Name: _____

Like a Breath of Fresh Air: The Respiratory System

Well, now it is time to discover yet another system in our wonderful machines. This time we will learn about the respiratory system. We will learn how the respiratory system helps our bodies, and we will discover what all the parts of the system are.

People can survive for a week or more without food. It would not be much fun, and we would become very weak, but we could stay alive for a while. People can survive for a few days without water. Do you know how long people can live without oxygen? You can only stay alive for a few minutes if your body does not have oxygen. Why can you live so long without food or water, and die so quickly if you do not have oxygen?

Your body has storage systems for food. When you eat, the nutrients that are not used right away are stored. Those nutrients can then be used in the future when new nutrients are not available. In a similar way, your body is able to store some water. If you do not have a supply of fresh water, you can use the stored water from your body to keep yourself alive. Your body does not, however, have any way to store oxygen. You must provide your body with new oxygen all the time. If you do not have a supply of fresh oxygen, you cannot stay alive.

This is not unique to humans. All organisms exchange gases with their environment. The gases needed and the wastes produced may be different from one organism to another, but all living things must absorb gases from the environment and release waste gases back into the environment.

The respiratory system is responsible for providing your body with the oxygen that it needs. The first job of this system is **to pass oxygen from the air to the blood**. Remember that one of the jobs of the circulatory system is to carry oxygen to all the body cells. The respiratory system brings in the oxygen, and then the circulatory system gets the oxygen to the places where it is needed.

Your circulatory system also removes wastes from your body cells. In order for you to be healthy, your body must have a way to get rid of its wastes. Some of those wastes are gases. They cannot stay in your body. Those wastes leave your cells and enter your blood. The blood carries the gaseous wastes to your respiratory system. The respiratory system then removes them from your body. This is the second job of the respiratory system: **to remove gaseous wastes from the body**.

Now you know why you have to have a respiratory system. Next we will take a look at some of the organs that help your respiratory system do its jobs.

Who "Nose" What the Parts of This System Are?

Think about standing in the kitchen. A loaf of bread is in the oven. It smells great. You close your eyes and take a deep breath. Mmm, you can hardly wait until the bread is done and you can eat a piece of it.

The Nose

When you smell the bread, you use your nose. You also use your nose for breathing. That is one of the ways you get oxygen into your body. (Sometimes you breathe through your mouth. This is the other way to get oxygen into your body.) Your nose, or your **nasal cavity**, is the first part of your respiratory system.

Let's take a closer look at your nose. Your nose is stuck in the middle of your face. It has two holes that lead into your head. These holes are called the **nostrils**. Inside your nostrils you have lots of tiny blood vessels. They are very close to the surface. You also have some tiny hairs that are called **cilia**. Finally, you have a moist, sticky fluid in your nose, called mucus.

Why does your nose need to have blood vessels, mucus, and cilia? They each have very important jobs to do. Remember you are bringing air from the environment into your body. Sometimes that air is dirty or the air may carry some kind of disease. You do not want the dirt or disease to get inside your body and spread to other parts of the body. The mucus and cilia are your first protectors. They have the task of making sure the air that goes into the rest of your body is as clean as possible. The sticky mucus traps some of the dust and dirt. The cilia trap more dust and dirt. They also move the dirt and dust out of your respiratory system, in a sneeze or a cough.

Sometimes the air that you are breathing is very cold. The inside of your body is nice and warm, so the air going into it needs to be as warm as possible. The blood vessels inside your nose are very close to the surface, and they are very small. The warm blood moving inside the blood vessels helps heat up the air that you are breathing.

The three jobs of the cilia, mucus, and blood vessels are to moisten, to warm, and to filter the air that you breathe.

The Pharynx

The next part of your respiratory system is called the **pharynx**. Another name for this is the throat. It is a muscular tube that is about five inches long. The pharynx connects the nasal cavity with the trachea. The pharynx is lined with cilia that trap any dirt that may have gotten past the filtering system in the nasal cavity.

The Trachea

The third part of your respiratory system is called the **trachea**. A more common name is the windpipe. As the common name suggests, this is a pipe or tube. It is about 12 inches long. Since you need oxygen all the time, this tube needs to remain open. The trachea is made of smooth muscle (remember that this is involuntary muscle) and is held open by rings of cartilage. The cartilage rings are "C" shaped and most people have between 16 and 20 of them.

If you tilt your head back and gently run your fingers over the outside of your throat you should be able to feel the cartilage rings in your trachea. Now if you hold your head up straight, you can gently move the trachea from side to side. You should still be able to feel the cartilage.

The Larynx

At the top of your trachea, you have a very important structure. The **larynx**, or voice box, is a series of folds of tissue surrounded by protective cartilage. When air passes over the folds of tissue, or **vocal cords**, sounds are made. You learn to control the amount of air passing through your larynx. If you want to talk in just a whisper, you need to use just a bit of air. If you want to yell loud enough to be heard across the school yard, you have to use a lot of air. That's why you seem to be out of breath after you have been screaming for a while.

The Epiglottis

When we talked about the digestive system, we said that you have a tube right next to your trachea that is called the esophagus. This tube carries food from your mouth to your stomach. It lies flat when you are not using it and opens up when you swallow. The trachea needs to remain open all the time so air can move from your nasal cavity to your lungs. With the two tubes being so close to each other, you might think it would be easy for food to get headed down the wrong tube.

Your body has a wonderful way of protecting you. At the end of the pharynx, which is also the beginning of the trachea, you have a flap of muscle called the **epiglottis**. When you are breathing, the epiglottis stays out of the way, letting air flow freely into your open trachea. When you swallow, the epiglottis moves to cover your larynx and the opening to your trachea. When the epiglottis moves, it opens up the way for food to move down the esophagus to your stomach. As soon as you have finished swallowing, the epiglottis moves back out of the way, and you are ready to breathe freely.

The Bronchi

At the base of your trachea, your respiratory system splits into two parts. Each part is a tube, called a bronchus. The **bronchi** (plural for bronchus), which lead into the right and left lungs, are made of involuntary muscle and they have rings of cartilage, similar to the trachea. The bronchi, however, are smaller. These tubes continue to clean and moisten the air that you breathe in with the mucus that lines them.

The Bronchioles and Alveoli

In the lungs, the bronchi become smaller and smaller. These tiny tubes are called **bronchioles**. The smallest bronchioles are surrounded by tiny clusters of air sacs. They almost look like bunches of grapes surrounding tiny branches on an upside down tree! The air sacs are called **alveoli**. Scientists believe there are about 300 million alveoli in each lung! The air sacs are able to expand and contract. When they are filled with air, they resemble tiny balloons. When the air is exhaled out of your lungs, the air sacs deflate like empty balloons, ready to take in new air with the next breath.

Each alveolus (singular for alveoli) in your lungs is surrounded by tiny blood vessels. Oxygen brought into your lungs through the respiratory system is able to pass through the walls of the alveolus and into the blood capillary. In a similar way, waste gases carried to the lungs by the circulatory system are able to pass from the capillaries to the alveoli so they can be removed from the body.

More About Your Lungs

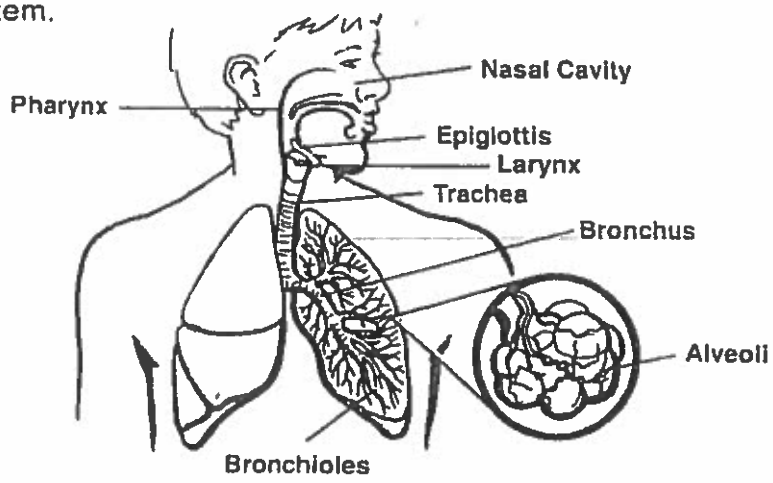
Together, the bronchioles and the alveoli make up your **lungs**. Your two lungs are cone-shaped organs made of spongy tissue. They are elastic in nature, being able to stretch larger when you inhale and return to smaller size when you exhale. The left lung is slightly smaller than the right lung because it needs to leave extra room for the tip of the heart!

If you were to spread a pair of lungs out flat, they would cover a huge area. If you were to spread out the entire skin of an average human, the lungs would be more than 20 times bigger than the skin. Remember, you must have oxygen to stay alive. It is needed by all the cells in your body and you do not have any way to store oxygen for later use. The large surface area of your lungs allows you to absorb a great deal of oxygen each time you breathe.

The Diaphragm

The final part of your respiratory system is a large sheet of muscle called the **diaphragm**. This muscle separates your chest from the lower part of your body. The diaphragm lies just under your ribs and looks like a small dome. When you inhale, the diaphragm contracts and moves down. When you exhale, the diaphragm relaxes and moves back up to its resting position.

Wow, that's a lot of information to learn. Try to remember that the respiratory system beins with the nasal cavity. Air leaving the nasal cavity travels through the pharynx, trachea, larynx, bronchi, bronchioles, and alveoli. The oxygen then moves into the blood and the first job of the respiratory system is done. Waste gases move from the blood into the alveoli. The wastes then travel through the bronchioles, bronchi, trachea, larynx, pharynx and leave your body through your mouth or nose. That completes the second job of the respiratory system.



What Is Breathing?

Breathing is something you do all day long, every day, from the moment you are born until you reach the end of your life. You breathe without really thinking about it. It is an involuntary action. Let's take a close look at what is going on inside your body when you breathe.

Inspiration

The first part of the process of breathing is called **inspiration**. It involves the taking in of oxygen through the parts of the respiratory system. Why does air move from your environment into your lungs? Let's take a look.

First, the diaphragm contracts. Remember, when this large sheet of muscle contracts, it moves down. At the same time, the muscles in the chest contract. These muscles pull the ribs up and out. The **sternum**, or breast bone, is also raised. As a result of the movement of the diaphragm, chest muscles, ribs, and sternum, the chest cavity becomes larger. When the size of the chest cavity changes, the air pressure in the chest changes also. There is more room in the chest for the air that is there, so there is less air pressure.

Air naturally moves from an area with higher air pressure, to an area with lower air pressure. When the chest cavity has lower air pressure, air from outside the body moves in, trying to equalize the pressure. This is when you inhale.

Expiration

The second part of the process of breathing is called **expiration**. This involves the removal of waste gases from the respiratory system. Why does air move out of your lungs back into the environment? Let's take a look at this part of the process now.

First, the diaphragm relaxes. This means the large sheet of muscle will move back up to its starting position under the ribs. At the same time, the chest muscles relax, letting the ribs fall back down and in. The sternum also falls back to its original position. This time when the diaphragm, chest muscles, ribs, and sternum all move, the cavity becomes smaller. The air pressure inside the chest cavity changes again. This time there is less room for the air that there is, so the air pressure increases.

Once again, air moves from an area with higher pressure to an area with lower pressure. When the chest cavity has a higher air pressure, some of the air moves out of the body. A new pressure balance is attained when you exhale.

The Air You Breathe

When you take a deep breath, you inhale air into your body. Just what does that air consist of? When you let out a deep breath, you exhale air out of your body. Just what does that air consist of? Take a good look at the following charts.

Inhaled Air	Exhaled Air
20.9% Oxygen	16.3% Oxygen
79.0% Nitrogen	79.0% Nitrogen
0.07% Carbon Dioxide	4.50% Carbon Dioxide
0.03% Other Gases	0.20% Other Gases

Respiration: What Is It?

We have been learning about the respiratory system: it's jobs and parts. We have even looked closely at the process of breathing. Now we need to try to understand what respiration is. After all, the system seems to have been named for it!

Respiration is a process that takes place in your body cells. Sometimes it is called internal respiration or cellular respiration. It is the process by which oxygen actually combines with glucose to release energy. Let's take a look at the sequence leading to respiration, step by step.

First, we need to refresh our memories a bit. Remember when we learned about the digestive system? We said the job of that system was to change the food we eat to a form that body cells can use. When food passes through the digestive system, it is broken down into simple molecules. One type of molecule that your body cells must have is called **glucose**. Glucose moves from the digestive system into the circulatory system. The circulatory system then carries the glucose to each of the body cells.

Okay, now we can go back to the respiratory system. We know that breathing brings oxygen into the body. The oxygen passes from the air through the respiratory system and ends up in the alveoli in the lungs.

The circulatory system plays the next part in the sequence. Tiny capillaries surround the alveoli. The oxygen molecules pass from the lungs into the blood. The circulatory system then delivers the oxygen to the body cells.

When the oxygen arrives in the body cells, it combines with the glucose provided by the digestive and circulatory systems. When the glucose and oxygen combine in a chemical reaction, energy is released. Wastes are also produced. The wastes are carbon dioxide and water. The combination of the two materials, the release of energy, and the production of the waste materials is the process known as respiration.

The circulatory system plays a second role in this sequence. The carbon dioxide produced during respiration must be removed from the cells. It moves into the capillaries and is carried through the circulatory system until it arrives at the lungs. There, the tiny capillaries surrounding the alveoli surrender the waste gas to the respiratory system.

After the molecules of carbon dioxide have moved into the lungs, expiration occurs. By breathing, the waste gases are exhaled from the body, and the entire sequence is ready to begin again.

The Sequence for Respiration

Breathing — Oxygen is inhaled.
Circulation — Oxygen is carried to cells.
Respiration — Oxygen and glucose combine in a chemical reaction to release energy.
Circulation — Carbon dioxide is carried to the lungs.
Breathing — Carbon dioxide is exhaled.

The Chemical Equation of Respiration

$$C_6H_{12}O_6 + 6O_2 \longrightarrow (\text{energy}) \text{ and } 6CO_2 + 6H_2O$$