

Lecture 4 Theory

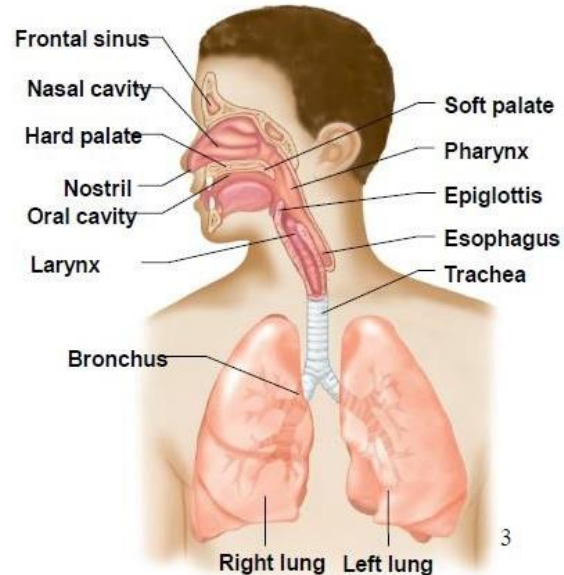
# Human Biology

Respiratory system (Oxygen Delivery System)

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# Function of the Respiratory System

- Oversees gas exchanges between the blood and external environment
- Passageways to the lungs purify, warm, and humidify the incoming air.
- Forms speech sound
- Defends against microbes
- Facilitates sense of smell
- Maintains acid-base balance



# Organs of the Respiratory system

The organ of this system is divided into:

- Nose
- Nasal cavity
- Pharynx

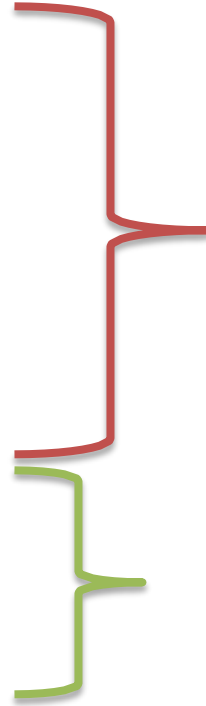


*Upper  
respiratory  
tract*

- Larynx
- Trachea
- Bronchi
- Respiratory bronchiole
- Alveoli
- Alveoli sac and ducts
- Lung



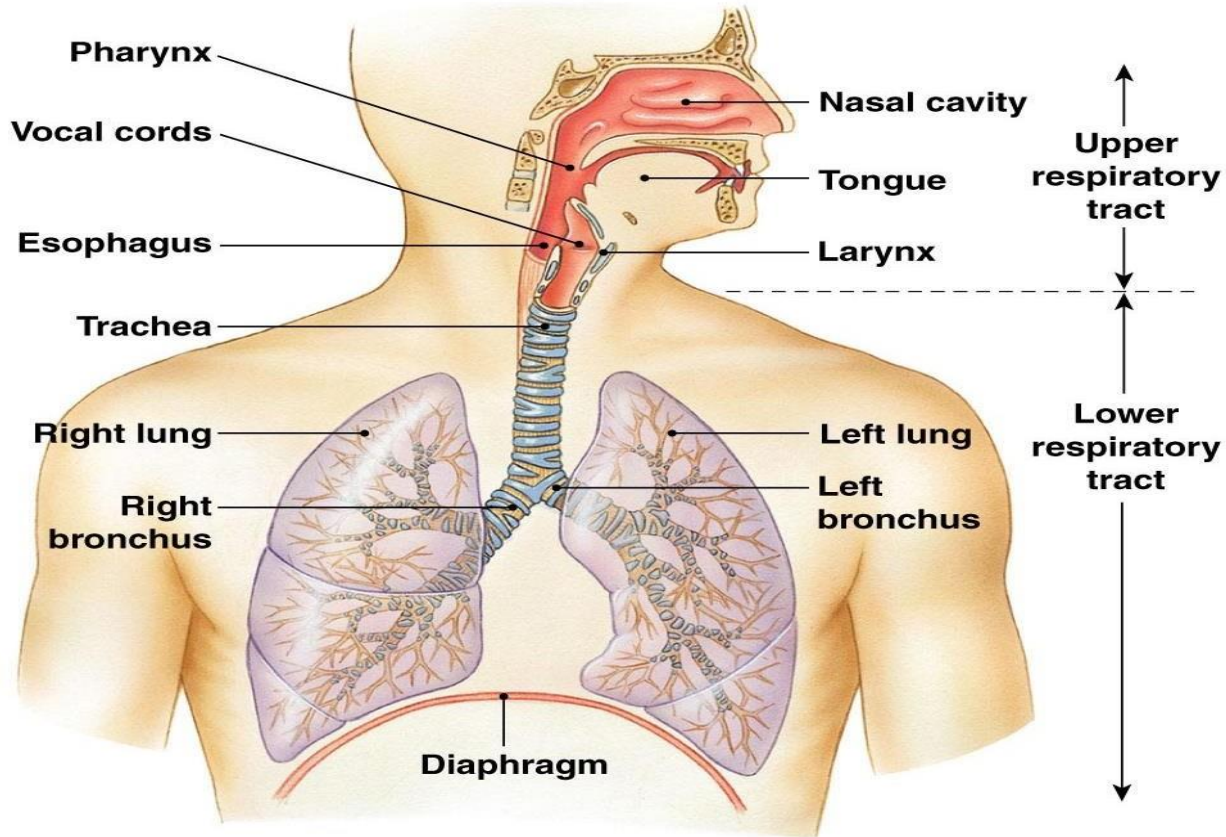
*Lower  
respiratory  
tract*



**Conducting parts**

**Respiratory parts**

**(a) The respiratory system**



# Parts of respiratory system

Its parts can be classified according to either structure or function. *Structurally*, the respiratory system consists of two parts:

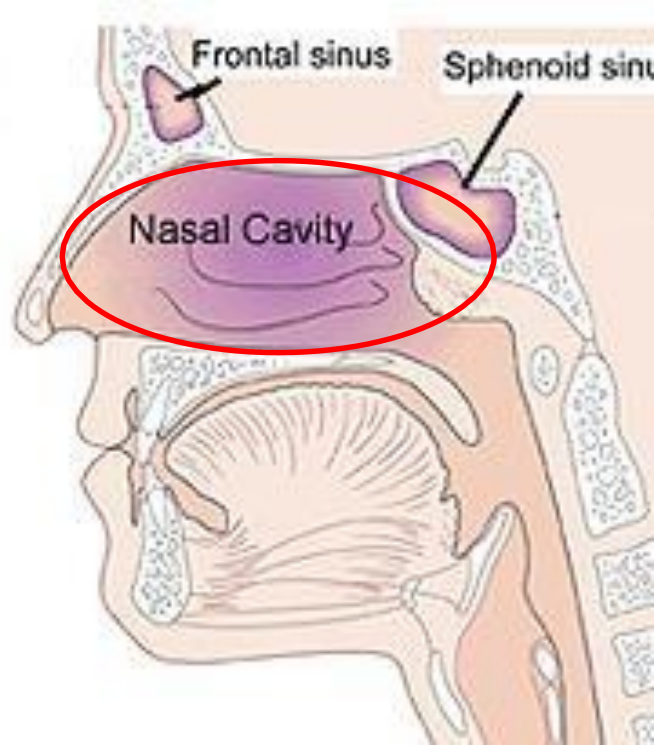
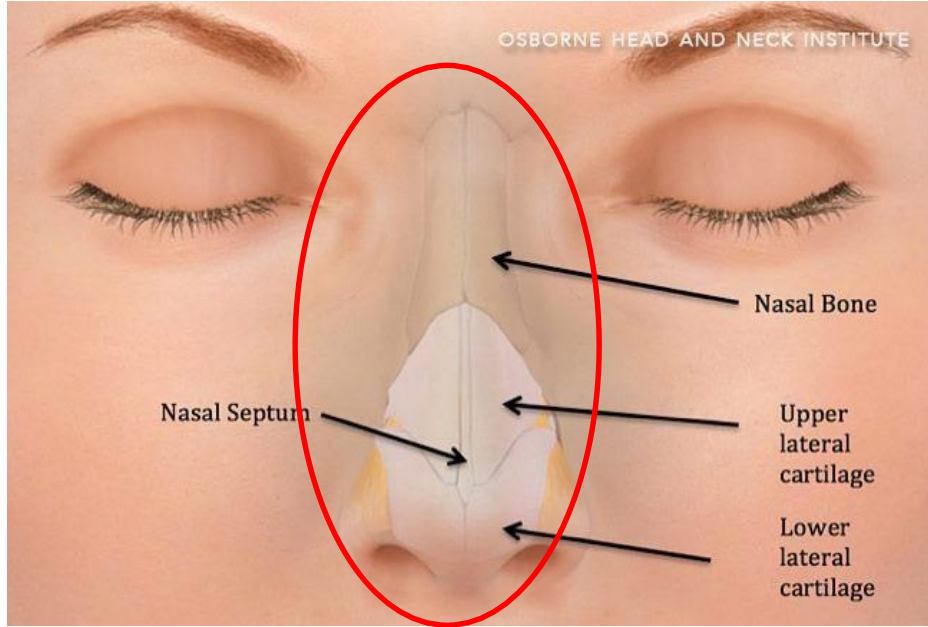
- (1) The **upper respiratory system includes** the nose, nasal cavity, pharynx, and associated structures.
- (2) The **lower respiratory system includes the larynx, trachea, bronchi,** and lungs.

*Functionally*, the respiratory system also consists of two parts:

- (1) The **conducting zone consists of a series of interconnecting** cavities and tubes both outside and within the lungs. These include the nose, nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles, and terminal bronchioles; their function is to filter, warm, and moisten air and conduct it into the lungs.
- (2) The **respiratory zone consists of tubes and tissues within the** lungs where gas exchange occurs. These include the respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli and are the main sites of gas exchange between air and blood.

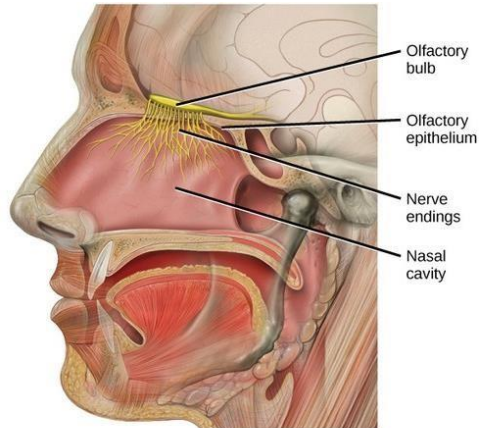
# The Nose

- The only externally visible part of the respiratory system.
- It is divided into an **external portion** and an **internal portion**.
- The external nose is the portion of the nose visible on the face and consists of a supporting framework of bone and hyaline cartilage covered with muscle and skin.
- The internal portion consists of a nasal cavity (it is lined with muscle and mucous membrane)

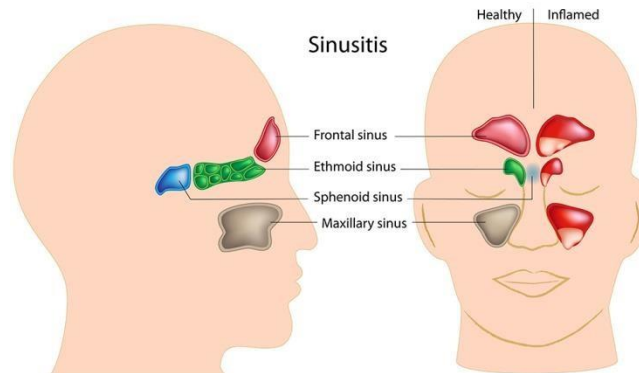


# Function of nose

1. Warming, moistening, and filtering incoming air.
2. Detecting olfactory stimuli.
3. Modifying speech vibrations as they pass through the large, hollow resonating chambers.
4. Trapping microbes and foreign particles by hair and mucus



(b)





# Pharynx (Throat)

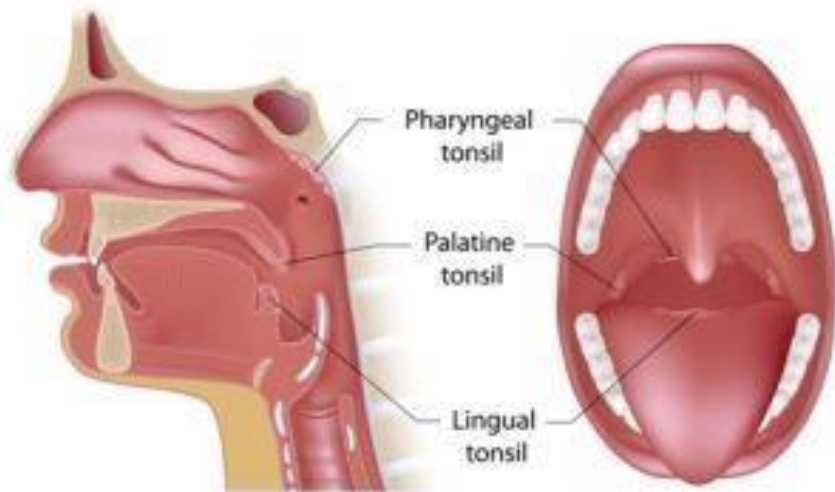
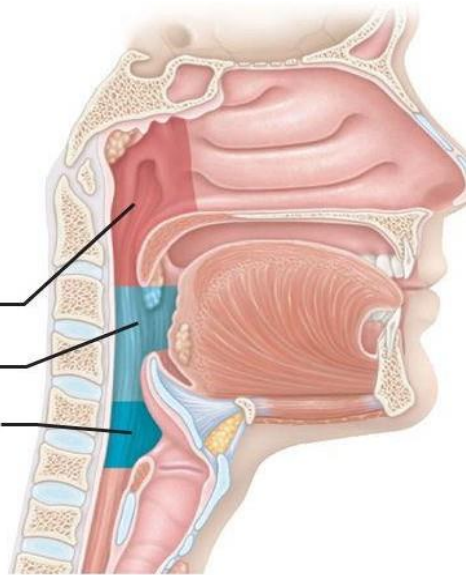
- Muscular passage from nasal cavity to larynx and it has three regions of the pharynx
  - **Nasopharynx:** superior region behind nasal cavity
  - **Oropharynx:** middle region behind mouth
  - **Laryngopharynx:** inferior region attached to larynx
- The oropharynx and laryngopharynx are common **passageways** for air and food.
- Its wall is composed of skeletal muscles and is lined with a mucous membrane.
- **The pharynx functions:**
  - passageway for air and food
  - provides a resonating chamber for speech sounds
  - houses the tonsils, which participate in immunological reactions against foreign invaders.

## Pharynx

Nasopharynx

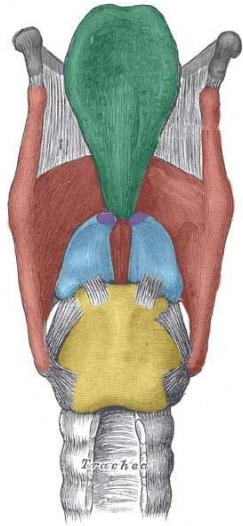
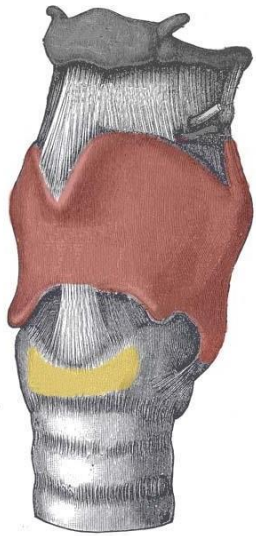
Oropharynx






Laryngopharynx



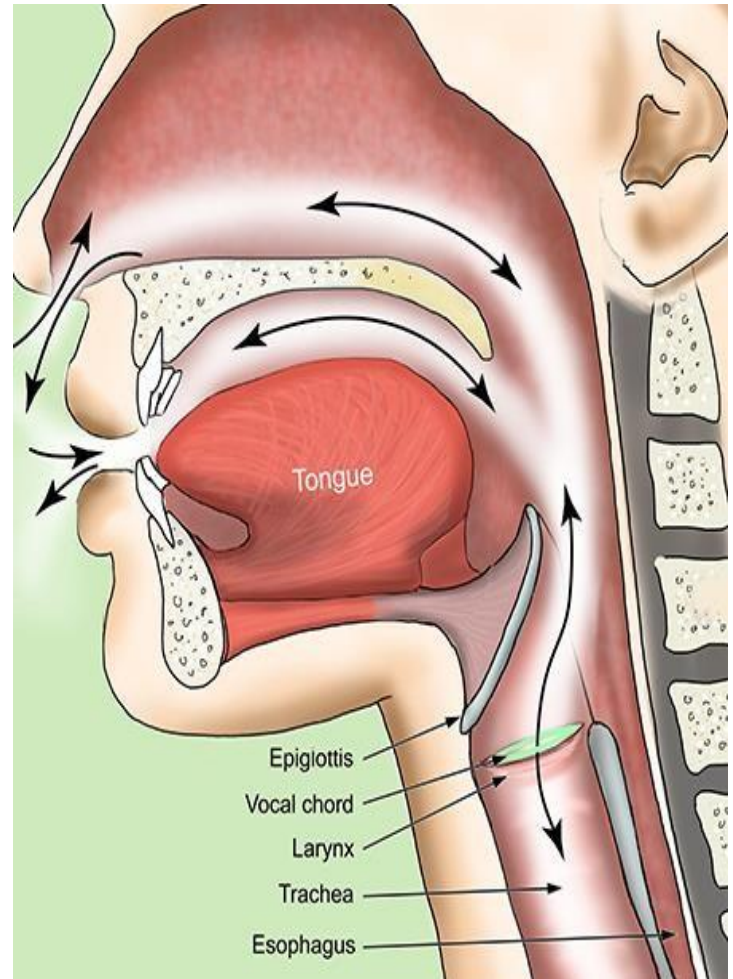
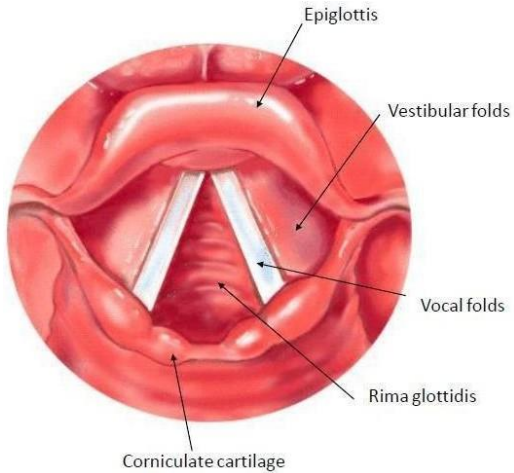
# Larynx (Voice Box)

- The larynx, commonly called the voice box, is the passageway for air between the pharynx above and the trachea below.
- It is formed by nine **cartilages** that are connected to each other by muscles and ligaments.
- At the top of the larynx sits a **spoon-shaped flap of elastic cartilage** (epiglottis) which prevents food & liquids from entering respiratory tract.
- Larynx contains 2 folds called **vocal cord** (As air leaves the lungs, the vocal cords vibrate and produce sound).
- **Larynx functions:**
  - Conduct air from pharynx to trachea.
  - Plays a role in speech
  - Prevents entering food and drinks to the trachea



- |   |                        |
|---|------------------------|
|    | Epiglottis             |
|  | Thyroid cartilage      |
|  | Arytenoid cartilages   |
|  | Cricoid cartilage      |
|  | Corniculate cartilages |

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# Trachea (Windpipe)

- The trachea or windpipe, is a tubular passageway for air that is about 12 cm (5 in.) long and 2.5 cm (1 in.) in diameter.
- It connects larynx with bronchi.
- It is located anterior to the esophagus.
- The layers of the tracheal wall, from deep to superficial, are the (1) mucosa, (2) submucosa, (3) hyaline cartilage, and (4) adventitia
- Trachea is lined with ciliated mucosa to clean the inhaled air.
- The walls of trachea are reinforced with C-shaped hyaline cartilage

# Respiratory Tree Divisions

Formed by division of the trachea into:

- Primary bronchi
- Secondary bronchi
- Tertiary bronchi

Cartilage present

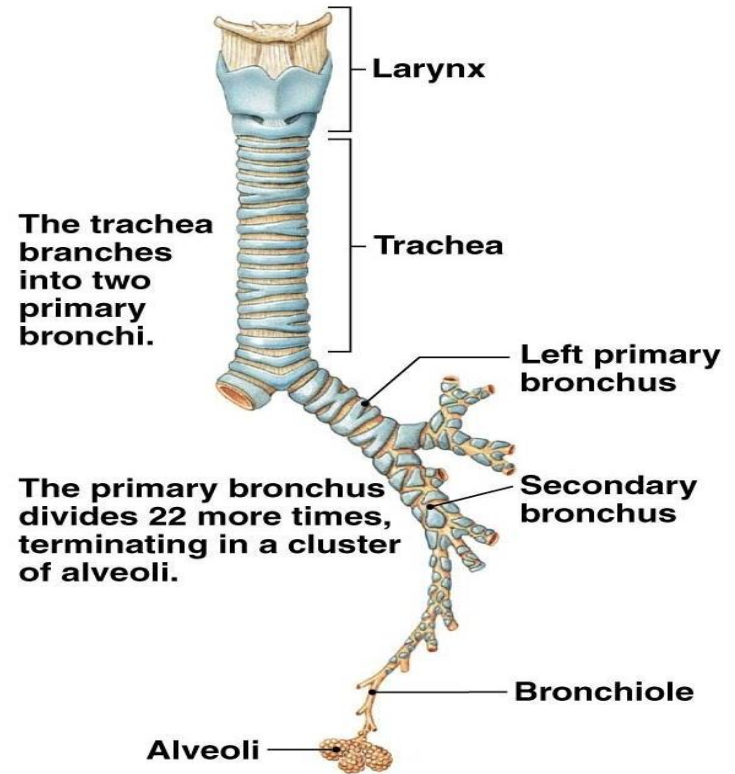
- Bronchiole
- Terminal bronchiole

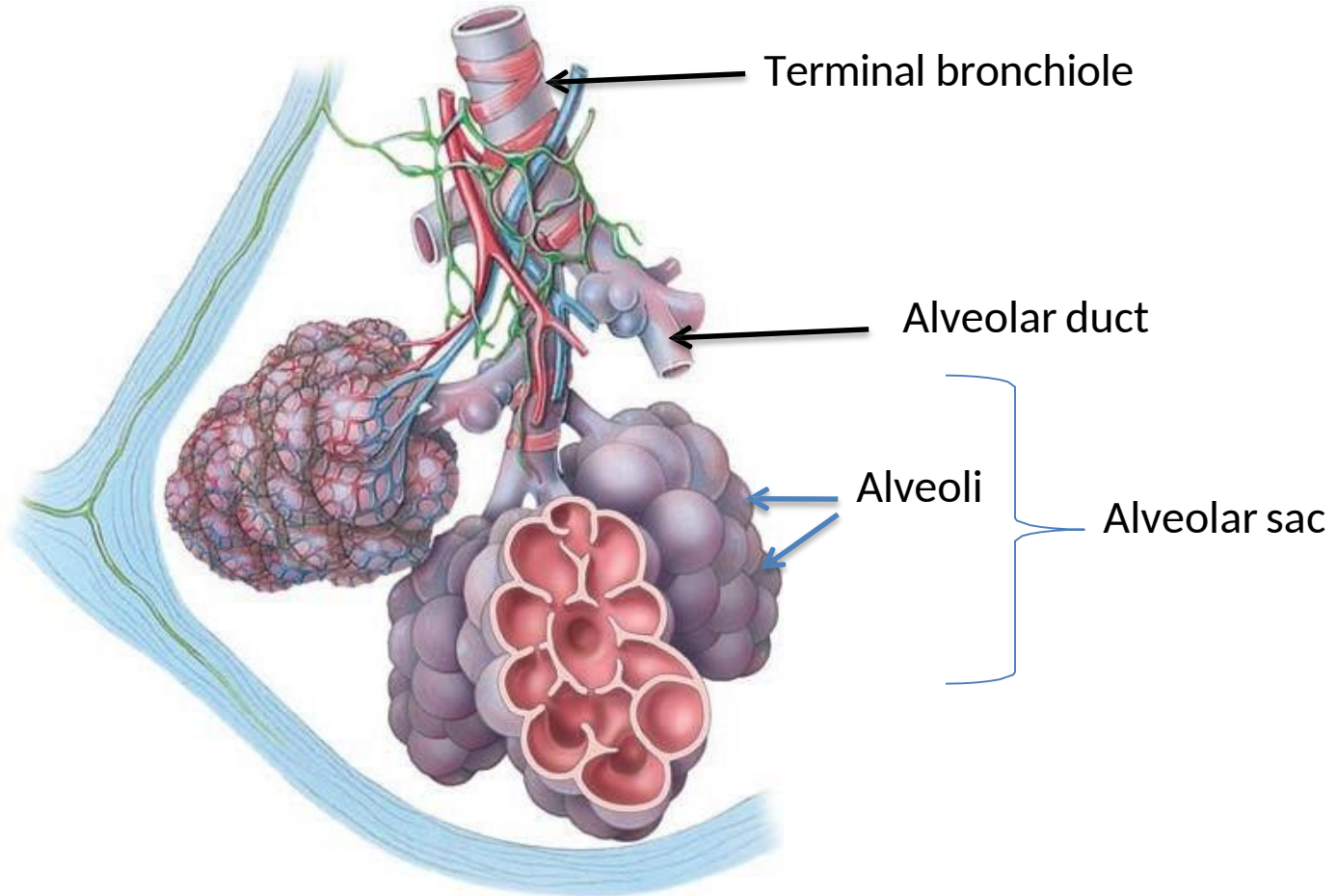
- Respiratory bronchiole

- Alveolar duct

- Alveolar sac

- Alveoli (500 million alveoli found in human lung and surrounded by network of capillaries to exchanges O<sub>2</sub> and CO<sub>2</sub>). (alveolus; singular, alveoli; plural)





# Cells types of the alveoli:

Alveoli are composed of:

## 1. Type I alveolar cells

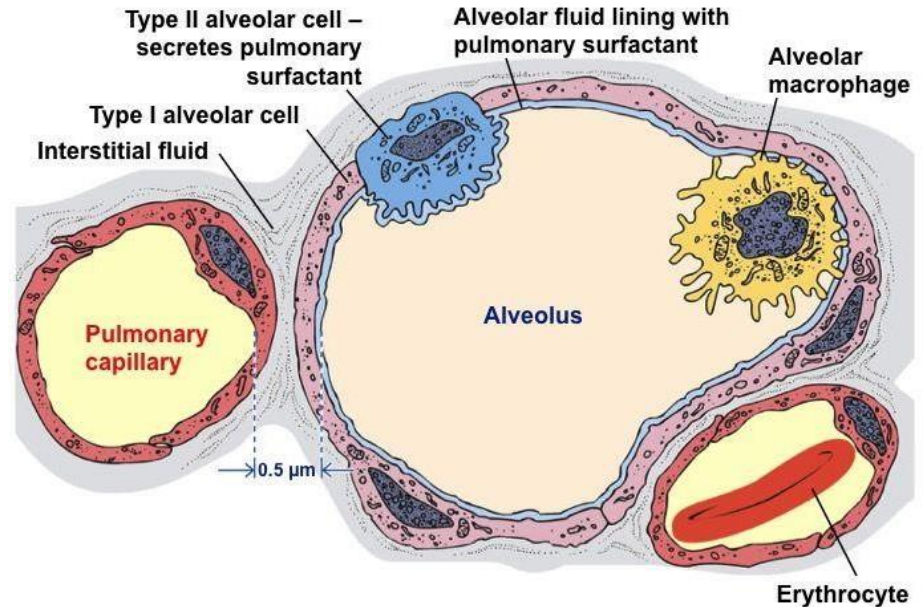
- Simple squamous cells where gas exchange here

## 2. Type II alveolar cells

- Free surface has microvilli
- Secret alveolar fluid containing surfactant

## 3. Alveolar dust cell

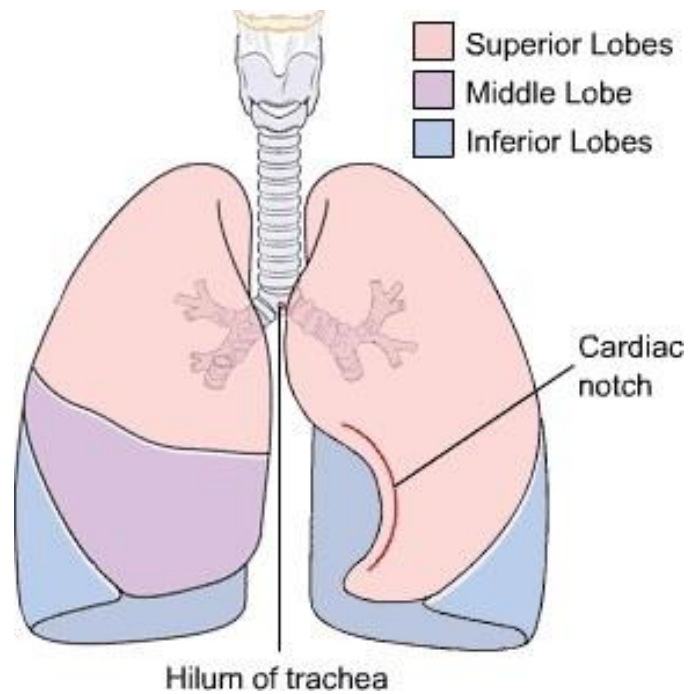
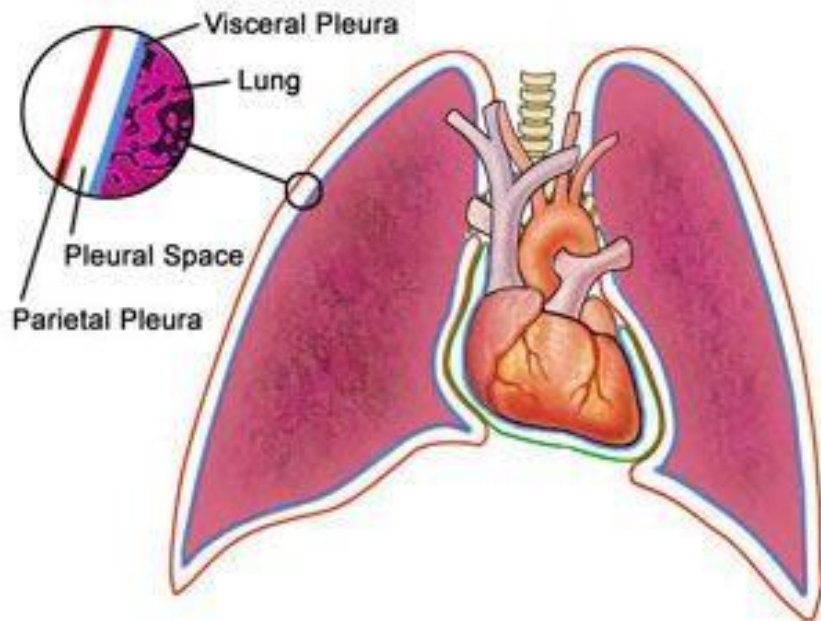
- Macrophage remove debris





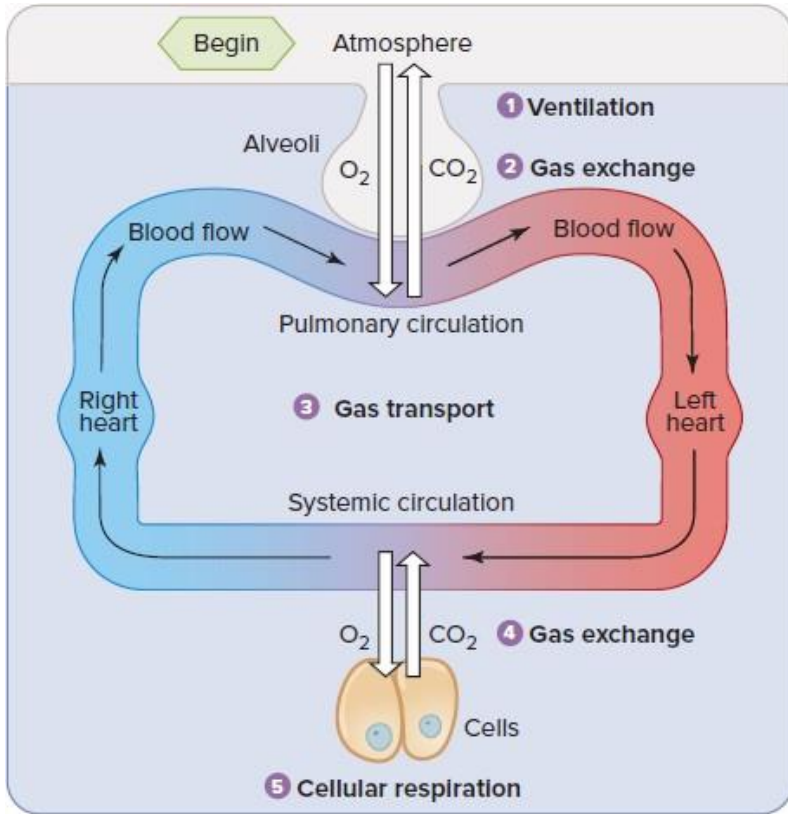
# Lungs

- Occupy most of the thoracic cavity.
- Each lung is enclosed and protected by a **double-layered serous membrane** called the pleural membrane.
  - **The superficial layer**, called the parietal pleura, lines the wall of the thoracic cavity
  - the deep layer, **the visceral pleura**, covers the lungs themselves
  - Between the visceral and parietal pleurae is a small space, **the pleural cavity**, which contains a small amount of lubricating fluid secreted by the membranes.
- Each lung is divided into lobes by fissures
  - Left lung - two lobes
  - Right lung - three lobes



# Events of Respiration

1. **Pulmonary ventilation** – moving air in and out of the lungs
2. **External respiration** – gas exchange between pulmonary blood and alveoli
3. **Respiratory gas transport** – transport of oxygen and carbon dioxide via the bloodstream
4. **Internal respiration** – gas exchange between blood and tissue cells in systemic capillaries



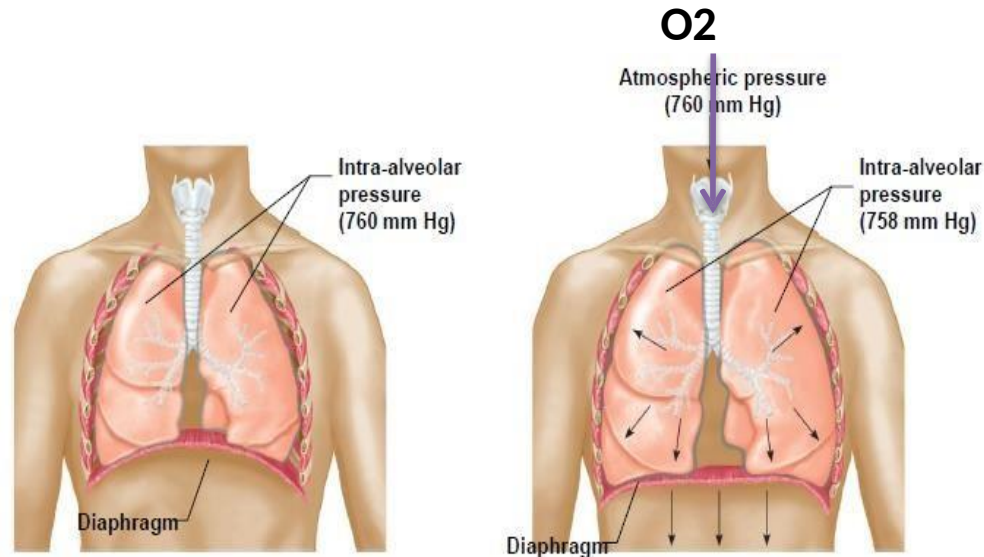
**Events of respiration**

# 1- Pulmonary Ventilation

- It is a mechanical process and depends on **volume** changes in the thoracic cavity.
- It is commonly referred to as breathing. It is the process of air flowing into the lungs during inspiration (**inhalation**) and out of the lungs during expiration (**exhalation**).
- Air flows because of pressure differences between the atmosphere and the gases inside the lungs.

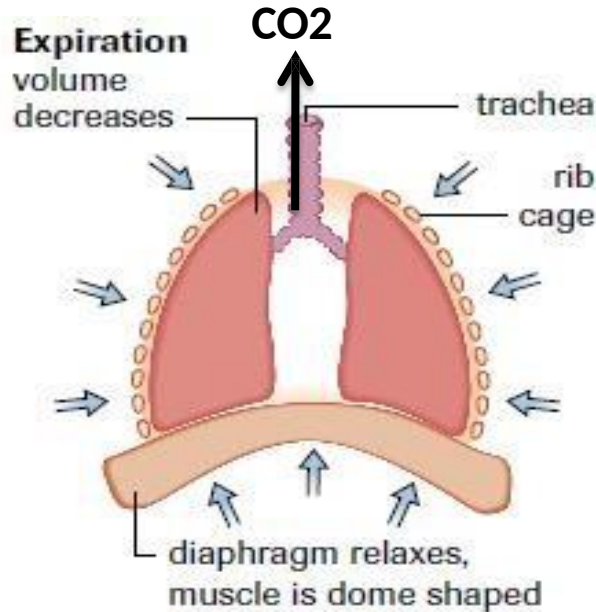
# Inspiration or inhalation

During inspiration, the diaphragm muscle contracts and pulls downward to abdomen while the muscles between the ribs contract and pull the ribs upward. As a result, the size of the thoracic cavity **increases** and lung pressure **decrease**. Therefore, air from an area of high pressure (atmosphere) moves to lower pressure(lung).



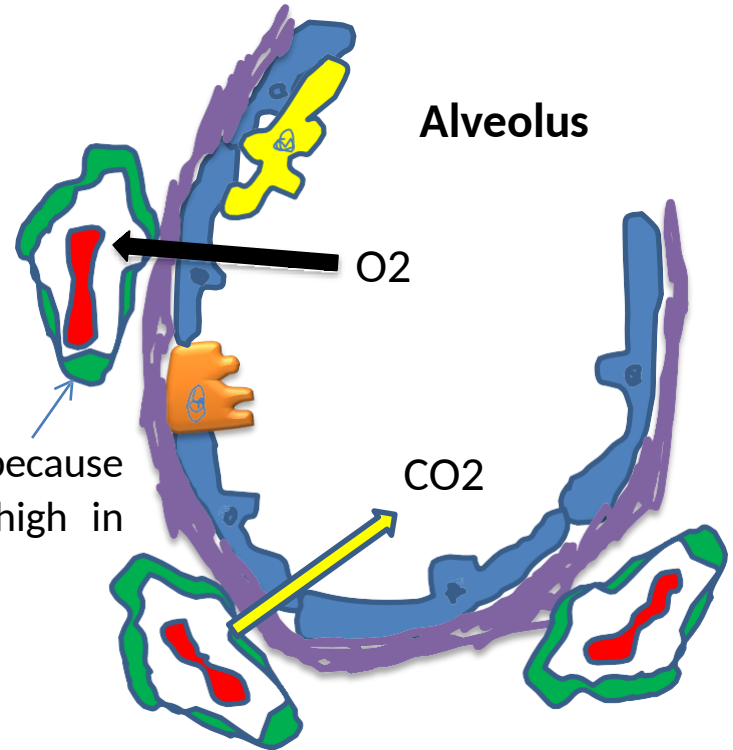
# Expiration or exhalation

During expiration, the relaxation of the diaphragm, muscles between the ribs as well as elastic tissue recoiling **decreases** the thoracic volume and **increases** the lung pressure. Therefore, air from an area of high pressure (lung) moves to an area of low pressure (atmosphere).



# 2-External Respiration

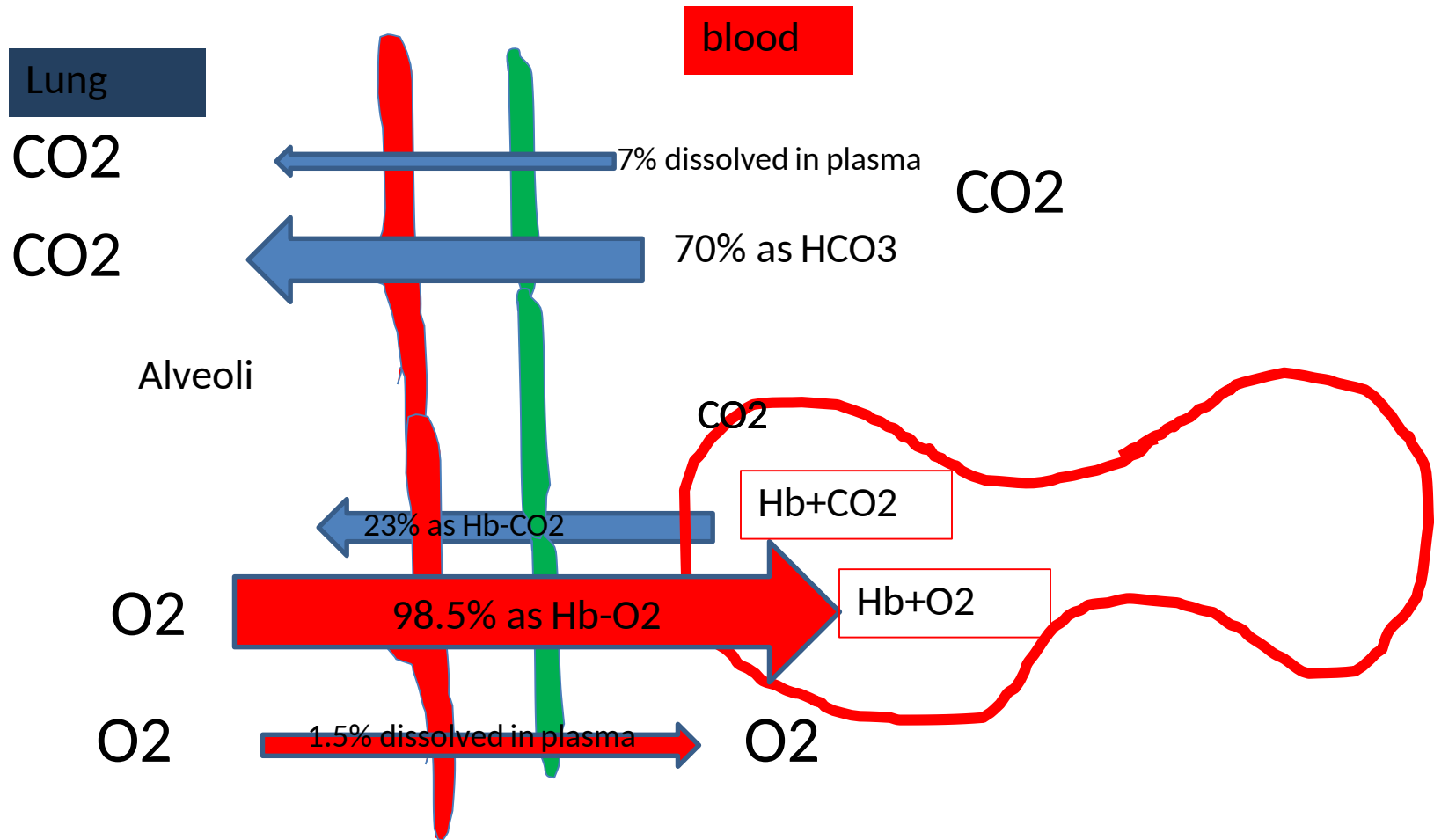
- This step occurs between alveoli and blood capillaries. It is gas exchanges between the lungs and blood.
- **Oxygen** moves by diffusion from alveoli toward blood capillaries. This will happen because O<sub>2</sub> concentration is high in alveoli, while it is low in capillaries.
- **Carbon dioxide** movement is out of the blood capillaries to the alveoli. This will happen because Capillary CO<sub>2</sub> concentration is low in alveoli, while it is high in capillaries.





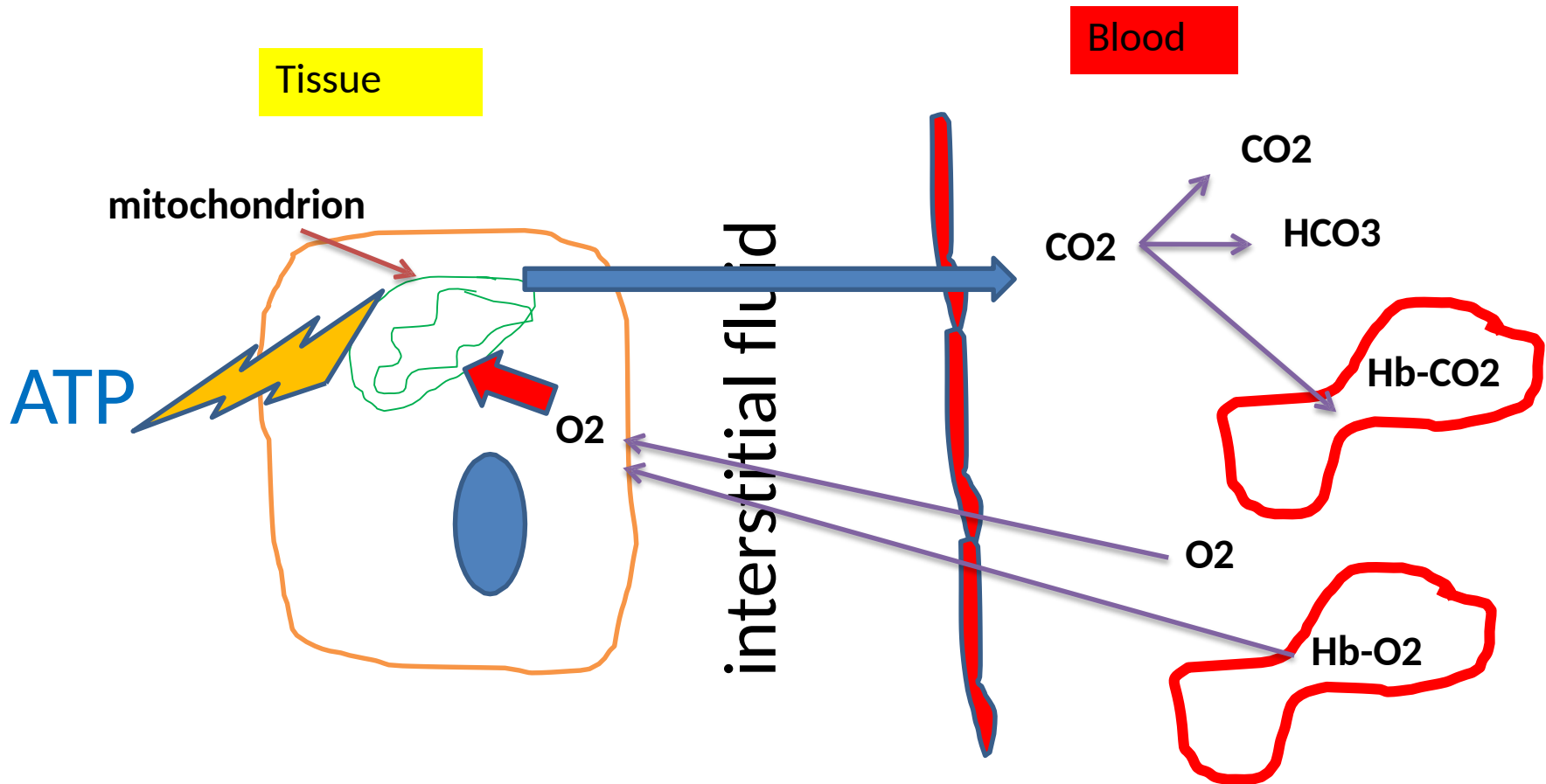
# 3- Gas Transport in the Blood

- **Oxygen** transport in the blood to the tissues by two ways:
  - Inside red blood cells attached to hemoglobin (oxyhemoglobin [ $\text{HbO}_2$ ])
  - A small amount is carried dissolved in the plasma
- **Carbon dioxide** transport from the tissues to blood by three ways:
  - Most is transported in the plasma as bicarbonate ion ( $\text{HCO}_3^-$ )
  - A small amount is carried inside red blood cells on hemoglobin
  - A small part is dissolved in plasma.



## 4- Internal Respiration

- It is exchanging of gases between blood and body cells
- Internal respiration is the process of diffusing  $O_2$  from the blood, into the interstitial fluid and into the cells.
- In this process,  $CO_2$  moves from the tissues into the interstitial fluid and into the blood.
- $O_2$  is used in cellular respiration in mitochondria to make energy (ATP) and as a result  $CO_2$  is generated from this process.



Tissue

Blood

mitochondrion

ATP

O<sub>2</sub>

interstitial fluid

CO<sub>2</sub>

CO<sub>2</sub>

HCO<sub>3</sub>

Hb-CO<sub>2</sub>

O<sub>2</sub>

Hb-O<sub>2</sub>