2019

AP® CollegeBoard

AP® Biology

Sample Student Responses and Scoring Commentary

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Free Response Question 8

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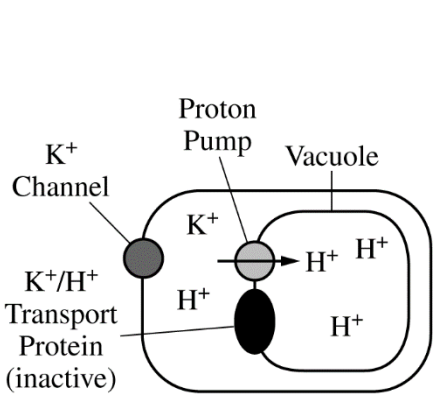
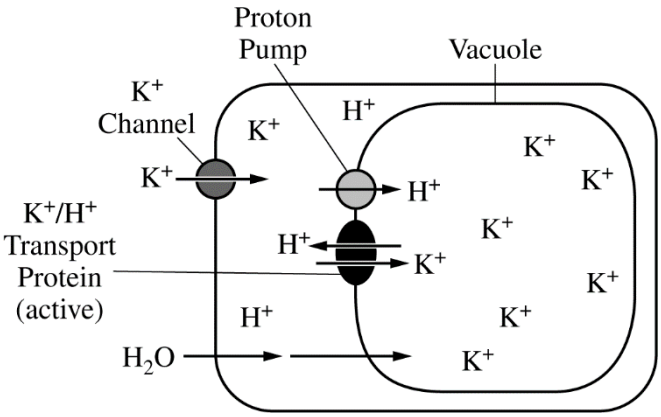
AP® BIOLOGY
2019 SCORING GUIDELINES

Question 8

TABLE 1. CHANGES IN MORNING GLORY PETAL CELLS DURING FLOWER OPENING

	BUD	OPEN FLOWER
		
Vacuole pH	6.6	7.7
Flower Color	Red	Blue
Cell Volume	Small	Large

The petal color of the Mexican morning glory (*Ipomoea tricolor*) changes from red to blue, and the petal cells swell during flower opening. The pigment heavenly blue anthocyanin is found in the vacuole of petal cells. Petal color is determined by the pH of the vacuole. A model of a morning glory petal cell before and after flower opening is shown in Table 1.

(a) **Identify** the cellular component in the model that is responsible for the increase in the pH of the vacuole during flower opening AND **describe** the component's role in changing the pH of the vacuole.

Identification (1 point)

- (K^+ / H^+) transport protein

Description (1 point)

- It moves H^+ out of the vacuole.

(b) A researcher claims that the activation of the K^+ / H^+ transport protein causes the vacuole to swell with water. **Provide reasoning** to support the researcher's claim.

Reasoning (1 point)

- The concentration of solute (K^+) is increasing inside the vacuole.
- The solute (K^+) is moving into the vacuole, making it hypertonic/hyperosmotic/lowering water potential.

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	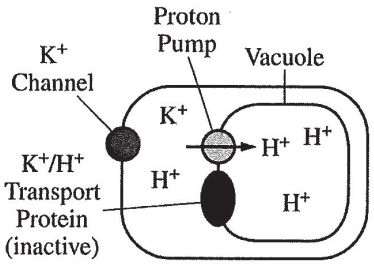	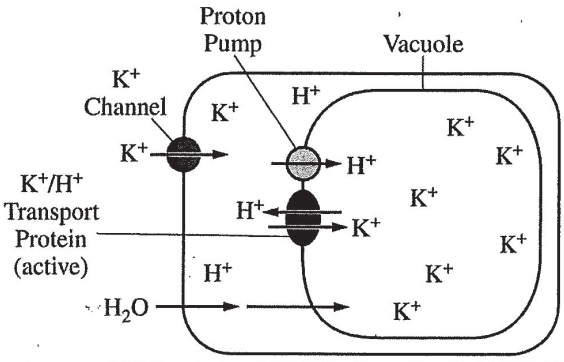
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8. The petal color of the Mexican morning glory (*Ipomoea tricolor*) changes from red to blue, and the petal cells swell during flower opening. The pigment heavenly blue anthocyanin is found in the vacuole of petal cells. Petal color is determined by the pH of the vacuole. A model of a morning glory petal cell before and after flower opening is shown in Table 1.

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The pH of the vacuole is increased by the K^+/H^+ transport protein. It changes the pH by removing the H^+ ions brought in by the proton pump, thus decreasing H^+, which equals increasing pH. It acts as an antiporter of K^+ and H^+.

The movement of K^+ into the vacuole is also accompanied by the diffusion (osmosis) of water, since moving K^+ into the vacuole by the pump decreases water potential, water moves in with the K^+ to balance out the changes in water potential to reach equilibrium, causing it to swell with water.

8B

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	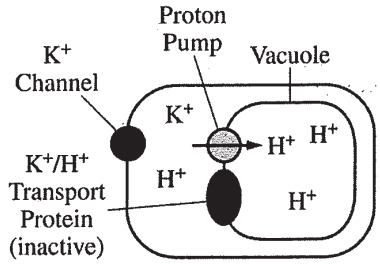	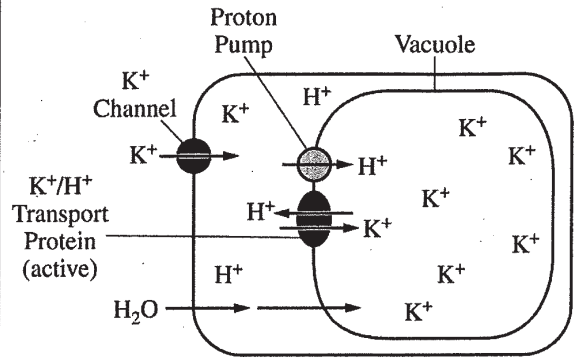
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(a) The cellular component that is responsible is the K^+/H^+ Transport Protein. It allows H^+s to leave the vacuole when the flower is open and fewer H^+s means a higher pH.

(b) Since water has a pH of 7, it will enter the vacuole through osmosis and cause it to swell in order to bring the vacuole's pH back to equilibrium at a pH of 7.

8C1

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	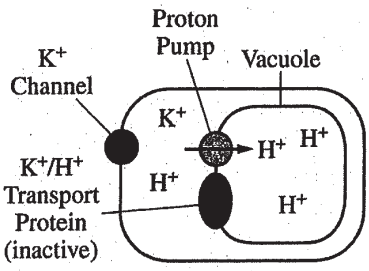	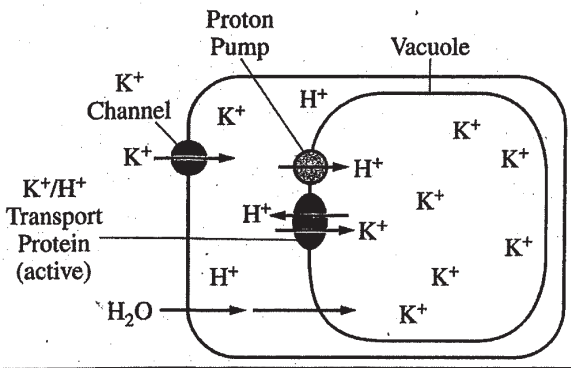
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PAGE FOR ANSWERING QUESTION 8

a- The cellular component in the model responsible for the increase in the PH is the K^+/H^+ transport protein. It's role changes from inactive to active when going from a bud to an open flower. It allows the H^+ and K^+ ions to move freely from the vacuole to the outter membrane and vise versa.

GO ON TO THE NEXT PAGE.

ADDITIONAL PAGE FOR ANSWERING QUESTION 8

b- When the K^+/H^+ transport protein is activated it allows H_2O to enter the vacuole, which in effect, causes the vacuole to swell with water.

AP® BIOLOGY
2019 SCORING COMMENTARY

Question 8

Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Overview

Students were provided with a model of petal cells in a bud and a fully opened flower. The models depicted a cell with a potassium ion channel in the plasma membrane and a proton pump and a K^+/H^+ transport protein in the vacuole membrane. Three main features of each cell were specified: the pH of the vacuole, the color of the flower, and the volume of the cell. The students were asked to identify the cellular component responsible for the increase in the pH of the vacuole during flower opening and to describe the component's role in changing the pH of the vacuole. Then students were asked to provide reasoning for a claim that the activation of the K^+/H^+ transport protein causes the vacuole to swell with water. Students needed an understanding of pH, osmosis/water potential, and membrane transport to correctly respond to this question. They also needed to interpret a model of a specific cell type, including how the cell changed during development.

Sample: 8A
Score: 3

The response earned 1 point in part (a) for identifying the K^+/H^+ transport protein. The response earned 1 point in part (a) for describing that "[i]t changes the pH by removing the H^+ ions." The response earned 1 point in part (b) for reasoning that "moving K^+ into the vacuole … decreases water potential."

Sample: 8B
Score: 2

The response earned 1 point in part (a) for identifying the K^+/H^+ transport protein. The response earned 1 point in part (b) for reasoning that "[i]t allows H^+s to leave the vacuole."

Sample: 8C
Score: 1

The response earned 1 point in part (a) for identifying the K^+/H^+ transport protein.