Respiratory system

Respiration

It is the exchange of gases between the atmosphere, lungs, blood, and tissues; where the oxygen (O_2) is taken in and carbon dioxide (Co_2) is given out.

Types of Respiration

Respiration is often classified into two types:

1. External respiration that involves exchange of respiratory gases, i.e. O_2 and Co_2 between lungs and blood.
2. Internal respiration which involves exchange of gases between blood and tissues.

Stages of Respiration

Respiration occurs in two stages:

1. Inspiration during the air enters the lungs from atmosphere
2. Expiration during the air leaves the lungs.

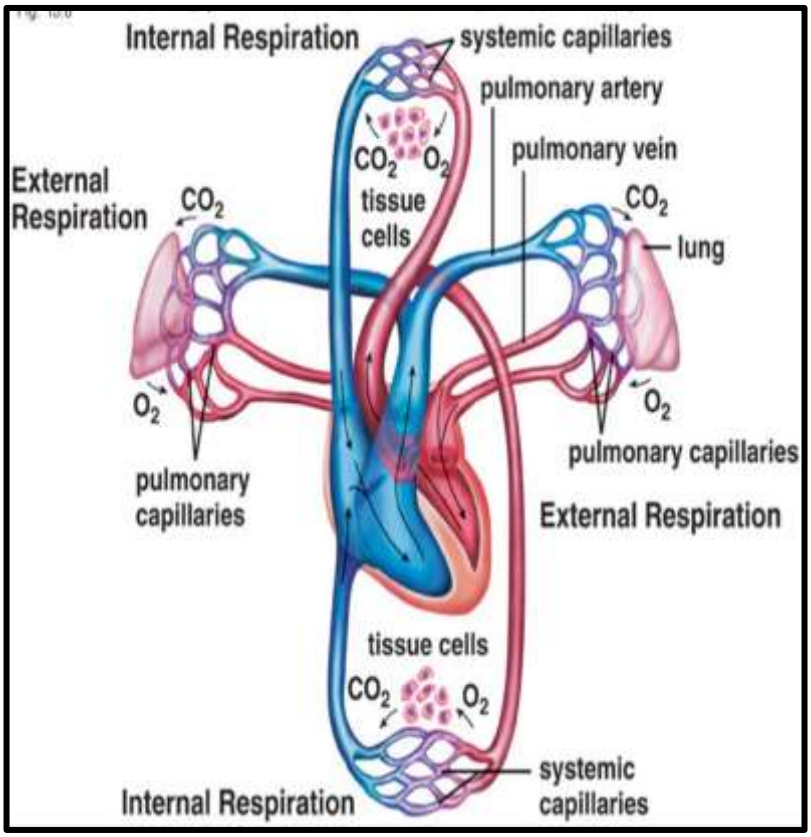
The term respiration includes 4 basic separate processes:

1. Pulmonary ventilation= (breathing)
   It is the inhalation (inflow) & exhalation (outflow) of air. Involve the exchange of air between the atmosphere and lungs alveoli (in and out).

2. External respiration= (pulmonary) within the lungs.
   It is exchange of gases between lung's alveoli & blood in pulmonary capillaries (of respiratory membrane) which gains O_2 and loses Co_2.

3. Transport of respiratory gases= (via the blood).
   Oxygen and carbon dioxide transported to and from the lungs and tissue cells of the body via the bloodstream.

4. Internal respiration = (cellular respiration) within the tissue "O_2 utilization"
   It is exchange of gases between blood in systemic capillary & tissue cells.

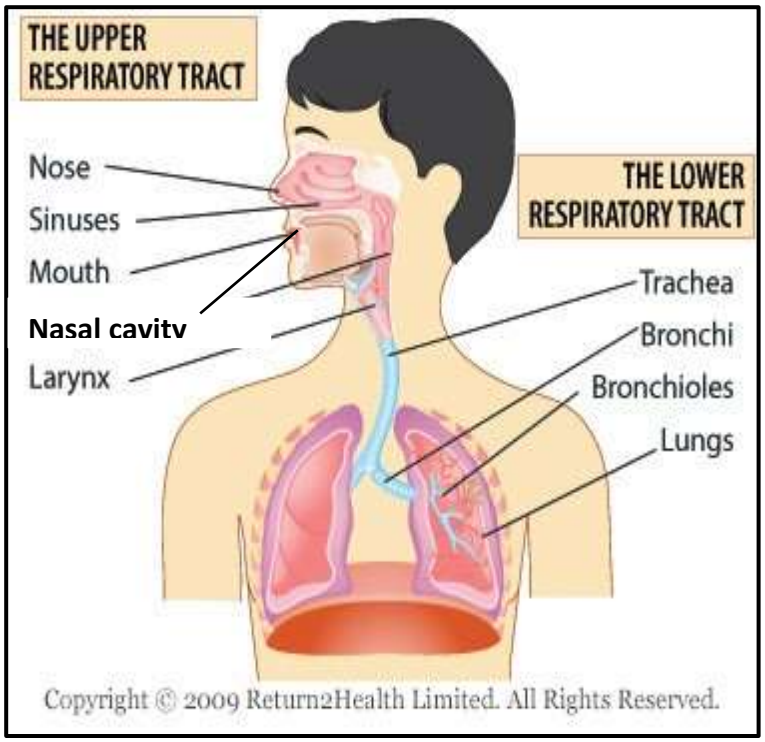


External and Internal Respiration

Respiratory tract

Respiratory tract is the anatomical structure through which air moves in and out. The organs of the *"Respiratory Tract"* can be divided **"STRUCTURALLY"** into two groups:

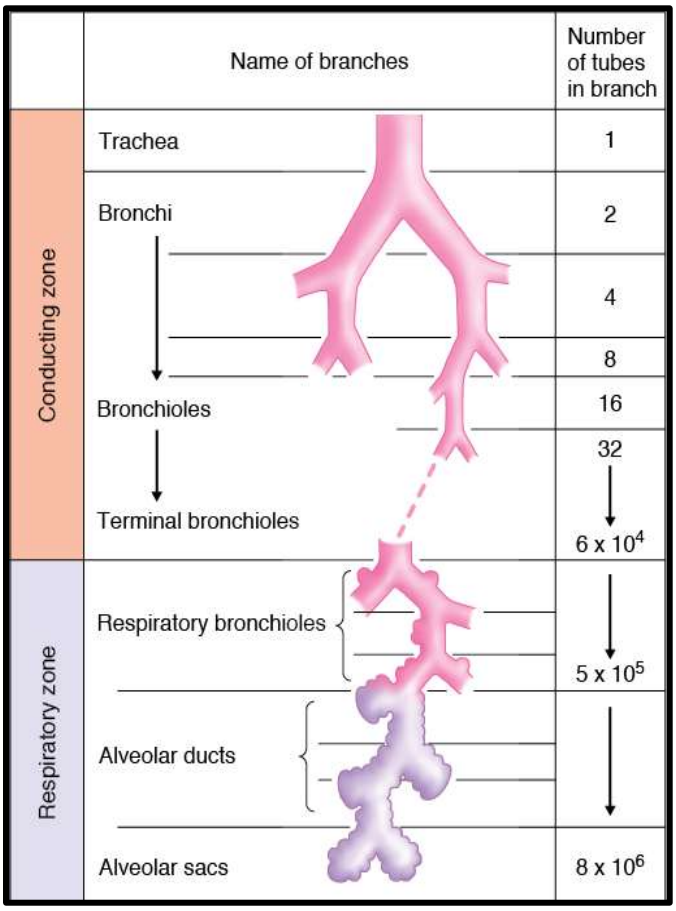
The Upper Respiratory Tract	The Lower Respiratory Tract
* Nose * Nasal cavity * Sinuses * Pharynx * Larynx	* Trachea * Bronchial Tree * Lungs

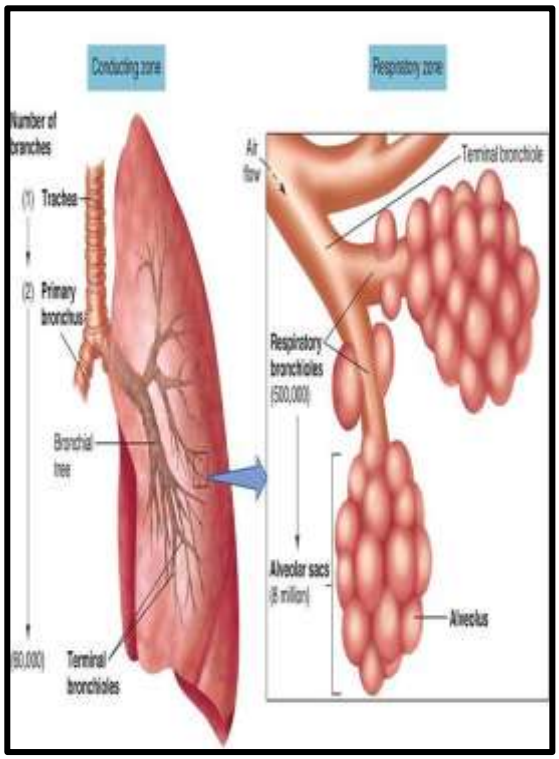


Upper and Lower Human Respiratory Tract

The organs of the *"Respiratory Tract"* can be divided "FUNCTIONALLY" into two groups:

The Conducting Portion	**The Respiratory Portion**
system of interconnecting cavities and tubes that conduct air into the lungs	system where the exchange of respiratory gases occurs
* Nose * Pharynx * Larynx * Trachea * Bronchi	* Respiratory bronchioles * Alveolar Ducts * Alveoli



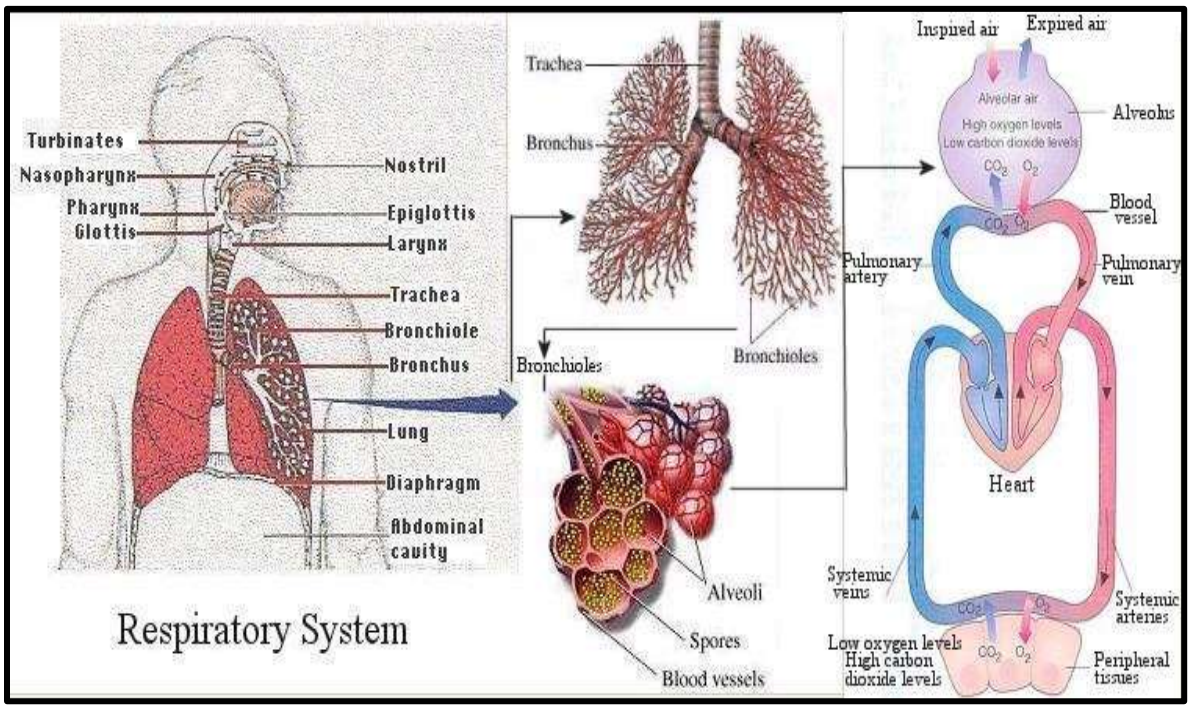


The lung

- It is the main and primary organ of the respiratory system. The paired soft, spongy, cone-shaped lungs separated medially and are enclosed by the diaphragm and thoracic cage. Each lung is enclosed by a bilayered serous membrane called **pleura or pleural sac**. The two layers of pleura are: the **visceral (inner) layer** lines the surface of the lungs; it is continuous with **parietal (outer) layer**, which is attached to the wall of the thoracic cavity. The narrow space in between the two layers of pleura is called **intrapleural space or pleural cavity**. Its space contains a thin film of pleural fluid which is involved in the creating the negative pressure called **intrapleural pressure** within **intrapleural space**.

Tracheobronchial Tree

- The trachea and bronchi are together called **tracheobronchial tree**. It forms a part of air passage. The ***trachea*** bifurcates into two main or ***primary bronchi*** called right and left bronchi. Each primary bronchus enters the lungs and divides into ***secondary bronchi***, these divide into ***tertiary bronchi***. The tertiary bronchi divide several times and the latest called ***terminal bronchiole***. Terminal bronchiole continues or divides into ***respiratory bronchiole***.

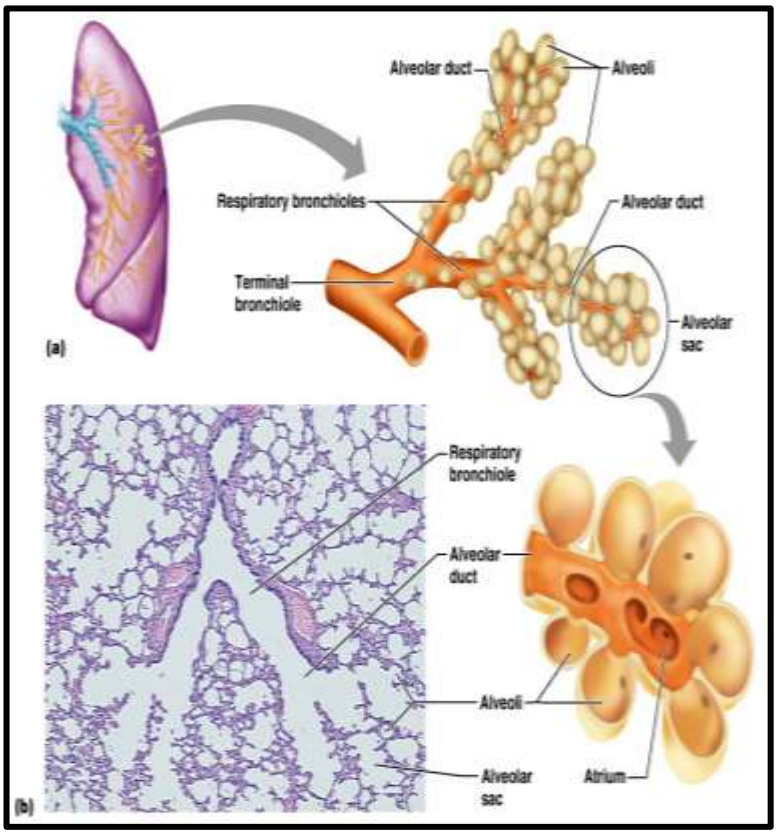


Respiratory unit

- Respiratory unit is defined as the structural and functional unit of lung; the exchange of gases occurs only in this part of the respiratory tract. The respiratory unit starts from the respiratory bronchioles. Each respiratory bronchiole divides into alveolar ducts. Each alveolar duct enters an enlarged structure called the alveolar sac. The space inside the alveolar sac is called antrum. Alveolar sac consists of a cluster of alveoli.

Thus, Respiratory unit includes:

1. Respiratory bronchioles.
2. Alveolar ducts.
3. Alveolar sacs.
4. Antrum.
5. Alveoli.



Non respiratory functions of respiratory tract

Besides the primary function of gaseous exchange, the respiratory tract is involved in several non-respiratory functions of the body:

1. Olfaction

Olfactory receptors present in the mucous membrane of nostril are responsible for olfactory sensation.

2. Vocalization

Along with other structures, larynx forms the speech apparatus.

3. Prevention of dust particles

The dust particles, which enter the nostrils from air, are prevented from reaching the lungs by filtration action of the hairs in nasal mucous membrane. The particles which escape the protective mechanisms in nose and alveoli are thrown out by cough reflex and sneezing reflex.

4. Defense mechanism

This is performed by their defenses and by the presence of various types of cells (leukocytes, macrophages, mast cells, natural killer cells and dendritic cells) in the mucous membrane lining the alveoli of lungs.

5. Maintenance of water balance

Respiratory tract plays a role in water loss mechanism. During expiration, water evaporates through the expired air and some amount of body water is lost.

6. Regulation of body temperature

During expiration, along with water, heat is also lost from the body. Thus, respiratory tract plays a role in heat loss mechanism.

7. Regulation of acid- base balance

Lungs play a role in maintenance of acid–base balance of the body by regulating the carbon dioxide content in blood.

8. Anticoagulant function

Mast cells in lungs secrete heparin; which is an anticoagulant.

9. Secretion of angiotensin converting enzyme.

Endothelial cells of the pulmonary capillaries secrete the angiotensin converting enzyme (ACE). It converts the angiotensin I into active angiotensin II which plays an important role in the regulation of blood pressure.

10. Synthesis of hormonal substances

Lung tissues are also known to synthesize the hormonal substances, which have many physiological actions in the body including regulation of blood pressure.

Mechanics of Pulmonary Ventilation:

The lungs can be expanded and contracted in two ways:

1. By downward and upward movement of diaphragm to lengthen or shorten the chest cavity.
2. By elevation and depression of ribs to increase and decrease the anteroposterior diameter of chest cavity.

Inhalation (inspiration):

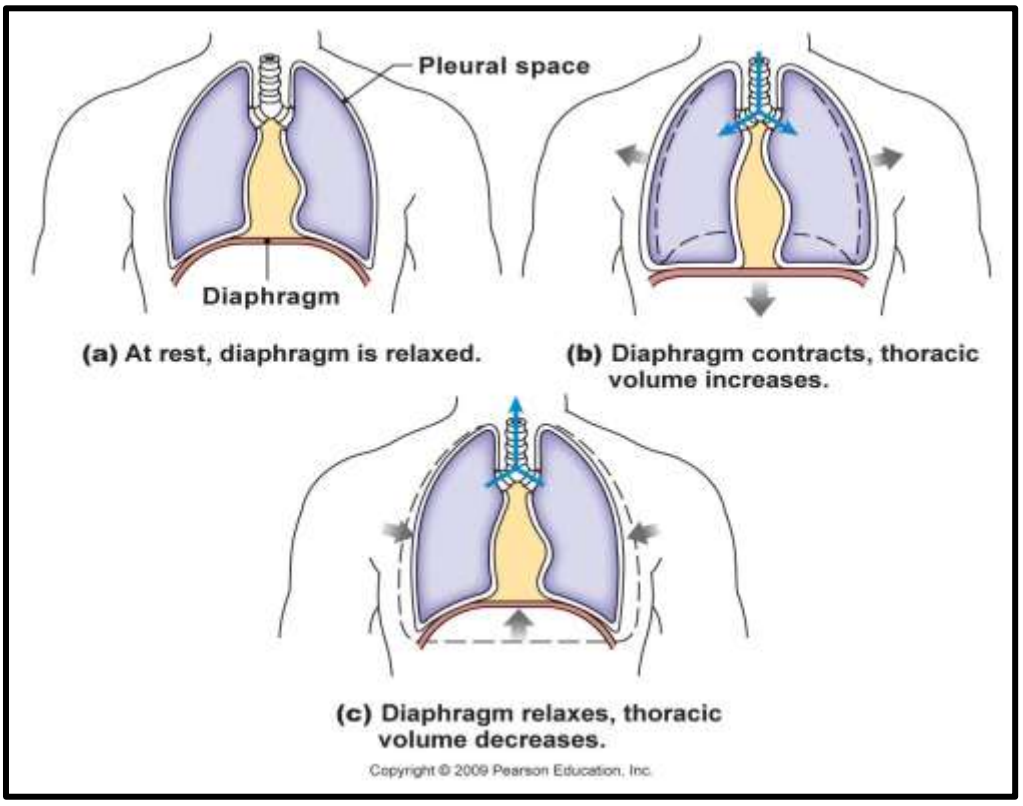
Stages involved during inhalation ***(active process)*** are:

1. External intercostal muscle contract and internal intercostal muscle relax, expanding rib cage (increased thoracic volume laterally).
2. Rib cage moves upward and forward.
3. Diaphragm contracts and flattens; increased thoracic volume vertically.
4. Intrapulmonary pressure decreases.
5. Air pushes in.

Exhalation (expiration):

Stages involved during exhalation ***(passive process)*** are:

1. External intercostal muscles relax and internal intercostal muscle contract, reducing rib cage - (decreased thoracic volume laterally).
2. Rib cage moves downward and backward.
3. Diaphragm relaxes; decreased thoracic volume vertically.
4. Intrapulmonary pressure increases.
5. Air moves out.



Factors causing collapsing tendency of lungs

Two factors are responsible for the collapsing tendency of lungs

1. Elastic property of lung tissues which show constant recoiling tendency and try to collapse the lungs.
2. Surface tension exerted on the surface of the alveolar membrane by the fluid secreted from alveolar epithelium.

Fortunately, there are some factors which save the lungs from collapsing.

Factors preventing collapsing tendency of lungs

Two factors preventing collapsing tendency of lungs

In spite of the elastic property of the lungs and the surface tension in the alveoli of lungs, the collapsing tendency of lungs is prevented by two factors:

1. Intrapleural pressure which is always negative. Because of negativity, it keeps the lungs expanded and prevents the collapsing tendency of lungs produced by the elastic tissues.
2. Surfactant secreted in alveolar epithelium. It is surface acting materials that decrease surface tension on the alveolar membrane and prevents the collapsing tendency produced by surface tension.

Respiratory pressures

Two types of pressures are exerted in the thoracic cavity and the lungs during the process of respiration:

1. Intrapleural pressure or intrathoracic pressure.
2. Intra-alveolar pressure or intrapulmonary pressure.

1- Intrapleural pressure

It is the pressure existing in pleural cavity, that is, in between the visceral and parietal layers of pleura. It is exerted by the suction of the fluid that lines the pleural cavity.

- ***Importance of Intrapleural Pressure***

Throughout the respiratory cycle intrapleural pressure remains lower than intra-alveolar pressure; this keeps the lungs always inflated.

- ***The intrapleural pressure has two important functions:***

1. It prevents the collapsing tendency of lungs.
2. It causes dilatation of vena cava and larger veins in thorax.

2- Intra-alveolar pressure

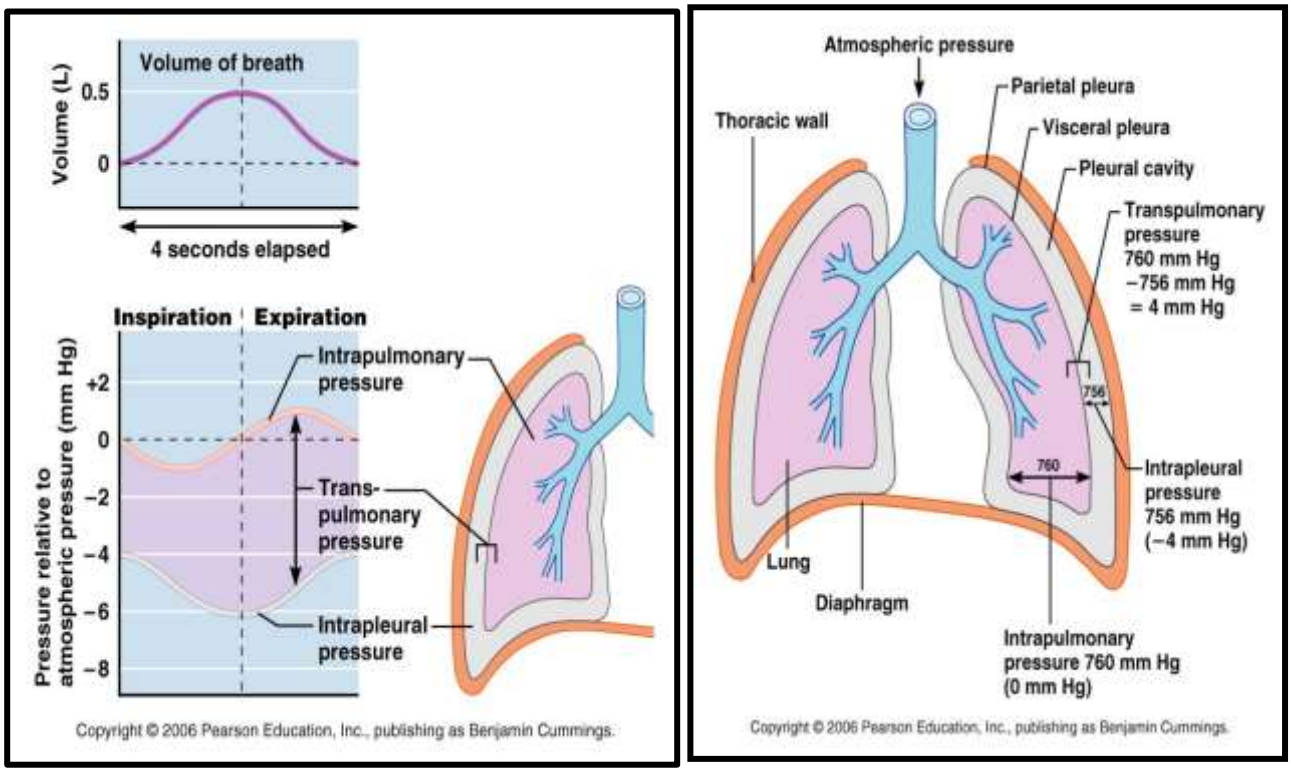
It is the pressure existing in the alveoli of the lungs.

- ***Importance of Intra-alveolar Pressure***

1. It causes flow of air in and out of alveoli. During inspiration, the intra-alveolar pressure becomes negative, so the atmospheric air enters the alveoli. And, during expiration, the air is expelled out of alveoli
2. It also helps in the exchange of gases between the alveolar air and the blood.

3- Transpulmonary Pressure

It is the difference between intra-alveolar pressure and intrapleural pressure.



Changes in respiratory pressures during inspiration and expiration '0' indicates the normal atmospheric pressure (760 mm Hg)