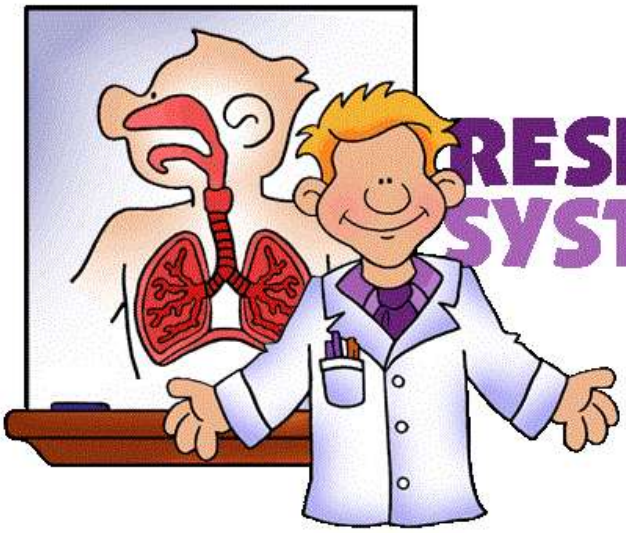
Physiology Team 432



1th Lecture

Functional organization of respiratory system

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1434- 2013

RESPIRATORY SYSTEM

The main goal of respiration:

- Provide O2 to tissues.
- Remove CO2.

Respiratory system consist of:

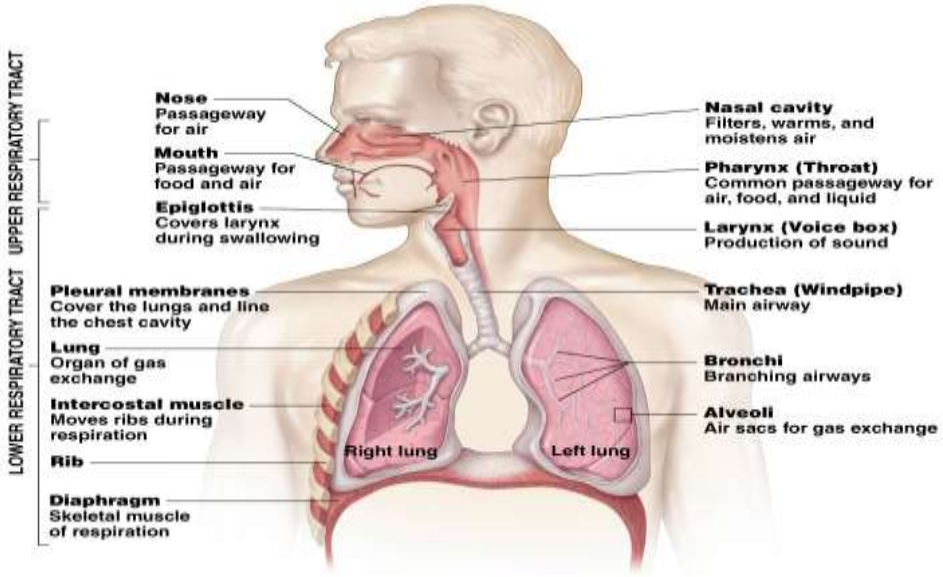
- Passages (airways). → **Conducting**
- muscles.
- centers. → **Respiratory unit** or respiratory zone or acinus

Upper respiratory tract :

- Nose
- Pharynx and associated structures

Lower respiratory tract :

- ❑ Larynx
- ❑ Trachea
- ❑ Bronchi
- ❑ Lungs



*Function of the respiratory system includes:

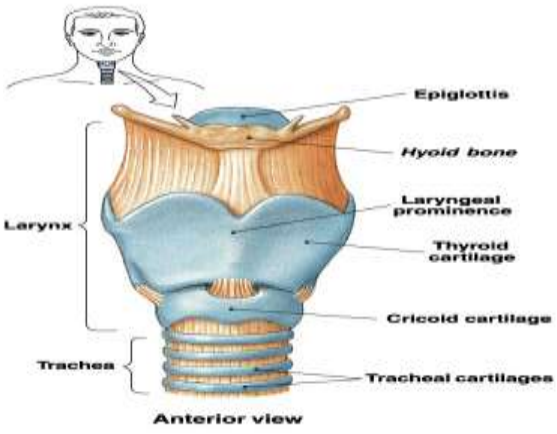
Respiratory	Non-Respiratory
Gas exchange (respiratory function).	Angiotensin I is converted to angiotensin II with the help of converting enzymes formed by the lungs
Phonation: is the production of sounds by the movement of air through the vocal cords.	Regulating the acid- base status (pH) of the Body by washing out extra carbon dioxide from the blood.
Pulmonary defense: - Immunoglobulin A (IgA) , - Alpha-1 antitrypsin - The pulmonary macrophages - in the alveoli	Secretion of important substances like surfactant.
Alveolar macrophages; specific in lungs: Engulf smaller particles, which pass through the muco-cilliary barrier filter	NOTE: Angiotensin is an oligo peptide that causes vasoconstriction and high BP.

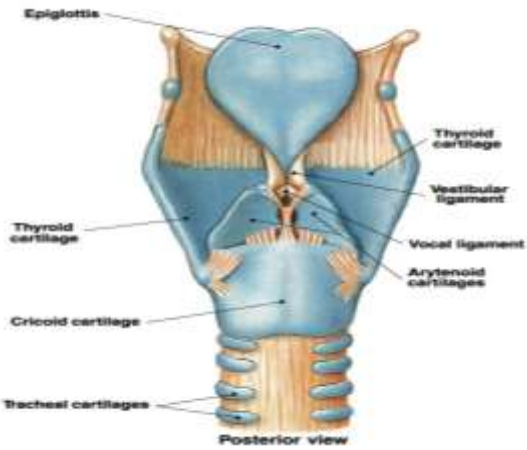
FUNCTIONS OF UPPER RESPIRATORY TRACT :

- **Nose :-**
  - Functions :
    - Passageway for air .
    - Cleans the air .
    - Humidifies, warms air .
    - Smell .
    - Along with paranasal sinuses are resonating chambers for speech .
- **Pharynx :-**
  - Functions :
    - Common opening for digestive and respiratory systems .

FUNCTION OF LOWER RESPIRATORY TRACT:

- **Larynx :-**
  - Functions :
    - Maintain an open passageway for air movement .
    - Epiglottis and vestibular folds prevent swallowed material from moving into larynx .
    - Vocal folds are primary source of sound production .





Respiratory passages (airways)

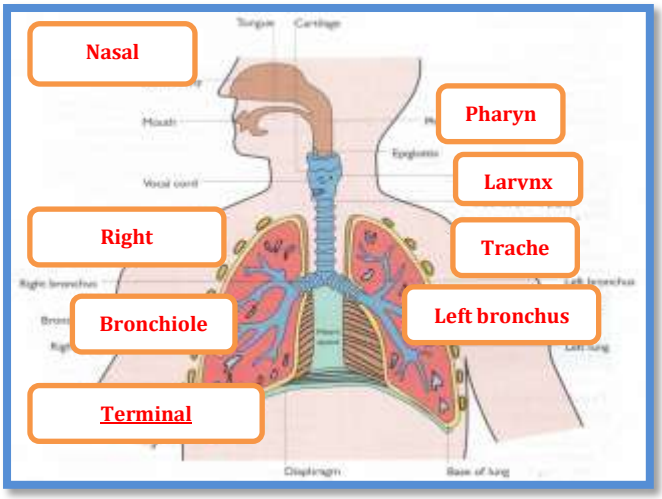
Respiratory passages (airways)

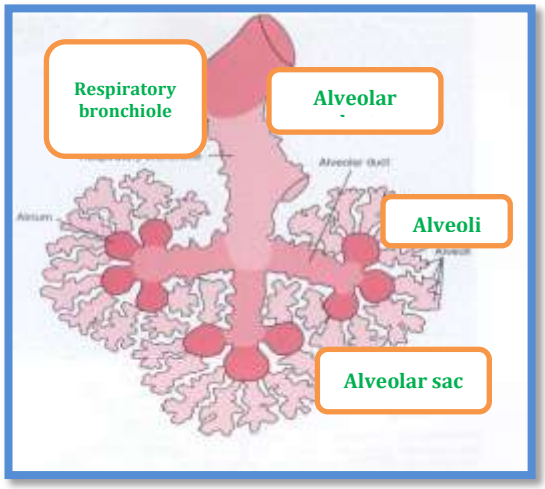
conducting zone

Starts from: Nose to the end of terminal bronchioles.

respiratory zone or respiratory unit or acinus

Includes: Respiratory bronchioles, alveolar ducts, alveolar sacs, alveoli.



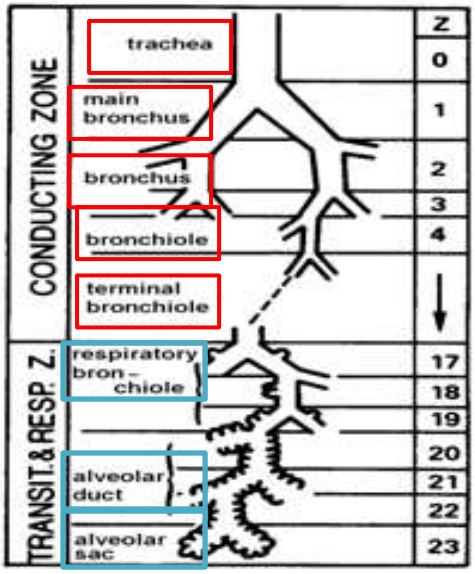


Functions

- Help warming, humidification, filtration of inspired air.
- Contains the olfactory receptors for smell sensation (phonation).
- Conducts the sound during speech.
- Protective function by cough & sneezing reflexes.

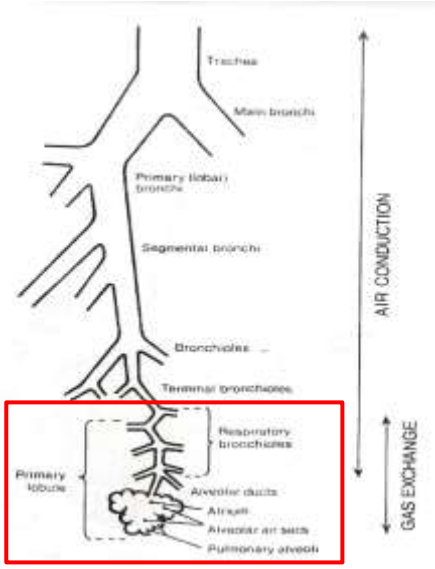
- Gas exchange.

ZONES OF THE RESPIRATORY TRACT



Conductive zone :
- Trachea
- Main bronchus
- Bronchiole
- terminal bronchiole

Respiratory zone :
- Respiratory bronchiole
- Alveolar duct
- Alveolar sac
- Alveoli



Functions of respiratory system as general include :

- Gas exchange (respiratory function)
- Phonation: is the production of sounds by the movement of air through the vocal cords.
- Pulmonary defense

  -Immunoglobulin A (IgA) ,

  -Alpha-1 antitrypsin

  -The pulmonary macrophages in the alveoli: engulf smaller particles which pass through the muco-cilliarybarrier filter.
- Angiotensin I is converted to angiotensin II with the help of converting enzymes 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 .

DEAD SPACE

Part s of the respiratory tract not participating in gas exchange

- **Anatomical dead-space:** Tracheo-bronchial tree down to respiratory bronchioles.
  Normally 2ml/kg or 150ml in an adult, roughly a third of the tidal volume.
- **Alveolar Dead Space:** Non perfused alveoli
- **Physiologic Dead Space:** Anatomical + Alveolar

TYPES OF RESPIRATORY PROCESS

- **Breathing (ventilation):** Air in to and out of lungs
- **External respiration:** Gas exchange between lungs and blood
- **Internal respiration:** Gas exchange between blood and body cells /tissues
- **Cellular respiration:** Oxygen use to produce ATP, carbon dioxide as waste.

Cellular respiration of glucose is carried out in three stages.

1. Glycolysis, 2. Oxidation of pyruvate, 3. citric acid cycle

The term cellular respiration refers to the biochemical pathway by which cells release energy from food molecules and provide that energy for essential processes of life.

EXTERNAL RESPIRATION

Superior & inferior vena cava take the deoxygenated blood from the tissue & enter into the right atrium to the right ventricle.
Right ventricle pumps the deoxygenated blood to the pulmonary capillaries.
Then the pulmonary vein carries the oxygenated blood to the left ventricle of the heart.

INTERNAL RESPIRATION

-Left ventricle pump the oxygenated blood by aorta artery, then the blood reach the systemic capillaries.
- The O2 diffuse from the systemic capillaries to the tissues & the CO2 diffuse from the tissues to the systemic capillaries.

EXTERNAL EXCHANGE: gas exchange of the level of ALVEOLI & PULMONARY CAPILLARIES.
INTERNAL EXCHANGE: gas exchange between SYSTEMIC CAPILLARIES & the TISSUES.

External respiration:

3 major functional events occur during it:

-Pulmonary ventilation: inward and outward movement of air between lung and atmosphere.
- Diffusion of oxygen and CO2 between the Alveoli and the pulmonary capillary blood
- Transport of O2 & Co2 in the blood and body fluids to and from the cells
{External respiration ends when O2 reaches tissue}.

RESPIRATION COULD BE EITHER:

- RESTING: NORMAL BREATHING DURING RESTING CONDITIONS.
- FORCED (MAXIMAL): DURING EXERCISE, IN PATIENTS WITH ASTHMA, ALLERGY.

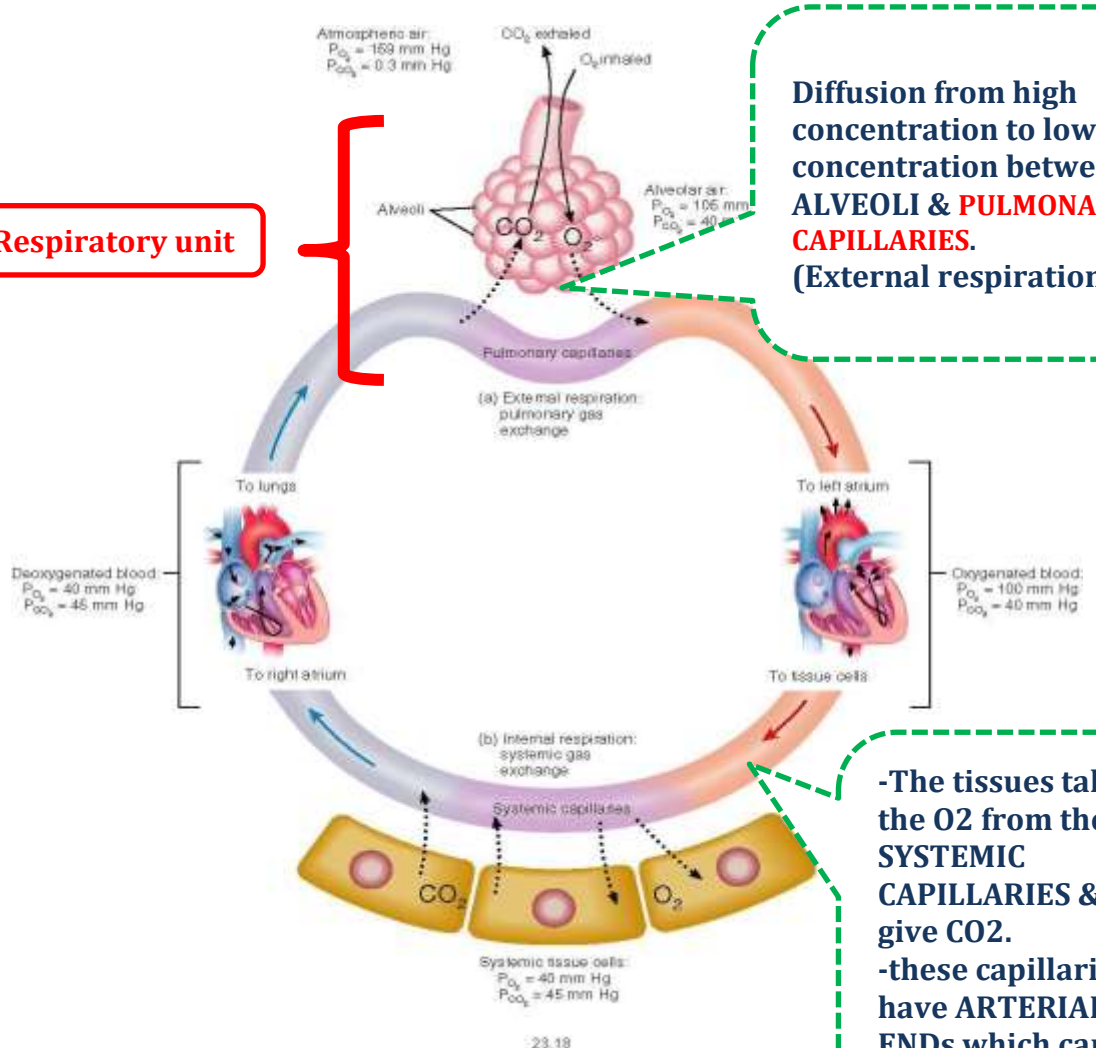
NOTES:

- Pulmonary artery carries venous blood (CO2) from the right side of the heart.
- After this artery takes O2 from lungs, it becomes pulmonary vein and goes to the left side of the heart.

Right

Left

Respiratory unit

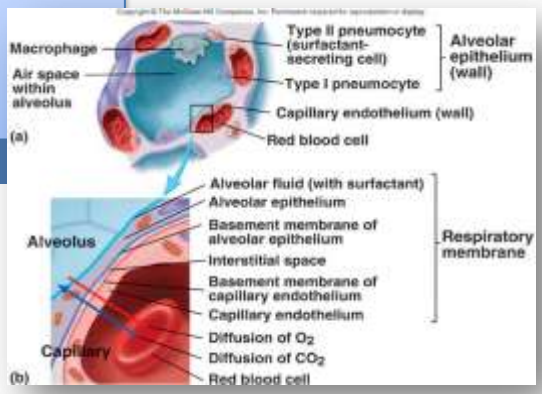


Diffusion from high concentration to low concentration between ALVEOLI & PULMONARY CAPILLARIES. (External respiration)

-The tissues take the O2 from the SYSTEMIC CAPILLARIES & give CO2.
-these capillaries have ARTERIAL ENDs which carry the oxygenated

Lining cells of the alveoli :

1-Type I alveolar cells (type I pneumocytes)	2-Type II alveolar cells (type II pneumocytes) (Secrete surfactant)	3-Alveolar macrophages



surfactant

Surfactant is the complex mixture of several phospholipids, proteins, and ions. The important components of which are phospholipids, dipalmitoyl lecithin, surfactant apoproteins, and calcium ions.

Surfactant is secreted by type II alveolar epethelial cells .

These cells comprise 10% of surface area of the alveoli .

Surfactant is a surface active agent, decreases surface tension .

It reduces surface tension throughout the lung , prevents alveolar collapse, decreases airway resistance and the work of breathing .

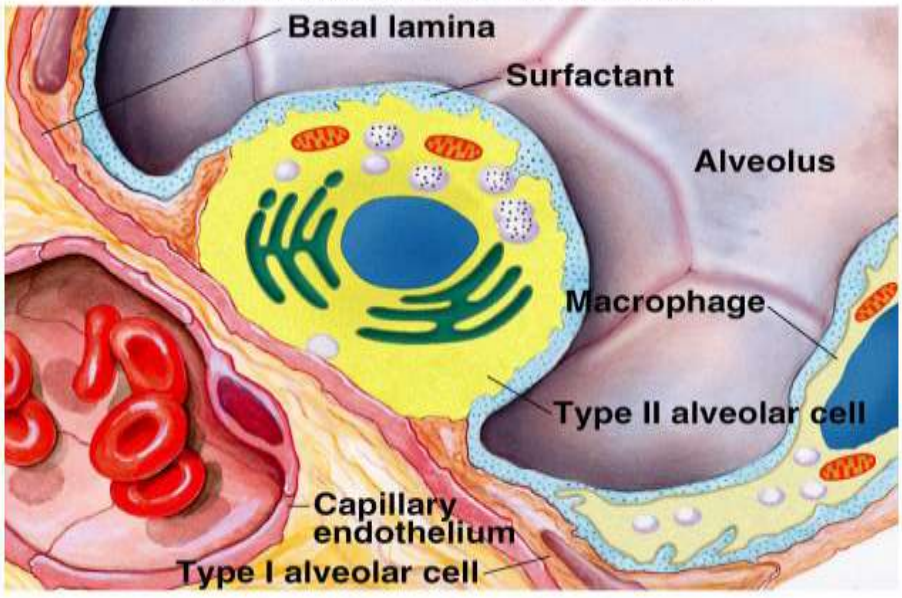
Component	% Composition
Phosphatidyl choline	62
Phosphatidyl glycine	05
Other phospholipids	10
Neutral lipids	13
Proteins	08
Carbohydrates	02

Type II alveolar epithelial cells start to from the surfactant during **7th month of intrauterine life**.

FUNCTIONS OF SURFACTANT

1- Prevents alveolar collapse.
2- Reduces the work of breathing, making respiration easier.
3- Keeps the alveoli dry. When surface tension force is higher, it sucks fluid into the alveolar spaces from the capillaries surrounding

- Surfactant decreases the surface tension
- Important for survival of premature infants
- When insufficient amounts of surfactant is present, the air and water (blood) surface tension becomes high and alveoli will collapse during expiration. This is called Respiratory Distress Syndrome [RDS] common cause of death in the premature infants
- This disease is therefore also known as hyaline membrane disease
- It has been suggested that surfactant have a bactericidal effect
- Factors increasing surfactant formation: Thyroxine and Glucocorticoids.



Explanation:

The walls of alveoli are coated with a thin film of water, H2O more attracted to each other than to air, and this attraction creates a force called surface tension. This surface tension increases as water molecules come closer together, and when it comes into contact with gases, which is what happens when we exhale & our alveoli become smaller. Surface tension could cause alveoli to collapse and, in addition, would make it more difficult to re-expand'. Fortunately, our alveoli do not collapse & inhalation is relatively easy because the lungs produce a substance called surfactant that reduces surface tension.

Deficiency of surfactant

- Deficiency in premature babies cause respiratory distress syndrome of the new born (RDS). (Hyaline membrane disease)

We give them Glucocorticoids because Glucocorticoids increase the maturation of the surfactant.

- Smoking in adult, Hypoxia or hypoxemia (low O2 in the arterial blood) or both, decrease the secretion of surfactant and cause adult respiratory distress syndrome.

We give them artificial

Innervations of lungs and bronchi

- **is by autonomic nerves**
- **Sympathetic causes dilatation of the bronchi.**
- **Parasympathetic causes constriction of the bronchi.**
- **Locally secreted factors :histamine, Slow reacting substances of anaphylaxis (SRSA) by Mast cells, Due to allergy often cause bronchiolar constriction and increase airway resistance.**