The Stairwell Signal

Trace how body systems keep internal conditions stable.

HAP.9.c "Construct an explanation of the respiratory system's relationships with other organ systems, including the body's mechanisms for maintaining homeostasis."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline changes in oxygen, carbon dioxide, pH, or water; circle the body parts that respond; and number the steps in one chain that helps restore stability.

What Happens at the Top of the Stairs?

1. At the top of a long stairwell, Maya notices that both her breathing and pulse have sped up. Her leg muscles have used more oxygen to release energy from fuel, producing extra carbon dioxide. Blood in nearby capillaries delivers oxygen to the muscles and takes up their carbon dioxide. The heart pumps that blood toward the lungs. In the lungs, oxygen from inhaled air moves into the blood, while carbon dioxide moves from blood into the air she exhales. The respiratory and circulatory systems work together to keep oxygen available for cells and remove a changing supply of waste gas.

2. Extra carbon dioxide does more than leave through the lungs. As it builds up in blood, it helps form an acid, causing blood pH to fall slightly. Sensors in the brainstem and large arteries detect changes linked to carbon dioxide and pH. The brainstem sends more frequent signals to the diaphragm and other breathing muscles, making breaths faster and often deeper. More air then reaches the lung air sacs each minute, allowing more carbon dioxide to leave the blood. This negative feedback limits the pH change, even as the leg muscles continue to work.

3. While Maya climbs, her heart rate also rises, moving blood between muscles and lungs more often. Faster breathing alone cannot deliver oxygen to leg cells unless blood carries it there. Maya also loses water in the air she exhales and in sweat that cools her skin. If she keeps losing water, her brain signals the release of a hormone that makes her kidneys return more water to the blood instead of losing it in urine. After she rests, muscles make less carbon dioxide, the drive to breathe eases, and her breathing and pulse slow. These linked responses help keep internal conditions within workable ranges.

2 ANSWER WITH EVIDENCE

Use the passage

1. Explain how the lungs, blood, and heart work together to supply Maya's leg muscles with oxygen and remove their carbon dioxide.

2. Trace the chain from rising carbon dioxide to a smaller change in blood pH. Include the sensors, breathing muscles, and lungs.

3. Why would faster breathing alone not meet Maya's leg muscles' need for oxygen? Explain the role of another organ system.

4. Maya loses water while breathing and sweating. Explain how a response involving her brain and kidneys helps limit the effect of that loss.

3 YOUR TURN

Your own words

Imagine a person at rest whose airways narrow during an infection, so less air reaches the lung air sacs. In four or five sentences, explain how this could affect blood gases, how the nervous and circulatory systems might respond, and why those responses might not fully restore stability.

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PART 1 · READ AND MARK

Underline changes in oxygen, carbon dioxide, pH, or water; circle the body parts that respond; and number the steps in one chain that helps restore stability. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Explain how the lungs, blood, and heart work together to supply Maya's leg muscles with oxygen and remove their carbon dioxide.	**Oxygen enters blood in the lungs, and the heart pumps that blood to the leg muscles. Blood picks up carbon dioxide from the muscles and carries it to the lungs to be exhaled.**
2	Trace the chain from rising carbon dioxide to a smaller change in blood pH. Include the sensors, breathing muscles, and lungs.	**Rising carbon dioxide helps lower blood pH. Sensors detect changes linked to carbon dioxide and pH, and the brainstem signals breathing muscles to increase ventilation. More carbon dioxide leaves through the lungs, limiting the pH change.**
3	Why would faster breathing alone not meet Maya's leg muscles' need for oxygen? Explain the role of another organ system.	**Breathing brings oxygen into the lungs, but the circulatory system must carry that oxygen in blood to the leg muscles.**
4	Maya loses water while breathing and sweating. Explain how a response involving her brain and kidneys helps limit the effect of that loss.	**Her brain signals the release of a hormone that causes her kidneys to return more water to the blood, so less water is lost in urine.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

If narrowed airways let less air reach the air sacs, less oxygen may enter the blood and less carbon dioxide may leave it. Rising carbon dioxide can lower blood pH and trigger sensors that signal the brainstem. The brainstem can drive faster, deeper breaths, while a faster heartbeat may move blood through the lungs and body more often. But if narrowed airways still limit airflow, those changes cannot fully replace missing oxygen or remove enough carbon dioxide. Blood gases and pH may remain outside their usual ranges.

Accept equivalent cause-and-effect explanations that connect a change in blood gases to responses by other organ systems. For Your Turn, students should recognize that faster breathing and circulation may not overcome limited airflow through narrowed airways.