Layers of the Lungs Appendix

The *Slicin’ and Dicin’ Activity* progresses from the back (posterior) of the thoracic cavity and stacks up to the front (anterior) of the chest. It is designed in this way so that students might visualize how the different parts work together. Below you will find a description of each layer from layer 1 to layer 10. Remember, we are building from the back!

**Layer One: Ribs and Vertebrae**

With every breath we take, the *ribs* expand. Attached to the *vertebrae* in the back and the *sternum* in the front, the ribs offer a protective cage around the lungs. You often hear the chest referred to as the rib cage, although it is actually the *thoracic cavity*. The spine is divided into three sections; the cervical spine, thoracic spine and the lumbar spine. The *thoracic spine* consists of twelve vertebrae that form the posterior part of the thoracic cavity. The lungs are not directly attached to any muscle, so they cannot expand or contract on their own. Instead, a major muscle called the *diaphragm* changes the size of the chest cavity as it contracts and relaxes, causes inhalation and exhalation.

**Layer Two: Mediastinum and Diaphragm**

The *mediastinum* (medi as ti num) is a region in the middle of the chest area. The term mediastinum refers to the space containing several structures and is not the name of the structures themselves.

The *mediastinum* is an interesting area to study because all of the parts to the lung intersect here and enter the lungs at the hilum. The *hilum* is found inside of the lungs where the arteries, veins, and bronchi enter each lung. In addition, the esophagus (from the digestive system) is found in this area and descending to the stomach. This drawing was adapted from *Carmine Clements’* work in the book *Clements’ Dissector*. The mediastinum and diaphragm are represented in black on the craft foam model.

**Layer Three: Posterior (Back) View of the Lungs**

The lungs are two spongy organs that fill most of the chest. They are protected by the rib cage. Deep furrows in the surface of the lungs divide them into different parts called lobes. The right lung has three lobes and the left lung has two lobes. The right lung has a right upper (superior), middle, and lower (inferior) lobe. The left lung has a left upper (superior) and lower (inferior) lobe. Two membranes called the *pleura membrane* further protect the lungs. One *pleura membrane* attaches to the wall of the rib cage and the other attaches to the surface of the lungs. Between the pleura a thin fluid is found that helps the lungs move without restriction. This lining also helps to keep the lungs clean and free from infection.
The posterior (back) view of the lungs differs from the anterior (front) view in that the posterior parts descend further down into the thoracic cavity. The diaphragm allows for more movement at the posterior (back) of the chest area.

In the craft foam model, the pleura are depicted in blue and the lungs in pink.

**Layer Four: Bronchi**

Air enters through the nose and/or mouth and passes through the *pharynx* (throat), the *larynx* (voice box), then enters the *trachea* (windpipe). The trachea then branches into two *bronchi*, one going to each lung, so air can reach both lungs. The bronchial branch into smaller *bronchioles* that lead to the *alveoli*. Alveoli are tiny, grape-like clusters surrounded by a capillary net. Here the respiratory system and the circulatory system work together to allow oxygen from the air to be picked up by the blood so it can be carried to all body cells. Carbon dioxide from the body cells is carried into the lungs so it can be exhaled. It is in the alveoli that the primary function of the respiratory system is carried out.

In an adult, the trachea is about 11 cm in length and 2.5 cm in diameter. Sixteen to twenty horseshoe-shaped rings of cartilage and a muscle layer at the back support the trachea. This muscle layer will constrict if something is caught in the throat and the horseshoe shaped rings will tighten together to prevent foreign substances from entering the lungs. The trachea is also lined with cilia that also help to keep harmful materials away from the lungs. Lymph nodes can be found all along the bronchial branches and help reduce infections in the lungs.

The model is colored in different colors. If a 3-D model is being made, the bronchi can be made with chenille sticks and bent to demonstrate that the bronchial tree branches throughout the lungs. When making the model, apply lymph nodes all along the sections of the bronchi.

**Layer Five: Alveoli**

Breathing in and out is only part of the story of respiration. When air enters your lungs, it goes through a maze of smaller and smaller tubes until it reaches tiny sacs called alveoli. The sacs look like bunches of grapes at the end of the bronchial tubes. The alveoli are where the oxygen from the air enters your blood, and the carbon dioxide from your body goes into the air. Alveoli are very tiny, but you have a lot of them in your lungs. In fact, you have over 300,000,000 alveoli in each lung. In the alveoli, gas exchange takes place. Tiny, thin-walled blood vessels called capillaries surround each alveolus. The cellular walls that make up the alveoli are extremely thin—one cell thick. This allows
oxygen to pass out of them into the blood and carbon dioxide can pass into them to be removed from the lungs. This exchange happens simultaneously. Why does this happen? The answer is diffusion. Gases naturally move from areas where they are concentrated to areas where they are not. The alveoli have plenty of oxygen and the blood vessels have little. Oxygen travels from the tiny air sacs in the lungs, through the walls of the capillaries, into the blood. At the same time, carbon dioxide, a waste product of metabolism, passes from the blood into the air sacs. Carbon dioxide leaves the body when you exhale.

Surfactant, a complex substance that keeps the alveoli resilient, lines the alveoli and smallest bronchioles. It reduces surface tension throughout the lung and stabilizes the thin walls of the alveoli so they do not collapse or restrict breathing.

In the craft foam model, the alveoli are created to lay directly over the bronchi. In building the model, the alveoli could be added to the bronchi. The alveoli are represented in white.

**Layer Six: Pulmonary Arteries**

Pulmonary circulation occurs when oxygen-poor (deoxygenated) blood is carried away from the heart to the lungs by the pulmonary artery. In the lungs, oxygen is picked up and carbon dioxide is released. The oxygen-rich (oxygenated) blood leaves the lungs and returns to the heart.

Through the pulmonary valve, blood travels to the pulmonary artery and then to tiny capillary vessels in the lungs. The pulmonary artery carries de-oxygenated blood through the lungs. The arteries branch out along the same routes as the bronchi and around the alveoli. This dense capillary network terminates along the walls of the alveoli. When observing the hilum, the branches of the pulmonary artery in the right and left lung are not symmetrical, so observing the location of the pulmonary artery in relation to the trachea is challenging.

*(Note: Arteries are blood vessels that carry blood away from the heart; usually arteries carry oxygen-rich (oxygenated) blood. One exception is the pulmonary artery, which carries oxygen-poor blood away from the heart. Veins, on the other hand, carry blood toward the heart; usually veins carry oxygen-poor blood. One exception is the pulmonary vein, which carries oxygen-rich blood toward the heart.)*

The pulmonary arteries are blue in the craft foam model. This is because they are carrying oxygen-poor blood into the lungs.
Layer Seven: Pulmonary Veins
The pulmonary veins are blood vessels that carry oxygenated blood out of the lungs toward the heart. Like the pulmonary arteries, pulmonary veins branch out along the same routes as the bronchi and around the alveoli. This creates a network that carries oxygenated blood out of the lungs and into the body.

Systemic circulation occurs as blood becomes oxygenated, leaves the lungs through the pulmonary veins and travels back to the left atrium of the heart. The oxygenated blood is then pumped into the left ventricle, where it will be pumped to all parts of the body, carrying needed oxygen. When observing the hilum, four blood vessels that carry oxygenated blood from the lungs to the left atrium of the heart can be seen. These vessels are the right and left superior (top) and inferior (lower) pulmonary veins.

The pulmonary veins are red in the craft foam model. This is because that the veins are taking oxygen-rich blood back through the lungs, into the heart, and out to the body.

Layer Eight: Heart
Your heart is really a muscle. It's located a little to the left of the middle of your chest, and it's about the size of your fist. The heart pumps blood around your body. The blood provides your body cells with the oxygen and nutrients they need and carries away waste, such as carbon dioxide. The blood is pumped from the heart through the pulmonary arteries to the lungs so it can release carbon dioxide. Here it collects oxygen, and is pumped back through the pulmonary veins to the left side of the heart. The heart then pumps the oxygen-rich blood out through the main artery, called the aorta. From here, it travels around the body.

Although the model shows the front of the heart, the back of the heart will be interesting to explore. Students should explore how the pulmonary veins and artery enters the heart. The heart is colored purple in the craft foam model.

Layer Nine: Anterior (Front) View of the Lungs
The lungs are two spongy organs that fill most of the chest. They are protected by the rib cage. Deep furrows in the surface of the lungs divide them into different parts called lobes. The right lung has three lobes and the left lung has two lobes. The right lung has a right upper, middle, and lower lobe. The left lung has a left upper and lower lobe. Two membranes called the pleura further protect the lungs. One pleural membrane attaches to the wall of the rib cage and the other attaches to the surface of the lungs (the pleura are represented in blue in the paper
model). Between the pleura a thin fluid is found that helps the lungs move without restriction. This lining also helps to keep the lungs clean and free from infection.

The front view of the lungs differs from the back view in that the front of the lungs ascends further up into the thoracic cavity. The diaphragm allows for less movement in the front (anterior) chest area. The left lung also has a cardiac notch where the heart rests.

**Layer Ten: Ribs and Sternum**

As you breathe in (*inhalation*), your *diaphragm flattens* and the *ribs expand* outward and upward because of muscles attached to the ribs known as the intercostal. This makes the chest cavity bigger allowing air to rush into the lungs. As you breathe out (*exhalation*), the *ribs and diaphragm* go back to the *normal position*. When the chest is back to normal position, air is forced out of the lungs through the nose and mouth. The diaphragm also holds organs of the thoracic cavity in an elevated position. The ribs are attached to the chest bone or sternum. Notice the the ribs extend below the lungs.

The vertebrae and ribs are represented in tan on the craft foam model.