The work of breathing is described by the formula minute volume (MV) equals the tidal volume (TV) times the respiratory rate (RR) \[ MV = TV \times RR \].\(^2\) When a patient increases his or her respiratory rate, the TV is decreased. Thus, there is more wasted ventilation that only moves in the dead space of the tracheobronchial tree. Less alveolar ventilation takes place and less oxygen is available. The effort of trying to take a deep breath and cough, in addition to a rapid respiratory rate just to breathe, exhausts the patient.

The upper and lower airways provide the structural support for the entry of air into the lungs. The upper airways consist of the nose, pharynx, and larynx. The nose warms the air, humidifies the air, and filters the air, thus protecting the lower airways from foreign particles. The pharynx is the area behind the nasal and oral cavities and extends to the top of the esophagus and larynx. The larynx is a complex structure similar to a sphincter valve. By closing, it protects the lower airways from food, liquids, and foreign objects. It also controls the airflow in and out that is needed for speaking and coughing. The lower airways include the trachea and bronchial tree. Separation between the trachea and bronchial tree is at the carina (Figure 3-1). The lungs are divided in five lobes, which are then in turn divided into bronchopulmonary segments. The right lung has three lobes (upper, middle, and lower) and ten segments. The left lung has two lobes (upper and lower) and eight segments (Figure 3-2).

Gas exchange takes place via the oxygen transport pathway (see Pattern A: Primary Prevention/Risk Reduction for the Cardiovascular/Pulmonary Disorders). The pathway starts in the upper airways and flows through the pulmonary system to the tissue level. Adequate gas exchange depends on the processes of ventilation and respiration.

**NORMAL RESPIRATION AND PULMONARY FUNCTION**

First and foremost, respiration encompasses the entire process of the interchange of gases within the human body, and therefore includes the taking in of oxygen, the utilization of oxygen in the tissues, and the giving off of carbon dioxide. Five processes occur during respiration.\(^1\) Understanding these processes can assist with differentiating between healthy and diseased breathing. These processes are ventilation, distribution, diffusion, perfusion, and circulation. Ventilation is simply the movement of air into and out of the lungs. Ventilation is often misunderstood for respiration; however, ventilation does not guarantee that the oxygen inhaled will combine with the blood in the lungs. Distribution is the passage of the air throughout the lungs to the alveoli. Adequate distribution occurs when the air reaches the areas of the lungs that have the most alveoli for gas exchange. In the normal upright lung, there are less alveoli in the upper or apical regions of the lung and a significant increase in alveoli in the lower regions or bases of the lungs. Diffusion is the passage...