chapter **46**

Physiology of the Respiratory System

Objectives

AFTER STUDYING THIS CHAPTER, THE STUDENT WILL BE ABLE TO:

1. Review roles and functions of the main respiratory tract structures in oxygenation of body tissues.
2. Describe the role of carbon dioxide in respiration.
3. List common signs and symptoms affecting respiratory function.
4. Identify general categories of drugs used to treat respiratory disorders.

OVERVIEW

The respiratory system helps meet the basic human need for oxygen (O_2). Oxygen is necessary for the oxidation of foodstuffs, by which energy for cellular metabolism is produced. When the oxygen supply is inadequate, cell function is impaired; when oxygen is absent, cells die. Permanent brain damage occurs within 4 to 6 minutes of anoxia. In addition to providing oxygen to all body cells, the respiratory system also removes carbon dioxide (CO_2), a major waste product of cell metabolism. Excessive accumulation of CO_2 damages or kills body cells.

The efficiency of the respiratory system depends on the quality and quantity of air inhaled, the patency of air passageways, the ability of the lungs to expand and contract, and the ability of O_2 and CO_2 to cross the alveolar–capillary membrane. In addition to the respiratory system, the circulatory, nervous, and musculoskeletal systems have important functions in respiration. Additional characteristics of the respiratory system and the process of respiration are described in the following sections.

Respiration

Respiration is the process of gas exchange by which O_2 is obtained and CO_2 is eliminated. This gas exchange occurs between the lung and the blood across the alveolar–capillary membrane and between the blood and body cells. More specifically, the four parts of respiration are:

- *Ventilation*—the movement of air between the atmosphere and the alveoli of the lungs
- *Perfusion*—blood flow through the lungs
- *Diffusion*—the process by which O_2 and CO_2 are transferred between alveoli and blood and between blood and body cells
- *Regulation* of breathing by the respiratory muscles and nervous system

Respiratory Tract

The respiratory tract is a series of branching tubes with progressively smaller diameters. These tubes (nose, pharynx, larynx, trachea, bronchi, and bronchioles) function as air passageways and air "conditioners" that filter, warm, and humidify incoming air. Most of the conditioning is done by the ciliated mucous membrane that lines the entire respiratory tract, except the pharynx and alveoli. *Cilia* are tiny, hair-like projections that sweep mucus toward the pharynx to be expectorated or swallowed. The mucous membrane secretes mucus, which forms a protective blanket and traps foreign particles, such as bacteria and dust.

When air is inhaled through the nose, it is conditioned by the nasal mucosa. When the nasal passages are blocked, the mouth serves as an alternate airway. The oral mucosa may warm and humidify air but cannot filter it.

Pharynx, Larynx, and Trachea

Air passes from the nasal cavities to the pharynx (throat). Pharyngeal walls are composed of skeletal muscle, and their lining is composed of mucous membrane. The pharynx contains the palatine tonsils, which are large masses of lymphatic tissue. The pharynx is a passageway for food, fluids, and air. Food and fluids go from the pharynx to the esophagus, and air passes from the pharynx into the trachea.

The larynx is composed of nine cartilages joined by ligaments and controlled by skeletal muscles. It contains the vocal cords and forms the upper end of the trachea. It closes