

The Respiratory System

What is the Respiratory System?

The Respiratory system is a tube opening to the outside world on one end, and along the way it divides and ends up in tiny, grape-like sacs, which interface with the blood. The structures of the system are; **nose, pharynx, larynx, trachea, lungs, bronchi, bronchioles, and alveolus.**

Why study the Respiratory System?

The primary function of the respiratory system is to provide a place for gas (*oxygen and carbon dioxide*) exchange to occur in the body. Our bodies are so complex, and our cells are so far away from where the air is, we need a system devoted to bringing the air inside the body. Once inside the body oxygen can be delivered by the Cardiovascular System to wherever the cells live. The added bonus is herbal constituents and essential oils are small enough to “tag along” with the air molecules on their journey into the body via the Respiratory System. This system is yet another entry point into the body for the herbal constituents. It is more immediate than the skin and is a good entry point when essential oils are needed throughout the whole body system. When the respiratory system is affected and in need of treatment, inhalation of essential oils is the preferred method of introduction. While the skin had a surface area of 22 square feet, the Respiratory system has a surface area of 750 square feet! The herbal constituents only need to go through 2 cells to get to the blood rather than the 40-50 cells of the skin before they get to the bloodstream.

What does the Respiratory System do for us?

1. Provides the mechanism to bring the air into the body, and move it out again.
2. Warms, moistens and filters the air as it comes in.
3. Provides a place for the **olfactory receptors** (sense of smell) to live.
4. Is involved in sound production
5. Elimination of waste products (carbon dioxide mostly)
6. Regulates blood pH (*how acidic or basic the blood is...without this regulation we would die*).

Let's talk anatomy, what are the different parts of the system, and what do they do?

Nose

The nose is the preferred point of entry for air over the mouth, because it contains coarse hair to filter out debris from the air (and bugs too!), and it warms and moistens the air as well. The **nasal cavity** is the space within the nose, from the openings at the nostrils (**external nares**), to the rear of the cavity at the **internal nares**. The cavity is divided into two chambers by the **nasal septum**, a mucous covered bony divider. The nasal cavity is specially designed to warm and moisten the air as it comes in, and cool and dehydrate the air as it leaves. The design is a series of shelves called **conchae** that are covered in a mucous membrane. (Mucous membranes line the entire respiratory system by the way.) Air travels in, is moistened by the mucus as it travels by the shelves and in the grooves, and is warmed by the blood found circulating under the mucous membrane. The top (**superior**) conchae, is the place where the olfactory receptors are found. We'll talk about them in the next chapter. Some essential oils could be absorbed here, but the majority will travel on in the system, and be absorbed in the lungs.

- ★ The nasal cavity has openings for the paranasal sinuses (“sinuses”) and the lacrimal ducts (tears).

- ★ The other function of the nasal cavity is as a resonating chamber for sound.

Pharynx

The pharynx is a five-inch, funnel-shaped tube extending from the internal nares of the nose, to the **larynx** (voice box). Air entering the nose or the mouth passes through the pharynx on the way to the lungs. The major job of the pharynx is to conduct the air on its way in or out of the body. Other functions include housing the **tonsils** and openings for the **eustachian tubes** (connects ears to pharynx), conducting food to the esophagus and being a resonating chamber for sound.

Larynx

The larynx is commonly known as the voicebox. Food and air coming to this structure get divided. Food and water traveling down the pharynx will cause a cartilaginous flap called the **epiglottis** to close over the larynx, and then the food will enter the esophagus. Air and the herbal constituents, do not stimulate the epiglottis to close, and therefore, pass through the larynx. The larynx is an amazingly complex structure. It consists of nine separate cartilage pieces, which form the “box”. Folds of tissue (vocal folds) connect across the box and vibrate as air passes by them, thus producing sound.

Trachea

Moving along our conducting tube to the lungs, we next encounter the **trachea**. It is commonly known as the windpipe, and can be felt along the front of the throat. The trachea is approximately five inches long and connects the larynx to the bronchi of the lungs. An interesting feature is the cartilage, c-shaped rings that create the trachea. You can actually feel them if you palpate the front of the throat. These rings ensure the trachea is always open....never collapses.

Bronchi

Finally the air enters the structures that will bring it into the lungs. The various **bronchi** form what is often called the “bronchiole tree.” The bronchi in each lung branch just like a tree does. The initial branches off the trachea are called the **primary bronchi** and each lung has one. The primary bronchi divide into **secondary bronchi** and the secondary bronchi divide into, you guessed it, **tertiary bronchi**. They then divide into **bronchioles**, which divide into **terminal bronchioles**. Smaller still, terminal bronchioles divide into **respiratory bronchioles** and finally **alveolar ducts** then **alveolus**. Let’s try a graphic representation.

Some interesting factoids...

All of the above listed structures until the terminal bronchioles have cartilaginous rings and make up the **Conducting Portion of the Respiratory System**. *What’s so special about that?* It means they never collapse or, they’re always held open. The terminal bronchioles and below, do not have cartilaginous rings, and deflate every time we exhale. They all have a ring of smooth muscle in their walls that can contract or relax. This contracting and relaxing in the Respiratory system is called **Bronchioconstriction** and **Bronchiodilation**. There are many ways to increase or decrease the lumen size of the bronchi such as stimulation from the Nervous system or when certain chemicals (**histamine** is one of them) are released.

- ★ When someone is having an “allergic reaction,” histamine is released. One of histamine’s functions is to contract the smooth muscles ring of bronchioles (bronchioconstriction), which decreases the area the air can move through as it moves in and out of the lungs. *What do anti-histamines do?*

- ★ Exercise and excitement increases nerve stimulation to the bronchioles, causing the smooth muscle to be relaxed (bronchiodilation), thus increasing the size of the opening the air moves in and out of....more air can more easily move in and out of the lungs.

Let's talk about the structure where all of the above live...the lungs.

The Lungs

Healthy lung tissue is pink and sponge-like. The lungs are made up of the bronchiole segments, which as stated before, are cartilaginous and tree shaped, alveoli and lots of blood and lymphatic vessels. The exchange of gasses occurs in the alveolus...more on that later. There are two lungs contained within the thoracic cavity (*ribcage*) and each lung is divided into different segments called **lobes** (three on the right, two on the left). The lungs extend just above the clavicle and rest inferiorly on the diaphragm. The heart is nestled in-between them. Each lung is encased in its own serous membrane called the **Pleura**. We will leave our discussion of the larger structure of the lungs, and discuss the smallest structure of the Respiratory system and the functional unit, the alveolus.

The place of exchange: the Alveolus

An **alveolus** is a cup-shaped sac only one cell thick. The oxygen-rich, incoming air ends up at this dead-end structure and can then diffuse into the neighboring blood vessel. The blood vessel, called a **capillary**, is one cell thick also (*capillaries surround the little alveoli*). Oxygen, Carbon dioxide, and our friendly herbal constituents only need to move through *two* cells here to get into the bloodstream. Wow! What a difference from the skin. Carbon dioxide coming from the cells as a waste product also diffuses *from* the blood into the alveolus so it can then be exhaled.

Two alveoli usually open into a common space. The alveolus and the space they empty into are called an **alveolar sac**. Alveolar sacs empty into **Alveolar ducts**. Alveolar ducts transport the gas to and from the alveolus to the **respiratory bronchioles**. The lungs are made of three million of these structures. They are designed this way to increase the surface area for exchange. The surface area for gasses to exchange in the lungs is as big as a tennis court (750 square feet). Wow someone was thinking when they designed the body.

More to know about the alveolus.

Three types of cells make up the alveolus. One type makes the wall of the alveolus itself, another makes a substance called **surfactant**, and the third, a macrophage (*big eater*), cleans up any dead cells, dust or foreign invaders. Surfactant is a substance that prevents the alveoli from sticking together after they have deflated and allows them to easily reinflate (*Do you remember what happens to a balloon you've played with all day...getting saliva inside it? It won't re-inflate sometimes.*) Macrophages are needed here to protect the blood and body from foreign invaders. The distance for gasses, essential oils *and* foreign invaders to travel to get to the blood is so short, it's a good defense to have cells nearby to deactivate unwanted organisms.

What does this have to do with Herbalism?

First of all, if the Respiratory System is the effected system, it would be good to know about the structures involved since they are the structures to be treated. Secondly, the Respiratory System is a fast and efficient way to administer herbal constituents to the *entire body*. It has a HUGE surface area available for exchange and entry. Inhalation of the herbal constituents would not only enter through the Respiratory System, but also stimulate the olfactory receptors, nerves and brain directly (this will be discussed in the next chapter...yeah!). Not

only does this system have a huge surface area, the distance the herbal constituents have to travel to get to the blood is extremely small...only two cells thick. One cell making the wall of the alveolus, and one cell making the wall of the capillary and the herbal constituent is in the “euro-rail” of the body, the bloodstream. Once in the blood, the herbal constituents can go anywhere to carry out its desired effect.

What could affect the rate of exchange of gasses and essential oils?

- * The total surface area for gas exchange to occur. Pulmonary disorders such as emphysema decreases the surface area available. In emphysema the little alveolus are ruptured, so instead of having 20 different alveoli per duct, there might just be one big sac. This would severely decrease the surface area.
- * The distance the gasses/ herbal constituents need to diffuse to get to the blood. If the distance is increased, the rate of exchange will decrease. Pneumonia and pulmonary edema increase the distance by adding fluid either within the alveolus (pneumonia) or between the alveolus and the blood (pulmonary edema). So instead of moving through two cells like we’ve talked about, the herbal constituents and gas need to also move through a collection of water also.