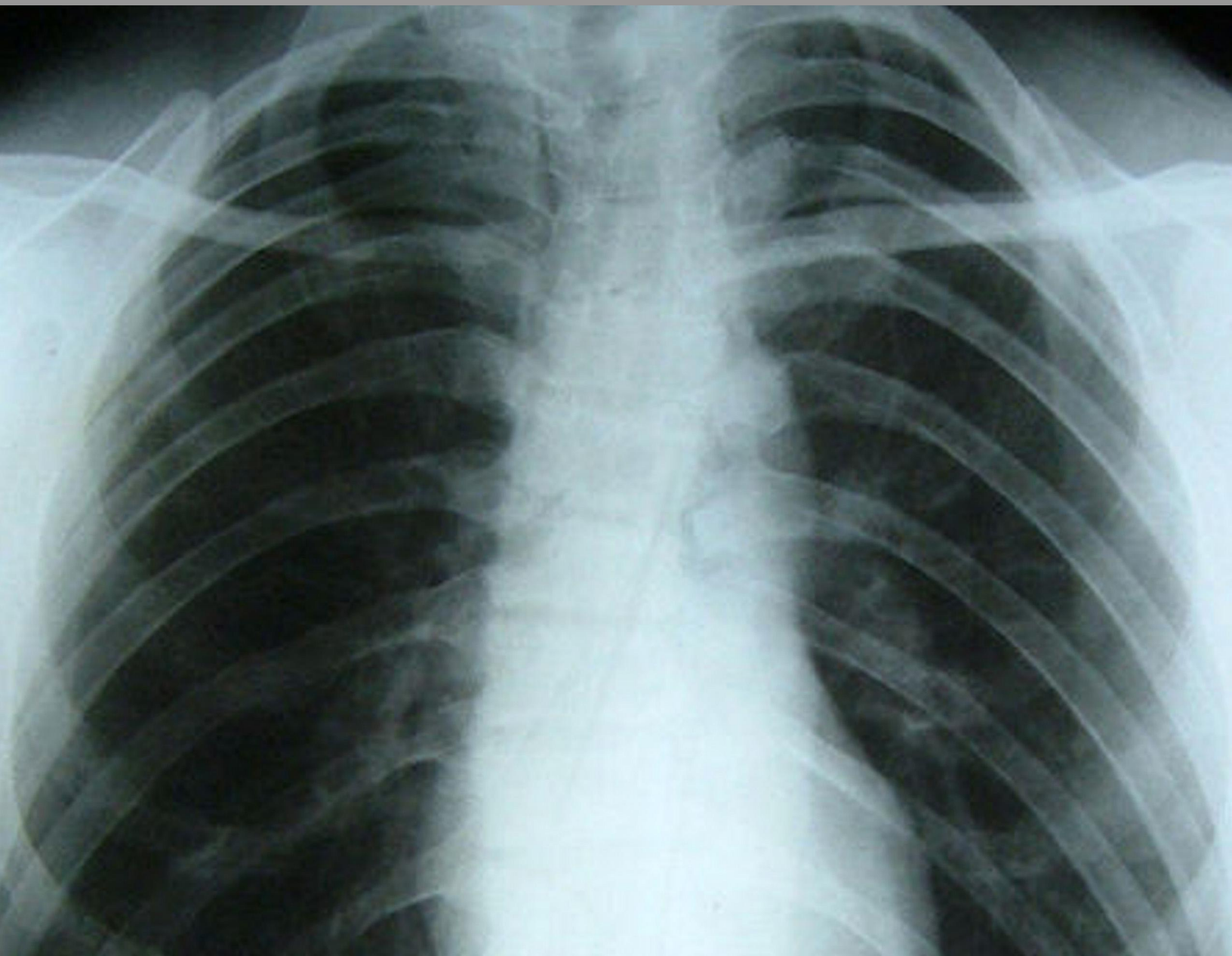


# Human Biology - Breathing

## Teacher's Guide



# Human Biology Breathing Teacher's Guide

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The Program in Human Biology,  
Stanford Uni- versity  
The Program in Human Biology,  
Stanford Un- iversity, (HumBio)

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# CHAPTER **1** Introduction to Breathing - Teacher's Guide (Human Biology)

## Chapter Outline

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- 1.1 OVERVIEW
  - 1.2 ACKNOWLEDGMENTS
  - 1.3 PREFACE
  - 1.4 LETTER TO THE TEACHER
  - 1.5 UNIT PLANNING
-

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# 1.1 Overview

## **Human Biology: An inquiry-based guide for the middle school student.**

Developed by the Program in Human Biology at Stanford University and  
EVERYDAY LEARNING®

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### **Dedication**

The faculty, staff, and teachers of Stanford University's Human Biology Middle Grades Life Science Curriculum Project dedicate the publication of the HumBio Curriculum in memory of our colleagues and friends, Mrs. Donna Harrison and Dr. Mary Budd Rowe. Donna was the lead science teacher at Dozier Middle School, the project test site school in Newport News, Virginia. She was an outstanding teacher, a community leader, a devoted wife and mother, and a wonderful human being. Her involvement in the HumBio Project enriched the curriculum materials and brought great joy to our lives. Although her life ended suddenly and tragically, the inspiration she gave to all who knew her will live on in what we do to improve the education of children and youth. Mary Budd Rowe was our most distinguished science education colleague and our dear friend. She guided the early organizational stages of the project as a group of university scientists attempted to address issues of middle level science education. Her unbridled enthusiasm for the education of children always reminded us of the important purpose of our work. Mary continued her unwavering support of the HumBio curriculum until her passing in June of 1996.

---

## 1.3 Preface

Stanford University's Middle Grades Life Science Project began in 1986 with the vision of David A. Hamburg, M.D., then President of Carnegie Corporation of New York. A new wave of science education reform was gathering momentum following the release of *A Nation at Risk* by the United States Department of Education and *Educating Americans for the Twenty-First Century* by the National Science Board. Dr. Hamburg brought together the concerns of scientists and science educators over the watered down, vocabulary-laden life science curricula that were typical of middle level science courses at that time with broader public concern over large and increasing numbers of adolescents who engaged in high-risk behaviors leading to school failure, teen pregnancy, and other health problems. Because of his leadership in developing Stanford's undergraduate Program in Human Biology and his interests as a physician and scientist in the major physiological and behavioral transitions in the lives of children, Dr. Hamburg believed that a rigorous middle grades life science curriculum focused on human biology, and where possible on the adolescent, not only would greatly improve the science taught at this level, but through its relevance would capture the interest of this age group.

Initial work on the Human Biology (HumBio) Middle Grades Life Science Curriculum brought together faculty, staff, and students from Stanford's Program in Human Biology and its School of Education with local middle and high school teachers. The curriculum development team was enriched in 1991 by twelve interdisciplinary teams of middle level teachers from diverse test site schools across the country. These teams became our most valued collaborators. The teachers attended annual two week summer institutes at Stanford between 1991 and 1994 and used the draft curriculum units in their classes between 1991 and 1995. The teachers and their students provided extensive formative evaluation data on the field-test materials, which has shaped the final student and teacher versions of the units that comprise the HumBio Curriculum. Using HumBio units as a starting point, many teams also created their own innovative, interdisciplinary materials, which they taught across the middle level curricula in their schools.

The Project's Advisory Board provided insightful advice on the development of the curriculum from the unique perspectives of the professional associations, the institutions, and the fields its members represented. We are grateful to all of those who served for periods of time during the past seven years. We also would like to express our appreciation to the education consultants from universities, the National Middle School Association, and the California State Department of Education who made presentations and worked with the teacher teams during the summer institutes at Stanford. C. Stuart Brewster served with great distinction as our adviser on publication. We are indebted to him for his keen insights and good advice.

The Project faculty, the staff, and the teachers contributed more to the development of the HumBio Curriculum than anyone could have imagined before this work began. Their expertise, determination, and dedication to improving the education of young adolescents were inspirational. Supporting the curriculum development team and the test-site teachers were wonderful groups of Stanford undergraduates from the Program in Human Biology. They helped to ensure a productive and pleasurable working environment, which was an essential part of the success of the summer institutes.

To be sure, none of this work would have been possible without funding from Carnegie Corporation of New York, the National Science Foundation, and most recently The David and Lucile Packard Foundation. On behalf of the entire Project team we would like to thank these foundations and the program officers who have worked with us over the years for their support. As always, the final content of this curriculum is the sole responsibility of the Stanford University Middle Grades Life Science Project and does not necessarily reflect the views of Carnegie Corporation of New York, the National Science Foundation, or The David and Lucile Packard Foundation.

H. Craig Heller, *Principal Investigator*

Mary L. Kiely, *Project Director*

January, 1998. Stanford, California

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## 1.4 Letter to the Teacher

**Dear Teacher:**

I believe you and your students will enjoy this unit that explores breathing. We want to make science relevant to students' lives, and how much more relevant can anything be than to study breathing? Students can relate directly to breathing. They do it all their lives. They also recognize that breathing is a limiting factor in their physical performance.

Throughout the unit students explore concepts, issues, and concerns they have observed and about which they have wondered. What's an Adam's apple? Why do I get out of breath in the mountains? Why do smokers cough so much? Why do people wheeze? What causes coughs, colds, and flu? How does all this stuff inside me work and stay in balance? We get them interested in relevant content and we give them the tools to be good decision makers about their own behavior, health, and lifestyles. Once students have a better understanding of the breathing machine they explore factors that affect them in both good and bad ways. They explore pollution of all kinds including direct and indirect pollution from smoking. They investigate diseases such as TB, bronchitis, pneumonia, mononucleosis, the flu, and common colds. They investigate what affects their own breathing machine and what they can do about it. They explore links between nature and their own breathing system to ask questions, answer questions, solve problems, and make good decisions.

You will notice as you review this unit and actually begin to teach it that hands-on learning experiences are used to introduce, enhance, and wrap up the students' explorations of relevant concepts. One of the main goals of HumBio is to use hands-on and activity-based experiences because students learn more by doing and thinking than by only reading and listening. The activities are simple to set up, observe, and monitor and require only common household items. Look over the very first activity as an example. In Activity 1-1 the students build their own model that demonstrates how lungs are ventilated. Not only do students produce a working model, but also the activity offers you the opportunity to introduce barometric pressures and the impact of positive and negative pressures.

We are confident that your students will enjoy this unit and their enjoyment will lead them to learn more about respiration. We also believe that the links we make to other curricular disciplines such as health, social studies, math, language arts, performing arts, and make what they are learning even more relevant in their everyday lives. Most importantly we believe that what students learn and the tools they will practice using in this unit will have a positive influence on their behavior, their health, and their decision making.

Best wishes,

H. Craig Heller

Chair, Department of Biological Sciences, Stanford University

## 1.5 Unit Planning

### Content Overview

#### **Breathing: We must breathe every day. Why? How?**

In this activity-driven unit students study the structure and function of the human respiratory system to understand how it works and how to keep it healthy. They investigate the mechanics of breathing and the oxygen/carbon dioxide gas exchange that is necessary for life. Students observe the operation of lungs as they are inflated and deflated by the diaphragm muscles. They construct and use a model of a lung and a spirometer to examine the relationship of the breathing passages leading to air sacs (alveoli) in the lungs and what happens when these air sacs are damaged through smoking and emphysema. Through hands-on activities students analyze the chemical processes of photosynthesis and respiration, as well as the role of humans in carbon and oxygen cycles of the environment. The intricate connection between the respiratory and circulatory systems is explored by recording and analyzing heart and breathing rates under different physiological conditions. Students learn that body control systems actively regulate the respiratory system. The role of red blood cells as oxygen carriers is examined with respect to the respiratory system. Students complete the unit with an investigation of the natural protection mechanisms of the respiratory system and how smoking, infections, and environmental pollution can damage this natural protection. Students relate their respiratory health to environmental pollution problems and determine ways to improve both.

Breathing is something we don't usually think about unless we have a problem. Then it becomes our first priority. *Breathing* reviews the human respiratory system, its structure and functions, and some of its problems. The unit divides naturally into five sections. Each section has activities that are essential to the student's understanding of the content. The following list identifies the main points of the unit and how this unit relates to the student's everyday lives.

- The human respiratory system is an engineering masterpiece. Its design and structure maximize oxygen uptake and carbon dioxide release and keep the majority of germs and particulates out of the lungs.
- Gaining knowledge of the gas exchange in human lungs helps us appreciate the oxygen and carbon dioxide cycles in the world around us.
- The body's control systems allow the respiratory system to adapt to changing circumstances either in the short term (by breathing more or less) or in the long term (by making more or fewer red blood cells).
- Although the respiratory system can do a lot to keep us healthy, it can't do it all. We must make some conscious effort to maintain our health, beginning with understanding the things that can harm our lungs. Then we must do things to help our lungs work most efficiently (such as drinking a lot of water and not smoking).

#### **Why Teach This Unit?**

- We take approximately 700 million breaths during our lifetime and these breaths sustain our lives.
- Each year 200,000 people die from cardiovascular disease.
- Around 400,000 people die each year from diseases caused by smoking.
- Approximately 14.6 million Americans suffer from asthma.

(Centers for Disease Control, U.S. Public Health Service, 1994.)

As world population continues to grow, numerous policy questions arise regarding public health. For example, the affect of air pollution on lung diseases can be enormous. Many people take risks or create risks for others because

they don't fully understand how the human body works. Many people assume that nothing bad will happen to them. They have not had the opportunity to study the engineering and beauty of the human breathing system. However this wonderful system cannot be abused. Students learn about how the respiratory system works and how it can fail. They also begin to appreciate how their behavior and environmental factors affect lung functions and the overall health of their body.

### Questions for the Unit

*Who is responsible for keeping the air we breathe clean?*

*In what ways does lifestyle affect how our lungs function?*

Exercise and good nutrition can improve and maintain healthy lung function. Choosing to smoke or use drugs can lead to lung problems. Some industrial workers are at risk through exposure to hazardous materials. Activities such as mountain climbing or deep sea-diving present challenges to the function of the lungs.

*How is our breathing linked to our environment?*

Our breathing provides carbon dioxide essential to the survival of plant life. Plants provide the oxygen essential to our lives.

**TABLE 1.1: Unit Activities and Key Ideas**

Section	Key Ideas	Activity
<b>1 Breathing: Why and How?</b> What happens when I breathe?	<ul style="list-style-type: none"> <li>You breathe in to get oxygen from the air, and you breathe out to get rid of carbon dioxide, a waste gas produced by your cells.</li> <li>Your lungs inflate and deflate in response to the contraction and relaxation of the diaphragm muscle</li> <li>Changes in air pressure cause the lungs to expand and contract.</li> </ul>	<b>Activity 1-1:</b> How Do You Breathe? <b>Mini Activity:</b> How Many Breaths in a Lifetime?

**TABLE 1.1:** (continued)**Section****2 My Breathing Machine**

What do my lungs look like, and how do they work?

**Key Ideas**

- Your airways are structured to provide oxygen-rich, moist air to the air sacs inside your lungs.
- Your lungs have millions of air sacs to maximize efficiency of gas exchange. If air sacs are damaged, breathing efficiency is reduced.
- The structure of your airways ensures that some air remains in the lungs as a reserve.

**Activity**

**Mini Activity:** Voice Box

**Activity 2-1:** Building Clusters of Balloon Alveoli

**Activity 2-2:** The More, the Airier  
**Mini Activity:** Words from the Latin Language

**Activity 2-3:** Building and Using a Spirometer

**3 Oxygen, Carbon Dioxide, and Energy**

How are respiration and photosynthesis linked?

- Photosynthesis and respiration represent the cycles of oxygen and carbon dioxide in animals and plants. Animals breathe in  $O_2$  and breathe out  $CO_2$ ; plants absorb  $CO_2$  and give off  $O_2$
- Photosynthesis is the process by which plants incorporate the energy of the sun into the chemical bonds of sugar (fuel).
- Cellular respiration can be compared to burning candles. They both need fuel and oxygen in order to burn, and they produce carbon dioxide and water as they release the energy from the chemical bonds of the fuel.

**Mini Activity:** Miles = Trees

**Activity 3-1:** It's a Gas!- Carbon Dioxide and Oxygen

**Activity 3-2:** Cell Candles

**Enrichment 3-1:** The Drama of Carbon Dioxide and Oxygen

**TABLE 1.1:** (continued)

<b>Section</b>	<b>Key Ideas</b>	<b>Activity</b>
<p><b>4 Breathing Mission Control</b> How is breathing controlled to match the needs of the cells?</p>	<ul style="list-style-type: none"> <li>• The body has control systems that regulate, through negative feedback, essential body functions</li> <li>• Controllers allow the respiratory system to adapt to changing conditions, such as exercise or changing oxygen levels in the air coming in.</li> <li>• Red blood cells pick up and deliver oxygen to cells and carbon dioxide from cells as needed. Your body can adapt to changing conditions by making existing cells work harder, or by making more red blood cells to increase capacity.</li> </ul>	<p><b>Mini Activity:</b> Homeostasis <b>Activity 4-1:</b> How Does a Controller Work? <b>Enrichment 4-1:</b> Using a Bicycle to Demonstrate How Controllers Work</p>
<p><b>5 Keeping Your Breathing Machine Healthy</b> what are some common problems with breathing?</p>	<ul style="list-style-type: none"> <li>• Your breathing machine is designed to keep you healthy. It provides airways and air sacs for the exchange of blood gases, and an automatic cleaning mechanism consisting of mucus, cilia, and the mucus escalator.</li> <li>• Many viruses cause mucus tissue in the airways to produce more mucus-typically cold and flu viruses, Viruses can cause us to feel very uncomfortable, but will go away. In some cases, they can lead to a longer lasting bacterial infections.</li> <li>• Environmental causes of lung disease and lung damage include smoking and air pollution.</li> </ul>	<p><b>Mini Activity:</b> Take Action! <b>Mini Activity:</b> Motivating through Ads <b>Activity 5-1:</b> Smoke in Your Lungs <b>Activity 5-2:</b> Emphysema <b>Mini Activity:</b> Advertising for Good Health</p>



---

## Teacher's Guide Overview

This *Breathing* unit is built around a variety of student activities. Text material can be used to introduce, reinforce, and extend the concepts developed in the activities. The activities are the foundation of this unit, so the unit's success depends on students' involvement in the activities. Embedded activities are interrelated, since the concepts developed in one may be applied in another.

### Section Planning

For each section, you'll find extensive advance planning for the student activities and the section topic. Key ideas, section objectives, background information, suggestions for introducing activities, and the materials needed for each activity are listed on the Section Planning page. Review this information ahead of time to ensure that materials for each activity are available when you need them.

### Support for Embedded Activities

Embedded activities are those activities contained or "embedded" in the student edition. Procedures for each embedded activity are contained in the student edition. In the Teacher's Guide, you'll find activity planning information, activity assessment, and student procedures and reproducible pages for each embedded activity.

### Enrichment Activities

Enrichment activities are activities found in the Teacher's Guide. These activities are designed to extend and enrich students' learning experiences. Complete Enrichment activities, including Teacher Activity Notes and student procedures and reproducible pages, are located at the end of each appropriate section of the Teacher's Guide.

### GroupWork Activities

Learning science is a process that is both individual and social. Students in science classrooms often need to interact with their peers to develop a knowledge of scientific concepts and ideas, just as researchers, engineers, mathematicians, and physicians who are working in teams do to answer questions and to solve problems. The GroupWork activities of the HumBio Curriculum for Middle Grades have been developed to foster a collaborative environment for groups of students. Students plan experiments, collect and review data, ask questions and offer solutions, use data to explain and justify their arguments, discuss ideas and negotiate conflicting interpretations, summarize and present findings, and explore the societal implications of the scientific enterprise. In short, GroupWork activities provide an environment in which students are "doing science" as a team.

For more information, refer to "Using GroupWork Activities" on TE. The specific GroupWork activities for this unit can be found beginning on TE.

### Projects

The research and action projects in HumBio are varied and provide students with time to explore a particular topic in depth. With Projects, students have the opportunity to take a position based on knowledge gained through research, debate an issue, and devise a plan of action. In this way, students can apply what they are learning to larger issues in the world around them.

Projects for this unit include

- Research Questions and Action Projects
- Air Pollution
- Antismoking Campaign
- Plant-A-Tree
- Mini Science Fair

---

## Assessment Overview

Within each section of the unit there are suggestions for assessment that can be used individually or in combination to develop a complete assessment package. The list below describes the variety of assessment tools provided.



### Apply Your Knowledge

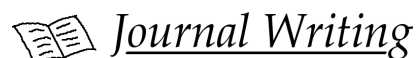
*Apply Your Knowledge* questions appear throughout each section. They can be used as homework assignments and as ways to initiate a class discussion. These questions are designed to assess

- communication skills
- depth of thought and preparation
- problem-solving skills
- ability to apply concepts to related or big ideas
- how well students relate their new knowledge to different problems

### What Do You Think?

These Questions appear in each section. They provide students with opportunities to think and write about the concepts they are learning in a larger context. You can use these questions to assess

- writing skills
- problem-solving abilities
- creativity and depth of thought
- the ability to analyze and summarize



### Journal Writing

*Journal Writing* prompts are suggested throughout the unit. These prompts provide opportunities for students to write critically and creatively about concepts and issues. The writing products can be used to assess

- writing skills
- depth of thought
- and the ability to explain and expand concepts

### Review Questions

*Review Questions* are located at the end of each section. These questions can be used for written responses or as the basis for class discussion. These Questions are designed to assess content knowledge and whether students can explain the concepts explored in the section.

### Activity-Based Assessment

Inquiry-based student-centered activities are the foundation of the *Human Biology* Program. The unit is rich with relevant and exciting activities that introduce support, or reinforce concepts students are exploring. Within the Teacher's Guide, you'll find extensive teacher information, including assessment strategies, for each type of activity:

- Embedded Activities
- Enrichment Activities
- Mini Activities
- GroupWork
- Projects

You can use students' products to assess their progress. These products include models, simulations, observations and report of laboratory investigations, role-plays, written responses to questions and written observations, student-designed explorations and procedures, poster presentations, and classroom presentations.

*You may want to have your students develop a portfolio for the unit. Portfolio assessment is an excellent way to assess the student as he or she progresses throughout the unit. Although there are many opportunities to select a variety of the student's products, the following list shows one possible assessment portfolio for this unit:*

### PORTFOLIO ASSESSMENT

- Written responses to one *Apply Your Knowledge* questions from each section.
- An analysis of their two favorite activities and how those activities helped them learn an important concept
- An Activity Report from three laboratory investigations- *Activity 3-1: It's a Gas-Carbon Dioxide and Oxygen; Activity 3-2: Cell Candles, Activity 4-1:How Does a Controller Work? or Activity 5-2: Emphysema.*
- Two examples of constructing a model-*Activity 1-1: How Do You Breathe?; Activity 2-1: Building Clusters of Balloon Alveoli; Activity 2-2: The More, the Airier; or Activity 5-1: Smoke in Your Lungs.*
- One example of an artistic creation or role-play-*Enrichment 3-1: The Drama of Carbon Dioxide and Oxygen; or Mini Activity: Advertising for Good Health.*

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## Getting Started

**Keep Students Interested.** Encourage the students to read the text. Every effort was made to make the text interesting to students and appropriate to their reading level.

Text material can be used to introduce, reinforce, and extend the concepts addressed in the activities. The success of this unit depends on completion of the activities. Some activities are related since the data obtained in one may be used in another.

**Plan Ahead.** The entire unit is activity based. You can select the activities that best fit your class. The activities are listed in the Unit Matrix. Some activities called Mini Activities are short and can be done individually with minimal teacher input. The Mini Activities are located in the margin of the student edition. The Embedded activities in the student text are longer activities or laboratory investigations that require some planning and setup time. Other laboratory investigations called Enrichment activities are located at the end of each section in the Teacher's Guide. These Enrichment activities greatly enhance student understanding of the concept explored in the section.

A variety of Projects were designed to accompany the unit. These include ongoing class projects, school projects, and/or community projects. These Projects are found at the end of the Teacher's Guide beginning.

**Launch the Unit.** Begin the unit by using models, photographs, or live animals to discuss and compare different ways animals breathe using lungs, gills and/or skin. Assign Project 1 as a follow-up to these demonstrations.

**Customize the Unit.** Each section of this unit builds upon knowledge gained from the previous sections. Two suggested Teaching Timelines are included. The first timeline on page xx schedules the unit within a three-week period of time. The second timeline on page xxi schedules the unit within a five-week period of time. When designing your own timeline consider the inclusion of the Embedded activities first. The Enrichment activities, Groupwork activities, and Projects can then be included, depending on your time restrictions. The timelines are guides which can vary if some activities are done at home and in other classes in addition to science.

**Use Current Events.** You might want to ask the students to bring in newspaper clippings that relate to what they are investigating each week in the *Breathing* unit. Relating the unit content to current events helps the students see that what they are doing in class is, in fact, relevant to their lives. Students can use current events to make group scrapbooks, bulletin boards, and posters or to develop class presentations. Keep a bulletin board for news articles related to health.

You may want to have a “question box” available to the students. Ask students to think of questions they have about what they are investigating. They can write down their questions and put them in the box. Then, when the time is right, pull out the questions and read them to the class. These questions make excellent discussion generators. They can also be used to initiate class research projects.

**Use a Variety of Resources.** For the duration of the unit, we encourage you and your students to use a wide variety of sources for information. The activities provide rich opportunities for students to explore a variety of concepts; and the more they can incorporate information from sources outside the classroom, the richer their experiences will be. Use computer services for student and teacher information, networking (student pen pals, other schools, and communities), and connecting with experts in the field. There are numerous organizations that can provide audiovisual materials, literature, guest speakers and references.

**Make Career Connections** Some careers mentioned are respiratory therapist, paramedic, EMT, doctor, nurse, and athletic trainer. Invite guest speakers to discuss their careers. You can also invite a speaker with a respiratory condition. If you select a guest speaker with a respiratory condition to address that condition be sure to prepare your students appropriately so they will be sensitive and compassionate listeners. Prepare speakers by sharing with them the knowledge base of students.

**Plan for Field Trips.** Field trips to local hospitals, fire stations, industrial sites, or universities need to be arranged in advance. Contact the public affairs offices of these institutions for assistance. Schedule field trips to local hospitals and fire stations.

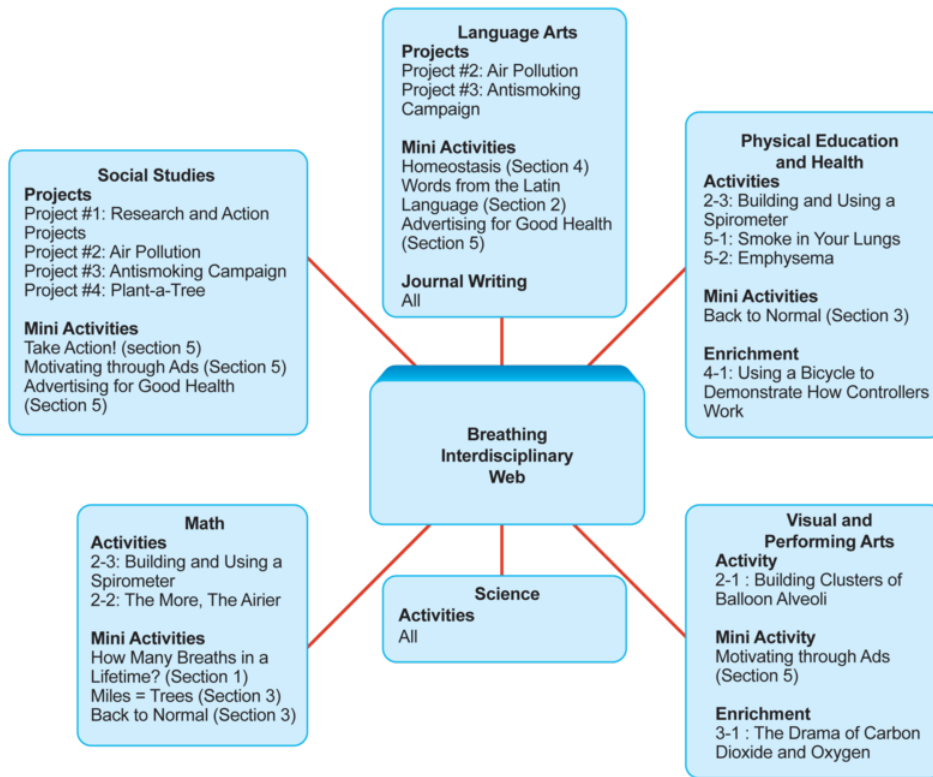
**Address Health Concerns.** Be aware of any special health problems your students may have. Some students may have special health concerns that would make it uncomfortable for them to participate in certain physical activities such as those that may require exercise. Examples of such health problems include congenital or accidental respiratory conditions such as asthma. For students unable to participate fully in these activities you may wish to create an alternative assignment or to have them use data from another group. If the class is prepared appropriately the affected students may want to share their special circumstances with the class to enhance appreciation and understanding for all of the students.

**Connect with Other HumBio Units.** To help students make connections between the respiratory and circulatory systems, we recommend teaching the *Circulation* unit before the *Breathing* unit.

**Connect with Other Disciplines.** The Interdisciplinary Web is provided to assist in your planning if your school uses an interdisciplinary, team-teaching approach. The web classifies the unit’s activities and projects by related discipline-language arts, math, social studies, physical education and health and, of course, science.

For interdisciplinary planning, schedule meetings with your team early. You are encouraged to tap the talents and interests of your team members as well as of your unique school and community resources in developing other suitable activities for this unit.

Some test-site teachers have developed Fitness units using activities in the HumBio units on *Circulation*, *Breathing* and *Digestion Nutrition*. Activities and concepts from these units can be combined to study the “Risk Factors for Cardiovascular Disease.”



## Teaching Timelines

You can use these timelines as a place to start in designing your own timelines, or you can use them as they are laid out. If you’re planning your own timeline, consider the inclusion of the Embedded activities first. The “Embedded activities” are included in the student edition. The Enrichment activities, GroupWork activities, and Projects can then be included, depending on your time restrictions. The timelines are guides that can vary if some activities are done at home or in other classes in addition to science class.

Given your time constraints, it may not be possible to do all the activities shown on these timelines. If you need to remove activities, be careful not to remove any activities critical to the content of the unit. You may want to divide the activities among interdisciplinary members of your teaching team.

Page references in these charts refer to the student edition, except when Enrichments are suggested. The page references for Enrichments refer to this Teacher’s Guide.

**TABLE 1.2: Option 1:ThreeWeek Timeline**

	<b>Monday</b>	<b>Tuesday</b>	<b>Wednesday</b>	<b>Thursday</b>	<b>Friday</b>
<b>Week 1</b>	Read Section 1 Text <b>Activity 1-1:</b> How Do You Breathe?	<b>Mini Activity:</b> Motivating through Ads Continue Activity 1-1	<b>Mini Activity:</b> How Many Breaths in a Lifetime? Review Section 1	Read Section 2 Text <b>Activity 2-1:</b> Building Clusters of Balloon Alveoli	Continue Activity 2-1

**TABLE 1.2:** (continued)

	<b>Monday</b>	<b>Tuesday</b>	<b>Wednesday</b>	<b>Thursday</b>	<b>Friday</b>
<b>Week 2</b>	<b>Activity 2-2:</b> The More, the Airier	<b>Activity 2-3:</b> Building and Using a Spirometer	Assessment for Sections 1 and 2	Read Section 3 Text <b>Activity 3-1:</b> It's a Gas-Carbon Dioxide and Oxygen	<b>Activity 3-2:</b> Cell Candles Review Section 3
<b>Week 3</b>	Read Section 4 Text <b>Mini Activity:</b> Homeostasis	<b>Activity 4-1:</b> How Does a Controller Work? Read Section 5 Text	<b>Activity 5-1:</b> Smoke in Your Lungs <b>Activity 5-2:</b> Emphysema	Unit Assessment Group Sharing	<b>Mini Activity:</b> Take Action! <b>Mini Activity:</b> Motivating through Ads

**TABLE 1.3:** Option 2: Five Week Timeline

	<b>Monday</b>	<b>Tuesday</b>	<b>Wednesday</b>	<b>Thursday</b>	<b>Friday</b>
<b>Week 1</b>	Read Section 1 Text <b>Activity 1-1:</b> How Do You Breathe?	<b>Mini Activity:</b> Motivating through Ads Continue <b>Activity 1-1:</b> How Do You Breathe	Continue <b>Activity 1-1:</b> How Do You Breathe <b>Mini Activity:</b> How Many Breaths in a Lifetime?	Review Section 1 Read Section 2 Text	<b>Mini Activity:</b> Voice Box
<b>Week 2</b>	<b>Activity 2-1:</b> Building Clusters of Balloon Alveoli	<b>Activity 2-2:</b> The More, the Airier	<b>Mini Activity:</b> Words from the Latin Language	<b>Activity 2-3:</b> Building and Using a Spirometer	Assessment for Sections 1 and 2
<b>Week 3</b>	<b>Mini Activity:</b> Miles = Trees <b>Activity 3-1:</b> It's a Gas-Carbon Dioxide and Oxygen	Continue <b>Activity 3-1:</b> It's a Gas-Carbon Dioxide and Oxygen	<b>Activity 3-2:</b> Cell Candles	<b>Mini Activity:</b> Back to Normal <b>Enrichment 3-1:</b> The Drama of Carbon Dioxide and Oxygen	Continue <b>Enrichment 3-1:</b> The Drama of Carbon Dioxide and Oxygen
<b>Week 4</b>	Read Section 4 Text <b>Mini Activity:</b> Homeostasis	<b>Activity 4-1:</b> How Does a Controller Work?	<b>Enrichment 4-1:</b> Using a Bicycle to Demonstrate How Controllers Work	Assessment for Sections 3 and 4 <b>Mini Activity:</b> Take Action!	Introduce Section 5
<b>Week 5</b>	<b>Mini Activity:</b> Motivating through Ads	<b>Activity 5-1:</b> Smoke in Your Lungs	<b>Activity 5-2:</b> Emphysema	<b>Mini Activity:</b> Advertising for Good Health	Assessment

## Safety for Teachers

- Always perform an experiment or demonstration on your own before allowing students to perform the activity. Look for possible hazards. Alert students to possible dangers. Safety instructions should be given each time

an experiment is begun.

- Wear glasses and not contact lenses. Make sure you and your students wear safety goggles in the lab when performing any experiments.
- Do not tolerate horseplay or practical jokes of any kind.
- Do not allow students to perform any unauthorized experiments.
- Never use mouth suction in filling pipettes with chemical reagents.
- Never “force” glass tubing into rubber stoppers.
- Use equipment that is heat resistant.
- Set good safety examples when conducting demonstrations and experiments.
- Turn off all hot plates and open burners when they are not in use and when leaving the lab.
- When students are working with open flames, remind them to tie back long hair and to be aware of loose clothing in order to avoid contact with flames.
- Make sure you and your students know the location of and how to use fire extinguishers, eyewash fountains, safety showers, fire blankets, and first-aid kits.
- Students and student aides should be fully aware of potential hazards and know how to deal with accidents. Establish and educate students on first-aid procedures.
- Teach students the safety precautions regarding the use of electricity in everyday situations. Make sure students understand that the human body is a conductor of electricity. Never handle electrical equipment with wet hands or when standing in damp areas. Never overload electrical circuits. Use 3-prong service outlets.
- Make sure that electrical equipment is properly grounded. A ground-fault circuit breaker is desirable for all laboratory AC circuits. A master switch to cut off electricity to all stations is desirable for all laboratory AC circuits.
- Make sure you and your students are familiar with how to leave the lab safely in an emergency. Be sure you know a safe exit route in the event of a fire or an explosion.

## For Student Safety

### Safety in the Classroom

- Wear safety goggles in the lab when performing any experiments. Tie back long hair and tuck in loose clothing while performing experiments, especially when working near or with an open flame.
- Never eat or drink anything while working in the science classroom. Only lab manuals, notebooks, and writing instruments should be in the work area.
- Do not taste any chemicals for any reason, including identification.
- Carefully dispose of waste materials as instructed by your teacher. Wash your hands thoroughly.
- Do not use cracked, chipped, or deeply scratched glassware, and never handle broken glass with your bare hands.
- Lubricate glass tubing and thermometers with water or glycerin before inserting them into a rubber stopper. Do not apply force when inserting or removing a stopper from glassware while using a twisting motion.
- Allow hot glass to cool before touching it. Hot glass shows no visible signs of its temperature and can cause painful burns. Do not allow the open end of a heated test tube to be pointed toward another person.
- Do not use reflected sunlight for illuminating microscopes. Reflected sunlight can damage your eyes.
- Tell your teacher if you have any medical problems that may affect your safety in doing lab work. These problems may include allergies, asthma, sensitivity to certain chemicals, epilepsy, or any heart condition.
- Report all accidents and problems to your teacher immediately.

### HANDLING DISSECTING INSTRUMENTS and PRESERVED SPECIMENS

- Preserved specimens showing signs of decay should not be used for lab observation or dissection. Alert your teacher to any problem with the specimen.

- Dissecting instruments, such as scissors and scalpels, are sharp. Use a cutting motion directed away from yourself and your lab partner.
- Be sure the specimen is pinned down firmly in a dissecting tray before starting a dissection.
- In most cases very little force is necessary for making incisions. Excess force can damage delicate, preserved tissues.
- Do not touch your eyes while handling preserved specimens. First wash your hands thoroughly with warm water and soap. Also wash your hands thoroughly with warm water and soap when you are finished with the dissection.



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# CHAPTER **2** Breathing: Why and How? - Teacher's Guide (Human Biology)

## Chapter Outline

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- 2.1 PLANNING**
  - 2.2 USING BREATHING: WHY AND HOW? – STUDENT EDITION (HUMAN BIOLOGY)**
  - 2.3 ACTIVITIES AND ANSWER KEYS**
-

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## 2.1 Planning

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### Key Ideas

- We breathe in to get oxygen from the air, and breathe out to get rid of carbon dioxide, a waste gas produced by our cells.
- Our lungs inflate and deflate in response to the contraction and relaxation of the diaphragm muscle.
- Changes in air pressure cause the lungs to expand and contract.

---

### Overview

This section gives students a quick overview of the structure and function of the human respiratory system. Students build a model lung to visualize how air moves in and out as the diaphragm expands and contracts. There is a general discussion of the roles of oxygen and carbon dioxide in breathing. Students explore how scientists and physicians determine individual breathing rates.

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### Objectives

Students:

- ✓ demonstrate how the expansion and the contraction of the diaphragm moves air in and out of a model lung.
- ✓ determine their own breathing rates.
- ✓ explain how air moves in and out of a human lung.

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### Vocabulary

carbon dioxide, diaphragm, lungs, oxygen

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### Student Materials

#### Activity 1-1: How Do You Breathe?

Per team

- Activity Report
- Clear, plastic bottle (about 1 liter); Scissors; Tape ; 2 balloons or one balloon and a rubber glove

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## Teacher Materials

### Activity 1-1: How Do You Breathe?

- Activity Report Answer key
- Diagram or model of respiratory system showing lungs and diaphragm

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## Advance Preparation

See Activity 1-1 in the Student Edition

### Activity 1-1: How Do You Breathe?

- Have students collect clear, plastic, 1 -liter bottles. Each team will need one plastic bottle.
- Depending upon the needs of your students, an adult could assist students with cutting the bottles during class. Another option is to cut the bottles yourself before class.
- You may want to prepare a sample model ahead of time for reference after the activity is completed by students.

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## Interdisciplinary Connections

**Health and Physical Education** In completing this activity emphasis can be placed on keeping the lungs healthy.

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## Enrichment Activities

None

### Background Information

You might want to review the Prerequisites and Background Information for *Activity 1-1: How Do You Breathe?* on TE.

During inhalation, the diaphragm contracts and pulls downward. This increases the volume of the thoracic and pleural cavities. The increase in volume creates negative pressure or suction that causes air to enter the lungs. Intercostal muscles can aid inhalation by lifting the ribs up and outwards, which also increases the volume of the thoracic space. Exhalation is usually passive, beginning when the diaphragm relaxes and moves up resulting in the recoiling of the lungs forcing air out.

If air leaks into the pleural cavity, as in the case of a puncture wound to the chest, the lung will collapse. If the hole is not plugged, the contractions of the diaphragm and the intercostal muscles pull air into the pleural cavity instead of the lung. This compromises the exchange of oxygen and carbon dioxide in the alveoli.

## 2.2 Using Breathing: why and How? – Student Edition (Human Biology)

Discuss the role of models in science.

Begin this topic with *Activity 1-1: How Do You Breathe?* In this activity students build a model of the lungs and explore what happens if the lungs are damaged.

Make sure there is a convenient place for students to store the models they build in Activity 1-1. They will refer to their lung models in other activities throughout the unit.

Assign the *Mini Activity: How Many Breaths in a Lifetime?*

Draw students' attention to the key ideas by using means such as posters or overhead transparencies.


Select appropriate Projects and other activities if time permits.

Throughout and at the end of the section refocus students' attention on the key ideas.

- A suggested response will be provided upon request. **Please send an email to [teachers-requests@ck12.org](mailto:teachers-requests@ck12.org).**

$\xrightarrow[\text{Your}]{\text{Apply}}$  KNOWLEDGE

**A person who can't breathe will faint or "black out." What is fainting and why is it one of the first things to happen when you can't breathe?**

 *Journal Writing*

**I Think Breathing . . .** Write a paragraph or a poem about breathing. What is breathing? How can you tell if you are breathing or not? How does breathing look as you observe someone? How does it feel? How does it sound? What happens when you breathe more quickly? What happens when you breathe more slowly?

$\xrightarrow[\text{Your}]{\text{Apply}}$  KNOWLEDGE

**When you exercise, you breathe deeply. During exercise you take in more air per breath than when you are resting. Do you think this is because the diaphragm contracts more strongly when you exercise? What other muscles can help your diaphragm when you have to breathe deeply? Put your hands flat against the sides of your chest and breathe deeply. Can you feel other muscles helping you to breathe?**

## 2.3 Activities and Answer Keys

### Activity 1-1 : How Do You Breathe?

#### PLAN

**Summary** Students investigate how a lung expands and contracts by building a model of the lung inside a chest wall. After using the model to learn how a “normal lung” functions, students observe what happens when a change in pressure causes a lung to collapse. Making a hole in their model causes the change in pressure and simulates damage to the chest cavity.

#### *Objectives*

Students:

- ✓ explain how air moves in and out of a human lung.
- ✓ demonstrate and explain the function of the diaphragm.
- ✓ differentiate between the changes in air pressure in the lungs when a person inhales and exhales.

#### *Student Materials*

Per team

- Activity Report
- Clear, plastic bottle (about 1 liter) ; Scissors; Tape; 2 balloons or one balloon and a rubber glove

#### *Teacher Materials*

- Activity Report Answer Key
- Diagram or model of respiratory system showing lungs and diaphragm

#### *Advance Preparation*

Have students collect clear, plastic 1-liter bottles. Each team will need one plastic bottle.

Depending upon the needs of your students, an adult could assist students with cutting the bottles during class. Another option is to cut the bottles yourself before class.

You may want to prepare a sample model ahead of time for reference after students perform the activity.

**Estimated Time** One 50-minute period

#### *Interdisciplinary Connection*

**Physical Education** Develop exercise plans to keep the lungs healthy.

#### *Prerequisites and Background Information*

Students need some manual dexterity to successfully tape the balloon or glove over the open end of the cut bottle.

The model shows how a lung expands as the diaphragm (balloon or rubber glove) is pulled down (contracts). Contracting enlarges the model chest cavity by expanding the rib cage, and lowers air pressure between the chest

wall and the lung. Students can see this effect when they poke a hole in the bottle, and air enters when they pull the diaphragm down. Air always moves from a region of higher air pressure to a region of lower air pressure. Asking what happens to the volume of air between the balloon and the bottle wall when the diaphragm (balloon or rubber glove) is pulled down (contracts) gets at the idea of falling pressure in the chest. As the chest model expands, air pressure in it falls and the model lung balloon expands. As the lung balloon expands, air pressure in it falls. Air from the room (where air pressure is high) enters the balloon to equalize the pressure difference and fill the increased volume in the balloon.

In expiration, the diaphragm moves up (relaxes). The volume between the model chest wall and the balloon gets smaller. Consequently, the pressure in this space increases. The rising pressure in the chest cavity squeezes the lung balloon and makes it smaller. The squeeze increases the air pressure in the lung model above the air pressure in the room. Air moves from the model lung (where air pressure is high) into the room, where air pressure is lower.

A lung collapses when air gets between it and the chest wall. For example, a puncture wound to the chest or a tear in the lung itself can cause a collapsed lung. The air in the chest caused by the leak increases the pressure and volume of gas between the lung and the chest wall. Two new things can be observed in the model.

- a. The lung balloon does not open up well when the diaphragm falls.
- b. Air enters the hole in the chest wall when the diaphragm falls, making the problem worse.

An interesting application of this phenomenon is the ventilator used in hospitals. When the diaphragm is paralyzed and cannot move (contract and relax) on its own, the ventilator blows up the lungs inside the chest by puffing a volume of air into the lungs under pressure. During this positive pressure ventilation, air pressure in the lungs is greater than room air pressure at the end of an inspiration. In normal breathing, air pressure in the lungs is the same as the air pressure in the room.

Students can blow up the model lung balloon inside the chest by mouth to examine this phenomenon. As a challenge, try to figure out what happens to the pressure between the lung and chest in each type of breathing.

## IMPLEMENT

**Introduce Activity 1-1** by reviewing with students the information and diagram in section 1 of the text. You may want them to summarize the information in their own words, either orally with a partner or in writing.

**Steps 1-2** You may want to demonstrate how to feed the open end of the balloon up through the mouth of the bottle from the inside and roll the balloon over the lip of the bottle. Remind students about potential safety hazards of using sharp instruments. You may want to post the safety rules from TE.

**Steps 3-7** Check students' models to make sure there are no air leaks between the balloon and the bottle. In addition, make sure the balloon is not so tight that it pulls the sides of the bottle together.

**Step 8** Demonstrate how to make a hole in the bottle safely.

Demonstrations and/or investigations relating to changes in air pressure and the behavior of gases can be provided and discussed.

*Use large balloons of good quality.*

*Have students put names on their models and keep the models for reference throughout the unit.*

*Encourage students to take their models home to demonstrate and explain what they are learning.*

## Helpful Hints

Students can “blow up” the lung balloon by mouth. This is called positive pressure ventilation. When the diaphragm is paralyzed, a hospital ventilator puffs a volume of air into the lungs under pressure. After positive pressure ventilation (at the end of inspiration), air pressure in the lungs is greater than room air pressure. Students must

hold the lung open with air pressure. Expiration occurs when the machine drops the pressure and the lungs and chest relax. When students take their mouths from the balloons, the balloons empty passively.

As a challenge, students can figure out what happens to pressure between the lung and chest at the end of inspiration in each type of breathing.

**Conclude Activity 1-1** by discussing the questions on the Activity Report. You may want to assign the questions as written class work or homework.

## ASSESS

Use the model of a lung in the chest wall and the written answers on the Activity Report to assess if students can

- ✓ describe how a “normal lung” functions.
- ✓ compare and contrast the differences between inhaling and exhaling.
- ✓ demonstrate the important role the diaphragm plays in the process of breathing.
- ✓ explain the effect on the lung when there is a sudden change in pressure.

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## Activity 1-1: How Do You Breathe? – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**
1. What happens between the lung and the chest when the diaphragm pulls down? Why?
  2. What happens between the lung and the chest when the diaphragm moves up? Why?
  3. What happens between the lung and the chest with a hole when the diaphragm pulls down?
  4. What happens between the lung and the chest with a hole when the diaphragm moves up?
  5. How can you make the model work properly?
- A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

*Apply*  
→  
*Your* → **KNOWLEDGE**

**What are hiccups? What happens to your diaphragm when you get the hiccups? What causes hiccups?**




Mini-  
Activity

**How Many Breaths in a Lifetime?** Students determine breathing rate per minute and per lifetime when sitting and when exercising. Encourage students to make a data table and present it to the class.

*Apply*  
→  
*Your* → **KNOWLEDGE**

**Why would the Olympic cross country running team train at high altitudes?**

Write a poem or a song using the vocabulary in this section to describe what you think about breathing. You can relate your lungs to objects such as broccoli or relate your breathing to functions you commonly encounter, such as wind outside your window.

 *Journal Writing*

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**Review Questions/Answers**

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**
1. Why do you need to breathe continuously?
  2. Why do you exhale carbon dioxide ( $CO_2$ )?
  3. Describe how your diaphragm works to make you breathe in and out.

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**Activity 1-1 Report: How Do You Breathe? (Student Reproducible)**

1. What happens between the lung and the chest when the diaphragm pulls down? Why?
2. What happens between the lung and the chest when the diaphragm moves up? Why?
3. What happens between the lung and the chest with a hole when the diaphragm pulls down?
4. What happens between the lung and the chest with a hole when the diaphragm moves up?
5. How can you make the model work properly?



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CHAPTER **3** **My Breathing Machine -  
Teacher's Guide (Human Biology)**

**Chapter Outline**

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- 3.1 PLANNING**
  - 3.2 USING MY BREATHING MACHINE – STUDENT EDITION(HUMAN BIOLOGY)**
  - 3.3 ACTIVITIES AND ANSWER KEYS**
-

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## 3.1 Planning

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### Key Ideas

- Your airways are designed to provide oxygen-rich, moist air to the air sacs inside your lungs.
- Your lungs have millions of air sacs to maximize efficiency of gas exchange. If air sacs are damaged breathing efficiency is reduced.
- The structure of your airways ensures that some air remains in the lungs as a reserve.

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### Overview

This section covers the structure and function of each part of the respiratory system, from the nose to the many alveoli. Students build a model of the voice box. They relate the number and size of the alveoli to the total surface area of the lungs. Students explore the relationship between surface area and efficient gas exchange in the lungs. They measure their lung volumes with a student-made spirometer and find out about how much air they exhale during normal and deep breathing.

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### Objectives

Students:

- ✓ explain how each part of the respiratory system assists in breathing.
- ✓ describe how the numbers and the size of the air sacs relate to the amount of oxygen that can be utilized by the lungs.
- ✓ demonstrate the relationship between size of the sphere and the total surface area.
- ✓ compare breathing rates and gas volumes among different individuals to illustrate differences from person to person.

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### Vocabulary

alveoli, arteries, bronchi, bronchioles, capillaries, diffusion, epiglottis, esophagus, glottis, larynx, mucus, pharynx, trachea, veins, venules, vital capacity

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## Student Materials

### Activity 2-1: Building Clusters of Balloon Alveoli

Per student

- Activity Report

Per team

- Balloon; Yarn; Glue; Rope; String

### Activity 2-2: The More, the Airier

Per student

- Activity Report

Per team

- 1 volleyball; Calculator; 4-liter freezer bags; 16 tennis balls; 60 golf balls; Ruler or tape measure (metric)

### Activity 2-3: Building and Using a Spirometer

Per student

- Activity Report

Per team

- Large container for water (metal washtub or deep plastic basin)
- 2 plastic gallon jugs; Funnel; Rubber tubing; 100 *ml* (milliliter) beaker; Waterproof marker; Calculator; Plastic straw to fit inside tubing

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## Teacher Materials

### Activity 2-1: Building Clusters of Balloon Alveoli

- Activity Report Answer Key

### Activity 2-2: The More, the Airier

- Activity Report Answer Key
- Optional: 4-liter bag of sand; 4-liter bags of BB's; Marbles; Sand; Gravel ; Grapes; Slides of cross sections of normal and diseased lungs

### Activity 2-3: Building and Using a Spirometer

- Activity Report Answer Key

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## Advance Preparation

### Activity 2-1: Building Clusters of Balloon Alveoli

Purchase balloons of good quality.

See Activity 2-1, 2-2, and 2-3 in the Student Edition.

### Activity 2-2: The More, the Airier

- Obtain slides of normal lung tissue and lung tissue with carbon particles. They may be ordered from :
- TRIARCH Prepared Microscope Slides, P.O. Box 98, Ripon, WI 54971 (414) 748-5125
- Collect used tennis balls. A department of recreation or park where tennis lessons are given can be a good source or students can provide them.
- Collect used golf balls. A driving range may be able to supply them or students can provide them.
- Sort the balls into separate containers for each group. Since the 4-liter bags hold about 16 tennis balls and about 60 golf balls, make sure there are enough at each station to fill the bags.
- The surface areas calculated for the three types of balls and for the alveoli can be marked off on the floor or the ground outside. You may decide to do this ahead of time.

### Activity 2-3: Building and Using a Spirometer

- One week before doing this activity, have your students collect clear, plastic gallon, or larger, jugs (e.g., milk jugs).
- Make sure that the tubing has an internal diameter that will allow for a piece of a straw (mouthpiece) to fit snugly inside.
- A few large basins (large metal washtubs) or plastic containers can be set up so that each can be used for more than one group of students.
- Note: Instead of using one class period for calibrating the jugs, you may want to calibrate the jugs ahead of time using student help.

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## Interdisciplinary Connections

**Math** Students find the surface area of a sphere, the diameter of a circle, square root, and the significance of  $\pi$ .

**Physical Education and Health** Students discuss ways to maintain healthy lungs.

### Background Information

The volume of air breathed in per inhalation during normal breathing is called the tidal volume. Not all of the air breathed in reaches the alveoli. Some of it remains in the air spaces (nose, pharynx, larynx, trachea, and bronchi) and is called dead air volume. In addition, the air breathed in mixes with stale air before it reaches the alveoli.

- Tidal Volume (500 ml): Volume of air breathed in one inhalation during normal breathing.

- Inspiratory Reserve Volume (3,100 ml): The volume of air inhaled during a very deep breath minus the tidal volume.
- Expiratory Reserve Volume (1,200 ml): The extra volume of air we are able to exhale forcibly.
- Residual Volume (1,200 ml): The air that remains in the lungs after forcible exhalation. The slightly negative pressure of the pleural cavities keeps the lungs and the alveoli partially inflated.
- Inspiratory Capacity (3,600 ml): The sum of the tidal volume and the inspiratory reserve volume. It is the total inspiratory ability of the lungs.
- Functional Residual Capacity (2,400 ml): Sum of the residual volume plus expiratory reserve volume.
- Vital Capacity (4,800 ml): The sum of the tidal volume, expiratory reserve volume, and the inspiratory reserve volume.
- Total Lung Capacity (6,000 ml): Sum of the residual volume, the expiratory reserve volume, tidal volume, and inspiratory reserve volume.

These values are average for an adult but vary widely depending on body size.

## 3.2 Using My Breathing machine – Student Edition(Human Biology)

Discuss the role of models in science.

Begin with *Activity 2-1: Building Clusters of Balloon Alveoli*. This activity will help students visualize the structure of the lungs and learn that many alveoli compose the lung.

Assign *Activity 2-2: The More, the Airier*. This activity helps students visualize the surface area of the lungs where gas exchange occurs, emphasizing that the greater the surface area the more gas exchange takes place.

Review the necessary math skills for *Activity 2-2: The More, the Airier*. The science teacher can provide the formulas as students are doing the activity, or spend time before the activity using the formulas to measure the volume of various spheres. An interdisciplinary connection with the math teacher can help build the skills needed to use the formulas.

Assign *Activity 2-3: Building and Using a Spirometer*.

Draw students' attention to the key ideas using means such as posters or overhead transparencies.

Select appropriate Projects.

Throughout and at the end of the section refocus students' attention on the key ideas.

*Cold medicines such as decongestants slow the production of mucus. As you learned, mucus is the body's way of catching and getting rid of germs and foreign materials. Do you think it is wise or not to take cold medications like decongestants? Why or why not?*

**What Do You Think?**



### Mini-Activity

**Voice Box** Students build a voice box using a cardboard box, a stick, and rubber bands.

A suggested response will be provided upon request. **Please send an email to [teachers-requests@ck12.org](mailto:teachers-requests@ck12.org).**

*Apply*  
→ *Your* → **KNOWLEDGE**

**What is the function of the rings of cartilage in your trachea?**

## 3.3 Activities and Answer Keys

### Activity 2-1: Building Clusters of Balloon Alveoli

#### PLAN

**Summary** Students learn about the breathing pathway by making a model using balloons, string, yarn, and rope. An analogy for the interconnected system of the breathing pathway is the balloon cluster.

#### *Objectives*

Students:

- ✓ make an analogy between the balloon cluster and their lungs.
- ✓ identify the different parts of the breathing pathway.
- ✓ explain the relationship between circulation and respiration.

#### *Student Materials*

Per student

- Activity Report

Per team

- Balloon; Yarn; Glue; Rope; String

#### *Teacher Materials*

- Activity Report Answer Key

#### *Advance Preparation*

Purchase good quality balloons.

**Estimated Time** 40 minutes

#### *Prerequisite and Background Information*

The model emphasizes the important concept that air in the trachea follows individualized paths to separate alveoli (with some mixing, of course).

Discuss that the blood in the lung capillaries comes from the heart through the pulmonary artery and goes back to the heart through the pulmonary vein. If students have studied the circulatory system, this will be a review. If they have not studied the circulatory system, the connection between circulation and breathing can be made here. An appropriate question might be, “Where is there more oxygen- the pulmonary artery from heart to lungs or pulmonary vein from lungs to heart?”

## IMPLEMENT

**Introduce Activity 2-1** by making an analogy to a tree or freeway. Cars traverse roadways from smaller to larger, then come into a highway from on ramps (branches). Cars leave the highway by way of off ramps (branches). Cars traverse smaller and smaller roadways until they reach parking areas (alveoli) where they stop.

**Steps 1-6** Some students may require help tying off the blown-up balloons. It may help to put the glue to be used for the string in a small bowl. Then demonstrate how to bunch up the string to cover it with glue. Demonstrate this process by placing the string in the glue bowl, pulling it out, and running it between your thumb and forefinger to remove excess glue.

*You may want to substitute fish nets, court nets, or hair nets for the string to represent the capillaries. Contact a beauty school to obtain hair nets. Spray paint the string or nets red and blue to represent the oxygen-rich and oxygen-poor capillaries.*

*Provide a place and materials for washing hands after handling the glue.*

### Helpful Hints

Display the balloon clusters throughout the unit. Students can break some of the balloons after they complete *Activity 5-2: Emphysema* on page 48 to represent the loss of alveoli due to lung disease such as emphysema.

**Conclude Activity 2-1** by again discussing where the blood in the capillaries comes from (pulmonary artery) and where the blood goes (pulmonary veins).

## ASSESS

Use the written answers on the Activity Report to assess if students can

- ✓ make an analogy between the balloon cluster and their lungs.
- ✓ explain the relationship between circulation and respiration.
- ✓ identify the different parts of the breathing pathway (trachea, bronchi, and alveoli).
- ✓ locate the position of the alveoli capillaries.

- A suggested response will be provided upon request. **Please send an email to [teachers-requests@ck12.org](mailto:teachers-requests@ck12.org).**

$\xrightarrow[\text{Your}]{\text{Apply}}$  KNOWLEDGE

**Different molecules diffuse at different rates. Give an example of different molecules that diffuse at different rates. Even one kind of molecule can diffuse at different rates depending on the conditions under which it is diffusing. Give an example of a molecule that can diffuse at a different rate when the temperature is cold than when the temperature is warm.**

---

## Activity 2-1: Building Clusters of Balloon Alveoli – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to [teachers-requests@ck12.org](mailto:teachers-requests@ck12.org) to request sample answers.**

1. What part of your breathing system model does each of the following represent?



- a. Balloons
  - b. Yarn
  - c. Rope
  - d. String
2. What do the capillaries in your lungs do for you?
  3. How does the structure of all your airways together appear like a tree?

---

## Activity 2-2: The More, the Airier

### PLAN

**Summary** Students compare the total surface area of a volume of small spheres with the same volume of large spheres to determine which is greater. They apply their finding to the surface area of the lungs. The air sacs (alveoli) are small and provide the lungs with a large surface area for gas exchange.

#### *Objectives*

Students:

- ✓ calculate the surface area of a sphere.
- ✓ demonstrate that the difference in total surface area of a given volume of spheres depends on the size of the sphere.
- ✓ explain what happens if the number of air sacs in the lung are reduced.

#### *Student Materials*

Per student

- Activity Report

Per team

- Calculators; 4-liter freezer bags; 16 tennis balls; 60 golf balls; Pencils; Rulers or tape measures (metric); 1 volleyball

#### *Teacher Materials*

- Activity Report Answer Key

Optional:

- 4-liter bag of sand; 4-liter bags of BB's; Marbles; Sand; Gravel; Grapes; Slides of cross sections of normal and diseased lungs

#### *Advance Preparation*

Obtain slides of normal lung tissue and lung tissue with carbon particles- they may be ordered from TRIARCH Prepared Microscope Slides, P.O. Box 98, Ripon, WI 54971 (414) 748-5125.

Collect used tennis balls. A department of recreation or park where tennis lessons are given can be a good source or students can provide them.

Collect used golf balls. A driving range may be able to supply them or students can provide them.

Sort the balls into separate containers for each group. Since the 4-liter bags hold about 16 tennis balls and about 60 golf balls, make sure there are enough at each station to fill the bags.

The surface areas calculated for the three types of balls and for the alveoli can be marked off on the floor or the ground outside. You may decide to do this ahead of time.

**Estimated Time** Several class periods

If students understand area and can use  $\pi$  and the formula for the surface of a sphere: surface area = diameter<sup>2</sup> ×  $\pi$ , they can count the balls, measure, and calculate in one period, and explore the relationships in a second period.

### **Interdisciplinary Connections**

**Math** Students can determine the surface area of a sphere, the diameter of a circle, square root, and the significance of  $\pi$ .

### **Prerequisite and Background Information**

This activity has several math connections, such as measuring the diameter of a circle, calculating surface area, taking the square root of a number, and using and/or understanding the meaning of  $\pi$ . Before doing the activity, it is helpful for students to have some knowledge and practice using these math skills.

One way to investigate the meaning of  $\pi$  is by wrapping balls in squares of paper whose sides equal the ball's diameter. This may help some students grasp more fully that  $\pi$  is a fixed ratio of a circumference divided by its diameter. A school-yard activity clarifies this further. Using a string and chalk, mark circles on the ground. Then use the string to find the circles' diameters. Then step off this diameter using the string to measure off the circumference of each circle to show that the ratio is a little bit more than three diameters in any circumference, e.g., 3.1. In this lab a value of 3.1 instead of 3.14159 represents sufficient accuracy.

The tennis and golf balls represent “air sacs” of varying diameters. Using 4-liter plastic bags to represent the lung, the number of tennis or golf balls that fit in the 4-liter bag are counted. Then the total surface area in each bag of balls can be calculated. A number for the diameter of the air sacs is provided so that the surface area of the lungs can be calculated. These values are compared. Students see that the surface area of the bag of balls increases as the size of the ball decreases. This finding leads to a discussion of why the large number of air sacs in the lungs provides an efficient gas exchange system for the body.

A large surface area for gas exchange is provided in lungs filled with many small alveoli. There are about 150 million alveoli in each human lung (right and left), and each averages 200 microns or .0002 m in diameter. This finding leads to estimations that the 150 million alveoli in each lung have a surface area of between 60 and 80 square meters. Estimates vary because the sizes of real alveoli vary around a mean value of about 200 microns. Functional surface area available for gas exchange also depends on how expanded the chest is (i.e., deep or shallow breath) or whether a person is lying down or standing. Gravity collapses lower alveoli but opens up higher ones because the lung is almost always partially collapsed like a hanging slinky with one end on the floor. If the number of functioning alveoli is reduced, as they are in people with emphysema, the available surface area is decreased. Smokers are often victims of emphysema, which is a disease that causes the alveoli to lose elasticity and remain filled with air. Many alveoli join together, thus reducing surface area. Other diseases that can affect the function of the alveoli are TB, pneumonia, and lung cancer.

## **IMPLEMENT**

**Steps 1- 2** Remind students to use Data Table 1 to record data from Steps 1 and 2 of the Procedure.

Remind students that they need to transfer the surface areas that were calculated and recorded on Data Table 1 onto Data Table 2.

**Steps 3-6** Students may need hints to calculate the square root in order to calculate the measurement of the sides of the squares when marking off the surface areas of the 4 spheres.

**Conclude Activity 2-2** by discussing the questions on the Activity Report. You may wish to assign the questions as written class work or homework.

*When measuring the diameter of the balls, students must place the ball on the ruler or tape and use index cards or books set perpendicular to the table.*

*A metric tape measure taped onto the table top can be used by more than one pair of students. Students place the ball on the tape measure to measure the diameter.*

*This activity works well when students work in pairs, but groups of four can be used.*

*4-liter bags of marbles, BB's, pebbles, grapes, and sand can be used to generate discussion on how the total surface area increases as the size of the units decreases.*

### Helpful Hints

**Extend this Activity** by having students count or estimate the number of marbles, BBs, and/or pebbles in the 4-liter bag. Then have them predict how the surface area would be changed compared to the surface area of the tennis and/or golf balls.

Students can take the displaced water from the spirometer in Activity 2.3, pour it into a freezer bag, and see that the volumes are about equal. Only the residual volume-the volume in the lung that cannot be exhaled-does not show up in the student's water measurement.

### ASSESS

Use the written answers on the Activity Report to assess if students can

- ✓ measure the diameter of a circle.
- ✓ use equations to calculate the surface area of a sphere and the total surface area of a given volume of spheres.
- ✓ determine the relationship between the size of the sphere and the amount of surface area represented.
- ✓ measure an area represented by the total surface area of all the alveoli.

---

## Activity 2-2: The More, the Airier – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

**TABLE 3.1: Data Table 1**

Type of Sphere	Diameter(cm)	Diameter <sup>2</sup> (cm <sup>2</sup> )	$\pi$ (3.1)	Surface area of ball (cm <sup>2</sup> )
volleyball				
tennis ball				
golf ball				
alveoli	.025	.0006	3.1	.002

**TABLE 3.2: Data Table 2**

Type of Sphere	Surface area of ball ( $cm^2$ )(From Table 1)	×Number of spheres	= Total surface area ( $cm^2$ )
volleyball			
tennis ball			
golf ball			
alveoli	.002	× 300 million	= 600,000 $cm^2$ ? or 60 $m^2$

1. How many volleyball-sized units can the chest hold? Tennis ball-sized units? Golf ball-sized units? Air sacs (alveoli)?
2. Explain what happens to the number of balls as the size of the ball gets smaller.
3. What is the surface area of a volleyball-sized sphere? all the tennis ball-sized? all the golf ball-sized? all the air sacs (alveoli)?
4. Draw to scale squares representing the surface areas of the spheres listed below. For the air sacs, find a large area outside or in the classroom. What are the dimensions of each square?
5. If for some reason the number of your air sacs (alveoli) were reduced and the total surface area of your air sacs was reduced, what effect would it have on your breathing? Give some examples.



## Mini-Activity

**Words from the Latin language** Students research the Latin word origins of terms introduced in Section 2.

### Activity 2-3: Building and Using a Spirometer

#### PLAN

**Summary** Students measure the vital capacities of their lungs by building and using a spirometer. They also estimate the amount of gas exhaled in a minute, a day, and a year.

#### Objectives

Students:

- ✓ demonstrate the vital capacities of their lungs using a spirometer.
- ✓ measure the volume of gas exhaled in normal and deep breathing.
- ✓ estimate the amount of gas exhaled in a minute, a day, and a year.
- ✓ determine the relationship between breathing rates and volume of gas exhaled and how this varies from person to person.

#### Student Materials

- Activity Report
- A large plastic container, basin or washtub,  $\frac{1}{2}$  to  $\frac{2}{3}$  full of water
- Two plastic gallon jugs; Funnel; Rubber tubing; 100 ml (milliliter) beaker; Waterproof marker pens; Calculator; Plastic straw

#### Teacher Materials

- Activity Report Answer Key

### ***Advance Preparation***

One week before doing this activity have your students collect clear, plastic, gallon, or larger, jugs (e.g., milk jugs). Make sure that the tubing has an internal diameter that will allow for a piece of a straw (mouthpiece) to fit snugly inside.

A few large basins (large metal washtubs) or plastic containers can be set up so that each can be used for more than one group of students.

**Note:** Instead of using one class period for calibrating the jugs, you may want to calibrate the jugs ahead of time using student help.

**Estimated Time** Two 50-minute periods

### ***Interdisciplinary Connection***

**Math** Students can measure volume of various objects in milliliters. In addition, they can calculate breathing rates under different physical conditions.

### ***Prerequisite and Background Information***

When resting, an adult normally breathes about 500 ml of air in and out (tidal volume). Taking a deep breath can increase the volume up to six times (inspiratory reserve volume). After inhaling a normal breath, an adult can forcibly exhale over twice as much as was taken in. That is called your expiratory reserve volume. The adult vital capacity (about 4,800 ml) is the sum of the tidal volume (500 ml) plus the inspiratory reserve volume (3,100 ml), plus the expiratory reserve volume (1,200 ml). Vital capacity plus the air in an adult chest that cannot be breathed out (dead space) is the total lung capacity (6,000 ml).

## **IMPLEMENT**

**Introduce Activity 2-3** by demonstrating and discussing the following.

- Use a Short piece of plastic straw as a mouthpiece. The straw should fit snugly into the tubing.
- Stress the importance of not sharing straws.
- Demonstrate how to label the jug, beginning at the bottom.

**Step 1** Instead of using one class period for this, you may want to calibrate jugs ahead of time using student assistants.

**Steps 2-11** Check that students are recording the measurement for the exhaled air and not the water volume.

**Steps 8-12** Stress the importance of not sharing straws, and make sure students discard the straws for sanitary reasons so no one else uses them.

**Step 12** Students can visualize different volumes of air by placing the following amount of water into different containers:

Normal breath-tidal volume 500 ml

Deep breath-inspiratory capacity 3,500 ml

Normal Expiration-expiratory reserve volume 1,200 ml

Total lung capacity 6,000 ml

*This activity works well when it is done outside.*

*The order of the activity can be changed: i.e., the deep breaths can be taken and recorded before the regular breaths, if the students are competitive about the volume of the regular breath.*

Students can measure volumes of regular and irregularly-shaped objects.

Compare air volumes after exercise with the air volumes measured at rest.

### Helpful Hints

### ASSESS

Use the spirometer and the written answers on the Activity Report to assess if students can

- ✓ explain that the air was measured by displacing an equal volume of water.
- ✓ describe the importance of repeating the experiment to determine an average.
- ✓ distinguish between an estimate and an actual measurement.
- ✓ discuss the accuracy of using a spirometer to measure vital capacity.
- ✓ compare the variation in normal lung volumes from one person to another.

## Activity 2-3: Building and Using a Spirometer – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

**TABLE 3.3:** Data Table 1 Observations will vary.

Breaths	Column 1 Volume (ml/breath)	exhaled	Column 2 Breaths/minute	Column 3 Volume (ml/min.)	exhaled/min.
Normal Breath					
1					
2					
3					
Total					
Average			×		=

**TABLE 3.4:** Data Table 2 Observations will vary.

Breaths	Column 1 Volume (ml/breath)	exhaled	Column 2 Breaths/ minute	Column 3 Volume exhaled/min.(ml/min.)
Deep Breath				
1				
2				
3				
Total				
Average			×	=

1. How much air did you breathe out in a minute in a normal breath?
2. How much air did you breathe out in a minute in a deep breath?
3. How would total volume of air breathed by a person with healthy alveoli compare with that of a smoker with

emphysema whose alveoli are reduced in number?

- A suggested response will be provided upon request. **Please send an email to teachers-requests@ck12.org.**

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**People who were born and lived their whole lives in the high Andes Mountains of South America are described as being “barrel-chested.” Why do you think this is so? What is the effect of altitude on the oxygen you breathe?**

$\xrightarrow[\text{Your}]{\text{Apply}}$  **KNOWLEDGE**

**The air you breathe is 20% oxygen. Do you think the concentration of oxygen is the same in your alveoli when you breathe in? Explain.**

*Pretend you are a small quantity of air. Describe your journey through your breathing system. Begin your journey entering the nose and mouth and stopping when you leave the breathing system to enter the blood capillaries. Your response can be in the form of a short story, cartoon, or poem.*

### Journal Writing

## Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**
1. Explain how each major part of your respiratory system from your nose to your alveoli helps you to breathe.
  2. How are your air sacs designed to maximize the amount of oxygen you can get from the air you breathe?
  3. What happens in your lungs when you hold your breath?

## Activity 2-1 Report: Building Clusters of Balloon Alveoli (Student Reproducible)

1. What part of your breathing system model does each of the following represent?
  - a. Balloons
  - b. Yarn
  - c. Rope
  - d. String
2. What do the capillaries in your lungs do for you?
3. How does the structure of all your airways together appear like a tree?

## Activity 2-2 Report: The More, the Airier (Student Reproducible)

**TABLE 3.5: Data Table 1**

Type of Sphere	Diameter (cm)	Diameter <sup>2</sup> (cm <sup>2</sup> )	$\pi(3.1)$	Surface area of ball (cm <sup>2</sup> )
volleyball			3.1	
tennis ball			3.1	
golf ball			3.1	
alveoli	.025	.0006	3.1	.002

**TABLE 3.6: Data Table 2**

Type of Sphere	Surface area (From Table 1)	× Number of spheres	= Total surface area (cm <sup>2</sup> )
volleyball		×	=
tennis ball		×	=
golf ball		×	=
alveoli	.002	× 300 million	= 600,000 cm <sup>2</sup>

1. How many volleyball-sized units can the chest hold?

Tennis ball-sized units?

Golf ball-sized units?

Air sacs (alveoli)?

2. Explain what happens to the number of balls as the size of the ball gets smaller.

3. What is the surface area of

a volleyball-sized sphere?

all the tennis ball-sized?

all the golf ball-sized?

all the air sacs (alveoli)?

4. Draw to scale squares representing the surface areas of the spheres listed below. For the air sacs, find a large area outside or in the classroom. What are the dimensions of each square?

The volleyball-sized unit?

The tennis ball-sized unit?

The golf ball-sized unit?

All of the air sacs (alveoli)?

5. If for some reason the number of your air sacs (alveoli) were reduced, and therefore total surface area of your air sacs was reduced, what effect would it have on your breathing? Give some examples.

## Activity 2-3 Report: Building and Using a Spirometer (Student Reproducible)



**TABLE 3.7: Data Table 1**

<b>Breaths</b>	<b>Column 1 Volume (ml/breath)</b>	<b>exhaled</b>	<b>Column 2 Breaths/minute</b>	<b>Column 3 Volume exhaled/min.(ml/min.)</b>
Normal Breath				
1				
2				
3				
Total				
Average				

**TABLE 3.8: Data Table 2**

<b>Breaths</b>	<b>Column 1 Volume (ml/breath)</b>	<b>exhaled</b>	<b>Column 2 Breaths/minute</b>	<b>Column 3 Volume (ml/min.) exhaled/min.</b>
Deep Breath				
1				
2				
3				
Total				
Average				

1. How much air did you breathe out in a minute in a normal breath?
2. How much air did you breathe out in a minute in a deep breath?
3. How would the total volume of air breathed by a person with healthy alveoli compare with that of a smoker with emphysema whose alveoli are reduced in number?

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CHAPTER **4** **Oxygen, Carbon Dioxide,  
and Energy - Teacher's Guide (Human  
Biology)**

**Chapter Outline**

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- 4.1 PLANNING
  - 4.2 USING OXYGEN, CARBON DIOXIDE, AND ENERGY – STUDENT EDITION (HUMAN BIOLOGY)
  - 4.3 ACTIVITIES AND ANSWER KEYS
  - 4.4 ENRICHMENT
-

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## 4.1 Planning

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### Key Ideas

- Photosynthesis and respiration represent the oxygen and carbon dioxide cycles in animals and plants.
  - Photosynthesis is the process by which plants incorporate the energy of the sun into the chemical bonds of sugar (fuel).
  - Cellular respiration can be compared to burning candles. Like candles, cells need fuel and oxygen in order to burn, and they produce carbon dioxide and water as they release the energy from the chemical bonds of the fuel.
- 

### Overview

Following the study of breathing in the previous sections, students investigate the importance of photosynthesis and cellular respiration. They complete activities that test for carbon dioxide as part of the respiration-photosynthesis cycle, and they observe the production of oxygen as part of the process of photosynthesis. Cellular respiration is compared to a burning candle. Students create and present a play in which the movement of the molecules and the cyclic relationship of respiration and photosynthesis is depicted.

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### Objectives

Student:

- ✓ explain the importance of respiration and photosynthesis.
  - ✓ show the relationship between photosynthesis and respiration.
  - ✓ compare cellular respiration to a burning candle.
- 

### Vocabulary

cellular respiration, glucose, photosynthesis

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### Student Materials

#### Activity 3-1: It's a Gas-Carbon Dioxide and Oxygen

- Activity Report

- Bromthymol blue indicator solution; Plastic wrap or 2 test tube stoppers; Masking or labeling tape; Straws; 2 Test tubes; Beaker or similar container; *Elodea* or some other water plant; Pond water

### Activity 3-2: Cell Candles

- Activity Report
- 1 tall glass, glass jar, or beaker; 1 bowl larger than the glass, glass jar, or beaker; 1 candle; Matches; Water

---

## Teacher Materials

### Activity 3-1: It's a Gas-Carbon Dioxide and Oxygen

- Activity Report Answer Key
- Bromthymol blue indicator
- Baking soda or sodium hydroxide and vinegar to adjust pH
- Light source

### Activity 3-2: Cell Candles

- Activity Report Answer Key
- 3 candles
- Bromthymol blue

---

## Advance Preparation

See Activities 3-1 and 3-2 in the Student Edition.

### Activity 3-1: It's a Gas-Carbon Dioxide and Oxygen

- Obtain individually wrapped straws from the cafeteria or fast food restaurants.
- Prepare bromthymol blue solution with vinegar or adjust color to medium blue.
- Confirm that Steps 1 and 2 will result in BTB going from
- Blue → Green → Yellow
- Obtain *Elodea* from an aquarium store.

### Activity 3-2: Cell Candles

- Obtain bowl, pie tin, culture dish, or any container that can hold water to a depth of 3 *cm*.
- Make sure all necessary materials are available.

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## Interdisciplinary Connection

**Language Arts or Visual and Performing Arts** Students write and perform a play about the connection between respiration and photosynthesis.

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## Enrichment Activity

### Enrichment 3-1: The Drama of Carbon Dioxide and Oxygen

#### Background Information

The cell uses the energy stored in adenosine triphosphate (ATP) to perform its functions. ATP is composed of an adenine molecule bonded to a ribose molecule, with three phosphate groups bonded on the ribose molecule. Breaking the bonds between the phosphate molecules releases large amounts of energy. However, typically the cell only breaks the bond holding the last phosphate molecules for work. This separates the ATP molecule into two molecules, adenosine diphosphate (ADP) and a phosphate. Cellular respiration uses the energy released from food to take ADP and a phosphate and form ATP.

## 4.2 Using Oxygen, Carbon Dioxide, and Energy – Student Edition (Human Biology)

Discuss the role of models in science.

Draw students' attention to the key ideas using means such as posters or overhead transparencies.

Emphasize the respiration/photosynthesis cycle and its components  $CO_2$  and  $O_2$  by using the observations and data from *Activity 3-1: It's a Ga-Carbon Dioxide and Oxygen* and *Activity 3-2: Cell Candles*.

Discuss the importance of controllers and how they allow the respiratory system to adapt to changing conditions.

Select appropriate Enrichment Activities and Projects as time permits.

Throughout and at the end of the section refocus students' attention on the key ideas.

A suggested response will be provided upon request. **Please send an email to [teachers-requests@ck12.org](mailto:teachers-requests@ck12.org).**

$\xrightarrow[\text{Your}]{\text{Apply}}$  KNOWLEDGE

**Assume that all the oxygen you breathe in comes from plants and all the carbon dioxide plants use comes from animals. Why is the destruction of the tropical rain forest of concern to us in the United States?**



### Mini-Activity

**Miles = Trees** Estimate the number of miles that your family drives in one year. How many acres of trees would your family have to plant to offset the amount of carbon dioxide produced by the number of miles you estimated? What other ways, besides driving, cause  $CO_2$  to be produced?

## 4.3 Activities and Answer Keys

### Activity 3-1: It's a Gas-Carbon Dioxide and Oxygen

#### PLAN

**Summary** Students explore the interdependence between respiration and photosynthesis.  $CO_2$  is a product of respiration and a raw material for photosynthesis.

#### Objectives

Students:

- ✓ predict the results of the experiment.
- ✓ determine the role of carbon dioxide in respiration and photosynthesis.
- ✓ use bromthymol blue as an indicator to confirm the presence of carbon dioxide.
- ✓ observe the gas oxygen produced by *Elodea* plant in water.

#### Student Materials

- Activity Report
- Bromthymol blue indicator solution; Plastic wrap or 2 test tube stoppers; Masking or labeling tape; Straws; 2 Test tubes; Beaker or similar container; *Elodea* or some other water plant; Pond water

#### Teacher Materials

- Activity Report Answer Key
- Bromthymol blue indicator
- Baking soda or sodium hydroxide and vinegar to adjust pH

#### Advance Preparation

Obtain individually wrapped straws from the cafeteria or fast food restaurants.

Prepare bromthymol blue solution with vinegar to adjust color to medium blue.

Confirm that Steps 1 and 2 will result in BTB going from Blue → Green → Yellow

Obtain *Elodea* from an aquarium store.

**Estimated Time** 10-15 minutes each of 2 consecutive class periods

#### Prerequisite and Background Information

The pH indicator bromthymol blue changes color to reflect changes in pH. In general, bromthymol blue and water ( $H_2O$ ) will be blue. When carbon dioxide ( $CO_2$ ) is added to the bromthymol blue and water, carbonic acid ( $H_2CO_3$ ) is formed. The solution becomes more acidic, turning yellow green, and eventually yellow. These changes are summarized below.

bromthymol blue +  $H_2O$  +  $CO_2$  →  $H_2CO_3$  + bromthymol blue (BLUE) carbonic acid (GREEN COLOR)

**IMPLEMENT**

**Introduce Activity 3-1** by demonstrating the color changes in bromthymol blue, using 2 test tubes partially filled with water to which bromthymol blue has been added.

**Steps 1-3** Use a straw to blow into one of the test tubes, to create the formation of carbonic acid and the subsequent color change to green/yellow.

If bromthymol blue is not a true blue when mixed with water, add a little weak base such as sodium hydroxide ( $NaOH$ ). Use enough bromthymol blue to color the water a medium blue, since a faint blue will not show the color change as dramatically.

**Step 4** Use healthy, large sprigs of *Elodea*.

**Step 7 (Part A) Steps 1-2 (Part B)** Provide an environment with a 24-hour light source.

*Discuss the components of a controlled experiment.*

*Limewater can be substituted for bromthymol blue. Your local high school chemistry teacher is a good source for limewater.*

**Helpful Hints****ASSESS**

Use the results of the experiment and written responses to the questions to assess if students can

- ✓ explain the importance of making predictions when performing experiments.
- ✓ demonstrate that carbon dioxide is a gas that is exhaled.
- ✓ explain the use of carbon dioxide by plants in the process of photosynthesis.

**Activity 3-1: It's a Gas-Carbon Dioxide and Oxygen – Activity Report Answer Key**

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

**Day 1**

1. What happened to bromthymol blue after you bubbled exhaled air into the test tube? Explain.
2. Predict what will happen to the test tubes in 24 hours.

**Day 2**

3. What happened? (How did the results compare with your prediction?) Record below:

**TABLE 4.1:**

Test Tube	Color of liquid before exhaled air is added	Color of liquid after exhaled air is added	Contains <i>Elodea</i> (yes/no)	Where placed (light/dark)	Color of liquid after 24 hours
-----------	---	--	---------------------------------	---------------------------	--------------------------------

#1

#2



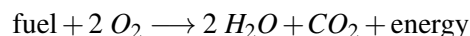
4. Explain the color changes.
5. Predict what will happen if you place a test tube of exhaled air with *Elodea* and bromthymol blue in the dark?  
Try it.
6. Predict what will happen if you place a test tube of exhaled air, bromthymol blue, without *Elodea*, in the dark?  
Try it.

---

## Activity 3-2: Cell Candles

### PLAN

**Summary** Students model cellular respiration by burning candles that are set in water and covered with a jar or a glass. The candles and the glucose within cells of the body are types of fuel that use oxygen and produce carbon dioxide and water:



### Objectives

Students:

- ✓ demonstrate that a burning candle (or cellular respiration) requires oxygen and produces carbon dioxide and water.
- ✓ explain that water in the form of visible droplets on the inside of the glass or jar after burning is a product.
- ✓ observe that energy is given off as heat and light.
- ✓ confirm that the water contains dissolved carbon dioxide as indicated by bromthymol blue (teacher demonstration).
- ✓ observe that oxygen makes up approximately 20% of the air.

### Student Materials

- Activity Report
- 1 tall glass, glass jar, or beaker
- 1 bowl larger than the glass, glass jar, or beaker; 1 candle; Matches; Water

### Teacher Materials

- Activity Report Answer Key
- 3 candles
- Bromthymol blue

### Advance Preparation

Obtain a bowl, pie tin, culture dish, or any container that can hold water to a depth of 3cm.

Make sure all necessary materials are available.

**Estimated Time** 20 minutes

### Prerequisite and Background Information

Students should be familiar with cellular respiration and photosynthesis after completing Activity 3-1 and reading the text.

For the teacher demonstration, students should know that bromthymol blue is an acid indicator. It changes from blue to green/yellow in the presence of an acid.

In Activity 3-1, students learned about this color change, and that  $CO_2$  forms a weak solution of carbonic acid when dissolved in water.

Remind students that air consists of close to 20% oxygen, and that heat and light are forms of energy.

## IMPLEMENT

**Introduce Activity 3-2** by reminding students of all the safety rules when working in a laboratory with MATCHES! Model safety expectations by wearing safety goggles when you are using matches. Make sure students know to douse the match and the candles in water before discarding them. Remind students to tie back long hair, and to be careful of sleeves when working with matches and candles.

**Step 1** Light the candles and monitor carefully when students have them in place.

**Steps 2-3** Demonstrate how to measure the water level before and after the burning.

Remind students to be certain that the jar or glass is completely dry both inside and out, so that the droplets of water formed inside the glass will be noticed after burning.

Caution students to observe carefully as the oxygen is used up almost immediately.

*The teacher or an aide can be responsible for lighting and disposing of matches.*

*Birthday candles, votive candles, or thicker candles may be used.*

*The water level on the outside of the bowl can be marked before lighting the candle so students will see the water level dropping as the candle burns.*

*The water level can be marked on the beaker so that students may more easily measure the rise of the water level.*

*It is important that the inverted beaker fit the container without too much extra space left around it.*

## Helpful Hints

**Extend this Activity** by using the following Teacher Demonstrations.

- Demonstrate that oxygen makes up approximately 20% of the composition of the air. Ask students to predict what would happen if two or three candles were used instead of one. Set up the experiment using three candles. Students observe that more candles produce the same rise in the water level, since the percentage of oxygen as part of the air is 20%. It is used up with one candle or three candles. Use a piece of Styrofoam with three holes, or small containers of clay, to hold the candles.
- Test for the presence of carbon dioxide as a by-product of burning. Three candles, lighted and extinguished by the jar or beaker, several times, a few minutes apart, will allow enough carbon dioxide to dissolve in the water to change bromthymol blue from blue to green. Students should notice the color change about 15 minutes after the candle has been extinguished for the last time.
- Show another analogy for cell candles. Burn a sugar cube to produce carbon.

**Conclude Activity 3-2** by discussing anaerobic respiration with the students. Discuss the fact that some organisms do not use oxygen to obtain energy.

## ASSESS

Use the results of the experiment and their written responses to the Activity Report to assess if students can

✓ show that water is displaced when oxygen is consumed.

- ✓ demonstrate how to measure the change in water level carefully and accurately.
- ✓ explain the essential role oxygen plays in the burning process.
- ✓ explain the analogy between a candle burning and cellular respiration process.
- ✓ explain the production of water as a by-product of the burning process.

*Why do you think a person's breathing rate is one of the factors measured in a lie detector test?*

### What Do You Think?

*Write a letter to your town council in support of, or objecting to, a paper production company locating to your town. The company will bring lots of jobs to the area. But it will begin the cutting of the forest around your town, too. The people in your town need the jobs. But are the new jobs worth the cost of cutting down trees? Take into account the health effects of cutting the trees. Give the letter to your teacher to mail.*

## Journal Writing



### Mini-Activity

**Back to Normal** How long does it take for your heart and lungs to return to their normally functioning rate after you exercise? Find out. Find your heart rate while sitting quietly. Now run in place for 3 minutes. Take your heart rate again. Wait 1 minute and take your heart rate a third time. Wait another minute and take your heart rate again the fourth time. Record your heart rate each time. Continue to find your heart rate until it is back to your resting rate. How long did it take? Do you think this time period would get longer or shorter if you were an Olympic athlete who's been training for years? Now do the same experiment for your breathing rate. Try not to intentionally alter your breathing rate. It is best to have a partner measure your breathing rate while you think of other things.

---

## Activity 3-2: Cell Candles – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to [teachers-requests@ck12.org](mailto:teachers-requests@ck12.org) to request sample answers.**
1. Record the rise of the water in centimeters (cm).
  2. How long did it take for the candles to go out?
  3. What fraction of the empty space in the glass or jar did the water rise up?
  4. How can you compare the burning candle to cellular respiration in your body?
  5. Predict what would happen if you were to repeat this procedure using three candles.
  6. You learned that carbon dioxide is a by-product of cellular respiration and thus of the burning candle. How can you test for carbon dioxide after the candle is extinguished?

---

## Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to [teachers-requests@ck12.org](mailto:teachers-requests@ck12.org) to request sample answers.**

1. Explain how photosynthesis and respiration are part of the same cycle. Draw a picture and describe the cycle.
2. Explain how your cells are like burning candles.
3. How do the cells in your body respond when you exercise?
4. How do your heart and lungs respond to the increased demand for oxygen when you exercise?

### Activity 3-1 Report: It's a Gas-Carbon Dioxide and Oxygen (Student Reproducible)

#### Day 1

1. What happened to bromthymol blue after you bubbled exhaled air into the test tube? Explain.
2. Predict what will happen to the test tubes in 24 hours.

#### Day 2

3. What happened? (How did the results compare with your prediction?) Record below:

**TABLE 4.2:**

Test Tube	Color of liquid before exhaled air is added	Color of liquid after exhaled air is added	Contains <i>Elodea</i> (yes/no)	Where placed (light/dark)	Color of liquid after 24 hours
#1					
#2					

4. Explain the color changes.
5. Predict what will happen if you place a test tube of exhaled air with *Elodea* and bromthymol blue in the dark? Try it.
6. Predict what will happen if you place a test tube of exhaled air, bromthymol blue, without *Elodea*, in the dark? Try it.

### Activity 3-2 Report: Cell Candles (Student Reproducible)

1. Record the rise of the water in centimeters (cm).
2. How long did it take for the candles to go out?
3. What fraction of the empty space in the glass or jar did the water rise up?
4. How can you compare the burning candle to cellular respiration in your body?
5. Predict what would happen if you were to repeat this procedure using three candles.
6. You learned that carbon dioxide is a by-product of cellular respiration, and thus of the burning candle. How can you test for carbon dioxide after the candle is extinguished?

## 4.4 Enrichment

### Enrichment 3-1: Teacher Activity Notes

#### The Drama of Carbon Dioxide and Oxygen

##### PLAN

##### Summary

Students write and perform a play to demonstrate their knowledge of cellular respiration, photosynthesis, and their relationship to each other. Each process is examined separately and then combined.

##### Objectives

Students:

- ✓ demonstrate their knowledge of the respiration and photosynthesis cycles.
- ✓ explain the interdependence between the two cycles.

##### Student Materials

- Activity Guide
- Resources 1 and 2
- Activity Report
- Construction paper; Scissors; Blue cards; Markers; Costumes; Some scenery

##### Teacher Materials

- Activity Report Answer Key
- Resources 1 and 2
- Provide “cell sheets” and materials for animal and plant cells (sheets, fabric, paints, markers).

##### Advanced Preparation

Prepare diagrams of large cells on sheets or large pieces of butcher paper. Use fabric paint or markers to draw cell structures for the plant and animal cells. A group of students can make these ahead of time.

Cast students yourself or select a group of interested students to do the casting.

Allow time for students to make props, i.e., signs with their roles, such as CARBON DIOXIDE, WATER, etc.

##### Estimated Time

One to two 50-minute periods-One period is set aside for writing, rehearsing, and preparing the play. Another period is set aside for presenting the play to the class.

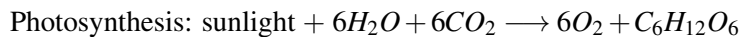
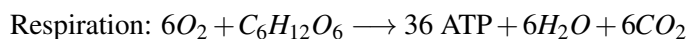
##### Interdisciplinary Connections

**Language Arts or Visual and Performing Arts** Students can write the play in language arts, and can prepare diagrams of large cells on sheets of paper and make props such as signs in art class. Students also can rehearse the script.

### Prerequisites and Background Information

Students should have some knowledge of the processes of cellular respiration and photosynthesis. The play itself will put these processes together and demonstrate student knowledge.

Students could benefit from familiarity with the following summaries of respiration and photosynthesis.



Students should have completed Activities 3-1 and 3-2.

## IMPLEMENT

**Introduce Enrichment 3-1** by reviewing the concepts of photosynthesis and respiration before students write the script and play production begins.

**Steps 1-3** Provide resource materials and/or background information for the processes of photosynthesis and respiration.

**Steps 4-5** Determine where the play will be performed. You might want to make a connection between circulation and breathing. Also connect this activity to physical science through balancing chemical equations and/or discussions of atoms, molecules, and energy.

As an alternative approach you can have students use the script provided in Resource 2 on TE pp. 44 titled *Model Respiration/Photosynthesis Play*. This script can be used as a model for the students to review before they write their play, or allow them to use the script for their performance.

*This activity is best at the end of Section 3 after completion of Activities 3-1 and 3-2.*

*Videotape the presentations. The tape can be used for assessment purposes and as a review for students. The students like to see themselves in action, and their play can be shared with other classes and with parents or guardians.*

### Helpful Hints

## ASSESS

Use the performance of the play, students' discussion, and their written answers on the Activity Report to assess if students can

- ✓ identify the reactants and products involved in the process of respiration.
- ✓ identify the reactants and products involved in the process of photosynthesis.
- ✓ explain the role that energy (light) plays in photosynthesis.
- ✓ describe the relationship between photosynthesis and respiration.
- ✓ complete the diagram with appropriate labels.
- ✓ accurately fill in the chart comparing cellular respiration with photosynthesis.

## Enrichment 3-1: The Drama of Carbon Dioxide and Oxygen – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**
1. What process is used by cells to get energy?
  2. What process is used by plants to capture the sun's energy?
  3. What substance in the plant cell is needed for photosynthesis to take place?
  4. Complete the chart below.

**TABLE 4.3:**

Cellular Respiration	Photosynthesis
Where? Animal cells, plant cells, or both animal and plant.	
When? Day, night, or all the time.	
What is used?	
What is produced?	
Purpose?	

5. Place the materials in the appropriate place on the chart below.  $CO_2$  sunlight  $O_2$  sugar (glucose)  $H_2O$  chlorophyll ATP

**TABLE 4.4:**

I. Involved in cellular respiration only	II. Involved in both respiration and photosynthesis	III. Involved in photosynthesis only

6. What is a relationship between respiration and photosynthesis?

## Enrichment 3-1 Activity Guide: The Drama of Carbon Dioxide and Oxygen (Student Reproducible)

### Introduction

Do you know the chemical reactions involved in cellular respiration and photosynthesis? Do you know how these two processes are connected? In this activity you write and perform a play to demonstrate your knowledge of cellular respiration, photosynthesis, and their relationship to each other.

If you studied the *Ecology* unit, you performed in a play about photosynthesis. In this unit, you write and perform a play that connects respiration and photosynthesis.

### Materials

- construction paper
- scissors
- blue cards
- markers
- costumes

- some scenery
- Resources 1 and 2

### Procedure

**Step 1** Brainstorm a list of roles in the play. For example, someone will need to play the role of “Sugar,” and someone else will play the role of “Carbon Dioxide.”

**Step 2** Write a script to represent the steps that occur in a plant and animal cell during the processes of photosynthesis and respiration.

**Step 3** Design and create signs, props, or costumes so that the audience knows what each person represents.

**Step 4** Perform Acts I, II, and III, of “The Drama of Carbon Dioxide and Oxygen.”

**Step 5** Answer the questions on the Activity Report.

---

## Enrichment 3-1 Resource 1: The Drama of Carbon Dioxide and Oxygen (Student Reproducible)

The information you need for Acts I, II, and III is listed below. Review the list and use separate paper to plan and write your script.

### Act I: Cellular Respiration

Cast :	Narrator	Glucose (sugar)	Blood	Oxygen
	Carbon dioxide	Mitochondrion	Water	Energy (ATP)

#### Scenery:

Draw parts of an animal cell on a sheet. Drape it over 4 stools or hang it as a curtain. Characters stand off-stage.

**Play:** Roles and scripts.

### Act II: Photosynthesis

Cast :	Narrator	Sugar
	Sun	Water
	Carbon dioxide	Oxygen

#### Scenery:

Draw parts of a plant cell on an old bed sheet with markers. Hang it over 4 stools. Leave a place for people to hide in the back. Every character, except Oxygen, Sugar, and the Sun, stands off-stage. Oxygen and Sugar hide behind the sheet. The sun crouches a few feet away from the cell.

**Play:** Roles and scripts.

### Act III: Photosynthesis and Respiration Together

**Cast:**



Narrator	Carbon dioxide	Chloroplast	Water
Sun(energy)	Mitochondrion	Blood	Lung
Sugar	Oxygen	ATP (energy)	Digestive tract

**Scenery:** Draw the layout on the stage with chalk **Chloroplast** stands on leaf. **Sun** stands on sun spot. **Lung** stands on lung circle. **Digestive tract** stands in DT circle. **Mitochondrion** stands on body cell.

**Play:** Roles and scripts.

## Enrichment 3-1 Resource 2: The Drama of Carbon Dioxide and Oxygen (Student Reproducible)

### *Model Respiration/Photosynthesis Play*

#### **Act I** (Action in parentheses)

Narrator Here is an animal cell. It is dark because the cell is in your body. Blood circles around the cell in a capillary.

Blood (Enters, walks around the cell and leaves the stage.)

Narrator You see blood in a capillary flowing by the cell. The blood brings glucose and oxygen, and leaves with water and carbon dioxide.

Blood (Enters with oxygen and glucose. As blood passes the cell, oxygen and glucose go behind the sheet. Blood leaves.)

Narrator The mitochondria inside the cell take oxygen and glucose, and release energy.

Energy Here I am! (Pops up holding an energy card.)

(Blood reappears with oxygen and glucose. As these two duck under the sheet, carbon dioxide and water emerge and follow blood off the stage.)

(Curtain falls)

#### **Act II** (Action in parentheses)

Narrator The sun rises on a new day.

Sun (Sun stands up and opens arms out.)

Narrator A young plant cell prepares for photosynthesis. Deep inside, a chloroplast with chlorophyll absorbs Sun's energy.

Sun (Waves arms over cell.)

Narrator The plant takes water from the soil through the roots.

Water (Jumps up behind the cell.)

Narrator Carbon dioxide enters the leaf through stomates, which are openings on the underside of the leaf.

Carbon dioxide (Carbon dioxide makes hissing sound and pops up behind cell.)

That was a tight squeeze but I'm here!

Narrator As long as there is light, the cell works hard performing photosynthesis.

(Water and carbon dioxide move about behind the cell.)

Narrator Finally, photosynthesis is finished.

Chloroplast Boy, that was hard work!

Sugar I'm the product. I'm sweet. I'm sugar.

Oxygen Don't leave me out. I'm the by-product of photosynthesis. I'm oxygen.

(Water and carbon dioxide drop down out of sight, as oxygen and sugar rise up.)

Narrator Sugar is stored as starch in the leaf for later use. Oxygen enters the atmosphere.

Oxygen Just wait. You'll see me again in the next act.

(Curtain falls)

**Act III** (Action in parentheses)

Sun It's day. I shine on the leaf. I warm the world. I have a sunny personality.

(Sun touches the chloroplast over and over.)

Chloroplast I'm the energy factory of the leaf. I get water, sunlight, and carbon dioxide. When I have these, I make sugar and oxygen. People breathe the oxygen in that I release to the atmosphere. They also consume the sugars in me when they eat plants.

(The chloroplast passes cards to the digestive tract. The cards say "sugar." Chloroplast passes cards to lung that say oxygen.)

### Enrichment 3-1 Activity Report: The Drama of Carbon Dioxide and Oxygen (Student Reproducible)

1. What process is used by cells to get energy?
2. What process is used by plants to capture the sun's energy?
3. What substance in the plant cell is needed for photosynthesis to take place?
4. Complete the chart below.

**TABLE 4.5:**

	Cellular Respiration	Photosynthesis
Where?	Animal cells, plant cells, or both animal and plant.	
When?	Day, night, or all the time.	
What is used?		
What is produced?		
Purpose?		

5. Place the materials in the appropriate place on the chart below.

*amp; CO<sub>2</sub>*

*amp; O<sub>2</sub>*

*amp; H<sub>2</sub>O*

ATP

sunlight

sugar (glucose)

chlorophyll

**TABLE 4.6:**

<b>I. Involved in cellular respiration only</b>	<b>II. Involved in both respiration and photosynthesis</b>	<b>III. Involved in photosynthesis only</b>
---	--	---

---

6. What is a relationship between respiration and photosynthesis?

---

CHAPTER **5** **Breathing Mission Control -  
Teacher's Guide (Human Biology)**

**Chapter Outline**

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- 5.1 PLANNING
  - 5.2 USING BREATHING MISSION CONTROL – STUDENT EDITION (HUMAN BIOLOGY)
  - 5.3 ACTIVITIES AND ANSWER KEYS
  - 5.4 ENRICHMENT
-

---

## 5.1 Planning

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### Key Ideas

- The body has control systems that regulate essential body functions mostly through negative feedback.
- Controllers allow the respiratory system to adapt to changing conditions, such as exercise or changing levels of oxygen in air.
- Red blood cells pick up and deliver oxygen to cells as needed and help get rid of excess carbon dioxide. Your body can adapt to changing conditions by making existing cells work harder, or by making more red blood cells to increase capacity.

---

### Overview

Students extend their knowledge of the human respiratory system from the previous sections by investigating the control systems of the body and how they affect short- and long-term changes in breathing. In the controller activity, students use a model of negative feedback and relate it to the body's control system for regulating temperatures and the exchange of oxygen and carbon dioxide gases.

---

### Objectives

Students:

- ✓ describe how a negative feedback system works.
- ✓ explain how homeostasis relates to feedback.
- ✓ manipulate a model to learn about how a negative feedback system works.
- ✓ relate a water bath control system to the body's temperature control system.
- ✓ discuss the role of the nervous system in the regulation of the breathing system.

---

### Vocabulary

blood gas level, control systems, feedback information, homeostasis, thermostat

---

## Student Materials

### Activity 4-1: How Does a Controller Work?

- Resource 1
- Resource 2
- Resource 3
- Activity Report
- Water bath (e.g., 1,000 – ml beaker); Thermometer; Crushed ice in container; Heater (hot plate)

---

## Teacher Materials

### Activity 4-1: How Does a Controller Work?

- Activity Report Answer Key
- Additional supply of ice and towels
- Cold water; Examples of other controllers such as a thermostat (demonstration)
- Extension cords; Hot pads; Diagram of brain showing hypothalamus, pons, and medulla; Multiple plug electrical strip (surge protector)

---

## Advance Preparation

See Activity 4-1 in the Student Edition

### Activity 4-1: How Does a Controller Work?

- Confirm that the electrical outlets will handle the electrical load.
- Prepare containers of ice water in advance.
- Position hot plates so the cords are not a hazard.

---

## Enrichment Activity

### Enrichment 4-1: Using a Bicycle to Demonstrate How Controllers Work

#### Background Information

The terms *regulation* and *control* might seem to be interchangeable, but they are different. Regulation refers to maintaining a desired value within specific limits, while control implies the ability to change a process or the rate of a reaction. Feedback information in physiological systems is used to regulate many body functions. The information provided by feedback is compared to the desired value (set point), and any differences result in corrective action to return to the desired value. Negative feedback is the most widely used feedback in physiological systems and maintains the desired value. The information results in a change of direction back toward the desired value. For example, when body temperature is falling, negative feedback reverses it, resulting in an increase in body temperature back to normal. Positive feedback would amplify the initial response of the falling temperature. You can see why

negative feedback makes good sense for physiological regulatory systems. We use the term *controller* in the student edition when discussing the regulation of physiological systems because it is more appropriate for students in middle grades.

## 5.2 Using Breathing Mission Control – Student Edition (Human Biology)

Draw students' attention to the key ideas using means such as posters or overhead transparencies.

Assign the *Mini Activity: Homeostasis* and have students discuss homeostasis as it relates to the respiratory system.

Discuss the importance of negative feedback and how it allows the respiratory system to adapt to changing conditions.

Select appropriate Enrichment activities, Groupwork activities, and Projects, as time permits.

Throughout and at the end of the section refocus students' attention on the key ideas.



### Mini-Activity

**Homeostasis** Students define *homeostasis* and relate homeostasis to feedback. See TE background-*Activity 4.1: How Does a Controller Work?*

- A suggested response will be provided upon request. **Please send an email to [teachers-requests@ck12.org](mailto:teachers-requests@ck12.org).**

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**Your breathing control systems use negative feedback. Can you think of any other negative feedback systems in your body?**



## 5.3 Activities and Answer Keys

### Activity 4-1: How Does a Controller Work?

#### PLAN

**Summary** Students relate how controllers work in their bodies to the control of temperature in a water bath. They control the temperature of a water bath around a set point of  $37^{\circ}\text{C}$  (degrees Celsius), which is also their body temperature. Changes in temperature occur when they add ice or heat. Students graph the results and study the effects of overshoot and delay of a variable on a control system.

#### Objectives

Students:

- ✓ identify the effects of a specific change (adding ice or heat) on the regulating system of a water bath.
- ✓ relate the regulating system of a water bath to regulating systems of the body.

#### Student Materials

- Resource 1
- Resource 2
- Resource 3
- Activity Report
- Water bath (e.g., 1,000 – ml beaker); Thermometer; Ice cubes in container; Heater (hot plate)

#### Teacher Materials

- Activity Report Answer Key
- Additional supply of ice and towels; Cold water; Examples of other controllers such as a thermostat (demonstration); Extension cords; Hot pads; Diagram of brain showing hypothalamus, pons and medulla; Multiple plug electrical strip (surge protector)

*This activity works well in groups of 2, 3, or 4 students.*

*Monitor use of ice.*

*It is recommended for safety considerations, not to substitute alcohol or Bunsen burners for hot plates.*

*Identify students who can help in the setup for the next class.*

#### Helpful Hints

##### Advance Preparation

Confirm that the electrical outlets will handle the electrical load.

Prepare containers of ice water in advance.

Position hot plates so the cords are not a hazard.

**Estimated Time** One 50-minute period

### ***Interdisciplinary Connections***

**Performing Arts** Students write and perform a role-play demonstrating how a control system works using temperature or breathing as examples.

**Visual Arts** Students create a cartoon illustrating how a control system works.

### ***Prerequisite and Background Information***

Students need to know how to read a thermometer. They also should have basic knowledge of how to work with tables and graphs.

Control loops utilize negative feedback in which the system counteracts a change with a response in the opposite direction that brings the output back to a set point. A sensor recognizes a rise or fall from the set value of the variable being measured (temperature in this instance), and the controller (the student) compensates for the change in the opposite direction by adding ice or heat.

## **IMPLEMENT**

***Introduce Activity 4-1*** by reviewing with students the related text information. You may want them to summarize the information in their own words verbally with a partner or in writing.

It is essential that students can identify a variable and have experience working with variables prior to completing the activity.

As a part of your introduction to the activity you may want to demonstrate how to position the thermometer so that it doesn't rest on the bottom of the water bath. A ring stand works well to secure thermometer.

Review safety procedures with students including wearing safety goggles and turning off the hot plate when finished.

*Coordinate with math teachers regarding table and graph skills. Students may make their table and graph in math class prior to doing the activity.*

*As an option, you may want to provide the table(Resource 2) and graph (Resource 3).*

### **Helpful Hints**

Since controllers are common in physiological systems and central to maintaining homeostasis, this activity occurs in 3 places in the curriculum : (1) *Circulation*, (2) *Breathing*, and (3) *Nervous System*.

***Steps 1-2*** You might want to list the roles on the chalkboard or on poster board and post it in the front of the room.

***Step 3-5*** Remind students of safety rules for using hot plates or any heating device. Act as a model by wearing safety goggles when using a hot plate.

At the beginning of each class, be sure the water bath is less than one-fourth full of ice water.

## **ASSESS**

Use observations during the activity and the written answers on the Activity Report to assess if students can

- ✓ construct and read a table and graph.
- ✓ summarize the importance of an efficient regulating system.
- ✓ explain how the water bath example relates to the regulation of the exchange of gases in their body.

## Activity 4-1: How Does a Controller Work? – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Was your group able to keep the temperature constant (close to  $37^{\circ}\text{C}$ ) over the 20 minutes? Explain.
2. What adjustments did you make to keep the temperature constant?
3. Describe your graph. Explain.
4. Where in your brain is the controller for body temperature?
5. On the diagram of a control system below, add the terms temperature, your role, water bath, and thermometer. Write a brief paragraph to explain how a control system works. Use Resource 1 to check your answers.
  - a. If the temperature of the water increases (Figure 4.1a) the sensor signals the controller to add ice to the water, causing the temperature of the water to decrease to  $37^{\circ}\text{C}$
  - b. If the temperature of the water decreases (Figure 4.1b) the sensor signals the controller to turn up the heat, causing the temperature of the water to increase to  $37^{\circ}\text{C}$ .

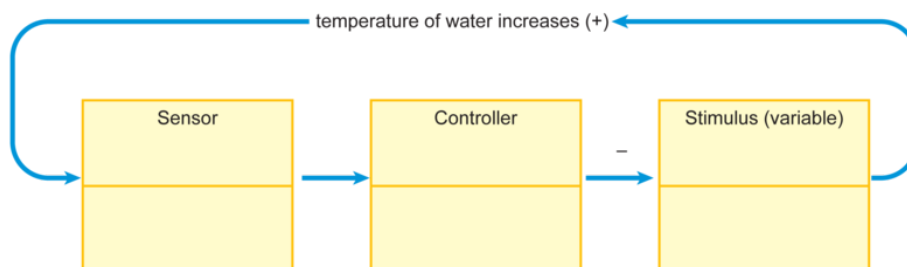
*What is your opinion about the procedure that some athletes use called “blood doping”? Some athletes have some of their blood withdrawn and put in cold storage. Their bodies make new red blood cells to replace the ones that were withdrawn. The athletes have their stored blood transfused back into their bodies just before the event. This increases the number of red blood cells in their blood and the amount of oxygen they are able to take up from each breath. Why do you think an athlete might do this? Do you think blood doping should be an illegal procedure? Why or why not?*

### What Do You Think?

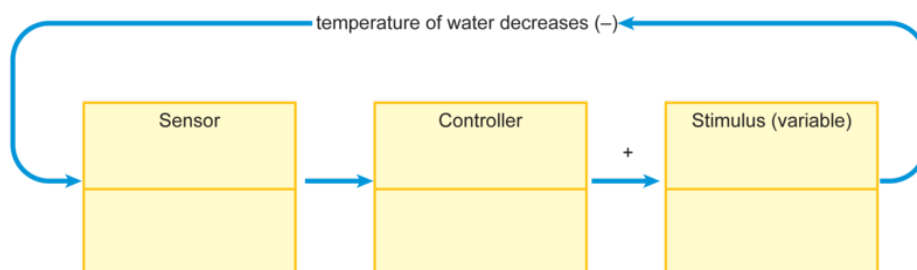
## Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**
1. How does the need for oxygen change as you exercise? How does the amount of oxygen in your blood change as you go to a higher altitude?
  2. Describe how your body's controllers work like thermostats by using negative feedback.
  3. How does your breathing controller work?
  4. Describe how red blood cells and diffusion relate to breathing.

## Activity 4-1 Resource 1: How Does a Controller Work? (Student Reproducible)



At the start of the experiment, the temperature was adjusted to  $37^{\circ}\text{C}$ . The temperature was monitored by the thermometer (sensor) for 20 minutes. If the temperature (variable) of the water in the water bath (controlled system) went up, you (controller) added ice to the water bath. If the temperature of the water in the water bath went down, you turned on the heater under the water bath.




---

### Activity 4-1 Resource 2: How Does a Controller Work? (Student Reproducible)

**TABLE 5.1:**

**Time**

0

2

4

6

8

10

12

14

16

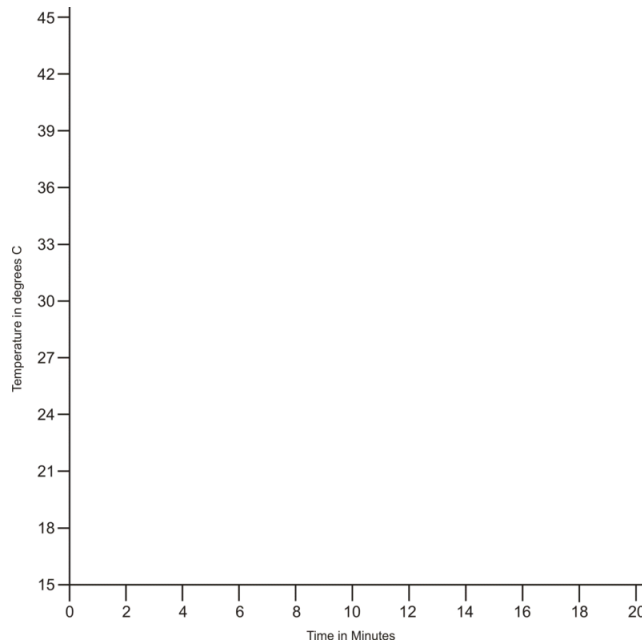
18

20

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**Water Temp. in degrees C**

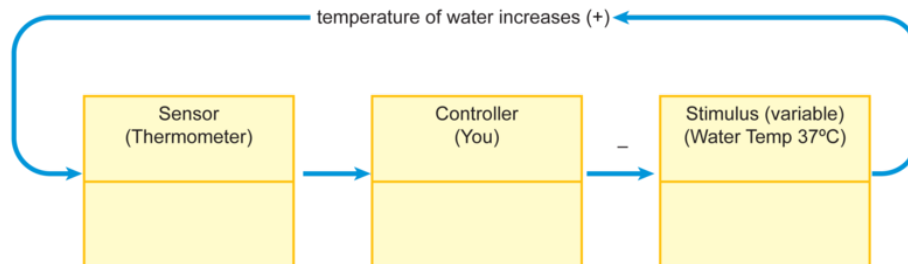
### Activity 4-1 Resource 3: How Does a Controller Work? (Student Reproducible)



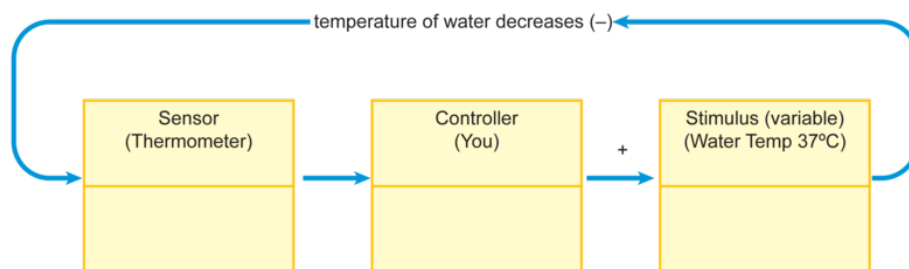
### Activity 4-1 Report: How Does a Controller Work? (Student Reproducible)

1. Was your group able to keep the temperature constant (close to 37°C) over the 20 minutes? Explain.
2. What adjustments did you make to keep the temperature constant?
3. Describe your graph. Explain.
4. Where in your brain is the controller for body temperature?
5. On the diagram of a control system below, add the terms temperature, your role, water bath, and thermometer. Write a brief paragraph to explain how a control system works. Use Resource 1 to check your answers.

a.



b.



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## 5.4 Enrichment

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### Enrichment 4-1: Teacher Activity Notes

#### Using a Bicycle to Demonstrate How Contollers Work

##### PLAN

###### Summary

In this demonstration activity, teacher and students use a bicycle to show how a controller works. Feedback loops and delay are demonstrated. After the demonstration, students create diagrams of the bicycle control loop.

###### Objective

Students:

✓ explain how the control system of the body regulates the exchange of  $O_2$  and  $CO_2$  gases.

###### Student Materials

- Activity Guide
- Activity Report
- Bicycle; Clothespins (3 or 4); Deck of cards

###### Teacher Materials

- Activity Report Answer Key

###### Advance Preparation

Arrange to have a bicycle in the classroom.

###### Estimated Time

One 50-minute period

###### Prerequisites and Background Information

Students should have completed *Activity 4-1: How Does a Controller Work?*

##### IMPLEMENT

**Step 1** Turn the bicycle upside down on its handle bars and seat. Be careful not to get your fingers or clothing near the spokes.

**Step 2** Use clothespins to hold playing cards so they buzz against the spokes of the rear wheel.

**Step 3** Start the rear wheel spinning and maintain at a fairly high speed (uniform pitch).

**Step 4** Use the hand brake and pedal as necessary to maintain a constant speed.

**Step 5** Discuss what happens with the class.

**Step 6** Repeat Steps 3, 4, and 5, dividing the tasks with a group of *four* students. The *controller* listens to the buzz and tells the *pedal turner* when to pedal and the *braker* when to brake. The *recorder* records observations.

## ASSESS

Use the performance of the demonstration and the written answers on the Activity Report to assess if students can

- ✓ explain and/or demonstrate how to maintain a constant speed on a bicycle.
- ✓ explain how breathing is monitored and regulated in their bodies
- ✓ define the terms: sensor, controller, controlled system, variable, feedback, and delay.

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## Enrichment Activity 4-1: Using a Bicycle to Demonstrate How Controllers Work – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Can the pitch of the buzzing be kept even by just turning the pedal? Why?
2. Can the speed of the wheel be controlled by using both the pedal and the brake simultaneously? Why?
3. Is control easier or harder with four people? Why?
4. What happens when delay is added to a control system?
5. Below are parts of any control system. Explain what each one does and give an example of each from this activity or another control system.
  - a. sensor :
  - b. controller:
  - c. controlled system:
  - d. variable:
  - e. feedback:
  - f. delay:

---

## Enrichment 4-1 Activity Guide: Using a Bicycle to Demonstrate How Controllers Work (Student Reproducible)

### Introduction

In this demonstration, teacher and students spin a bicycle wheel and the class investigates more about feedback.

### Materials

- Activity Report
- Bicycle
- Clothespins (3 or 4)
- Deck of cards
- Paper
- Pencils



## Procedure

**Step 1** Turn the bicycle upside down on its handle bars and seat. Be careful not to get your fingers or clothing near the spokes.



**Step 2** Use clothespins to hold playing cards so they buzz against the spokes of the rear wheel.

**Step 3** Start the rear wheel spinning and maintain at a fairly high speed (uniform pitch).

**Step 4** Use the hand brake and pedal as necessary to maintain a constant speed.

**Step 5** Discuss what happens with the class.

**Step 6** Repeat steps 3, 4, and 5, dividing the tasks with a group of *four* students. The *controller* listens to the buzz and tells the *pedal turner* when to pedal and the *braker* when to brake. The *recorder* records observations.

---

## Enrichment 4-1 Activity Report: Using a Bicycle to Demonstrate How Controllers Work (Student Reproducible)

1. Can the pitch of the buzzing be kept even by just turning the pedal? Why?
2. Can the speed of the wheel be controlled by using both the pedal and the brake simultaneously? Why?
3. Is control easier or harder with four people? Why?
4. What happens when delay is added to a control system?
5. Below are parts of any control system. Explain what each one does and give an example of each from this activity or another control system.
  - a. sensor
  - b. controller
  - c. controlled system
  - d. variable
  - e. feedback
  - f. delay

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CHAPTER

**6**

# Keeping Your Breathing Machine Healthy - Teacher's Guide (Human Biology)

## Chapter Outline

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- 6.1 PLANNING
  - 6.2 USING KEEPING YOUR BREATHING MACHINE HEALTHY – STUDENT EDITION (HUMAN BIOLOGY)
  - 6.3 ACTIVITIES AND ANSWER KEYS
-

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## 6.1 Planning

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### Key Ideas

- Your respiratory system is designed to keep you healthy. It provides airways and air sacs for the exchange of blood gases, and an automatic cleaning mechanism consisting of mucus and cilia.
- Many viruses-typically colds and flu-cause mucus tissue in the airways to produce more mucus. Viruses can cause us to feel very uncomfortable, but will go away. In some cases they can lead to longer lasting infections.
- Environmental causes of lung disease and lung damage include smoking and air pollution.

---

### Overview

This final section allows students to apply their knowledge of the structure and functions of the respiratory system to health problems. Some common problems with breathing resulting from illness, such as flu and colds, and from environmental causes, such as air pollution, are discussed. Students explore ways to keep the lungs healthy. They analyze ads about smoking and create a flyer or brochure promoting good health. In another activity, they observe preserved tissue samples from normal and diseased lungs, and relate these to the structure, number, and function of alveoli in the lungs.

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### Objectives

Students:

- ✓ discuss the impact of disease and the environmental pollution on the respiratory system.
- ✓ explain how smoking affects the lungs.
- ✓ analyze ads about smoking.
- ✓ explain how breathing is affected by reduced surface area in lungs.
- ✓ design a flyer or brochure for promoting good health and healthy lungs.
- ✓ describe how to perform the abdominal thrust maneuver for choking.
- ✓ distinguish between the lung diseases of pneumonia, emphysema, and bronchitis.

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### Vocabulary

aerosol, asthma, bacteria, bronchitis, cilia, mucus escalator, pneumonia, tuberculosis, viruses

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## Student Materials

### Activity 5-1: Smoke in Your Lungs

- Activity Report
- 1-liter clear, plastic detergent or soda bottle; Cotton balls, enough to fill the bottle; Clay or play dough; Rubber tubing (to fit over cigarette)

### Activity 5-2: Emphysema

- Activity Report
- Microscopes; Slides or photographs of normal and diseased lung tissue; Slides of emphysema; (May substitute good photographs of each, but must have the same magnification); Calculators; Tennis balls; Golf balls; 4-liter freezer bags; Balloon; Lung models from Activity 1-2

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## Teacher Materials

### Activity 5-1: Smoke in Your Lungs

- Resource-Letter Home
- Activity Report Answer Key

### Activity 5-2: Emphysema

- Activity Report Answer Key

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## Advance Preparation

See Activities 5-1 and 5-2 in the Student Edition.

Obtain slides of normal lung tissue and lung tissue with carbon particles (these alveoli look like alveoli of emphysematous lungs). They may be ordered from:

TRIARCH Prepared Microscope Slides

P.O. Box 98

Ripon, WI 54971

(414) 748-5125

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## Interdisciplinary Connections

**Social Studies** Students can do the *Mini Activity: Motivating through Ads* in which they analyze smoking ads.

**Language Arts** Students can write a persuasive letter to a loved one or a friend who smokes to convince them to quit.

**Health and Physical Education** Students can discuss how to keep the lungs healthy.

## 6.2 Using Keeping Your Breathing Machine Healthy – Student Edition (Human Biology)

Draw students' attention to the key ideas using means such as posters or overhead transparencies.

Begin this section with *Activity 5-2: Emphysema* emphasizing the connection between emphysema and reduced surface area for gas exchange.

Assign and discuss the *Mini Activity: Take Action!* and *Mini Activity: Advertising for Good Health*.

Encourage students to use 6 panels by folding 8.5" by 11" paper into thirds when completing the *Mini Activity: Advertising for Good Health*.

Have students share the brochures they made as part of *Mini Activity: Advertising for Good Health*.

Select appropriate Projects and other activities, as time permits.

Throughout and at the end of the section refocus students' attention on the key ideas.

A suggested response will be provided upon request. **Please send an email to [teachers-requests@ck12.org](mailto:teachers-requests@ck12.org).**

*What does having a cold feel like? How is your breathing affected? How do your lungs and your nose feel? What do you do to make yourself feel better? Do you think it is a good idea or bad idea to exercise when you have the flu or a cold? What can you do to prevent future colds?*

### Journal Writing

$\xrightarrow[\text{Your}]{\text{Apply}}$  KNOWLEDGE

**How do you think flu epidemics can spread around the world in only a few weeks?**

$\xrightarrow[\text{Your}]{\text{Apply}}$  KNOWLEDGE

**Okay, you learned that TB can't be spread unless the bacteria are active. Then what is the significance of TB being a silent disease?**



### Mini-Activity

**Take Action!** Students write a letter to an elected official stating their position on some aspect of air pollution (e.g., cigarette smoke or industrial pollutants). Make available the names of elected officials. Mail the letters for the students. Share the responses from officials in class.

*Should there be a pollution tax for industries that cause air pollution? How about for cars, lawn mowers, and leaf blowers? How should the money from a pollution tax be spent to improve our atmosphere and to improve the health of the people affected by air pollution?*

**What Do You Think?**

$\xrightarrow[\text{Your}]{\text{Apply}}$  KNOWLEDGE

**Suppose you were given the job of monitoring the air pollution levels in your city. What are some of the things you would want to measure?**

*When products are found to be “tainted” or to cause harm they are usually removed from the market by the manufacturer or by law. Why hasn’t this happened with cigarettes?*

**What Do You Think?**

$\xrightarrow[\text{Your}]{\text{Apply}}$  KNOWLEDGE

**Who is the Surgeon General? What is the Surgeon General’s job in the government?**

*Collect and analyze 3 or 4 ads about smoking. Discuss with students “Advertising Techniques” such as:*

*1. Sex Appeal-beautiful people use this product. 2. Bandwagon-everyone uses this product. 3. Snob Appeal-people who are rich and famous use this product. 4. Having Fun-you will have lots of fun if you use this product.*

*Students also can use these questions to analyze the ads they have collected.*



## Mini-Activity

**Motivating through Ads**

- What does the ad really say?
- Identify the advertising technique.
- Is the information about the product true?
- Is there important information left out?

*Do you mind if people around you smoke? Explain why you feel the way you do. How would you ask someone not to smoke near you?*

**What Do You Think?**

## 6.3 Activities and Answer Keys

### Activity 5-1: Smoke in Your Lungs

#### PLAN

**Summary** Students build a smoking machine and observe what happens when cigarette smoke deposits tar, oils, and nicotine on cotton.

#### *Objectives*

Students:

- ✓ identify the products from the burning of cigarettes.
- ✓ explain how smoking affects your lungs.

#### *Student Materials*

- Activity Report

#### *Teacher Materials*

- Resource-Letter Home
- Report Answer Key

#### *Advance Preparation*

Collect clear detergent bottles. The smaller 16 to 24 ounce size works best.

You and/or the students can assemble the bottles in advance. You can also use the same apparatus in all the classes.

Send letters informing parents about the activity that explains the possible smell of smoke noticeable in their child's hair and clothing.

**Estimated Time** One 50-minute period

#### *Interdisciplinary Connections*

**Math** Students can compute the cost of using cigarettes over specific time periods (for example, from ages 15 to 20 and then from ages 15 to age 65). Students can estimate the total costs of smoking (e.g., cigarettes, clothes replacement and cleaning, additional health costs), and make a wish list of what they could buy or do with that money.

**Social Studies** Students can hold a public policy debate or a mock Senate committee hearing on secondhand smoke and/or the issues surrounding tobacco company research on adjusting nicotine levels.

**Language Arts** Students can write a letter to someone they know who is a smoker, advising them about some of the dangers of smoking and how they could quit. They can create a flyer or brochure promoting a no-smoking policy in their town.

**Health** Students can design a health promotion campaign aimed at preventing young adolescents and teens from smoking cigarettes. These student products could be sent to the office of the Surgeon General at the United States Public Health Service.



### ***Prerequisites and Background Information***

The deposit of tars and oils lead to the destruction of the ciliated mucus in the respiratory tract. Smokers have more bronchitis and pneumonia than nonsmokers. Smoker's "hack" occurs when mucus and other airway secretions drip into large bronchi during the night and stimulate cough reflex sensory nerves when the person gets up. With normal ciliated mucus such secretions would be cleansed from the airway overnight.

## **IMPLEMENT**

***Introduce Activity 5-1*** by discussing the accumulation of tar from smoking.

***Steps 1-2*** Guide students in building their model.

***Steps 3-4*** You should check the rules about using such materials as tobacco on school grounds, even as an experiment. You also might want to handle the cigarettes yourself rather than having students light them and insert them.

***Steps 5-7*** Demonstrate how to make the bottle exhale and inhale.

*A plastic syringe or turkey baster also serve as good bottle substitutes.*

*Rotate the teams so that one team at a time goes outside the classroom to use the smoking machine.*

*Use new bottles for each class period.*

*Continue using some bottles from the previous periods so that they will show cumulative effects after 5 or 6 classes.*

*Keep 1 bottle as a control.*

*Keep 1 bottle with no cigarette to track secondhand smoke. This bottle should be pumped during the experiment to simulate inhaling and exhaling secondhand smoke.*

### **Helpful Hints**

***Conclude Activity 5-1*** by repeating the activity using the lung model from *Activity 1.1: How Do You Breathe?* Place the cotton with cigarette in neck of bottle. Seal with plastic wrap. After the activity is completed, remove and observe the cotton balls.

Discuss lung cancer and emphysema.

Be careful in disposing of cigarettes. Make sure they are completely out to prevent a fire. Then send smoking machines (without cigarettes) home after use to promote discussion with family members of its effects on the lungs.

**To extend this activity** remove some tar from the neck of the smoking machine with a cotton swab. Swab on plant seedlings. Have students predict its effect on plant growth. Set up control planes and observe.

## **ASSESS**

Use the smoking machine and the observations of the cotton to assess if the students can

- ✓ identify the type of deposits that can be left in a person's lungs after smoking.
- ✓ explain their attitudes and/or behavior regarding smoking.
- ✓ identify the health problems associated with smoking.

---

## Activity 5-1: Smoke in Your Lungs – Activity Report Answer Key

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**
1. Describe how your model is similar to your lungs. How is it different?
  2. Describe what happened when the model lung inhaled then exhaled the smoke.
  3. What evidence of tar, oils, and/or nicotine do you observe?

---

## Activity 5-2: Emphysema

### PLAN

**Summary** Students compare slides of normal lung tissue with slides of emphysematous lung tissue using a microscope. Using the model from Activity 1-1 and the data from Activity 2-1, students investigate the effect of emphysema on a person’s lungs.

### Objectives

Students:

- ✓ observe the tissue of a healthy lung and a lung with emphysema.
- ✓ explain how reduced surface area affects breathing.
- ✓ determine and explain how emphysema reduces the number of alveoli in the lungs.

### Student Materials

- Activity Report
- Microscope; Slides of normal lung tissue; Slides of lung tissue from a lung with emphysema (You may substitute photographs of each, but the magnification of each must be the same.)
- Calculator; Tennis balls; Golf balls; 4-liter freezer bags; Balloon; Lung models from Activity 1-1

### Teacher Materials

- Activity Report Answer Key

*One set of each of the slides per student group is best, although one set of slides can be set up as a demonstration.*

*The American Cancer Society has a brochure that shows photographs of diseased lungs.*

*The booklet “Tobacco Biology and Politics” listed in the Resources has excellent information on diseased lungs.*

### Helpful Hints

This activity can be related to *Activity 1-1: How Do You Breathe?*, *Activity 2-1: The More, the Airier*, and the *Circulation* unit.

### Advance Preparation

Obtain slides of normal lung tissue and lung tissue with carbon particles. (These alveoli look like alveoli of emphysematous lungs.) They may be ordered from

TRIARCH Prepared Microscope Slides

P.O. Box 98

Ripon, WI 54971

(414) 748-5125

**Estimated Time** One 50-minute period

### **Prerequisite and Background Information**

Completion of *Activity 1-1: How Do You Breathe?*

Completion of *Activity 2-1: The More, the Airier*

Studying the slides reveals large air spaces instead of normal alveoli, as well as black carbon deposits in the emphysematous lung tissue. When compared to the size of the inflated balloon in Activity 1-1, the double balloon will not inflate as well because of reduced elasticity, which is characteristic of an emphysematous lung. Capacity for gas exchange is compromised because of the reduced elasticity.

In Activity 2-1, the surface areas of 4 liters of tennis balls and golf balls were determined. These numbers are used in answering question number 5, which assumes that the surface area is reduced in lungs with emphysema. The challenge is to compare the surface area of a bag filled with  $\frac{1}{2}$  golf balls and  $\frac{1}{2}$  tennis balls with the surface area of a bag filled only with golf balls.

## **IMPLEMENT**

**Introduce Activity 5-2** by reviewing *Activity 1-1: How Do You Breathe?* and *Activity 2-1: The More, the Airier*.

**Steps 1-2** If students are using a microscope that requires natural light, remind them not to point the mirror directly at the Sun.

**Steps 3-4** Provide student responses from *Activity 2-1: The More, the Airier* for the value of total surface area of the 4-liter bags of golf balls and tennis balls.

## **ASSESS**

Use the comparison between slides, modification of the lung model, change of sphere size, and the written response to the Activity Report to assess if students can

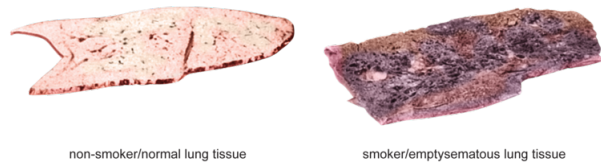
- ✓ describe the characteristics of healthy lung tissue.
- ✓ describe the characteristics of lung tissue from a person with emphysema.
- ✓ explain how emphysema reduces the surface area of the lungs.
- ✓ demonstrate how the presence of emphysema affects breathing.

---

## **Activity 5-2: Emphysema – Activity Report Answer Key**

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Draw a section of each of the slides. Label your drawings “normal lung tissue” and “emphysematous lung tissue.”



2. Describe the difference between the slides of the normal lung tissue and the emphysematous lung tissue.
3. About how many alveoli from the normal lung could fit into an open space of the emphysematous lung?
4. Which lung model is easier to inflate—the one-balloon or two-balloon model? Explain.
5. How does the surface area of all golf balls in the bag compare to the surface area of half golf balls and half tennis balls in the bag?
  - a. Surface area of all golf balls is
  - b. Surface area of all tennis balls is
  - c. Surface area of  $\frac{1}{2}$  tennis balls and  $\frac{1}{2}$  golf balls is
6. In emphysema, what happens to the respiratory surface area normally available for gas exchange?
7. How might this difference in surface area affect that person's ability to exercise?
8. Do you know of someone who suffers from emphysema? How is the way he/she lives different from that of others his/her age?



## Mini-Activity

**Advertising for Good Health** This assignment can be introduced to the students at the beginning of the unit. Design a flyer or brochure that promotes good health and healthy lungs.

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### Review Questions/Answers

- Sample answers to these questions will be provided upon request. **Please send an email to teachers-requests@ck12.org to request sample answers.**

1. Why is mucus important to your health?
2. How do viruses and bacteria spread? What are the best ways to protect yourself from getting them?
3. What is the difference between pneumonia, bronchitis, asthma, and emphysema?
4. Describe at least four reasons why smoking is hazardous to your health.
5. Describe three ways you can help your lungs stay healthy.

---

### Activity 5-1: Resource: Smoke in Your Lungs (Student Reproducible)

Date \_\_\_\_\_

To: The parent of \_\_\_\_\_  
(Student Name)

From \_\_\_\_\_  
(Teacher Name)

Regarding: A Respiratory System Activity in *Breathing*

It is a pleasure working with your child, and I thank you for your support as we explore life science and health through the Stanford Human Biology Curriculum.

We are presently in the midst of an exciting series of classroom activities to help your student learn about the respiratory system and what it does. This knowledge of human physiology is the foundation for making good decisions and developing healthy lifestyle choices.

One of the activities we will be doing, *Activity 5-1: Smoke in Your Lungs*, engages students in building a model of a lung from a plastic bottle filled with cotton. Students let the lung model “breathe” in normal air. Then students let the model breathe in air coming through a lighted cigarette.

Your student will be closely supervised at all times while I light a cigarette and allow the model lung to “breathe” in the smoke-filled air. I will conduct this activity outside. However, students may come into contact with some smoke. Therefore, they may arrive home with a smell of smoke on their clothing and hair resulting from this classroom activity.

At the end of the activity, students will be able to observe the effects of cigarette smoke on the lungs.

If you have any questions or concerns about your student's participation in this activity, please contact me at (School Telephone Number).

Sincerely,

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### Activity 5-1 Report: Smoke in Your Lungs (Student Reproducible)

1. Describe how your model is similar to your lungs. How is it different?
2. Describe what happened when the model lung inhaled then exhaled the smoke.
3. What evidence of tar, oils, and/or nicotine do you observe.

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### Activity 5-2 Report: Emphysema (Student Reproducible)

1. Draw a section of each of the slides. Label your drawings “normal lung tissue” and “emphysematous lung tissue.”

Microscopic view of normal

lung tissue

Microscopic view of emphysematous

lung tissue

2. Describe the difference between the slides of the normal lung tissue and the emphysematous lung tissue.
3. About how many alveoli from the normal lung could fit into an open space of the emphysematous lung?
4. Which lung model is easier to inflate-the one-balloon or two-balloon model? Explain.
5. How does the surface area of all golf balls in the bag compare to the surface area of half golf balls and half tennis balls in the bag?
  - a. Surface area of all golf balls \_\_\_\_\_
  - b. Surface area of all tennis balls \_\_\_\_\_
  - c. Surface area of  $\frac{1}{2}$  tennis balls and  $\frac{1}{2}$  golf balls \_\_\_\_\_
6. In emphysema, what happens to the respiratory surface area normally available for gas exchange?

7. How might this difference in surface area affect that person's ability to exercise?
8. Do you know of someone who suffers from emphysema? How is the way he/she lives different from that of others his/her age?

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CHAPTER

**7**

# Additional Resources Breathing - Teacher's Guide (Human Biology)

## Chapter Outline

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- 7.1 USING GROUPWORK ACTIVITIES
  - 7.2 ADDITIONAL RESOURCES
  - 7.3 GLOSSARY
-

## 7.1 Using GroupWork Activities

Learning science is a process that is both individual and social. Like researchers, engineers, mathematicians or physicians who work in teams to answer questions and to solve problems, students in science classrooms often need to interact with their peers to develop deeper knowledge of scientific concepts and ideas. The GroupWork activities were developed to foster an environment in which groups of students work cooperatively to:

- plan experiments,
- collect and review data,
- ask questions and offer solutions,
- use data to explain and justify their arguments,
- discuss ideas and negotiate conflicting interpretations,
- summarize and present findings,
- and explore the societal implications of the scientific enterprise.

The GroupWork environment is one in which students are “doing science” as a team. Suggestions about when to introduce these group activities are included in the Teacher Activity Notes.

### Format and Organization of GroupWork Activities

Each GroupWork activity includes teacher activity notes, an activity guide, an individual report, resource materials, and at times, data sheets. The activity guide contains instructions for the group’s task and questions to be discussed as students plan for and work on a group product. Resource materials are varied. They might include textual information, visual resources such as photos, drawings, graphs or diagrams, video, or audiotapes. Individual reports by students are an integral part of each activity to be completed in class or as part of a homework assignment. Planning information for the teacher is found on the Teacher Activity Notes page.

Sets of Group work activities are organized around a central concept or a basic scientific question—a “big idea.” Ideally, as students rotate to complete these activities, they encounter this central idea, question, or concept in different scientific contexts or in different social settings. These rotations provide students with multiple opportunities to grapple with the material, explore related questions and dilemmas, look at different representations, and think of different applications. Figure 1 shows how students rotate from activity to activity around the “big idea.”

The GroupWork activities were designed to be open-ended to foster the development of higher-order thinking skills. Such open-endedness allows students to decide as a group how to go about completing the task, as well as what the final group product might be. Open-ended group activities increase the need for interaction as students serve as resources for one another, draw upon each other’s expertise and knowledge, and take advantage of their different problem-solving strategies. When groups are heterogeneous and GroupWork include students with many different intellectual abilities, the repertoire of strategies and previous experiences is rich and diverse. As students interact with their peers, they learn how to communicate effectively, justify their arguments when challenged, and examine scientific problems from different perspectives. Such interaction scaffolds students’ knowledge of scientific concepts and principles.

These GroupWork activities then are quite different from traditional lab activities that include more step-by-step procedures and are crowded with details. In addition to reading, writing, and computing (the traditional academic abilities), students use many different intellectual abilities to complete their task. They make observations, pose questions, plan investigations; they use and create visual models, access and interpret scientific information from different sources and from different media, and convey scientific findings in diagrams, graphs, charts, or tables. The use of a wide array of resource materials provides students with additional ways to access and use information, as well as with additional opportunities to demonstrate their intellectual competence and be recognized for their contributions. We have included in the Teacher Activity Notes a partial list of some of the multiple abilities students



might be observed using in these group activities.

When group activities are open-ended, rich, and intellectually demanding, a single student will not be able to complete the task in a timely fashion by himself or herself. Making students responsible as a group to interpret a challenging task and to design a common product or group presentation increases group interdependence. Teachers know, however, that it is also important to hold each student personally accountable for contributing to the group's success and for mastering the concepts or the big idea of the activity. To do so, students are required to complete individual written reports in which they respond in their own words to key discussion questions and summarize what they have learned in the group activity. These written responses can be useful for teachers in gauging and monitoring student understanding and progress.

**Role of the Teacher** Planning ahead and organizing the classroom for GroupWork is important for the successful implementation of group activities. We suggest that you refer to Elizabeth Cohen's book, *Designing GroupWork: Strategies for Heterogeneous Classrooms*, published by Teachers College Press in 1994. (See also Lotan, R.A., J.A. Bianchini, and N. C. Holthuis (1996). "Complex Instruction in the Science Classroom: The Human Biology Curriculum in Action," in R.J. Stahl, (Ed.) *Cooperative Learning in Science. A Handbook for Teachers*, Addison-Wesley Publishing Company.)

Many teachers have realized that when students work in groups, direct instruction is no longer practical. The teacher can't be everywhere at once, telling students exactly what to do and how to do it. Thus, teachers delegate authority to students and students take responsibility for their own behavior and their own learning. Rather than constantly turning to the teacher for help, students talk with each other to find out what they should be doing and to solve the challenging problems assigned to them. Teaching students to work collaboratively and to be responsible to one another as a group is an important prerequisite for successful GroupWork. Students also support the smooth operation of groups when they have learned to play different roles in their groups effectively. For example, the facilitator sees to it that everyone in the group knows what has to be done and gets help when necessary. The recorder keeps notes of the group's discussions and checks to see if individual reports have been completed. The materials manager sees to it that the group has all the equipment necessary and that the tables are cleared at the end of the lesson. The reporter presents the findings of the group during wrap-up time. When the activity involves hazardous materials, a safety officer might be needed. Every student must have a role to play, and roles rotate so students learn how to perform each role competently.

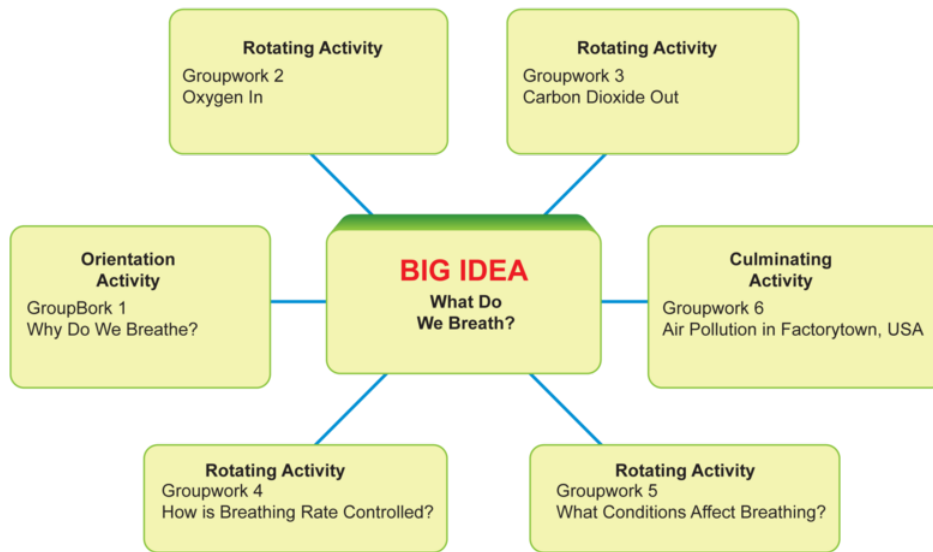
Delegating authority doesn't mean that the teacher withdraws from the class or completely stays out of the action. Instead of being the focal point of the classroom, the teacher carefully observes the students as they work in the groups, stimulates and extends their thinking, and provides specific feedback.

**Equalizing Participation among Members of the Group** Making sure that all members of the group have access to the materials and that one group member doesn't take over or dominate the group while another withdraws are among the principal challenges of GroupWork. Teachers can increase participation of students by explaining how the different intellectual abilities are relevant to the successful completion of the task. The teacher states that while no one group member has all the abilities, everyone in the group has some of the intellectual abilities necessary to complete the task successfully. Furthermore, after careful observation of the students' work in groups, the teacher can publicly acknowledge those students who have made relevant contributions and explain specifically how these contributions made the group move forward and become more successful. It is important that the teacher be able to notice the intellectual contributions of students who have low academic or peer status, and who are frequently left out of group interactions. These strategies are particularly relevant in untracked classrooms, where students have a wide range of previous academic achievement (mainly in reading) or where significant proportions of students are English-language learners. Teachers, classmates, and the low-status students themselves need to understand that when many different intellectual abilities are necessary to complete a task successfully, everybody's contribution becomes critical to the success of the group. As more previously low-achieving students feel and are expected to be competent, their participation in the group increases, and subsequently their learning achievements increase as well.

Rachel A. Lotan, Ph.D.

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**Figure 1:** Activity Rotation in GroupWork  
**GroupWork Contents**

**TABLE 7.1:**

Activity	Duration	Materials Activity	Summary
1. Orientation Activity: Why Do We Breathe?	40 minutes	Approximately 60 small balls (e.g., tennis or table-tennis balls), half of one color, half of another	In this activity, the whole class simulates the process of gas exchange in the cells. The teacher acts as the director.
2. Oxygen In	40 minutes	Matches, tin pan, paper clip, cork, glass jar, candy (gummy bears or jelly beans), poster paper, pens of different colors, and art supplies	Students explore the relationship between oxygen and energy production. They first burn candy in the presence and absence of oxygen. They then connect the burning of candy in a tin to the “burning” of glucose in their body cells.
3. Carbon Dioxide Out	35 minutes	2 medium-sized beakers or cups filled with equal amounts of bromthymol blue (BTB) solution, 2 straws	Students compare the amount of carbon dioxide in exhaled air before and after exercise by experimenting with BTB solution.

**TABLE 7.1:** (continued)

<b>Activity</b>	<b>Duration</b>	<b>Materials Activity</b>	<b>Summary</b>
4. How is Breathing Rate Controlled?	40 minutes	Two stopwatches and art supplies	In this activity, students learn how and why breathing rate is controlled. They conduct an experiment determine the effect of exercise on breathing rate.
5. What Conditions Affect Breathing?	40 minutes	Costumes and props for skit	Students explore how a behavior (smoking, a disease (asthma), or an environmental condition (air pollution) affect one's ability to breathe and why.
6. Culminating Activity: Air Pollution in Factory-town, USA	2-3 class periods	Costumes and props (optional)	Groups debate whether a factory that is both an employer in a small town and a source of pollution be shut down.

## GroupWork 1: Teacher Activity Notes - Orientation Activity: Why Do We Breathe?

### Big Idea: Why Do We Breathe?

#### PLAN

**Summary** In this activity, the whole class simulates the process of gas exchange in the cells. The teacher acts as the director. Note: There is no student activity guide for this activity.

**Group Size** 4 to 5 students

#### Objectives

Students:

- demonstrate the process of gas exchange in the cells.
- explain why people breathe.

#### Multiple Abilities

- Logically analyzing the problem, making connections between ideas/concepts, applying and integrating information from other units, analyzing the strengths and limitations of a model(reasoning ability)
- Visualizing the connection between the model and “real” life (spatial visual and creative ability)

#### Student Materials

Approximately 60 small balls (e.g., tennis or table tennis balls), half of one color, half of another

**Estimated Time** 40 minutes

**Suggested Use**

- This set of activities works well near the end of the unit.

**IMPLEMENT**

1. Before beginning the activity, have students consider why we breathe? Students may respond initially by saying we breathe so we won't die. While accurate, this is too simple an answer. Stress to students that humans breathe so that two important things can happen.

- Oxygen gets to the cells of your body, and
- Carbon dioxide gets out. In this activity, the whole class simulates the process, using balls to represent these two important gases.

2. For the simulation, students play the following roles:

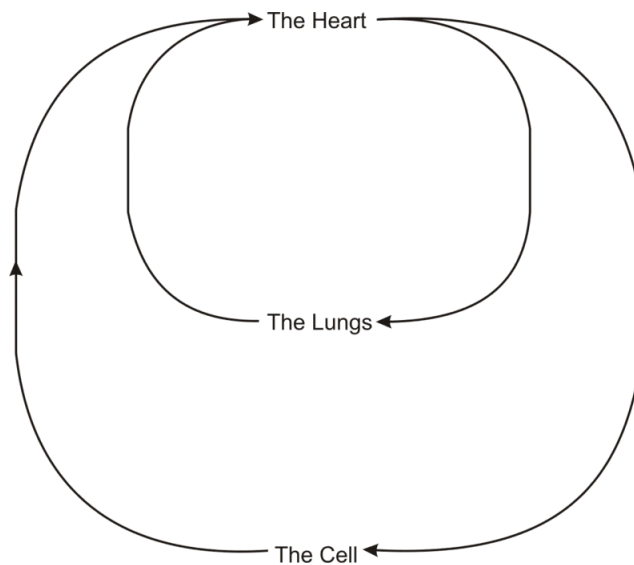
The Heart-One Student

The Lungs-One Student

The Cell-One Student

Red Blood Cells-All remaining students

Students follow the path depicted below:



3. Start by having all the red blood cells go one-by-one past the heart toward the lungs. At the lungs, the lung student should give each red blood cell that comes by an oxygen ball. The red blood cells should then return to the heart, passing by it without exchanging any gas balls. Red blood cells should then travel to the cell. As they pass by the cell, they should hand the cell an oxygen ball, which the cell may place in a box in front of it, and get a carbon dioxide ball from the cell. Red blood cells should then pass by the heart on their way back to the lungs. At the lungs, each red blood cell should give the lung student the carbon dioxide ball, and get another oxygen ball. The cycle is then repeated.

**Extend this Activity**

- At some point you may want the cell to begin moving in place to simulate exercise. The blood should then begin moving faster in order to get enough  $O_2$  to the cell.

- The heart could be represented by four students- each one representing one of the four chambers of the heart.

### Extension Questions

- How could we model the effect of exercise on this process?
- What would happen if the blood were not able to carry enough oxygen (as with sickle cell anemia) or the lungs weren't able to get enough oxygen (as with emphysema, asthma, or lung cancer)? How could you simulate these situations?

## ASSESS

Use the group discussion, group presentation, and individual report to assess if students can

- explain why people breathe.
- demonstrate the process of oxygen getting to and carbon dioxide leaving the cell.
- explain how and why gases such as oxygen and carbon dioxide are carried by the blood.

---

## GroupWork 2: Teacher Activity Notes - Oxygen In

### Big Idea: Why Do We Breathe?

#### PLAN

**Summary** Students explore the relationship between oxygen and energy production. First they burn candy in the presence and absence of oxygen. Then they connect the burning of candy in a tin to the “burning” of glucose in their body cells.

**Group Size** 4 to 5 students

#### Objectives

Students:

- identify different forms of energy.
- describe the relationship between oxygen and energy production.
- explain how and why cells use oxygen.

#### Multiple Abilities

- Conceiving of an idea for an experiment, creating an engaging and influential presentation (creative ability)
- Clearly and logically explaining to others how and why we breathe (communication skills)
- Logically analyzing the problem, solving a problem experimentally, making connections between ideas/concepts, hypothesizing (reasoning ability)

#### Student Materials

Matches, tin pan, paper clip, cork, glass jar, candy (gummy bears or jelly beans), poster paper, pens of different colors, and art supplies.

**Estimated Time** 40 minutes

#### Suggested Use

This set of activities works well near the end of the unit.

## IMPLEMENT

- Discuss with students the different forms of energy-nuclear, mechanical, chemical, heat, and light. Discuss that the burning of glucose in cells produces chemical and heat energy.
- The cork and paper clip must be large enough to support a burning gummy bear or jelly bean without tipping over. The glass jar must be large enough to fit over the candy-paper clip-cork setup.
- Caution students about the use of matches. Also, remind students to embed the paper clip securely into the cork, and to place the tin on a flat surface.

### Extend this Activity

- The burning of glucose in cells produces heat as well as chemical energy. What do animals do with the heat produced?
- Discuss the following question. How do people suffocate from carbon monoxide?

### Extension Questions

- Is oxygen the only gas we inhale? How do you know?
- What other gases do we inhale? Where do they come from? Are any important for maintaining life? How do you know? How could you find out?
- When we exercise vigorously, we may not always get enough oxygen to our muscles. What happens in this case? How do we feel? How do our muscles continue to burn energy if they don't have enough oxygen?

## ASSESS

Use the group data sheet, presentation, individual report, and group discussion to assess if students can

- distinguish between different forms of energy such as mechanical, chemical, heat, light, and nuclear.
- describe how the burning of glucose in the cells produces chemical and heat energy.
- explain how and why cells use oxygen for cellular respiration.

## GroupWork 2 Activity Guide: Oxygen In (Student Reproducible)

### Big Idea: Why Do We Breathe?

#### Introduction

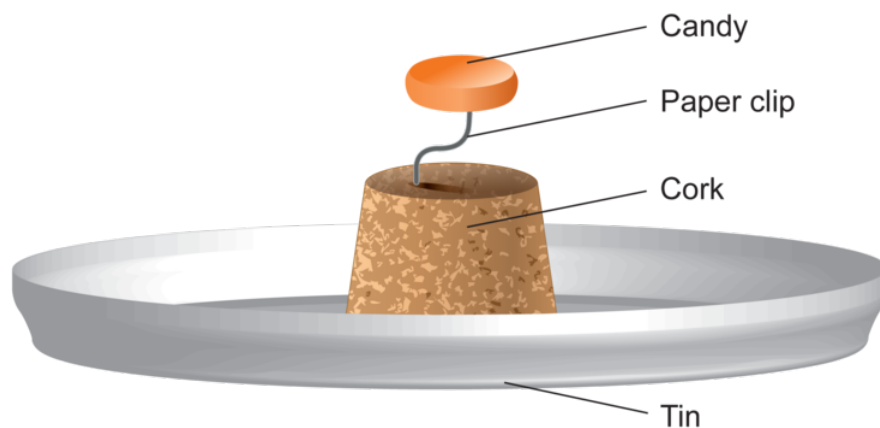
It's the middle of class and you start to hiccup. "Hold your breath," a friend tells you. For the first minute, you do. Then, it grows more and more difficult. Finally, you take a breath. Why can you survive days without water and weeks without food, but only a couple of minutes without oxygen? In this activity you learn more about why we breathe.

#### Materials

- Matches, tin pan, paper clip, cork, glass jar, piece of candy, poster paper, pens of different colors, and art supplies
- Data Sheet
- Individual Report
- Resource

#### Procedure

- Our cells need oxygen to burn food. To model and learn about this process, conduct the following experiment.



2. Set up the materials as shown in the diagram above. Light the piece of candy. After it begins to burn, place a glass jar over it.

3. In your group, discuss the following question.

- What happens to the flame when you cover it? Why?

4. Use the Resource to explain the following:

- How do cells use oxygen? How do you know?
- How do cells use energy?

5. Create a presentation to explain to the rest of the class why we need oxygen. Include the following in your presentation.

- How the candy experiment models what happens in our cells.
- How and why cells use oxygen.
- Why this information is important to know. Provide a real-life example.

### GroupWork 2 Data Sheet: Oxygen In (Student Reproducible)

#### Big Idea: Why Do We Breathe?

For the candy-burning experiment:

1. Record your procedure:
2. Record your observations:
3. Record your conclusions:

### GroupWork 2 Individual Report: Oxygen In (Student Reproducible)

#### Big Idea: Why Do We Breathe?

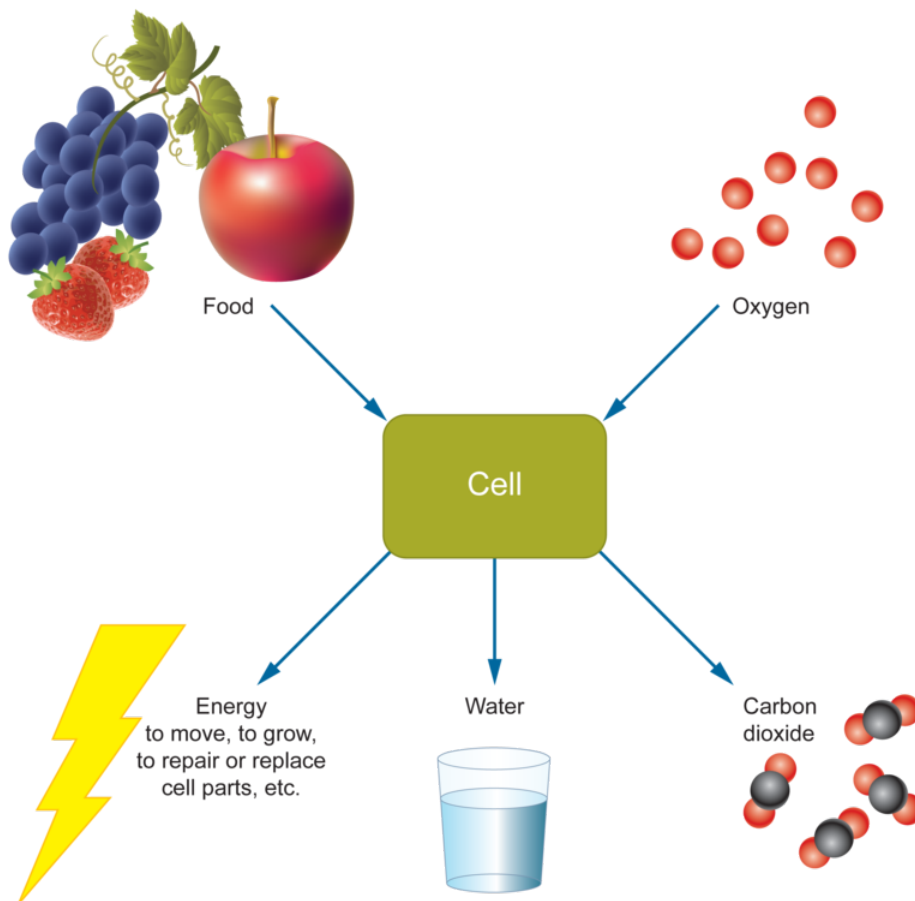
1. What happened to the flame when you covered the candy with a glass jar? Why?
2. The candy experiment models the process of cellular respiration in cells. What does the candy represent? What does the flame represent?

3. How do cells use oxygen?
4. Why can a person live only a couple of minutes without oxygen?

### GroupWork 2 Resource: Oxygen In (Student Reproducible)

#### Big Idea: Why Do We Breathe?

- When we eat, the food is broken down and absorbed into our cells. We then burn the food very slowly in combination with oxygen to produce energy, water, and carbon dioxide. Our cells need energy to maintain themselves and to grow. Examine the diagram below.



- The process by which cells break down food (specifically glucose) in the presence of oxygen to release energy is called *cellular respiration*.

---

### GroupWork 3: Teacher Activity Notes - Carbon Dioxide Out

#### Big Idea: Why Do We Breathe?



## PLAN

**Summary** Students compare the amount of carbon dioxide in exhaled air before and after exercise by experimenting with BTB solution.

**Group Size** 4 to 5 students

### **Objectives**

Students:

- identify  $CO_2$  in exhaled air using BTB (an indicator of carbon dioxide).
- demonstrate how the relative levels of  $CO_2$  can be measured using the BTB solution.
- explain how and why the level of  $CO_2$  changes after exercise.

### **Multiple Abilities**

- Conceiving of an idea for an experiment (creative ability)
- Logically analyzing the problem, solving a problem experimentally, making connections between ideas/concepts, hypothesizing (reasoning ability)
- Organizing group, breaking the task into its parts, focusing on goal, prioritizing tasks and ideas (ability to make plans)
- Recording data correctly and clearly, measuring accurately, observing carefully and accurately (ability to be precise)

### **Student Materials**

2 medium-sized beakers or cups, bromthymol blue (BTB) solution, and 2 straws

Individual Report

Data Sheet

Resource

**Estimated Time** 35 minutes

### **Suggested Use**

- This set of activities works well near the end of the unit.

## IMPLEMENT

1. To make a 0.04 bromthymol blue solution, dissolve 0.4 g of BTB powder in 1,000 ml of distilled water. To produce a deep blue color, you may wish to add a drop of concentrated ammonia solution. Caution students not to get any BTB solution in their mouths.

Students will be able to observe the color change more easily if they place white paper under the beakers.

2. Students may initially perform the experiment incorrectly by using the same beaker of solution to blow into before and after exercise. If this happens, you can point out to the group, during their presentation, that they need to use two separate beakers in order to have a control. Then the next group to perform the activity should not make this same mistake.

### **Extension Questions**

- What happens to the water in this experiment that also happens during cellular respiration?

- How could you find out if water is exhaled?(Breathing on mirror, especially if it is chilled, will quickly show the moisture present in an exhaled breath.)
- Graph the information you recorded in either or both of your tables.

## ASSESS

Use the group data sheet, presentation, individual report, and group discussion to assess if students can:

- identify  $CO_2$  in exhaled air using BTB.
- measure the relative levels of  $CO_2$  using the BTB solution.
- explain that through the process of cellular respiration, cells break down glucose in the presence of oxygen to produce energy, water, and  $CO_2$ .
- describe the relationship between burning glucose and increased  $CO_2$  levels when exercising.

## GroupWork 3 Activity Guide: Carbon Dioxide Out (Student Reproducible)

### Big Idea: Why Do We Breathe?

#### Introduction

Breathing is a two-part process. You breathe *in* so that you get an important gas-oxygen-into your lungs and eventually to your blood and cells. You also breathe *out* to release gases that your body doesn't need any more. In this activity you examine the gas you exhale and consider why it's important to get rid of it.

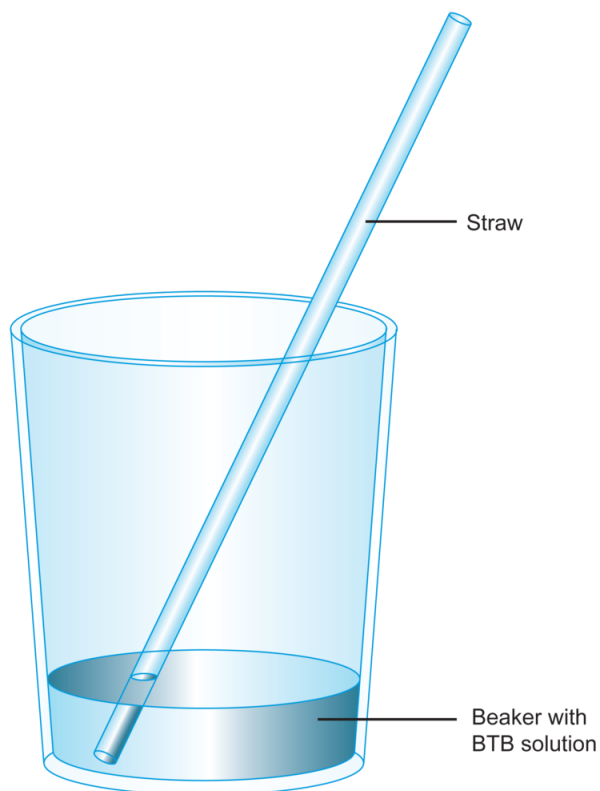
#### Materials

- 2 medium-sized beakers or cups, bromthymol blue (BTB) solution, and 2 straws
- Individual Report
- Data Sheet
- Resource

#### Procedure

1. Bromthymol blue (BTB) is called an indicator because it indicates when carbon dioxide ( $CO_2$ ) is present by changing colors. The more carbon dioxide present, the more color change you will see.
2. Using the materials provided, test the levels of carbon dioxide gas in exhaled air before *and* after exercise. Before you begin the experiment, discuss the following questions:

- Is it necessary to use equal amounts of BTB solution in each cup? Why?
- Why is it important to blow into each solution for an equal amount of time before and after exercise?
- How long should the person exercise before blowing into the straw?



3. Create a table on the data sheet and record the color of each solution.
4. Use the Resource to discuss the following questions:
  - How does exercise affect the level of carbon dioxide in the air you exhale?
  - How do you know? Why do you think that is?
  - Where does carbon dioxide in your exhaled breath come from? How is it produced in your body?
5. Create a presentation for the class to explain how and why the level of  $CO_2$  in the air you exhale changes after exercise. In your presentation include
  - the design and results of your experiment.
  - an explanation of why  $CO_2$  levels change with exercise.

### GroupWork 3 Individual Report: Carbon Dioxide Out (Student Reproducible)

#### Big Idea: Why Do We Breathe?

1. What effect does exercise have on the amount of  $CO_2$  in the air that you exhale? Why?
2. Where and how is carbon dioxide produced in your body?

### GroupWork 3 Data Sheet: Carbon Dioxide Out (Student Reproducible)

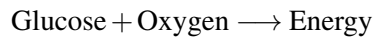
#### Big Idea: Why Do We Breathe?

Design a table to record your data. Record the color of each solution in your own table.

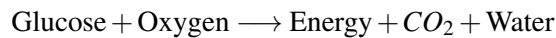
### GroupWork 3 Resource: Carbon Dioxide Out (Student Reproducible)

#### Big Idea: Why Do We Breathe?

- The process by which cells break down food (specifically glucose) to release energy is called *cellular respiration*.
- Cellular respiration, like its name implies, uses oxygen.



- Just like a burning candle, your cells must have oxygen in order to produce energy. While a candle burns wax and wick, your body burns glucose.
- Also like a burning candle, the product of the reaction is not just energy. Rather, carbon dioxide ( $CO_2$ ) and water are also produced during cellular respiration. Where does this  $CO_2$  and water go?




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### GroupWork 4: Teacher Activity Notes - How Is Breathing Rate Controlled?

#### Big Idea: Why Do We Breathe?

#### PLAN

**Summary** In this activity, students learn how and why breathing rate is controlled. They conduct an experiment to determine the effect of exercise on breathing rate.

**Group Size** 4 to 5 students

#### Objectives

Students:

- explain how and why breathing rate is controlled by the brain.
- describe the relationship between breathing rate and energy usage.

#### Multiple Abilities

- Conceiving of an idea for an experiment, creating an engaging and influential presentation (creative ability)
- Clearly and logically explaining to others how and why we breathe (communication skills)
- Logically analyzing the problem, solving a problem experimentally, making connections between ideas/concepts, hypothesizing (reasoning ability)

**Student Materials**

Two stopwatches and art supplies

Individual Report

Data Sheet

Resource

**Estimated Time** 40 minutes

**Suggested Use**

- This set of activities works well near the end of the unit.

**Background Information**

- *During* exercise, the main continuous factor is depth (or volume) of each breath. Rate of breathing varies. For example, in the case of running, rate of breathing is tied to stride. *After* exercise, the rate and depth of respiration increase. Therefore, the “minute-volume” increases due to both increased breaths per minute and increased exchange per breath. There are generally no changes, or only small changes, in carbon dioxide content in each exhaled breath during exercise. After exercise, the amount of carbon dioxide in each breath may go up a little temporarily.
- In this activity, we stressed receptors sensitivity to levels of oxygen. However, receptors in the blood and brain also are sensitive to levels of oxygen and hydrogen ion concentration. For example, receptors respond to large decreases in oxygen concentration in the blood. When the oxygen concentration decreases below a certain level, the receptors send impulses to the respiratory center in the brain. The response of the brain is to increase the breathing rate until the oxygen concentration is back to normal.

**IMPLEMENT**

1. Explain to students the difference between anaerobic and aerobic exercise.
2. Discuss the following question.

Does breathing rate change after both aerobic and anaerobic exercise?

**Extend this Activity**

This activity can be used as an introduction to the concept of homeostasis, which is the regulation of body processes that keeps the internal conditions of the body the same or nearly the same.

**Extension Questions**

- What is the difference between voluntary and involuntary control by the nervous system? Is control of your respiratory system voluntary or involuntary? How do you know?
- What would you expect to happen to your breathing rate when you're asleep? Why?

**ASSESS**

Use the group data sheet, presentation, individual report, and group discussion to assess if students can

- describe the inverse relationship between oxygen and carbon dioxide.
- explain how breathing rate is controlled by the brain through the use of receptors that measure and respond to carbon dioxide levels in the blood.
- explain the relationship between breathing rate and energy usage.

## GroupWork 4 Activity Guide: How Is Breathing Rate Controlled?(Student Reproducible)

### Big Idea: Why Do We Breathe?

#### Introduction

Our bodies have the amazing ability to keep us supplied with the right amount of oxygen. Whether we're watching TV or running a mile, our bodies' breathing rate speeds up or slows down to keep the levels of oxygen and carbon dioxide in our blood fairly constant. In this activity you learn how and why our rate of breathing is controlled.

#### Materials

- 2 stopwatches and art supplies
- Individual Report
- Data Sheet
- Resource

#### Procedure

1. Design and conduct an experiment to determine how exercise affects rate of breathing. Record your procedures and results on the data sheet.
2. In your group discuss the following.
  - Compare the average breathing rate of your team (include all members of the group) before and after exercise.
  - What accounts for the changes in breathing rate after exercise?
  - How does your body control breathing rates?
3. Create a presentation to explain to your classmates how and why breathing rate is controlled. Include
  - a diagram to explain how your brain controls rate of breathing.
  - the design and results of your experiment.
  - an explanation of why breathing rate is tied to energy needs.

## GroupWork 4 Data Sheet: How Is Breathing Rate Controlled? (Student Reproducible)

### Big Idea: Why Do We Breathe?

For the breathing rate experiment:

1. Record your procedure:
2. Record your results:

## GroupWork 4 Individual Report: How Is Breathing Rate Controlled? (Student Reproducible)

### Big Idea: Why Do We Breathe?

1. How does your body control breathing rate?
2. What was the average breathing rate of your group before exercise? after exercise? Why did breathing rate change?
3. Why is it important to run more than one trial in any experiment?
4. How is breathing rate tied to energy needs? What is some evidence the two are connected?

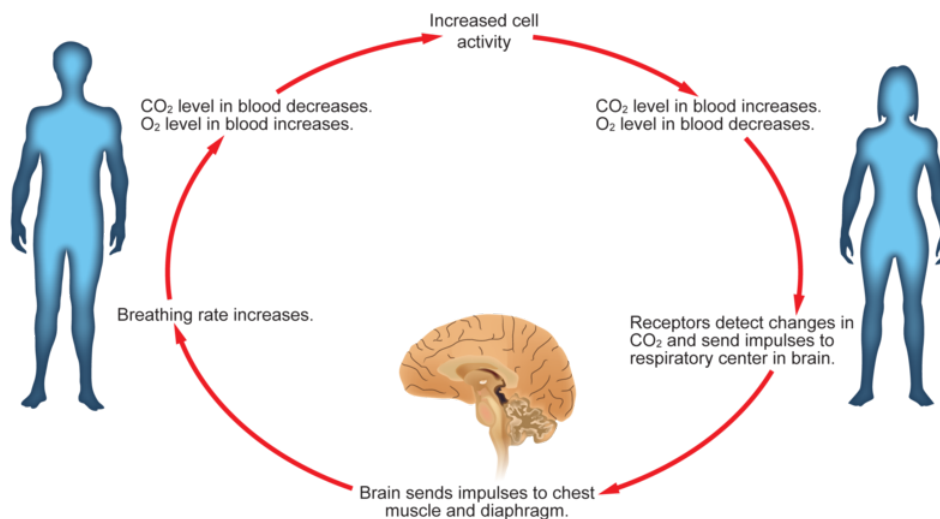
### GroupWork 4 Resource: How Is Breathing Rate Controlled? (Student Reproducible)

#### Big Idea: Why Do We Breathe?

Rate of breathing changes according to the amount of carbon dioxide in your blood.

- Oxygen ( $O_2$ ) and carbon dioxide ( $CO_2$ ) in your blood are inversely related. That means that when one *increases*, the other *decreases*, and vice versa. Thus, if the level of  $CO_2$  in your blood increases, the level of  $O_2$  decreases.
- Specialized nerve cells, called *receptors*, measure and respond to increases and decreases of carbon dioxide ( $CO_2$ ) in your blood.
- An increase in  $CO_2$  causes the receptors to send messages to the *respiratory center in your brain-the medulla*.
- Your medulla responds to these messages by sending signals to your diaphragm and ribs to breathe faster.
- When you breathe faster, both the amount of  $CO_2$  you exhale, and the amount of  $O_2$  you inhale increases. Thus, the amount of oxygen in your blood increases while the amount of carbon dioxide decreases.

The following diagram shows the entire cycle:



### GroupWork 5: Teacher Activity Notes - What Conditions Affect Breathing?

#### Big Idea: Why Do We Breathe?

#### PLAN

**Summary** Students explore how a behavior (smoking), a disease (asthma), or an environmental condition (air pollution) affects one's ability to breathe and why.

**Group Size** 4 to 5 students

#### Objectives

Students:

- identify the causes of breathing difficulties.
- describe the consequences of a breathing difficulty.

- explain how breathing problems could be prevented or alleviated.

### **Multiple Abilities**

- Applying and integrating information from other units, analyzing a situation or issue (reasoning ability)
- Writing a creative, original script, directing people, role-playing someone very unlike yourself, expressing emotions (dramatic/creative ability)

### **Student Materials**

Costumes and props for skit

Reports 1, 2, and 3

Resources 1, 2, and 3

**Estimated Time** 40 minutes

### **Suggested Use**

This set of activities works well near the end of the unit.

## **IMPLEMENT**

- a. **IMPORTANT:** There are three *different* resources and individual reports. Each group should get only one resource and its corresponding individual report. If groups are rotating through the activities, you may wish to rotate the resources as well, in order to vary the presentations more. If all the groups are doing this activity at the same time, you could have them each using a different resource.
- b. Schedule times and places for student performances.

### **Extension Questions**

- Although smoking and extreme air pollution can be equally hazardous to your health, how and why do people's opinion of them differ?
- How does one's control over smoking, asthma, and air pollution differ?

## **ASSESS**

Use the group product, individual report, and group discussion to assess if students can

- identify the causes of breathing difficulties such as smoking, asthma, or air pollution.
- discuss the relationship between breathing difficulties and the consequences of smoking, asthma, or air pollution.
- explain how breathing problems could be prevented or alleviated.

## **GroupWork 5 Activity Guide: What Conditions Affect Breathing? (Student Reproducible)**

### **Big Idea: Why Do We Breathe?**

#### **Introduction**

Poof. You have been transported through time and space and are now famous Hollywood scriptwriters. As writers of the most popular TV show, you have decided your next episode will highlight the importance of a healthy respiratory system. More specifically, you have decided this episode will examine a behavior such as smoking, a disease such as asthma, or an environmental condition such as air pollution that makes it harder for people to breathe.



## Materials

- Props and costumes for skit
- Resources 1, 2, and 3
- Individual Reports 1, 2, and 3

## Procedure

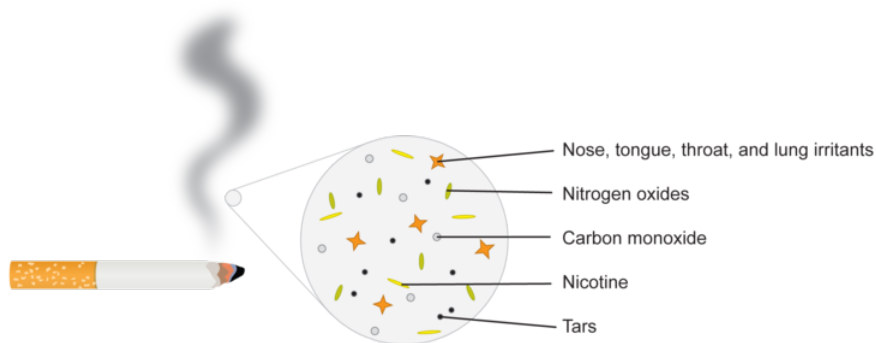
1. The resource contains some necessary background information for you to use in writing your script.
2. The head producer has suggested that you discuss the following questions before you begin to write.
  - How will your selected topic be presented?
  - What message do you want the audience to receive?
  - What potential consequences or solutions will be offered?
3. Now, as a team write a script, the plot of which revolves around the topic described on the resource. The script should use the characters and setting of an actual TV show.
4. Perform your TV episode for the class.

## GroupWork 5 Resource 1: What Conditions Affect Breathing? (Student Reproducible)

### Big Idea: Why Do We Breathe?

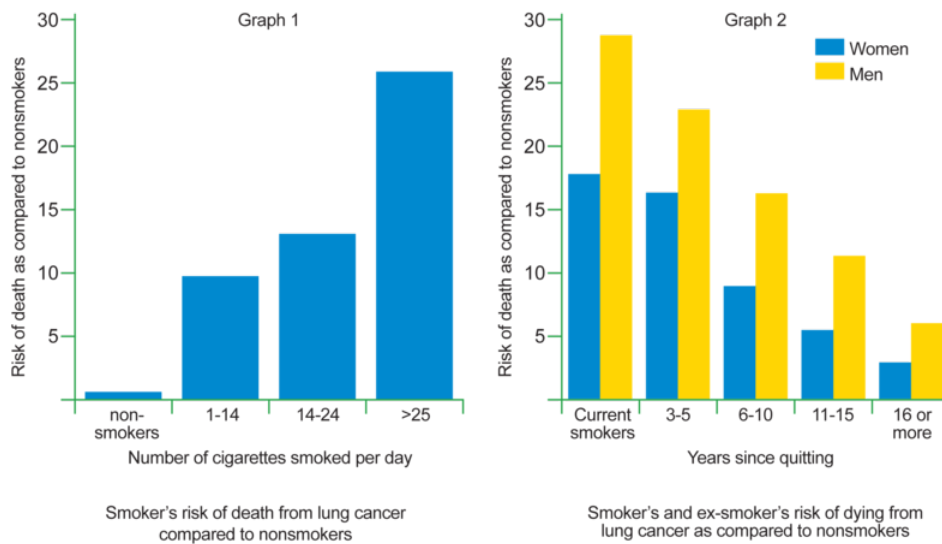
#### Behavior: Smoking

The diagram below shows the ingredients given off when someone smokes tobacco. These ingredients are inhaled by the smoker, as well as by people nearby.



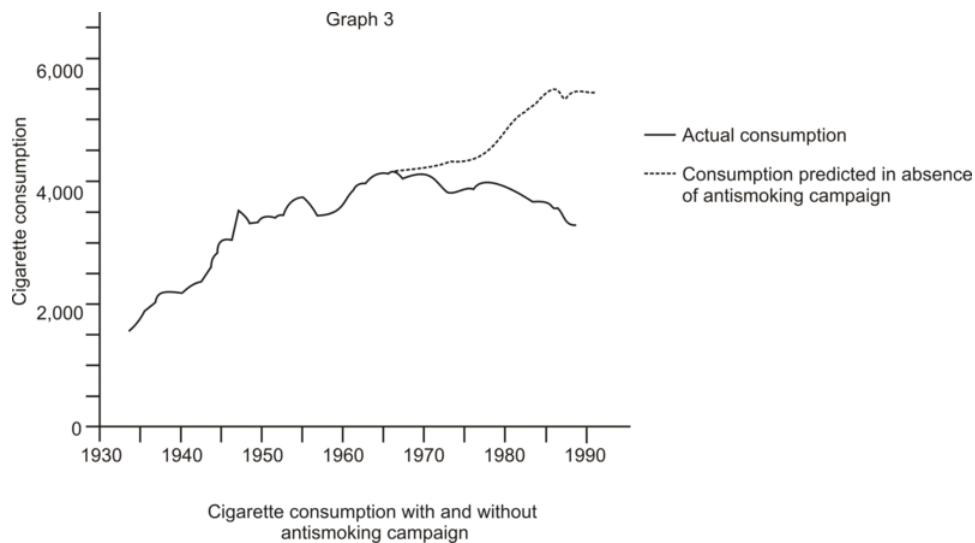
Nicotine is one of many harmful ingredients in cigarette smoke. Nicotine is a drug. It causes people to become addicted to tobacco. Nicotine also makes smokers become breathless more easily.

Tar is a second harmful ingredient. It is a thick, yellow-brown liquid produced when unburned particles and gases collect in the lungs. Tar and other particles damage the cilia lining the trachea and bronchi, slowing or stopping the removal of foreign substances from the lungs. Frequent sore throats and coughs result. Over time, tar builds up and irritates the cells of the lungs. This irritation may lead to cancer.



Since 1964, scientists have linked smoking to lung cancer. A person with lung cancer has a harder time breathing. More importantly, a person with lung cancer usually dies from this disease. According to Graph 3, what is the risk of death from lung cancer for smokers as compared to nonsmokers? According to Graph 2, why should people try to quit smoking?

What can be done to discourage people from smoking? Since 1965, antismoking campaigns have attempted to change the public's attitudes towards and behaviors about smoking. According to Graph 3, what is one thing these campaigns have accomplished?



Sources : Graph 1-*Smoking and Cancer*; The American journal of Medicine. (1992)

Graph 2-*Surgeon General's Report on the Health Benefits of Smoking Cessation*, Public Health Reports. ( 1990)

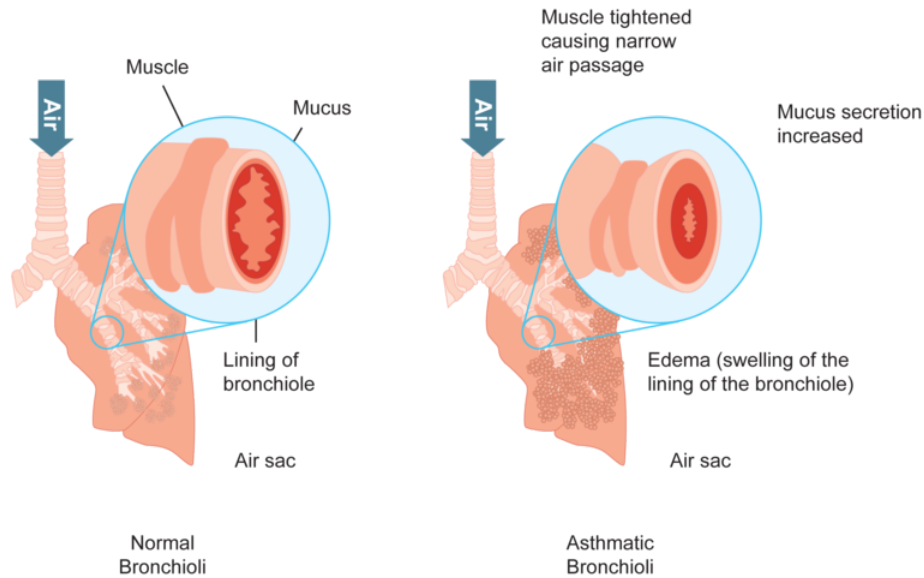
Graph 3-*Effects of the Antismoking Campaign: An Update* American Journal of Public Health. (1989)

### GroupWork 5 Resource 2: What Conditions Affect Breathing? (Student Reproducible)

**Big Idea: Why Do We Breathe?**

**Disease: Asthma**

Asthma is a disease that makes it more difficult for a person to breathe. During an asthma attack, the walls of the airways constrict, blocking the flow of air into and out of the lungs. The diagram below shows what happens during an asthma attack.



A “trigger factor” triggers an asthma attack. Triggers include allergic responses to foods, ragweed, dust, dust mites, pollen, molds, or food coloring. Triggers can also involve a reaction to cold weather, exercise, stress, or air pollution.

Asthma symptoms vary dramatically. They can range from a slight tightening of the chest or an occasional cough to intense feelings of breathlessness, coughing, and wheezing. During a moderate to severe attack, people with asthma may feel that they are fighting for every breath of air they take in. Medication often helps relieve these symptoms. These symptoms can sometimes send the person to an emergency room.

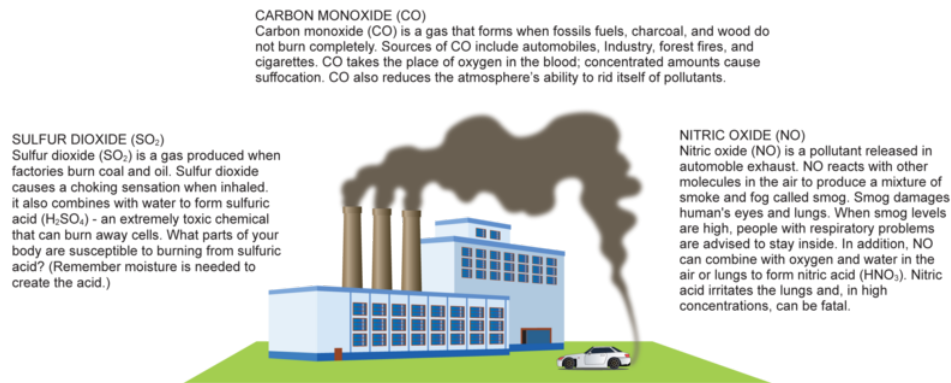
Medical scientists have not been able to cure asthma. However, they have made progress in controlling and treating asthma symptoms. Scientists have learned asthma symptoms can be relieved by proper diet, exercise, and medication. For example, doctors now use two basic types of medication to help treat asthma. One type of medication relieves the symptoms of an asthma attack, while the other prevents the onset of an attack. Through preventive care and medication to relieve symptoms, most asthma patients can lead very active lives.

### GroupWork 5 Resource 3: What Conditions Affect Breathing? (Student Reproducible)

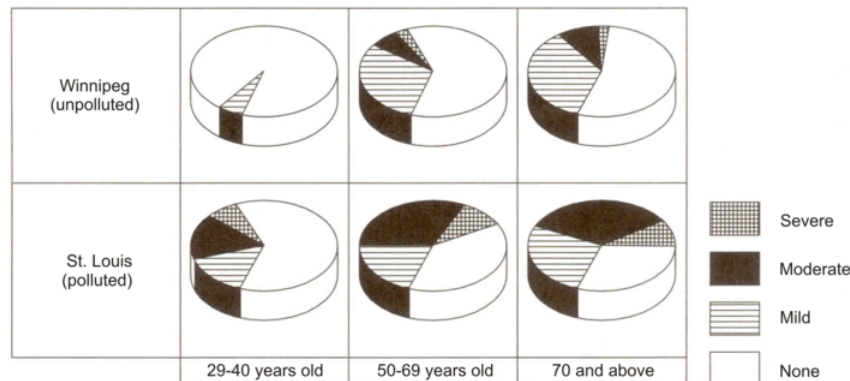
#### Big Idea: Why Do We Breathe?

##### Environmental Condition: Air Pollution

Most air pollution is the result of the burning of fossil fuels such as coal, oil, and gasoline in cars and factories. The major air pollutants are described below.



One effect of long-term exposure to air pollution is shown in the figure below. Emphysema is an incurable disease that kills more people each year than lung cancer and tuberculosis combined. The rate of this disease is compared in polluted and unpolluted cities. What do these charts tell you about the percentage of people with emphysema in Winnipeg as compared to St. Louis? How would you explain the difference in emphysema rates?



Since the 1960s, we have made progress in reducing some forms of air pollution. Many factories have attached antipollution devices called scrubbers to their smokestacks. Scrubbers remove sulfur dioxide before it gets into the atmosphere. Others use low-sulfur coal. Low-sulfur coal can be found in nature or produced when high-sulfur coal is “washed” to remove some of its sulfur. In addition, automobiles and aircraft have been equipped with antipollution devices to reduce the amount of pollutants they release. These antipollution practices are expensive. Do you think they are worth the price?

Source for Pie Graphs: *Environmental Science: Action for a Sustainable Future*, by D. Chiras. Benjamin/Cummings Publishing Co. (1991)

### GroupWork 5 Individual Report 1: What Conditions Affect Breathing? (Student Reproducible)

#### Big Idea: Why Do We Breathe?

1. How does smoking affect a person's respiratory system? Provide at least three ways.
2. Why do people smoke?
3. What advice would you give a friend who smokes?
4. What message did you send about smoking to the audience of your TV show? Why?

### GroupWork 5 Individual Report 2: What Conditions Affect Breathing? (Student Reproducible)

#### Big Idea: Why Do We Breathe?

1. How does asthma make it more difficult for a person to breathe?
2. How can a person control the symptoms associated with an asthma attack?
3. There has been an alarming increase in the number of people with asthma during the last five years. Provide possible reasons for this increase.
4. How did you present the issue of asthma in your TV script? How did the characters of the show react to the problem of asthma? Why?

### GroupWork 5 Individual Report 3: What Conditions Affect Breathing? (Student Reproducible)

#### Big Idea: Why Do We Breathe?

1. How does air pollution-specifically  $CO$ ,  $SO_2$ , and  $NO$ -make it more difficult for a person to breathe?
2. What can your family do on a daily basis to reduce air pollution?
3. What should the federal government or EPA do about the problem of air pollution? Provide support for your answer.
4. How did you present the problem of air pollution in your TV script? What solutions did you include?

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## GroupWork 6: Teacher Activity Notes - Culminating Activity-Air Pollution in Factorytown, USA

#### Big Idea: Why Do We Breathe?

#### PLAN

**Summary** Groups debate whether a factory that is both an employer in a small town and a source of pollution be shut down.

**Group Size** 4 to 5 students

#### Objectives

Students:

- identify the causes and effects of air pollution.
- describe the real-life dilemmas that can arise around issues of air pollution.
- explain how air pollution can be alleviated or eliminated.

#### Multiple Abilities

- Arguing persuasively, clearly stating the issues and problems involved (communication skills)
- Listening carefully to others, respecting others' views, allowing others to have their own opinion, arguing without personally attacking or hurting other students' feelings (interpersonal skills)
- Considering all possible sides of the issue, rebutting other students' arguments (reasoning ability)

**Student Materials**

Costumes and props (optional)

Resources 1 and 2

**Estimated Time** 2-3 class periods. Day 1- students prepare in their groups. Days 2 (and 3)-the debate is held with the whole class.

**Suggested Use**

This set of activities works well near the end of the unit.

**IMPLEMENT**

1. You may have some difficulties getting students to focus on the scientific concepts. Insist that they use what they have learned about breathing, breathing problems, and air pollution to construct their arguments and make a decision.
2. Previous experience in debating or specific training in the art of debate would be helpful in completing this activity. If students in the class are familiar with debate and skilled at developing their own arguments and rebuttals, you may wish to withhold the “Description or Roles.” In addition, you may let students decide what roles they wish to play, or whether they want to play roles at all. In the latter case, they may create pro and con sides and debate the issue in a more traditional manner.

We suggest that classes or groups who may not have developed the necessary skills be given a step-by-step lesson on the construction of arguments, “fair” fighting, rebuttals, etc.

**Extension Questions**

- What alternatives or options are available to the town if it decides to close the factory down?
- If the factory is kept open, what are some of the options to lower the level of pollutants the factory emits?
- What information or data do you need to know to make an informed decision about the factory?
- Is there an issue in your area in which employment and the economy are pitted against health or the environment? Explain and compare.

Specify length of piece.

Make clear the purpose and the audience.

Suggest sources and ideas for information.

Provide in-class time for compiling information and writing.

Require students to exchange papers and provide written feedback.

Provide a breakdown of due-dates for the following stages: choice of topic, outline, rough draft and final draft.

Permit students to supplement a written report with a skit, a piece of artwork, a piece of music, a dance, a video, or a multimedia presentation.

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## ASSESS

Provide the students with evaluation criteria that include:

- accuracy of the content based on guiding questions.
- clarity of writing.
- effective organization of main ideas.
- use of detailed examples or citing evidence to support their conclusions.

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## Project 1: Teacher Activity Notes - Research Questions and Action Projects

### Project #1: Research Questions

This project differs from the others. It is a list of potential research topics organized according to some key ideas and addressed to the students.

- Do all animals have the same respiratory system? Compare the human respiratory system to that of a fish, amphibian, reptile, or bird. How might you explain similarities and differences? Provide reasons why this comparative study is interesting or useful.
- Since most organisms need oxygen to live, why hasn't Earth run out of oxygen? To answer this question, research the oxygen cycle. Explain where oxygen is produced, stored, and used. Also explain how oxygen helps sustain life on Earth. Will Earth ever run out of oxygen? How do you know?
- What happens to all the carbon dioxide that organisms release? To answer this question, research the carbon cycle. Explain where carbon dioxide is produced, stored, and used. Also explain why scientists are becoming more and more concerned about the concentration of carbon dioxide in the atmosphere. Is too much carbon dioxide bad? Should you be worried about the level of carbon dioxide in the atmosphere? How do you know? What can you, your school, businesses, or the government do to address this issue?
- How did scientists come to know what is in the air we breathe? How did they learn why we breathe? Trace the history of scientists' understanding of the respiratory system. What motivated scientists to explore these questions? How have humans been influenced by their discoveries over time?
- Why do people sing? How do they do so (in terms of anatomy and physiology)? Why are some people better singers than others? Research the answers to these questions.
- At what altitude do you live? How does altitude affect what and how you breathe? What would happen if you went to visit a city at a much higher altitude? What would happen if you went to visit a city at a much lower altitude? How do you know?
- Why is holding your breath under water for long periods of time dangerous? What happens if you hyperventilate before doing so? What are several ways to convince children and teenagers not to play potentially deadly swimming games?
- How do scuba divers breathe underwater? What are the "bends" and what must divers do to avoid getting them? Do you scuba dive or would you like to learn how? Why or why not?
- What does a healthy respiratory system look like under a microscope? How do doctors tell if a person's respiratory system is healthy? What procedures and/or tests do doctors use to check for signs of disease? To find answers to these questions, conduct independent research and interview at least one doctor.
- Cigarette smoking is a cause of illness and early death. Why do people continue to smoke? What does smoking do to someone's lungs? What is second hand smoke and what effect does it have on the lungs? How can people learn to stop smoking? Incorporate your own experiences with smoking and/or with people who smoke.
- Tuberculosis, bronchitis, pneumonia, asthma, and emphysema are examples of human respiratory diseases. Select one of these diseases and explain its cause, as well as its treatment and prevention.

1. What is a respiratory therapist? What does he or she do? What education and training is required to become a respiratory therapist? Are you interested in joining that profession? Why or why not?

---

## Project 2: Teacher Activity Notes - Air Pollution

### PLAN

**Summary** Students investigate their local air quality through research. They develop and present an action plan to help reduce air pollution in their community.

#### *Interdisciplinary Connections*

Social Studies, Language Arts

#### *Estimated Time*

- One week for initial research and sharing of information
- Two weeks for development of a plan of action
- 10 minutes, once per week, for periodic reports on the progress of their plan
- Several class periods for students to prepare and present their projects

#### *Student Materials*

Brochures and information packets that discuss and identify the quality of air, sources of air pollution, and effective strategies for reducing pollution in your community or state

#### *Product*

Students develop

- a research presentation on local air pollution.
- a written action plan for addressing local air pollution problems
- a presentation of a completed community service project to improve local air quality.

### IMPLEMENT

1. Have students research the answers to the following questions:

- How big a problem is air pollution in your city, region, or state?
- What are the major sources of air pollution?
- What is being done to regulate and/or improve air quality? Who is responsible for this regulation and its implementation?
- Is air pollution getting better or worse?

Provide students with or have them locate magazine articles, government reports, and environmental brochures. If possible, suggest that they interview local or state officials, as well as members of conservation organizations found in your area. You may want to invite a guest speaker, such as someone with experience in testing or regulating air quality. Then have groups present the information they found to the rest of the class. Use the Internet, if possible, to find information from the Environmental Protection Agency (EPA).

2. As a class, select two ways to improve the quality of air in your community or state, and have students create a plan of action to implement their improvements. Frame the assignment with the following questions.



- As individuals, what can you do to reduce air pollution?
- As members of a larger community, how can you help?

Make sure students specify what the class will do, and how they will educate others with their project.

3. If possible, have students implement their plan. Students could design and conduct experiments to determine local air quality to create a “before” and “after” assessment of their work.
4. After one to two months, ask students to evaluate the effectiveness of their plan. Students can create a presentation explaining the severity of the air pollution problem in their area, the steps they took to improve air quality, and the results of those efforts to date.
5. When projects are complete, have students present their project summaries to their school, parents, or community. Students could write about their experience in an article to be submitted to the school or local paper for publication. You also may want to have students conduct a follow-up study to determine the effectiveness of their air pollution action project.

## ASSESS

Use student products to assess if students can

- define and describe the major sources of air pollution in their community.
- identify possible ways for reducing air pollution.
- describe methods for measuring the quality of air.
- present an organized action plan with realistic timelines for improving air quality.
- clearly explain the methods they used and what they learned about the problems of reducing air pollution.
- organize and present data in a written format to the class.
- use visuals to illustrate major points.
- effectively answer questions from the class.

---

## Project 3: Teacher Activity Notes - Antismoking Campaign

### PLAN

**Summary** Students investigate the effects of smoking and the social and political issues surrounding it. They develop an antismoking campaign in their community.

#### *Interdisciplinary Connections*

Social Studies, Language Arts

#### *Estimated Time*

- Two weeks to conduct initial research, share information, and create a plan of action
- 20 minutes per week for several months for updates on how the plan is proceeding
- Two to three periods to prepare for their class presentations

#### *Student Materials*

Brochures, articles and/or videos that discuss and demonstrate the effects of smoking.

#### *Product*

Students develop

- a presentation of research on the effects of smoking and related social and public policy issues.
- a written action plan for an antismoking campaign.
- a presentation of a completed community service project.

## IMPLEMENT

1. Begin by asking students the following questions. In the face of all the negative effects associated with smoking, why do people continue to smoke? More importantly, why are more teenagers smoking at younger ages? What can you do to convince yourself and others not to smoke?
2. Divide students into groups and have them research one of the following topics. You may also want to conduct experiments on smoking. Or, ask a current or former smoker to talk to your class about smoking as a habit.
  - Trace the history of scientists' discoveries about the dangers of smoking cigarettes and of secondhand smoke. When did scientists first link smoking with cancer? Why? When did they find out expectant mothers should not smoke? When did they begin to recommend banning smoking in public places?
  - How many people smoke in your community? Why do they do so? How many have quit? Conduct a survey of the people in your community to find answers to these questions.
  - Why do cigarettes remain big business? Research one or more of the companies that produce and sell cigarettes. Where are these companies located? To whom do they target their advertisements? What reasons do they give for continuing to make cigarettes? Are they selling more or fewer cigarettes than in years past?
  - Why is smoking considered hazardous to one's health? What diseases are caused by smoking? What problems are associated with secondhand smoke? Why should pregnant women avoid smoking?
3. Have students present their group findings to the rest of the class.
4. Either in groups or as a class, pick one method useful for convincing others not to smoke. Target your school, community, city, or state. Have students develop a detailed plan of action. Emphasize that their plan should address a particular problem and provide one or more specific solutions.
5. If possible, have students implement their plan. As part of their project, you might ask students to write to local or state politicians. The letter should summarize student research, plan of action, and results as well as encourage politicians to enact the plan on a larger scale.
6. After one or two months, have students evaluate the effectiveness of their plan. Has it done its job? Does more need to be done? How could the plan be changed to be more effective? Ask students to explain why smoking is unhealthy and what they have done to convince others to stop smoking.

## ASSESS

Use student products to assess if students can

- identify the effects of smoking.
- explain why people continue to smoke even when they know the negative health effects of smoking.
- evaluate the impact of advertisements that promote smoking and public service announcements that discourage smoking.
- present an organized action plan for developing an antismoking campaign.
- evaluate the impact of an antismoking campaign for

a) teenagers;

b) parents;

c) medical personnel;

- d) tobacco companies;
  - e) health insurance companies;
  - f) the federal government.
- make a convincing presentation using factual information.

---

## Project 4: Teacher Activity Notes - Plant-A-Tree

### PLAN

**Summary** Students explain the benefits and limitations of planting trees in their community as a way to improve air quality.

#### *Interdisciplinary Connection*

Social Studies

#### *Estimated Time*

- One to two weeks to collect information, share research and decide on a plan of action
- Two weeks to implement the plan
- Four class periods to prepare and give presentations

#### *Student Materials*

News, Internet, and magazine articles about plant-a-tree efforts and ways citizens can improve the air quality of their community

#### *Product*

Students develop

- a presentation of research on the effects of planting trees on the environment.
- a written action plan.
- a presentation of the completed project.

### IMPLEMENT

- a. Divide students into groups of three to five to research the following question: What does planting trees do for the quality of air and/or environment? You may want them to consult organizations that support plant-a-tree efforts, environmental agencies, ecologists, and Projects botanists. Have students share the information their group collects with the rest of the class.
- b. Have the class brainstorm the most effective way that they could improve the air quality of their community based on the effects of trees on the environment. Contact the local chamber of commerce to get permission and help in organizing a tree-planting effort in the community. Have students write a detailed plan and budget for their project. Review the plan, materials (trees, shovels, etc.), budget, and timelines.
- c. Students get started with project.
- d. After the project is complete, students create a presentation to share information, project plan, and project results with the rest of the school or community. They may want to invite an ecologist or environmental scientist to speak to the class and assess the quality of the completed project. They also may want to erect a current events board on which students can pin-up articles on air pollution, the greenhouse effect, and other environmental problems.

## ASSESS

Use student products to assess if students can

- identify the benefits and limitations of planting trees to improve air quality.
- present an organized action plan with a budget and realistic timelines.

---

## Project 5: Teacher Activity Notes - Mini Science Fair

### PLAN

**Summary** Students investigate various aspects of the respiratory system by conducting a series of experiments.

**Estimated Time** Approximately five class periods over a one month period

#### **Student Materials**

Science references with ideas for experiments and supplies as needed for experiments

#### **Product**

Students develop

- a science fair project.
- a written report or poster explaining the experiment and its results.
- a presentation of the project.

### IMPLEMENT

1. Organize and conduct a mini science fair based on student questions about the respiratory system. Begin by having students brainstorm questions about the respiratory system to be answered through an experiment or survey. For example:

- How are heart rate and breathing rate related?
- How much does the air quality in your community Vary from day to day?

2. Have students choose a question and design and carry out their experiment. They'll need to conduct necessary background research, design, and run their experiment, and collect and analyze their data. If students have little experience, review how to conduct a controlled experiment. Give them time in class to formulate their research question. You will want to check students' questions and experimental designs before they conduct their experiment. If any of the projects are of exceptional quality, submit students' work to a larger science fair.

3. Have students create a poster that describes the purpose, design, and results of their experiment. Present this poster to the rest of the class as part of a mini-science fair.

4. For a follow-up activity, ask students to apply what they learned from these projects to a real-world problem. Perhaps they could create an after-school exercise program or sponsor a local clean-up-the-air campaign.

## ASSESS

Use student products to assess if students can

- formulate a research question on some aspect of the respiratory system.

- design and conduct an experiment to test a research question.
- identify the variable(s) to be tested and include a control in the experimental design.
- write a procedure for conducting the experiment that can be replicated by someone else.
- construct data tables for recording observations and results.
- clearly explain the methods used and what was learned.

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## 7.2 Additional Resources

### Information Pamphlets

Cancer Facts

National Cancer Institute

Office of Cancer Communications

Building 31, Room 10A24

Bethesda, MD 20892

Publications list for the public and patients includes cancer prevention materials, information on early detection, general materials, and patient materials.

National Cancer Institute

Office of Cancer Communications

Building 31, Room 10A24

Bethesda, MD 20892

American Cancer Society

1-800-ACS-2345

### Multimedia Resources

It's hard to recommend the most up-to-date resources because they change so quickly. Below we list a few favorites, but suggest that you subscribe to a catalogue that will keep you up to date on resources available to you. Some good catalogues include

Educorp

7434 Trade Street

San Diego, CA 92121-2410

Enhance

1-800-777-ENHANCE

This catalogue also publishes some good articles on using computer technology and educational software.

Sunburst

101 Castleton Street

P.O. Box 100

Pleasantville, NY 10570-0100

1-800-321-7511

Educational Resources

1-800-624-2926

### Internet Resources

SchoolHouse Mac: A resource tool for K-12 teachers who use Macs in the classroom. It offers some good ideas about teaching tools and programs available to teachers for free on the Internet and offers teachers a way to

communicate with each other. SchoolHouse Mac, 5326 Coats Grove Rd., Hastings, MI, 49058. On the Internet, charlie@938aol.com

You might also explore the possibility of subscribing to America On-Line, which offers a lot of good resource listings and public domain (freeware or shareware) material on various topics. The cost runs about \$10 per month.

Anatomy and Physiology, Videodiscovery and HarperCollins, 1-800-548-3472. Appropriate for high school and college students. An in-depth exploration of body functions and anatomy. More detailed than you need, but would help students visualize what they are learning about.

### **Software/CD-ROM Programs**

A.D.A.M. Essentials, A.D.A.M. Software, \$119.95 School edition. (1-800-777-3642) Interactive exploration of the human body.

3-D Body Adventure, Knowledge Adventure (1-818-542-4200) Interactive, guided tours of the body and its functions. Great graphics, easy to use.

The Human Body, National Geographic (1-800-624-2926) Uses pictures and sound effects to explore the human body.

Body Scope, MECC, School version (1 -800-777-3642)

Bear Byttes, Ltd.

2115 Highway 2 East #7

Kalispell, MT 59901

Bergwall Educational Software

106 Charles Lindbergh Blvd

Uniondale, NY 11553

Stanford Program in Human Biology

“How the Heart and Lungs Work,” CD-ROM

Big G Software

RT 2, Box 11

Alleyton, TX 78935

BrainBank, Inc.

220 Fifth Ave.

New York, NY 10001

COMPRESS

P.O. Box 102

Wentworth, NH 03282

Cramer Software Group

153 W. Warren, P.O. Box 1001

Gardiner, KS 66030

Dietary Data Analysis

P.O. Box 26

Hamburg, NJ 07419

Educational Activities, Inc.

P.O. Box 392

Free port, NY 11520

Educational Images

P.O. Box 3456, West Side Station

Elmira, NY 14905

HRM Software

175 Tompkins Ave.

Pleasantville, NY 10570

Institute for Aerobics Research

12330 Preston Rd

Dallas, TX 75230

Intellectual Software

562 Boston Ave

Bridgeport, CT 06610

Kellog's

P.O. Box 5159

Kalamazoo, MI 49003-5159

MECC

Minnesota Educational Computing Corp.

3490 Lexington Ave N.

St. Paul, MN 55126

Persimmon Software

910 Memory Lane

Mobile, AL 36608

Queue, Inc.

562 Boston Ave

Bridgeport, CT 06610

Sally Ayer/SOFTSHARE

Physical Education & Human Performance

California State University

Fresno, CA 93740-0028

Sunburst Communications Inc.

39 Washington Ave.

Pleasantville, NY 10570

Wholebody Health Management



18653 Ventura Blvd., Suite 137

Tarzana, CA 91356

### **Videotapes and Films**

*Circulatory and Respiratory Systems*, film or video, National Geographic.

*The Lungs and Respiratory System*, film or video, EBE.

*The Living Body: Design for Living*, video, Films for the Humanities, Inc.

### **Internet Sites**

National Center for Chronic Disease Prevention and Health Promotion

<http://www.edc.gov/needphp/needhome.htm>

American Lung Association <http://www.lungusa.org/ndex.html>

Global Initiative for Asthma <http://www.gingsthma.com/>

Environmental Protection Agency (EPA) <http://www.epa.gov/>

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## 7.3 Glossary

**aerosol**

chemicals suspended in the air like a mist or a fog.

**air pollution**

a name for the substances put into the air that contaminate our atmosphere.

**alveoli**

air sacs that are clustered around the smallest bronchioles. They are the site of gas exchange between the air and the blood.

**arteries**

blood vessels that carry blood from the heart.

**asthma**

a condition in which the small airways leading to the air sacs get narrow.

**bacteria**

tiny organisms that can enter your body and change the function of cells causing sickness.

**blood gas levels**

the amount of carbon dioxide and oxygen in your blood.

**bronchi**

tubes that branch off the trachea and lead to the smaller bronchioles.

**bronchioles**

tubes that branch off the bronchi and repeatedly branch into smaller and smaller tubes.

**bronchitis**

infection of the upper airways and smaller air tubes. Two symptoms are wheezing and a persistent cough.

**capillaries**

tiny blood vessels through which materials pass between cells and the blood.

**carbon dioxide**

a waste gas your cells make, exhaled when you breathe.

**cellular respiration**

a process in which the cell uses oxygen to break down fuel molecules to produce energy and the waste products-carbon dioxide and water.

**cilia**

tiny hairs that line airways for breathing.

**control systems**

systems in your body that help regulate and maintain body functions at a normal level.

**diaphragm**

a large dome-shaped sheet of muscle, located beneath the lungs.

**diffusion**

the natural movement of particles from an area of high concentration to an area of low concentration.

**emphysema**

a disease that destroys the delicate membranes of the air sacs. As a result, individual alveoli combine into larger and larger air sacs.

**epiglottis**

a flap-like trap door that closes when you eat or drink to keep food out of the airways.

**esophagus**

the tube that carries what you eat and drink to your stomach.

**feedback information**

information used by control systems indicating a change has occurred and a function is deviating from normal.

**glottis**

a slit-like opening between your vocal cords.

**glucose**

a simple sugar molecule.

**larynx**

the voice box-connects the pharynx with the windpipe that goes to the lungs.

**lungs**

a pair of sponge-like organs responsible for the exchange of gases during breathing.

**mucus**

a secretion produced by tissues in the airways that help moisten air and protect your body from particles and infection.

**mucus escalator**

term for the way particles are moved towards the throat. The motion of the cilia combined with the mucus create the mucus escalator.

**nervous system**

the system composed of the brain, spinal cord, and nerve cells that connect to all parts of the body.

**oxygen**

a tasteless, odorless, and colorless element of air. About 20% of air you breathe is oxygen.

**pharynx**

the throat-the section of the digestive system that leads from the mouth to the esophagus.

**photosynthesis**

the process in which plant cells use carbon dioxide to produce sugars (or starches) from energy (sun).

**pneumonia**

condition when the small air tubes and air sacs in the lungs get infected with bacteria. The infected cells produce fluids, which makes breathing difficult.

**thermostat**

a device which controls temperature. The “thermostat” in the human body is located in the part of the brain called the hypothalamus.

**trachea**

the main breathing tube to the lungs.

**tuberculosis (TB)**

one of the ten leading causes of death in the world. Active tuberculosis bacteria destroy the air sacs in a person’s lungs.

**veins**

blood vessels that carry blood to the heart.

**venules**

small blood vessels that carry the blood from the capillaries to the larger veins.

**viruses**

tiny parasites smaller than bacteria.

**vital capacity**

the biggest possible breath a person can breathe in and exhale out.