

BACKGROUND

The primary function of the respiratory system is to supply the blood with oxygen in order for the blood to deliver oxygen to all parts of the body. The respiratory system does this through breathing. When we breathe, we inhale oxygen and exhale carbon dioxide. This exchange of gases is the respiratory system's means of getting oxygen to the blood.

Respiration is achieved through the mouth, nose, trachea, lungs, and diaphragm. Oxygen enters the respiratory system through the mouth and the nose. The oxygen then passes through the larynx (where speech sounds are produced) and the trachea which is a tube that enters the chest cavity. In the chest cavity, the trachea splits into two smaller tubes called the bronchi. Each bronchus then divides again forming the bronchial tubes. The bronchial tubes lead directly into the lungs where they divide into many smaller tubes which connect to tiny sacs called alveoli. The average adult's lungs contain about 600 million of these spongy, air-filled sacs that are surrounded by capillaries. The inhaled oxygen passes into the alveoli and then diffuses through the capillaries into the arterial blood. Meanwhile, the waste-rich blood from the veins releases its carbon dioxide into the alveoli. The carbon dioxide follows the same path out of the lungs when you exhale.

The diaphragm's job is to help pump the carbon dioxide out of the lungs and pull the oxygen into the lungs. The diaphragm is a sheet of muscles that lies across the bottom of the chest cavity. As the diaphragm contracts and relaxes, breathing takes place. When the diaphragm contracts, oxygen is pulled into the lungs. When the diaphragm relaxes, carbon dioxide is pumped out of the lungs.

The Three Stages of the Breath

- 1. Inhaling Oxygen (Air) INTO the Body:** The diaphragm expands into the abdominal cavity, where the intestines are located. Other muscles cause the ribs to move up and out, creating room in the chest (thoracic cavity). The lungs expand with the air that has entered through the nose and mouth. **Inhalation (or inspiration) is the active breathing phase.**
- 2. Gas Exchange in the Lungs:** Air enters the lungs through the bronchial tube that branches into bronchioles which branch into alveoli. The alveoli are surrounded by the capillaries of the pulmonary arteries and veins. Oxygen from the inflated lungs moves from the alveoli into the capillaries as carbon dioxide moves from the capillaries into the alveoli.
- 3. Exhaling Carbon Dioxide (Air) OUT of the Body:** The diaphragm muscle relaxes and returns to its dome-like position inside the ribcage. The ribcage muscles also relax. This pressure surrounding the lungs pushes air out of the body. Carbon dioxide is released from the body by traveling through the alveoli to the bronchiole to the bronchi, up the trachea and out through the nose and mouth. **Exhalation (or expiration) is the passive phase of breathing.**

Physiologically, breathing is an activity of the respiratory system and it is actively connected to many other body systems. Breathing and its benefits are not an isolated activity involving only the lungs.

- The respiratory system is connected to the heart and circulatory system through the cardio-pulmonary circulatory process that accomplishes the gas exchange required to keep oxygen and carbon dioxide in balance. Oxygen is carried in the blood, traveling everywhere throughout the body.
- The nervous system is involved with the breath and is affected by the breath as well. The autonomic nervous system engages the sympathetic and parasympathetic divisions to activate and calm breathing rhythms associated with the **stress response**.
- The respiratory activity of transporting oxygen around the body connects to the digestive system, supplying energy for digestion.
- Oxygen in the blood goes to the muscular system, providing energy to burn the food nutrients needed for muscle movement.

Parts of the Respiratory System

The respiratory system consists of more than just the lungs. These are the major parts of the respiratory system:

- **Nasal cavity** – The passage for air entering and leaving the lungs.
- **Cilia** – The lining of the nasal cavity. These are tiny hair-like structures that trap the small particles of dust and foreign matter that don't belong in the lungs. This is a very important function that helps keep our lungs clean and clear, allowing us to breathe efficiently.
- **Mouth** – A passageway for air as well as food into the body.
- **Pharynx** – Located in the throat, this is the passageway for food into the esophagus.
- **Epiglottis** – Acting as a trapdoor to the trachea, it keeps food from entering the trachea and blocking the airway.
- **Trachea** – Branching off from the esophagus, this is the passageway for air to the lungs, often called the windpipe.
- **Bronchia** – branches off from the trachea, with one branch going to each lung
- **Alveoli** – Attaches and branches off the bronchioles throughout the lungs. The oxygen/carbon dioxide exchange happens in these tiny air sacs. There are about 300 million alveoli in the lungs. This extraordinary number of alveoli provides a gas contact area of about 60 sq meters, or the area of a room 24 x 24 feet, roughly the size of a tennis court.
- **Lungs** – In these two large organs the oxygen/carbon dioxide exchange occurs. The left lung is slightly smaller than the right as the heart intrudes into the left lung area a bit. The left lung has two lobes, while the right one has three. The lungs are large, taking up most of the chest or thoracic cavity, and are soft, spongy, expandable, and light. Each one weighs about a pound (454 grams) and contains about 30,000 bronchioles in each lung. Bronchioles are only as thick as a single strand of

the finest hair, each ending in a group of bubble-like air sacs called alveoli. There are about 350 million alveoli in each lung.

- **Pleura** – Airtight sacs surrounding each lung.
- **Diaphragm** – Because the lungs are not capable of any movement on their own, they are entirely dependent upon the surrounding musculature called the diaphragm. A large dome-shaped muscle below the lungs, the diaphragm is the **primary muscle** of respiration. When we are breathing properly this muscle is doing most of the work, not the muscles of our neck, shoulders, and chest.

BASIC LESSON

Objective(s)

Students will be able to... describe the parts of the respiratory system.

- explain the function of the lungs, diaphragm, trachea, bronchia, and alveoli.
- explain the three stages of the breathing process and what occurs in each stage.
- explain two major risk factors for five respiratory problems.
- explain two ways to protect themselves against five respiratory problems.
- explain the connection of the respiratory system to four other body systems.

State Science Content Standard(s)

1.1: Develop abilities necessary to safely conduct scientific inquiry, including asking questions about objects, events, and organisms in the environment.

- Make observation using the five senses
- Record observations by drawing or orally explaining

3.1: Identify that plants and animals have structures and systems that serve functions for growth, survival, and reproduction.

- List characteristics of living organisms (body systems)]

Materials

Safety

From the Kit

- Pre-Quiz found in binder
- Right Lung Model
- Respiratory Chart
- Respiration Parts handout
- Funnel
- Droppers
- Clear cups- reusable
- Straws
- Bromothymol blue
- 15 safety goggles

Provided by Teacher

- Computer Access for lesson one, resource books, or teacher lecture
- Hair dryer
- Materials to make lung model – see lesson 1

- It is very tempting to use balloons when talking about the respiratory system but most schools ban the use because of student latex allergies.
- Safety goggles should be worn by students doing the activity. If there are not enough, the student exhaling into the cup (blowing bubbles) should have a pair on.
- Rinse eyes if bromothymol blue solution splashes but it is so dilute at this point the danger is minimal. Being safe is an important aspect of science experimentation.

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| <ul style="list-style-type: none"> • eight 50 mL graduated cylinders • 12 stop watches • Diseased lung model • Diseased lung chart • Milk jug • Tubing • Tub • Plastic measuring cup | | |
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| Key Vocabulary | Mastery Questions |
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| <ul style="list-style-type: none"> • Nasal Cavity • Trachea • Lung • Bronchiole or Bronchia • Alveoli • Pharynx • Epiglottis • Larynx • Pleura • Diaphragm • Tidal Volume | <ul style="list-style-type: none"> • See Lesson plans |
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| Detailed Plan |
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Lesson 1: The Lungs and Respiratory System

Introduction

Assess student knowledge by giving the Pre-Quiz found in the binder.

Answers to the quiz:

1. Two lungs.
2. Lungs conduct the oxygen-carbon dioxide exchange.
3. Left lung is slightly smaller than the right.
4. Ask: ***"Why is that?" (The heart intrudes into the left lung area.)***
5. The left lung has two lobes.
6. The right lung has three lobes.
7. They are soft, spongy, expandable, and light.
8. Each lung weighs about one pound (454 grams).

Have the students self-correct and then collect it to be used again later. Use the model of the healthy lung and the respiratory chart to point out the position of the different lobes and respiratory parts.

After the quiz, share additional interesting information:

- There are about 30,000 bronchioles in each lung.
- Each bronchiole is thinner than the finest hair.
- There are more than 600 million alveoli (bubble-like air sacs) in the lungs.

Exploration

1. Ask: **"Where does air go when it comes into our body through our nose or mouth?"**
2. Have students solve this question by working in groups. Give each student or group the Respiration Parts handout. Have students research the definition and function of each part (or you can share this information and the students can write the information on the handout). Students can be assigned all the parts or just one and share with the class later. The students can create their own picture and fill in the location of the respiratory parts and then describe their functions. If the students research the respiratory parts, have them do the following:
 - ❖ Have students/groups report back their results to the class and evaluate each other's' diagrams. Evaluations should be based on at least two criteria: **Accuracy** and **Thoroughness**. Students can determine other evaluation criteria and the rating scale to be applied to the criteria

Explanation[**\(Respiration Chart and Right Lung Model will be helpful here\)**](#)

1. Ask: **"What gives lungs their movement?"** *(Primarily the diaphragm and secondarily other surrounding muscles between the ribs. When we are breathing properly the diaphragm muscle is doing most of the work, rather than the muscles of our neck, shoulders, and chest.)*
2. Ask: **"What is the diaphragm and where is it located?"**
 - Large dome-shaped muscle below the lungs.
 - Separates the chest cavity from the abdominal cavity.
 - Makes a kind of floor for the chest cavity.
 - Covers the entire bottom area inside the ribcage from the spine and the ribs attaching to the spine wrapping all the way around to the front of the ribcage to the bottom of the sternum (breastbone).

(Note: In some anatomy diagrams, the diaphragm muscle looks like a mushroom cap when viewed "from" the abdominal cavity as if you were looking up at the bottom of it.)

3. Explain: **"We can feel the diaphragm when it is working."** Ask students to place their fingers on the bottom edge of the rib portion directly on either side of the sternum (breastbone) and slide the fingers an inch to two inches away from the midline of the body. Next, have them tuck their fingers slightly (and gently) into the body under the rib edge.
4. Now have students close or soft focus their eyes in order to pay attention to their breathing.

Tell them to inhale and exhale normally. They should feel their fingers being pushed out when the diaphragm presses into the abdominal cavity when they inhale. When they exhale the diaphragm presses back into bottom of the lungs to push air out. They will feel their fingers move back in towards the body.

5. Clarify the **three stages of the breathing cycle**:

STAGE #1: Active Breathing Phase – As oxygen (air) is inhaled into the body and muscles, the muscles expand to allow air into the body. Sufficient room is created in the chest as the diaphragm expands the abdominal cavity and other muscles cause the ribs to move up and out. The lungs expand and fill with air that has entered through the nose and mouth.

STAGE #2: Gas Is Exchanged in the Lungs — Air enters the lungs through the bronchial tube, and then branches into smaller bronchioles which branch into alveoli, bubble-like air sacs which are surrounded by the capillaries of the pulmonary arteries and veins. Oxygen from the inflated lungs moves from the alveoli into the capillaries, and carbon dioxide moves from the capillaries into the alveoli.

STAGE #3: Passive Breathing Phase — Carbon dioxide (air) is exhaled out of the body. During this process:

- Muscles relax
- Lung space is compressed
- Diaphragm muscle relaxes and returns to its dome-like position inside the ribcage, pushing up on the bottom of the lungs.
- Ribcage muscles also relax.
- Pressure surrounding the lungs pushes air out of the body.
- Carbon dioxide is released and travels through the alveoli to the bronchioles, then to the bronchi, up through the trachea and out of the body through the nose and mouth.

Extension

Using their drawings from the Exploration activity, have students assign numbers to each part to indicate the correct order of the breathing sequence, from inhalation to exhalation through the lungs.

Evaluation

Have students work together in threes, creating their own diagram or three-dimensional model illustrating the lungs (including bronchia, bronchioles, and alveoli) and gas exchange. The model can be an active or passive demonstration.

Possible materials can be sponges (no balloons because of latex allergies), liter soda or water bottles, straws and tubes of varying diameters, string, clay, beads etc.

Lesson 2: Breathing

Introduction

1. Ask: **“How many breaths do we take in a minute?”** Have students suggest answers, and then try to figure out how many breaths they take in one minute. Ask students to concentrate on their breathing, closing or soft focusing the eyes so that attention can be more focused on their breathing. Using the chart and/or model point out where the air is coming in and out, and how the lung expands.
2. Have students notice when they inhale and when they exhale air through the nose. Give them a minute or two to let them fall into the rhythm of paying attention. Ask the students to breathe as they normally do—they don’t need to change anything about *how* they breathe, just notice *when* they inhale and when they exhale.
3. When you feel they are ready, ask the students to count the times they inhale. Tell the students you will time them for 60 seconds. (They should *notice* when they exhale, but only *count* the number of inhales.) Have students record and save their results, then report results to the class. A bar graph could be created to show the different total number of breathes taken by class members. This also may give an opportunity to talk about data if there are any results that are very different a

(Note: This may be repeated once or twice if it is useful to help students get a more “accurate” count.)

4. Have students address the following questions based on their results: (Math opportunity ☺)
 - How many breaths do you take in an hour? A day? A year?
 - Approximately how many breaths have you taken since you were born?

Exploration:

Ask: **“What do we breathe in? Do we breathe in the same air we breathe out?”** To illustrate, perform the following demonstration:

Materials:

- Bromothymol blue – is an acid base indicator. A blue/green solution indicates a base or slightly neutral which is true for just water, yellow/green indicates acidic which is what happens when exhaled air enriched with carbon dioxide is added.
- Dropper
- Funnel
- Hair Blow dryer

- Cups
- Straws

Demonstration

1. Put 15 drops of bromothymol blue in 50 mL of water. The solution should be blue/green or slightly basic /neutral. A white background will help the students see the color differences better.
 2. Blow air into a funnel from a hair dryer or other source into the cup. This is adding oxygen only.
 3. Since the same air we breathe in is going in, the color should remain blue.
 4. Now blow into the water with a straw. Time how long it takes it to turn color. (Yellow/green indicates carbon dioxide is being added and turning the solution into an acidic solution.)
 5. Ask **“What do you think would happen if I ran in place for 5 minutes and then blew into the straw?”**
 6. After sharing class answers, tell them they are going to find the answer themselves by doing the Respiration Activity found in the binder.
 7. After completing the activity, have students share results and discuss differences between measurements and propose why different groups may be getting different results.
- Have several stations where students can go to obtain the bromothymol blue. Place the bromothymol blue in a cup and put several droppers in for students to use.
 - Please have students rinse the cups and graduated cylinder when done and return to the kit.
 - Rinse the droppers and return to kit.

Explanation:

1. Ask: **“When we inhale (about ½ liter of air), how much of our breath is oxygen and how much is carbon dioxide? When we exhale?”**

| | Oxygen | Carbon Dioxide |
|--------------------|--------|----------------|
| Inhaled Air | 21% | 0.04 % |
| Exhaled Air | 16% | 3.5% |

2. Have students find the solutions to these questions using math:
 - How much of the ½ liter or **inhaled** air is oxygen? ($0.5 \times 0.21 = .105$ L) Carbon dioxide? ($0.5 \times 0.0004 = 0.0002$ L)
 - How much of the ½ liter of **exhaled** air is oxygen? ($0.5 \times 0.16 = 0.08$ L) Carbon dioxide? ($0.5 \times 0.035 = 0.0175$ L)
 - Compare the oxygen decrease to the carbon dioxide increase. (A pie or bar chart can be used to illustrate.)
 - How many liters of air do you breathe in daily? (Each student can calculate this amount based on the Introduction activity that determined the number of their breaths per minute/per day.)

3. Around a pint (1/2 liter) of air is inhaled or exhaled with each breath. This is called **tidal volume**.
4. Ask: **“How does breathing connect to other body systems? What body systems does the respiratory process connect to and how?”**

Extension

1. Ask: **“What is tidal volume?”** (The amount of air moved into or out of the lungs during relaxed, normal breathing.)
2. Conduct a **Tidal Volume Experiment/Demonstration**. Items needed:
 - Water
 - Clean milk jug with cap
 - Marker
 - large clear tub
 - plastic tubing
 - plastic measuring cup
3. Directions:
 - 1) Pour the water into the milk jug, filling completely and trying to leave no air bubble. Place the cap on the jug.
 - 2) Fill the tub **half** full of water.
 - 3) Holding the top of the jug carefully, flip it upside down into the tub.
This means the top of the jug will be on the bottom of the tub.
 - 4) CAREFULLY remove the cap from the jug. The jug should still be full of water.
 - 5) Have one person hold the jug while another person puts the plastic tube into the top of the jug.
 - 6) Have one person take a deep breath and breathe into the tube. (However much water leaves the jug is the amount of air that person’s lungs can hold.)
 - 7) Determine the volume of air expelled into the jug by carefully putting the cap on the jug and then removing it from the tub. Flip the jug over, remove the cap and using the plastic measuring cup carefully add water to the jug until it is full, keeping track of how much you are adding. Use a funnel to help pour the water in the jug.
 - 8) Compare a deep breath to a normal breath. Have one person exercise vigorously for two minutes, then breathe into the tube. Compare the different breaths.

Evaluation: Check for understanding by asking students to:

1. Explain Tidal Volume.
2. Explain the influence of exercise on tidal volume.
3. Explain how **inhaled** air is different from **exhaled** air. Be specific. Explain why this is important.
4. Discuss if different people will have the same tidal volume. What factors might influence the values? (fitness of the test subject, size of test subject)

Lesson 3: The Respiratory System and Respiratory Problems

Introduction

1. Ask: **“How does breathing connect to other body systems? What body systems does the respiratory process connect to and how?”**
2. Have students, working in small groups, quickly brainstorm answers. Allow students no more than five minutes to come up with answers once the groups are formed.
3. Answers:
 - **Circulatory System:** The respiratory system is connected to the heart and circulatory system through the cardio-pulmonary circulatory process. Gas exchange occurs to keep oxygen and carbon dioxide in balance. Oxygen is carried in the blood and travels throughout the body, while carbon dioxide in the blood is returned to the lungs for removal from the body.
 - **Nervous System:** Involved with the breath and affected by the breath as well, the autonomic nervous system engages the sympathetic and parasympathetic divisions to activate and calm breathing rhythms in the stress response.
 - **Digestive System:** The respiratory activity of transporting oxygen throughout the body connects to the digestive system, providing energy for digestion.
 - **Muscular System:** Oxygen in the blood goes to the muscular system, providing energy to burn food nutrients needed for muscle movement.

Using the diseased lung model and the diseased lung chart, go over some of the problems associated with lung diseases.

Exploration

1. Arrange students into groups and have them conduct research into the following respiratory disorders:
 - Colds
 - Pneumonia
 - Allergies
 - Asthma
 - Lung cancer
2. Details they'll need to include in their reports are:
 - Description of the condition
 - Cause and risk factors
 - Communicable considerations
 - How to protect against getting it

Explanation

Have each group present their research about their topic. Use the chart, “Understanding Respiratory Problems” to help assess the students.

Extension

Have students interview someone they know who has a respiratory condition, asking:

- What it is the condition like?
- When did you get it?
- Is it preventable?
- Can anything be done to alleviate the symptoms?
- How do you deal with it?
- Does it prevent you from doing things that other people do?

Evaluate:

Evaluate students based on their research about their respiratory problems, using the following questions:

- Did they answer all the required questions thoroughly?
- How well did they present the information?

Ask students to review the chart and provide the following information:

1. What are **three** things you can do to protect yourself against exposure to or minimize your risk of getting these respiratory problems?
2. Create a new chart comparing and contrasting the risk factors for these respiratory problems. What conclusions can you draw about the risk factors for respiratory problems?

Optional Enrichment Activity:

Have students work in groups to research the following respiratory system topics, assigning the students to groups and having them organize and dividing up the tasks for their research and report:

1. Compare and contrast the human respiratory system with the respiratory systems of another organism (choose one):
 - Birds
 - Reptiles
 - Insects
 - Fish
2. Why do we consider life possible only on planets where there is oxygen?
3. What are those planets and what is their atmospheric make-up?
4. The rainforests are sometimes called the Earth's lungs. Is this an accurate description? Why? What role do they play in planetary respiration?
5. What role does global warming play with the planet's oxygen/carbon dioxide gas exchange? How is this similar to or different from conditions in the body and conditions that affect the respiratory system?

Have groups present their reports by creating a poster board that includes their topic, a visual representation of the topic, and their conclusion.

Additional Web Resources:

- Saskatchewan Lung Association - <http://www.sk.lung.ca/content.cfm>
- Lung Association - <http://www.lungusa.org/site/> Search: Your Lungs
- KidsHealth - www.kidshealth.org
Search: Lungs and Respiratory System, Asthma and titles of other respiratory conditions
- The Science Connection - <http://vilenski.org/science/humanbody> Search: Respiratory System

Assessment

See lessons

Resources

- ❖ The Franklin Institute: <http://www.fi.edu/learn/heart/systems/respiration.html>
- ❖ Healer Within http://www.healerwithin.org/IMLS/Gr7_Respiratory_Sys.pdf

EXPLORE MORE

- ❖]<http://fittips4life.blogspot.com/2013/02/fun-interactive-ways-to-teach-kids.html> fun way to teach about pulmonary system with wigs, grapes, other simple materials
- ❖ [Discovery Kids: Teaching with the Human Body](#)
- ❖ [Breathing is Essential to Life: Dianne Mehlinger](#)
- ❖ [Science Museum of Minnesota: Habits of the Heart: Lung Model](#)
- ❖ [Science Museum of Minnesota: Ins and Outs of Respiration](#)
- ❖ Welcome to the respiratory system <http://library.thinkquest.org/57777/resp1.htm?tqskip=1>