Overview:

This hands-on experiment is designed to show students how smoking can affect the lungs. A supporting lesson plan is included on the back cover.

Balloons of the same size, but with different elasticity, will model both healthy and damaged lungs. A single balloon, which is easier to fill with air, represents healthy lungs in which the alveoli (tiny air sacs in the lungs) are soft and pliable and can easily expand and contract to bring in air. A less elastic balloon, which is two balloons doubled up, is harder to fill and represents a smoker’s lungs. Smoking damages the elasticity of the alveoli tissue, leading to breathing difficulty known as emphysema. Smoking also causes chronic bronchitis, or swelling of the bronchial lining. This reduces the amount of air that flows into the lungs, which students will simulate in the experiment as well.

By comparing the balloons, students will see how less air fills the damaged lungs, analogous to the decreased air capacity that people who smoke experience.

TIME REQUIRED: Two 50-minute classes or one 90-minute class

SUMMARY OF PROCEDURE:
Step 1. Students will determine the volume of air that can be held in representations of a healthy lung and an unhealthy lung.

Step 2. Students will create a model comparing a healthy lung with a less elastic lung (emphysema) and simulate narrowed bronchial tubes (chronic bronchitis).

TEACHER SETUP:
• Collect the materials listed on the right, including gathering or instructing students to bring in plastic bottles. Cut off the bottom of each bottle before class time (use of a box cutter is recommended).

• Optional: Bring three additional balloons per student beyond what was provided in the kit. This will enable each individual student to enact Step 1 of the experiment (otherwise, one volunteer from each group will blow up the balloons).

• Reproduce the student directions on the inside for each student group.

LESSON: See back cover.

MATERIALS:
Each teacher’s kit includes materials for up to six small groups of five students.

Enclosed Materials
• 25 balloons (4 per group)
• 15 straws (2 per group)
• ½ lb. clay (chunk per group)

Materials Teacher Must Gather—Per Group
• Flexible tape measure, e.g., cloth
• Clear plastic container that resembles a one-liter soda bottle with the bottom cut off and the label removed. Make sure the plastic is thin enough to be able to be squeezed and constricted.
• Scissors
• Wide adhesive tape, such as masking tape
• Recommended: box cutter (for teacher only)
• Optional: additional balloons, three per student, for each student to use during Step 1

Accompanying Lessons, Worksheets, and Magazine: scholastic.com/get_smart_about_tobacco
HOW TO CONDUCT THE LUNG EXPERIMENT

Getting Started: Read all directions before beginning the experiment.

**Part 1**
You will use balloons to set up representations of a healthy lung and an unhealthy lung. Then, using mathematical formulas, you'll compare the volume of air each balloon holds.

1.1 “Healthy” elastic lung = **one balloon**

One volunteer from each group will blow up one balloon as big as possible in one large breath for four seconds. An additional volunteer can keep track of time.

Hold the balloon closed tightly while another volunteer uses a tape measure to find and write down its circumference.

1.2 “Unhealthy” less elastic lung = **two balloons**

Tobacco causes lung tissue to become less stretchy. To create a less elastic balloon, one volunteer should use both index fingers to widen the neck of one balloon so that another volunteer can insert a second balloon. The neck of the inner balloon should be inside the neck of the outer balloon so air can still enter the inner balloon.

Using this double balloon, repeat the process of blowing up the balloon for four seconds as well as measuring and recording its circumference.

1.3 Estimate the volume

Using a separate sheet of paper, estimate the volumes of air inside the “healthy” balloon and the “unhealthy” balloon. Assume they are spheres, and use the math formulas provided.

**FORMULA BANK**

Circumference = $2\pi r$

Volume of a sphere = $(4/3)\pi r^3$

**Note:** $\pi$ can be approximated with 3.14.

**THINK IT THROUGH:** How does the amount of air held in the less elastic “unhealthy” balloon lung compare to the air in the elastic “healthy” balloon lung? Why might this be?
2.1 Building the Lung Model

Use straws to represent the bronchial tubes through which air enters the lungs. Insert straws into the neck of both the “healthy” and “unhealthy” balloons. Squeeze the balloons to remove any extra air. Then, tape the balloon’s neck to the straw to create an airtight seal.

Using clay to make another airtight seal, attach the straws inside the neck of the clear plastic bottle. Be sure to cover the narrow space between the two straws with clay. The top of the straws will be open to the air above the bottle, and the balloons will hang inside the bottle.

To cover the bottle’s open bottom, cut off the top half of a balloon and knot the bottom tail. Then, while one volunteer holds the balloon bottom piece over the bottle, another volunteer should cover the edges with tape to make it airtight. While taping, squeeze the bottle to remove extra air.

2.2 Narrowing the Bronchial Tubes

Narrow the straw connected to the less elastic (double) balloon to simulate narrowed bronchial tubes in the lungs. You can use one or both of the following methods:

Option 1. Pinch the straw protruding from the less elastic balloon.

Option 2. Use clay to narrow the straw protruding from the less elastic balloon.

(The effect will be more noticeable if the straw is almost completely blocked.)

While one volunteer narrows the straw, push and pull the bottom balloon knot in and out to represent the movement of the diaphragm in the human body. The push/pull motion causes air to flow in and out of the balloons in the same way the lungs inflate and deflate as a person breathes.

THINK IT THROUGH: Observe and describe the inflation of the “healthy” versus “unhealthy” balloons. Compare and contrast the balloon models in terms of healthy human lungs versus lungs that have been damaged by tobacco smoke.
Objective: Students will create a model of the human lung that shows how tobacco smoke can impact lung function.

Skills Covered: Health; Developing and Using Models; Planning and Conducting Experiments; Critical Thinking

Lesson Plan: Before completing the activity, ask students:

1. How does smoking affect a person’s lungs? (The chemicals in tobacco smoke damage the tissues in lungs, which makes it difficult to breathe and may cause cancer.)

2. Describe how your body breathes air in and out. (Your diaphragm moves down, causing your lungs to inflate and draw in air through the bronchial tubes. When your diaphragm pushes up, it pushes air back out.)

3. How do you think smoking might affect how your lungs inflate and deflate? (Answers will vary but may include that smoking might make it harder for lungs to inflate and deflate.)

Hand out the enclosed materials and instructions and have students complete the hands-on activity. After everyone has finished, reconvene as a class and discuss the results.

Key Concepts: Healthy lungs have tiny air sacs called alveoli, which are soft and pliable. The alveoli can easily expand and contract to bring in air. Smoking hardens the alveoli tissue. This makes it difficult for the alveoli to expand and contract, making it harder to breathe. Smoking also inflames the bronchial tubes. When this happens, less air enters the lungs with each breath.

Critical-Thinking Questions: How were the two different balloons you used in the experiment analogous to the lung of a smoker and a healthy lung? Explain. (The less elastic balloon was more difficult to inflate, which is analogous to a smoker’s lung. The balloon was less flexible, similar to how the alveoli in the lungs of a smoker become less flexible and can’t hold as much air. The regular balloon was flexible and held more air.) Why is it important for lung tissue to stay flexible? (Lungs take in air by expanding and contracting. If someone’s lungs can’t flexibly expand all the way, a person won’t get enough air and will feel sick.)

VOCABULARY*

alveoli (noun): small air sacs in the lungs through which gases from the air move into and out of the bloodstream

> singular alveolus

analogous (adjective): similar

> related word analogy

approximate (verb): to estimate or to calculate the almost exact value

bronchial tube (noun): a tube that carries air from the windpipe (air tube in the throat) to the lungs

bronchitis (noun): a disease in which the bronchial tubes become inflamed (swollen) and produce too much mucus

chronic (adjective): occurring for a long time or occurring again and again

circumference (noun): the external boundary of a circle

contract (verb): to become smaller

diaphragm (noun): a muscle that separates the chest cavity from the abdomen

emphysema (noun): a disease in which the alveoli in the lungs break down and become less elastic, making it difficult to breathe

inflame (verb): to become affected by inflammation, in which damaged body tissues become swollen, red, and painful

volume (noun): the amount of space filled by an object

SUPPORT FOR HIGHER STANDARDS:

National Health Education Standards
1: Students will comprehend concepts related to health promotion and disease prevention to enhance health

Next Generation Science Standards (NGSS):
Investigations; Models; LS1.A: Structure and function

National Science Education Standards (NSES):
Personal health; Evidence, models, and explanation; Change, constancy, and measurement; Structure and function in living systems

Common Core Standards for Math
6.EE.B: One-variable equations and inequalities
7.EE.B: Real-life problems using algebraic expressions
MP.1: Problem solving
MP.4: Model with mathematics
MP.5: Use appropriate tools

Common Core Standards for Literacy in Science
RST.3: Follow a multistep procedure for experiments
RST.4: Determine the meaning of domain-specific words
RST.9: Compare information from experiments and texts

*Vocabulary sourced or adapted from The American Heritage Children’s Science Dictionary and Merriam-Webster.