Design for Balance

Test and improve a system for regulating hormone levels

HAP.7.5 "Enrichment: Use an engineering design process to develop effective treatments for endocrine disorders (e.g., methods to regulate hormonal imbalance).*"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the design goal and circle two risks or limits the team must address. In the last paragraph, number the first test, the design change, and the repeated test in order.

An Insulin System That Adapts

1. During soccer practice, Maya's glucose can fall quickly. Maya has type 1 diabetes, so her pancreas makes little or no insulin. Insulin helps glucose move from blood into cells, and she needs a reliable way to receive it. Too little insulin can leave her blood glucose dangerously high; too much can cause a dangerous low, especially during exercise. Her design team's goal is to keep glucose within a range set with her clinician, not to deliver the same amount of insulin at every moment. They also want a system Maya can use at school without constantly interrupting class.

2. The team sketches a wearable system that pairs a continuous glucose monitor with an insulin pump. The monitor estimates glucose in fluid beneath the skin and sends readings to a controller every few minutes. Software uses the readings and recent trends to adjust the pump's insulin delivery within clinician-set limits. Because sensor readings can lag behind blood glucose during rapid changes, the team adds an alert that tells Maya to check her blood glucose and follow her care plan when a reading seems unsafe. A battery failure must also trigger an alarm, since a silent shutdown could interrupt insulin delivery.

3. Before testing with people, the team runs simulated school days with meals, sports, sensor errors, and power loss. They record time in the target glucose range, minutes spent below it, and missed alerts. One version improves time in range but delivers too much insulin after practice, increasing low-glucose minutes. The team changes the software to respond more cautiously to falling readings, then repeats the same simulations. They also compare the cost and ease of replacing sensors, because a design that families cannot maintain will not meet Maya's needs. Clinical testing and regulatory review would still be required before real-world use.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which two details about Maya's needs show why delivering the same amount of insulin at every moment would not meet the design goal?

2. Choose one possible system failure from the passage. What feature does the team add to reduce its risk?

3. After changing the software, which two measurements should the team compare with the first test to see whether it reduced the after-practice problem without losing the earlier benefit?

4. Why is sensor replacement cost part of judging whether this design meets Maya's needs?

3 YOUR TURN

Your own words

A patient with hypothyroidism sometimes forgets a prescribed daily thyroid hormone tablet and cannot use a smartphone. In 5 to 7 sentences, design a non-phone system that includes a goal, two features, one constraint, a measurable test, and a change you would make if doses are still missed. Leave any dose changes to the clinician.

ANSWER KEY

Design for Balance

PART 1 · READ AND MARK

Underline the design goal and circle two risks or limits the team must address. In the last paragraph, number the first test, the design change, and the repeated test in order. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which two details about Maya's needs show why delivering the same amount of insulin at every moment would not meet the design goal?	**Her glucose can fall quickly during soccer, and both too much and too little insulin can be dangerous.**
2	Choose one possible system failure from the passage. What feature does the team add to reduce its risk?	**For sensor lag during rapid glucose changes, the team adds an alert telling Maya to check her blood glucose and follow her care plan. Alternatively, a battery failure triggers an alarm.**
3	After changing the software, which two measurements should the team compare with the first test to see whether it reduced the after-practice problem without losing the earlier benefit?	**Compare minutes spent below the target range, especially after practice, and time spent in the target range.**
4	Why is sensor replacement cost part of judging whether this design meets Maya's needs?	**If a family cannot afford to replace the sensors, it cannot maintain the system even if the glucose results are good.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

My goal is to help the patient take the prescribed tablet each day without a phone. A labeled weekly pill organizer would show which day's tablet is still in place. A paper checkoff card beside it would give the patient a daily cue and a place to record each dose. The system must be inexpensive and work without internet access. After four weeks, I would count missed days on the card and review the record with the patient. If doses are still missed, I would add a daily alarm clock and repeat the four-week test, leaving dose changes to the clinician.

Accept other passage-supported risks and matching safety features for question 2. For the open task, accept feasible non-phone designs that specify measurable evidence, a response to missed doses, and clinician oversight of dosing.