved and where they appear. Label the primary xylem and phloem, the secondary xylem and phloem, and the wood and bark.



Year 1 Year 2 Year 3

Name _____ Class _____ Date _____

For Questions 19–23, complete each statement by writing the correct word or words.

19. Most of what we call "wood" is made up of layers of _____ xylem.

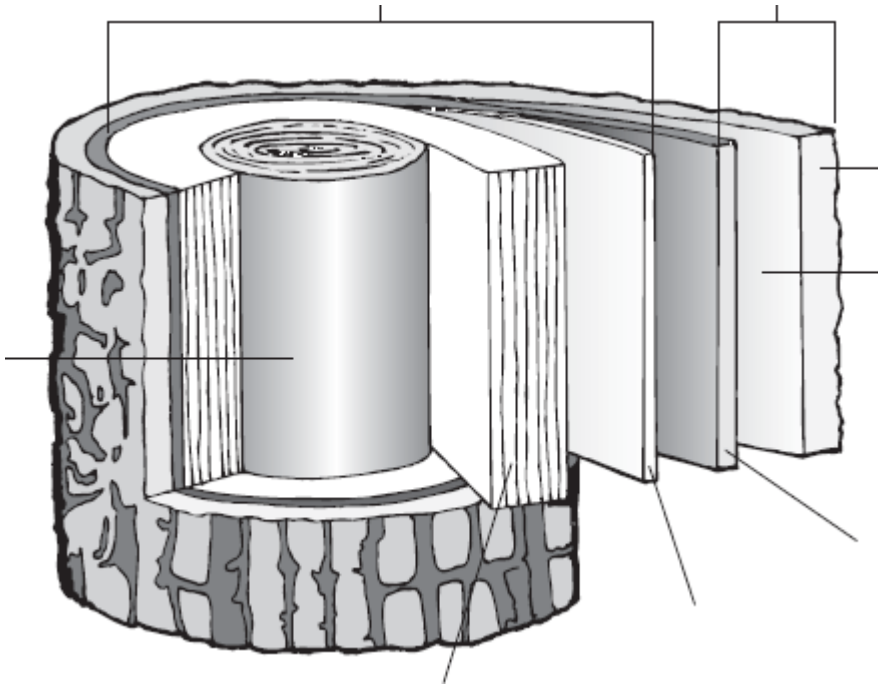
20. The dark wood that no longer conducts water is called _____.

21. The wood that is active in fluid transport is called _____.

22. The lighter wood in tree rings contains _____ cells with thin cell walls compared with the cells in darker wood.

23. Alternating layers of light wood and dark wood are used to estimate a tree's_____.

24. **THINK VISUALLY** Complete the illustration showing the formation of wood and bark. Use the following terms: wood, bark, cork, cork cambium, vascular cambium, phloem, heartwood, and sapwood.



Apply the Big idea

25. "Girdling" is a term that refers to removing the bark of a tree in a complete ring around the trunk or a branch. Predict the effect that girdling will have on a tree. Explain.

_____

_____

_____

_____

_____

Name _____ Class _____ Date _____

23.4 Leaves

Lesson Objectives

- Describe how the structure of a leaf enables it to carry out photosynthesis.
- Explain how gas exchange in leaves relates to homeostasis.

Lesson Summary

Leaf Structure and Function The structure of a leaf is optimized to absorb light and carry out photosynthesis.

- Most leaves have a thin, flattened part called a **blade,** which is attached to the stem by a thin stalk called a **petiole.** Leaves are made up of the three tissue systems.
  - Leaves are covered on their top and bottom surfaces by epidermis. The epidermis of nearly all leaves is covered by a waxy cuticle, which protects tissues and limits water loss.
  - The vascular tissues of leaves are connected directly to the vascular tissues of stems. Xylem and phloem tissues are gathered together into bundles called leaf veins that run from the stem throughout the leaf.
  - The area between leaf veins is filled with a specialized ground tissue known as **mesophyll,** where photosynthesis occurs.
- Photosynthesis happens in the mesophyll, which has two specialized layers:
  - The **palisade mesophyll** is beneath the upper epidermis. The cells are closely packed and absorb light.
  - Beneath this layer is a loose tissue called the **spongy mesophyll,** which has many air spaces between its cells. These air spaces connect with the exterior through small openings called **stomata.** Stomata allow carbon dioxide, water, and oxygen to diffuse in and out of the leaf.
- The mesophyll cells lose water by evaporation. This loss of water through leaves is called **transpiration.** Transpiration helps to cool the leaves, but also threatens their survival during droughts.

Gas Exchange and Homeostasis A plant's control of gas exchange is one of the most important elements of homeostasis.

- Plant leaves allow gas exchange between air spaces in the spongy mesophyll and the exterior by opening their stomata.
- Plants maintain homeostasis by keeping their stomata open just enough to allow photosynthesis to take place but not so much that they lose an excessive amount of water.
- **Guard cells** are highly specialized cells that surround the stomata and control their opening and closing depending on environmental conditions.
- Wilting results from the loss of water and pressure in a plant's cells. The loss of pressure causes a plant's cell walls to bend inward. When a plant wilts, its stomata close so the plant can conserve water.

Name _____ Class _____ Date _____

Leaf Structure and Function

For Questions 1-4, complete each statement by writing the correct word or words.

1. The structure of a leaf is optimized for the purposes of absorbing _____and carrying out _____.

2. The _____ of nearly all leaves is covered by a waxy_____.

3. The vascular tissues of leaves are connected directly to the vascular tissues of _____.

4. The area between leaf veins is filled with a specialized ground tissue known as _____.

For Questions 5-10, match the description with the leaf structure.

Description

_____ **5.** A layer of mesophyll cells that absorb light that enters the leaf

_____ **6.** Small openings in the epidermis

_____ **7.** The thin, flattened part of a leaf

_____ **8.** A bundle of xylem and phloem tissues in a leaf

_____ **9.** A stalk that attaches a leaf to a stem

_____ **10.** A loose tissue with many air spaces between its cells

Structure

A. leaf vein

B. blade

C. petiole

D. stomata

E. spongy mesophyll

F. palisade mesophyll

Gas Exchange and Homeostasis

11. Why can't stomata be kept open all the time?

_____

_____

12. Complete the flowchart that summarizes how guard cells help maintain homeostasis.

Guard cells are forced into a curved shape when water pressure _____.

↓

The thick inner walls of the guard cells pull away from one another, opening the . Water is lost by transpiration.

↓

Guard cells straighten out when water pressure_____.

↓

The inner walls of the guard cells pull together, closing the_____

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For Questions 13-17, write the letter of the correct answer on the line at the left.

_____ **13.** Which is likely to happen to a plant if it starts losing more water than it can take in?

A. It will reproduce.
B. It will flower.
C. It will grow.
D. It will wilt.

_____ **14.** Which is a plant that has narrow leaves with a waxy epidermis?

A. cactus
B. spruce
C. rock plant
D. rose bush

_____ **15.** A pitcher plant's leaves are adapted for

A. conducting photosynthesis.
B. limiting transpiration.
C. catching and digesting insects.
D. pollination and fertilization.

_____ **16.** A rock plant adapts to hot, dry conditions by having very few

A. thorns.
B. leaves.
C. stomata.
D. nutrients.

_____ **17.** A cactus's thorns are actually its

A. leaves.
B. stems.
C. roots.
D. bark.

Apply the Big idea

18. The inside of the glass or plastic walls of a greenhouse full of plants is very wet on cool days. Where does this water come from?

_____

_____

_____

Name _____ Class _____ Date _____

23.5 Transport in Plants

Lesson Objectives

- Explain the process of water movement in a plant.
- Describe how the products of photosynthesis are transported throughout a plant.

Lesson Summary

Water Transport The pressure created by water entering the tissues of a root push water upward in a plant stem, but this pressure is not enough. Other forces are much more important.

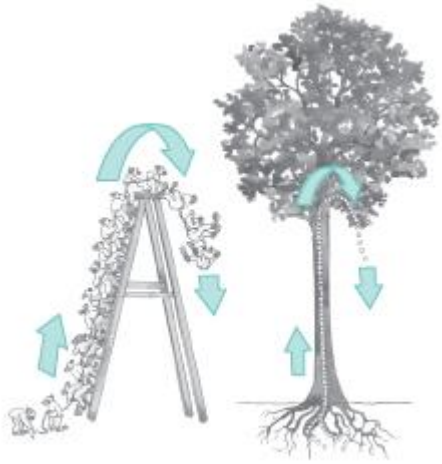
- The major force is provided by the evaporation of water from leaves during transpiration. Its pull extends into vascular tissue so that water is pulled up through xylem.
- Both the force of attraction between water molecules, cohesion, and the attraction of water molecules to other substances, **adhesion,** help with water transport. The effects of cohesion and adhesion of water molecules are seen in **capillary action,** which is the tendency of water to rise in a thin tube. Capillary action is important because xylem tissue is composed of tracheids and vessel elements that form hollow, connected tubes.

Nutrient Transport The leading explanation of phloem transport is known as the **pressure-flow hypothesis.**

- Active transport moves sugars into the sieve tube from surrounding tissues.
- Water then follows by osmosis, creating pressure in the tube at the source of the sugars.
- If another region of the plant needs sugars, they are actively pumped out of the tube and into the surrounding tissues. Pressure differences move the sugars to tissues where they are needed.
- Changes in nutrient concentration drive the movement of fluid through phloem tissue in directions that meet the nutritional needs of the plant.

Water Transport

For Questions 1–2, refer to the Visual Analogy of clowns being pulled up a ladder compared to water being pulled up a tree.



1. **VISUAL ANALOGY** In the visual analogy of the climbing circus clowns, what makes it possible for the falling clowns to pull others up the ladder?

_____

_____

_____

_____

Name _____ Class _____ Date _____

2. How are water molecules similar to the clowns?

_____

_____

_____

3. Complete the table about the types of attraction between molecules.

Attraction Between Molecules	
Type of Attraction	**Definition**
Cohesion	
Adhesion	

For Questions 4–8, complete each statement by writing the correct word or words.

4. Water cohesion is especially strong because water molecules tend to form _____ bonds with each other.

5. The tendency of water to rise in a thin tube is called _____.

6. The height to which water can rise in a tube is determined by its _____.

7. _____ in xylem form many hollow, connected tubes through which water moves.

8. The pull of transpiration extends from the leaves to the _____ of a plant.

Nutrient Transport

9. According to the pressure-flow hypothesis, why must sieve-tube elements in phloem be living cells?

_____

_____

_____

10. Where sugar concentration is high, what is the source of water taken in by phloem?

_____

_____

11. How does the structure of the vascular bundles in stems and roots and of the veins in leaves make the process of pressure-flow possible?

_____

_____

_____

Name _____ Class _____ Date _____

12. Complete the flowchart that summarizes the movement of sugars in plants.

Photosynthesis produces a high concentration of sugars in cells called _____ cells.

↓

Sugars move from a source cell to phloem, and water moves into the phloem by the process of _____.

↓

Water moving into the phloem causes an increase in _____ inside the sieve tubes.

↓

The pressure causes fluid to move through phloem toward _____ cells, where sugars are less concentrated.

13. What is one importance of the cell walls of xylem to the capillary action that occurs during transpiration?

_____

_____

14. According to the pressure-flow hypothesis, what process prompts rapid spring growth in a plant?

_____

_____

Apply the Big idea

15. Leaves range in size from very large to very tiny. In what type of environment would you expect to find the most plants with very large leaves? Very small leaves? Explain.

_____

_____

_____

_____

_____

Name _____ Class _____ Date _____

Chapter Vocabulary Review

For Questions 1–2, refer to the diagram.

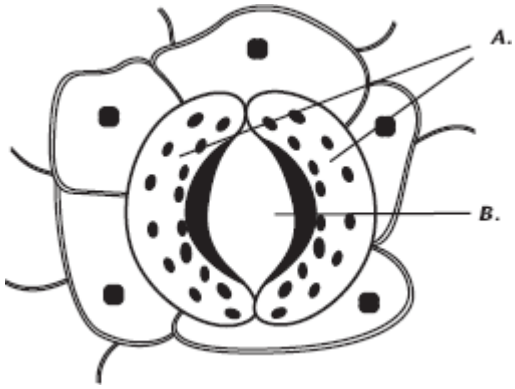
1. What are the names of the two parts of a leaf indicated in the diagram?

A. _____

B. _____

2. What process do the structures control?

_____



For Questions 3–9, match the description with the tissue or cell type.

Description

_____ **3.** Ground tissue specialized for photosynthesis

_____ **4.** Layer of ground tissue that encloses the vascular cylinder

_____ **5.** Thick-walled cells in ground tissue

_____ **6.** Dermal tissue in leaves and young plants

_____ **7.** Region of actively dividing unspecialized cells

_____ **8.** Very thick-walled cells that make ground tissue such as seed coats tough and strong

_____ **9.** Thin-walled cells in ground tissue

Tissue and Cell Types

A. sclerenchyma

B. collenchyma

C. parenchyma

D. mesophyll

E. meristem

F. epidermis

G. endodermis

For Questions 10–16, complete each statement by writing the correct word or words.

10. Most leaves have a flattened part called a _____, which is attached at a _ on the stem by a __.

11. The root _____ increase a root's surface area for absorption, while the root ___ protects the growing tip of the root.

12. The cells of the _____ mesophyll are tightly packed, but many air spaces separate the cells of the _____ mesophyll.

13. The meristem between xylem and phloem cells is called _____ and forms wood by __.

14. In a mature stem, the tissues outside the vascular cambium make up the _____; the tissues include phloem, cork, and the _____.

15. Water is drawn to the material in cell walls by the process called _____.

16. Monocot stems have scattered _____ while dicots form a ringlike pattern around the _____.