Fuel in Balance

Model how hormone signals keep blood glucose within a useful range.

HAP.7.3 "Model specific mechanisms through which the endocrine system maintains homeostasis (e.g., insulin/glucagon and glucose regulation; T3 / T4 and metabolic rates; calcitonin/parathyroid and calcium regulation…"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline changes in blood glucose, circle insulin and glucagon, and number the steps in each feedback loop from the glucose change to its correction.

From Lunch to the Walk Home

1. During a school day, blood glucose changes even though brain and muscle cells need a steady supply of fuel. After lunch, digested carbohydrates enter the blood as glucose. Cells in the pancreas detect the rising level and release insulin into the blood. Insulin signals muscle cells to take in more glucose and signals the liver to store glucose as glycogen. As glucose leaves the blood, its level moves back toward its usual range. The pancreas then releases less insulin. This sequence is negative feedback: a change triggers responses that reduce the original change.

2. Hours later, a student walks home before dinner. Working muscles use glucose, and little is entering the blood from a meal. As blood glucose falls, pancreatic cells release more glucagon and less insulin. Glucagon signals the liver to break down stored glycogen and release glucose into the blood. With less insulin present, the liver is less strongly directed to store glucose. The added glucose helps keep blood levels within a useful range, so the pancreas reduces glucagon release as the level recovers. The two hormones act in opposite directions on blood glucose, but both support a stable internal environment.

3. To model this system, trace a cause through a sensor, a hormone signal, a target organ, and a change in blood glucose. The pancreas responds to the current glucose level, but the liver carries out much of the correction. A model should also show when the signal decreases; otherwise it may suggest that hormone release continues without a limit. If glucose keeps dropping and the liver cannot release enough of its stored glucose, the normal response may not fully restore the level. Feedback helps maintain a range, not an unchanging number, and its success depends on organs responding to the signals.

2 ANSWER WITH EVIDENCE

Use the passage

1. Trace the feedback loop after lunch. Start with rising blood glucose and end with reduced insulin release.

2. During the walk home, how do changes in both hormones help reverse falling blood glucose?

3. Why is a model incomplete if it shows insulin causing glucose uptake but does not show a later change in insulin release?

4. After the liver releases stored glucose and blood glucose recovers, what change in glucagon release should a model show? Explain why.

3 YOUR TURN

Your own words

During a long practice, a student's liver stops responding to glucagon, but their muscles still use glucose. In 4 to 5 sentences, predict what happens to blood glucose, explain why the feedback loop cannot fully correct it, and describe what would change if the student drinks a glucose-containing drink.

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PART 1 · READ AND MARK

Underline changes in blood glucose, circle insulin and glucagon, and number the steps in each feedback loop from the glucose change to its correction. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Trace the feedback loop after lunch. Start with rising blood glucose and end with reduced insulin release.	**Rising blood glucose prompts the pancreas to release insulin. Muscle cells take in glucose, and the liver stores glucose as glycogen. As blood glucose moves toward its usual range, the pancreas releases less insulin.**
2	During the walk home, how do changes in both hormones help reverse falling blood glucose?	**The pancreas releases more glucagon, which signals the liver to release glucose from stored glycogen. It also releases less insulin, so the liver is less strongly directed to store glucose.**
3	Why is a model incomplete if it shows insulin causing glucose uptake but does not show a later change in insulin release?	**It leaves out the feedback step: as blood glucose moves toward its usual range, the pancreas releases less insulin.**
4	After the liver releases stored glucose and blood glucose recovers, what change in glucagon release should a model show? Explain why.	**The pancreas should release less glucagon because blood glucose has moved back toward its usual range.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

As the muscles use glucose, blood glucose would keep falling. The pancreas would release more glucagon and less insulin, but the liver would not release glucose in response to glucagon. The feedback signal is present, yet its target cannot carry out the correction. Glucose from the drink would enter the blood and raise blood glucose even though the liver still fails to respond.

Accept models that connect a change in blood glucose to pancreatic hormone release, a target-organ response, and feedback that reduces the signal. For Your Turn, students should distinguish glucose entering the blood from a drink from glucose released by the liver.