

UNIT 5

Our Lungs, Our Air, Our Health

The Health Effects of Air Pollution

ACTIVITY DESCRIPTION

The first part of this activity introduces students to the human respiratory system. Using provided posters of the human respiratory system, the teacher leads a review of how air moves into and through the body. Students will also be directed to online animations depicting the respiratory system and how air pollution affects the lungs. In Part II of this activity, students conduct before and after measurements on each other to see the effects that exercise has on their own heartbeat and breathing rates. Students measure each other's resting heart and breathing rates, exercise for a specific amount of time, then re-measure and note body changes. Results are discussed and related to human activity on unhealthy air days and the AQI.

curricular ties

See page x for the list of this lesson's curricular ties to District of the Columbia, Maryland, and Virginia education standards. All Education Standards are articulated in the Appendices.

time needed

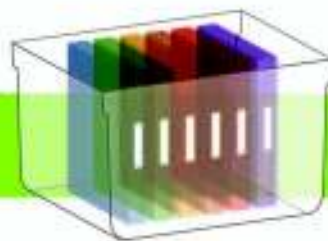
Two, 45 minute class periods

LEARNING OBJECTIVES

Upon completion of this Unit, students will be able to:

- ▣ Describe how air is exchanged in the body.
- ▣ List and describe the function of the different parts of the human respiratory system including the lungs, trachea, bronchial tubes, cilia, alveoli, and diaphragm.
- ▣ Explain how air pollution (ozone, PM, and CO) affects the lungs.
- ▣ Use a stethoscope to detect and measure the human heartbeat.
- ▣ Describe and discuss the effects of exercise on heartbeat and breathing rates.
- ▣ Infer how human health may be affected on pollution alert days.
- ▣ Describe how human activities (exercise) should be altered based on various AQI.

MATERIALS



Teacher Background Information:

American Lung Association—*Air Pollution and Exercise*

American Lung Association—*Children and Ozone Air Pollution Fact Sheet*

Lung Attack and other background material on the Internet (See *Technology Connections*)

Teaching Props:

Poster: *Respiratory System*

Medical Poster: *Effects of Common Air Pollutants* (AIRNow publication—also available online at: http://www.epa.gov/airnow//health-prof/EPA_poster-final_lo-res.pdf)

Student Handouts for Experiment:

Student Data Sheets—Resting Measurements, Active Measurements, and Thinking and Discussion Questions

Stop Watch (1 per pair of students)

Stethoscope (1 per group of 4 students)

Alcohol and cotton for cleaning ear buds on stethoscope

TEACHER PREPARATION

- ✿ Read the Teacher's Background Information from the American Lung Association—*Air Pollution and Exercise* and *Children and Ozone Air Pollution Fact Sheet*.
- ✿ Preview the web animation—*Lung Attack*.
- ✿ Access and review the other websites listed under *Technology Connections*, both for background information and to decide which you would like students to review.
- ✿ If possible, make preparations for the class to view *Lung Attack* and other selected websites (either as a class or individually in the computer lab).
- ✿ Review all the steps in the procedures before conducting the activity.
- ✿ Study the respiratory system poster and prepare to present it to the class.
- ✿ Make copies of the *Student Data Sheets*, 1 per student.
- ✿ Have the stethoscopes and stop watches ready for the student experiment.
- ✿ Display in the classroom the medical poster: *Effects of Common Air Pollutants*.

technology connections



<http://coep.pharmacy.arizona.edu/air/#lung>

Lung Attack (which must be selected within this link) provides an animated description of how the lungs work and how pollution affects the lungs. This site, *Air Info Now*, also provides other online, air quality activities and information. The animations require a flash player.

<http://www.lungusa.org/site/pp.asp?c=dvLUK900E&b=22576>

This page of the American Lung Association website displays a chart of the human respiratory system, describes the different parts of the respiratory system, and offers a link to an animation which depicts how the lungs work.

<http://www.lungusa.org/site/pp.asp?c=dvLUK900E&b=36292#health>

This page from the American Lung Association website describes how air pollution affects the body specifically during exercise. (Hard copy provided for teacher background.)

<http://www.lungusa.org/site/pp.asp?c=dvLUK900E&b=36296>

This page from the American Lung Association website describes how air pollution, specifically ozone, affects children's health. (Hard copy provided for teacher background.)

http://kidshealth.org/teen/your_body/body_basics/lungs.html

This page, from Kid's Health, provides an overview of the lungs and respiratory system. It is targeted to older student audiences (teens).

http://www.kidshealth.org/kid/body/lungs_SW.html

This page, from Kid's Health, provides an overview of the lungs and respiratory system. It is targeted to younger student audiences (4th-6th grades).

ACTIVITY PROCEDURES

Part I—Review of the Respiratory System and How Air Pollution Affects the Lungs

- 1 Review the human respiratory system with students using the posters provided in the kit. Be sure students can name and locate the following parts of the respiratory system: lungs, trachea, bronchial tubes, cilia, alveoli, and diaphragm.
- 2 Use the Respiratory System poster to point out how oxygen moves into and carbon dioxide moves out of the lungs.
- 3 Direct students to online resources for further review of how lungs work. *Lung Attack*, on the *Air Info Now* website, provides an animated description of how lungs work and how pollution affects the lungs. If computer time cannot be fit into the class period, it is suggested that this be assigned as homework.
- 4 Conduct a class discussion on how air pollution affects the lungs and human health in general. Use the key points from *Lung Attack* to guide the discussion:
 - Particulate Matter can build up in the lungs, reducing oxygen flow. Large particles may be trapped by mucous and coughed out.
 - Small particles can travel deeper into the lungs. Small particles may cause coughing and shortness of breath. Some small particles can be toxic and make people very sick.
 - Ozone (O₃) is an irritant to the lungs. It can be like “getting a sunburn inside your lungs” and can cause serious asthma attacks.
 - Breathing in carbon monoxide (CO) reduces the amount of oxygen in the body. Breathing too much CO can cause dizziness, headaches, and suffocation.

Part II—Student Experiment: Effects of Exercise on Heartbeat and Breathing Rate

- 1 Explain to students that once they understand how the lungs work and how air pollution affects the lungs, they can begin to consider how exercise on air pollution alert days affects human health. Explain that next, students are going to conduct an experiment on themselves to test how exercise affects their breathing and heart rate.
- 2 Divide the class into pairs of students. Each pair should work with another pair to form a group and share measuring instruments.
- 3 Distribute the data sheets to all students.
- 4 Distribute stethoscopes and stop watches among the student groups. (One pair will complete a set of measurements, then share instruments with the other pair in their group.) Review use of the instruments. **Point out that the stethoscope should be held in place on the chest by the person**

whose heartbeat is being measured—students do not need to touch each other for this exercise.

(Note: Be sure students clean the ear pieces with alcohol and cotton between uses.)

- 5 Have students conduct the experiments and complete their datasheets. Instructions for measuring heartbeat and breathing rates are provided on the student datasheet.
- 6 Once all students have completed their data sheets, conduct a class discussion on the results. Use the thinking and discussion questions from the data sheet to guide the discussion. Point out the key point of this experiment: *During exercise, we need more oxygen for the body to work. We breathe faster and our heart beats faster to deliver the oxygen to the body. Exercising on a day when the air quality is unhealthy (code orange and above) is not a good idea because the body will take in more air pollution.*

Teacher Background Information

AIR POLLUTION AND EXERCISE



April 2000

Who is Vulnerable?

How Air Pollution Affects Your Body

Minimize Your Risk

For More Information

WHO IS VULNERABLE

Millions of Americans live in areas where the air carries not only life-giving oxygen, but also noxious pollutants that reach unhealthful levels, such as ozone, carbon monoxide, fine particles, sulfur dioxide, nitrogen dioxide, or lead.

Exercise makes us more vulnerable to health damage from these pollutants. We breathe more air during exercise or strenuous work. We draw air more deeply into the lungs. And when we exercise heavily, we breathe mostly through the mouth, by-passing the body's first line of defense against pollution, the nose.

HOW AIR POLLUTION AFFECTS YOUR BODY

Our lungs are among the body's primary points of contact with the outside world. We may drink two liters of liquid each day. We breathe in an estimated 15,000 liters of air, approximately 6 to 10 liters every minute, drawing life-giving oxygen across 600 to 900 square feet of surface area in tiny sacs inside the lung.

Oxygen is necessary for our muscles to function. In fact, the purpose of exercise training is to improve the body's ability to deliver oxygen. As a result, when we exercise, we may increase our intake of air by as much as ten times our level at rest.

An endurance athlete can process as much as twenty times the normal intake. Mouth breathing during exercise by-passes the nasal passages, the body's natural air filter. These facts mean that when we exercise in polluted air, we increase our contact with the pollutants, and increase our vulnerability to health damage.

The interaction between air pollution and exercise is so strong that health scientists typically use exercising volunteers in their research.

MINIMIZE YOUR RISK: MANAGE YOUR EXERCISE

The news isn't all bad. You can minimize your exposure to air pollution by being aware of pollution and by following some simple guidelines: If you live in an area susceptible to air pollution, here's what you should do:

- Do train early in the day or in the evening.

- ☼ Do avoid midday or afternoon exercise, and avoid strenuous outdoor work, if possible, when ozone smog or other pollution levels are high.
- ☼ Do avoid congested streets and rush hour traffic; pollution levels can be high up to 50 feet from the roadway.
- ☼ Do make sure teachers, coaches and recreation officials know about air pollution and act accordingly.
- ☼ Most important, do be aware of the quality of the air you breathe!

Don't do the following:

- ☼ Don't take air pollution lightly, it can hurt all of us!
- ☼ Don't engage in strenuous outdoor activity when local officials issue health warnings.

FOR MORE INFORMATION

For more information about your local air quality, call your local air pollution control agency, or visit the US Environmental Protection Agency AirNow website at www.epa.gov/airnow.

Source: <http://www.lungusa.org/site/pp.asp?c=dvLUK900E&b=36292>

Teacher Background Information

CHILDREN AND OZONE AIR POLLUTION FACT SHEET



September 2000

While exposure to ozone air pollution causes adverse health effects in most people, children are especially susceptible to these effects. Children spend significantly more time outdoors, especially in the summertime when ozone levels are the highest.

National statistics show that children spend an average of 50 percent more time outdoors than do adults.

A recent study conducted by the American Lung Association shows that as many as 27.1 million children age 13 and under, and over 1.9 million children with asthma are potentially exposed to unhealthy levels of ozone based on the new 0.08 ppm, eight-hour ozone level standard.

Minority children are disproportionately represented in areas with high ozone levels. Approximately 61.3% of black children, 69.2% of Hispanic children and 67.7% of Asian-American children live in areas that exceed the 0.08 ppm ozone standard, while only 50.8% of white children live in such areas.

Children spend more time engaged in vigorous activity (i.e., exercise). Such activity results in breathing in more air, and therefore more pollution being taken deep into the lungs. A California study found that children spend three times as much time engaged in sports and vigorous activities as adults do.

Children have a higher breathing rate than adults relative to their body weight and lung surface area. This results in a greater dose of pollution delivered to their lungs. Most biological air pollution damage is related to the dose of pollution inhaled in relation to the body weight and surface area of the target organ.

Even when children experience significant drops in lung function, they do not seem to suffer or report some of the acute symptoms, such as coughing, wheezing or shortness of breath, associated with ozone exposure in adults. Thus, children are not likely to receive or may not understand the biological warnings to reduce their ozone exposure by stopping their exercise or moving indoors.

Children have narrower airways than do adults. Thus, irritation or inflammation caused by air pollution that would produce only a slight response in an adult can result in a potentially significant obstruction of the airways in a young child.

During exercise, children, like adults, breathe with both their nose and mouth rather than just their noses. When the nose is by-passed during the breathing process, the filtering effects of the nose are lost, therefore allowing more air pollution to be inhaled.

Air pollution, including ozone, can result in more frequent respiratory infections in children due to impairment of the lung's ability to defend itself. Scientists are concerned that children who experience more frequent lower respiratory infections may be at greater risk of lower-than-normal lung function later in life.

When ozone levels are high, children should avoid calisthenics, soccer, running and other strenuous outdoor exercise. They should be encouraged to participate in less strenuous activities such as recreational swimming, swinging or indoor activities such as floor hockey and gymnastics instead.

Source: <http://www.lungusa.org/site/pp.asp?c=dvLUK900E&b=44567>

Student Handout

Student Data Sheet—Resting Measurements

Your Name _____

Your Partner's Name _____

Instructions: In this activity, you will measure your partner's heartbeat and breathing rate before and after exercise. When relaxed and not exercising, your body is considered to be in a state of rest. These will be your "resting" measurements. You will take the average of three measurements for each experiment. You will then repeat the measurements after your partner has exercised. These will be your "active" measurements. Instructions for your active measurements are on those data sheets. Note: Be sure to wipe the ear buds of the stethoscope after each use.

Resting Heartbeat

- 1 Place the earpieces of the stethoscope comfortably in your ears. Have your partner hold the end of the stethoscope in place on the left side of his/her upper chest.
- 2 Listen carefully until you can clearly hear your partner's heartbeat.
- 3 Count the number of beats his/her heart makes in fifteen (15) seconds. (Use the stop watch.)
- 4 Repeat this for a total of three measurements.
- 5 Record all your measurements in the space provided.
- 6 Calculate beats per minute for each of your measurements. (Multiply beats per 15 seconds by 4—since 15 seconds goes into 60 seconds 4 times.)
- 7 Calculate the average beats per minute. (Add the three measurements together and divide by 3.)

_____ beats per 15 seconds (x 4) = _____ beats per minute

_____ beats per 15 seconds (x 4) = _____ beats per minute

_____ beats per 15 seconds (x 4) = _____ beats per minute

Average beats per minute = _____

Resting Breathing Rate

- 1 Have your partner relax.
- 2 Record the number of breaths (inhalations) your partner takes in 30 seconds. (Your partner should count his/her own breaths. Use the stop watch to tell him/her when 30 seconds has passed.)

Student Handout (cont'd)

Student Data Sheet – Resting Measurements

- 3 Repeat this for a total of three measurements.
- 4 Record all your measurements in the space provided.
- 5 Calculate the breaths per minute for each of your measurements. (Multiply breaths per 30 seconds by 2.)
- 6 Calculate the average breaths per minute. (Add the three measurements together and divide by 3.)

_____ breaths per 30 seconds (x 2) = _____ breaths per minute

_____ breaths per 30 seconds (x 2) = _____ breaths per minute

_____ breaths per 30 seconds (x 2) = _____ breaths per minute

Average breaths per minute = _____

Student Handout

Student Data Sheet – Active Measurements

Your Name _____

Your Partner's Name _____

Instructions: After you have recorded all the resting measurements, have your partner do jumping jacks for two (2) minutes. Even if your partner gets tired, have him or her continue to exercise for two whole minutes. As soon as the two minutes are up, record his/her heartbeat and breathing rate. Note: Your partner will start recovering immediately so you need to take all measurements as soon as possible after he/she exercises. You should calculate your averages after you have conducted all the measurements (for both heartbeat and breathing rate). Note: Be sure to wipe the ear buds of the stethoscope with alcohol after each use.

Active Heartbeat

- 1 Place the earpieces of the stethoscope comfortably in your ears. Have your partner hold the end of the stethoscope in place on the left side of his/her upper chest.
- 2 Listen carefully until you can clearly hear your partner's heartbeat.
- 3 Count the number of beats his/her heart makes in fifteen (15) seconds. (Use the stop watch.)
- 4 Repeat this for a total of three measurements.
- 5 Record all your measurements in the space provided.
- 6 Measure and record breathing rate (below) before continuing with the calculations.
- 7 Calculate beats per minute for each of your measurements. (Multiply beats per 15 seconds by 4—since 15 seconds goes into 60 seconds 4 times.)
- 8 Calculate the average beats per minute. (Add the three measurements together and divide by 3.)

_____ beats per 15 seconds (x 4) = _____ beats per minute

_____ beats per 15 seconds (x 4) = _____ beats per minute

_____ beats per 15 seconds (x 4) = _____ beats per minute

Average beats per minute = _____

Active Breathing Rate

- 1 Record the number of breaths (inhalations) your partner takes in 30 seconds. (Your partner should count his/her own breaths. Use the stop watch to tell him/her when 30 seconds has passed.)

Student Handout (cont'd)

Student Data Sheet—Active Measurements

- 2 Repeat this for a total of three measurements.
- 3 Record all your measurements in the space provided.
- 4 Calculate the breaths per minute for each of your measurements. (Multiply breaths per 30 seconds by 2.)
- 5 Calculate the average breaths per minute. (Add the three measurements together and divide by 3.)

_____ breaths per 30 seconds (x 2) = _____ breaths per minute

_____ breaths per 30 seconds (x 2) = _____ breaths per minute

_____ breaths per 30 seconds (x 2) = _____ breaths per minute

Average breaths per minute = _____

Student Handout

Student Data Sheet—Thinking and Discussion Questions

Your Name _____

Your Partner's Name _____

Enter your average resting and active results in the table below, then answer the following questions:

Average Measurements	Resting	Active
Heart Rate		
Breathing Rate		

1 Does your heart beat faster or slower after exercise?

2 Is your breathing rate faster or slower after exercise?

3 In general, describe what happens to your lungs and heart during exercise:

4 What do you think this experiment shows about exercising outdoors on a day when there is unhealthy air?

5 On what color AQI days is it OK to exercise?

6 On what color AQI days should you reduce outdoor exercise?

7 What are some things that you could do instead of exercising outdoors on unhealthy air days?

