Respiratory System

Human Biology (ANE106)

Year 1/ Spring semester

Lecture 4

Anesthesia Department

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Respiratory System

The respiratory system is the body system responsible for breathing and gas exchange. Its main role is to supply oxygen to the body cells and remove carbon dioxide produced during metabolism.

Main Functions of the Respiratory System

1. Gas Exchange

- Oxygen enters the blood.
- Carbon dioxide leaves the blood.

2. Regulation of Blood pH

- Carbon dioxide levels influence blood acidity.
- The respiratory system helps maintain acid-base balance.

Main Functions of the Respiratory System

3. Voice Production

- Air passing through the larynx produces sound.

4. Sense of Smell

- Olfactory receptors in the nasal cavity detect odors.

5. Protection

- Filters dust, microbes, and harmful particles.
- Mucus and cilia trap foreign materials.

Why is oxygen important for body cells?

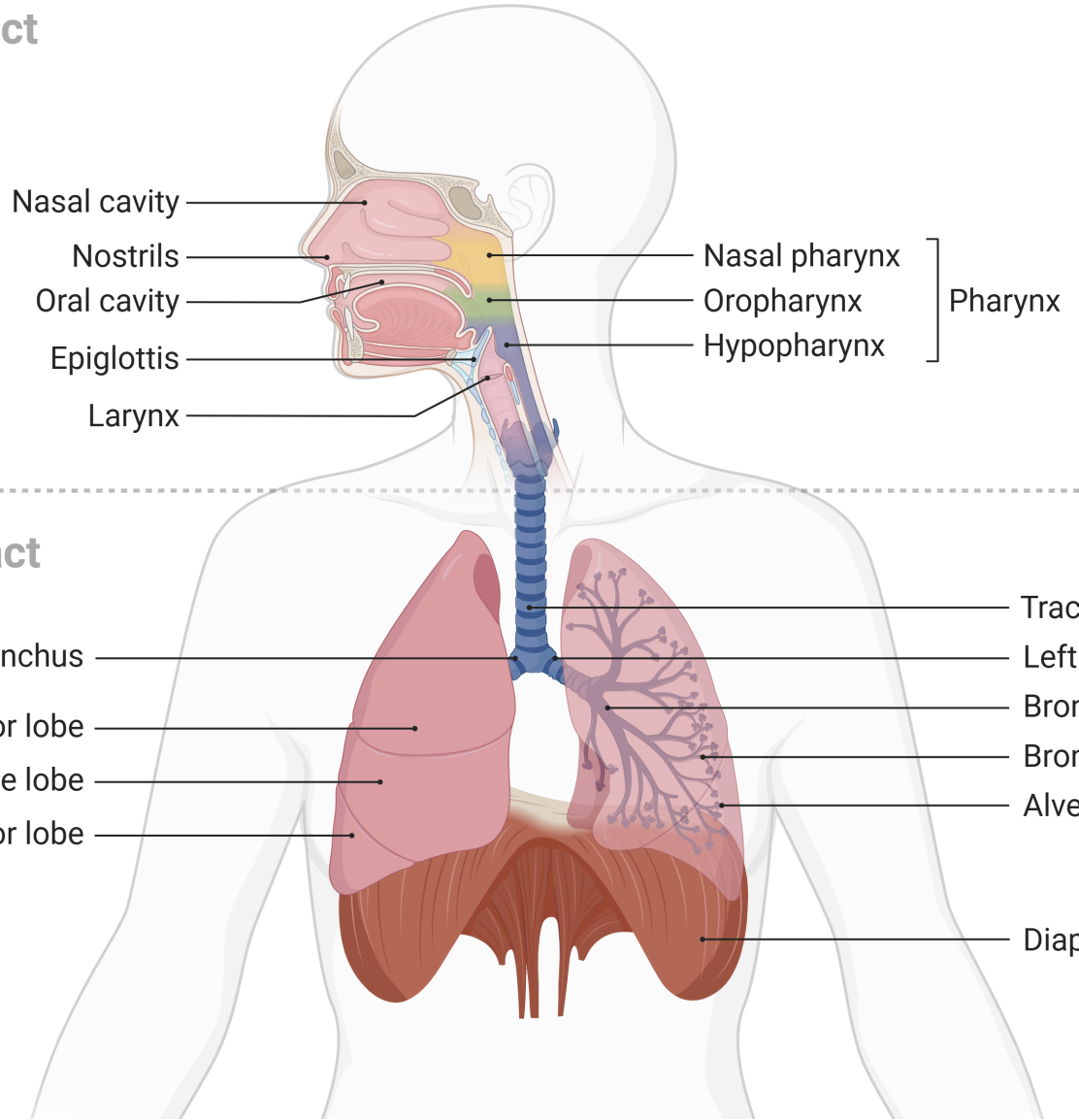
Anatomy of the Respiratory System

The respiratory system is divided into:

- Upper respiratory tract
- Lower respiratory tract

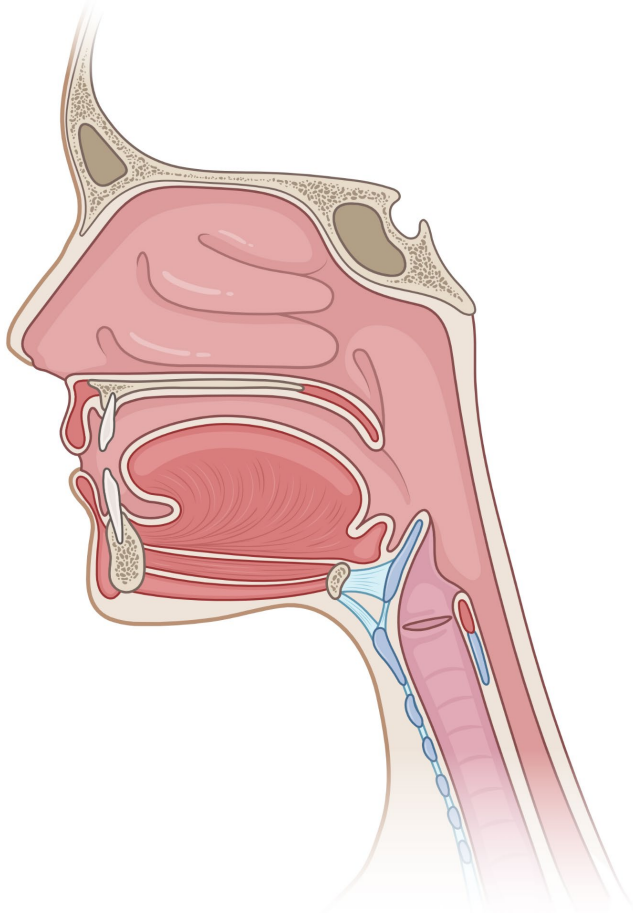
Human Respiratory System

Upper respiratory tract



Lower respiratory tract

Upper Respiratory Tract



A. Nose and Nasal Cavity

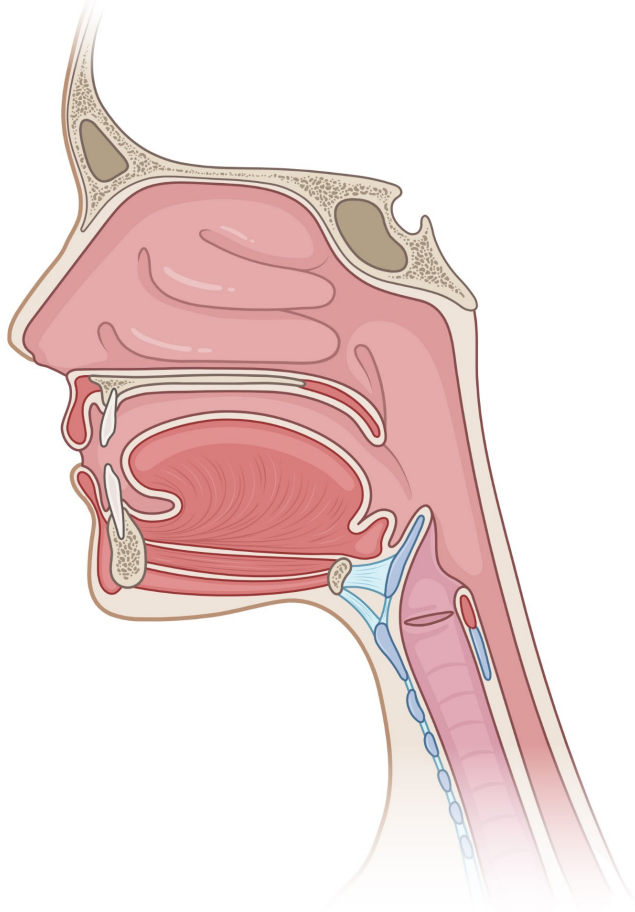
- Functions:
- Filters incoming air
- Warms the air
- Moistens the air
- Contains olfactory receptors

The nasal cavity contains mucus and tiny hair-like structures called cilia that trap dust and microorganisms.

Upper Respiratory Tract

B. Pharynx

The pharynx is a muscular passageway shared by the respiratory and digestive systems.



Divisions of the Pharynx

1. Nasopharynx
2. Oropharynx
3. Laryngopharynx

Functions:

- Passage for air
- Helps in swallowing

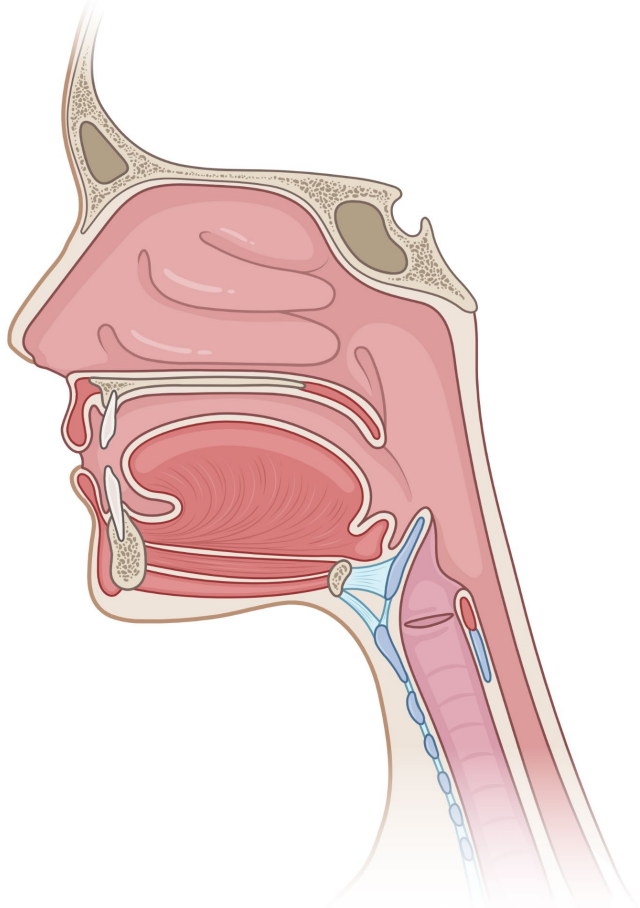
Upper Respiratory Tract

C. Larynx (Voice Box)

The larynx connects the pharynx to the trachea.

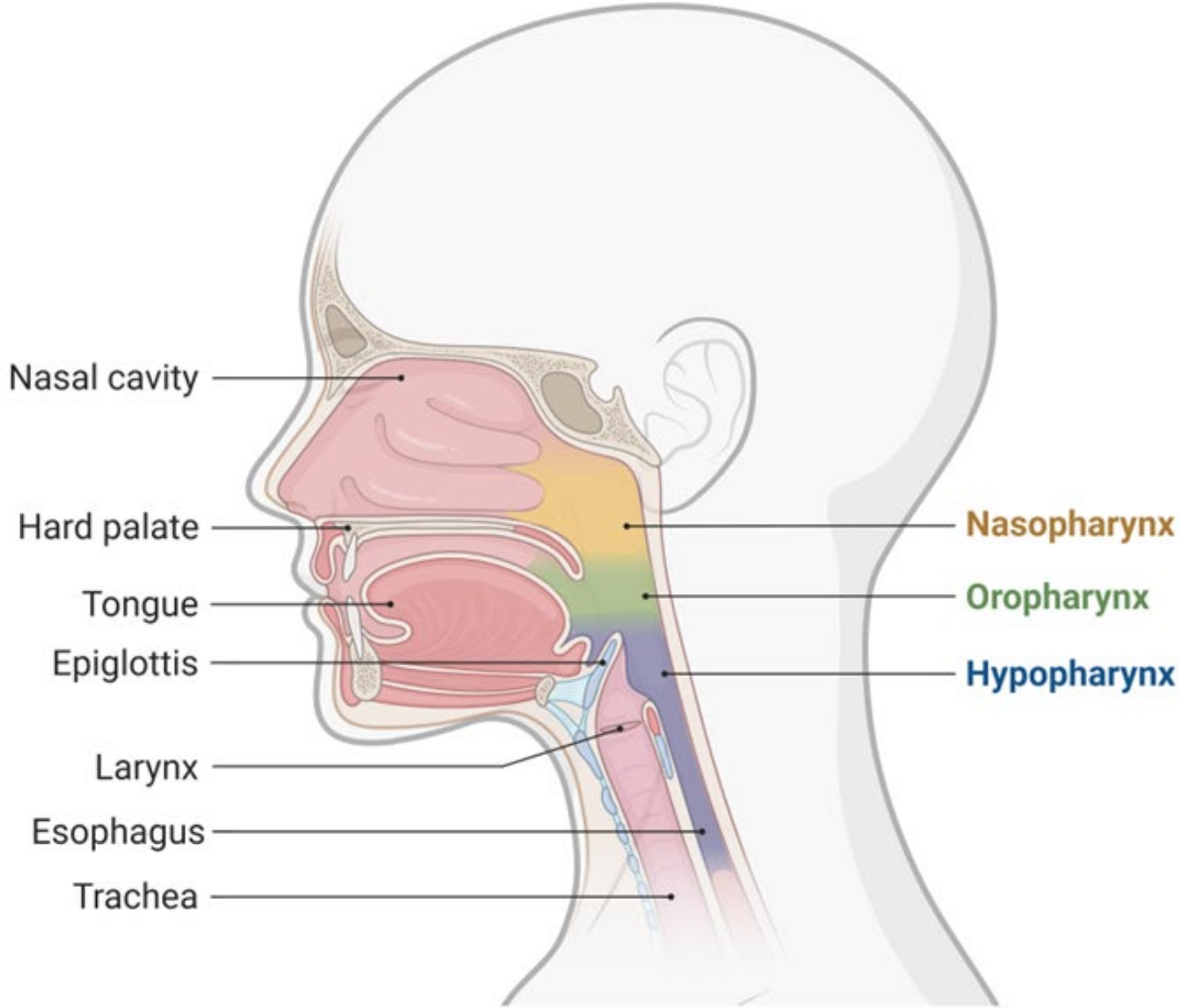
Functions:

- Produces sound
- Maintains open airway
- Prevents food from entering the trachea



Epiglottis

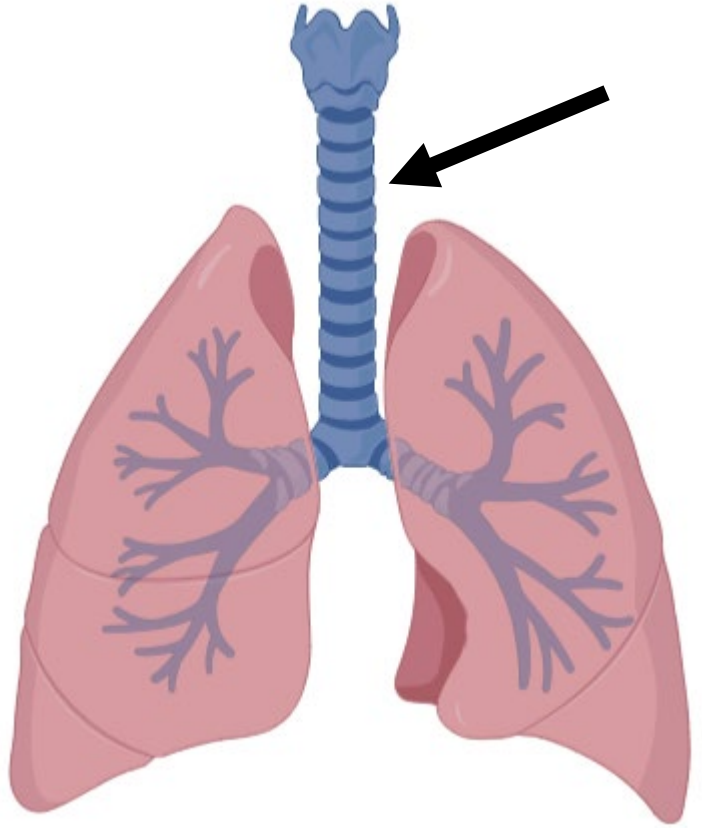
A flap-like structure that closes during swallowing to prevent food aspiration.


Nasal cavity
Hard palate
Tongue
Epiglottis
Larynx
Esophagus
Trachea
Nasopharynx
Oropharynx
Hypopharynx

Lower Respiratory Tract

A. Trachea

The trachea is a tube supported by C-shaped cartila rings.



Functions:

- Conducts air to the bronchi
- Prevents airway collapse

The trachea is lined with ciliated epithelium and mucus.

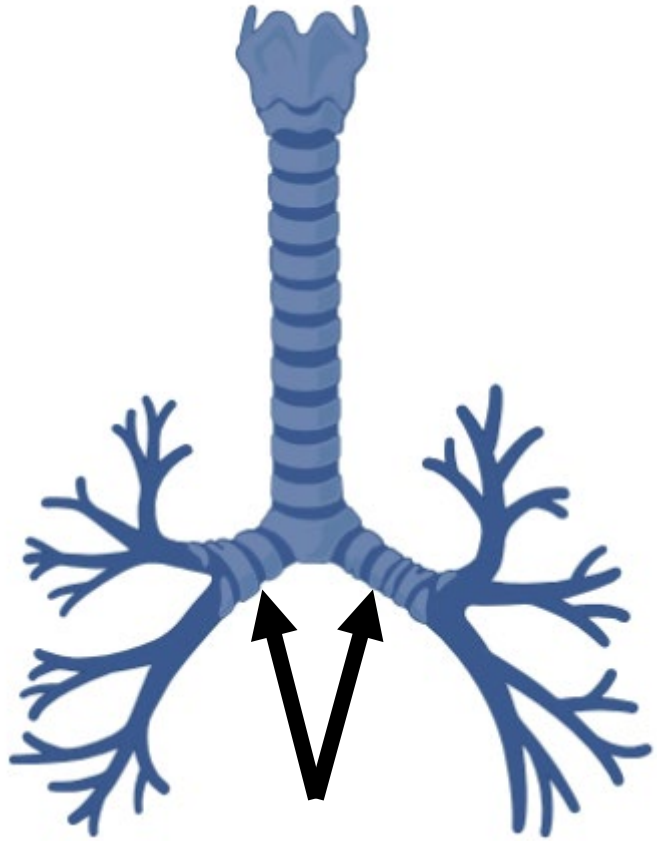
Lower Respiratory Tract

B. Bronchi

The trachea divides into:

- Right primary bronchus
- Left primary bronchus

The right bronchus is wider, shorter, and more vertical.



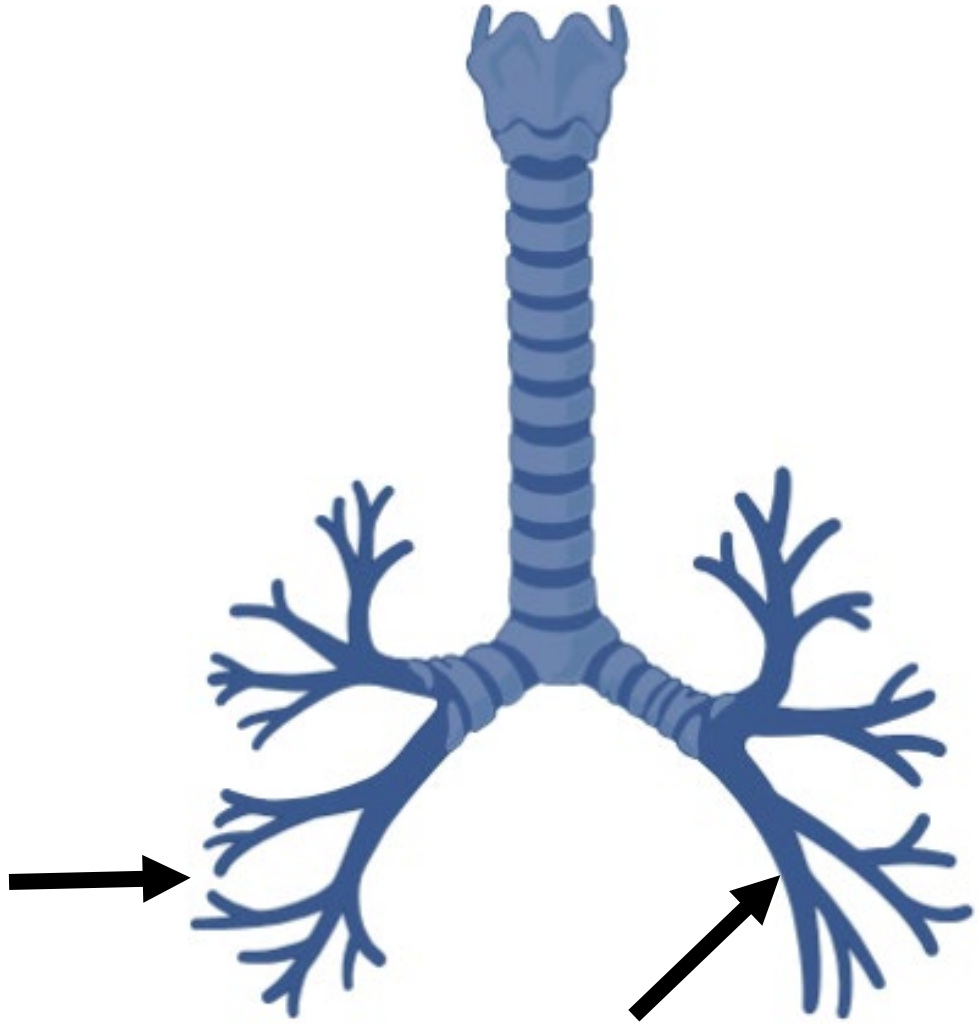
Lower Respiratory Tract

C. Bronchioles

Smaller branches of bronchi.

Characteristics:

- No cartilage
- Smooth muscle present
- Control airflow resistance



Why do you think bronchioles contain smooth muscle?

Lungs

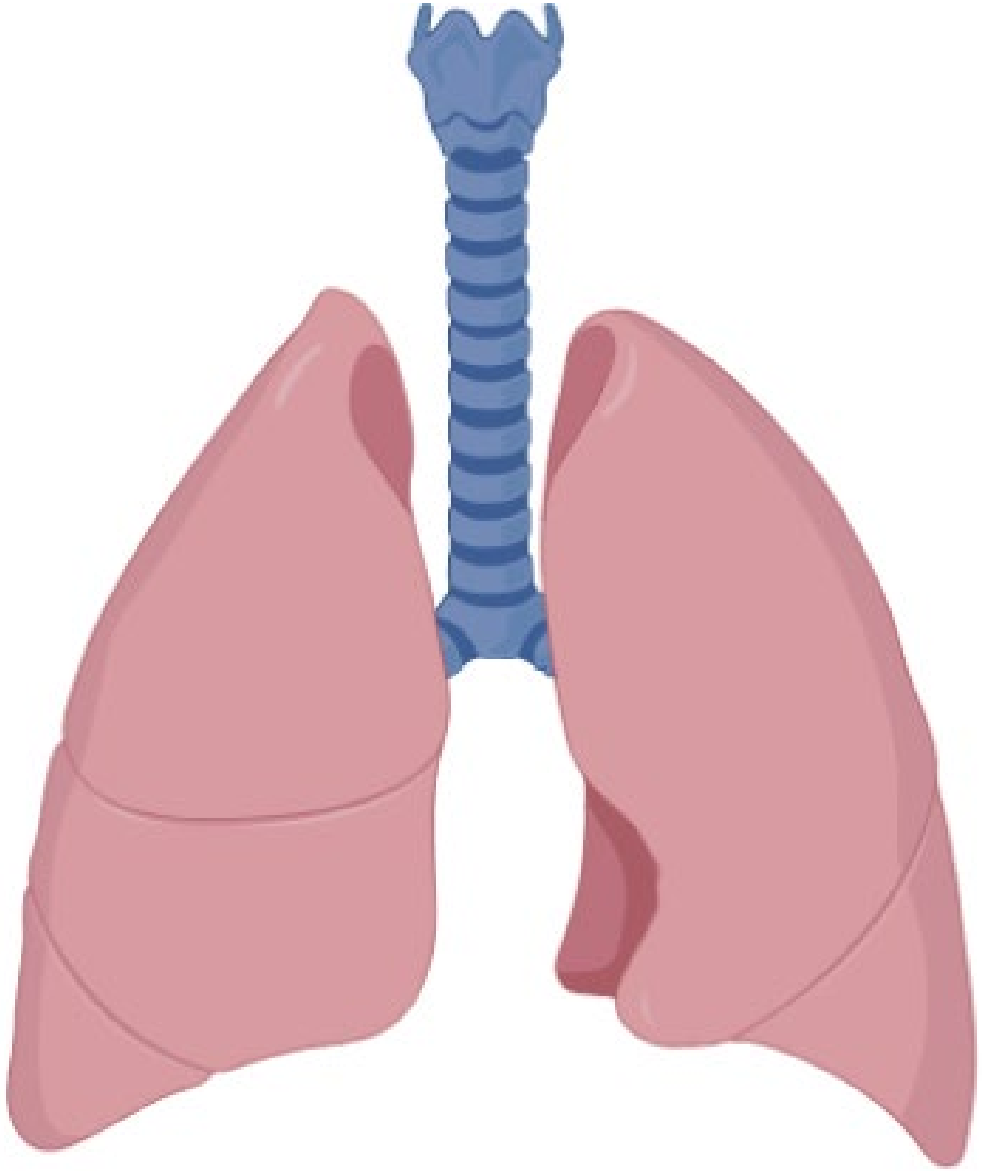
The lungs are paired organs located in the thoracic cavity.

Right Lung

- 3 lobes

Left Lung

- 2 lobes
- Contains cardiac notch for the heart



Pleura

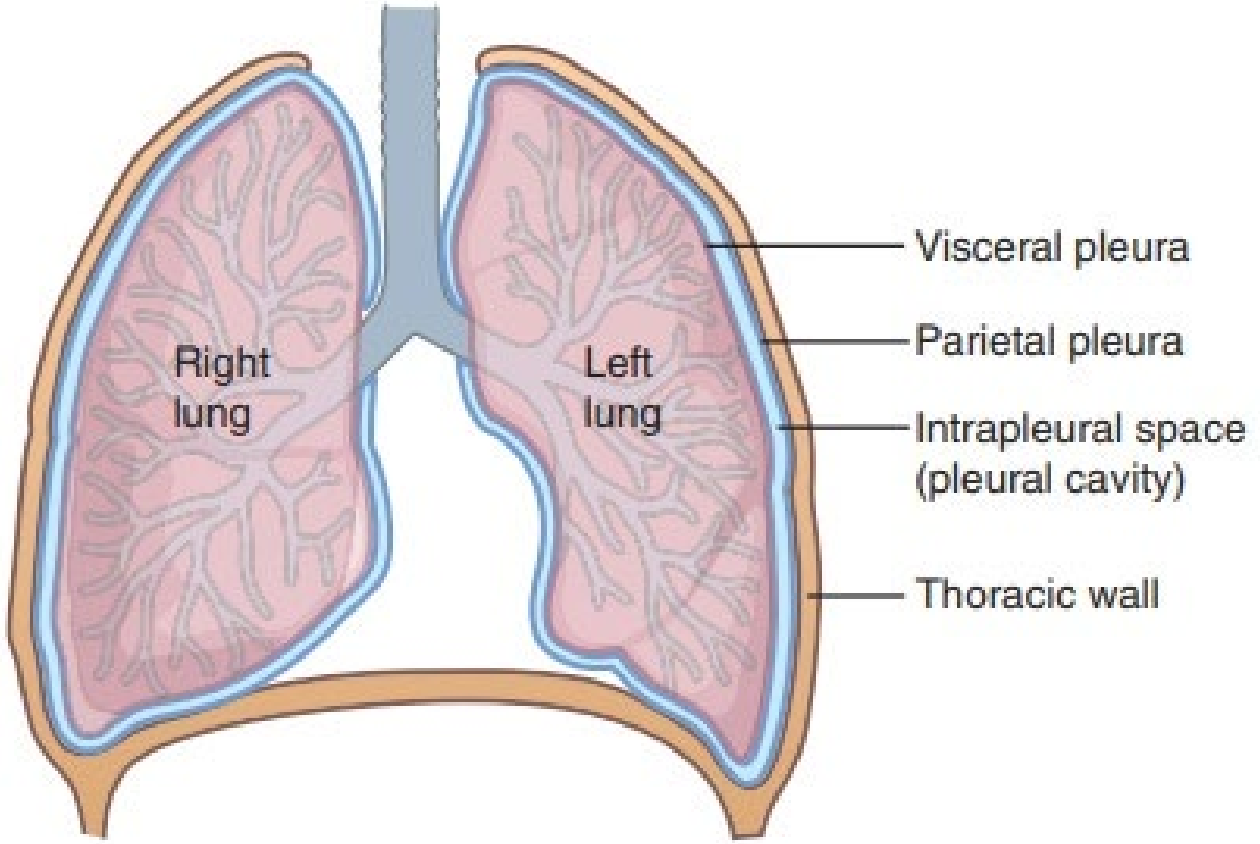
The lungs are surrounded by a double-layered membrane called pleura.

Layers

- Visceral pleura
- Parietal pleura

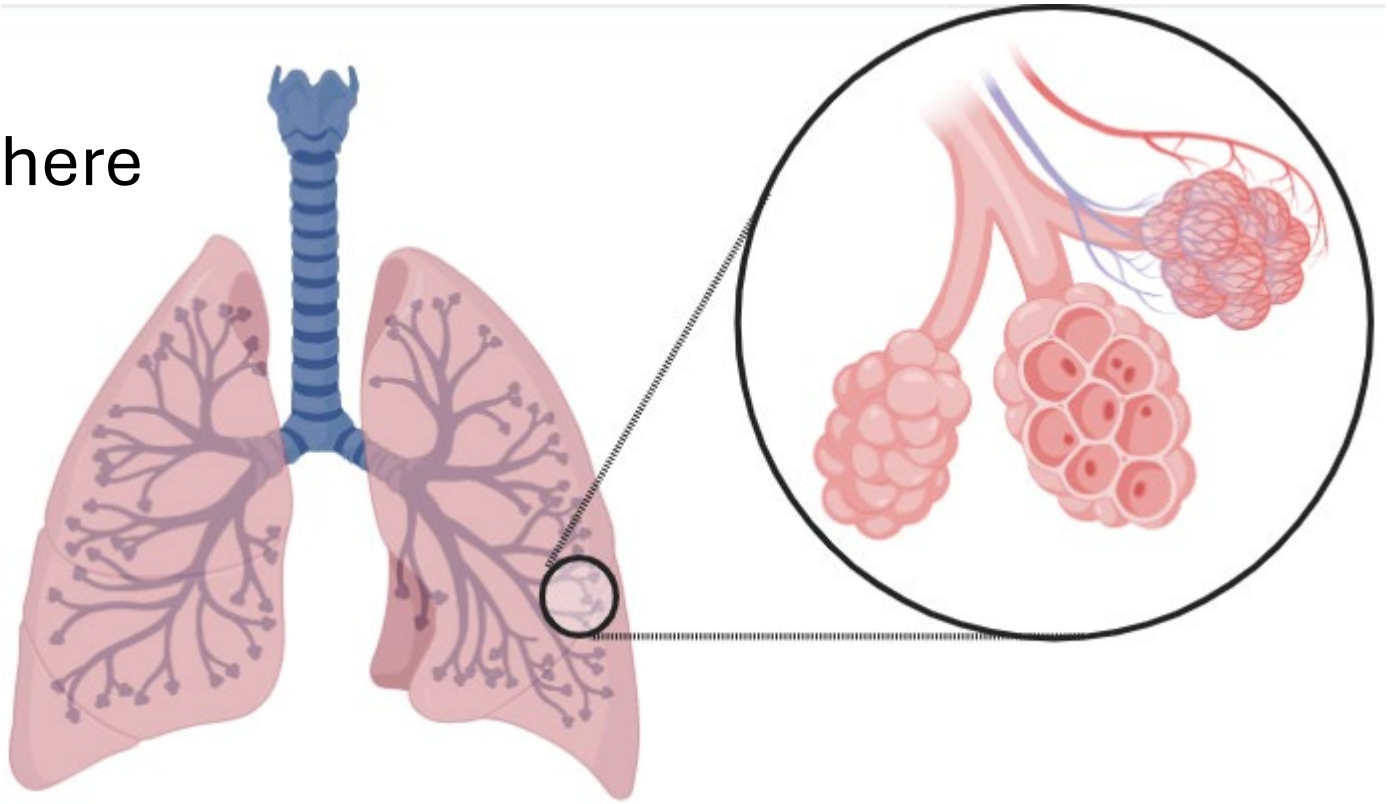
Pleural Fluid

- Reduces friction during breathing



Alveoli

Alveoli are microscopic air sacs where gas exchange occurs.



Characteristics:

- Thin walls
- Rich blood supply
- Large surface area

The walls are one cell thick to allow rapid diffusion.

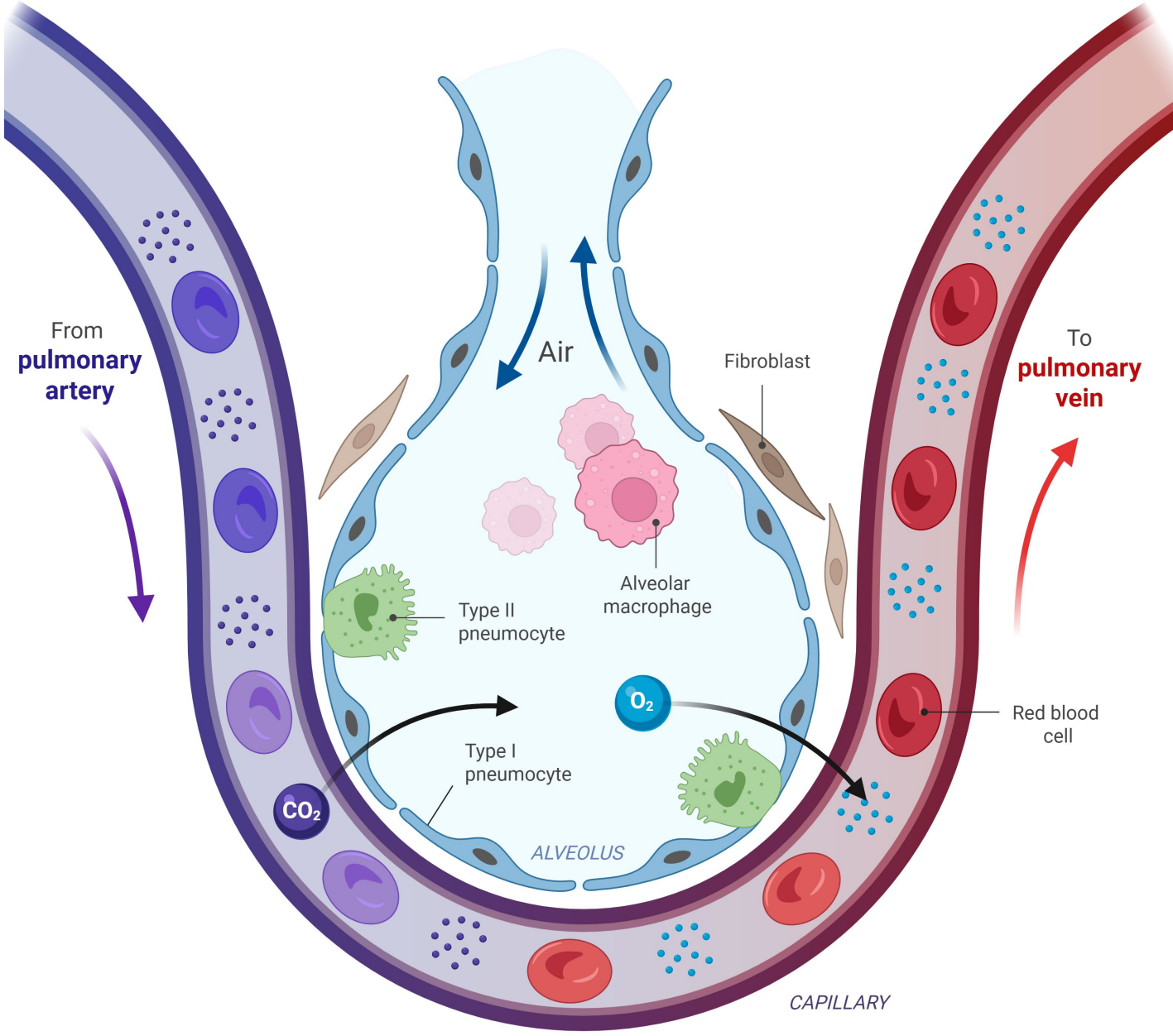
Alveoli

Surfactant

Produced by type II alveolar cells.

Functions:

- Reduces surface tension
- Prevents alveolar collapse



What would happen if alveoli did not contain surfactant?

Mechanics of Breathing

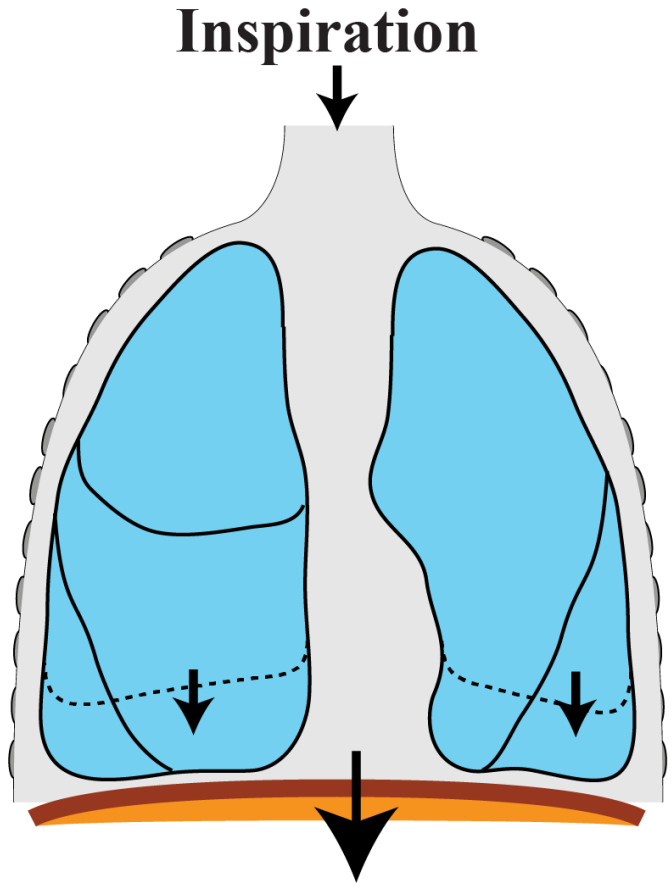
Breathing consists of:

- Inspiration
- Expiration

Inspiration (Inhalation)

During inspiration:

- Diaphragm contracts and moves downward
- External intercostal muscles contract
- Thoracic cavity volume increases
- Lung pressure decreases
- Air enters the lungs



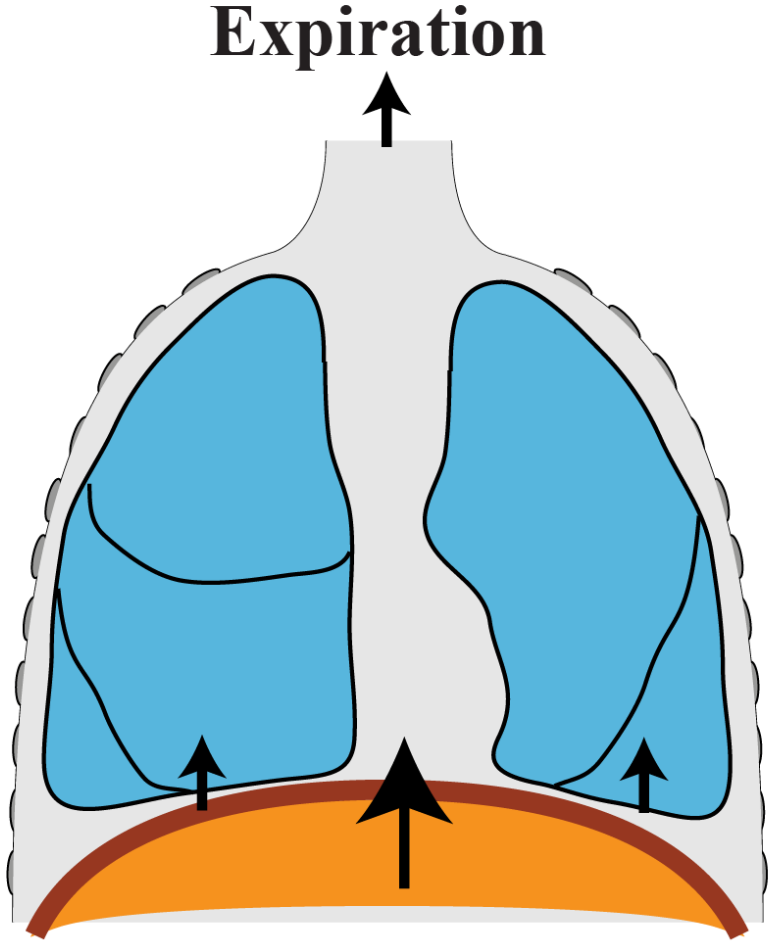
Main Muscle of Inspiration

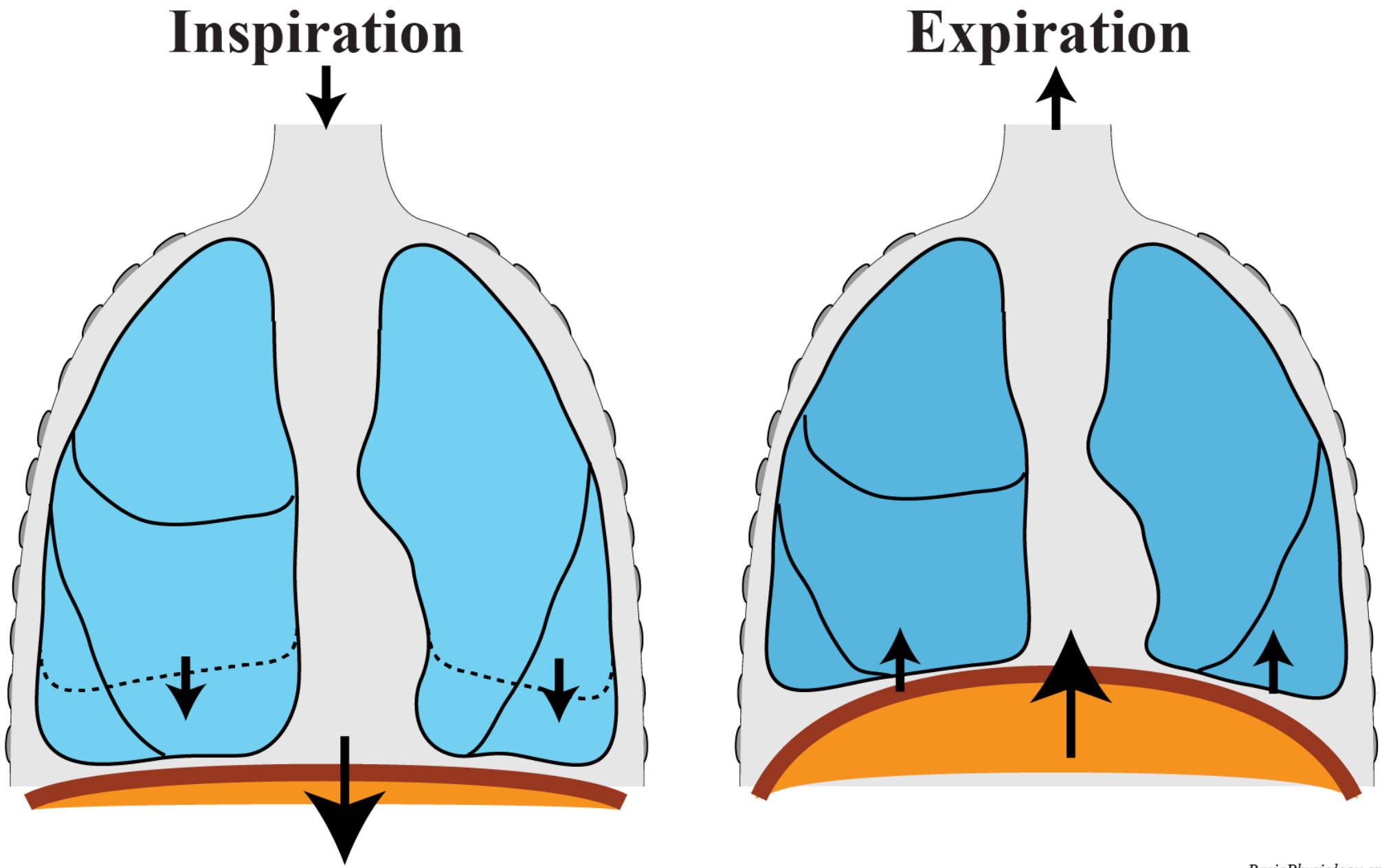
- The diaphragm is the primary muscle involved in breathing.

Expiration (Exhalation)

During quiet expiration:

- Diaphragm relaxes
- Thoracic volume decreases
- Lung pressure increases
- Air leaves the lungs




Inspiration
Expiration
BasicPhysiology.org

Gas Exchange

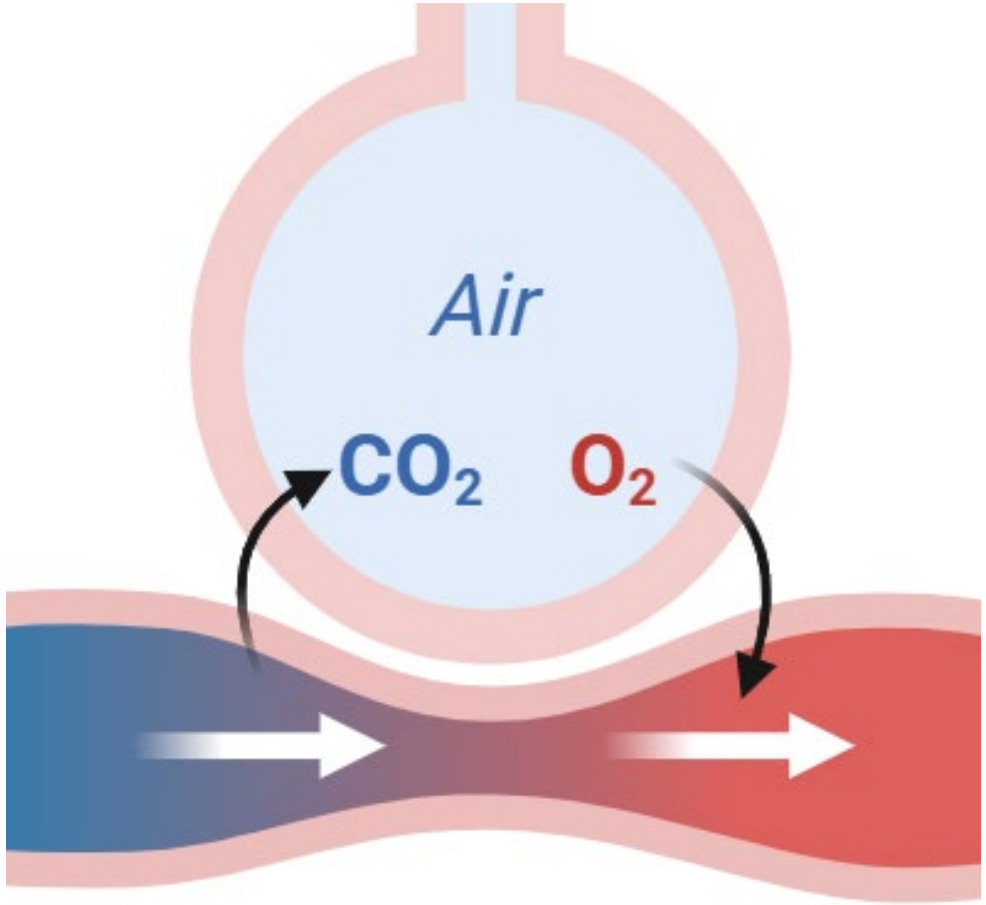
Gas exchange occurs by diffusion.

Oxygen moves:

- From alveoli to blood

Carbon dioxide moves:

- From blood to alveoli



Gas Exchange

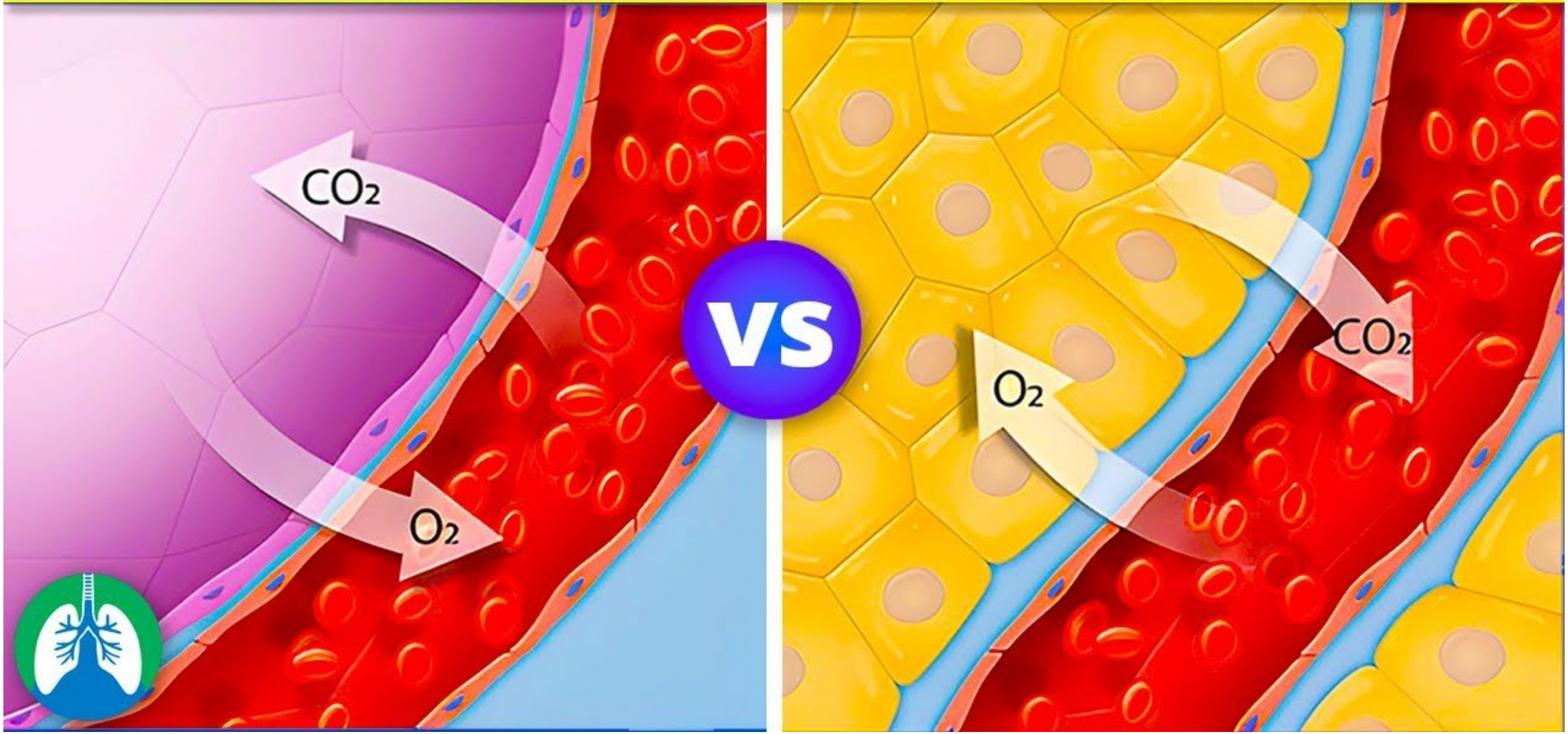
External Respiration

- Exchange of gases between alveoli and blood.

Internal Respiration

- Exchange of gases between blood and body tissues.

EXTERNAL INTERNAL



Factors Affecting Gas Exchange

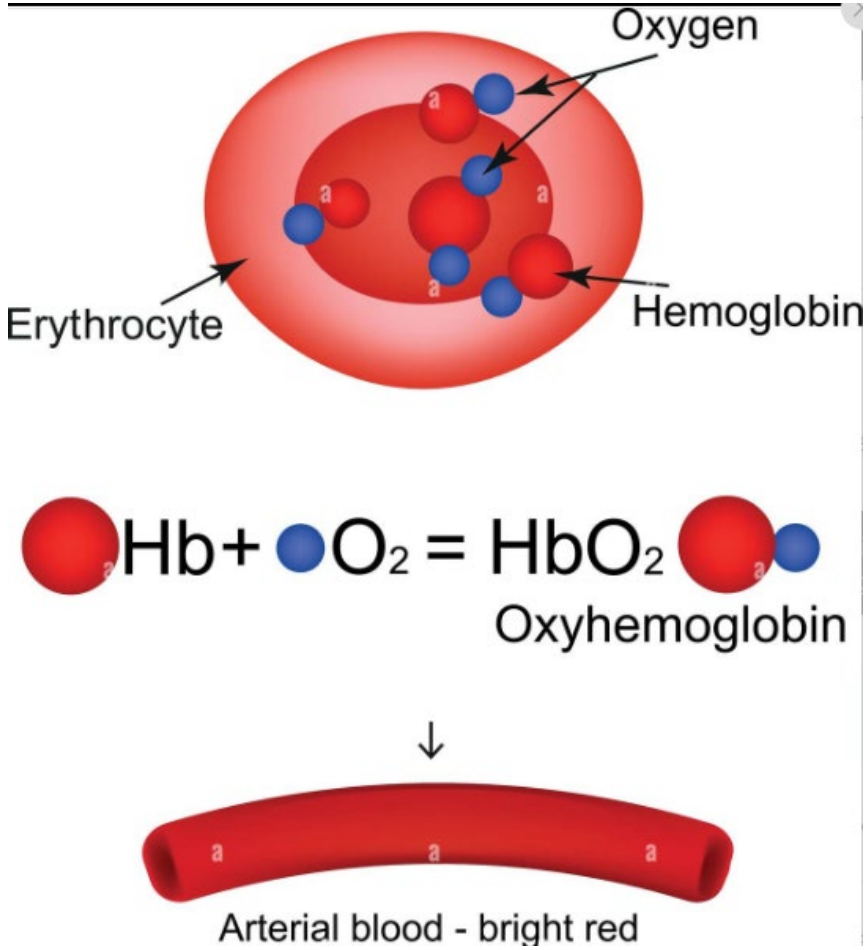
1. Surface area of alveoli
2. Thickness of respiratory membrane
3. Pressure differences
4. Blood supply

Oxygen Transport

Most oxygen is transported bound to hemoglobin inside red blood cells.

Oxyhemoglobin

- Hemoglobin combined with oxygen.
- Small amount of oxygen dissolves directly in plasma.



Carbon Dioxide Transport

- Carbon dioxide is transported in three forms:
- Dissolved in plasma
- Bound to hemoglobin
- As bicarbonate ions

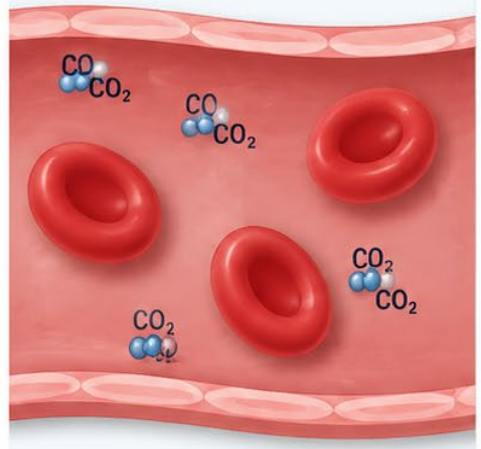
Most carbon dioxide is transported as bicarbonate.

CARBON DIOXIDE (CO_2) IS TRANSPORTED IN THREE FORMS

CO_2 produced in body tissues diffuses into the blood and is carried to the lungs in the following forms:

1 DISSOLVED IN PLASMA

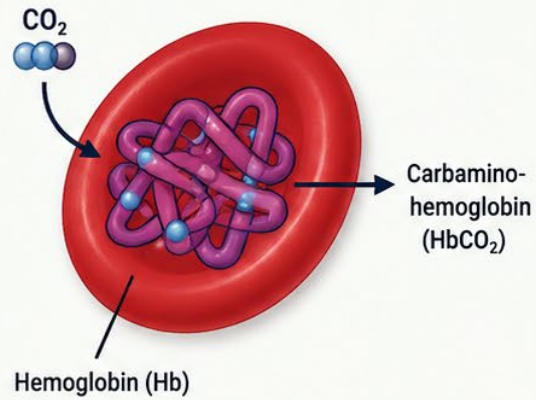
A small amount of CO_2 dissolves directly in the plasma.



~5–10% of total CO_2 transported

2 BOUND TO HEMOGLOBIN

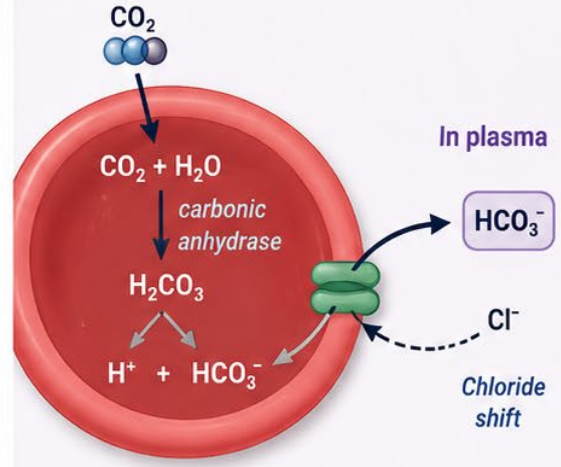
CO_2 binds to the amino groups of hemoglobin, forming carbaminohemoglobin ($HbCO_2$).



~20–30% of total CO_2 transported

3 AS BICARBONATE IONS

CO_2 is converted to bicarbonate (HCO_3^-) inside red blood cells and then enters the plasma.



~60–70% of total CO_2 transported

SUMMARY

Most CO_2 is transported as bicarbonate ions, some as carbaminohemoglobin, and a small amount dissolved in plasma.

- CO_2 (carbon dioxide)
- Hb (hemoglobin)
- Transporter protein (Band 3)
- Red blood cell
- Plasma / Blood vessel

Clinical Correlation

Carbon Monoxide Poisoning

- Carbon monoxide binds strongly to hemoglobin and reduces oxygen transport.

Symptoms:

- Headache
- Dizziness
- Shortness of breath
- Loss of consciousness

Why is carbon monoxide dangerous even in small amounts?

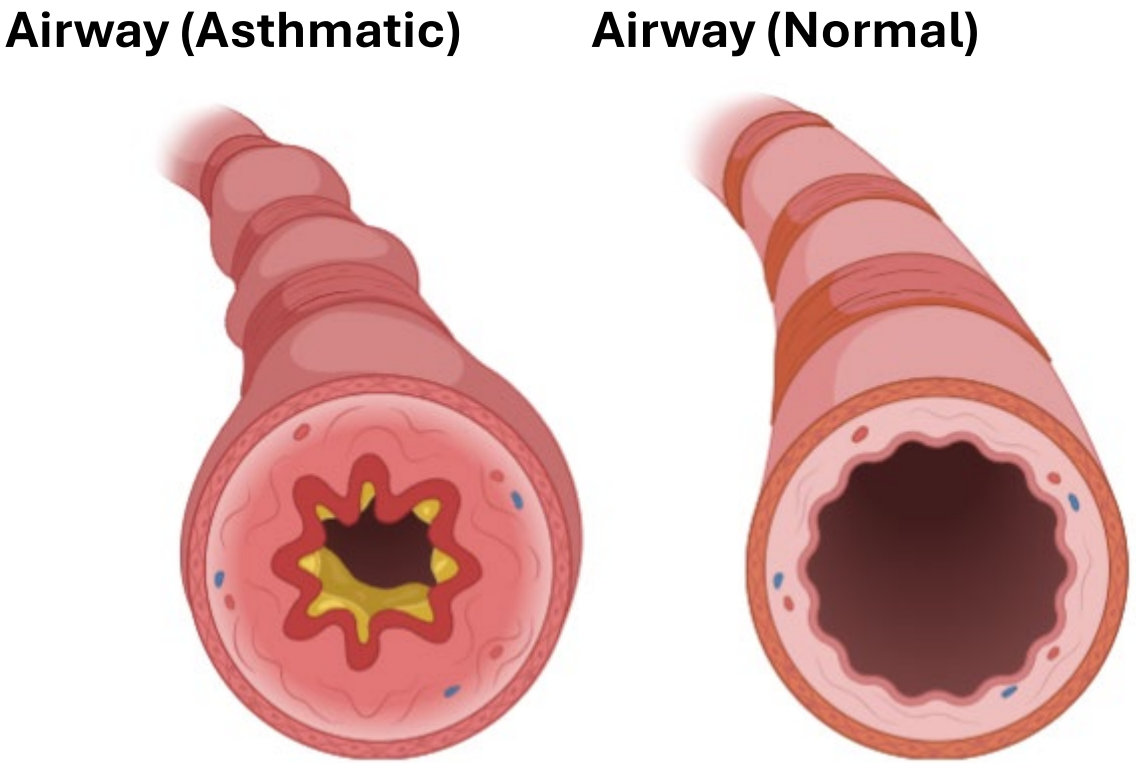
Common Respiratory Disorders

1. Asthma

A chronic inflammatory disease, causing narrowing of airways.

Symptoms:

- Wheezing
- Shortness of breath
- Chest tightness
- Coughing



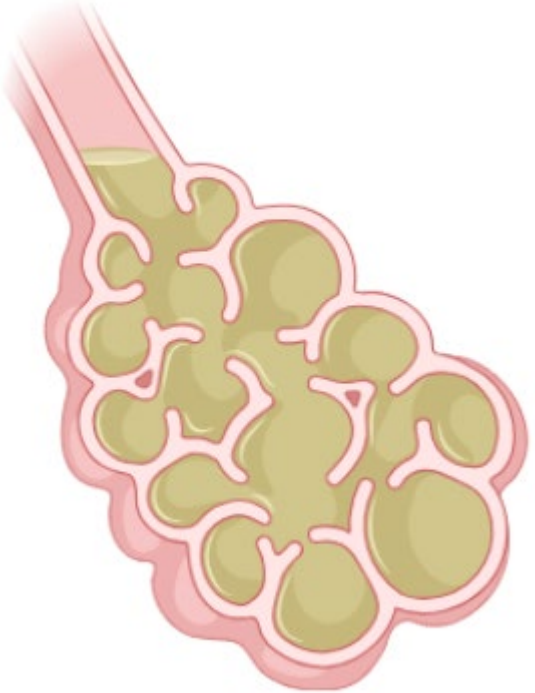
Common Respiratory Disorders

2. Pneumonia

- Infection of lung tissue causing fluid accumulation in alveoli.

Symptoms:

- Fever
- Productive cough
- Difficulty breathing



Common Respiratory Disorders

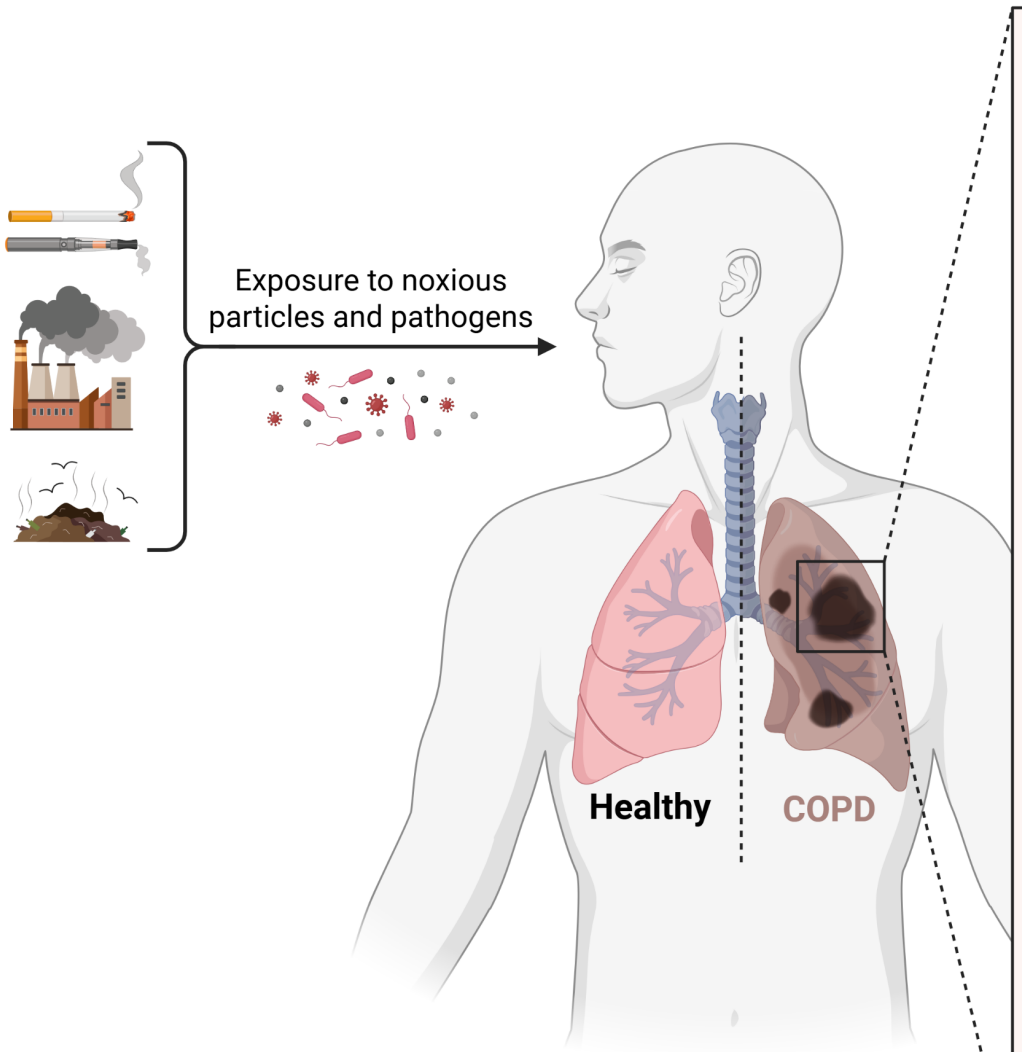
3. Chronic Obstructive Pulmonary Disease (COPD)

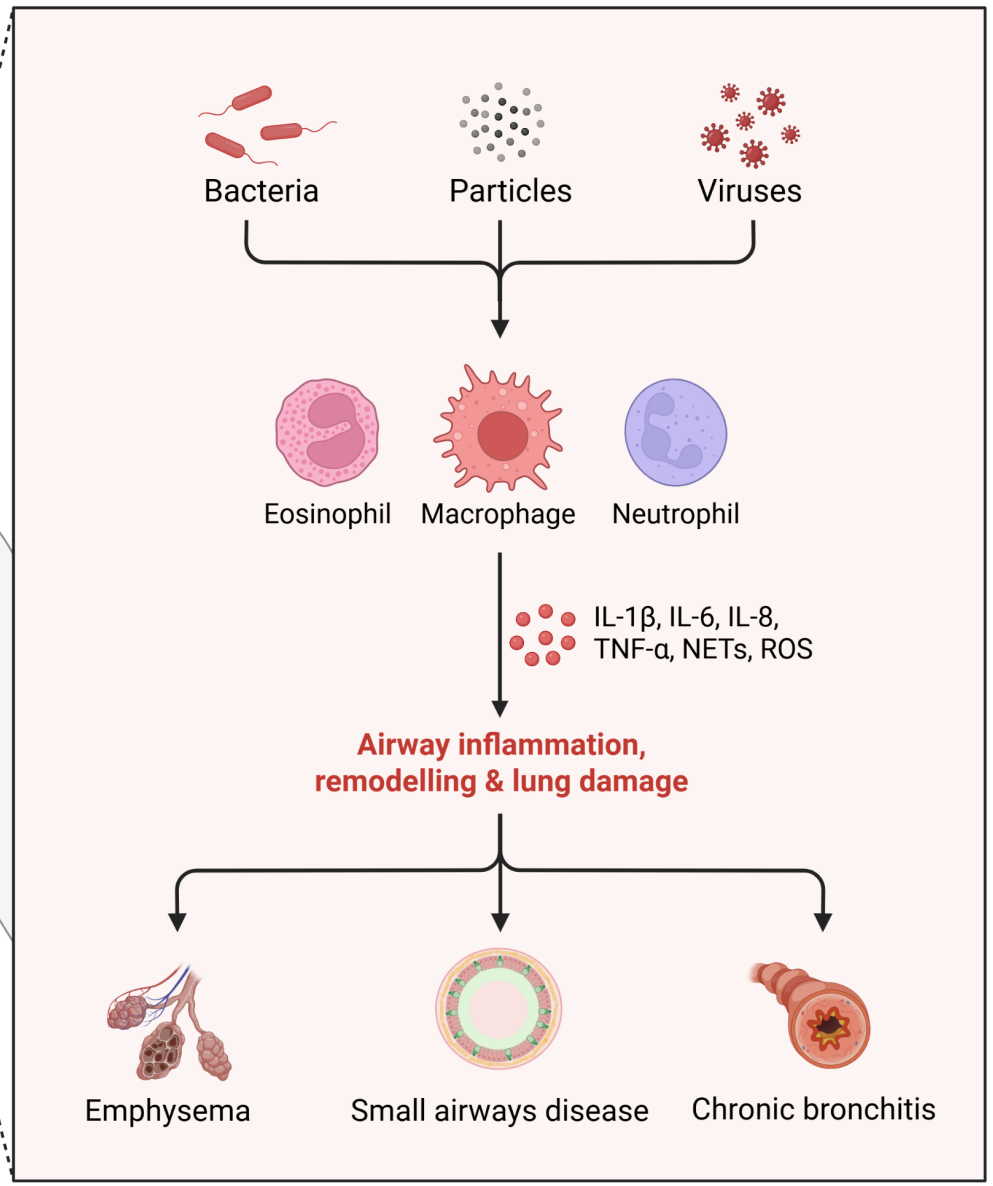
A progressive disease that obstructs airflow.

Common causes:

- Smoking
- Air pollution

Development of Chronic Obstructive Pulmonary Disease (COPD)

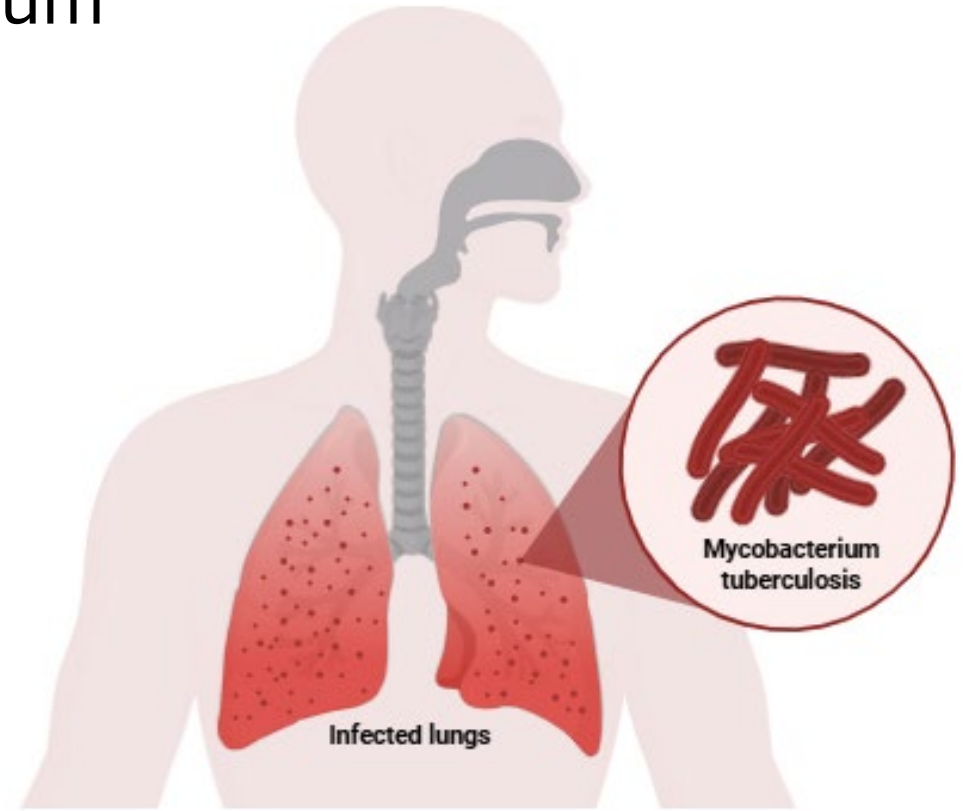




Common Respiratory Disorders

4. Tuberculosis (TB)

- A bacterial infection caused by Mycobacterium tuberculosis.
- Usually affects the lungs.



Common Respiratory Disorders

5. Lung Cancer

- Uncontrolled growth of abnormal lung cells.

Major risk factor:

- Smoking