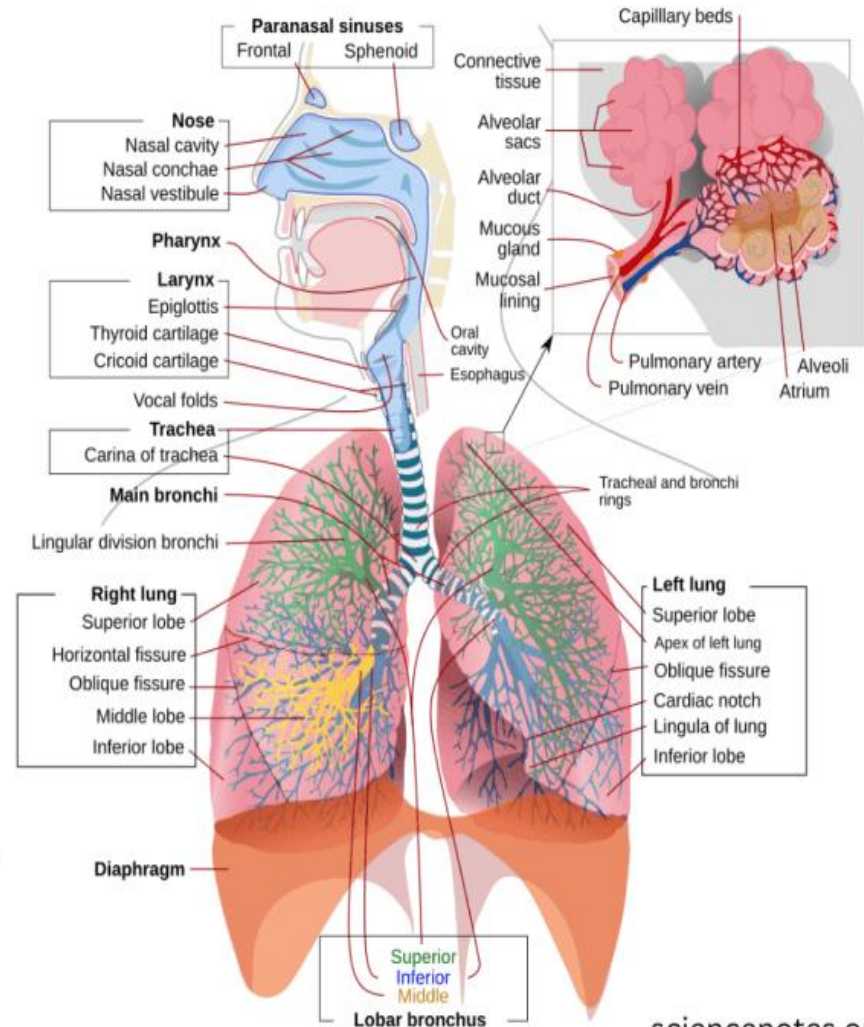


Gaseous Exchange

Human Respiratory System Diagram

1. **Inhalation:** Diaphragm contracts, intercostal muscles expand the rib cage, and air is drawn into the lungs.
2. **Gas Exchange:** Oxygen diffuses from alveoli into the blood; carbon dioxide diffuses from the blood into the alveoli.
3. **Oxygen Transport:** Oxygen binds to hemoglobin in red blood cells and is transported to body tissues.
4. **Cellular Respiration:** Cells use oxygen to produce energy (ATP) and release carbon dioxide as a waste product.
5. **Carbon Dioxide Transport:** Carbon dioxide is carried back to the lungs, mainly as bicarbonate ions in the blood.
6. **Exhalation:** Diaphragm and intercostal muscles relax, reducing chest cavity volume, and expelling carbon dioxide-rich air from the lungs.



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Gaseous Exchange

Gas exchange is the biological process through which gases are transferred across cell membranes to either enter or leave the blood.

Oxygen is constantly needed by cells for aerobic cellular respiration, and the same process continually produces carbon dioxide as a waste product.

Gas exchange takes place between the **blood** and **cells** throughout the body, with oxygen leaving the blood and entering the cells, and carbon dioxide leaving the cells and entering the blood.

Breathing vs. Gaseous exchange

Breathing: is the physical act of inhaling and exhaling air. During **inhalation**, the diaphragm contracts and flattens, and the external intercostal muscles elevate the rib cage, increasing thoracic volume and decreasing intrathoracic pressure, which allows air to flow into the lungs. **Exhalation** occurs when the diaphragm relaxes and the thoracic cavity contracts, pushing air out of the lungs.

Gas exchange: occurs at the **alveoli**, the tiny sac-like structures in the lungs. Oxygen from inhaled air diffuses across the thin, moist alveolar membranes into the blood in surrounding capillaries, while carbon dioxide diffuses from the blood into the alveoli to be exhaled.

Respiratory system

The human **respiratory system** is vital for sustaining life, as it facilitates the exchange of gases—oxygen (O_2) and carbon dioxide (CO_2)—between the body and the external environment. The primary function of the respiratory system is cellular respiration, which provides chemical energy for the body's metabolic functions.

The respiratory system is divided into three main sections:

1. Air pathways
2. Throat and lungs
3. Ribs and muscles

Air Pathways

The **air passages** in the respiratory system consists of a series of structures that facilitate the movement of air into and out of the lungs, including the nasal cavity, pharynx, larynx, trachea, bronchi, and bronchioles.

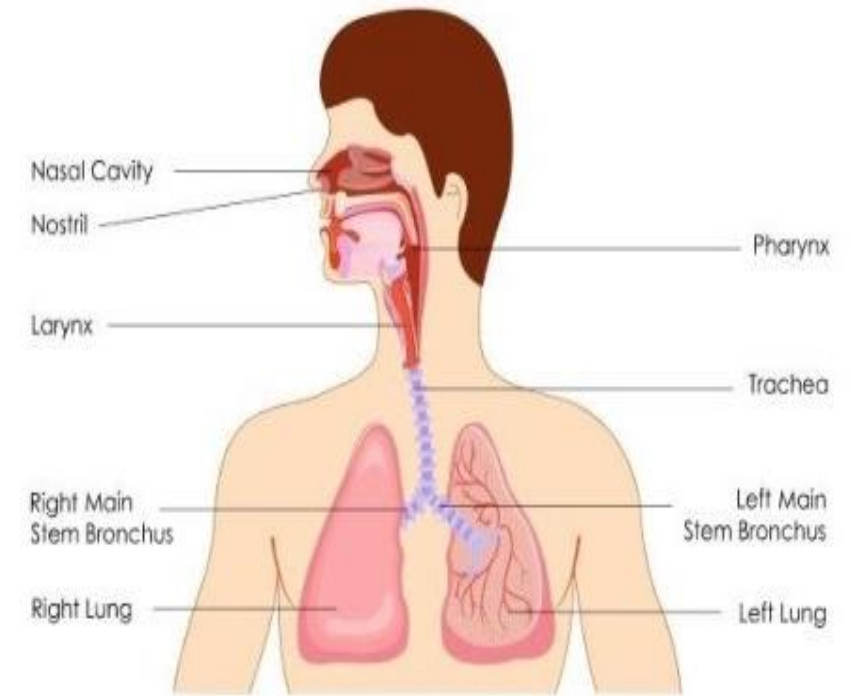
Nose and Nasal Cavity: The primary entry point for air. The nasal cavity warms, humidifies, and filters the air. It also contains olfactory receptors for the sense of smell.

Sinuses: Air-filled cavities within the bones of the skull. They help lighten the weight of the skull, warm and moisten the air, and enhance voice resonance.

Trachea (Windpipe): A cartilaginous tube that connects the larynx to the bronchi, providing a clear airway for air to enter and exit the lungs.

Bronchi and Bronchioles: The trachea divides into two main bronchi (left and right), which enter each lung and branch into smaller bronchioles. These passages further divide and become narrower, ending in tiny air sacs.

Alveoli: Microscopic air sacs at the end of bronchioles where gas exchange occurs. A network of capillaries surrounds the alveoli. The thin layer between the air in the alveoli and the neighboring capillaries allows O_2 to diffuse into the blood and CO_2 to diffuse out.



Throat and lungs

The **lungs and throat** are integral components of the respiratory system, working together to facilitate breathing and gas exchange.

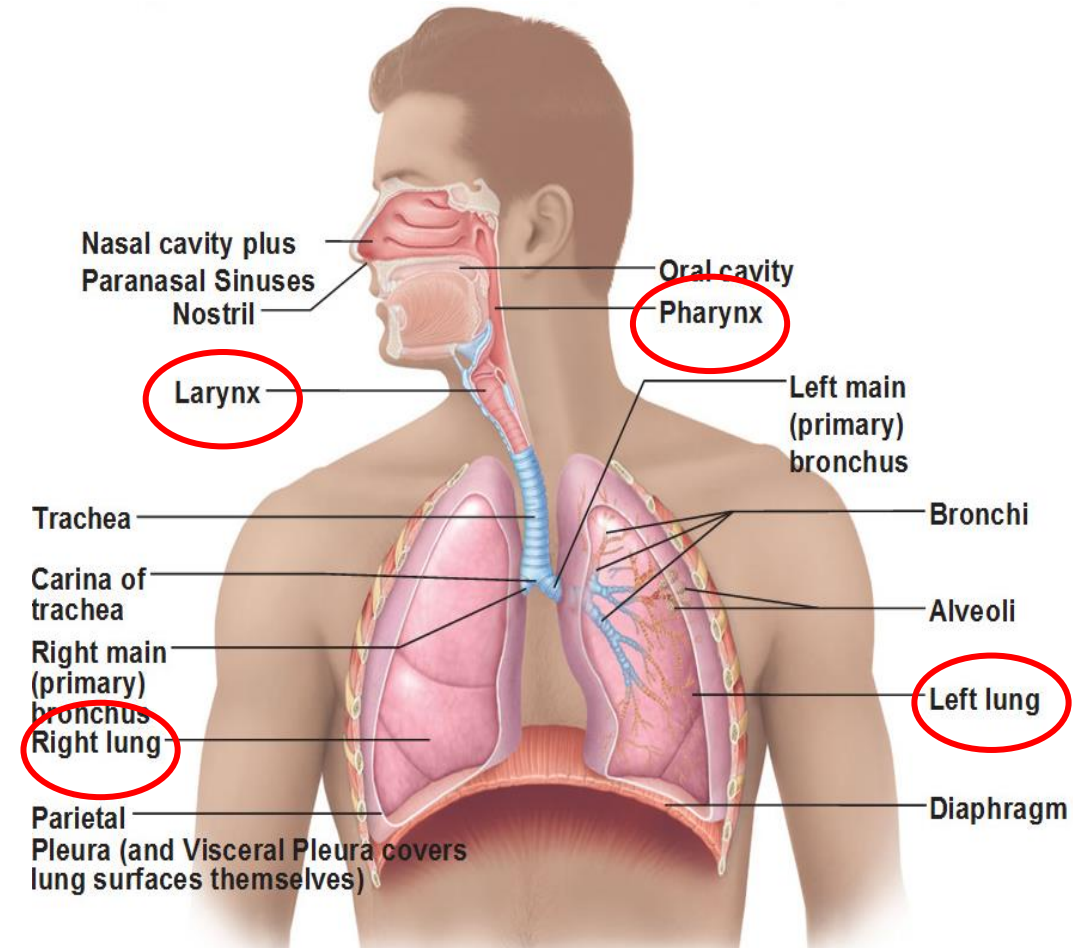
The throat and lungs work together to **regulate airflow**. The throat warms, moistens, and filters the air before it enters the lungs, ensuring that the air is suitable for gas exchange.

Pharynx (Throat): A muscular tube that connects the nasal and oral cavities to the larynx. It serves as a pathway for both air and food.

Larynx (Voice Box): Located at the top of the trachea, it is responsible for sound production and also protects the trachea from food aspiration.

Lungs: The lungs are the main respiratory organs, where gas exchange occurs. The right lung has three lobes, while the left lung has two lobes to accommodate the heart.

Epiglottis: a cartilage structure on top of the larynx (voice box).



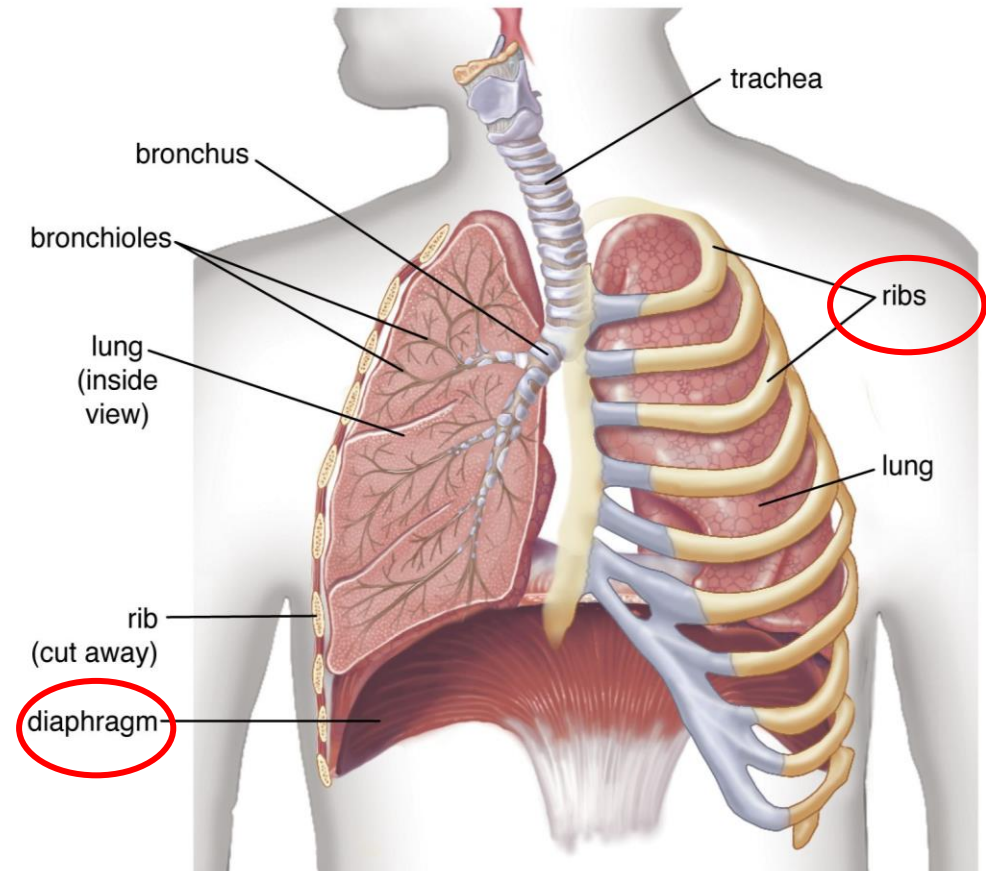
Ribs and muscles

The **muscles in the ribs**, particularly the intercostal muscles, play a crucial role in respiration by facilitating the expansion and contraction of the thoracic cavity during inhalation and exhalation.

Diaphragm: A dome-shaped muscle at the base of the lungs. It contracts and flattens during inhalation, increasing the thoracic cavity volume and drawing air into the lungs.

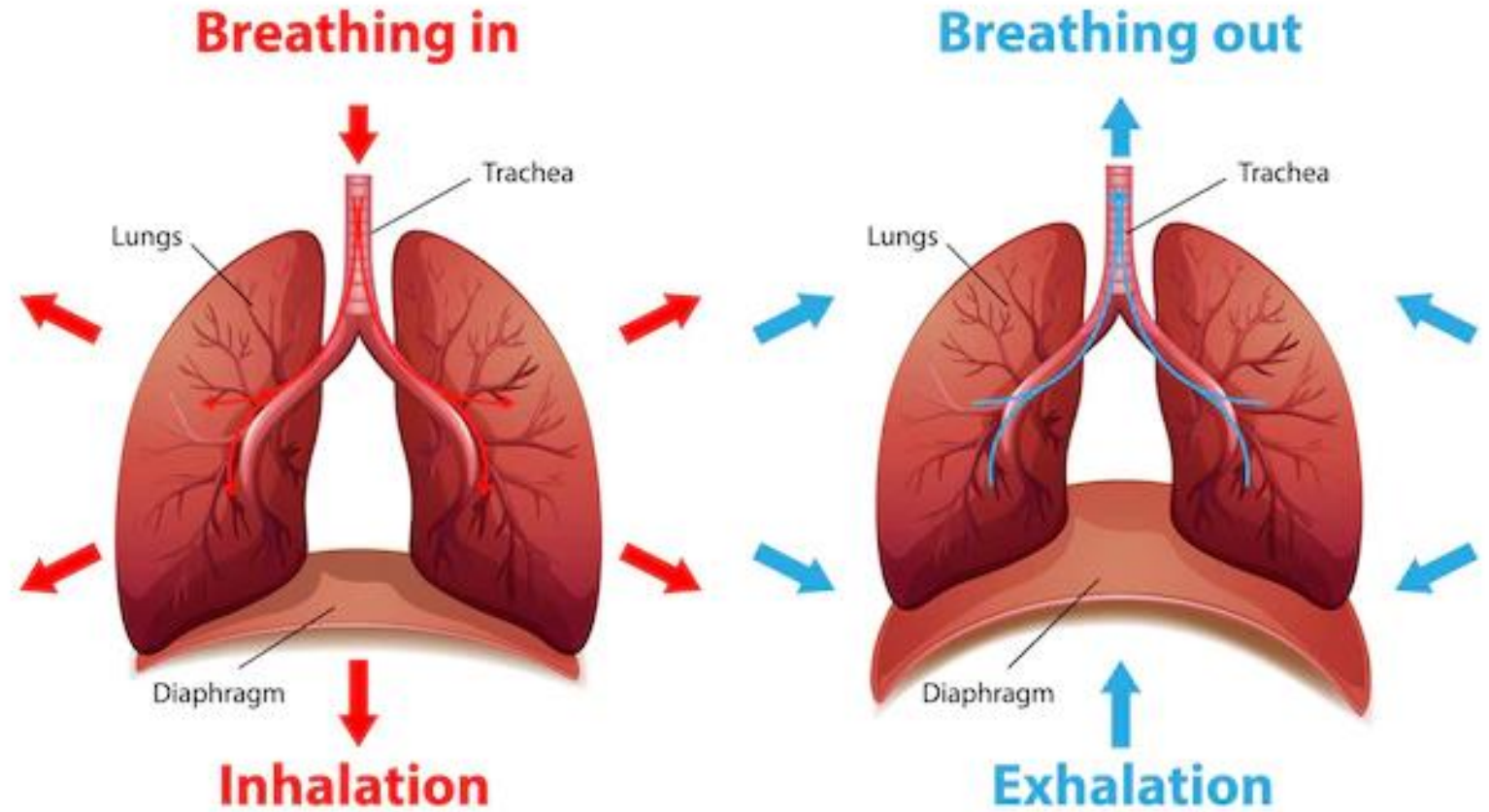
Intercostal Muscles: Muscles located between the ribs that assist with the expansion and contraction of the chest during breathing.

Ribs: on either side of the sternum, protect the lungs from injury.



Breathing

The mechanism of breathing involves **inhalation** and **exhalation**. The lung volume changes and allow the exchange of gases to support cellular function.

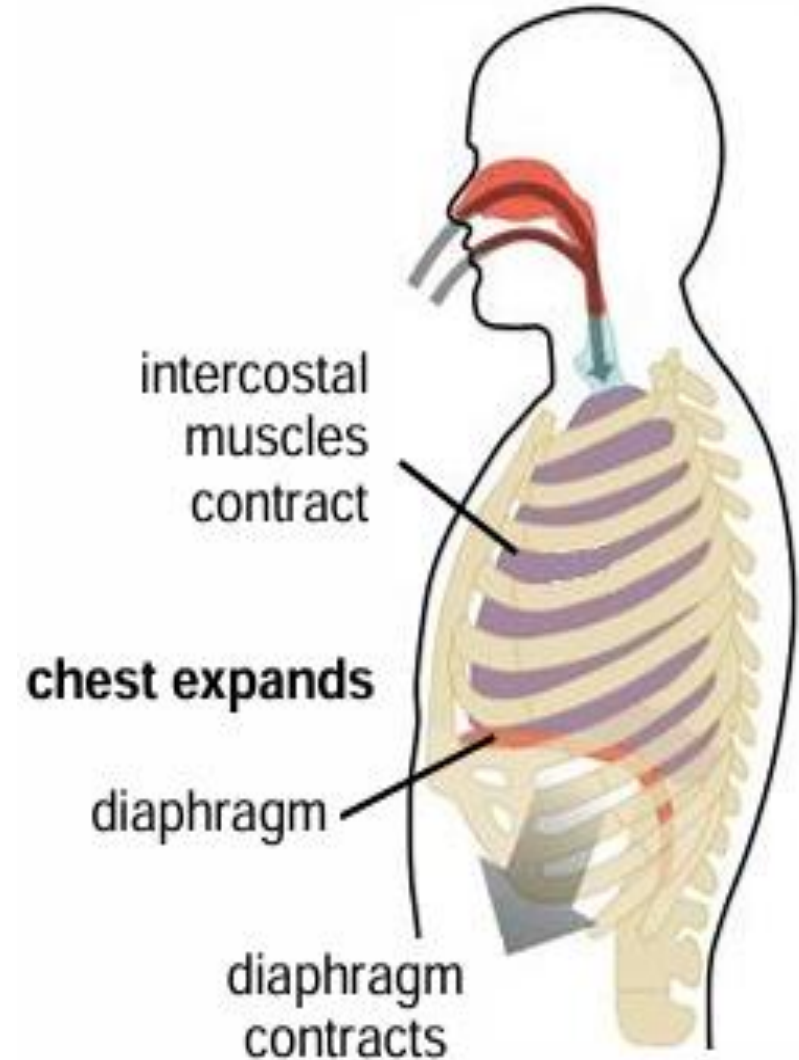


Inhalation (Inspiration)

Inhalation: involves the **intake of air** into the lungs. It is initiated by the contraction of the diaphragm, a dome-shaped muscle at the base of the chest, and the external intercostal muscles, which are located between the ribs.

Mechanism:

- The intake of atmospheric air into the lungs is known as inspiration.
- The diaphragm, respiratory muscle, contracts during inspiration.
- Contraction of the external intercostal muscles contributes to the expansion of the thoracic cavity.
- Air pressure in the lungs decreases as the chest volume increases.
- Atmospheric pressure is greater than the pressure inside the lungs and air flows in.



Exhalation (Expiration)

Exhalation: is the expulsion of air from the lungs. It occurs when the diaphragm and external intercostal muscles relax, allowing the chest cavity to decrease in size. This reduction in volume increases the air pressure within the lungs, causing the air, now rich in carbon dioxide, to be pushed out.

Exhalation is a **passive** process during rest, relying on the elastic recoil of the lungs and chest wall.

Mechanism:

- It occurs when the size of the thoracic cavity decreases and the air pressure outside increases.
- The external intercostal muscles relax and the internal intercostal muscles contract.
- As a result, the ribs are pulled inwards and the size of the thoracic cavity is reduced.
- The diaphragm is relaxed, and the lungs get compressed.
- Consequently, the pressure increases, and the air is forced outside.

