As I Live and Breathe

Air & Waste Management Association

Objectives

Students will do the following:

1. Name some ways that people use air
2. Referring to the list generated by the first objective, describe how dirty air might affect the ways that people use air
3. Describe human respiration
4. Explain that all living things need air and that the air exchanged between plants and animals is needed by each to survive

Topics:
How air quality may affect our health and quality of life.

Time:
2-4 class periods

Subjects:
Science, math, art, language arts, health

Materials:
Construction paper
A variety of magazines with lots of pictures
Scissors
Glue or glue sticks
Gallon jug with a small opening
Sink or large pan
Flexible tubing (36 in./1 m)
Plastic straws (one per student)
Measuring cup
Water
Masking tape
Pondweed
Glass bowl
Glass jar that will fit in bowl
Clean glass chimney from a kerosene lamp
One-hole rubber stopper to fit the top opening of the chimney
Glass or plastic tube to go through the hole of the stopper
Small rubber balloon
Two rubber bands
Bottom of large rubber balloon
OPTIONAL: See extension suggestions

Background Information

Air is important to us for many reasons. Of foremost importance to humans and animals is the fact that air carries the oxygen we need to live. Air also makes fire possible, which provides us with heat, light, and energy. Other uses of air make our lives easier or more pleasant. For example, air makes it possible to sail sailboats, fly kites, fly aircraft, and use windmills. It is also used to dry clothes and inflate tires and balloons.

Clean air, which is composed of nitrogen, oxygen, and other gases, is healthy for us to breathe. However, air — both indoor air and outdoor air—can become polluted; that is, contaminated with particles and gases that are not part of its natural composition, making the air dirty and unhealthy. Air can also become imbalanced and unhealthy with excessive amounts of gases that are part of its natural composition. Because we sometimes see and smell smog, odors, smoke, and other evidence of air pollution when we're outdoors, we often associate pollution only with outdoor air. Indoor air, however, may be dirtier and more polluted than the outdoor air.

The earth's atmosphere is a mixture of water vapor and many different gases: nitrogen, oxygen, argon, carbon dioxide, and others. Two of these gases, oxygen (O_2) and carbon dioxide (CO_2), are involved in a cycle that is critical to all living things on the planet.

For humans and animals, oxygen molecules (which are made up of two oxygen atoms bonded together) are an essential ingredient in the cellular chemistry that provides energy for growing and carrying on life's

activities. All animals and humans have mechanisms for getting oxygen from the ambient air into their body cells, where it is needed to sustain life. One of the by-products of the cellular chemistry is carbon dioxide (a molecule composed of two oxygen atoms and one carbon atom), which is sent out of the body and released into the atmosphere.

Carbon dioxide, as it turns out, is essential for the survival of green plants. Plants actually "breathe" through their leaves, taking in the air around them, most importantly carbon dioxide and water vapor. In the process of photosynthesis, carbon dioxide molecules are broken down, freeing the carbon atoms to become building blocks in molecules necessary for life. As by-products of photosynthesis, oxygen molecules are released into the atmosphere, where they are available for human and animal uptake. Through this process, humans, animals, and plants are involved in a mutually beneficial recycling of atmospheric gases.

Many people think that the air coming into our lungs forces the lungs to expand; that the air comes in and pushes the lungs open. Actually, the opposite is true—our chest cavity expands, and that causes air to enter our lungs. Air, which always moves from an area of higher pressure to one of lower pressure, enters our lungs because of unequal pressure. When we take a breath, the muscles attached to our ribs contract, pulling the ribs up and outward, and the thin sheet of muscle between our chest and abdomen (the diaphragm) tightens and pulls downward. This makes the chest cavity larger, which reduces the air pressure inside the lungs. Because the outside air is at a higher pressure, that air flows into the lungs. The opposite happens when we breathe out. (See overhead-transparency master.)

When we inhale, we take in air that contains about 21% oxygen and 0.03% carbon dioxide (the rest of the air is mostly nitrogen). When we exhale, we expel air that contains about 5% carbon dioxide and only 15% oxygen (again, the rest is mostly nitrogen). Notice that the air that goes into our bodies contains only a trace amount of carbon dioxide and plenty of oxygen, but the air that is expelled from our bodies contains much more carbon dioxide and significantly less oxygen.

The body carefully regulates the oxygen-carbon dioxide exchange. This is an easier job when the air is clean and the lungs are healthy. If the air isn't clean, the body tries to get rid of the impurities entering the lungs. Much of the respiratory tract is lined with a thin layer of mucus and little hairlike projections called cilia. The sticky mucus traps impurities, and the cilia sweep them up and to the mouth and/or nasal regions. The impurities are then expelled from the respiratory tract by coughing, sneezing, or swallowing. If there are too many impurities in the air, or if the lungs are damaged, the body may not be able to get rid of all of the impurities. Also, some particles are so small that they escape the body's cleansing mechanisms or take a very long time to be removed from the lungs. When these impurities stay in the lungs, they can cause damage and interfere with normal respiration.

Green plants "breathe" differently. Plants use a lot of carbon dioxide to make food for themselves, and they give off oxygen as a waste product. Inside every leaf is a green-pigmented chemical known as chlorophyll. With the help of chlorophyll and a source of light (natural or artificial), a leaf converts carbon dioxide into a simple sugar. That process is called photosynthesis. Photosynthesis also causes large amounts of oxygen to be released into the air. The sugar is then converted to a starch and stored in various parts of the plant. Plant cells can also make proteins and vitamins. The plant uses these nutrients stored in its cells to keep itself alive. As the plant consumes (oxidizes) its food, it uses oxygen and gives off carbon dioxide, just as humans do. Fortunately for us, however, during photosynthesis a plant gives off a lot more oxygen than it uses.

Plants thrive only when their environment allows them to. Proper amounts of light, water, heat, and nutrients are critical to plant life. An unclean environment can adversely affect plant life, which can affect the amount of oxygen available in the air.

Procedure

I. Setting The Stage

A. This activity relates to Objective 1. This will increase students' awareness of the myriad ways in which we use air, some of which we may often take for granted.

Third-graders

You will need the following materials:

- ☐ Construction paper
- ☐ A variety of magazines with lots of pictures
- ☐ Scissors
- ☐ Glue

B. Ask the students (either as individuals or in small groups) to make collages showing ways in which we use air. Display the collages. Then begin a class discussion by having each student name one way in which we use air. List the students' ideas on the board or on a chart.

C. If you cannot find enough pictures of air in use, brainstorm with your students uses of air and list them on the board. Have the students create a mural of uses of clean air.

Fourth- and fifth-graders

"Name That Use" Game.

D. Divide the class into teams with 3-5 students on each team. Give each team a sheet of paper with the heading, "How We Use Air." Tell the students that when you say "go" they have 5 minutes to list all the ways they can think of that we use air. Collect the papers and tape them on the board. Have a member of each team be the "reader" who comes up and reads the team's list to the class. Count the number of uses listed by each team (do not count duplicates within a given team's list, nor any uses that aren't legitimate). The team with the most uses listed wins.

II. Activity. Dirty Air

A. This activity relates to Objective 2. Students will begin to think about how dirty air might affect their lives.

B. Using the list generated in Setting the Stage, have the students identify which of the uses might be adversely affected by dirty air.

III. Activity. The Air We Breathe

A. This activity relates to Objective 3. This activity will help students determine their lung capacities, which will help them understand the concept of human respiration. During the second part of this activity they will learn about human respiration and the exchange of oxygen and carbon dioxide between plants and animals.

Third-, fourth-, and fifth-graders

B. Have the students determine their vital lung capacity.

You will need the following items:

- ☐ Gallon jug with a small opening
- ☐ Sink or large pan
- ☐ Flexible tubing (36 in./1 m)
- ☐ Plastic straws (one per student)
- ☐ Measuring cup
- ☐ Water
- ☐ Masking tape

1. Put about 3 or 4 in. (8 to 10 cm) of water in the sink.

2. Place a strip of tape on the jug to represent a measurement scale, i.e., 60 ml, 120 ml, etc.

3. Fill the jug completely with water.

4. Cover the top of the jug, turn it over, and stand it upside down in the sink with the opening in the water. When you uncover the opening, no air should enter the jug.

5. Tip the jug slightly to the side and insert one end of the tube into the opening of the jug. Insert a straw into the other end. (Be sure to use a new straw for each student.)

6. Have your partner hold the bottle upright while you do steps 7 and 8.

7. Take a deep breath and blow through the tube, emptying the air from your lungs as completely as you can into the jug.

8. Mark the water level on the jug with a piece of tape.

9. Empty the jug, turn it right side up, and use the measuring cup to measure the amount of water required to fill the jug to your mark. This is the amount of air you blew into the jug. It is the vital capacity of your lungs. In addition, you have about 25 percent of residual or "dead" air still left in your lungs which you cannot expel.

10. Repeat the activity for your partner and others if they wish. **NOTE: MAKE SURE THAT EACH STUDENT HAS HIS/HER OWN STRAW (OR OWN PIECE OF FLEXIBLE TUBING) TO USE. FOR HEALTH REASONS, STUDENTS SHOULD NOT SHARE THE STRAWS.** Compare and compute the average lung capacity of those who participate.

C. Next, ask the students the following questions:

1. How does air first enter our bodies? (Through our noses and mouths.)

2. Where does the air go then? (Down the windpipe and into the lungs)

3. Are the lungs big, hollow sacs, like balloons? (Anticipated answer: Yes. Correct answer: No)

D. Using the master provided, make an overhead transparency, Human Respiratory System #1. Use it to explain where the air that we breathe goes, up to the point where it gets into the alveoli. (See background material.)

E. Now ask the students:

1. What do you think happens after the air gets into the air sacs? (Anticipated answer: Don't know)

Third- and fourth-graders

F. Using the master provided, make an overhead transparency, Human Respiratory System #2. Use it to explain that the oxygen from the air goes through walls of blood vessels in the air sacs and ends up in the blood. The blood takes the oxygen to other parts of the body where it is needed. Explain that carbon dioxide from the blood goes through the walls of the blood vessels and into the air sacs, and is then "breathed out" into the atmosphere.

Fifth-graders

G. Using the overhead transparency, Human Respiratory System #2, explain that the oxygen from the air goes through walls of blood vessels in the air sacs and ends up in the blood. The blood takes the oxygen to other parts of the body where it is needed. Explain that carbon dioxide from the blood goes through the walls of the blood vessels and into the air sacs, and is then "breathed out" into the atmosphere.

H. Then ask the students:

1. Which do you think is true: (a) Air goes into our lungs, which makes our lungs expand and the chest expand, or (b) First our chest cavity expands, and that makes air go into the lungs? (Anticipated answer: (a); correct answer: (b)).

I. Use the overhead transparency, Human Respiratory System #3, to explain why (b) is the correct answer.

J. Have students make "lung chimneys."

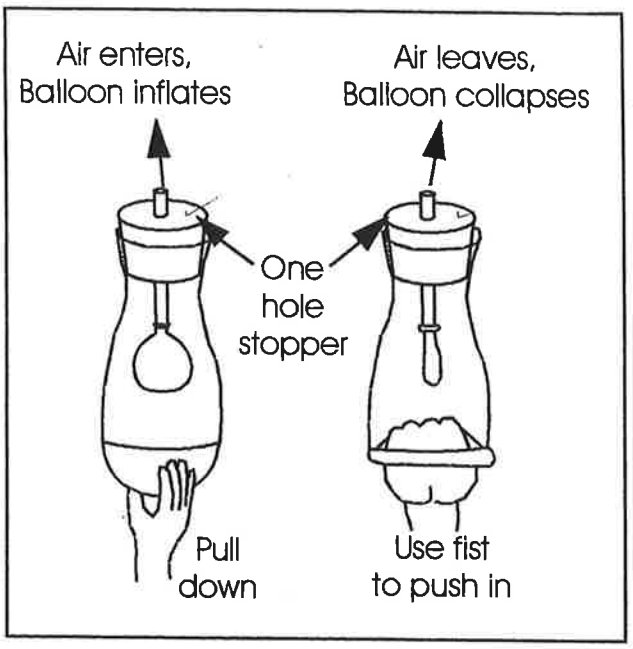
You will need the following materials:

- ☐ Clean glass chimney from a kerosene lamp or large clear plastic soda bottle
- ☐ One-hole rubber stopper to fit the top opening of the chimney
- ☐ Glass or plastic tube to go through the hole of the stopper
- ☐ Small rubber balloon
- ☐ Two rubber bands
- ☐ Bottom of large rubber balloon

1. The chimney represents the chest cavity, the balloon represents a lung, and the large piece of rubber represents the diaphragm.

2. Put the tube through the hole of the stopper and then put a balloon on the end of the tube. Secure it with a rubber band. Next, put the stopper in the top of the chimney (with the balloon inside the chimney). Stretch the large piece of balloon over the bottom of the chimney and secure it with a rubber band.

3. To demonstrate how lungs work, pull the large piece of rubber (which represents the diaphragm) downward. The air in the chimney (which represents the chest cavity) expands, reducing the air pressure in the chimney. Air from outside the chimney is forced in by outside air pressure, inflating the balloon (which represents the lungs).



4. Next, push the piece of rubber (diaphragm) upward with your fist. The air in the chimney (chest cavity) is compressed and contracts, increasing the air pressure in the chimney. Air is forced out of the chimney (chest cavity) through the glass tubing, causing the balloon (lung) to inflate.

5. Repeat this demonstration several times to simulate the steady action of inhaling and exhaling.

   Note: You can substitute a 2- or 3-liter clear plastic soda bottle with the bottom cut off for the chimney and put the balloon in the top of the bottle, with the neck of the balloon stretched over the top and secured with a rubber band (instead of using the stopper and tube). This set up is a bit less durable, but will work.

IV. Activity. All Living Things Need Air

A. This activity relates to Objective 4. This activity will help students understand that all living things need air and that the air exchange between plants and animals is necessary to the survival of both.

Third-, fourth-, and fifth-graders

You will need the following materials:

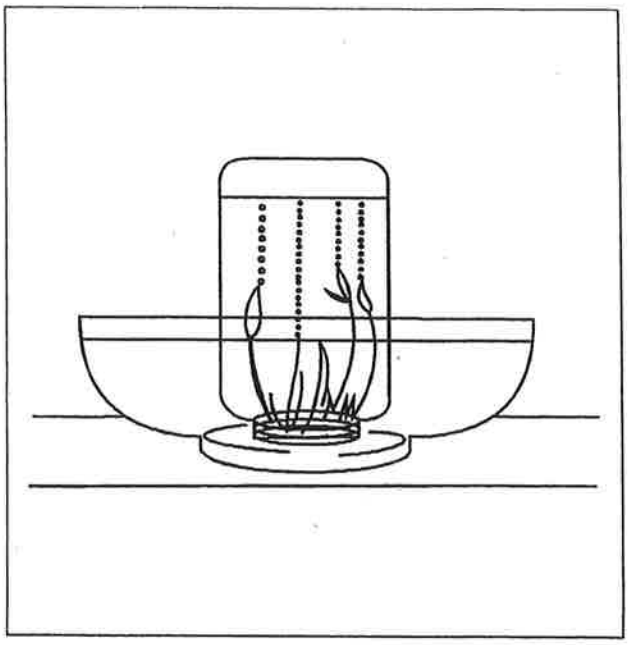
- ☐ Pondweed
- ☐ Glass bowl
- ☐ Glass jar that will fit in bowl
- ☐ Water

B. Ask the students the following questions:

1. What do you think happens to the carbon dioxide that humans exhale? (If students know the answer go on to (b). If they don't know, ask them to guess. List their answers.)

2. Where do you think that the oxygen in the air we breathe comes from?

C. Use the masters provided to make overhead transparencies. Use them to explain that plants use carbon dioxide for photosynthesis, which is their way of making food for themselves, and that they give off oxygen.



D. Have students perform the following activity:

1. Place some pondweed water plants in a bowl of water.
2. Fill a glass jar with water by lowering it into the bowl on its side.
3. Place the jar (bottom side up) to cover the plants.
4. Place the plants and jar in a sunny place.
5. You will notice streams of oxygen bubbles rising to the surface of the water. Eventually a little pocket of oxygen will collect at the top of the jar. Water plants release oxygen into the water just as land plants release oxygen into the air. Keep observing the plants for two weeks., and record the students' observations every few days on the Observation Sheet provided.

E. Ask students what happens when we lose or kill a large amount of plant life. (Less oxygen is available in the atmosphere.) This would be a good opportunity to discuss the destruction of the rain forests. For example, ask the students, "What happens when the rain forests of the world are cut down?" The rain-forest concept is an example that crosses several of the lessons in this guide. Issues include: less trees to provide oxygen, release of pollutants when felled trees are burned, etc.)

V. Follow-Up

You will need the following materials:

- ☐ Glue or glue sticks
- ☐ Scissors

A. Make photocopies for each child of the two "Your Respiratory System" masters.

B. Have the students cut out the pieces of the respiratory system.

C. Then have the students paste the pieces onto each piece's correct position on the outline of the respiratory system.

VI. Extension

A. Have the students write original stories or plays about Ollie Oxygen Atom and his/her journey through the human body. Encourage the students to research details of how oxygen travels, changes, and affects the body.

B. Have the students work with a partner to observe the effect of exercise on the rate of breathing. Partners take turns counting the number of breaths in one minute at rest (one inhalation plus one exhalation equals one breath). Then have them count the number of breaths in one minute after one minute of running in place, jumping rope, or doing jumping jacks. Have students make charts and compare their charts.

C. Have the students repeat Activity III. Have one student exert himself or herself for 2-3 minutes (jog in place, do jumping jacks, etc.) Let that student breathe air into the jug as described in the activity. Compare the results. (A larger amount of air is normally taken in and exhaled during exercise.)

D. Have the students perform the following activity to demonstrate that humans exhale carbon dioxide. Cover a jar of red cabbage juice for a couple of days. Then, using a straw, exhale into the juice. It should turn from a bluish color to a reddish color to indicate the presence of a weak carbonic acid.

E. Have the students conduct a "pound of pennies" collection in the school or community to buy an indoor plant for the school or a tree for the school yard "to help us breathe better."

Resources

Ardley, Neil. *101 Great Science Experiments.* London: Dorling Kindersley, 1993.

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Hann, Judith. *How Science Works.* London: Dorling Kindersley, 1991.

Trefil, James. *1001 Things Everyone Should Know about Science.* New York: Doubleday, 1992.

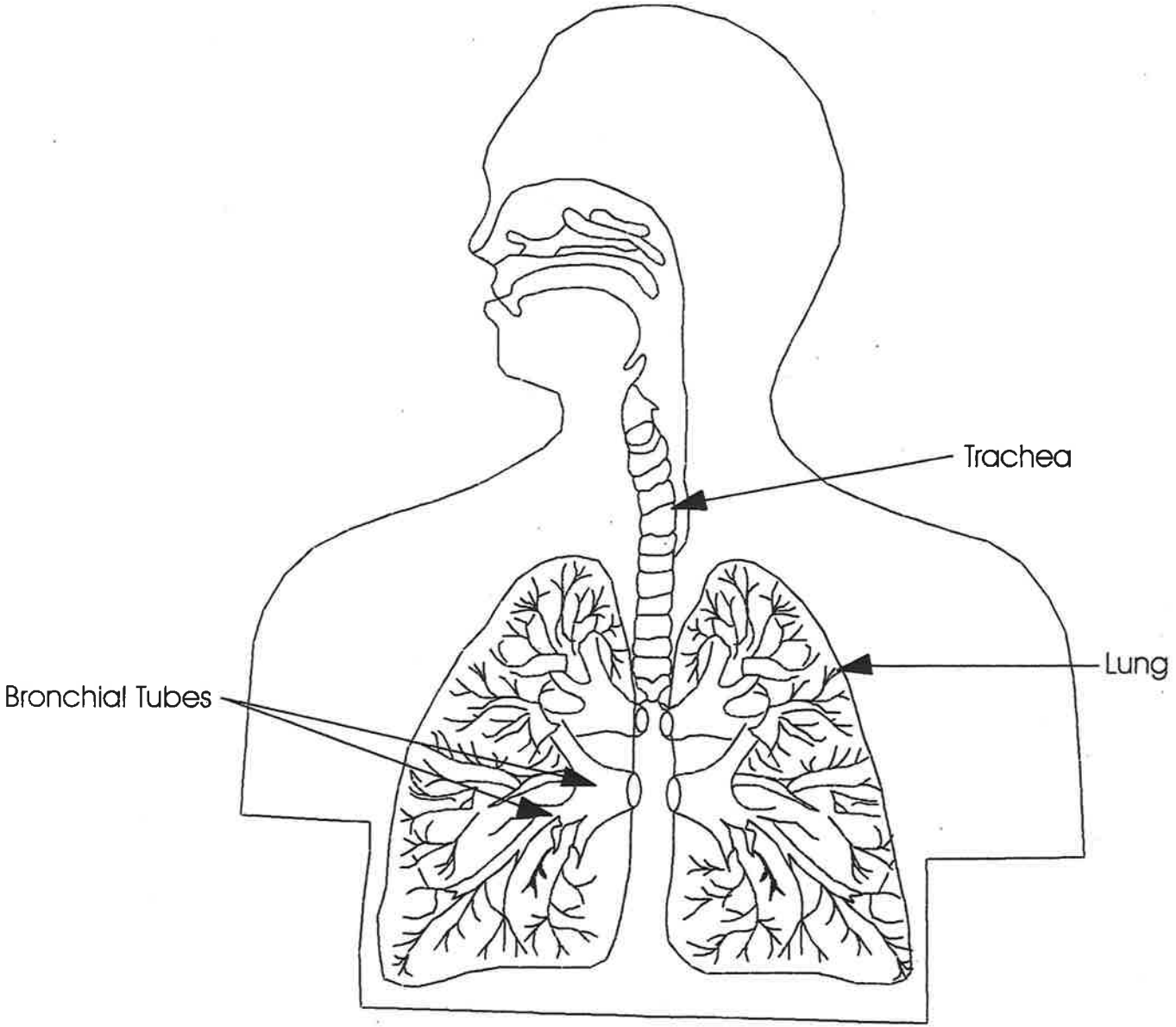
United States Environmental Protection Agency Office of Air Quality Planning and Standards. *Environmental Science Summer Institute Workbook.* Research Triangle Park, NC. 1995.

World Book Encyclopedia, 1994 edition, s.v. "Air."

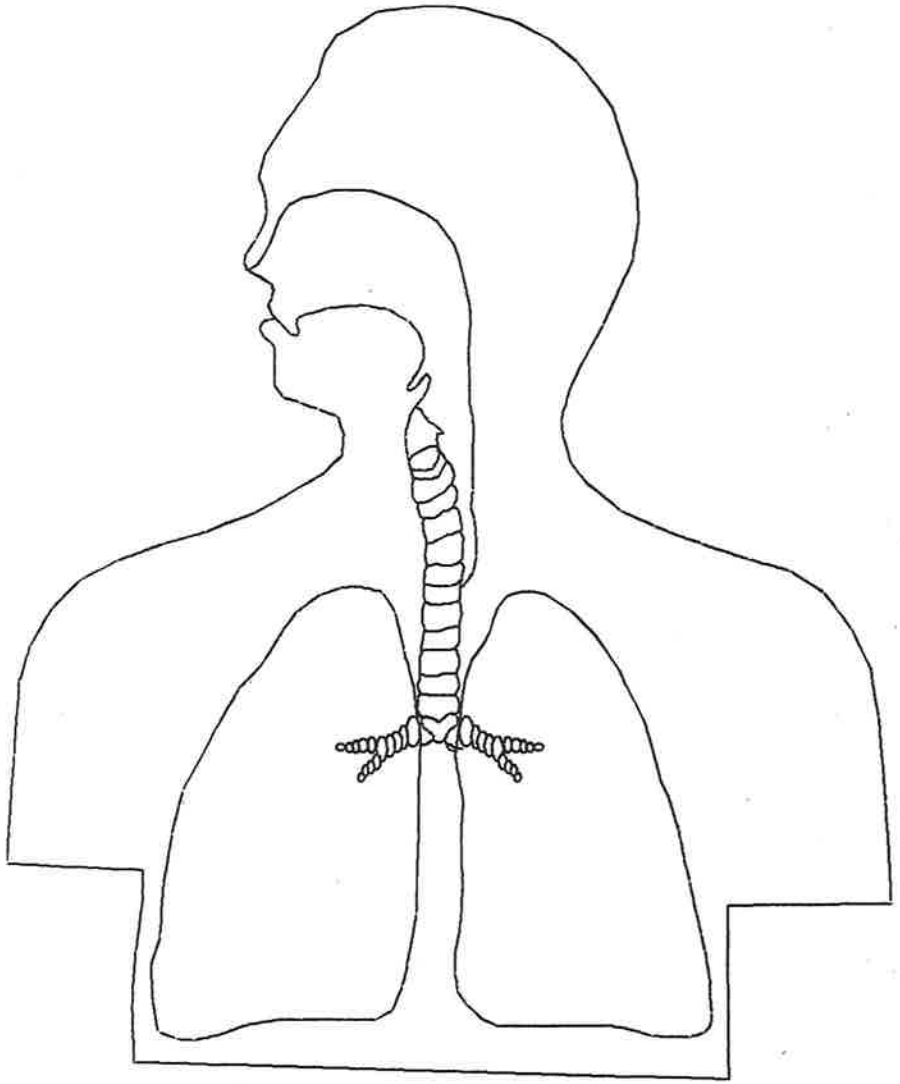
World Book Encyclopedia, 1994 edition, s.v. "Photosynthesis."

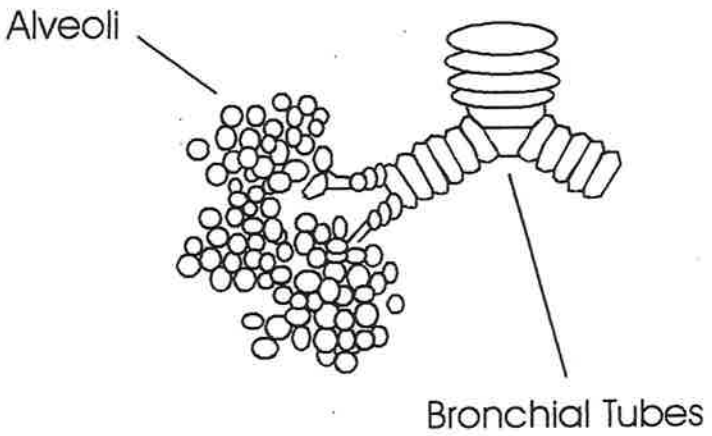
World Book Encyclopedia, 1994 edition, s.v. "Respiration."

Human Respiratory System #1

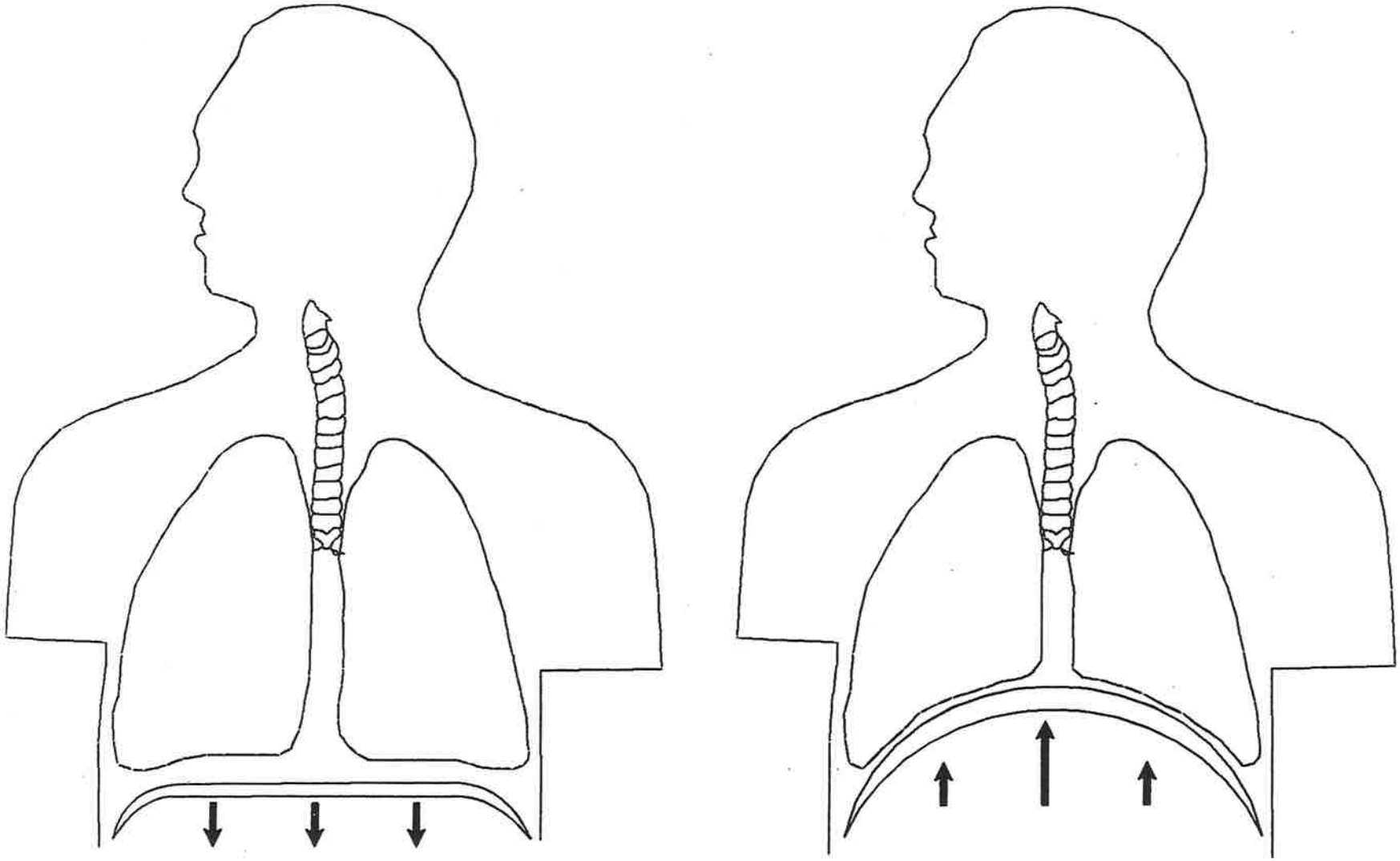


Human Respiratory System #2





Human Respiratory System #3



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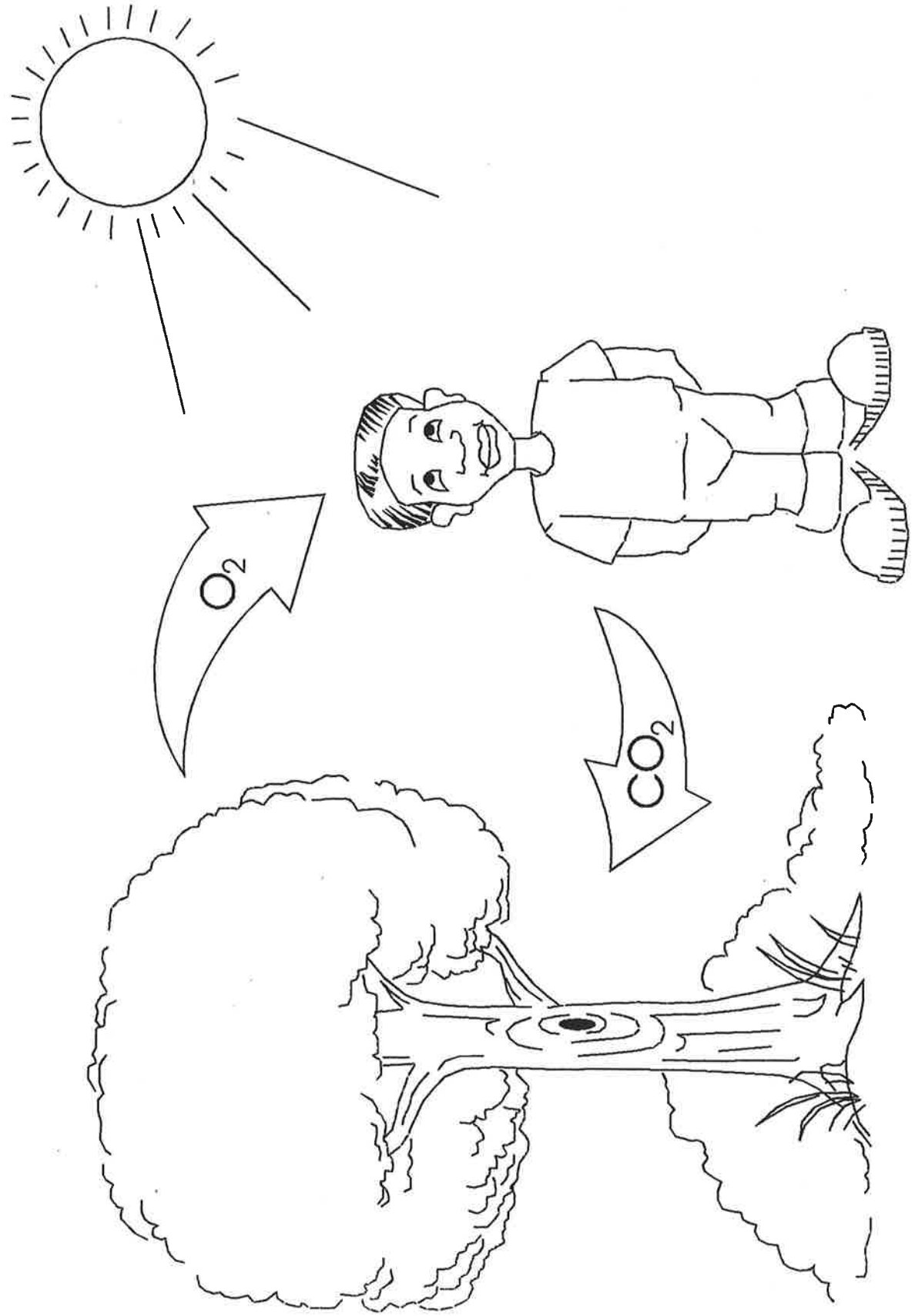
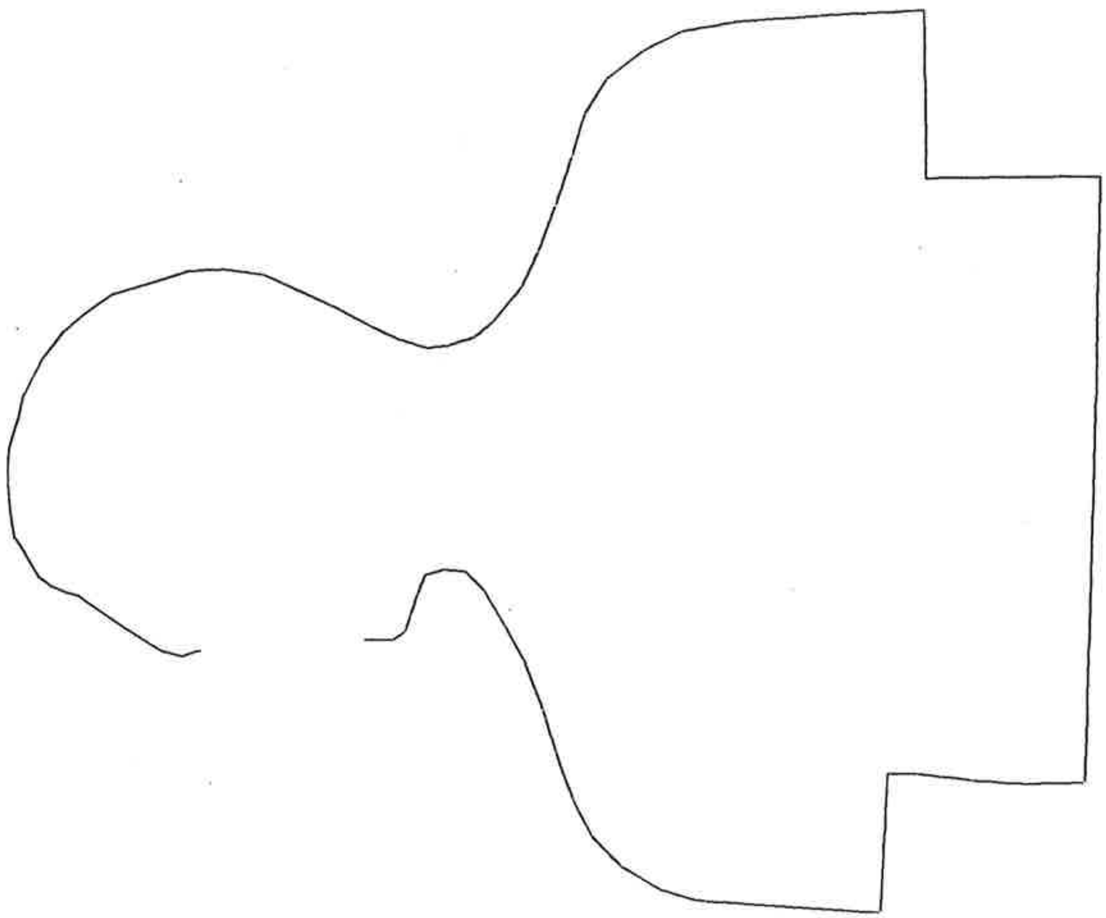
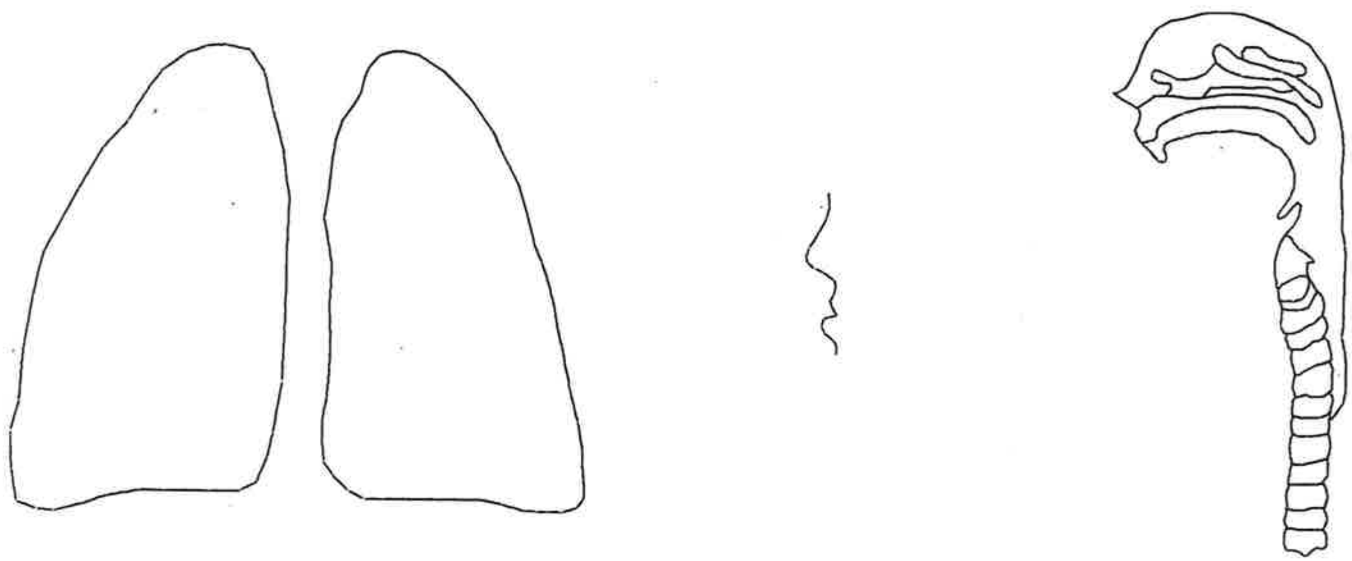


Your Respiratory System #1



Your Respiratory System #2

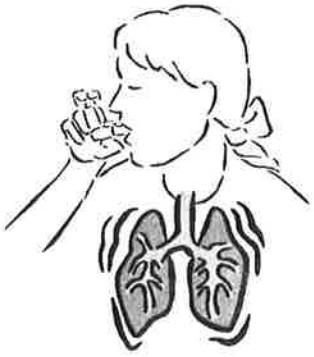


Easy Breathers:

Tell students that they are going to get a chance to feel what it is like to have an asthma attack

1. Have students place the straw in their mouths and ask them to breathe through the straw for 30 seconds (Discuss what that was like).
2. Next, ask students to do jumping jacks (or some other physical activity they can do while standing near their desks) without the straw in their mouths for 1 minute.
3. When students are done with the physical activity, have them quickly place the straw back in their mouths and have them breathe through their mouths (through the straw) for 30 seconds (Again, discuss what it feels like and compare that to the original activity).
4. Have the students repeat the physical activity, but this time ask them to do so with the straw in their mouths and remind them to only breathe through their mouths while completing the physical activity.
5. When students are done with their one minute exercise, have them breathe through the straw again. (Again, have students discuss what the experience was like and compare it to the original activity).

Now students have a general understanding of what it feels like to struggle to get enough air into their lungs. By completing this activity, students begin to gain some content knowledge about asthma.



Referenced: www.thinkport.org