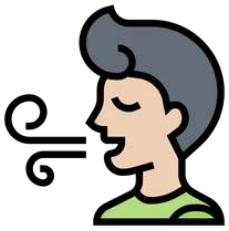
CO2



Breathe: Exploring the Human Respiratory System

Overview

You breathe about 20,000 times every day — without even thinking about it. But what actually changes when you exercise? What happens inside your body when you hold your breath? Today, you won't just talk about breathing — you will see real data from your own body using databot.

Grades: Middle School
Time: 45 Minutes
Subject: Life Science
Topics: Respiratory System, O2, CO2, Homeostasis, Effects of exercise on breathing

Background

Oxygen is necessary for cells to release energy from food through a process called cellular respiration. During this process, carbon dioxide is produced as a waste gas.

Air travels through:

- Nose or mouth
- Trachea
- Bronchial tubes
- Bronchioles
- Alveoli

In the alveoli, oxygen moves into the bloodstream and carbon dioxide moves out.

When you exercise:

- Muscles need more energy
- Cells use more oxygen
- Cells produce more carbon dioxide

Your body responds by increasing breathing rate and depth. This automatic adjustment helps maintain homeostasis — a stable internal balance of gases in the body.

What You Will Need/Prep

- databot
- IOS/Android Smart Device
- Plastic bag – 1 quart size, ziplock preferred!
- Drinking straw
- Install Vizeey™ on your Smart device.
- Scan the QR code to load the experiment.
- Test your databot™ connection.
- You will be prompted to select and connect to databot™ each time you launch an experiment.
- If there are two or more databot™'s listed, the one closest to your device will be highlighted.
- Study the background information and terms and prepare to explore!

CO2

In this lab, you will measure the carbon dioxide (CO_2) in your breath using databot™. You will discover how your body responds to exercise and how your respiratory system works to keep you alive and balanced.

Learning Objectives

In this investigation you will master the following knowledge and skills:

- Visualize, collect and analyze data
- Measure and record CO_2 levels in ppm.
- Understand that the human respiratory system is one system of many in the human body, and it is responsible for breathing!
- Compare CO_2 levels at rest and after exercise
- Explain why CO_2 levels change
- Connect breathing changes to cellular energy needs

Important Terms

Alveoli: Tiny air sacs in your lungs that facilitate the exchange of oxygen into your bloodstream and carbon dioxide out of it.

Bronchial Tubes: Branch off your trachea and carry the air you inhale into your lungs.

Bronchiole: Smaller passages off your bronchial tubes that lead to the tiny air sacs known as alveoli where gas exchange takes place.

Carbon Dioxide (CO_2): A colorless, odorless gas naturally present in the air you breathe. A waste gas produced during cellular respiration, which is absorbed by plants in photosynthesis.

Homeostasis: Your body's systems and processes that help maintain a balance of things like your oxygen and CO2 levels.

Parts per million - (ppm): Usually describes the concentration of something in air, water or soil. The term ppm expresses the number of units (part) of a given substance that exists as a portion of a greater substance comprised of one million parts.

Respiration: Facilitates the production of energy in the body through the process of breathing in oxygen and expelling carbon dioxide.

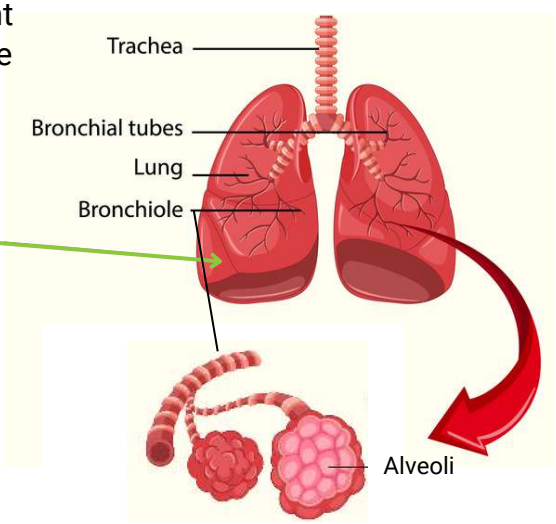
Respiratory System: your lungs, airway, and associated muscles, are responsible for breathing – taking in oxygen and expelling carbon dioxide.

Trachea, or windpipe: A large tube that conveys air to and from your lungs. It is an important part of your respiratory system.

CO2

Look for these important terms that identify important parts of your respiratory system on the diagram to the right. Trace their location on your own body. You are about to give your respiratory system a workout – good luck!

- Alveoli
- Bronchial tubes (Bronchi)
- Bronchioles
- Lungs (Right and Left)
- Trachea

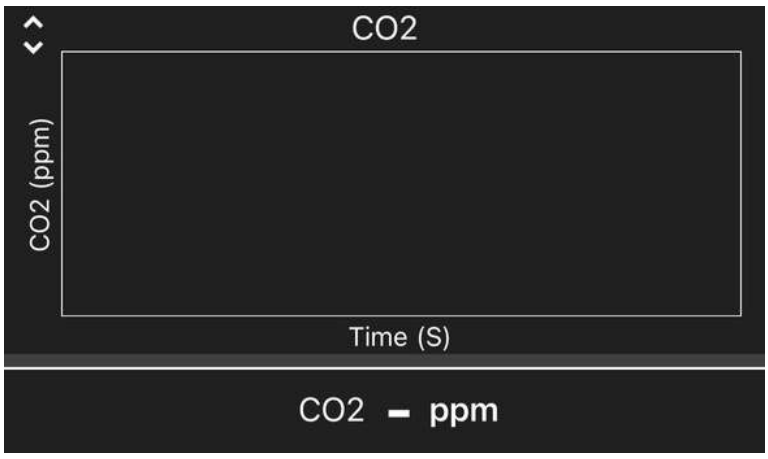


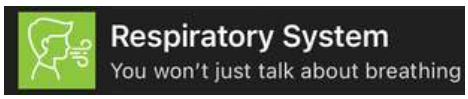
Using Vizeey

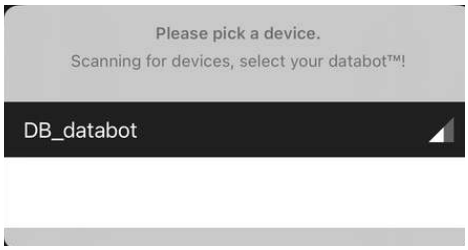
In order to work with the experiment you need to launch Vizeey application and click on + in the upper right corner.

Then select “Add experiment from QR code” and scan the QR code prepared for this experiment. Your experiment will appear in the list.

When you start the experiment you will be immediately offered to connect to your databot. Make sure that databot is enabled.







CO2

Part 1: Initial Observations and Questions

Why do you breathe faster when you run? Write your thoughts below.

Do you think you produce more CO_2 when resting or exercising?

What do you think will happen to CO_2 levels after holding your breath?

Part 2: Hypothesis

Predict how exercise will affect CO_2 levels.
Write your prediction below.

Part 3: Experiment Procedure

Before starting the experiment:

- Prepare databot, plastic bag, and a straw.
- Make sure your databot is fully charged.
- Turn on your charged databot™
  (using the small button on the left side) and place it in your ziplock bag.
- Zip the bag closed except for a small space for a straw.
- Open the Vizeey™ app on your smart device and click on the **Breathe** experiment
  - To start and to pause the experiment use:

Prepare to hop around a bit so you can test your CO2 level before and after exercise!

Part 3: Experiment Procedure

Activity 1: CO_2 at Rest vs. Exercise

- Measure CO_2 at Rest
  - Start your experiment with button ▶
  - Exhale gently into the bag through the straw, the bag will inflate and air will leak out around the straw which is fine.
  - Write down the highest level displayed by databot™ in the “Before” space into the table below.
- Exercise
  - Now exercise for two full minutes doing jumping jacks, running in place, hopping, etc. to get your heart rate up. Work as hard as you can and think about your breathing. Stop after two minutes.
  - Clear your data using 🗑 and start fresh measurements. Now breathe again into the bag with databot.
  - Write down the new value and calculate any change.
- Repeat for 3 trials.

Data Collection Table: CO_2 at Rest vs. Exercise

Trial	CO_2 Before (ppm)	CO_2 After Exercise (ppm)	Net Change
1			
2			
3			
Average			

Activity 2: Holding Your Breath

- Measure CO_2 at Rest and write down the highest level displayed in the “Before” space.
- Hold breath for 30 seconds (or comfortable time).

Safety:

  - Stop immediately if dizzy.
  - Do not compete for longest breath.
  - Sit down during breath-holding test.
- Clear your data and start fresh measurements.

Part 3: Experiment Procedure

- Breathe again into the bag with databot. Write down the new value and calculate any change.
- Repeat the experiment twice more and record the values.

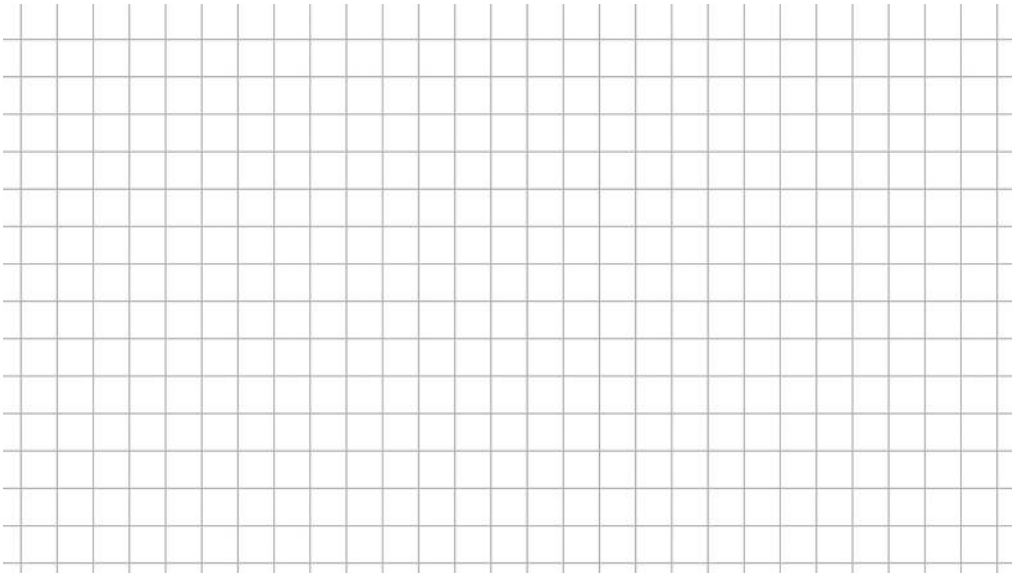
Data Collection Table: CO_2 and Breath Holding

Trial	CO_2 Before (ppm)	CO_2 After Holding (ppm)	Net Change
1			
2			
3			
Average			

Part 4: Data Analysis

Now that you have collected your data, it is time to analyze your results.

- Create a bar graph to visually compare your results:
  - X-axis: Condition - Resting CO_2, Post-exercise CO_2, Post-breath-holding CO_2;
  - Y-axis: Maximum CO_2 (ppm)



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Part 4: Data Analysis

- Did CO_2 increase after exercise?

- Which caused a greater change: exercise or breath-holding?

- Why does exercise increase CO_2 production?

- How does your body maintain homeostasis?

Part 5: Concept Questions

1. Why is carbon dioxide considered a waste product?

2. Why does your breathing rate change automatically?

3. How does this lab demonstrate that the body is a system of interacting parts?

Part 6: Reflection

1. What surprised you about your results?

2. Did the data match your prediction?