4.4.1

Respiratory System Structure and Function

The main function of the respiratory system is to provide cells with sufficient oxygen and to remove carbon dioxide from the body. This process is referred to as **respiration** and can be divided into four processes. 1) **ventilation** or breathing: moving air in and out of lungs; 2) **external respiration**: oxygen going from the lungs into the blood and carbon dioxide going from the blood into the lungs; 3) **gas transport**: oxygen traveling to the cells and carbon dioxide traveling to the lungs both by way of the circulatory system; 4) **internal respiration**: oxygen leaving the blood and entering the cells and carbon dioxide leaving the cells and entering the blood.

Additionally, the respiratory system plays a role in other important areas including:

1) **Maintaining blood pH homeostasis**. Recall the reversible reaction $CO_2 + H_2O <> H_2CO_3 <> H^+ + HCO_3^-$. By altering ventilation rate, the respiratory system can change blood pH

2) **Blood pressure regulation.** The lungs produce the majority of an enzyme called angiotensin converting enzyme (ACE) which when produced, leads to increased blood pressure.

3) **Sound production.** Air is forced past the vocal cords and folds causing them to vibrate and produce sound waves. Oral and nasal cavities and the tongue, teeth, and lips affect the final sound product.

4) **Sense of smell**. Chemoreceptors for olfaction are located in the superior region of the nasal cavity.

5) **Defense.** Foreign material such as dust and bacteria are filtered and trapped by hair and mucus and also are removed by the mucociliary escalator system and phagocytes.

The paired lungs are housed inside the thoracic cage with their surfaces in close proximity with the ribs. Pleural membranes line the outer surface of the lungs (visceral pleura) and the walls of the thoracic cavity (parietal pleura). The space between these membranes is the pleural cavity. This cavity is filled with a thin layer of **serous fluid** produced by the epithelial cells of the serous membranes. As the elastic lung tries to recoil (get smaller), it pulls away from the ribs. This increases the volume of the pleural cavity and a negative pressure is created in the pleural cavity that pulls or sucks on the lungs to keep them from collapsing. This enables the lungs to inflate or deflate with changes in thoracic cavity volume. Think of two wet microscope slides abutted up against one another when one attempts to pull them apart. The water in between them creates a negative pressure, making it very difficult to pull them apart. But they are easily able to slide past one another. It is the same with the parietal pleura of the thoracic cavity and the visceral pleura of the lungs - they strongly adhere to one another and are difficult to pull apart. But they will easily slide past one another because of the friction-reducing serous fluid that is in between them.

The functional unit of the lung is the alveolus (alveoli *pl.*). Think of the alveoli as being little pieces of fruit on the end of the very small branches (see image below). Gas exchange between air and blood takes place in these small, air-filled chambers. Together, both lungs house 300-400 million alveoli. They act to greatly increase the surface area for gas exchange.

The tubes leading to the alveoli are called bronchioles and are lined with smooth muscle. Relaxation and contraction of this smooth muscle changes the diameter of the bronchioles, affecting the volume of air that moves down the passages. During intense physical activity, smooth muscle lining respiratory tubes relax, resulting in decreased airflow resistance and increased airflow volume. An acute asthma attack is characterized by increased contraction of smooth muscle in the bronchi and bronchioles, decreasing air flow to the lungs. In extreme cases, airflow may become so restricted that an attack may be life threatening.