Outline – Respiratory System

I. Functions of the respiratory system
II. Parts of the respiratory system
III. Mechanics of breathing
IV. Regulation of breathing
V. Disorders of the respiratory system
The function of the respiratory system is to bring oxygen into the body and remove carbon dioxide.
Cells Lining Respiratory Tract

- Lined by **pseudostratified ciliated columnar epithelial cells**:
  - Cilia sweep mucus, germs, and debris toward the throat.

- Mucus produced by **goblet cells**.

- Smoking damages the ciliated cells!
(a) The cilia are yellow in this color-enhanced electron micrograph. The cells without cilia secrete mucus.

(b) Cigarette smoke first paralyzes and then destroys the cilia. As a result, hazardous materials can accumulate on the surfaces of the air passageways.
**Respiratory System**

**UPPER RESPIRATORY SYSTEM**
- Filters, warms, and moistens air

**Nasal cavity**
- Produces mucus
- Filters, warms, and moistens air
- Olfaction

**Sinuses**
- Cavities in skull
- Lighten head
- Warm and moisten air

**Pharynx**
- Passageway for air and food

**RESPIRATORY MUSCLES**
- Cause breathing

**Intercostal muscles**
- Move ribs during breathing

**Diaphragm**
- Muscle sheet between chest and abdominal cavities with a role in breathing
**Respiratory System**

**LOWER RESPIRATORY SYSTEM**
- Exchanges gases

**Larynx**
- Air passageway
- Prevents food and drink from entering lower respiratory system
- Produces voice

**Bronchi**
- Two branches of trachea that conduct air from trachea to each lung

**Bronchioles**
- Narrow passageways to conduct air from bronchi to alveoli

**Epiglottis**
- Covers larynx during swallowing

**Lungs**
- Structures that contain alveoli and air passageways
- Allow exchange of oxygen and carbon dioxide between atmosphere and blood

**Trachea**
- Connects larynx with bronchi leading to each lung
- Conducts air to and from bronchi

**Alveoli**
- Microscopic chambers for gas exchange

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1. Nasal Cavity

- **Functions:**
  1. Filter
  2. Warm air entering the lungs
  3. Moisten
  4. Smell
1. Nasal Cavity

- Parts of the nasal cavity:
  - Mucus membranes – secrete sticky mucus to trap germs and debris.
  - Olfactory receptor cells – important for the sense of smell.
  - Sinuses – air-filled cavities that warm and moisten air.
2. Pharynx

- **Functions:**
  - Passageway for air, liquids, and food (swallowing begins here).
  - Connects the nasal cavity with the esophagus and the larynx.

- Tonsils are also found here:
  - Lymphatic tissue that protects against infection.
3. Larynx

- **Functions:**
  1. Connects the pharynx to the trachea.
  2. Contains vocal cords used to generate sound.
  3. Prevents food from entering lower respiratory tract.

- Structure made from cartilage.

- Epiglottis closes the trachea when swallowing.
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.
4. Trachea

- Windpipe held open by concentric rings of cartilage.

- **Function:**
  - Connects the larynx to the bronchi.

- Trachea leads to the bronchial tree:
  - Bronchi (bronchus)
  - Bronchioles
  - Alveoli (alveolus)
Bronchial Tree
7. Alveoli

- Sacs at the end of the bronchioles:
  - Surrounded by blood capillaries.

- **Function:**
  - Oxygen diffuses across the membrane into the capillaries, and carbon dioxide goes from the capillaries to the inside of the lungs.
Alveoli

- Lungs have about 300 million alveoli!
- The structure of the alveoli increases surface area of lung.
- For alveoli to function properly, they are coated with phospholipid molecules called **surfactant** that help keep them open.
Gas Exchange in the Body

- $O_2$ enters and $CO_2$ leaves the lungs = external respiration.

- $O_2$ and $CO_2$ are exchanged between the blood vessels and tissues = internal respiration.

- This gas exchange is due to diffusion across the alveoli and capillaries.
Diffusion of Gases: Alveoli and Capillaries

O₂ = oxygen
CO₂ = carbon dioxide

Blood flow

Capillary network on surface of alveolus

CO₂ diffuses from blood plasma into alveolus
O₂ binds to hemoglobin in red blood cell

External Respiration: Gas exchange in lungs
Internal Respiration: Gas exchange in capillary beds throughout body tissues.
Oxygen Transport

- Oxygen is transported on hemoglobin.
- When oxygen is bound to hemoglobin, then it is called oxyhemoglobin.
Carbon Dioxide Transport

1. Dissolved in the plasma (10%)

2. Bound to hemoglobin (20%)

3. Converted to bicarbonate ions (70%):

\[
\text{CO}_2 + \text{H}_2\text{O} \xrightarrow{\text{Carbonic anhydrase}} \text{H}_2\text{CO}_3 \xrightarrow{} \text{H}^+ + \text{HCO}_3^- 
\]
Which cells secrete mucus?

1. Ciliated columnar epithelial
2. Goblet
3. Squamous epithelial
4. Osteocytes
The tube connecting the larynx to the primary bronchi is called the:

1. pharynx
2. trachea
3. bronchioles
4. alveoli
Common passageway for air, food, and drink:

1. pharynx
2. trachea
3. bronchioles
4. alveoli
Conducts air from the trachea to the bronchioles:

1. pharynx
2. trachea
3. bronchi
4. alveoli
Gas exchange takes place here:

1. pharynx
2. trachea
3. bronchioles
4. alveoli
The primary mechanism of carbon dioxide transport in the blood is:

1. Dissolved in the plasma
2. Bound to hemoglobin
3. Converted to bicarbonate ions
Inhalation

The lungs expand, and air moves in.

The chest cavity increases in size, and pressure within the lungs decreases.

Diaphragm contracts and flattens

Intercostal muscles contract

Rib cage moves up and out

The lungs expand, and air moves in.
Inhalation

- When the **diaphragm** and **intercostal muscles** contract, the volume of the thoracic cavity increases, causing the pressure in the lungs to decrease.
  - This draws air INTO the lungs.

- Inhalation is also called inspiration.
Exhalation

The lungs recoil, and air moves out.

The chest cavity decreases in size, and pressure within the lungs increases.

Diaphragm relaxes and moves upward

Intercostal muscles relax

Rib cage moves down and inward

Air flow

The lungs recoil, and air moves out.
Exhalation

- When the same muscles relax, the volume of the thoracic cavity decreases, and pressure in the lungs increase.
  - This pushes air OUT OF the lungs.

- Exhalation is also called expiration.
Air Volumes

- The volume of air inhaled or exhaled during a normal breath is called the **tidal volume**.

- Tidal volume is usually around 500 mL.

- The volume of air moved into and out of the lungs is an indication of health.
Regulation of Breathing

- Normally we take 12-15 breaths per minute.
- This rate is controlled by the medulla oblongata region of the brain.
  - Nerves transmit the signals to the diaphragm and muscles.
- Chemoreceptors in the medulla oblongata and arteries detect levels of \( \text{CO}_2 \) and \( \text{O}_2 \) in the blood, controlling the rate and depth of breathing.
Respiratory Disorders

- Common cold
- Flu
- Pneumonia
- Strep Throat
- Asthma
- Emphysema
- Lung Cancer
Respiratory Disorders – Common Cold

- Caused by several types of viruses.

- Symptoms: runny nose, sore throat, sneezing, nasal discharge.

- Treatment: rest and plenty of fluids!

- Prevention: wash your hands!
Respiratory Disorders – Flu

- Caused by the *influenza* viruses.

- Symptoms: similar to colds, but appear suddenly and are more severe.
  - Fever and chills, muscle aches, headache, and weakness.

- Treatment and prevention: same as a cold
  - Can take medications to ease symptoms.
Respiratory Disorders – Pneumonia

- Inflammation of the lungs that causes fluid to accumulate in the alveoli, reducing gas exchange.

- Usually caused by a viral or bacterial infection.

- Symptoms: fever, chills, chest pain, cough, shortness of breath.

- Treatment depends on cause: bacteria can be treated with antibiotics.
Respiratory Disorders – Strep Throat

- Caused by *Streptococcus* bacteria.
- Can lead to rheumatic fever, which can damage heart, and kidney disease.
- Symptoms: sore throat accompanied by swollen glands and fever.
- Treatment: antibiotics
Respiratory Disorders – Asthma

- Smooth muscles surrounding the bronchi spasm.
  - Causes the bronchi to constrict, making it hard to breathe.

- Causes and triggers: allergies, colds, exercise, stress
Respiratory Disorders – Emphysema

- Caused by the destruction of alveoli, usually by smoking.

  (a) Normal alveoli
  (b) Emphysema causes breakdown of alveolar walls.

- Reduction in the surface area available for gas exchange results in shortness of breath.

- Treatment: no cure, but can supplement with oxygen and use medications to dilate airways.
Lung Cancer

- Results from uncontrolled cell division.
- Often caused by inhaled carcinogens, including those found in tobacco smoke.
  - Smoke irritates the lining of the bronchi.
- The cilia that normally function to clear dust and particles from the lungs are destroyed.
- Between 85–90% of lung cancer is from smoking.
Lung Cancer

Figure 14.15
Important Concepts

- Read Chapter 14
- What is the function of the respiratory system?
- What is the location and function of all the parts of the respiratory system?
- What are the parts of the nasal cavity and their functions?
- What are the parts of the larynx and their functions?
Important Concepts

- Which cell types line the trachea and what are their functions?
- Where does the exchange of gases occur in the lungs?
- What controls the rate of breathing?
- You should be able to discuss the mechanics of breathing (inhalation and exhalation).
Important Concepts

- How are oxygen and carbon dioxide carried in the blood?
  - You do not need to know the chemical equation of bicarbonate formation.

- Discuss the disorders of the respiratory system including: description, symptoms, cause, and treatments.
Definitions

- Goblet cell, sinuses, epiglottis, surfactant, diaphragm, intercostal muscles, inhalation/inspiration, exhalation/expiration, tidal volume, oxyhemoglobin, chemoreceptors