Functions and organization of the respiratory system

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Learning Objectives

- **By the end of this lecture you will be able to:-**

1-Describe the structures and functions of the conductive and respiratory zones of airways.

2-Distinguish the difference between internal and external respiration.

3-Discuss the functions of the respiratory system, including non-respiratory functions, like clearance mechanism by mucus and cilia, production of surfactant and its physiological significance.

Functions of the respiratory system

- Gas exchange (respiratory function).
- Phonation: is the production of sounds by the movement of air through the vocal cords.
- Pulmonary defense: the respiratory mucus membrane has muco-cilliary barrier filter and it produces:

1. Immunoglobulin A (Ig A).
2. Alpha-1 antitrypsin: protects the lung from the action of trypsin.

In addition, the pulmonary macrophages in the alveoli: engulf smaller foreign particles which pass through the muco-cilliary barrier filter.

Cont..functions of the respiratory system

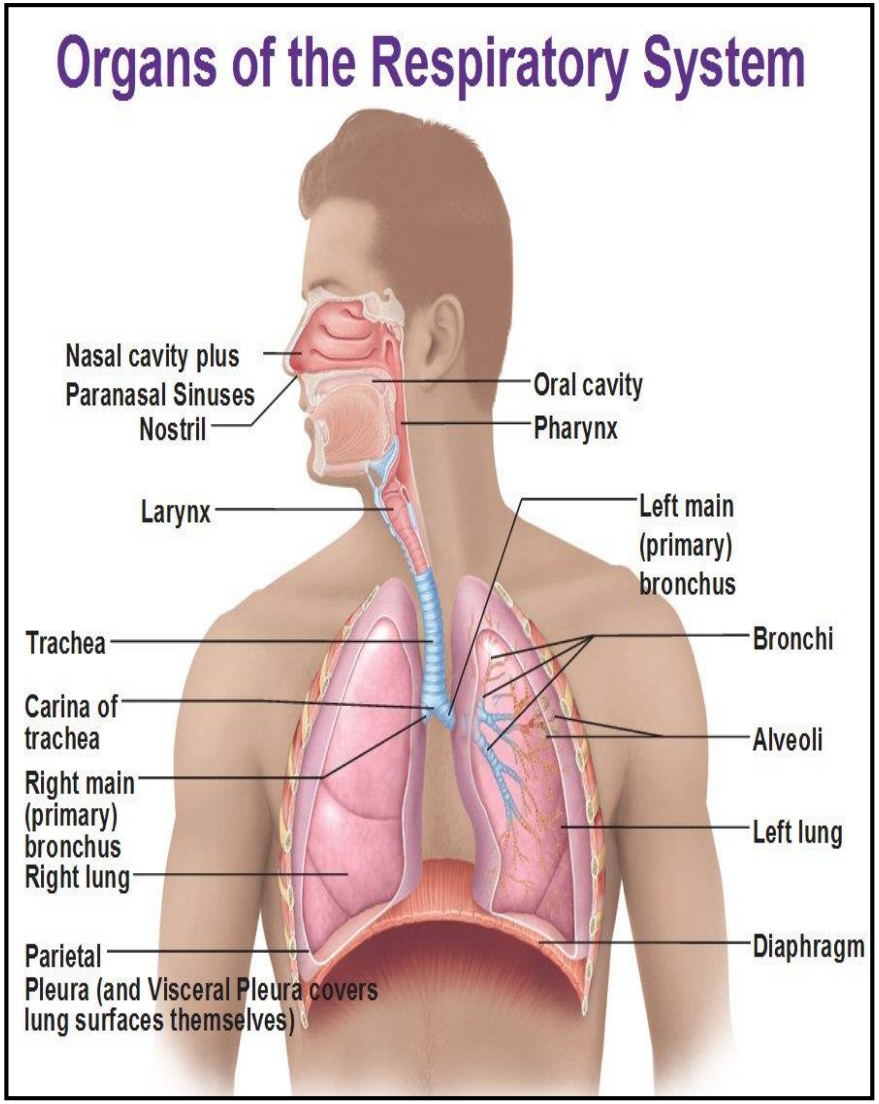
- Angiotensin I is converted to angiotensin II with the help of angiotensin converting enzyme formed by the lungs.
- Regulating the acid- base status of the body by washing out extra carbon dioxide from the blood.
- Secretion of important substances like surfactant**.**

The main function of respiration is to:

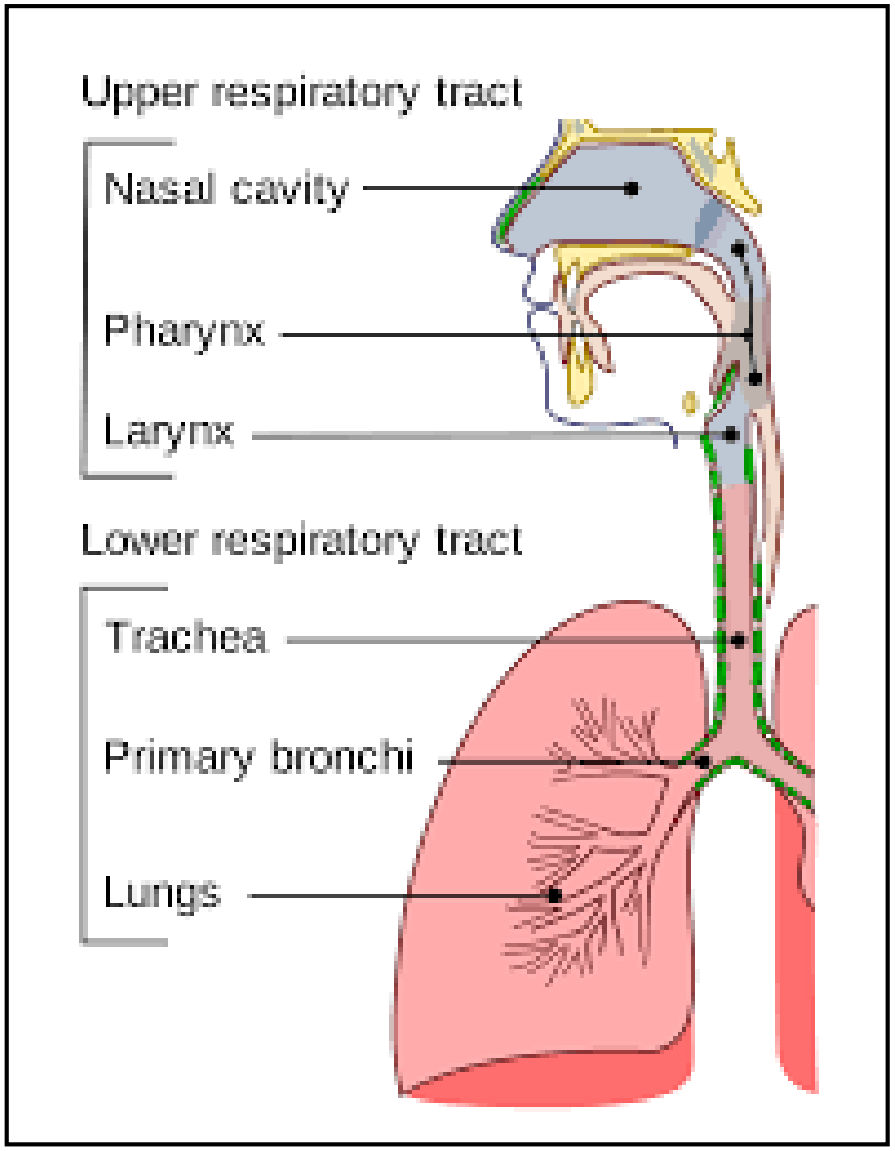
1-Provide oxygen to tissues.

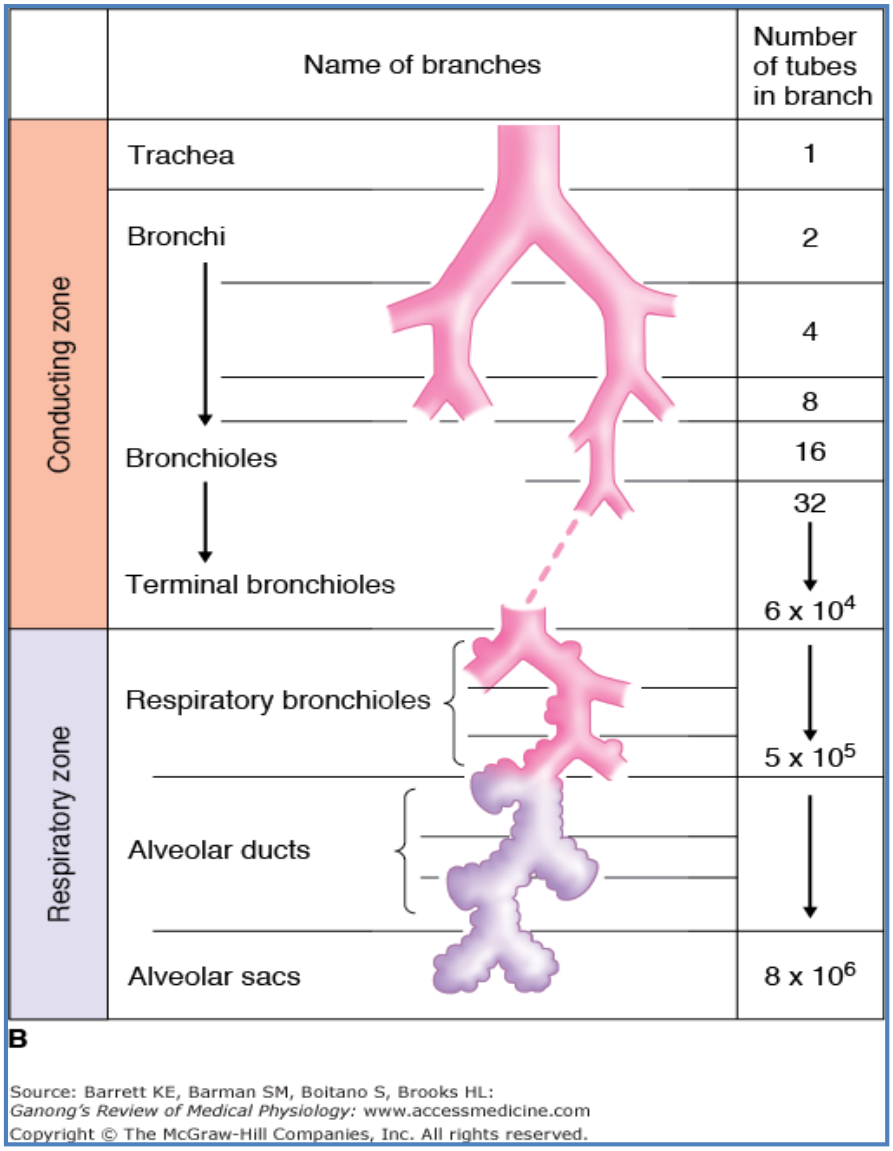
2- Remove CO_2 from the body.

- Respiratory system can be divided anatomically to :
  1. passages (airways).
  2. muscles.
  3. centers.



Organization of respiratory system





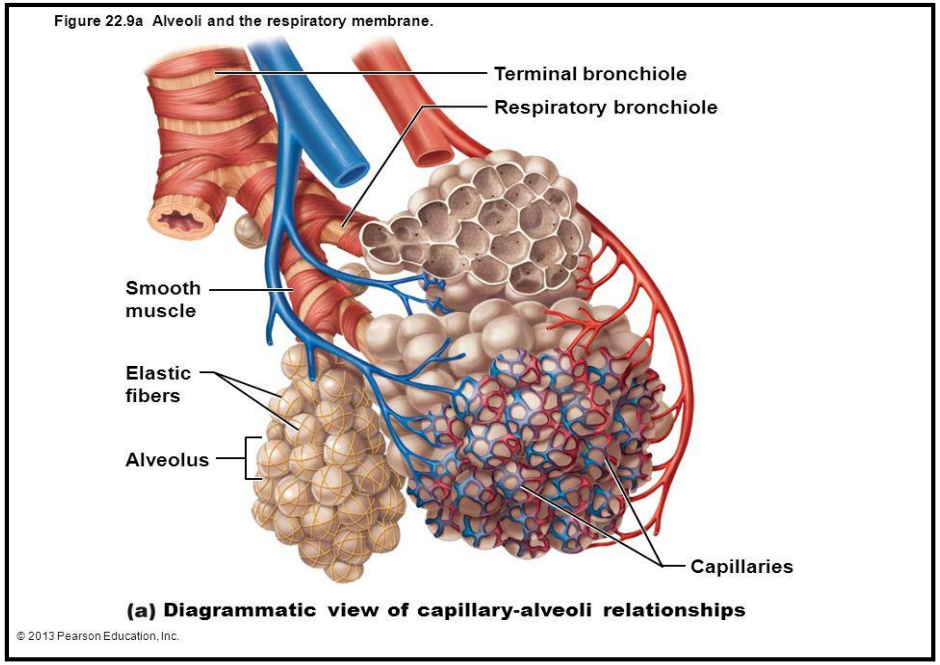
I- Conductive Zone (No gas exchange)

- Starts from nose to the end of terminal bronchioles.
- Helps: warming, humidification, filtration of inspired air.
- Contains the olfactory receptors for smell sensation.
- Conducts the sound during speech.
- Protective function by cough and sneezing reflexes.

II- Respiratory Zone (Respiratory unit)

- Includes:

  Respiratory bronchioles, alveolar ducts, alveolar sacs, alveoli
- Function: gas exchange.



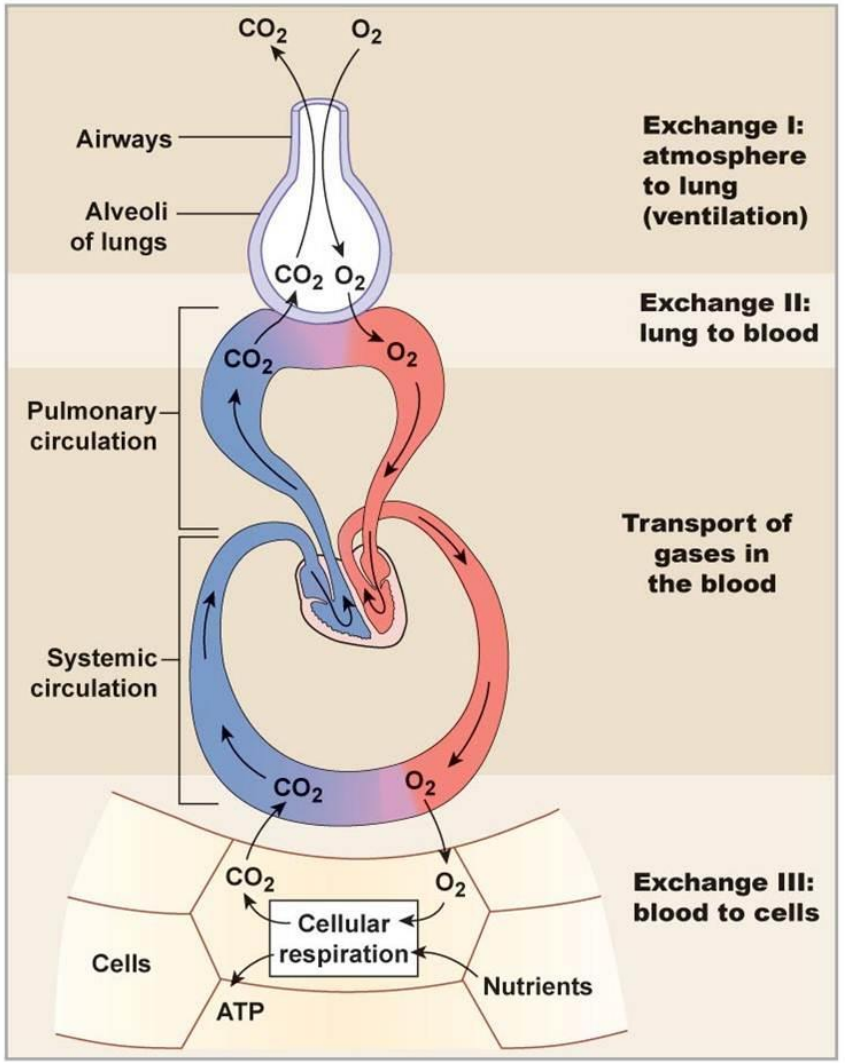
External and Internal Respiration

External respiration:

The absorption of O2 and removal of CO2 from the body as a whole.

Internal Respiration:

The utilization of O2 and production of CO2 by the cells.



Respiration

4 major functional events occur during it:

(1) Pulmonary ventilation.

(2) Diffusion of (O2) and(CO2) between the alveoli and the blood.

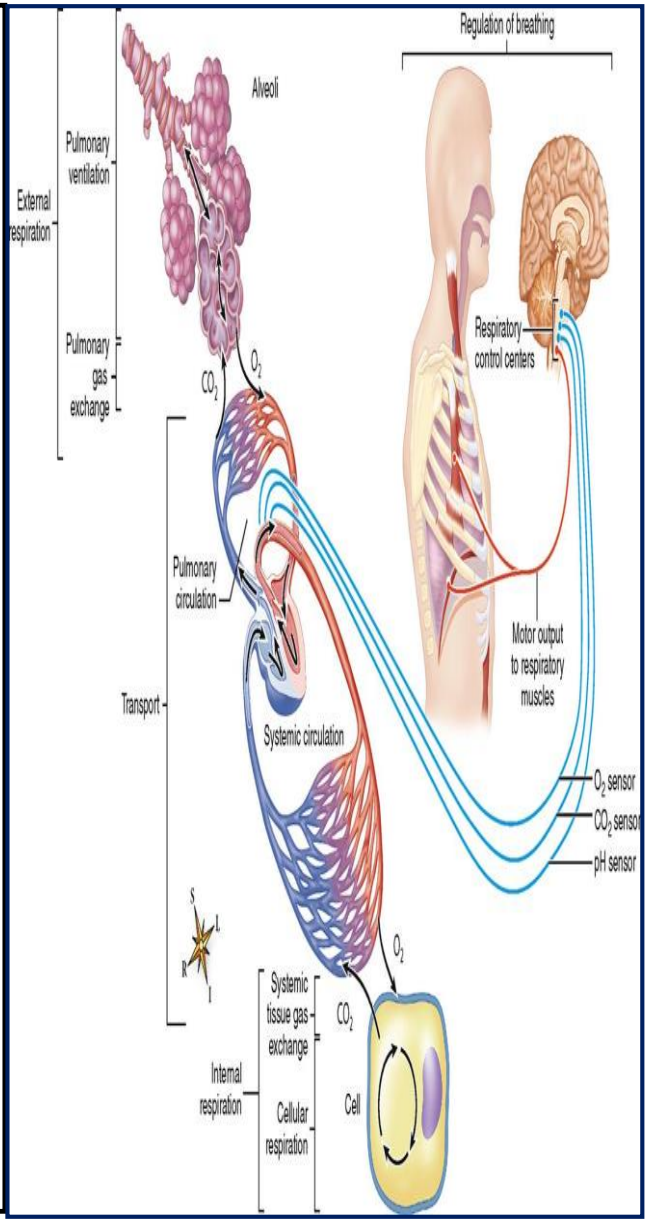
(3) Transport of Oxygen and carbon dioxide in the blood and body fluids to and from the body's tissue cells.

(4) Regulation of ventilation.

<u>Respiration (breathing) could be either:</u>

***Resting breathing*:** normal breathing during resting conditions.

Forced (maximal) breathing: *It occur* during exercise and in patients with bronchial asthma, allergy, other pulmonary diseases.



Lining cells of the alveoli

1- Type I alveolar epithelial cells

(type I pneumocytes)

*Participate in the respiratory membrane , across which gas exchange takes place.

2- Type II alveolar epithelial cells

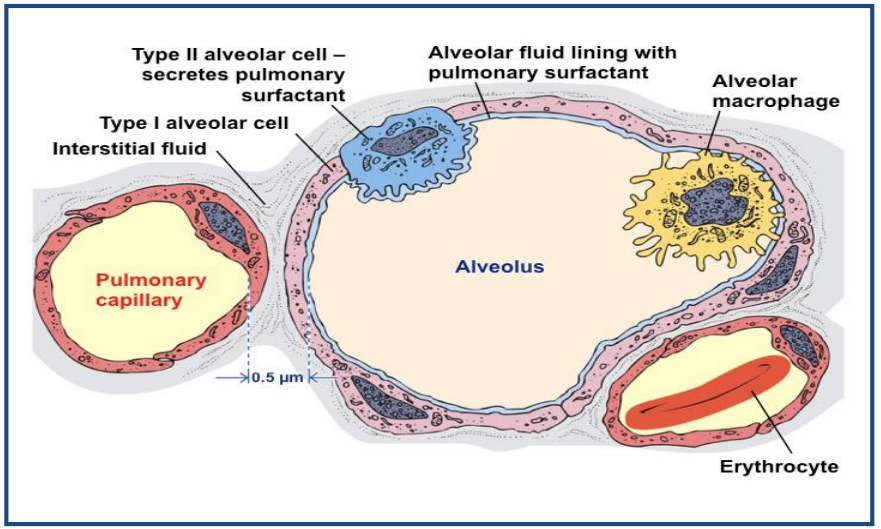
(type II pneumocytes) (10% of the surface area of alveoli)

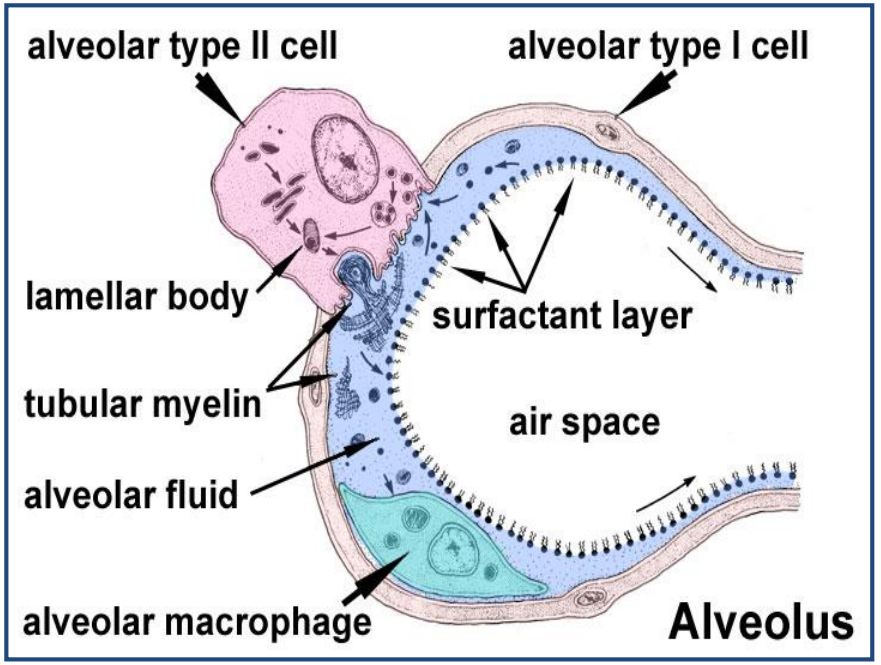
*Secrete surfactant.

3- Alveolar macrophages

*Engulf the foreign bodies

that reach the alveoli.





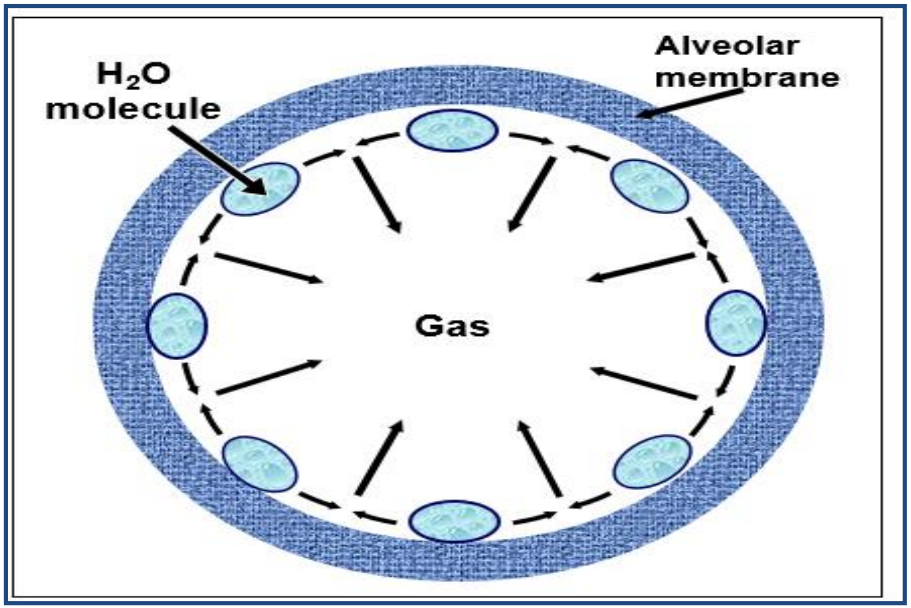
Surface Tension

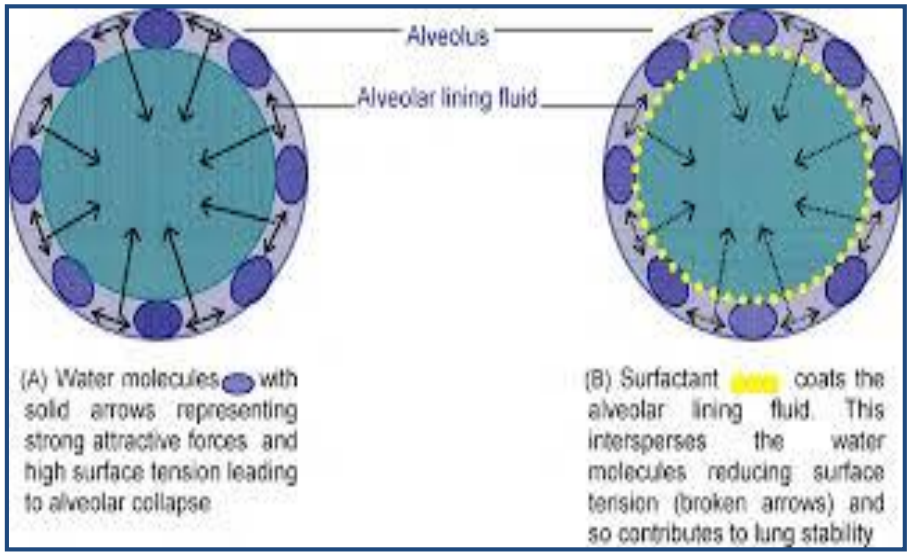
H_2O molecules at the surface of alveoli are attracted to each other by attractive forces that resist distension called: surface tension.

- Surface tension tends to oppose alveoli expansion.
- Pulmonary surfactant reduces the surface tension of the fluid lining the alveoli.
- Collapsing Pressure is Caused by Surface Tension and is indirectly related to the size of alveoli

(law of LaPlace)

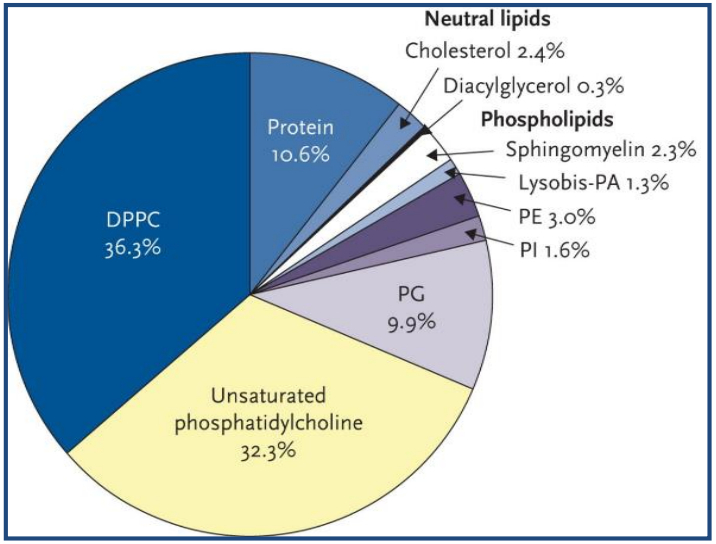
$$\text{Pressure} = \frac{2 \times \text{Surface tension}}{\text{Radius of alveolus}}$$

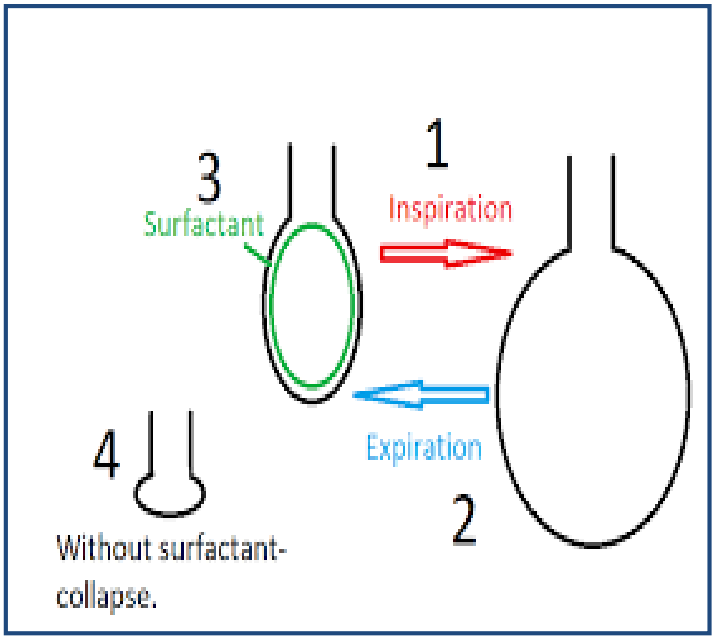




Surfactant

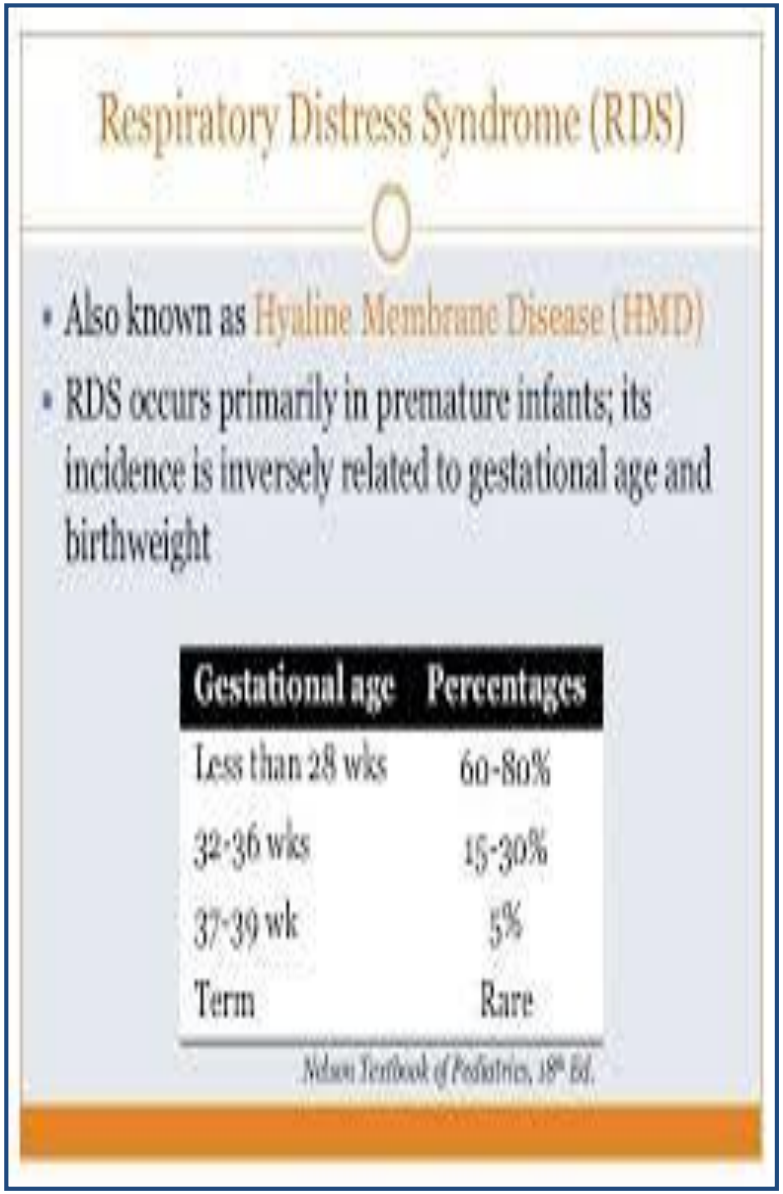
- Surfactant is a complex compound containing phospholipids especially dipalmitoylphosphatidyl choline and a number of Apo proteins.
- The earliest detection of surfactant from fetal alveoli begins between 6-7th month but this could be delayed in others to wk 35 of intrauterine life.
- Surfactant **reduces surface tension** throughout the lung, **reducing the effort required** by the respiratory muscles to expand the lungs, **prevents alveolar collapse**, **decreases airway resistance** and **decreases work of breathing.**





Surfactant deficiency

- Deficiency in premature babies causes respiratory distress syndrome of the new born (RDS) (hyaline membrane disease).
- Prevention: Corticosteroid injection to mothers expected to deliver prematurely. This will enhance surfactant maturation.
- After delivery they are given inhaled surfactant.
- Smoking in adults, hypoxia or hypoxemia, decrease the secretion of surfactant and cause adult respiratory distress syndrome.



Innervations of lungs and bronchi

- By autonomic nerves.
- Sympathetic stimulation releases epinephrine (adrenaline) which causes dilatation of the bronchi.
- Parasympathetic stimulation releases acetyl choline which causes constriction of the bronchi.
- Locally secreted factors :histamine, slow reacting substances of anaphylaxis (SRSA) secreted by the mast cells due to allergy (as in patients with asthma) often cause bronchiolar constriction and increased airway resistance leading to forced breathing.
- The same irritants that cause parasympathetic constrictor reflexes of the airways—smoke, dust, sulfur dioxide, and some of the acidic elements in smog—may also act directly on the lung tissues to initiate local, non-nervous reactions that cause obstructive constriction of the airways.

Resistance to Airflow in the Bronchial Tree

- The greatest amount of resistance to airflow occurs in some of the larger bronchioles and bronchi near the trachea. The reason for this high resistance is that there are relatively few of these larger bronchi in comparison with the approximately 65,000 parallel terminal bronchioles,
- In some disease conditions, the smaller bronchioles play a far greater role in determining airflow resistance because of their small size and because they are easily occluded by :
- (1) Muscle contraction in their walls, (2) Edema occurring in the walls, or (3) Mucus collecting in the lumens of the bronchioles.

Airway resistance decreases as lung volume increases