

Field Investigation: What Your Body Changes When Your Muscles Work Harder

Investigation question: How do breathing rate and the carbon dioxide in exhaled breath change after two minutes of brisk activity, and what do those changes tell us about cellular respiration inside muscle cells?

Classroom field investigation

Groups of 4

1 session

Setup 10 · Activity 35 · Cleanup 10 min

MS-LS1-7 · practice

MS-LS1-6 · supports

Name _____

Group _____

Date _____

Your role today

- ☐ **Mover:** Sits quietly for the baseline readings, does the two minutes of activity at the agreed pace, and exhales gently through the straw for the indicator tests. Can decline to exercise at any time and switch roles.
- ☐ **Timer:** Runs the stopwatch for the one-minute breath counts, the two-minute activity and the indicator color-change timing, and calls start and stop.
- ☐ **Breath counter:** Counts the Mover's breaths for one minute by watching the chest or shoulders, without telling the Mover when counting starts.
- ☐ **Indicator technician and recorder:** Pours the indicator, holds the cup steady and level, watches for the color change against the key, and writes every value on the recording sheet.

Safety

- Exercise is voluntary and moderate. Any student with asthma, a heart condition, an injury, illness or a parent note does not exercise and takes another role. The Mover stops at once and sits if dizzy, short of breath beyond normal, or in any pain, and the teacher is told.
- Never suck through the straw; exhale only, gently. Use a new straw for each student and throw it away afterward. Do not share straws or cups.
- Bromothymol blue is a mild skin and eye irritant and stains. Goggles on during every indicator test; hold the cup low and level so bubbling does not splash; wipe spills with a wet towel and wash hands before leaving.
- Keep the activity area clear of cups, bags and cords; do step-ups only on a stable low step or bottom stair with a hand near the rail.
- Used indicator goes in the class bucket, not on the ground; cups and straws go in the trash.

Procedure

1. At the site, set up the group's cups: measure 20 mL of indicator into two cups for the Mover's two tests and label them REST and AFTER. Record the starting color number of each from the key.

2. Baseline breathing: the Mover sits still for two minutes. The Breath counter then counts breaths for one full minute without the Mover knowing when the count starts; repeat for a second minute. Record both counts and the average as breaths per minute at rest.
3. Baseline indicator test: goggles on. The Mover exhales gently and steadily through a new straw into the REST cup while the Timer runs the stopwatch; the technician watches for the color to reach yellow (3) and the Timer stops. Record the seconds. If the Mover needs to take a breath, keep the straw in the cup and keep timing.
4. Activity: the Mover does two minutes of the agreed activity at the agreed brisk pace while the Timer calls out each 30 seconds. The rest of the group watches for any sign the Mover should stop.
5. Immediately after: the Breath counter counts breaths for one minute while the Mover stands or sits; record it as breaths per minute after activity.
6. Immediately after that count: with a new straw, the Mover exhales into the AFTER cup while the Timer times the change to yellow. Record the seconds.
7. Recovery: count breaths for one minute again at three minutes after the activity ended. Record it.
8. If time allows and a second group member wants to be the Mover, repeat the whole sequence with fresh cups and straws. Otherwise, compute the group's changes and add the Mover's values to the class table.
9. Back in the classroom, graph the pooled class data (rest versus after) and answer the recording-sheet and analysis questions individually.

Record your observations

Lab 3 recording sheet: What your body changes when your muscles work

Record the Mover's values in the order the procedure gives. Color key numbers: 1 = blue, 2 = green, 3 = yellow. Time the indicator until it reaches 3.

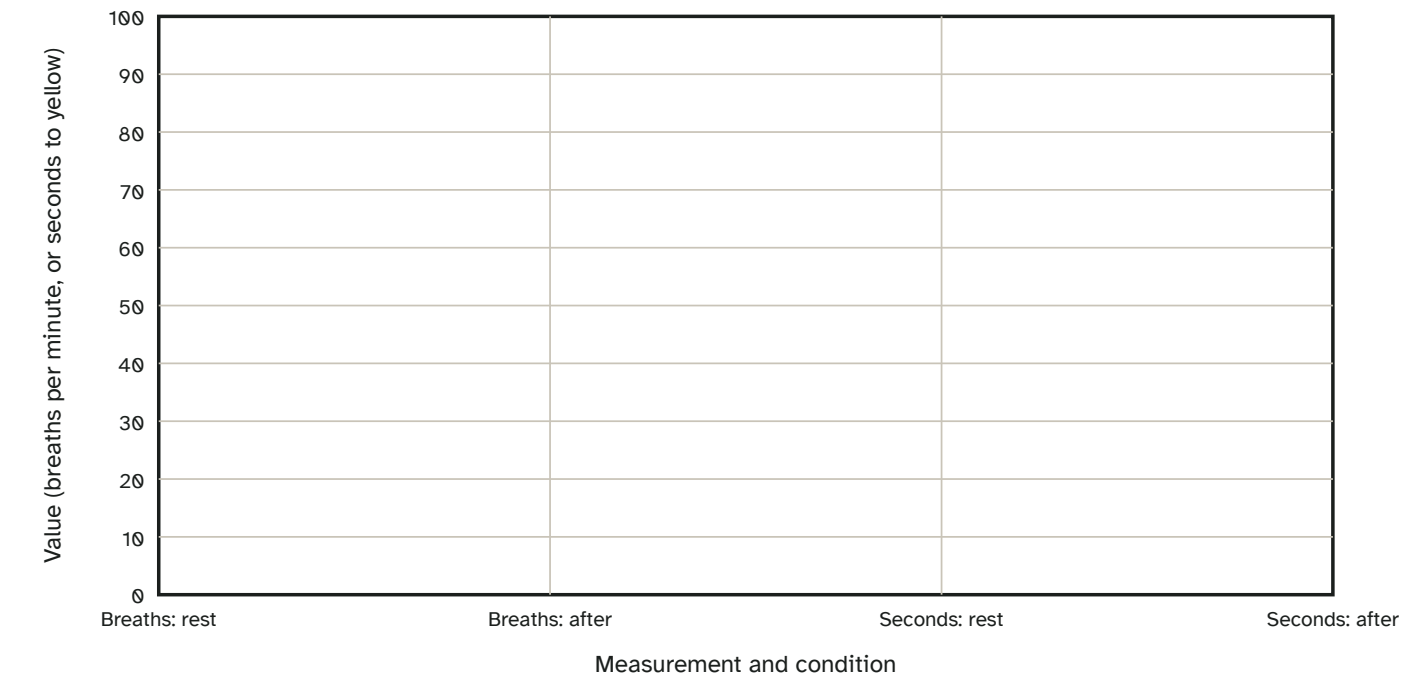
Our Mover's data

Measurement	At rest	Immediately after 2 minutes of activity	3 minutes after activity	Change (after minus rest)
Breaths per minute, count 1				
Breaths per minute, count 2				
Breaths per minute, average				
Seconds to turn 20 mL of indicator yellow				
Activity done and pace				

Class pooled data (copy from the board)

Mover (group letter)	Breaths per minute at rest	Breaths per minute after	Seconds to yellow at rest	Seconds to yellow after
A				
B				
C				
D				
E				
F				
G				
H				
Class average				

Class averages: rest versus after activity



1. Describe what happened to each of the two measurements after the activity, using your Mover's numbers and the class averages.
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2. Why did the procedure take two breath counts at rest and not tell the Mover when counting started? What could go wrong without those steps?

Analysis questions

3. Fewer seconds to turn the indicator yellow means more carbon dioxide arrived in the cup per second. Where in the body was that extra carbon dioxide made, and from what? Use the word equation for cellular respiration in your answer.

4. Explain the chain of cause and effect from 'muscle cells need more energy' to 'the Mover breathes faster'. Put at least four steps in order.

5. Breathing changed, but breathing is not cellular respiration. Using this lab, explain the difference between the two and how one serves the other.

6. Compute the class average change in breaths per minute (after minus rest) and the class average change in seconds to yellow. Then say whether every Mover showed the same direction of change, and what it would mean if one did not.

7. The Mover's breathing was still above rest three minutes after stopping. Explain why the body does not return to normal the instant the muscles stop working.

8. A faster indicator change after exercise could be because each breath carries more carbon dioxide, because the Mover blew harder, or both. Which of these did the procedure try to control, and how? Suggest one improvement to the design.
