Lung Capacity

By Kay Holmes

Grade Level:
This was taught at the 3rd grade level, but would be appropriate for the 4-7 grade levels with adjustments made according to students' previous knowledge and skill level.

Introduction:
This lesson is part of a greater unit covering the organs of the human body and how they all work together.

Theme:
Inside the human body

Focus:
This lesson focuses on the respiratory system and related experiments.

Concepts:

A. To learn how our bodies get oxygen.
B. To learn how to design and conduct an experiment.

Alaska Science Standards:
B1), A9), A10)

Time required:
5-6 days (one to one and a half hour segments)

Materials:

- ✓ clear plastic (produce-type) bags
- ✓ "Thinking Like A Scientist" poster
- ✓ handouts (see attached)
- ✓ clear gallon jug (measured in 200 milliliter increments from bottom of jug)
- ✓ clear flexible tubing (about 5 mm in diameter)
- ✓ small funnels (tubing must be able to fit in pointed part of funnel)
- ✓ dishpans or tubs
- ✓ water
- ✓ sink
- ✓ pencils
- ✓ towels

DAY 1

Gear-Up:

Demonstrate the activity "In the Bag" in Blood and Guts (page 65.) Ask students to observe rate of breathing, any facial changes and count number of inhales. Preface demo with warning about the hazards of plastic bags and young children. This Gear-Up activity demonstrates the necessity of having fresh oxygen available every minute of our lives.

- ✓ Using clear plastic (produce type) bag, blow in to bag.
- ✓ Form snug seal over nose/mouth with fingers.
- ✓ Continue to use same breath of air till uncomfortable to do so.
- ✓ Ask students to observe and count breaths.
- ✓ Ask students to record number of breaths and their observations.

Explore:

Have students perform same activity with partner. Have students end this activity on an exhale and seal up the air in the bag. One student blows while the other records on *"How we get oxygen"* handout. Students should switch.

Questions to ask:

1. What is in the bag after breathing in and out of it, besides air? What is your evidence (moisture drops on side of bag?)
2. What can we infer about what is in the air remaining in the bag after we could no longer breathe from it?
3. What is the temperature of the exhaled air? Warmer, cooler or same as room air temperature?
4. Is the air we breathe in the same as the air we breathe out? How do we know?

Explore process skills:

Observing, Inferring, Predicting, Measuring, Experimenting, Collecting data, Estimating, Interpreting results, Communicating, Graphing, Drawing conclusions

Generalize:

Questions for Discussion:

1. Why do we need fresh oxygen? (Use analogy of fire to explain how cells use oxygen to burn the fuel/nutrients to do work.)
2. How do our bodies get fresh oxygen? (Key organ: Lungs. Also discuss the function of rib cage and diaphragm.)
3. How can we measure lung capacity? How do scientists measure volume? (Liters/milliliters for fluid volume.)
4. What are some of the things that might affect lung capacity and ability to get that oxygen? Brainstorm ideas.
5. Tell students that they will help to design a test to see how one of these factors might affect lung capacity.
6. After discussing the impracticality of having some of the group smoke cigarettes or getting sick, have students vote on what they want to test. *(Students in my class chose to see how exercise affected their lung capacity.)*

7. Introduce "**How to think like a scientist"** poster which introduces the scientific method in a simplified four-step format. This poster was adapted from the article, "*Blow-by-Blow Inquiry*" by Cathy Wittrock and Lloyd Barrow in Science and Children (vol. 37, no. 5):

Pose the question: What do you want to find out?

- ✓ Direct students to do an experiment.
- ✓ Ask them to think of an experiment or test that will answer their question.
- ✓ Ask them to record their data.
- ✓ Ask them to write down their measurements or observations as they do the test.
- ✓ Encourage students to think, write and share.
- ✓ Ask students to think about any patterns that their data might show.
- ✓ Ask students to decide whether or not their experiment answered their question and if they have come to some kind of conclusion.
- ✓ Ask students to write down their conclusion and share.

Apply/Assess:

Questions for Discussion:

1. How can we maximize our lung capacity and keep our respiratory system healthy?
2. What are activities/circumstances that we should avoid to maximize lung capacity (don't smoke or breathe second hand smoke, avoid polluted air, exercise regularly.)
3. Read aloud *pre-assessment handout* and have kids fill in independently.

DAY 2

Review:

- ✓ role of lungs in respiratory system
- ✓ key organs involved in circulatory system and digestive system
- ✓ steps in "Thinking like a scientist" poster
- ✓ the class decision to explore how exercise affects lung capacity

Experiment:

Use "Lung Capacity Experiment" handout.

1. Have students decide whether they think that exercising will increase, decrease or not change lung capacity, and ask students to record their prediction on experiment form.
2. Discuss how class can develop a fair test.
3. Determine what kind of exercise and how long students will do it. (In my class, students chose to do jumping jacks and run in place for 5 minutes. This was later changed to 4 minutes when I brought up need to speed things along and said that if students really worked out, this would be long enough. Originally, some students thought they should exercise for 10-20 minutes. When it came to the actual experiment, even 4 minutes was a long time for some students.)
4. Discuss what would happen if there was lag time between the exercise and the measurement. Would this be a fair test?

Lung Capacity Measurement Procedure:

These steps are adapted from Blood and Guts, page 64.

1. You will need a gallon jug, a funnel with a notch or slit in it at wide end, a rubber hose, and a large tub or sink to set the device in.
2. Starting from the bottom of the jug, measure the jug in 200 ml increments. Mark with permanent marker.
3. Fill jug with water. Fill tub so there is enough to cover the funnel. Invert funnel (wide end down) in bottom of tub. Position hose so one end is coming out the pointed end of funnel and other end is free of the tub. The hose will be held in place by the notch or slit in funnel.
4. Holding hand over the mouth of the jug to keep all water in, invert and place over inverted funnel.
5. Exhale into hose to displace water and read the volume of air in the jug.

Data Collection Procedure:

1. Define "volume" and how to measure volume using metric units (the liter and milliliter.)
2. Hand out calibrated beakers for students to see and fill using _, _ and 1 cup measuring cups. (This group of third graders had been measuring distances using metric units but had not been introduced to volume measurements; so we had to spend some time discussing this concept.)
3. Use poster or overhead projector to show students how to read the measurements (presented in 200 ml increments,) and how to estimate values that fall in between the lines.

Demonstration Procedure:

Select smallest and largest student from the class and have them blow into the filled containers to show students how to get some measurements of lung capacity. (My students discussed how to make the test a fair one. They decided to take three deep breaths and then blow. We also discussed importance of not taking any additional breaths… "Only one blow per customer.")

Day 3

Collect and Record Data:

1. Conduct experiment with small groups of students. (My class had enough materials to have two sets of jugs and tubs so we did four students at a time. It took at least 30 minutes for a group of four to take their "before exercise" lung capacity measurements and "after 4 minutes of exercise" measurements. We only got through 8 students in the hour of time we had allotted.)
2. Ask students to record "before" and "after" measurements on their experiment report forms.

Day 4

Collect and Record Data:

Continue with remaining groups in collecting data.

Day 5

Interpreting results:

1. Ask students if they recall steps in "Thinking like a scientist."
2. Record their answers on the board and put up poster and compare how much they remembered (interpreting results.)

Group discussion:

Relate the parts of our experiment to the steps on the poster.

- ✓ Did we follow all of the steps?
- ✓ Are we done with the experiment after collecting all the data?
- ✓ What do we do with it now?

Hand out graph paper. Since my students had just been introduced to graphs, I simplified things by drawing the x and y axis on their graphs and included lines for a title and additional labels for the axes. I demonstrated on an overhead projector while students labeled the title and axes of their individual graphs and wrote up a key for the terms "before exercise" and "after exercise."

List student results on board. After each student reports their "before" and "after" capacities, ask the class if the measurements increase or decreased after exercise. Record individual results in a bar graph. Students write measurements on the "before" bar with one color marker and on the "after" bar using another color.

Questions/Discussion:

1. What do all these numbers mean? Can we see any patterns?
2. Can we decide, based on the evidence provided by our data, whether exercise affects lung capacity? (All my students but one had their lung capacity decrease after exercise.)
3. Calculate percentage. (My students decided there was enough evidence to come to a conclusion.)
4. Pose the following questions:
5. "What if half the students had greater, and half had less, lung capacity after exercising?
6. Discuss the fact that scientists don't always get clear-cut results and have to try figure out if their results answer their question?. (It would be appropriate to discuss with older students the use of statistics to help determine significance of findings and the importance of sample size.)

Apply/Assess:

- ✓ Can students think of another question about the human body that they could design an experiment for?
- ✓ Why is it important that the tests be fair? (Discuss importance of accurate testing for medical and drug treatments and possible dangers which could result from inaccurate or poorly designed tests.)
- ✓ Have students fill out a *self-assessment form.*
- ✓ Use scoring guide (rubric) to score experiment forms and bar graphs.

Extensions:

Design an experiment that would look at how your heart rate (Circulatory System) is affected by exercise.

- Do "starch and spit" test in Blood and Guts *(*Allison, 1976*,* page 78) for an experiment related to digestive system.
- Look at cheek cells under microscope (prepared slide of blood smear.)
- Read Cells are Us *(*Balkwill, 1990*.)*
- Read Magic School Bus Inside the Human Body *(*Cole,1989*.)*
- Make life-size silhouettes of students and place body organ cut-outs in appropriate places.

LEARNING ABOUT LUNGS: HOW WE GET OXYGEN

Name: _____ Date: _____

1. How long do you think you could go without fresh air? _____ (Will you use minutes, hours or days for your units?)

2. Circle the name of the system that humans use to supply our bodies with fresh oxygen?

a. Circulatory system

b. Respiratory system

c. Digestive system

3. What do you think are some things that might affect how big a breath you can take?

4. Every living cell in our body needs two things besides water to survive and do its work. Name these two critical things:

a._____
b._____

5. _____ come from the foods we eat.

6. _____ comes from the air we breathe.

7. The main organ I use to get fresh oxygen is my _____.

LUNG CAPACITY EXPERIMENT FORM

Name: _____ Date: _____

What is our question?

How does lung capacity change after activity?

Prediction (what do I think we will find?):

I think that lung capacity will _____ after intense activity.

Materials (the stuff we need to do the test):

- ✓ Clear gallon jug, measured in milliliters
- ✓ Hose
- ✓ Funnel
- ✓ Tub
- ✓ Water
- ✓ Pencil and paper to record data

Procedure (what we will do to find out):

See Blood and Guts, page 64 for description.

Data (the results, or measurements that we record):

_____
_____
_____
_____
_____

Conclusion (what I learned from doing this experiment):

I learned that: _____
_____
_____

LUNG CAPACITY EXPERIMENT REPORT FORM

Name: _____ Date: _____

Fill in as we do the activity:

1. How many times was I able to use the same breath of air in my bag before I was uncomfortable? _____

2. How did my rate of breathing change as I used the same air over and over? *Circle one:*

It stayed the same It got faster It got slower

3. Is there anything else in your bag besides air? If yes, what do you think it is? _____

4. How does the used air in the bag feel? *Circle one:*

Warm Cool Room temperature

Self-Assessment Form

WHAT I LEARNED FROM THE LUNG CAPACITY EXPERIMENT

Name _____ Date: _____

Name *two* things you learned in our lessons about the lungs and lung capacity *(Use complete sentences!):*

1._____

_____

2._____

_____

Draw a line from each of the following systems to an important organ that helps it do its work:

1. Circulatory System	lungs
2. Respiratory System	stomach and intestines
3. Digestive System	heart

We can compare how our cells use oxygen and nutrients with what process? *(circle one):*

1. An avalanche
2. A tornado
3. A fire

Scientists using the metric system use this unit to measure volume or how much space something takes up *(circle one):*

1. milliliters (ml) or liters (l)
2. centimeters (cm) or meters (m)
3. grams (g)

The first step in "Thinking like a scientist" is to *(circle one):*

1. do an experiment
2. collect data
3. ask a question

One definition of *"data"* is *(circle one):*

1. the **conclusion** a scientist makes after doing an experiment
2. the **bits of information** a scientist records
3. the **materials** needed for an experiment

Scoring Rubric for Lung Capacity Lesson

Activity	Needs Improvement	Satisfactory	Well-Done
Class Participation in group/oral discussions	No involvement. Asks no questions. Any responses to teacher questions are off topic. Clearly lacks understanding of material being covered.	Asks questions or responds to teacher questions. Answers not always clearly related to topic. Understanding not clearly evident.	Actively engaged in discussions. Asks questions and responds to teacher questions with answers that are clearly related to topic and show understanding of material covered.
Experiment participation	Does not follow directions or stay on task in carrying out experiment. Data not useable.	Able to follow most directions and steps in carrying out experiment. Data useable.	Follows directions from set-up through recording of data and clean-up. Is helpful and offers assistance to other students.
Filling out experiment report form	Leaves one or more blanks in experiment report form. Conclusion not consistent with class data.	Leaves no blanks but data incorrectly recorded or not labeled with units. Conclusion not written as a complete sentence.	All blanks filled in. Data correctly recorded and units labeled. Conclusion consistent with class data and in complete sentence form.
Bar Graph completion	Title incomplete or missing. One or both axes incorrectly labeled. Missing data or points incorrectly plotted on graph.	One or two minor parts (labels) incomplete. No missing data. One or two points may be incorrectly plotted.	Title complete. All labels correct and complete. Data for all students correctly recorded. Attempts have been made to correct any errors.
Final Assessment	Misses more than three questions. One of the sentences contains incorrect information.	Misses 2 or 3 questions. No incorrect information in sentences.	Misses no more than one question on final test.