

11. Respiratory system

Respiratory system is of exchanging gas through our body with the external environment. These means the process of supplying body with O₂ and dispose of CO₂ from body, which means every cell body needs O₂ to survive. The major function of the respiratory system is to supply the body with oxygen and dispose of carbon dioxide. To accomplish this function, at least four processes, collectively called respiration, must happen:

1. Pulmonary ventilation: movement of air into and out of the lungs so that the gases there are continuously changed and refreshed (commonly called breathing).

2. External respiration: movement of oxygen from the lungs to the blood and of carbon dioxide from the blood to the lungs.

3. Transport of respiratory gases: transport of oxygen from the lungs to the tissue cells of the body, and of carbon dioxide from the tissue cells to the lungs. This transport is accomplished by the cardiovascular system using blood as the transporting fluid.

4. Internal respiration: movement of oxygen from blood to the tissue cells and of carbon dioxide from tissue cells to blood.

Note that: the actual use of O₂ production of CO₂ by tissue cell is called cellular respiration. It is the cornerstone of all energy producing chemical reaction in the body.

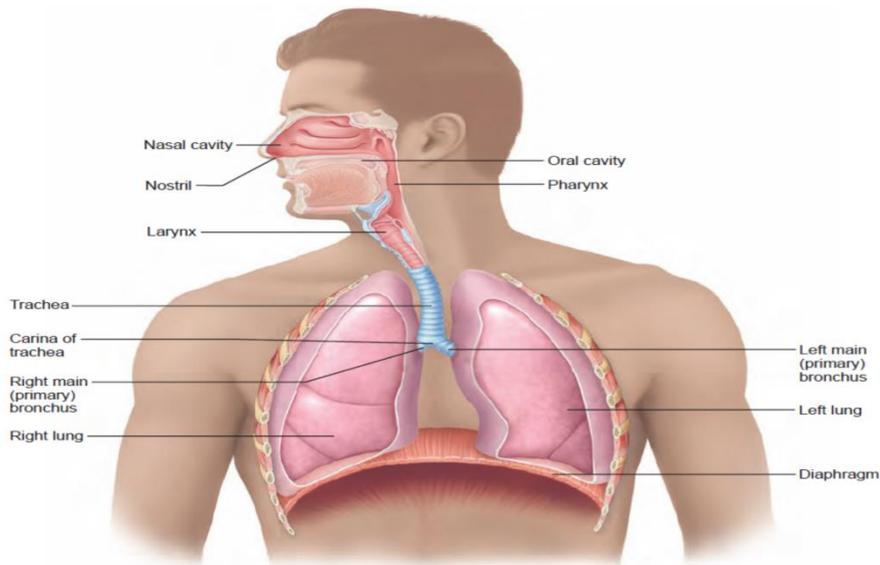


Figure 1. Respiratory system organs

Organs of respiratory system

They include nose, nasal cavity, paranasal sinuses, pharynx, larynx, the trachea and bronchi and their bronchioles and lung and alveoli (sac).

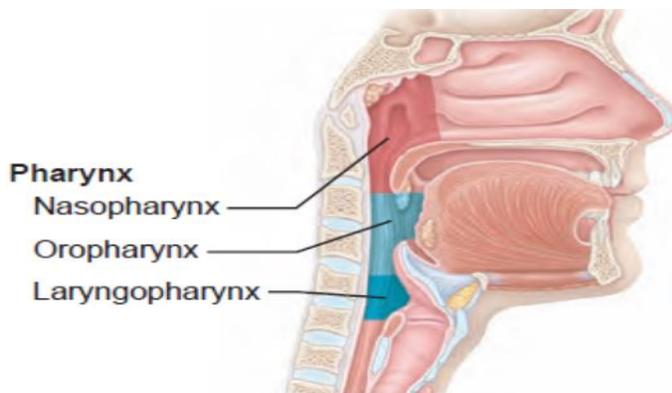
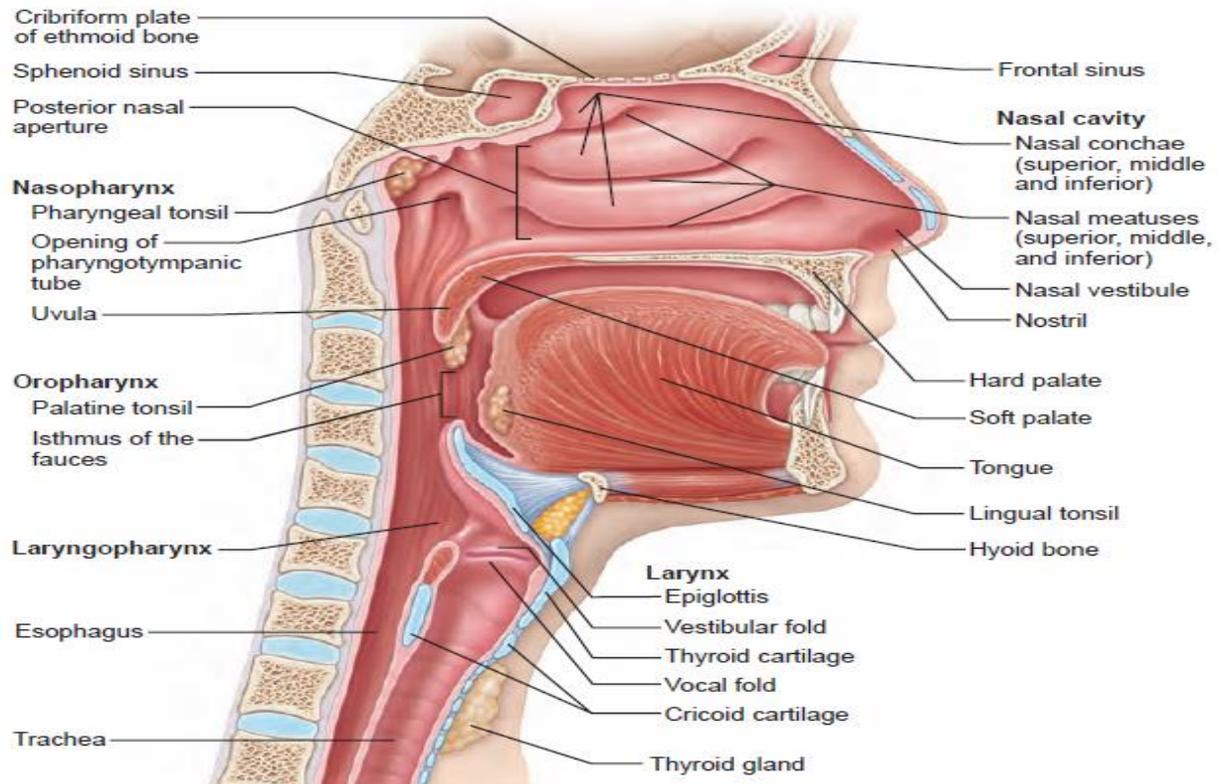
1). Nose: is the only externally visible part of the respiratory system. They provided airway for respiration. The air is warmed, moistened and filtered by mucous secretions and hairs in the nose

2). Pharynx: The pharynx (throat) is a tube like structure about 12.5 cm long that connects the posterior nasal and oral cavities to the larynx and esophagus. It extends from the base of the skull to the level of the sixth cervical vertebrae. Structurally the pharynx can be divided into three anatomical parts according to its location.

- ✓ The **nasopharynx** (posterior to the nasal chambers) is located between the internal nares and the soft palate and lies superior to the oral cavity. At the base of the nasopharynx are the soft palate and the uvula. At the wall of the nasopharynx are the auditory (Eustachian) tubes connected to the middle ear. The pharyngeal tonsils (adenoids) are located in the nasopharynx on its posterior wall opposite the posterior internal nares.
- ✓ The **oropharynx** (posterior to the mouth) is located posterior to the mouth, inferior from the soft palate, and superior to the level of the hyoid bone. At this location the mouth

leads into the oropharynx and both food and inhaled air pass through it. The palatine (faucial) tonsils lie in the lateral walls of the fauces.

- ✓ The **laryngopharynx** (hypopharynx) (posterior to the pharynx) extends from the hyoid bone to the esophagus. It is inferior to the epiglottis and superior to the junction where the airway splits between the larynx and the esophagus. The lingual tonsils are found at the posterior base of the tongue which is near the opening of the oral cavity.



(b) Regions of the pharynx

3). **Larynx or Voice Box:** The larynx sits at the top of the trachea. It contains your vocal cords. Each time you breathe in or inhale, the air passes through the larynx, down the trachea and into the lungs. When you breathe out or exhale, the air moves from your lungs, up your trachea and out through your nose and mouth. When you speak, the vocal cords tighten up and move closer together. Air from the lungs is forced between them and causes them to vibrate. This produces sound. Your tongue, lips and teeth form words out of these sounds.

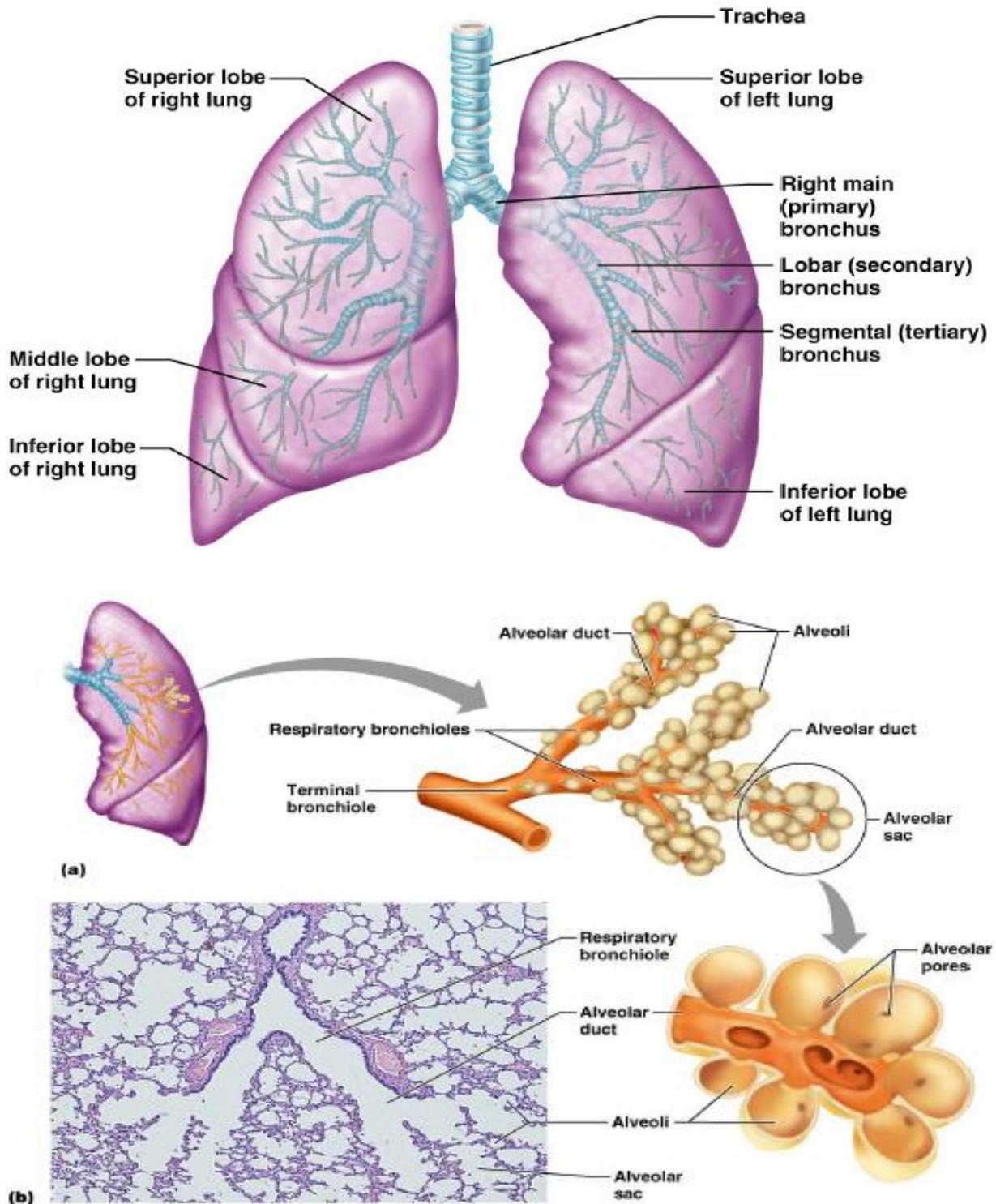
4). **Trachea:** The trachea is the tube that connects the mouth and nose to your lungs. It is also called the **windpipe**. You can feel some of your trachea in the front of your neck. It feels firm with tough rings around it.

5). **Bronchial Tubes (respiratory tree):** The trachea splits into 2 bronchial tubes in your lungs. These are called the left bronchus and right bronchus. The bronchus tubes keep branching off into smaller and smaller tubes called bronchi. Only the primary bronchi are external to lungs and the rest are embedded in the lungs tissue. The tubes are lined with fine hair-like structures called cilia, smooth muscle and cartilage rings. As the cilia sway back and forth, they carry the mucous upwards to the trachea where it can be coughed up or swallowed.

6). **Alveoli:** At the end of the bronchial tubes (alveolar duct) are air sacs called alveoli. The alveoli look like bunches of grapes but contain air. This is where the oxygen enters the blood and the carbon dioxide exits. There are about 300 million alveoli in each lung.

7). **Lungs:** Your lungs are made up of 5 pink, spongy lobes. There are 3 lobes on your right side and 2 lobes on your left side. Your heart is between them a little to the left. Thoracic cavity is lined with a body membrane called parietal pleura, while the surface of lungs is covered with visceral pleura. The thin space between the two pleural membranes is called pleural cavity which is filled with a clear fluid called pleural fluid to minimize friction between the tissues and to provide surface tension and to prevent collapsing of lungs in the pleural cavity. A chemical substance called surfactant secreted by the lungs also facilitate the surface tension

8). **Diaphragm:** The diaphragm is a long, flat muscle that sits below your lungs. The diaphragm helps you get air in and out of your lungs by moving up and down. When your diaphragm moves down, you breathe in or inhale. When your diaphragm moves up, you breathe out or exhale.



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Figure 3. Lungs and their accessory structures

Mechanism of breathing

Gas exchange between the air and the blood occur within the alveoli. The respiratory membrane consists of the alveolar and capillary walls. Gas changed through these walls. About 30 billion capillaries can be found in each lung and roughly 100 capillaries per alveolus (single sac).blood returning from the systemic circulation depleted in the oxygen has a partial oxygen pressure (PO₂) of about 40mmHg. By contrast the PO₂ in the alveoli is about 105mmHg. The difference in pressure 65mmHg (Fick law). These lead to O₂ moving into blood. The blood leaving the lungs as a result of this gas exchange normally contain PO₂ of about 100mmHg. The lungs do very affective but, not perfect jobs of oxygenating blood.

Note that: the two laws state about gas exchange between difference pressures.

- ❖ **The Gas law** states that gas molecules always diffuse from a higher pressure area to a lower pressure area.
- ❖ **The Boyle's law** states that pressure and volume are inversely related (with the temperature remains constant), where pressure will increase in a smaller volume of gases, and pressure decreases in a larger volume of gases

INSPIRATION: Inspiration is the active part of the breathing process, which is initiated by the respiratory control center in medulla oblongata (Brain stem). Activation of medulla causes a contraction of the diaphragm and intercostal muscles leading to an expansion of thoracic cavity and a decrease in the pleural space pressure. The external intercostal muscles connect adjacent ribs. When they contract the ribs are pulled upward and forward causing further increase in the volume of the thoracic cavity. As a result fresh air flows along the branching airways into the alveoli until the alveolar pressure equals to the pressure at the airway opening (atmospheric pressure).

EXPIRATION: Expiration is a passive event due to elastic recoil of the lungs and the diaphragm recoil to their original position. Thus, the diaphragm and the external intercostal muscles relax and recoil thoracic volume decrease which raise the intra alveolar pressure (again due to the boyle's law). However, when a great deal of air has to be removed quickly, as in exercise, or when the airways narrow excessively during expiration, as in asthma, the internal

intercostal muscles and the anterior abdominal muscles contract and accelerate expiration by raising pleural pressure. When intralveolar pressure is raised above the atmospheric pressure (762 mmHg versus 760 mmHg, respectively), gases move from the lungs into the environment (again due to the gas law).

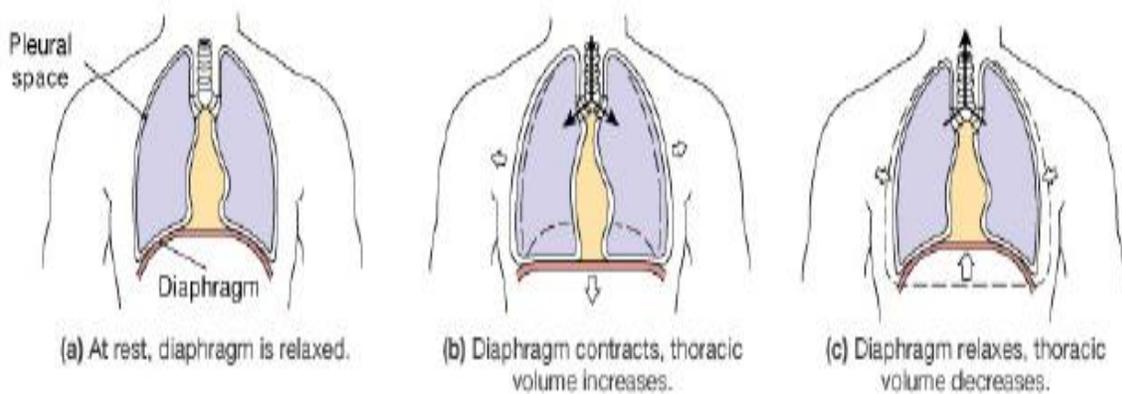


Figure 4. Inspiration versus expiration