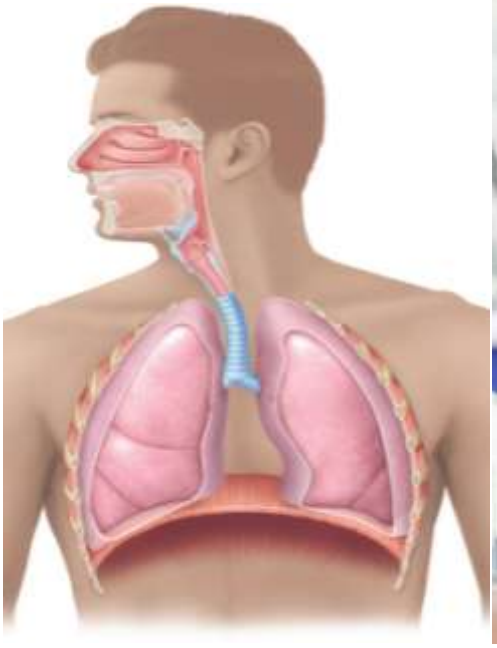




Lecture 6: Introduction to the Respiratory System

Code: RRS-209

By

Prof. Marwa Abd Elaziz Ahmed

Professor of Medical Physiology

Faculty of Medicine

Assiut University

LEARNING OBJECTIVE:

Knowledge:

- Know the function of different part of the respiratory system.
- Describe the mechanism of inspiration and expiration.
- Explain how the intrapulmonary and intrapleural pressures vary during ventilation
- List the non respiratory functions of the respiratory system.

Intellectual:

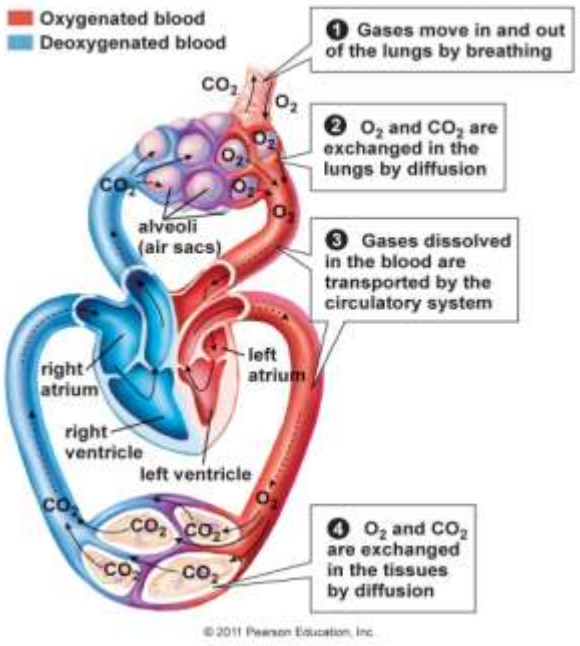
- Explore functions of different part of the respiratory system.

Recall:Think: Breathing Vs Respirtion

Breathing is the mechanical (physical) process of inhaling and exhaling gases between the cells and the environment.

Respiration: is a chemical process that takes place in the cell.

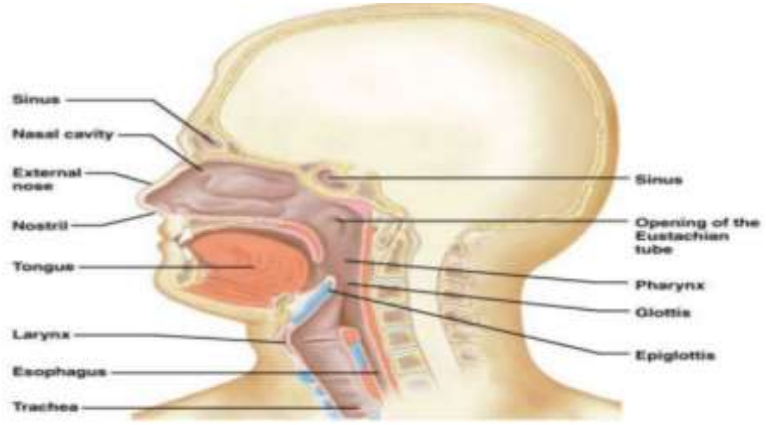
Why do we breathe?



- Lungs facilitate exchange of O_2 and Co_2 between tissues and the atmosphere. O_2 uptake is necessary to support aerobic (oxidative) metabolism, and Co_2 is eliminated as a metabolic waste products.

Functions of Upper Respiratory Tract (URT):

Air Passages: Nasal cavity, pharynyx and Larynx



- Nose:

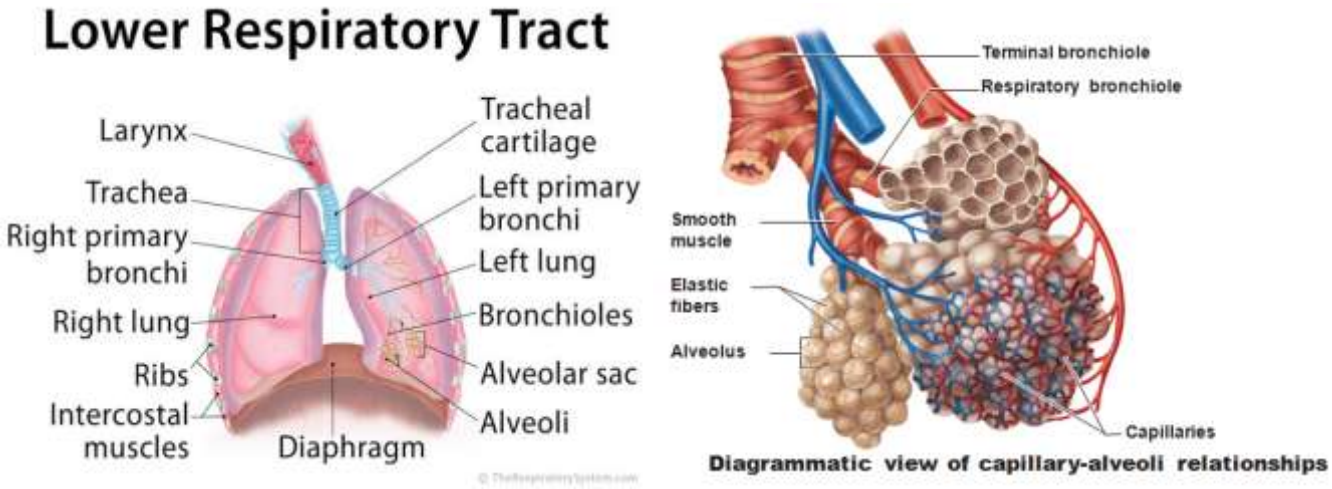
1) It has receptors for smell.
2) The inspired air is humidified and warms incoming air by blood capillaries lining of the nose.
3) The nose hairs help filter large particles from larger foreign material. Turbulent air flow cause precipitation of particles as the get contact with the mucous layer.
4) The sneeze reflex is initiated by irritation of the nasal passages and helps clear nasal passages and be expired. Think why breathing through mouth is not preferred

- Pharynx:

1) It is common pathway for respiratory and digestive system. The epiglottis act as a barrier between the pharynx and the larynx. When food or liquids are swallowed, the epiglottis seals the larynx and prevents aspiration of food and liquid into the lower airway (trachea).
2) The pharynx acts as a resonating chamber for the sound produced in the larynx .

- Larynx: Chambers for voice

Functions OF Lower Respiratory Tract (LRT):



- Tracheobronchial tree connect between the larynx and the alveoli.
- It starts with trachea which ends at branching points into left and right bronchi (main bronchi then they give sub divisions bronchioles which ends terminal bronchioles then respiratory bronchiole, alveolar duct and alveolar sac **Functional unit of respiration**.

- Functions of LRT:

A- Trachea:

1-The elasticity of the trachea allows the bronchial tree to lengthen & shorten with distention and collapse of the lung respectively.

2- The air while passing into the trachea is warmed and humidified.

3- The goblet cells lining the airways secrets mucus which trap the inspired particles.

B- Bronchi and bronchioles (no cartilage): They transmit air into alveoli.

C. Alveoli: They are the functional component of the lung where gas exchange occurs.

Respiratory Pressures

1- Pleural Pressure: It is the pressure in the narrow space between the lung pleura and the chest wall pleura (*the **pleural cavity,** normally contains < 10 mL of fluid. In some disease states, fluid accumulates in the pleural cavity, forming a **pleural effusion.***)

- It is a slight –ve pressure.
- Normal Values: At Rest: -3 -4 mmHg
- Normal inspiration: -6 -8mmHg. •Normal expiration: -2 mmHg.

Functions of pleural pressure :

1- Help respiratory movements.

2- It is required on the outside of the lungs to keep the lungs expanded and remain in contact with the chest wall.

3- Responsible for dome shape of the diaphragm.

4- Helps venous return of blood to heart and helps lymph flow.

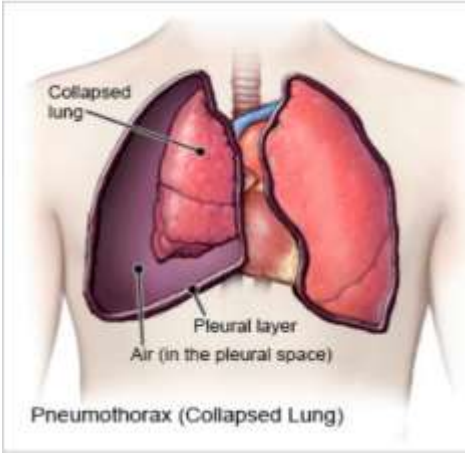
Think : What will occur if the –ve pleural pressure is lost?

2- Alveolar Pressure (Intrapulmonary Pressure): It is the pressure inside the lung alveoli. At rest, It equals 0

3-Tran pulmonary Pressure: It is the pressure difference between the alveolar pressure and the pleural pressure. Trans pulmonary = Intrapulmonary pressure – intra pleural pressure.

Pneumothorax

Def.: It is a collection of air in the intapleural space outside the lung that causes the lung to collapse.



1-Spontaneous Pneumothorax: occurs in the absence of a traumatic injury to the chest or a known lung disease. It is caused by a rupture of a cyst or a small sac (bleb) on the surface of the lung (mostly congenital). It is most common in men between the ages of 20 and 40,

particularly in tall, thin men. Smoking has been shown to increase the risk for spontaneous pneumothorax.

2-Secondary pneumothorax (Complicated): is as a result of an underlying lung condition such as a tumour or, infection. In these cases, the lung are broken down leading to air entering the intrapleural space.

3-Traumatic pneumothorax: is caused by trauma to the chest wall, for example following a stabbing to the chest. Air may enter the intrapleural space either from the atmosphere through a hole in the chest wall.

Tension pneumothorax: In the majority of cases, gas flow stops when the pressure in the intrapleural space reaches atmospheric. Very rarely, the pressure within the intrapleural space continues to rise above atmospheric. This is usually because the defect in the lung wall behaves like a valve, allowing gas to enter the intrapleural space without allowing it to leave. A tension pneumothorax is a **medical emergency**.

Effects of Pneumothorax

1- Collapse of the lung. 2-Loss of the dome shape of the diaphragm.

3- Shift of the mediastinum toward the normal side.

4-Decrease the venous return & lymph flow. 5- Cardiac and pulmonary abnormalities

Mechanism of Breathing:

Air movement during both inspiration and expiration ***requires the creation of a pressure gradient between the atmospheric pressure and the inrta-thorasic pressure***

In quiet breathing, inspiration is the **only active part of breathing.**

1- The diaphragm is the most important muscle for inspiration

A- Normal breathing uses diaphragm for inspiration.

- ✓ During inspiration: Diaphragm contract (flattens) leading to increase the volume of the thorax. When the diaphragm contracts, the abdominal contents are pushed downward, and the ribs are lifted upward and outward.

- ✓ So the changes are:(1) by downward or upward movement of the diaphragm to lengthen or shorten the chest cavity; and (2) by elevation or depression of the ribs to increase or decrease the anteroposterior diameter of the chest cavity.
- ✓ These changes produce an increase in intrathoracic volume, which lowers intrathoracic pressure and initiates the flow of air into the lungs.
- ✓ Then, **during expiration**, the diaphragm simply relaxes, and the elastic recoil of the lungs, chest wall, and abdominal structures compresses the lungs and expels the air.
- ✓ ***So, normal quiet breathing is accomplished almost entirely by movement of the diaphragm***.

During exercise, when breathing frequency and tidal volume increase, so extra force is achieved mainly by contraction of the external intercostals muscles, abdominal musccle and accessory muscles.

Steps of inspiration:

1- The diaphragm contracts. 2- So, the intra thoracic pressure drops causes the lung to expand by pulling the lungs toward the abdominal cavity.

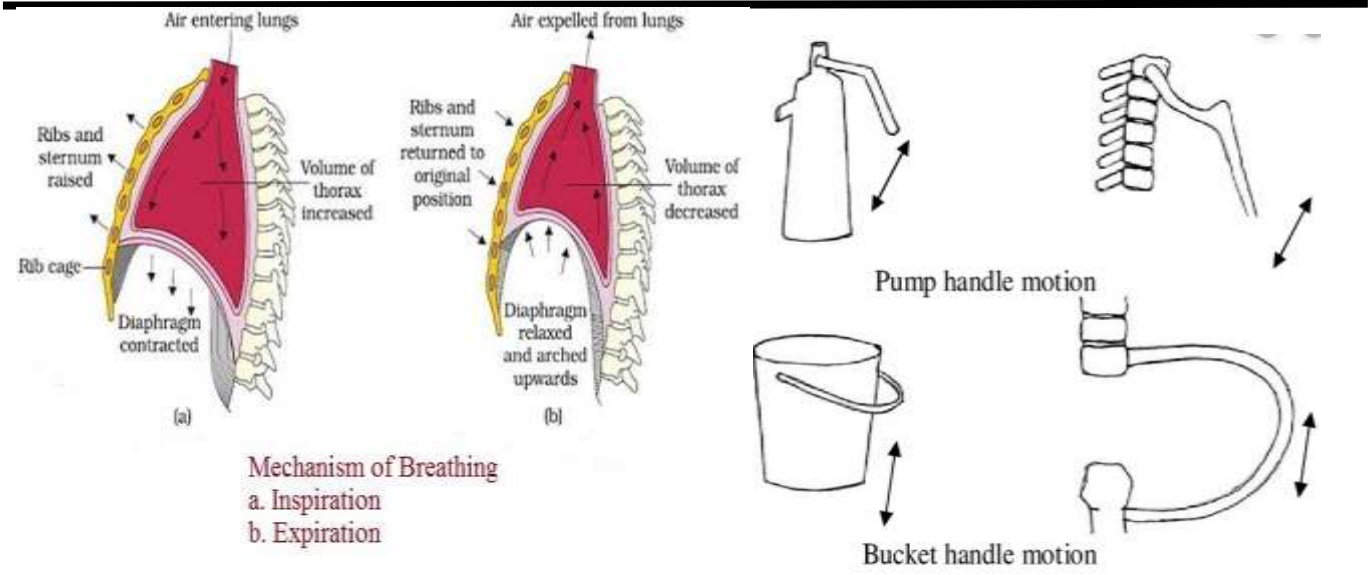
3- Then, the chest expands, and the alveoli stretched, so the pressure in the alveoli becomes low. 4- Finally, air is thus sucked into the lungs.

N.B. The external inter costal muscles: (N.B. <u>they act during heavy breathing associated with exercise as well as diseases characterized by excessive respiratory effort</u>.

These muscles cause two types of movement during inspiration:

1. 'Pump-handle' movements, in which the anterior end of each rib is elevated like the action of an old-fashioned water pump.

2.' Bucket-handle movements, in which the diameter of the chest increases, each rib on either side acting like the raising of the handle of a bucket from the horizontal position.



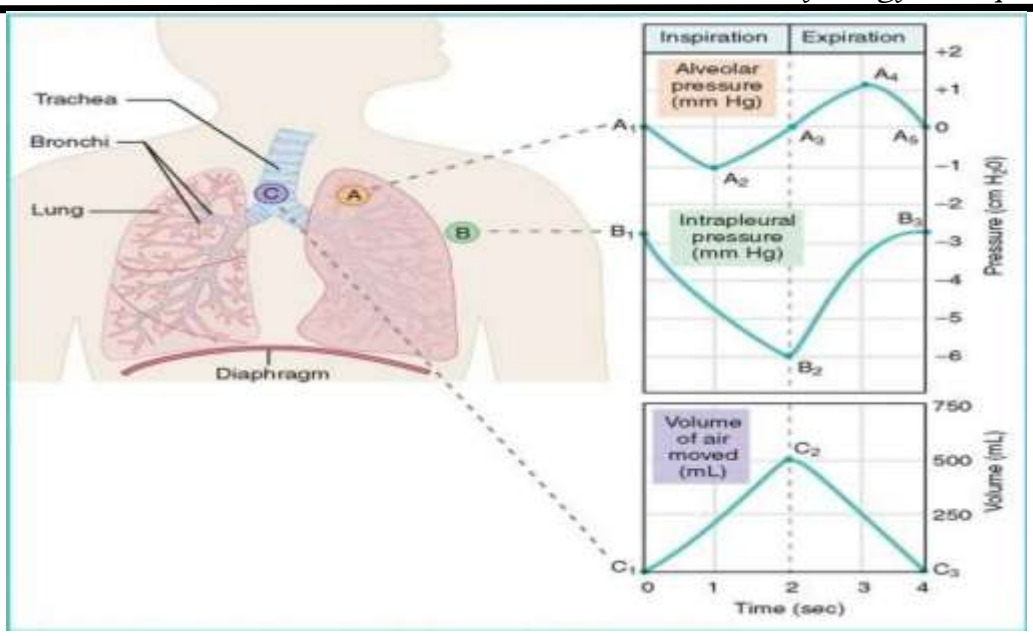
Expiration at rest is a rather "**passive"** process and relies on the elastic recoil of the lung and thoracic wall to reduce the size, increase the pressure in the lung ("intrapulmonic"), and force the air out. **Expiratory muscles can contract actively** during high rates of breathing (e.g exercise) or if the airways are obstructed by disease.

Changes of respiratory pressures during the respirator cycle

1- During inspiration, intrepleural pressure decreases due to expansion of the thoracic cage.

2- Lung expansion causes alveolar pressure to become negative relative to the atmosphere, air enters the lungs. Inspiration stops when the entering air causes alveolar pressure to rise to be equal to the atmospheric pressure.

3- During expiration, the cycle is reversed, with decrease in lung size causing an increase in alveolar pressure. As air flows out of the lungs, alveolar pressure returns to atmospheric pressure so the respiratory cycle is stopped and then restarts again.



Non respiratory functions of the respiratory system

1- Defense: The blood filtering function of the lungs, protecting the vulnerable cerebral and coronary circulations.

a- Humidification, cooling or warming of the inspired air.

b- The hair in the nostrils help in particle expulsion (coughing, sneezing),

c- Bronchial secretion of immunoglobulins and lysozymes that help in resistance of infection.

d- Pulmonary alveolar macrophages: are phagocytic.

e-Secretion of mucus by goblet cells and mucus glands helps to trap the foreign particles.

2- Behavior: Changes in patterns of breathing can signal emotion, and above all we use our respiratory system to power speech and vocalization.

3 - Metabolism of circulating biologically active substances:

The lungs are ideally situated to rapidly control levels of substances circulating in the blood. They remove or degrade substances whose effects need to be rapidly terminated once they have carried out their function: noradrenaline, ATP, ADP, Bradykinin 5HT, PGE 1 , PGE 2.

4- Anticoagulant Function: **Mast cells** in lungs secrete **heparin.** Heparin is an anticoagulant and it prevents the intravascular clotting.

5- Regulation Of Acid-Base Balance

Lungs play a role in maintenance of acid base balance of the body by regulating the carbon dioxide content and ph of the blood in blood (see next).

End of the lecture