33.3 The Respiratory System

Identify the structures of the respiratory system and describe their functions.

Describe gas exchange.

Describe how breathing is controlled.

Describe the effects of smoking on the respiratory system.

Lesson Summary

Structures of the Respiratory System  For organisms, respiration means the process of gas exchange between a body and the environment. The human respiratory system picks up oxygen from the air we inhale and releases carbon dioxide into the air we exhale. The structures of the respiratory system include the

- nose, where air is filtered, moisturized, and warmed.
- pharynx, or throat, which serves as a passageway for both air and food.
- trachea, or windpipe, and the larynx, or vocal cords.
- bronchi, two large tubes that lead to the lungs. Each bronchus branches into smaller passageways called bronchioles that end in tiny air sacs called alveoli within the lungs.

Gas Exchange and Transport  Oxygen and carbon dioxide are exchanged across the walls of alveoli and capillaries. Chemical properties of blood and red blood cells allow for efficient transport of gases throughout the body.

- Carbon dioxide and oxygen are exchanged across capillary and alveolus walls.
- Hemoglobin binds with and transports oxygen that diffuses from alveoli to capillaries. It also increases the efficiency of gas exchange.
- Carbon dioxide is transported in the blood in three ways. Most combines with water and forms carbonic acid. Some dissolves in plasma. Some binds to hemoglobin and proteins in plasma.

Breathing  Movements of the diaphragm and rib cage change air pressure in the chest cavity during inhalation and exhalation.

- The dome-shaped muscle at the bottom of the chest cavity is the diaphragm. During inhalation, contraction of the diaphragm and rib muscles increases chest volume and air rushes in. In exhalation, these muscles relax and air rushes out.
- The nervous system has final control of the breathing muscles. Breathing does not require conscious control.

Smoking and the Respiratory System  Chemicals in tobacco smoke damage structures throughout the respiratory system and have other negative health effects. Smoking causes a number of diseases, including chronic bronchitis, emphysema, and lung cancer.
Structures of the Respiratory System

1. Label each of the structures indicated in this drawing of the human respiratory system.

   - nose
   - pharynx
   - larynx
   - trachea
   - bronchus
   - lung

Gas Exchange and Transport

For Questions 2–7, complete each statement by writing the correct word or words.

2. The surface area for gas exchange in the lungs is provided by the ________.

3. The gases exchanged in the lungs are carbon dioxide and ________.

4. The process that exchanges gases across the walls of capillaries is ________.

5. Oxygen diffuses from an area of ________ concentration to an area of lesser concentration.

6. ________ binds with oxygen and increases the blood’s oxygen-carrying capacity.

7. Most carbon dioxide combines with ________ in the blood, forming carbonic acid.
Breathing

8. Complete the flowchart to show how breathing works.

![Flowchart showing breathing process]

Smoking and the Respiratory System

9. Complete the table to describe the health effects of three substances in tobacco smoke.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicotine</td>
<td>Nicotine is addictive. It increases heart rate and blood pressure.</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>Carbon monoxide is a poisonous gas that blocks hemoglobin from binding with oxygen, thus interfering with oxygen transport in the blood.</td>
</tr>
<tr>
<td>Tar</td>
<td>Tar contains at least 60 compounds known to cause cancer.</td>
</tr>
</tbody>
</table>

10. What causes smoker’s cough?
   Tobacco smoke paralyzes cilia in the trachea. Inhaled particles stick to the walls of the respiratory tract or enter the lungs. Smoke-laden mucus is trapped along the airways. Irritation from all this triggers a cough as the smoker tries to clear the airways.

11. Smoking even a few cigarettes on a regular basis can lead to chronic bronchitis. What happens to people with this disease?
   They often find simple activities, like climbing stairs, difficult.

Apply the Big Idea

12. Smoking and secondhand smoke damage both the respiratory system and the circulatory system. Explain how the close structural relationship of these two systems accounts for the effect of smoke on both systems.
   Gases are exchanged across the thin membranes of alveoli and the thin walls of the capillaries. Compounds in smoke affect both structures, reducing airflow in the alveoli and interfering with the oxygen-binding capacity of hemoglobin.
Chapter Vocabulary Review

Across
1. the sinoatrial node of the heart
3. fluid and the small particles it contains that leaves blood cells
5. the circulation pathway that sends blood from the heart to the lungs and back to the heart
8. a muscle layer in the heart
10. the build-up of fatty deposits in artery walls
14. the smallest blood vessel
15. Leukocytes, or ___________ blood cells, guard against infection.
16. the protein in the blood that binds oxygen

Down
2. an upper chamber of the heart
4. the fluid portion of the blood
6. a blood vessel that returns blood from the body to the heart
7. a structure that keeps blood moving through the heart in one direction
9. a lower chamber of the heart
10. a blood vessel that carries blood from the heart to body tissues
11. Erythrocytes, or ___________ blood cells, transport oxygen.
12. the circulation that sends blood from the heart to all the body except the lungs
13. a cell fragment that makes blood clotting possible

For Questions 17–19, complete each statement by writing the correct word or words.

17. The throat is also called the ___________.
18. The windpipe is also called the ___________.
19. The vocal cords are in the ___________.
IN THE BLOOD

The Chapter Mystery focused on a rare genetic disease known as familial hypercholesterolemia. Far more common are diseases that are often directly associated with cigarettes and other types of tobacco use: lung cancer and heart disease.

Smoking, Lung Cancer, and Heart Disease: Should the FDA Regulate Tobacco?

Lung cancer and heart disease are among the nation’s top killers. Together, they account for the deaths of hundreds of thousands of Americans each year.

Federal lawmakers have long debated how to best regulate tobacco products. A bill passed in the House of Representatives would require the U.S. Food and Drug Administration (FDA) to regulate cigarettes and other tobacco products if it is enacted.

Read the following statement made on the floor of the U.S. House of Representatives by Congressmember Rosa DeLauro (D-CT) urging passage of the bill, called H.R.1108:

HOUSE OF REPRESENTATIVES, JULY 30, 2008

Ms. DeLAURO. Madam Speaker, I rise in support of H.R. 1108, the Family Smoking Prevention and Tobacco Control Act. This legislation would grant the Food and Drug Administration (FDA) long-needed authority to regulate the manufacture, sale, distribution and marketing of tobacco products.

As we all know, tobacco use contributes to the death of more than 400,000 Americans and costs the nation’s health care system nearly $100 billion each year. The most tragic part of this statistic is that virtually all of these deaths are preventable. It is alarming that preventable diseases such as emphysema, heart disease and cancer all can be attributed to the use of tobacco. In addition to providing consumers with science-based information about tobacco products, granting FDA the authority to regulate tobacco will more importantly help protect our children from using these products. Approximately 90 percent of all adult smokers began their habit while in their teens, or earlier, and two-thirds become regular, daily smokers before they reach the age of 19. According to the American Medical Association, each day, about 4,000 children try smoking a cigarette for the first time and another 1,000 become new, regular, daily smokers. This means that one-third of these children will die prematurely.

Despite their claims to the contrary, the tobacco companies continue to market their products aggressively toward children. This bill will give FDA the authority to impose marketing restrictions, labeling requirements, as well as to ban candy-flavored tobacco products in order to prevent tobacco companies from addicting children to tobacco. This bill has strong bipartisan support, and is endorsed by key groups including the American Cancer Society, the American Medical Association, the American Heart Association, the American Lung Association, and Campaign for Tobacco-Free Kids.
21st Century Themes  Science and Civic Literacy, Science and Health Literacy

1. How many deaths in the United States are directly attributed to tobacco use each year?
   More than 400,000

2. How much are tobacco-related diseases estimated to cost the United States health care system annually?
   Nearly $100 billion each year

3. If the U.S. Food and Drug Administration (FDA) regulated tobacco products, what changes could the agency impose?
   The FDA could impose marketing restrictions, labeling requirements, and ban candy-flavored tobacco products.

4. At what age did most adult smokers begin their habit?
   Approximately 90 percent of all adult smokers began their habit while in their teens, or earlier.

5. Do you think that bill H.R. 1108 should be passed into law? Why or why not?
   Answers will vary. Accept any answers that show logical reasoning and are supported by facts.

21st Century Learning  Letter to Your Senator

The skills used in this activity include critical thinking and systems thinking, information and media literacy, communication skills, and social responsibility.

Using the Internet, visit the Library of Congress’s powerful legislative database called “Thomas,” named after the third U.S. President, Thomas Jefferson. Use the database to track the status of bill H.R. 1108. Read the bill, search for comments by other representatives, and review the economic assessment of the bill from the Congressional Budget Office. Based on this research, write a letter to your Senator voicing your opinion about whether the bill should be, or should have been, passed into law. Clearly state your reasons why or why not in your letter.

Evaluate students’ letters based on their inclusion of facts about the bill and careful reasoning about its impact. Their arguments for or against the bill should be supported by facts.