The Respiratory System

BIO 105
Chapter 14

Functions of the Respiratory System

1. Air distribution
2. Gas exchange
3. Filters, warms, and humidifies air
4. Speech/sound production
5. Olfaction
### Nose

**Functions:**
1. Olfaction
2. Filtration and cleaning
3. Conditioning the air

### Sinuses

**Functions:**
1. Lighten weight of bones
2. Condition air
3. Resonating chambers
Pharynx (throat)

Functions:
1. Serves as a passageway for air and food
2. Tonsils are found here
3. Auditory tube connects

Larynx

Functions:
1. Entrance to the lower respiratory tract

(a) The epiglottis is open during breathing but covers the opening to the larynx during swallowing to prevent food or drink from entering the trachea.
Larynx

Functions:

2. Voice production

During quiet breathing, the vocal cords are near the sides of the larynx, and the glottis is open. During speech, the vocal cords are stretched over the glottis and vibrate as air passes through them, producing the voice.

Trachea

- Also known as the “windpipe”
Bronchial Tree

Bronchi
Bronchioles

Alveoli

(a) Each alveolus is a cup-shaped chamber. In this section, area of the alveolus have been cut open and you can see into them.

(b) Much of the surface of each alveolus is covered with capillaries. The interface provides a vast surface area for the exchange of gases between the alveoli and the blood.

Newborn Respiratory Distress Syndrome

Anatomy Summary

The Lungs and Thoracic Cavity

Epithelium

Type I pneumocyte
Type II pneumocyte
Surfactant
Lined with interstitial fluid
Blood vessels
Membrane

Alveolar structure

(a) Alveolar structure

(b) Exchange surface of alveolus
Alveoli

Function:
Gas-exchanging portion of the respiratory tract

Steps to respiration

- Ventilation
- External respiration
- Gas transport
- Internal respiration

Dalton’s Law

The total pressure exerted by a mixture of gases is the sum of the pressures exerted by the individual gases.

- The pressure of a single gas in a mixture is known as its partial pressure.
Boyle's Law: \( P_1 V_1 = P_2 V_2 \)

Decreasing volume increases collisions and increases pressure.

Ventilation – Inhalation

- The chest cavity increases in size, and pressure within the lungs decreases.
- The diaphragm contracts, and air rushes in.
- The lungs expand, and air rushes in.

Ventilation – Exhalation

- The chest cavity decreases in size, and pressure within the lungs increases.
- The diaphragm relaxes, and air rushes out.

The Respiratory Muscles

The diaphragm is shaped like a parachute.

- Scalenes
- Anterior rectus
- Posterior rectus
A spirometer is used to measure air volumes entering and leaving lungs.

External Respiration

Breathing means air in and out of the lungs.

External respiration is the exchange of oxygen and carbon dioxide between the lungs and the body tissues.

Gas transport means oxygen and carbon dioxide between the lungs and the body tissues.

Internal respiration is the exchange of oxygen and carbon dioxide between blood and the body tissues.

Blood flow

\[ \text{O}_2 = \text{oxygen} \]

\[ \text{CO}_2 = \text{carbon dioxide} \]

Capillary network on surface of alveolus

CO₂ diffuses from blood into alveolar tissue.

O₂ binds to hemoglobin in red blood cell.
Gas Transport

Once gas exchange occurs at the level of the alveoli, how is it transported in the blood?

Internal Respiration

Breathing moves air in and out of the lungs.

External respiration is the exchange of oxygen and carbon dioxide between the lungs and the blood.

Gas transport moves oxygen and carbon dioxide between the blood and the body tissues.

Internal respiration is the exchange of oxygen and carbon dioxide between blood and the body tissues.

Internal Respiration: Gas exchange in capillary beds throughout body tissues

Cytoplasm

Glycolysis

Preparatory reaction

Citric acid cycle

Electron transport chain

NADH and FADH2

CoA

NAD+

O2

H2O

ATP

O2

CO2

Humidity
How is ventilation rate controlled?

**NEURAL CONTROLS**
- Cerebral cortex
- Hypothalamus
- Medulla oblongata
  - Breathing center

**CHEMICAL CONTROLS**
- Medulla oblongata
  - Chemoreceptors respond to increased acidity
  - Increased blood level of carbon dioxide (increased acidity, H⁺)
- Cerebral cortex
  - Hypothalamus
  - Medulla oblongata
  - Breathing center
- Bronchial tubes
  - Chemoreceptors respond to decreased blood level of oxygen
- Lungs
- Heart
- Intercostal muscles
- Diaphragm

Increased blood level of carbon dioxide (increased acidity, H⁺)
- Sensed by chemoreceptors in medulla
- Sensed by peripheral chemoreceptors in aortic and carotid bodies
- Breathing control center in medulla stimulated
- Breathing rate increased (more carbon dioxide exhaled)
- Carbon dioxide level in blood returns to normal