Name _____ **Period** _____

Chapter 39: Plant Responses to Internal and External Signals

This chapter explores many different ways in which plants respond to signals, and you will see many links to other chapters, including cell signaling, hormones, and immune response. Plants exhibit a number of behaviors that enhance their biological fitness. Specific to the AP Biology Curriculum Framework, you should understand phototropism and photoperiodism.

Concept 39.1 Signal transduction pathways link signal reception to response

This concept brings together the general ideas on cell communication from Chapter 11 with specific examples of signal transduction in plants. As with animals, plants have receptors that trigger signal transduction pathways when activated. Let's begin with a review of three steps in signal transduction.

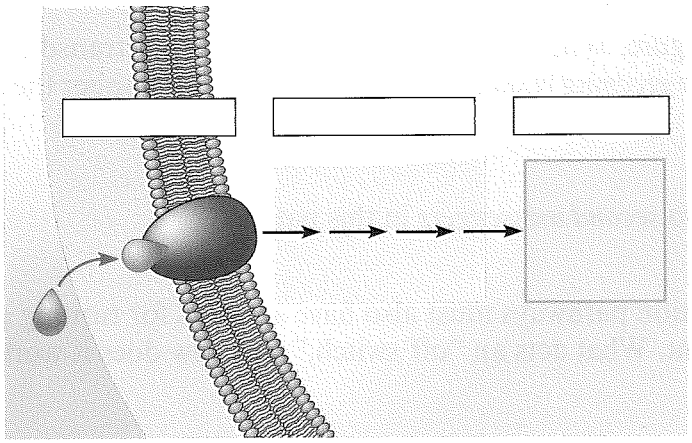
Step 1: Reception. Cell signals are detected by receptors that undergo changes in shape in response to a specific stimulus.

Step 2: Transduction. Transduction is a multistep pathway that amplifies the signal. This effect allows a small number of signal molecules to produce a large cellular response.

Step 3: Response. Cellular response is primarily accomplished by two mechanisms:

a. increasing or decreasing mRNA production
b. activating existing enzyme molecules

1. Label the important parts of signal transduction on this figure. Below each step, give an example of what a failure at that step might cause to happen within a cell or organism. You may give examples from any type of cell to show that you understand the normal function of a pathway, as well as how it may be disrupted.

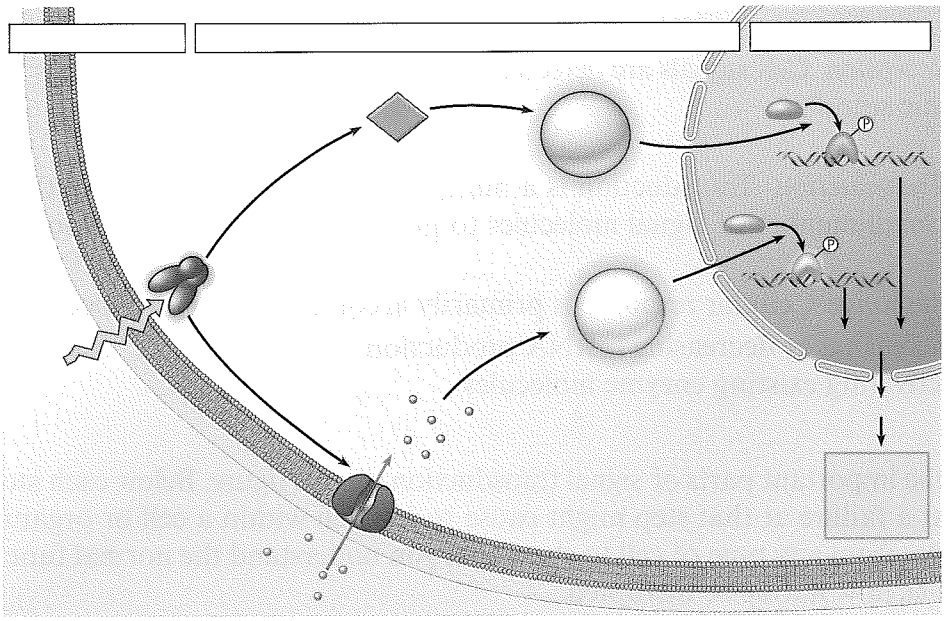


2. Have you ever seen a shriveled potato sending out skinny, pale sprouts? What is this called? What is the stimulus?

3. How do the potato's morphological adaptations for growing in darkness increase its biological fitness?

4. If you move the potato into the light, the sprout will respond by forming short, sturdy stems and broad, green leaves. What is this response to light called?

5. The following figure gives a specific example of a signal transduction in plants for the *greening* or *de-etiolation response* previously described. Label these parts of the figure: *reception, transduction, response, phytochrome, signal,* Ca^{2+} *channel, second messenger (cGMP), protein kinase, transcription factor,* and *DNA*.



6. Return to the figure. What is the signal? What occurs in transduction? Explain how the light signal causes the *greening response*. You may choose to number the steps, as shown in the figure in your text.

7. What are the two *second messengers* in this pathway?

8. Signal transduction pathways must also have a means for turning off when the initial signal is no longer present. What acts an "off switch," and how does it work?

9. Focus on the final section in this concept, De-Etiolation Proteins. Give at least three specific ways in which proteins that are either activated or newly transcribed contribute to the process of greening.

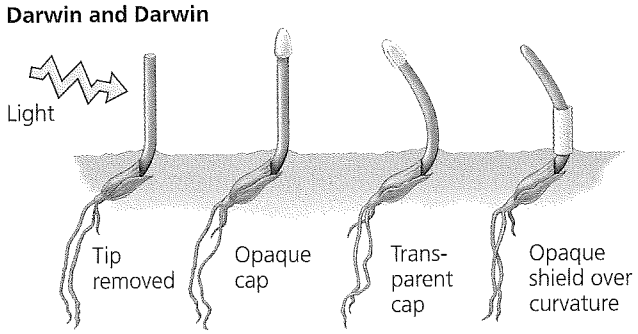
***Concept 39.2** Plant hormones help coordinate growth, development, and responses to stimuli*

10. Both plants and animals have *hormones*. The original definition of a hormone has three parts. What are they?

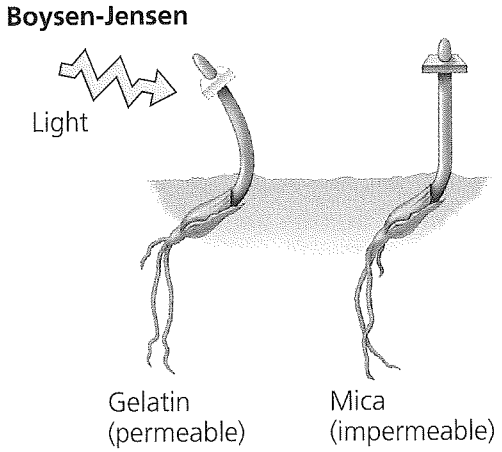
11. Many modern plant biologists think the term *hormone* as previously defined doesn't quite fit plants. What term do they use instead?

12. What is a *tropism*?

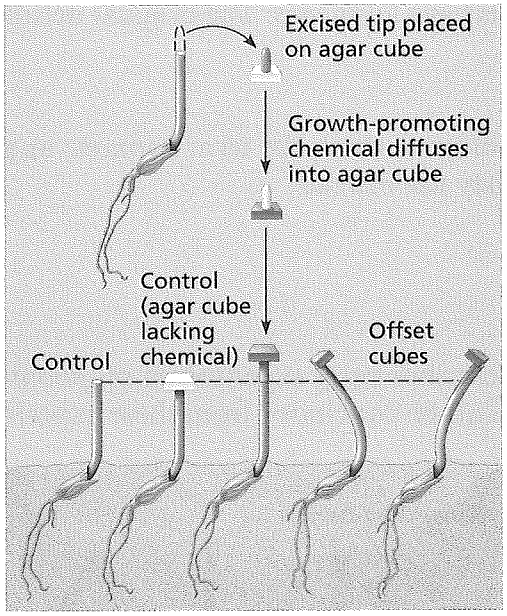
13. The following sketch describes early experiments on *phototropism* conducted by Charles and Francis Darwin. What can be concluded from these experiments? Cite evidence that supports this conclusion.



14. Here is a sketch of the *Boysen-Jensen experiment.* What conclusions can be drawn from it?



15. Boysen-Jensen's work was published in 1913. In 1926, Frits Went modified the experiment using agar cubes with a chemical from the coleoptile tips. This experiment is shown in the following figure, and is described on page 842 of your text. Summarize what is shown in this experiment. Explain these results.



16. What name did Went give to this chemical messenger that infused the agar blocks? _____ What was its chemical structure found to be?

17. In jest, we tell our students that when in doubt about which plant hormone causes which plant response, just answer *auxin*. Auxin has so many functions, this answer often works. List and describe four functions of auxin.

Auxin Function	Description

18. Did you catch the discussion of auxins as herbicides? Perhaps you have used **Weed-B-Gon®** to kill dandelions in your lawn. Explain how this product kills dandelions without killing the grass.

19. How did *cytokinins* get their name?

20. All plant hormones are signaling molecules and can generate a wide range of cellular effects. In order to be familiar with this group, fill out the following chart by selecting one function you think to be most important or interesting for each hormone. (See Table 39.1 for help.)

Hormone	Major Function
Auxin	
Cytokinins	
Gibberellins (GA)	
Abscisic acid (ABA)	
Ethylene	

21. *Ethylene* is the only hormone in our group that is a gas. The functions of ethylene are many and varied. One that has practical application for you is that it promotes fruit ripening and senescence. That old phrase "one rotten apple can spoil the bunch" is true. Under what conditions is *ethylene* produced?

***Concept 39.3** Responses to light are critical for plant success*

22. Researchers have determined that plants have two major classes of light receptors. List each class.

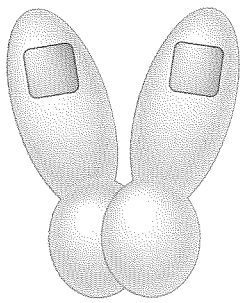
23. What wavelengths of light are absorbed by *phytochromes*?

24. What are three different responses initiated by blue light?

25. Read carefully the discussion of *phytochromes* and how they work. Pay attention to the two types of red light. What is the wavelength of *red light*? _____ Of *far-red light*? _____

26. Phytochromes are photoreceptors that have two isomer forms, P_r and P_{fr}. This figure shows the conversion of P_r to P_{fr} and the reverse. Label all of the boxes.

27. What conditions maintain phytochrome as P_r?



28. Which is the active form of phytochrome, P_r or P_{fr}? _____

29. Look again at the effect of light exposure on lettuce seed germination shown in Figure 39.16. What is the role of red and far-red light in determining the seed's response?

30. To make sense of all this, you will want to read carefully the Phytochromes and Shade Avoidance section. Which type of red light is more common in a shaded area? Why?

31. What is a *circadian rhythm*? Give one plant example and one human example.

32. How do phytochromes function in plant circadian rhythms?

33. What is the *photoperiod*?

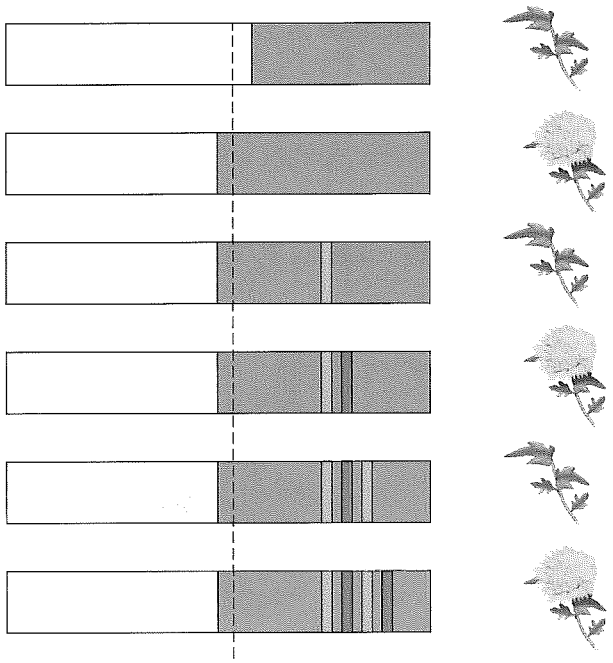
34. Plants detect photoperiod, and in many species it affects their time of flowering. Explain each of the following, and give an example of a plant that is in the group.

short-day plant

long-day plant

day-neutral plant

35. The plant in the following sketch is a short-day plant. Label *R, FR,* and *critical dark period.* For each line, explain why flowering occurs or does not occur.



***Concept 39.4** Plants respond to a wide variety of stimuli other than light*

36. What is *gravitropism*? How may a plant detect gravity?

37. What is *thigmotropism*? How is it adaptive?

38. List six different ways in which a plant responds to drought.

39. Select any other stress situation besides water deficit, and explain plant mechanisms for dealing with this.

***Concept 39.5** Plants respond to attacks by pathogens and herbivores*

40. Like animals, plants have immune responses. The first line of immune defenses is called *PAMP-triggered immunity.* (PAMP = pathogen-associated molecular patterns.) How are the plant immune responses similar to vertebrate responses? Different?

41. What occurs when PAMPs are recognized?

42. Study the **Make Connections** Figure 39.27 on page 862. Plants are able to combat herbivory by defenses at several levels of biological organization. For each level, describe the general mode of defense and give an example.

Level of Defense	Mode of Defense/Example
Molecular	
Cellular	
Tissue	
Organ	
Organismal	
Population	
Community	

Test Your Understanding Answers

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

1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____

7. _____