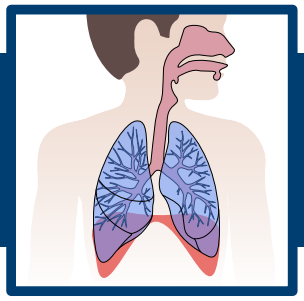
LESSON 1: MAPPING PULMO PARK

Activity 1A: *Think About It: Respiratory Structure and Function*



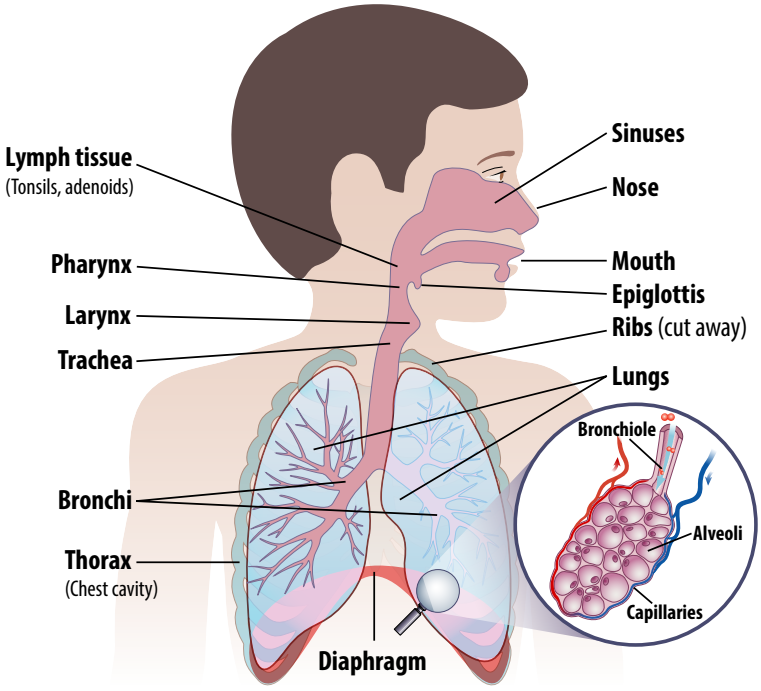
TEXAS BIOMEDICAL RESEARCH INSTITUTE
HEALTH STARTS WITH SCIENCE

Respiratory Physiology: The Relationship Between Form and Function

The lungs are divided into lobes and work closely with the heart for pulmonary circulation. The ribs attach to the backbone and ***sternum*** which is located in the front center of the chest, forming a protective cage around the lungs. This protective cage is called the ***thorax***.

At the top of the respiratory system, air enters the nostrils, where it is warmed and humidified. The air then travels into the sinuses. These are air pockets located inside the bones of the skull. The sinuses are lined with tiny hairs called cilia which protect the nasal passageways and other parts of the respiratory tract by filtering out dust, plant pollen, and other particles. ***Mucus*** is a slightly sticky substance produced by the body which coats the inside of the nasal passageways and traps particulates. If air is taken into the mouth, the air bypasses the filtering mechanism within the nose and sinuses.

The nasal cavity and mouth meet at the pharynx. The pharynx is commonly referred to as the throat. It is part of the digestive system and the respiratory system because the pharynx carries both food and air. Within the throat are small clusters of specialized cells called lymph nodes. Commonly known as tonsils and adenoids, these specialized cells are part of the immune system and filter out invaders, like bacteria.



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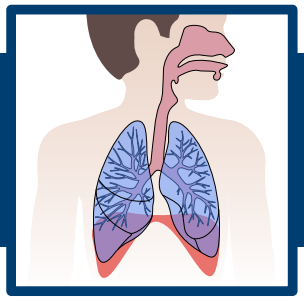
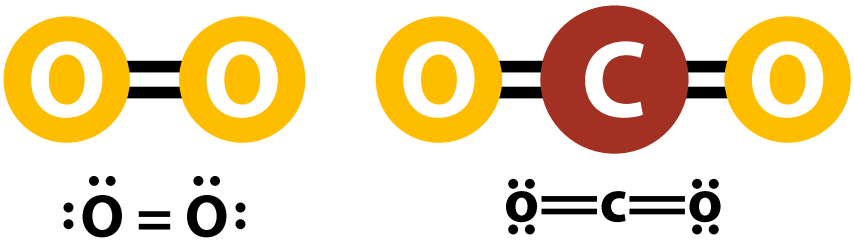


At the bottom of the pharynx, the pathway splits into two tubes. One tube, called the esophagus carries food to the stomach. The other tube is called the trachea and it leads to the lungs. A small flap of tissue, called the epiglottis, covers the trachea when we swallow to keep food and liquid from going into the lungs. The walls of the trachea are strengthened by stiff rings of cartilage. The trachea is also lined with cilia which sweep fluids and foreign particles up and out of the trachea, helping to keep the lungs clear.

In the upper section of the trachea is the larynx, or voice box. The larynx contains the vocal cords, a pair of thin membranes which touch in the middle of the larynx. Past the larynx, the trachea enters the chest cavity. Inside the chest cavity, the trachea branches into left and right tubes call bronchi, each leading into the lungs. Within the lungs, the bronchi branch into smaller tubes called bronchioles. Bronchioles lead into tiny air sacs called alveoli. The alveoli resemble clusters of grapes. Each lung houses about 300 to 400 million alveoli. Within the alveoli, oxygen (O_2) diffuses into the body and carbon dioxide (CO_2) diffuses out of the body.



Breathing Under Pressure

Breathing is a passive process resulting from a pressure difference between the lungs and the atmosphere. Inhaling expands the chest which creates low pressure within the lungs. In other words, the pressure inside the lungs is less than the pressure outside of the body. Air naturally moves from an area of higher pressure into an area of lower pressure until the pressures are equalized. As air enters the lungs, the pressure in the lungs increases. When the air pressure inside the lungs is equal to the air pressure outside the body, inhaling stops.

Because lungs have elastic properties, they can expand. But just like a stretched rubber band, there is a limit to how far the lungs can expand. When a stretched rubber band is released, it returns to the original size and shape. Just like the rubber band, when the lungs approach their expansion limit, their elastic properties pull them back. As the lungs contract, the air inside has less room, forcing the air molecules together. When gases are forced together, the pressure increases, resulting a higher pressure inside the lungs. The air inside the lungs moves out of the body into the now lower external pressure. As the air flows out of the body, this is called exhaling or exhalation.

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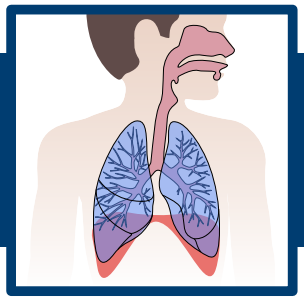

The air pressure outside the body has not changed. Only the air pressure inside the lungs change. The changes in air pressure within the thoracic cavity is largely due to the movement of the diaphragm. This large, flat muscle separates the thoracic cavity from the abdominal cavity. As the diaphragm contracts and moves downward toward the abdomen. This expands the thoracic cavity and air flows into the lungs through the nose and/or mouth. When the diaphragm relaxes, it moves upward, forcing the thoracic cavity to get smaller which works with the contracting lungs to force lung gases closer together which increases the pressure in the lungs. The body takes advantage of pressure changes to passively move air in and out of the body. This greatly reduces the amount of energy the body uses to breathe.

The Mechanics of Respiration

Air is a mixture of different gases. Approximately 20% of this mixture of gases is O_2. When we inhale, air enters the lungs. The air moves through a series of smaller and smaller passages in the lungs and ends up in the alveoli. The alveoli are surrounded by tiny, tubular blood vessels called capillaries. Oxygen diffuses (passes through) from the alveoli, where oxygen levels are comparatively high, and enters the circulatory system (bloodstream) through the capillaries, where oxygen levels are comparitively low. Once in the bloodstream, O_2 binds to red blood cells and is carried through the pulmonary veins which lead to the heart. The heart pumps the oxygen-rich blood to the body through a series of blood vessels, starting with large arteries which branch into smaller arterioles.

The arterioles branch into even smaller capillaries. Once in the capillaries, the oxygenated red blood cells come in close contact with the body's cells. The body cells are low in oxygen, but high in carbon dioxide (CO_2), a cellular waste product. Through diffusion, the O_2 and CO_2 trade places. The O_2 moves into the body's cells while the CO_2 moves into the red blood cells. Blood which carries carbon dioxide is called "oxygen-poor" blood. The capillaries move the oxygen-poor red blood cells into larger venules. The venules connect to even larger veins which carry the oxygen-poor blood back to the heart. The heart pumps the oxygen-poor blood into the pulmonary arteries. The pulmonary arteries carry the oxygen-poor blood to the lungs, where the carbon dioxide diffuses into the lungs and is exhaled. And the process repeats.

Constructing a System

Living things are arranged according to levels of organization. The most basic level of organization is the cell. In a living thing made of more than one cell, cells can organize into tissues to do a specific job. For example, the circulatory system contains different types of cells and fluids. Together, these cells and fluids are called blood tissue. In more complex living things, tissues can organize into organs and work together to do a particular job. For example, blood tissue, muscle tissue, and nerve tissue form the heart, an organ that pumps blood to all parts of the body. Organs work together as systems to accomplish a particular job. For example, the heart, blood, and blood vessels make up the circulatory system. Many systems working together form a living organism.

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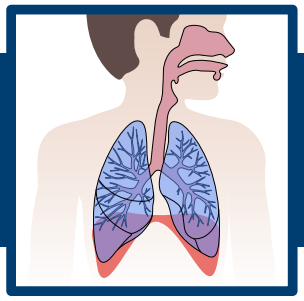

Cell System Organization