The Calcium Balance

Trace how bones help keep blood calcium stable

HAP.4.5 "Construct explanations detailing how mechanisms (e.g., Ca2+ regulation) are used by the skeletal system to maintain homeostasis."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline changes in blood Ca^{2+}, circle the cells and organs that respond, and number the steps in each response that return blood Ca^{2+} toward its usual range.

When Bones Help the Blood

1. At the end of a long run, a runner's leg muscles depend on calcium ions, Ca^{2+}, to contract. Nerve cells also need a steady supply of calcium in the blood to send signals. Most of the body's calcium is stored as mineral in bones, which provide support and protect organs. Blood calcium can change as the body uses calcium or absorbs it from food. Bones are not simply hard shelves: their tissue is constantly being removed and rebuilt. By adjusting how much calcium moves between bone and blood, the skeletal system helps keep internal conditions stable, a state called homeostasis.

2. Suppose the runner eats very little calcium for several days, and blood Ca^{2+} falls below its usual range. The parathyroid glands respond by releasing more parathyroid hormone, or PTH. In bone, PTH causes osteoblasts to send signals that increase the activity of osteoclasts, cells that break down bone tissue. As bone mineral breaks down, calcium enters the blood. PTH also tells the kidneys to conserve calcium instead of losing as much in urine. In addition, PTH helps the body activate vitamin D, which increases absorption of available calcium from food. Together, these responses raise blood Ca^{2+} toward its usual range.

3. If blood Ca^{2+} rises above its usual range, the parathyroid glands release less PTH. With less PTH stimulation, osteoclasts remove bone more slowly. Osteoblasts can deposit calcium into new bone mineral, and the kidneys can allow more calcium to leave in urine. Blood calcium then moves back toward its usual range. This loop is negative feedback: a change triggers responses that reduce that change. The balance matters because long-lasting PTH stimulation may keep drawing mineral from bone. That can weaken the skeleton even if blood calcium remains adequate for muscles and nerves.

2 ANSWER WITH EVIDENCE

Use the passage

1. When blood Ca^{2+} falls, how does the response in bone help restore its level? Trace the steps from the parathyroid glands to the blood.

2. How do the kidneys and activated vitamin D work alongside bones when blood Ca^{2+} is low?

3. When blood Ca^{2+} rises above its usual range, how do changes in PTH affect bone and the kidneys?

4. Why can the response to low blood Ca^{2+} help muscles now but harm the skeleton if it continues for a long time?

3 YOUR TURN

Your own words

A medicine keeps PTH release high even after a patient's blood Ca^{2+} returns to its usual range. In four sentences, predict what could happen to blood calcium and bone strength over time, and explain how the medicine disrupts feedback using cells and organs from the passage.

The Calcium Balance

PART 1 · READ AND MARK

Underline changes in blood Ca^{2+}, circle the cells and organs that respond, and number the steps in each response that return blood Ca^{2+} toward its usual range. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	When blood Ca^{2+} falls, how does the response in bone help restore its level? Trace the steps from the parathyroid glands to the blood.	**The parathyroid glands release more PTH. PTH causes osteoblasts to signal osteoclasts to break down more bone tissue, releasing calcium into the blood.**
2	How do the kidneys and activated vitamin D work alongside bones when blood Ca^{2+} is low?	**PTH causes the kidneys to conserve calcium and helps activate vitamin D. Activated vitamin D increases absorption of available calcium from food, adding to the calcium released from bone.**
3	When blood Ca^{2+} rises above its usual range, how do changes in PTH affect bone and the kidneys?	**PTH release falls, so osteoclasts remove bone more slowly. Osteoblasts can deposit calcium into bone, and the kidneys can allow more calcium to leave in urine.**
4	Why can the response to low blood Ca^{2+} help muscles now but harm the skeleton if it continues for a long time?	**Breaking down bone releases calcium that muscles need for contraction. If PTH stimulation continues, ongoing mineral loss can weaken bones.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The medicine prevents PTH from falling when blood Ca^{2+} returns to its usual range. Continued PTH signaling increases osteoclast activity, so more bone mineral breaks down and calcium enters the blood. The kidneys also conserve more calcium, which could raise blood Ca^{2+} above its usual range. Continued loss of bone mineral could weaken the skeleton over time.

Accept equivalent cause-and-effect explanations that distinguish a short-term benefit to blood calcium from a possible long-term cost to bone. In Part 3, blood calcium may rise above its usual range, but students should not claim that it must.