Chapter 15
Respiratory System

Overview: Gas exchange involves breathing, transport of gases, and exchange of gases with tissue cells

- The three phases of gas exchange

**MECHANISMS OF GAS EXCHANGE**

Animals exchange O\(_2\) and CO\(_2\) across moist body surfaces

- Respiratory surfaces must be thin and moist for diffusion of O\(_2\) and CO\(_2\) to occur

- Some animals, like the earthworm use their entire skin as a gas-exchange organ

- In most animals specialized body parts provide large respiratory surfaces for gas exchange
Terrestrial vertebrates have lungs

- In mammals, air inhaled through the nostrils. Air passes through the pharynx and larynx into the trachea, bronchi, and bronchioles.

15.1 The Respiratory System

The Trachea

- Connects larynx with primary bronchi
- Held open by C-shaped cartilage rings
- Cilia sweep mucus toward the pharynx. Smoking can destroy cilia

- The bronchioles end in clusters of tiny sacs called alveoli
  - Where gas exchange occurs

![Diagram of the respiratory system](image-url)
15.2 Mechanisms of Breathing

Respiratory Volumes

- Tidal volume
  - Amount of air moving in and out with each breath
  - Only about 500 ml

- Vital capacity
  - Maximum volume moved in and moved out in a breath
  - Illness can affect vital capacity

- Residual volume
  - Stale air that stays in the lungs

Breathing ventilates the lungs

- Breathing is the alternation of inhalation and exhalation
- The contraction of rib muscles and the diaphragm expands the chest cavity and reduces air pressure in the alveoli (negative pressure breathing)

Breathing is automatically controlled

- Breathing control centers in the brain
  - Keep breathing in tune with body needs, sensing and responding to the CO$_2$ level in the blood
• A drop in blood pH
  – Triggers an increase in the rate and depth of breathing

Blood transports respiratory gases
• The heart pumps oxygen-poor blood to the lungs where it picks up O$_2$ and drops off CO$_2$
• Then the heart pumps the oxygen-rich blood to body cells where it drops off O$_2$ and picks up CO$_2$

Hemoglobin carries O$_2$ and helps transport CO$_2$ and buffer the blood
• Hemoglobin in red blood cells
  – Transports oxygen, helps buffer the blood and carries some CO$_2$

• Most CO$_2$ in the blood
  – Is transported as bicarbonate ions in the plasma
The human fetus exchanges gases with the mother’s bloodstream

- A human fetus
  - Exchanges gases with maternal blood in the placenta

- Fetal hemoglobin
  - Enhances oxygen transfer from maternal blood
  - At birth, increasing CO₂ in the fetal blood
    - Stimulates the breathing control centers to initiate breathing

15.4 Disorders of the Respiratory System

Disorders of the Upper Respiratory Tract

- Pharyngitis
  - Inflammation of the throat
  - *Streptococcus pyogenes* causes “strep throat”

- Tonsillitis
  - Tonsils (lymphoid tissue) become inflamed and enlarged
  - Removed surgically in tonsillectomy

- Laryngitis
  - Inflammation of the larynx
  - Causes hoarseness

- Sinusitis
  - Infection of the cranial sinuses
  - Nasal congestion blocks sinus openings
  - Symptoms include postnasal discharge, headache, and facial pain
15.4 Disorders of the Respiratory System
Disorders of the Lower Respiratory Tract

- Acute bronchitis
  - Inflammation of the primary and secondary bronchi
  - Usually it is preceded by a viral infection that leads to a secondary bacterial infection

- Chronic bronchitis
  - Airways are inflamed and filled with mucus
  - Bronchi have undergone degenerative change including the loss of cilia
  - Smoking is the most common cause

Smoking is a deadly assaults on our respiratory system

- Mucus and cilia in the respiratory passages protect the lungs and can be destroyed by smoking
- Smoking causes lung cancer, heart disease, and emphysema. Lung cancer is the leading cause of cancer death in men and women.

15.4 Disorders of the Respiratory System
Disorders of the Lower Respiratory Tract

- Asthma
  - A disease of the bronchi and bronchioles
  - Marked by wheezing, breathlessness
  - Sometimes coughing and expectoration of mucus
  - Airways are usually sensitive to specific irritants
    - Smooth muscle in bronchioles spasms
  - Incurable but can be treated with medicines
15.4 Disorders of the Respiratory System

Disorder of the Lungs

• Pneumonia
  – Infection in which bronchi or alveoli fill with thick fluid
  – High fever, chest pain, and headache
  – Caused by bacteria, viruses, and other infectious agents

• Pulmonary tuberculosis
  – Caused by the bacterium *Mycobacterium tuberculosis*
  – Cells build a protective capsule (tubercle) around the bacteria
  – TB skin test – checks for exposure to *M. tuberculosis*