The Staircase Breath

Trace how air, blood, and body signals work together

HAP.9 "Obtain, evaluate, and communicate information to explain the relationship between the structures and functions of the respiratory system. a..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two links between a structure and its function, circle the two lung-pressure comparisons, and number the structures oxygen passes through on its way from the air to a leg muscle.

What Happens After a Climb?

1. At the top of a flight of stairs, your breathing quickens, but air does not enter because your lungs pull it in like a vacuum cleaner. The diaphragm contracts and flattens while muscles between the ribs lift the rib cage. These movements enlarge the chest cavity, causing pressure inside the lungs to fall below pressure outside the body. Air then flows down this pressure gradient into the lungs. When these muscles relax, chest volume decreases and pressure inside the lungs rises above outside pressure. Air flows out. This pressure model explains airflow, not the movement of gases across lung tissue.

2. Inside the lungs, air reaches millions of tiny alveoli, or air sacs. Their thin, moist walls and large total surface area allow oxygen to diffuse into nearby capillaries. Oxygen moves from air with a higher oxygen concentration into blood with a lower concentration. Red blood cells carry much of that oxygen attached to hemoglobin. The heart pumps oxygen-rich blood to working leg muscles, where oxygen leaves the blood and helps cells release energy from food. Carbon dioxide made by those cells enters the blood, travels back to lung capillaries, and diffuses into the alveoli to be exhaled.

3. During a climb, muscle cells use more oxygen and make more carbon dioxide. Rising carbon dioxide in the blood can lower its pH. Sensors in blood vessels and the brain detect this change and signal the brain stem, which increases the rate and depth of breathing. Breathing out more carbon dioxide helps bring blood pH toward its usual range, an example of homeostasis. The circulatory system must keep moving blood between lungs and muscles: faster breathing cannot supply a muscle whose blood supply has stopped. Together, breathing movements, gas exchange, blood flow, and nervous system signals meet changing demands.

2 ANSWER WITH EVIDENCE

Use the passage

1. Use changes in chest volume and lung pressure to explain why air enters during inhalation and leaves during exhalation.

2. How do the structure of the alveoli and the oxygen concentration difference help oxygen enter the blood?

3. Explain how the respiratory and circulatory systems work together to deliver oxygen to leg muscles and remove their carbon dioxide.

4. During a climb, how does rising carbon dioxide lead to a change in breathing that helps maintain homeostasis?

3 YOUR TURN

Your own words

A classmate says faster breathing will deliver oxygen to a leg muscle even if blood flow to that muscle stops. In five or six sentences, evaluate the claim using a model of pressure changes during inhalation and exhalation, the paths of both respiratory gases, and the nervous system's usual response to rising carbon dioxide.

The Staircase Breath

PART 1 · READ AND MARK

Underline two links between a structure and its function, circle the two lung-pressure comparisons, and number the structures oxygen passes through on its way from the air to a leg muscle. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Use changes in chest volume and lung pressure to explain why air enters during inhalation and leaves during exhalation.	**Inhalation increases chest volume and lowers lung pressure below outside pressure, so air enters. Exhalation decreases chest volume and raises lung pressure above outside pressure, so air leaves.**
2	How do the structure of the alveoli and the oxygen concentration difference help oxygen enter the blood?	**The alveoli have thin, moist walls and a large total surface area. Oxygen diffuses from air with a higher oxygen concentration into nearby blood with a lower concentration.**
3	Explain how the respiratory and circulatory systems work together to deliver oxygen to leg muscles and remove their carbon dioxide.	**Oxygen diffuses from alveoli into capillaries, and the heart pumps oxygen-rich blood to leg muscles. Carbon dioxide from those muscles enters the blood, returns to lung capillaries, diffuses into the alveoli, and is exhaled.**
4	During a climb, how does rising carbon dioxide lead to a change in breathing that helps maintain homeostasis?	**Rising blood carbon dioxide can lower pH. Sensors signal the brain stem to increase breathing rate and depth, helping the body exhale more carbon dioxide and bring pH toward its usual range.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

When the diaphragm contracts, chest volume rises and lung pressure falls below outside pressure, so air enters. When it relaxes, chest volume falls and lung pressure rises above outside pressure, so air leaves. Oxygen in the alveoli diffuses into capillaries, where blood can carry it toward the leg. If blood flow to that leg stops, oxygen cannot reach its muscle cells even if breathing speeds up. Carbon dioxide produced in the blocked muscle cannot be carried away efficiently and may build up there. Normally, rising carbon dioxide in circulating blood lowers pH, and sensors signal the brain stem to increase breathing and help restore pH.

Accept equivalent descriptions of pressure gradients and gas pathways. In Part 3, look for the distinction between moving air into the lungs and using blood flow to deliver oxygen to muscle.