Name _____ **Period** _____

Chapter 36: Resource Acquisition and Transport in Vascular Plants

As you work through this chapter, continue your efforts to see how evolution shapes adaptations to fit a new environment—in this case, movement of plants onto land. Concentrate your study on water potential and how it affects the movement of water through plants and plant cells. The process of transpiration ties your study back to Chapter 3, Water and Life, as well as connecting to plant anatomy and photosynthesis.

Concept 36.1 Adaptations for acquiring resources were key steps in the evolution of vascular plants

1. Competition for light, water, and nutrients is intense among the land plants. Plant success is generally related to photosynthesis, so evolution has resulted in many structural adaptations for efficiently acquiring light from the sun and CO_2 from the air. As you read this section, focus on how this is accomplished. Let's look first at adaptations to increase light capture. How do plants reduce *self-shading*?

2. What triggers *self-pruning*?

3. There are different *leaf orientations*, and each orientation affects light capture. Compare the following as to the type of plant that has each orientation, and describe the advantage.

Orientation	Type of Plant	Advantage
Vertical leaf orientation		
Horizontal leaf orientation		

4. The evolution of *mycorrhizae* was a critical step in the successful colonization of land by plants. What are they, and what is their role in resource acquisition?

Concept 36.2 Different mechanisms transport substances over short or long distances

This section gives you a good review of the transport mechanisms you studied in Chapter 7. The information in the next group of questions should be familiar. Many AP teachers include a diffusion/osmosis lab such as AP Investigation 4 when covering the topics of Chapter 7. This lab covers the concept of water potential, so now is a good time to review water potential.

5. Water and solutes move through plant tissues in several ways, including between and around cell walls, and from cell to cell. Communication between plant cells is accomplished because the cytosol of adjacent cells is continuous. Describe and explain how this is accomplished by the *plasmodesmata.*

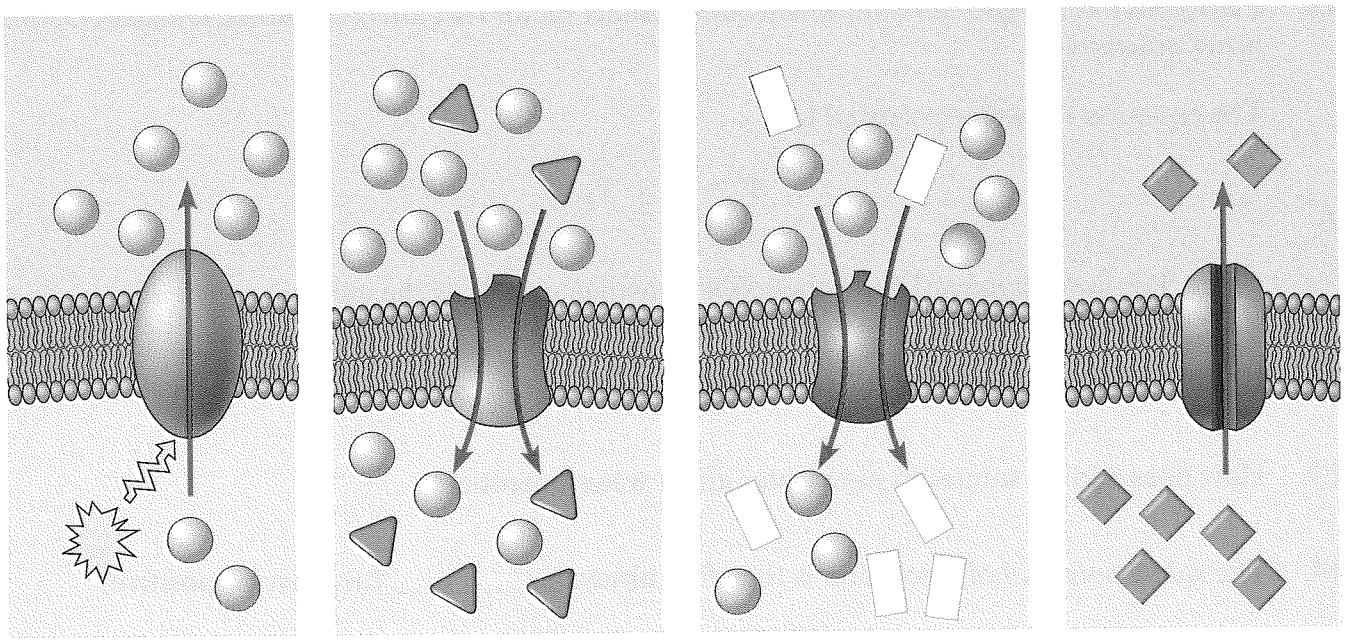
6. To be sure you are solid about the general principles of transport, answer the following questions. Reference Chapter 7 if you are unsure about any of the questions.

   a. What is *passive transport*?

   b. What is *active transport*?

   c. What are *transport proteins*?

7. Transport in plants involves many of the same mechanisms seen in other cells; but for this section focus on some ways plants differ from animals in solute transport. Study and complete Figure 36.6 to highlight processes of solute transport across plant cell membranes. Label each mechanism type and the key ions or molecules involved, then give a short description of each process.



Description of each mechanism

8. What is *membrane potential*? How can it be established?

9. Explain *cotransport*.

10. What is *osmosis*?

Study Tip

In order to fully understand transport in plants, you need to add the concept of water potential. Work hard on this section, as it is addressed in several AP Biology learning objectives. You will need to be able to work problems using the formulas in this concept.

11. Plant cells have a rigid cell wall, which adds another factor that affects osmosis: *pressure*. Define *water potential*.

    The equation for water potential is

$$\Psi = \Psi_s + \Psi_p,$$

    where Ψ is *water potential*, Ψ_s is the *solute potential*, and Ψ_p is the *pressure potential*.

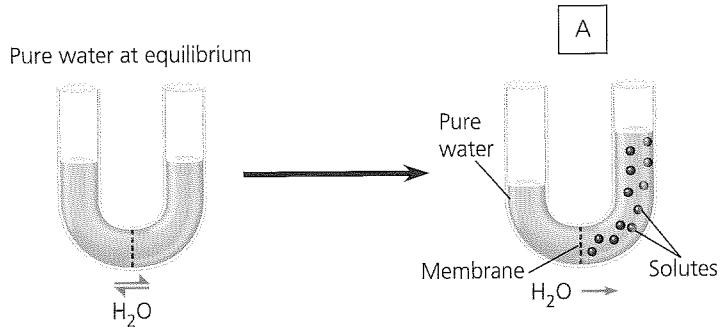
12. By definition, what is the Ψ_s of pure water?

13. How does adding solutes to pure water affect water potential?

14. The *solute potential* of a solution is therefore always _____. (negative or positive)

15. What is *pressure potential*? Under what conditions will it decrease?

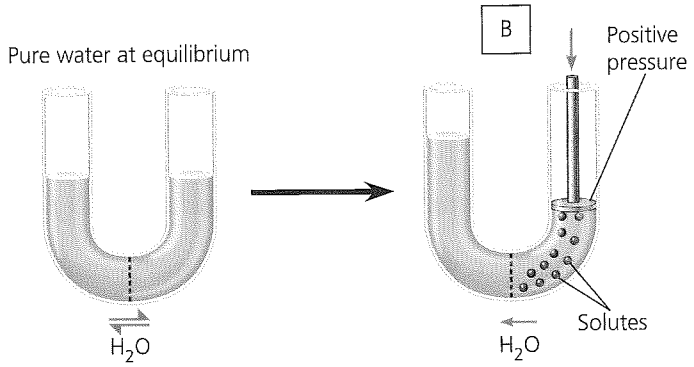
16. The two figures that follow show U-tubes, in which water or a solution (indicated by red dots) is placed, with the two arms of the tube separated by a selectively permeable membrane (indicated by the black dotted line). The membrane will freely allow the passage of water. In these figures, the red arrow(s) show the net movement of water molecules. What is the water potential on the left side of tube A? Why?



17. Is the water potential on the right side of tube A positive or negative? Use the equation for water potential to explain your response.

18. Explain, in terms of water potential, why the level of the liquid is higher on the right side of tube A.

19. In the U-tubes shown below, pressure is being applied on the right side in tube B. This is much like the pressure exerted by the cell wall when a plant cell takes up water. Explain, in terms of water potential, why the level of the liquid is higher on the left side.

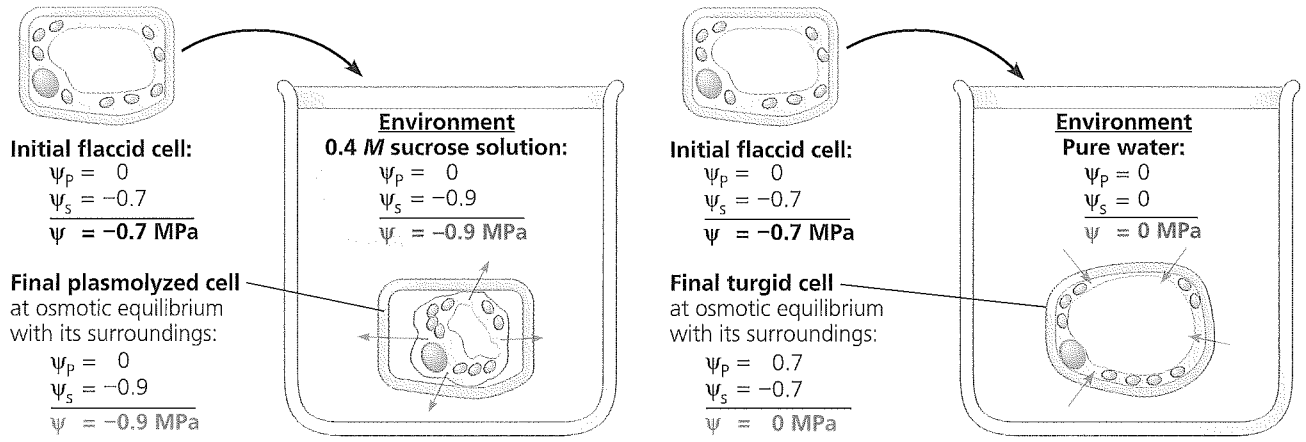


20. To summarize, *water moves from regions of* _____ *water potential to regions of* _____ *water potential.*

21. Use the concept of water potential to describe what occurs in *plasmolysis.*

22. If a *flaccid* plant cell is bathed in pure water, describe how it will change. Again use the terminology of water potential to frame your answer.

23. In the following figure, a plant cell that has an initial water potential of –0.7 MPa is placed into two different conditions. Explain, in terms of water potential, what happens in each case.



(a) Initial conditions: cellular ψ > environmental ψ. **(b) Initial conditions: cellular ψ < environmental ψ.**

(a)

(b)

24. What are *aquaporins*?

25. What is *bulk flow*? Does it depend on solute concentration?

26. Summarize the three processes that act together to transport resources through the whole plant.

***Concept 36.3** Transpiration drives the transport of water and minerals from roots to shoots via the xylem*

27. Study Figure 36.8 in your text, which shows how water is funneled from the soil into the xylem. Test your understanding by answering the following questions.

    a. Which structure controls the movement of water and minerals into the xylem? How are its cells modified to achieve this function?

    b. How is the surface area for absorption greatly increased?

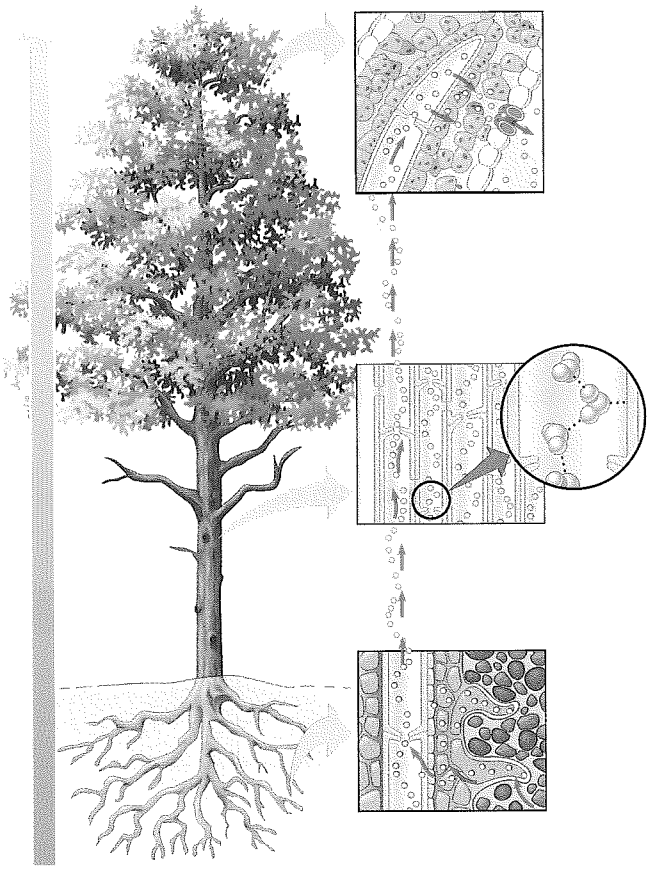
    c. How is it possible for water to pass from one root cell to another?

28. What is *transpiration*?

29. There are two mechanisms that pull water up through the plant, from roots to leaves. Explain *root pressure*. Note that it is a minor mechanism for the upward movement of water.

30. What is the *cohesion-tension hypothesis*?

31. The second mechanism that pulls water up through the plant involves transpiration, adhesion, and cohesion. Refer to Figure 36.11 in your text. Note that water moves from a region of high water potential to a region of lower water potential. The arrow on the left side of the figure shows this gradient. Write an essay to explain the movement of water from the roots to the leaves. Include each of these terms in your essay, and label them on the figure: *root hairs*, *lower water potential, higher water potential, hydrogen bonding, adhesion, cohesion, xylem tubes*, and *stoma*. **Spend time with this figure and its explanation. It is an essential concept!**



***Concept 36.4** The rate of transpiration is regulated by stomata*

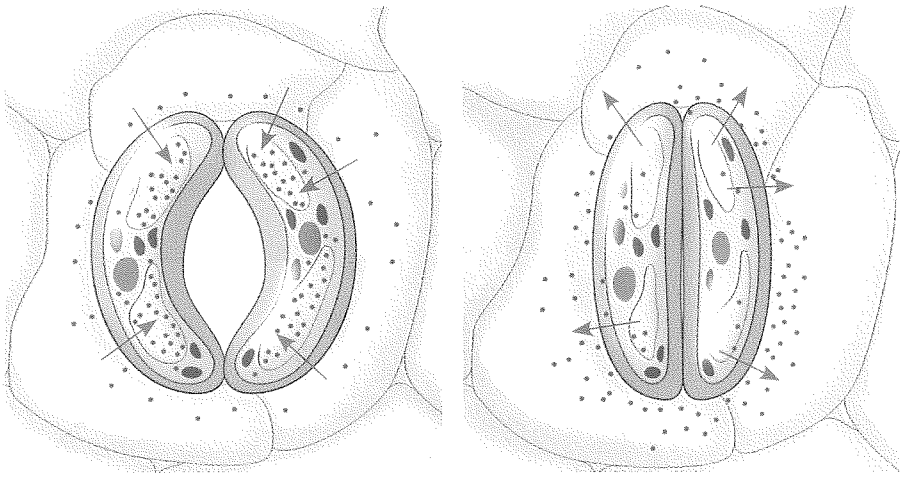
32. Leaves generally have large surface areas and high surface-to-volume ratios. Give an advantage and disadvantage of these traits.

advantage

disadvantage

33. Plants lose 95% of their water through stomata! What controls the amount of water loss?

34. On the following sketches, label the *guard cell, stomata,* K^+, and H_2O. Explain why the stoma opens when K^+ accumulates in the guard cells.



35. Three types of environmental stimuli can cause guard cells to open and close stomata. Name and explain how each one works.

Stimulus for Stomatal Opening and Closing	Explanation

36. What plant hormone is produced in response to water deficiency?

37. Reducing water loss is important for terrestrial plants and drives many evolutionary adaptations. List four different physiological or morphological adaptations of *xerophytes*, and explain how each of them reduces water loss.

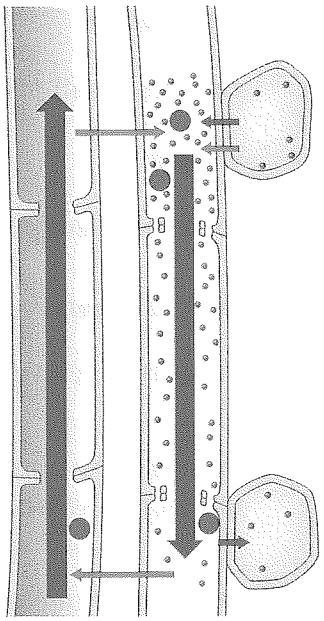
***Concept 36.5** Sugars are transported from sources to sinks via the phloem*

38. What is *translocation*?

39. What is a *sugar source*, and what is a *sugar sink*? Give an example of each.

40. What cell types transport the sugars?

41. Explain the process of *pressure flow* by annotating the figure to the right. Refer to your text, and divide this process into four steps.



42. Study Figure 36.17 in your text. How do aphids feed? When houseplants are infested with aphids, why is there a sticky mess on the floor around them?

***Concept 36.6** The symplast is highly dynamic*

43. An important concept is how cells communicate with other cells in an organism. Read how phloem serves as an information superhighway. Give two specific signals that move through the symplast, and describe the function of each signal.

Test Your Understanding Answers

Now you should be ready to test your knowledge. Place your answers here:

1. _____ 3. _____ 4. _____ 5. _____ 6. _____

7. _____ 8. _____

10. (Show your work and calculations in the space below. This question is typical of what you might see on the AP Biology Exam.)