Respiratory system

#1. Respiration

Respiration is defined as the transport of oxygen from the outside air to the cells within tissues, and the transport of carbon dioxide in the opposite direction.

#2. Steps involved in respiration

a) Pulmonary ventilation
    a. Air moves in and out of lungs
    b. Continuous replacement of gases in alveoli (air sacs)
b) External respiration
    a. Gas exchange between blood and air at alveoli
    b. O2 (oxygen) in air diffuses into blood
    c. CO2 (carbon dioxide) in blood diffuses into air
c) Transport of respiratory gases
    a. Between the lungs and the cells of the body
    b. Performed by the cardiovascular system
    c. Blood is the transporting fluid
d) Cellular Respiration
    a. Oxygen (O2) is used by the cells
    b. O2 needed in conversion of glucose to cellular energy (ATP)
    c. Carbon dioxide (CO2) is produced as a waste product
    d. The body's cells die if either the respiratory or cardiovascular system fails
e) Internal respiration
    a. Gas exchange in capillaries between blood and tissue cells
    b. O2 in blood diffuses into tissues
    c. CO2 waste in tissues diffuses into blood

$$C_6H_{12}O_6 + 6O_2 = 6CO_2 + 6H_2O + 38\ ATP$$

#3. The respiratory zones

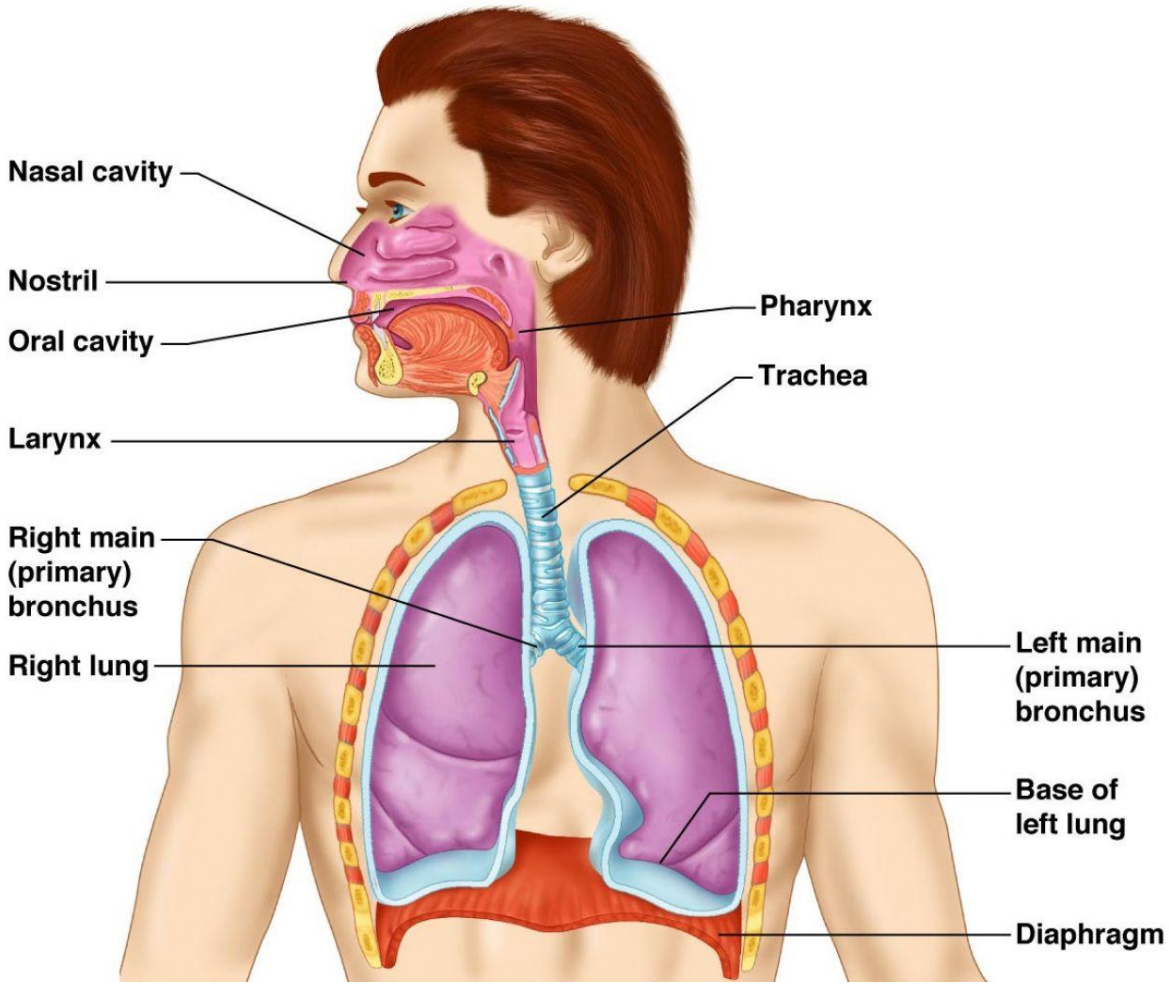
The organs of the respiratory system are divided into the **conducting zone** and **respiratory zone.** The conductive zone carries, filters, humidifies and warms incoming air. The respiratory zone is the site where the actual gas exchange occurs.

#4. Conductive zone

The conducting zone of the respiratory system includes the organs and structures not directly involved in gas exchange.

The major functions of the conducting zone are

- To provide a route for incoming and outgoing air.
- Remove debris and pathogens from the incoming air.
- Warm and humidify the incoming air.
- Helps in sensing odors
- Metabolize some airborne carcinogens.



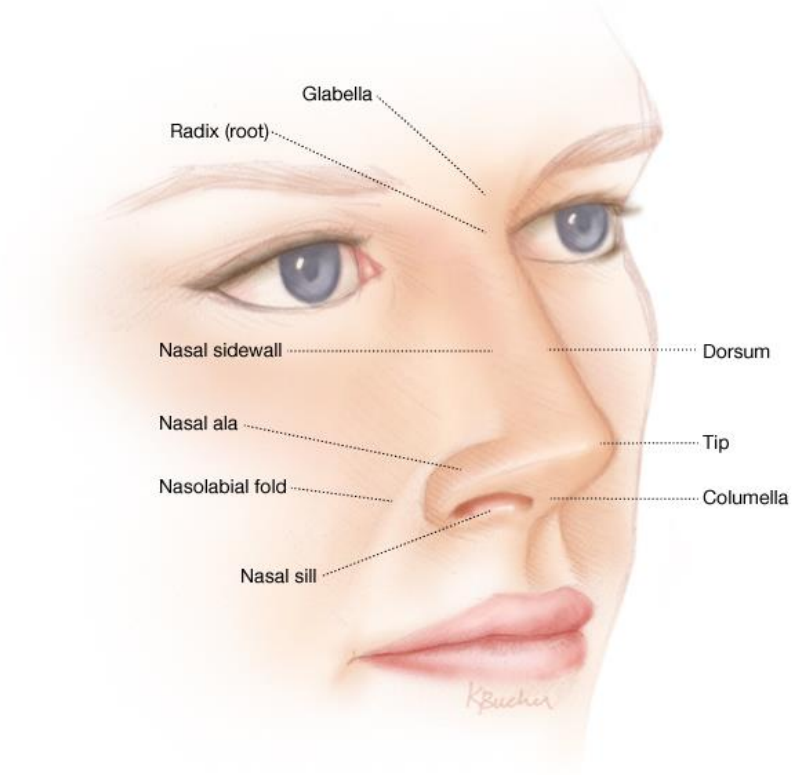
 # 5. Parts of conductive zone

- Nose
  - ✓ Nostrils
  - ✓ Nasal Cavity
- Paranasal sinuses
- Pharynx
- Larynx
- Trachea

 # 5.1. Nose

- The human nose is more than just a flap of flesh and cartilage on the front of the face.
- The major entrance and exit for the respiratory system is through the nose.
- It is divide it into two major sections: the **external nose**, and the **nasal cavity** or **internal nose**.
- The external nose consists of the surface and skeletal structures.
- It consists: root, bridge, dorsum nasi, ala, apex and philtrum.
- The two openings in the nose care called **nostrils**, or **napes**.

- They lead to two nasal cavities that are separated by the septum, a wall of **cartilage**.
- The human nose can smell over **1 trillion of scents**.
- The nose smells with the **olfactory cleft**, which is the roof of the **nasal cavity.**



#5.2. Paranasal sinuses

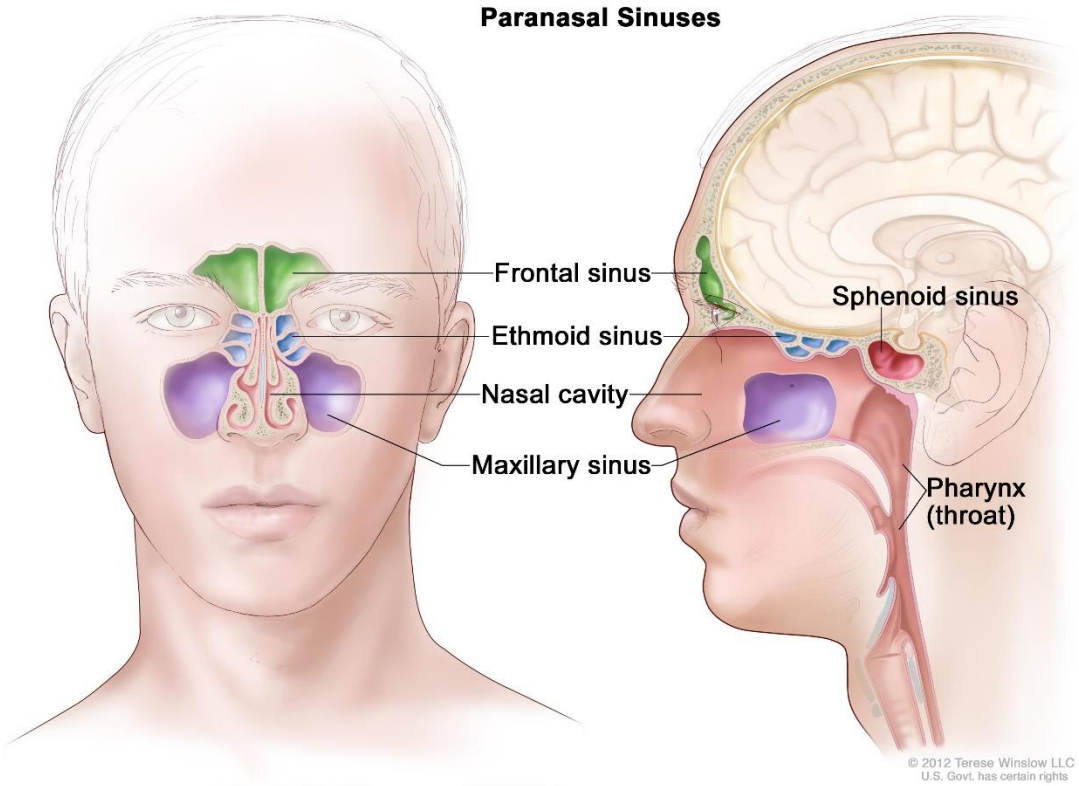
Several bones that help form the walls of the nasal cavity have air-containing spaces called the paranasal sinuses. The paranasal sinuses are air-filled spaces located within the bones of the skull and face.

They are centered on the nasal cavity and have various functions:

- Lightening the weight of the head
- Humidifying and heating inhaled air
- Increasing the resonance of speech

The four paranasal sinuses are:

- Maxillary sinuses
- Frontal sinuses
- Sphenoid sinuses
- Ethmoid sinuses



A. Maxillary sinuses

- The maxillary sinus is a paired pyramid-shaped paranasal sinus within maxillary bone
- It is the largest paranasal sinus.
- It is lies inferior to the eyes in the maxillary bone.
- It is the first sinus to develop and is filled with fluid at birth.

B. Frontal Sinuses

- The frontal sinus is located in the frontal bone, superior to the eyes in the forehead.
- It is formed by the upward movement of anterior ethmoid cells after the age of 2.
- The frontal sinuses are funnel-shaped structures.
- The posterior wall of the frontal sinus is much thinner than its anterior wall.

C. Sphenoid sinus

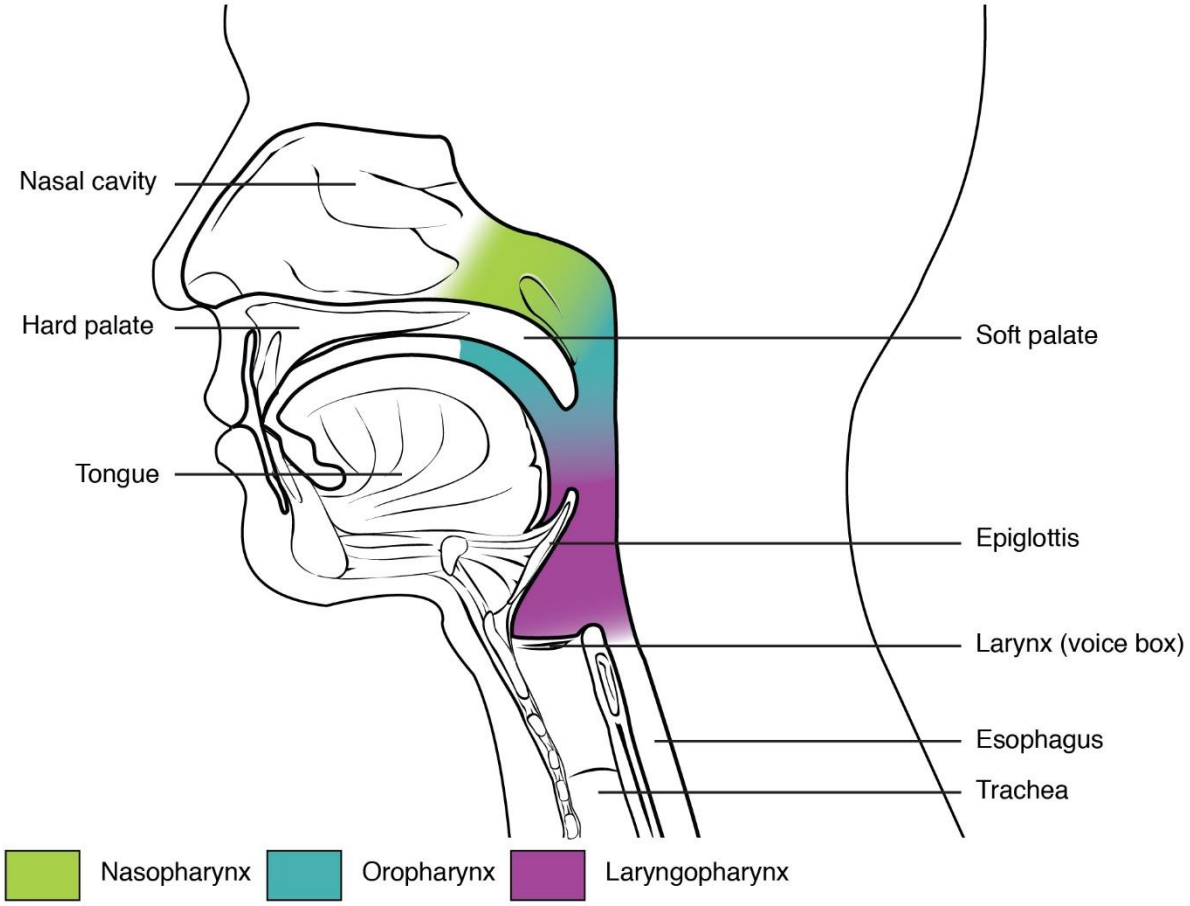
- The sphenoid sinus originates in the sphenoid bone at the center of the head.
- It arises from the nasal embryonic lining.
- The sinus reaches its full size by the late teenage years.
- The thickness of the walls of the sphenoid sinus is variable.

D. Ethmoid sinuses

- The ethmoid sinuses arise in the ethmoid bone
- They are a collection of fluid-filled cells at birth that grow and matured until the age of 12.
- The ethmoid cells are shaped like pyramids.

5.3. The pharynx (Throat)

The pharynx is a tube **formed** by **skeletal muscle** and **lined** by **mucous membrane.** It is continuous with the nasal cavities. The pharynx is divided into three major regions: the **nasopharynx**, the **oropharynx**, and the **laryngopharynx**.



A. Nasopharynx

- The nasopharynx is situated by the **conchae** of the nasal cavity
- It serves only as an **airway.**
- At the top of the nasopharynx are the pharyngeal tonsils.

B. Oropharynx

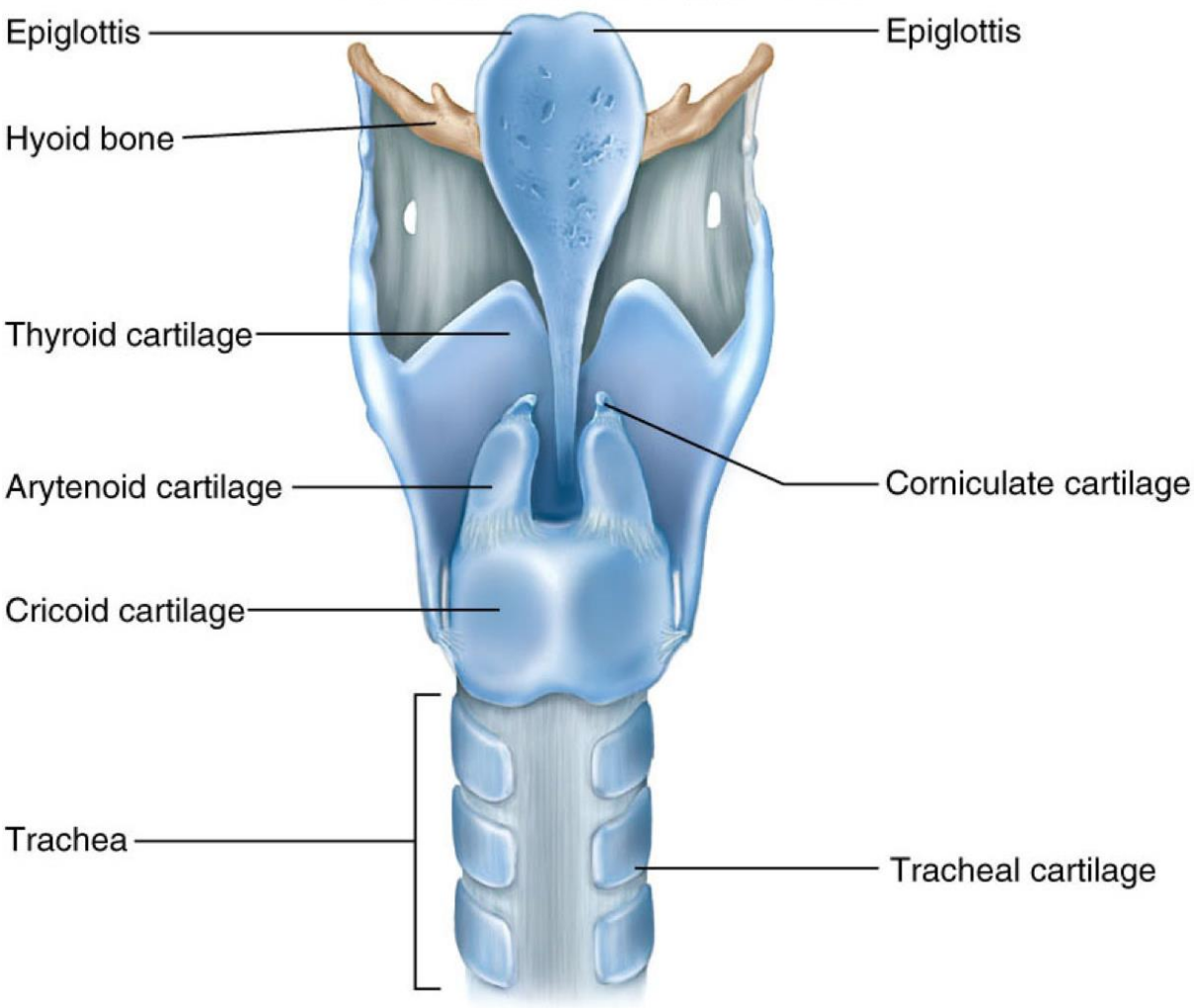
- The oropharynx is a passageway for both air and food.
- The **fauces** is the opening at the connection between the oral cavity and the oropharynx.
- The nasopharynx layer is the **stratified squamous epithelium**.
- The oropharynx contains two distinct sets of tonsils, the **palatine** and **lingual** tonsils.

C. Laryngopharynx

- The laryngopharynx is inferior to the oropharynx and posterior to the larynx.
- It continues the route for ingested material and air
- The laryngopharynx layer is also the **stratified squamous epithelium**

#5.4. The larynx (Voice box)

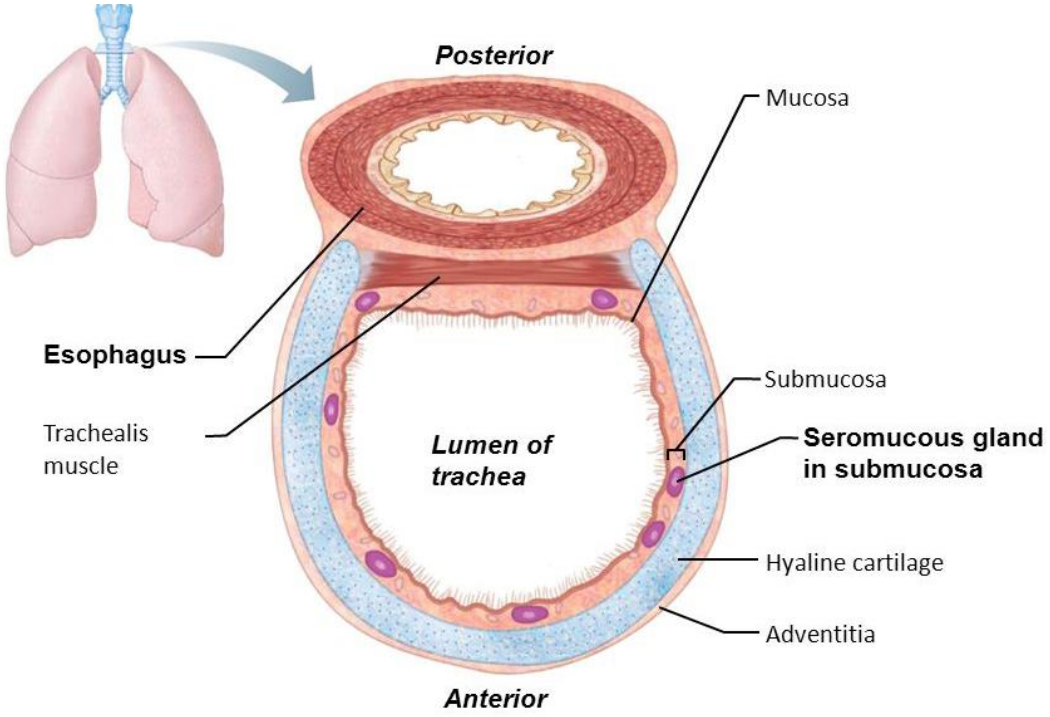
- The larynx is a cartilaginous structure that is inferior to the laryngopharynx
- It connects the pharynx to the trachea
- It helps to regulate the volume of air that enters and leaves the lungs.
- This is our voice box.
- The larynx is made of 9 specially shaped cartilages that are connected by ligaments.
- **Three** large cartilage pieces—the **thyroid cartilage**, **epiglottis**, and **cricoid cartilage**.
- The thyroid cartilage consists of the **laryngeal prominence.**
- Three smaller, paired cartilages are: the **arytenoids**, **corniculates**, and **cuneiforms.**



(b) Posterior

#5.5. Trachea (the windpipe)

- The trachea (windpipe) extends from the **larynx** toward the **lungs**.
- The trachea is formed by 16 to 20 stacked, C-shaped pieces of **hyaline cartilage** that are connected by dense connective tissue.
- The **trachealis muscle** and elastic connective tissue together form the **fibro-elastic membrane**.
- The **fibro-elastic membrane** allows the trachea to stretch and expand slightly during inhalation and exhalation.
- Whereas the rings of **cartilage** provide structural support and prevent the trachea from collapsing.



(a) Cross section of the trachea and esophagus

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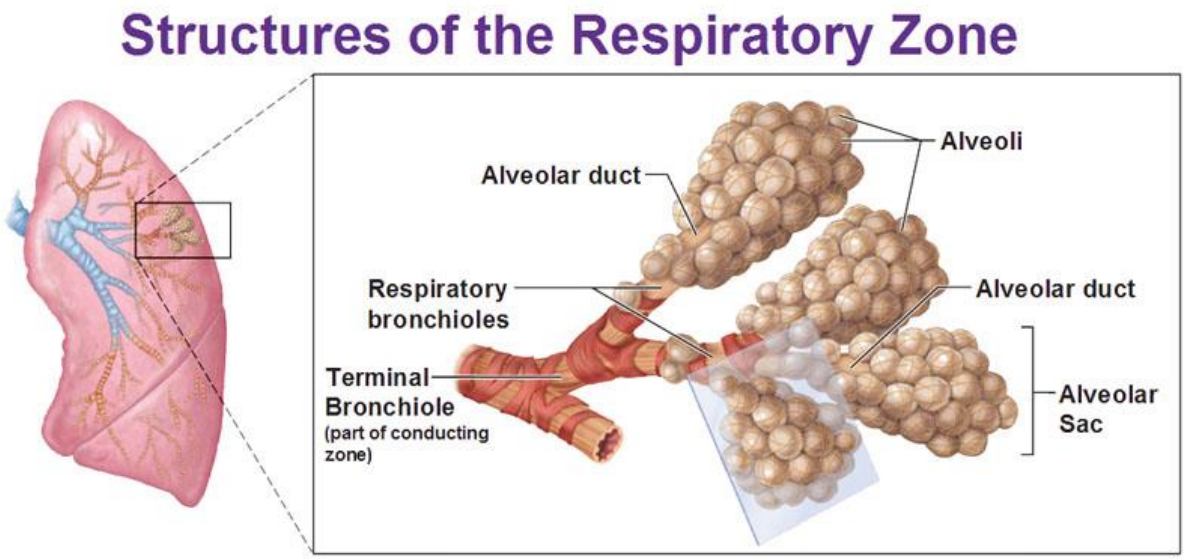
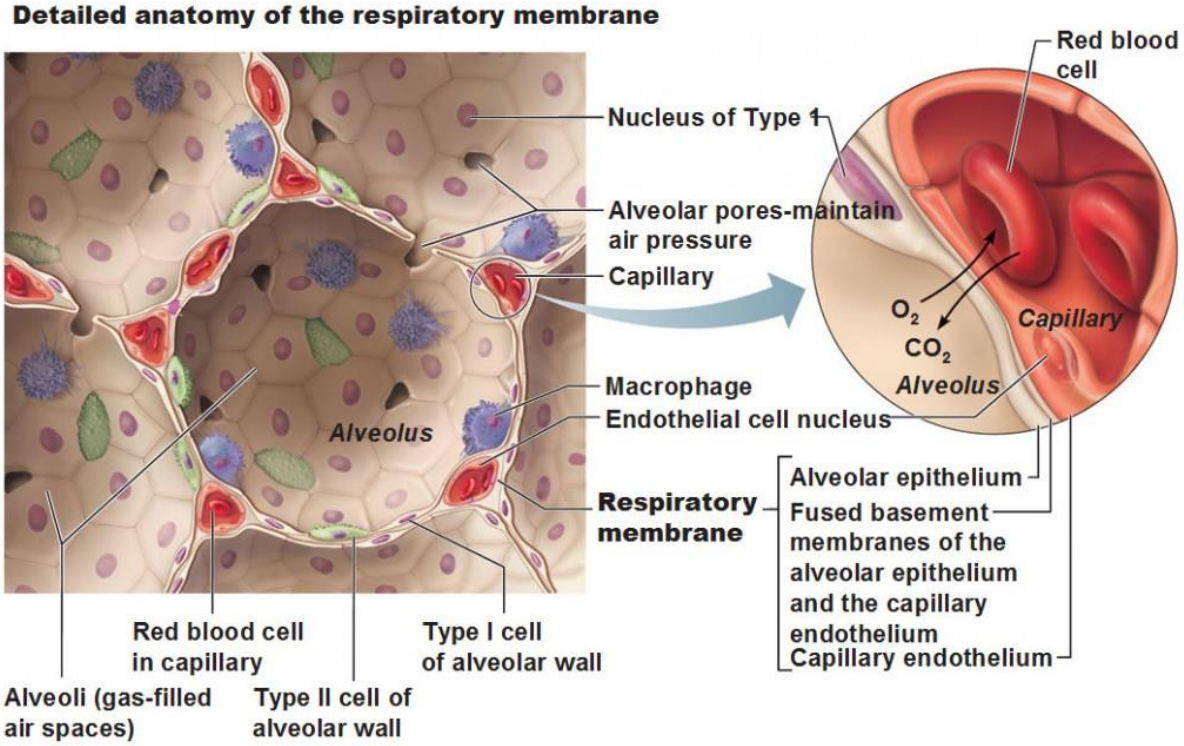
6. Respiratory zone

The respiratory zone includes structures that are directly involved in gas exchange. The respiratory zone begins where the **terminal bronchioles** join a **respiratory** bronchiole, the smallest type of bronchiole. This bronchiole then leads to an **alveolar duct** and opening into a cluster of **alveoli.**

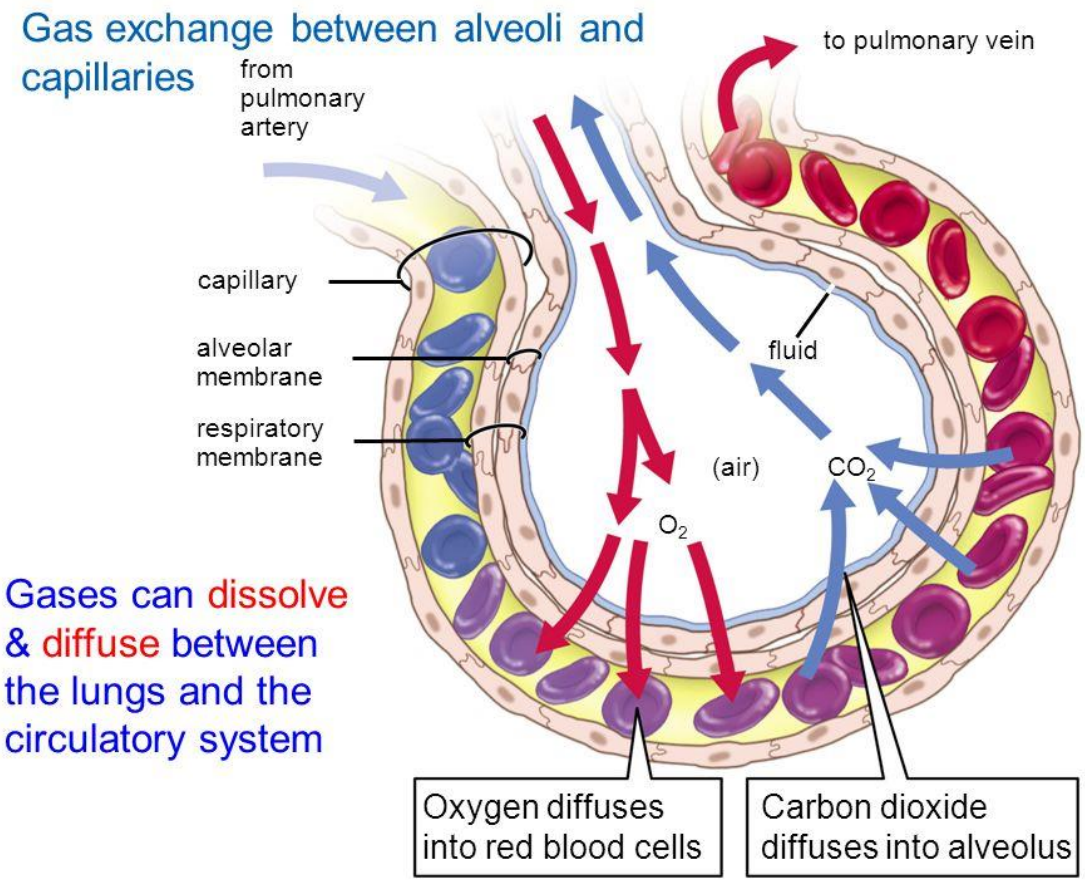


6.1. Alveoli and gas exchange mechanism

- At the ends of the **respiratory bronchioles** there are **alveoli** and a cluster of alveoli is called the **alveolar sac**.
- The next branch after the bronchioles is called the **alveolar duct**.
- An alveolus is approximately **200 µm** in diameter with elastic walls.
- Each of these alveoli, are made of simple **squamous epithelial cells**.
- **Alveoli** are connected to their neighbors by **alveolar pores**, which help maintain equal air pressure throughout the alveoli and lung.
- The alveolar wall consists of three major cell types: **type I alveolar cells**, **type II alveolar cells**, and alveolar **macrophages**.

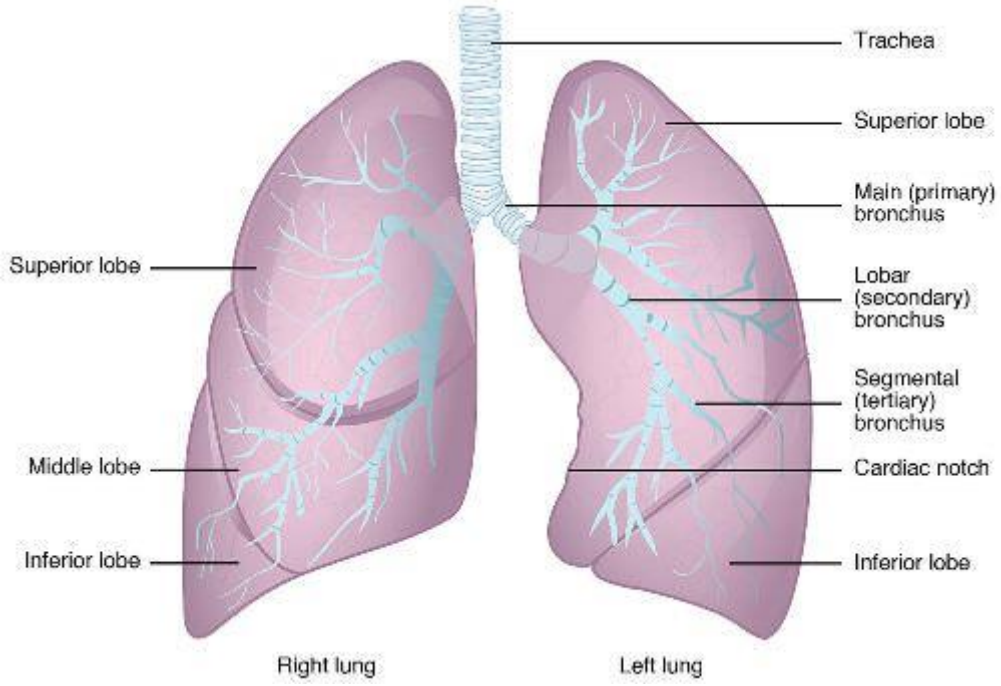


- A type I alveolar cell is a **squamous epithelial** cell of the alveoli, which constitute up to **97 percent** of the alveolar surface area.
- These cells are about ***25* nm thick** and are highly permeable to **gases**.
- A **type II alveolar** cell is interspersed among the type I cells.
- They secrete pulmonary **surfactant**, a substance composed of **phospholipids** and **proteins** that reduces the surface tension of the alveoli.
- **Alveolar macrophage**, a phagocytic cell that removes pathogens that have reached the alveoli.
- Through simple diffusion, oxygen is picked up by the blood for transport and CO2 is released into the air of the alveoli.



 # 7. Lungs

- The lungs are a pair of spongy, air-filled organs located on either side of the chest.
- The trachea (windpipe) conducts inhaled air into the lungs through its tubular branches, called bronchi.
- The bronchi then divide into smaller and smaller branches (bronchioles).
- The bronchioles eventually end in clusters of microscopic air sacs called alveoli.
- In the alveoli, oxygen from the air is absorbed into the blood.
- Carbon dioxide, a waste product, travels from the blood into the alveoli, where it can be exhaled.
- The right lung is divided into three different sections, called lobes and the left lung has just two lobes.
- The lobes are made of sponge-like tissue that is surrounded by a membrane called pleura.



#8. Human respiratory organs