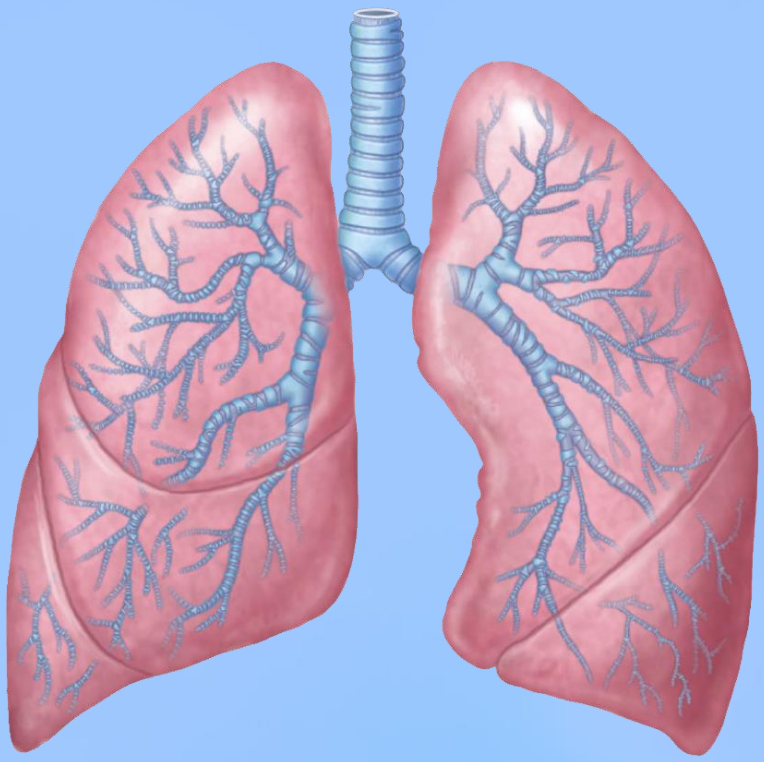
1 Functional organization of the respiratory system



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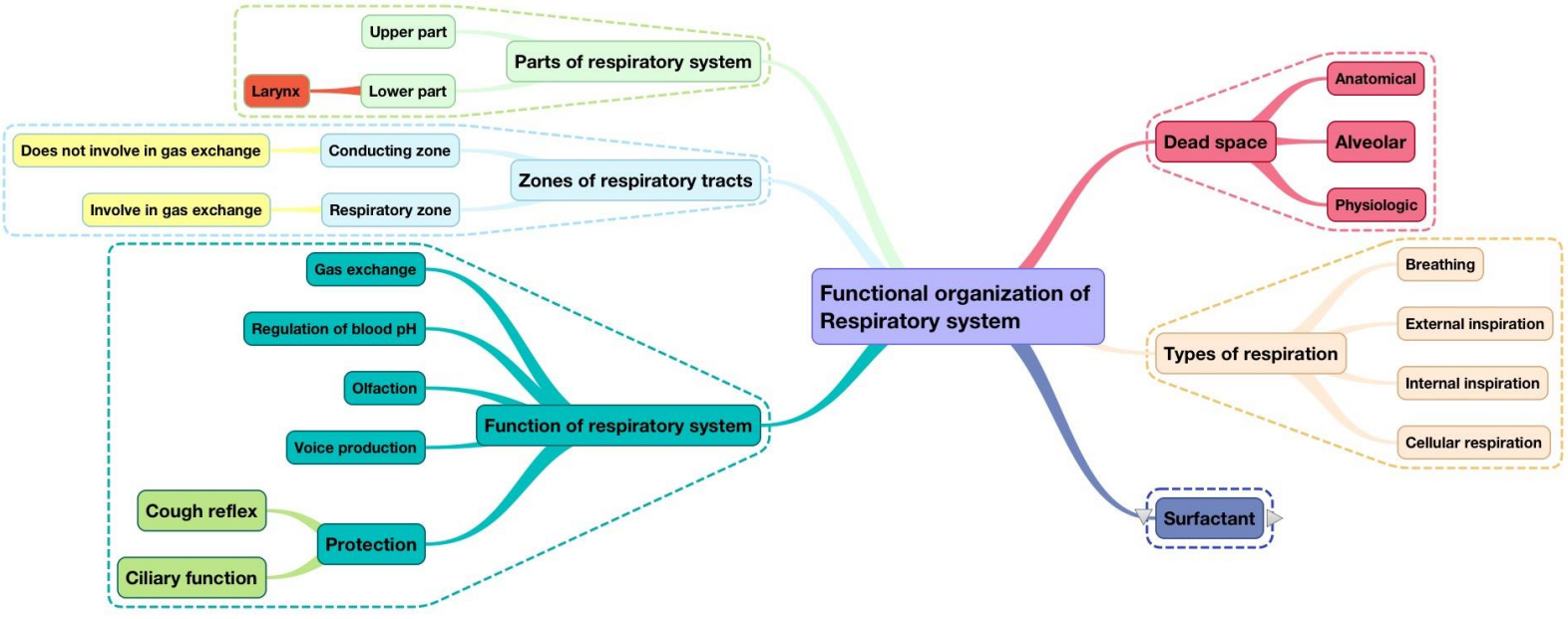
Respiratory Block

Objectives:

1. Structures and functions of the conductive and respiratory zones
2. Difference between internal and external respiration
3. Functions of the respiratory system, including non-respiratory functions, like clearance mechanism by mucus and cilia, production of surfactant

Mind Map:



Respiratory System

THE MAIN GOAL OF RESPIRATION

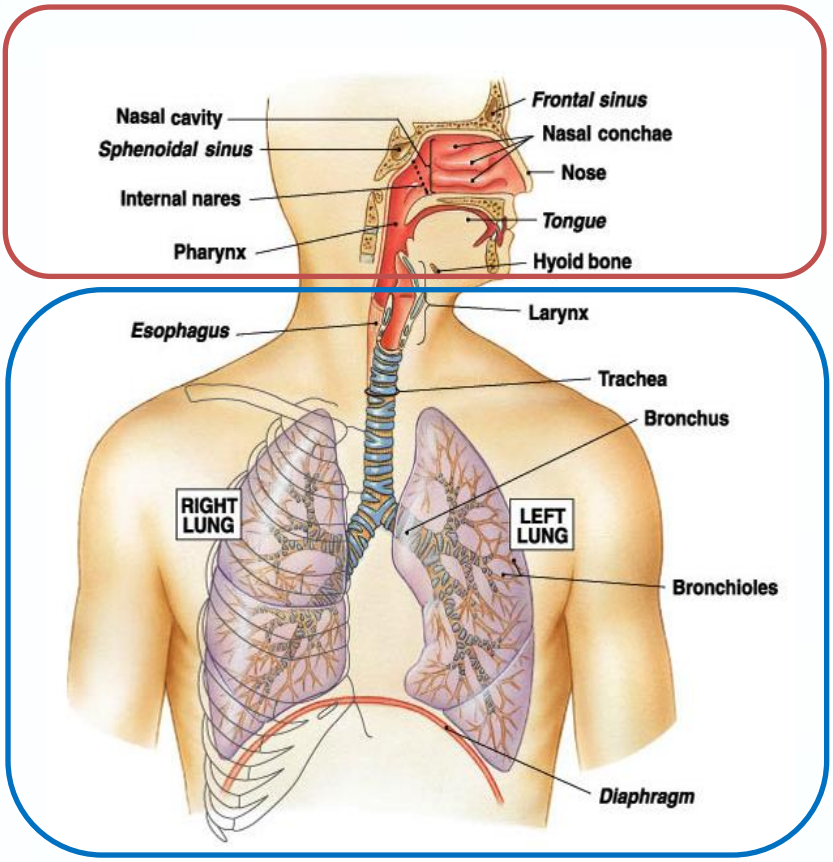
Provide oxygen (O_2) to tissues and Remove carbon dioxide (CO_2).

Upper respiratory tract

- Nose
- Pharynx and associated structers

Lower respiratory tract

- Larynx
- Trachea
- Bronchi
- Lungs



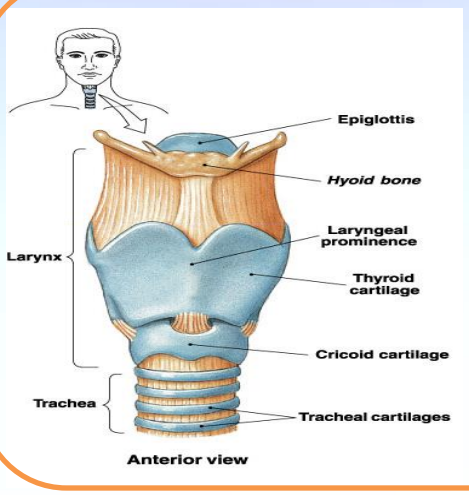
Function of respiratory system :

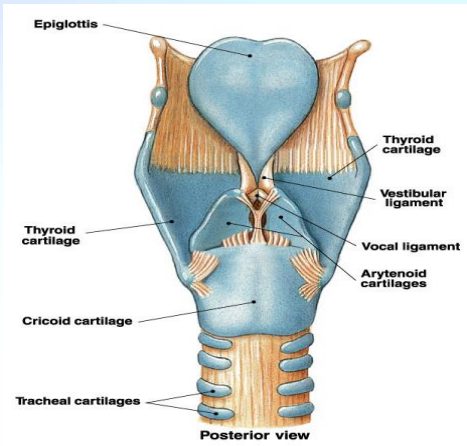
- Passageway for respiration
- Receptors for smell
- Filters foreign material
- Moistens and warms incoming air
- Resonating chambers for voice

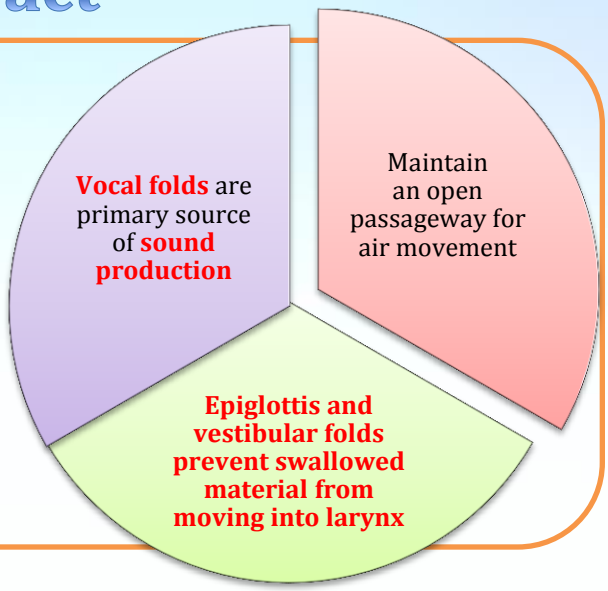
Non-respiratory function of lungs

- Secret Angiotension converting enzymes than convert Angeotension I to angeotension II
- Regulate PH of the body by washing out CO_2 from blood
- Secret Surfactant.

LARYNX "Part of lower tract"







ZONES OF THE RESPIRATORY TRACT

ZONES OF THE RESPIRATORY TRACT

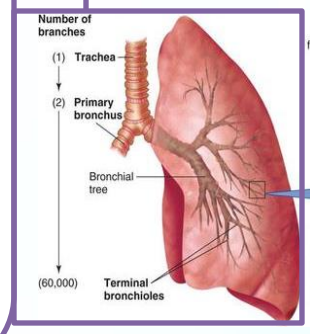
Conducting Zone

Starts from nose to the end of terminal bronchioles.

Component of Conduction zone:

1. Trachea
2. Main bronchus
3. Bronchus
4. Bronchioles
5. Terminal bronchioles
6. Olfactory receptors. (For small sensation)

Functions: conduct the sound and protective function by cough.

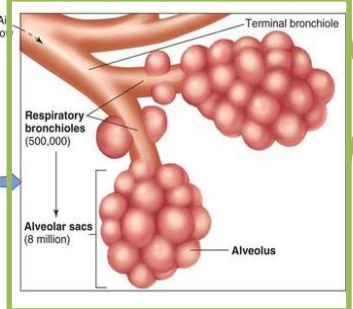


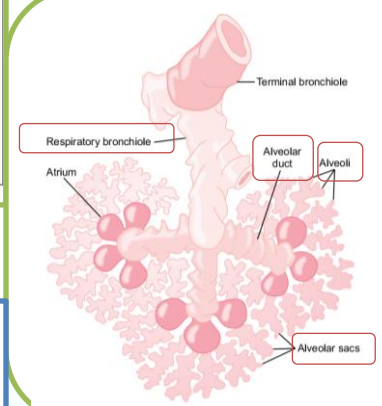
Respiratory Zone (Respiratory unit or acinus)

Component of respiratory zone (respiratory unite):

1- Respiratory bronchiole
2- Alveolar duct
3- Alveoli
4- Alveolar sacs

Function: Gas exchange





NOTE

<u>Conducting zone</u> is not involved in gas exchange while

<u>Respiratory zone</u> is involved in gas exchange

Dead space

Part s of the respiratory tract not participating in gas exchange

Divided to 3 types

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 [(1)].

Alveolar Dead Space: Non perfused alveoli

Physiologic Dead Space: Anatomical + Alveolar

NOTE

(1) Tidal volume means normal inhalation and exhalation when extra effort is not applied; in young adult is about 500 ml.

Types of respiratory process

Breathing (ventilation)

Air in and out lungs

External respiration

Gas exchange between **air in the lungs and blood**

internal respiration

Gas exchange between **blood and body cells /tissues**

cellular inspiration

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. Living cells must carry out cellular respiration.

Prokaryotic : (Single-celled organisms like bacteria) carry out cellular respiration within **the cytoplasm or on the inner surfaces of the cells.**

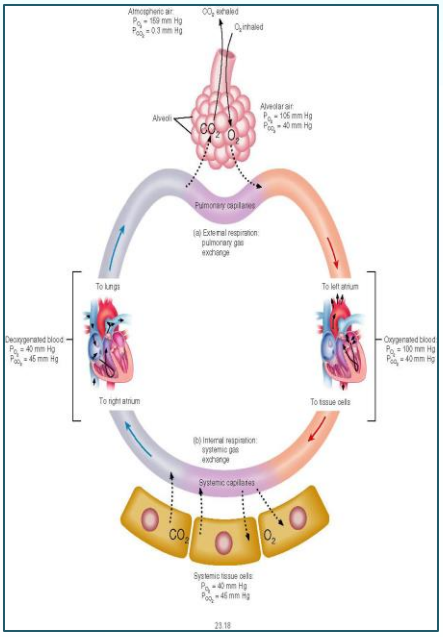
Eukaryotic : (Multi cellular animals including humans) are made up of complex cells with multiple internal organelles. **Mitochondria are the site of the reactions. Energy of cells is ATP**

EXTERNAL AND INTERNAL RESPIRATION

NOTE

This table was only mentioned orally during the lecture to understand the differences between internal and external respiration.

	Between	Carrying vessels	Type of blood
External respiration: pulmonary circle	From heart to lungs (alveoli)	Pulmonary capillaries	Venous blood (deoxygenated)
	From lungs (alveoli)	Pulmonary veins	Arterial blood (oxygenated)
Internal respiration: systemic circle	From heart to body cells	Arteries	Arterial blood (oxygenated)
	From body cells to the heart	Veins	Venous blood (deoxygenated)



External respiration

(which is the type we will focuce on in physiology)

3 major functional events occure during it:

Pulmonary ventalation	Diffusion	Transport
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

RESPIRATION COULD BE EITHER

- Resting: normal breathing during resting conditions
- Forced (maximal): during exercise, in patients with asthma, allergy,…

lining cells of the alveoli

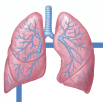
- Type 1 alveolar cells
- Type 2 alveolar cells
- Alveolar macrophages

→ secratory function (surfactant)

→ Respiratory Function (gas exchange)

Innervations of lungs and bronchi

- ✓ Innervations of lungs and bronchi by autonomic nerves.
- ✓ Sympathetic causes dilatation of the bronchi
- ✓ Parasympathetic causes constriction of the bronchi.
- ✓ Locally secreted factors: histamine and (SRSA) causes bronchiolar constriction



NOTE

(SRSA) slow reacting substances of anaphylaxis

Surface Tension

What is surface tension?

Water molecules at the surface are attracted to other water molecules by attractive forces that resist distension

what does it do?

Tends to oppose alveoli expansion

How our lungs resist surface tension

Pulmonary surfactant reduces surface tension

FUNCTIONS OF RESPIRATORY SYSTEM

- Gas exchange: Oxygen enters into the blood and carbon dioxide leaves
- Regulation of blood pH: Altered by changing blood carbon dioxide levels
- Voice production: Movement of air support the vocal folds to make sound and speech
- Olfaction: Smell sensation when airborne molecules drawn into nasal cavity
- Protection: Against microorganisms by preventing entry and removing them via cough and sneez reflex

Dust particles with an aerodynamic diameter of:
10µm= nose and pharynx.
2-10µm= tracheo-bronchial tree
0.1-2µm within the alveoli.
Particles smaller then 0.1µm remain in the air stream and are exhaled.

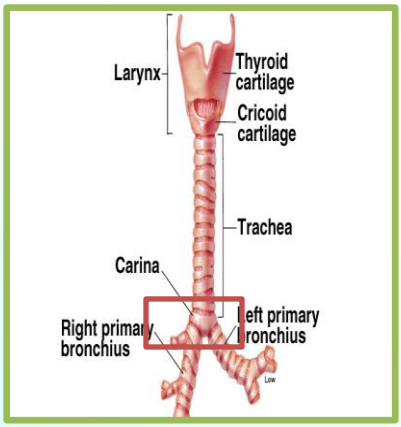
- Each liter of air may contain several million particles of dust.
- Cilia beat at a frequency of 1000–1500 cycles / min
- Cilia move particles away from lungs at a rate of 16 mm/min
- Particles less 0.1-2µm in diameter reach the alveoli, where they are ingested by the macrophages.

Cough reflex:

- The larynx and carina are very sensitive to dust particles
- Terminal bronchioles and even the alveoli are also sensitive to chemical such as sulfur dioxide or chlorine gas.
- Air expelled at velocities ranging from
  75 to 100 miles / hour [Guyton]
  965 Km (600 miles / hour [Ganong]

Ciliary Function:

Bronchus in the lungs are lined with hair-like projections called cilia that move microbes and debris up and out of the airways. Scattered throughout the cilia are goblet cells that secrete mucus which helps protect the lining of the bronchus and trap microorganisms



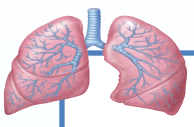
Defective ciliary motility leads to:

- Chronic sinusitis
- Recurrent lung infections
- Bronchiectasis.
- Ciliary immotility may produced by air pollutants, or congenital disorders such as **Kartagener's syndrome**
- Patients with this condition also infertile because they lack motile sperm

Surfactant

What is it ?	Contains	Function	Secreted from
Complex surface-active agent.	Mixture of several **phospholipids, proteins, and ions**. The important components are **phospholipids, dipalmitoyl lecithin, surfactant apoproteins, and calcium ions.**	✓ Surfactant decreases the surface tension and airway resistance. ✓ Important for survival of prem infants by preventing alveolar collapse. ✓ Surfactant have a bactericidal effect	**Type II alveolar epithelial cells**

When it develops?	Factors that will increase surfactant formation	Insufficient amount of surfactant	
		Premature babies	**Adults**
Start to from during 6th to 7th month of intrauterine life.1)	1. Thyroxin 2. Glucocorticoids	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 Therefore also known as **hyaline membrane disease**.	**Smoking in adult, hypoxia or hypoxemia (2) can lead to decrease in surfactant**



NOTE

(1) Surfactant starts to be secreted into the alveoli until between the 6th and 7th month and in some cases even later than this.
So 7 month= around 30 weeks, this is the earliest possible start of secretion that may be delayed in some infants and the secreted surfactant is not expected to mature and normally functioning at its early secretion.

(2) Low oxygen in the arterial blood.

Q1: What of the following Structures can be found in the upper respiratory tract?

A- Larynx
B- Pharynx
C- Trachea
D- Lungs

Q2: Vocal folds can be found in?

A- Larynx
B- Pharynx
C- Trachea
D- Bronchi

Q3: The main difference between conduction zone and respiratory zone is?

A- The amount of gas ions in conducting zone
B- The amount of gas which is higher in conducting zone
C- The ability of gas exchanging at respiratory zone
D- None of them

Q4: Respiratory zone start with terminal bronchioles?

A- T
B- F

Q5: Anatomical dead-space can be seen at?

A- Trachea
B- Alveolus
C- Terminal bronchioles
D- A and C

Q6: Gas exchanging between blood and body cells known as?

A- Cellular respiration
B- External inspiration
C- Internal inspiration
D- Ventilation

Q7: the final distention of dust particles with diameters of 0.1-0.2 nm is?

A- Alveoli
B- Nose and Pharynx
C- Remain at air stream
D- Tracho-bronchile tree

Q8: Type2 alveolar epithelial cells start to form surfactant during?

A- 5th-6th months
B- 6th-7th months
C- 7th-8th months
D- 8th-9th months

Answers: 1-B 2-A 3-C 4-B 5-D 6-C 7-A 8-B

Summary

Respiratory System

- **Upper respiratory tract**
  - Nose
  - Pharynx and associated structers
- **Lower respiratory tract**
  - Larynx
  - Trachea
  - Bronchi
  - Lungs

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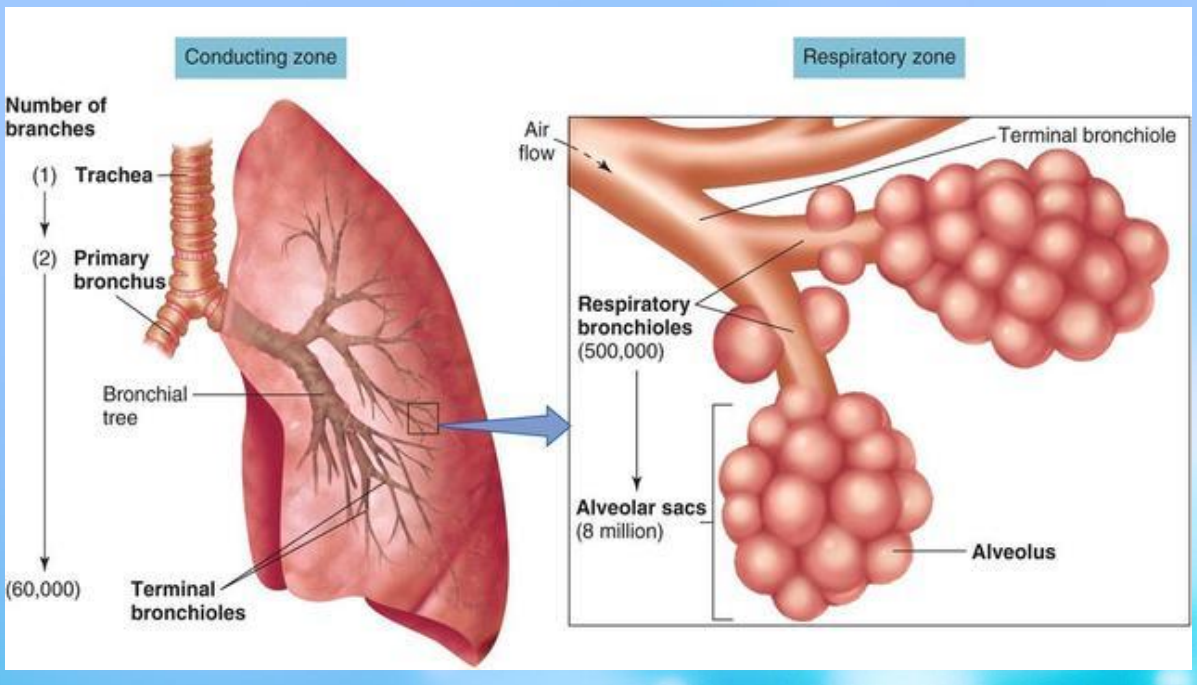

Types of respiration

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External inspiration

Gas exchange between **air in the lungs and blood**

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Gas exchange between **blood and body cells /tissues**

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Divided to 3 types

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- Physiologic Dead Space: **Anatomical + Alveolar**

Surfactant

Surfactant is a surface active agent, decreases surface tension and it is by **type II alveolar epithelial cells**

Respiratory System:
http://www.youtube.com/watch?v=MrDbiKQOtlU
Conducting zone & Respiratory zone:
http://education-portal.com/academy/lesson/gross-anatomy-of-the-airway-and-lungs-conducting-respiratory-zones.html