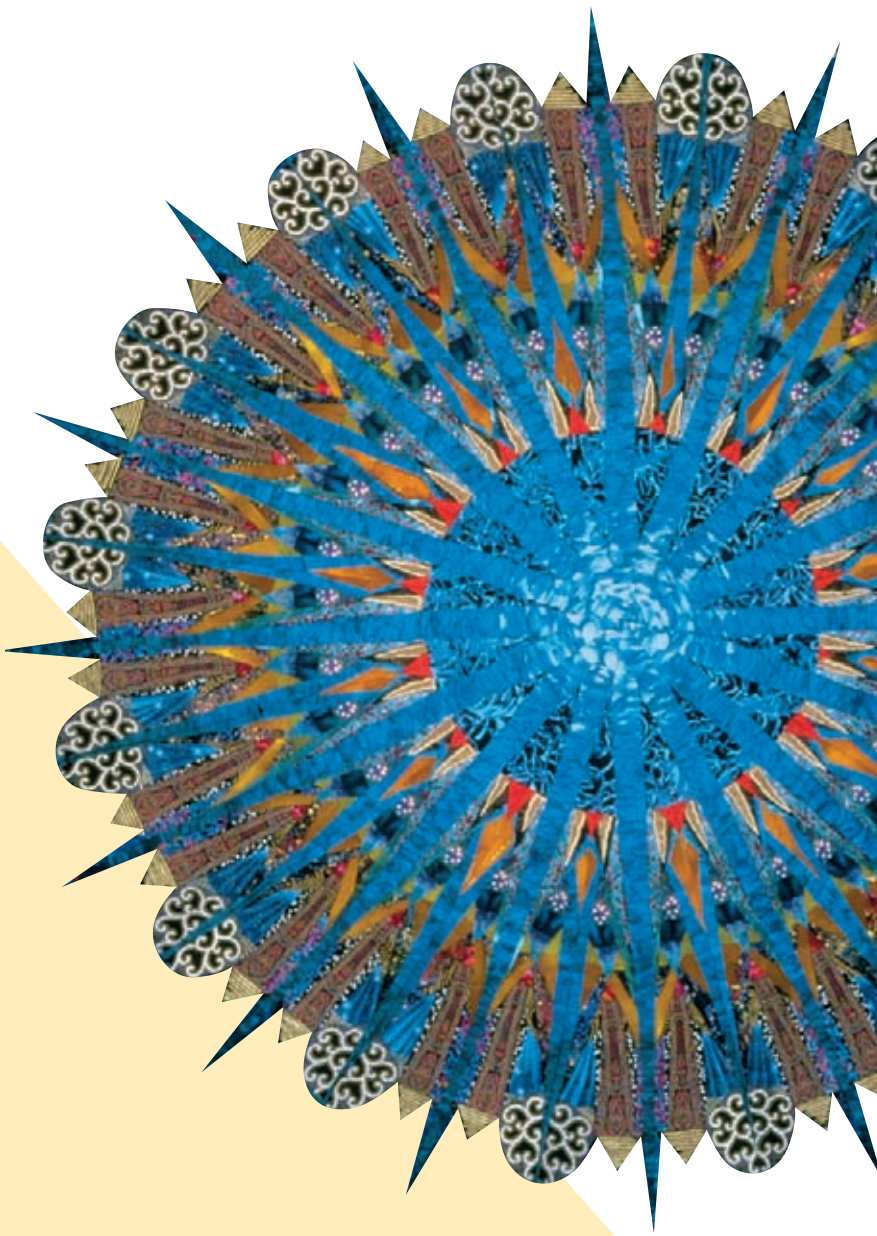
UNIT 11 Responses to Altered Respiratory Function



CHAPTER 36 Assessing Clients with Respiratory Disorders

LEARNING OUTCOMES

- Describe the anatomy, physiology, and functions of the respiratory system.
- Explain the mechanics of ventilation.
- Compare and contrast factors affecting respiration.
- Identify specific topics for consideration during a health history interview of the client with health problems involving the respiratory system.
- Describe normal variations in assessment findings for the older adult.
- Identify manifestations of impairment of the respiratory system.

CLINICAL COMPETENCIES

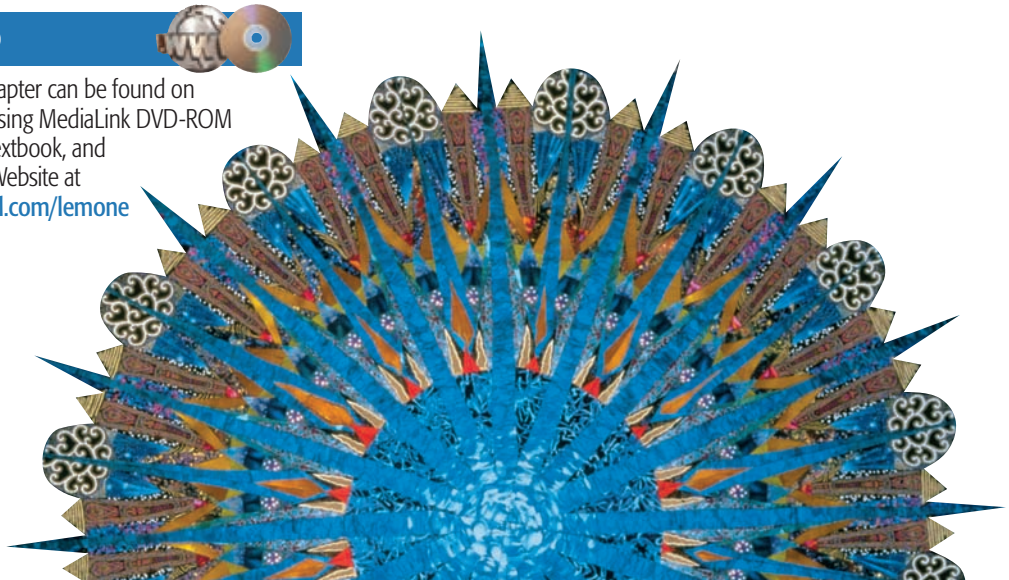
- Conduct and document a health history for clients having or at risk for alterations in the respiratory system.
- Conduct and document a physical assessment of respiratory structures and functions.
- Monitor the results of diagnostic tests and report abnormal findings.

EQUIPMENT NEEDED

- Tongue blade
- Penlight
- Nasal speculum
- Metric ruler
- Marking pen
- Stethoscope with diaphragm

MEDIALINK

Resources for this chapter can be found on the Prentice Hall Nursing MediaLink DVD-ROM accompanying this textbook, and on the Companion Website at http://www.prenhall.com/lemone



KEY TERMS

apnea, *1223*
atelectasis, *1223*
bradypnea, *1223*
crackles, *1226*
friction rub, *1226*
lung compliance, *1216*
oxyhemoglobin, *1216*
surfactant, *1216*
tachypnea, *1223*
tidal volume (TV), *1214*
vital capacity (VC), *1214*
wheezes, *1226*

The respiratory system provides the cells of the body with oxygen and eliminates carbon dioxide, formed as a waste product of cellular metabolism. The events in this process, called respiration, are:

- *Pulmonary ventilation:* Air is moved into and out of the lungs.
- *External respiration:* Exchange of oxygen and carbon dioxide occurs between the alveoli and the blood.
- *Gas transport:* Oxygen and carbon dioxide are transported to and from the lungs and the cells of the body via the blood.
- *Internal respiration:* Exchange of oxygen and carbon dioxide is made between the blood and the cells.

ANATOMY, PHYSIOLOGY, AND FUNCTIONS OF THE RESPIRATORY SYSTEM

The respiratory system functions as a whole, but is divided into the upper respiratory system and the lower respiratory system for discussion of respiratory disorders in the following chapters.

The Upper Respiratory System

The upper respiratory system serves as a passageway for air moving into the lungs and carbon dioxide moving out to the external environment (Figure 36–1 ■). As air moves through these structures, it is cleaned, humidified, and warmed.

The Nose

The nose is the external opening of the respiratory system. The external nose is given structure by the nasal, frontal, and maxillary bones as well as plates of hyaline cartilage. The nostrils (also called the external nares) are two cavities within the nose, separated by the nasal septum. These cavities open into the nasal portion of the pharynx through the internal nares. The nasal cavities just behind the nasal openings are lined with skin that contains hair follicles, sweat glands, and sebaceous glands. The nasal hairs filter the air as it enters the nares. The rest of the cavity is lined with mucous membranes that contain olfactory neurons and goblet cells that secrete thick mucus. The mucus not only traps dust and bacteria but also contains lysozyme, an enzyme that destroys bacteria as they enter the nose. As mucus and debris accumulate, mucosal ciliated cells move it toward the pharynx, where it is swallowed. The mucosa is highly vascular, warming air that moves across its surface.

Three structures project outward from the lateral wall of each nasal cavity: the superior, middle, and inferior turbinates. The turbinates cause air entering the nose to become turbulent

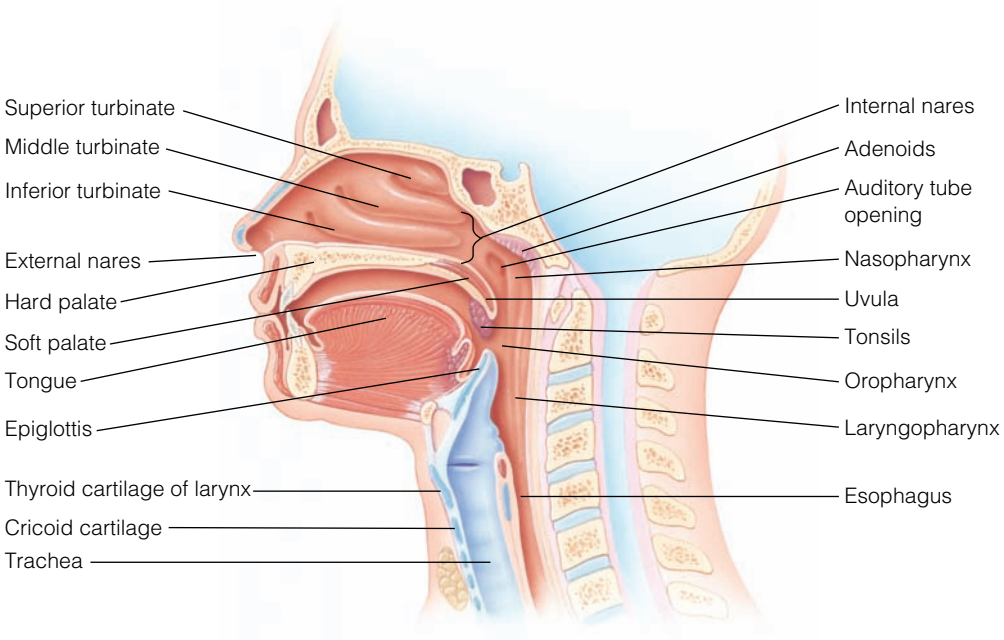


Figure 36–1 ■ The upper respiratory system.

and also increase the surface area of mucosa exposed to the air. As air moves through this area, heavier particles of debris drop out and are trapped in the mucosa of the turbinates.

The Sinuses

The nasal cavity is surrounded by paranasal sinuses (Figure 36–2 ■), located in the frontal, sphenoid, ethmoid, and maxillary bones. Sinuses lighten the skull, assist in speech, and produce mucus that drains into the nasal cavities to help trap debris.

The Pharynx

The pharynx, a funnel-shaped passageway about 5 inches (13 cm) long, extends from the base of the skull to the level of the C6 vertebra. The pharynx serves as a passageway for both air and food. It is divided into three regions: the nasopharynx, the oropharynx, and the laryngopharynx.

The nasopharynx serves only as a passageway for air. Located beneath the sphenoid bone and above the level of the soft palate, the nasopharynx is continuous with the nasal cavities. This segment is lined with ciliated epithelium, which continues to move debris from the nasal cavities to the pharynx. Masses of lymphoid tissue (the tonsils and adenoids) are located in the mucosa high in the posterior wall; these tissues trap and destroy infectious agents entering with the air. The auditory (eustachian) tubes also open into the nasopharynx, connecting it with the middle ear.

The oropharynx lies behind the oral cavity and extends from the soft palate to the level of the hyoid bone. It serves as a passageway for both air and food. An upward rise of the soft palate prevents food from entering the nasopharynx during swallowing. The oropharynx is lined with stratified squamous epithelium that protects it from the friction of food and damage from the chemicals found in food and fluids.

The laryngopharynx extends from the hyoid bone to the larynx. It is also lined with stratified squamous epithelium, and serves as a passageway for both food and air. Air does not move into the lungs while food is being swallowed and moved into the esophagus.

The Larynx

The larynx is about 2 inches (5 cm) long. It opens superiorly at the laryngopharynx and is continuous inferiorly with the trachea. The larynx provides an airway and routes air and food into the proper passageway. As long as air is moving through the larynx, its inlet is open; however, the inlet closes during swallowing. The larynx also contains the vocal cords, necessary for voice production.

The larynx is framed by cartilages, connected by ligaments and membranes. The thyroid cartilage is formed by the fusion of two cartilages; the fusion point is visible as the Adam's apple. The cricoid cartilage lies below the thyroid cartilage; other pairs of cartilages form the walls of the larynx. The epiglottis, also a cartilage, normally projects upward to the base of the tongue; however, during swallowing, the larynx moves upward and the epiglottis tips to cover the opening to the larynx. If anything other than air enters the larynx, a cough reflex expels the foreign substance before it can enter the lungs. This protective reflex does not work if the person is unconscious.

The Trachea

The trachea begins at the inferior larynx and descends anteriorly to the esophagus to enter the mediastinum, where it divides to become the right and left primary bronchi of the lungs. The trachea is about 4 to 5 inches (12 to 15 cm) long and 1 inch (2.5 cm) in diameter. It contains 16 to 20 C-shaped rings of cartilage joined by connective tissue. The mucosa lining the trachea consists of pseudostratified ciliated columnar epithelium containing seromucous glands that produce thick mucus. Dust and debris in the inspired air are trapped in this mucus, moved toward the throat by the cilia, and then either swallowed or coughed out through the mouth.

The Lower Respiratory System

The lower respiratory system includes the lungs and the bronchi (Figure 36–3 ■ and Figure 36–4 ■).

The Lungs

The center of the thoracic cavity is filled by the mediastinum, which contains the heart, great blood vessels, bronchi, trachea, and esophagus. The mediastinum is flanked on either side by the lungs (see Figure 36–3). Each lung is suspended in its own pleural cavity, with the anterior, lateral, and posterior lung surfaces lying close to the ribs. The hilus, on the mediastinal surface of each lung, is

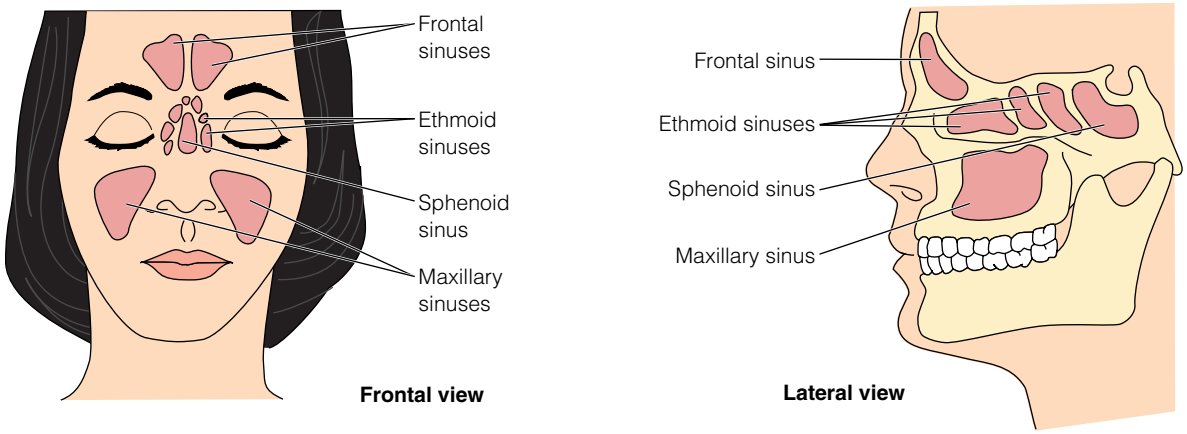


Figure 36–2 ■ Sinuses, frontal and lateral views.

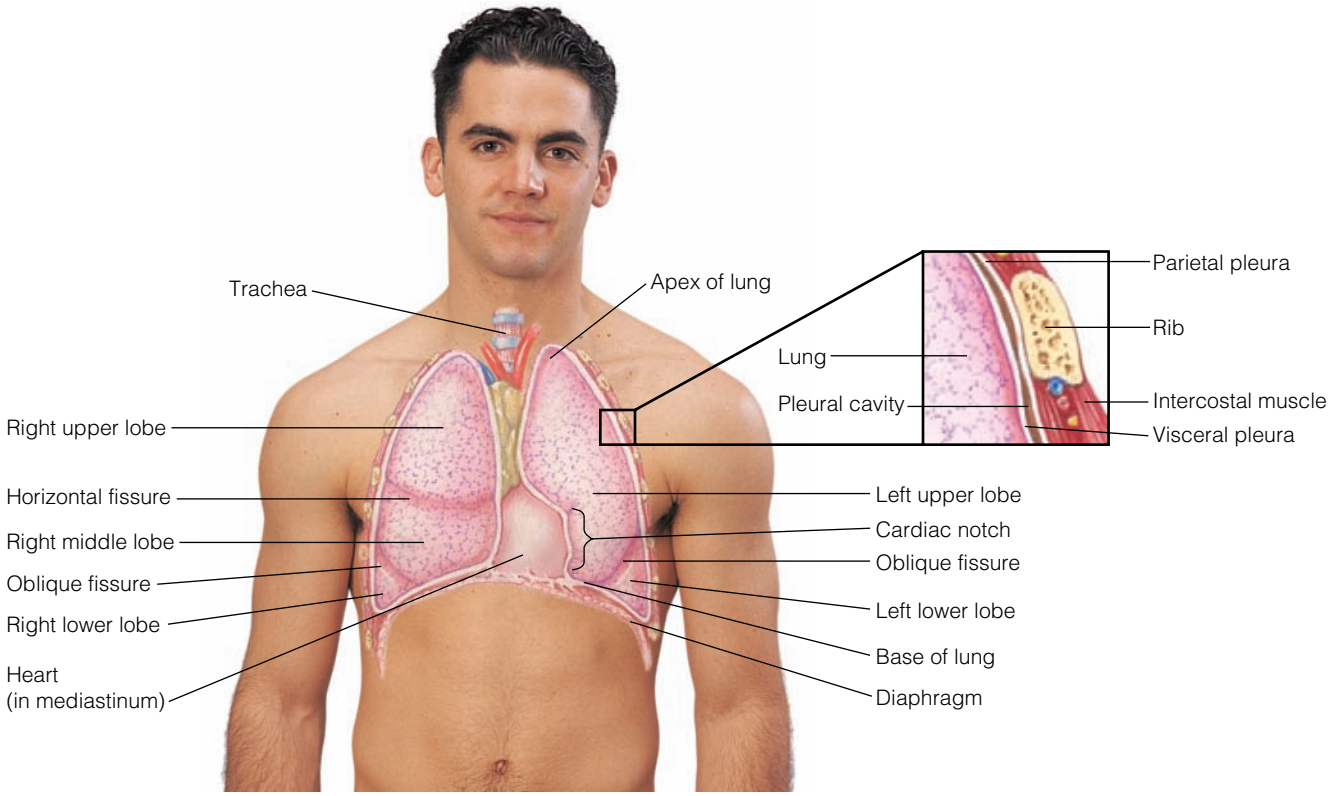


Figure 36–3 ■ The lower respiratory system, showing the location of the lungs, the mediastinum, and layers of visceral and parietal pleura.

where blood vessels of the pulmonary and circulatory systems enter and exit the lungs. The primary bronchus also enters in this area. The apex of each lung lies just below the clavicle, whereas the base of each lung rests on the diaphragm. The lungs are elastic connective tissue, called stroma, and are soft and spongy.

The two lungs differ in size and shape. The left lung is smaller and has two lobes, whereas the right lung has three lobes. Each of the lung lobes contains a different number of bronchopulmonary segments, separated by connective tissue. There are 8 segments in the two lobes of the left lung and 10 segments in the three lobes of the right lung.

The vascular system of the lungs consists of the pulmonary arteries, which deliver blood to the lungs for oxygenation, and the pulmonary veins, which deliver oxygenated blood to the heart. Within the lungs, the pulmonary arteries branch into a pulmonary capillary network that surrounds the alveoli. Lung tissue receives its blood supply from the bronchial arteries and drains by the bronchial and pulmonary veins.

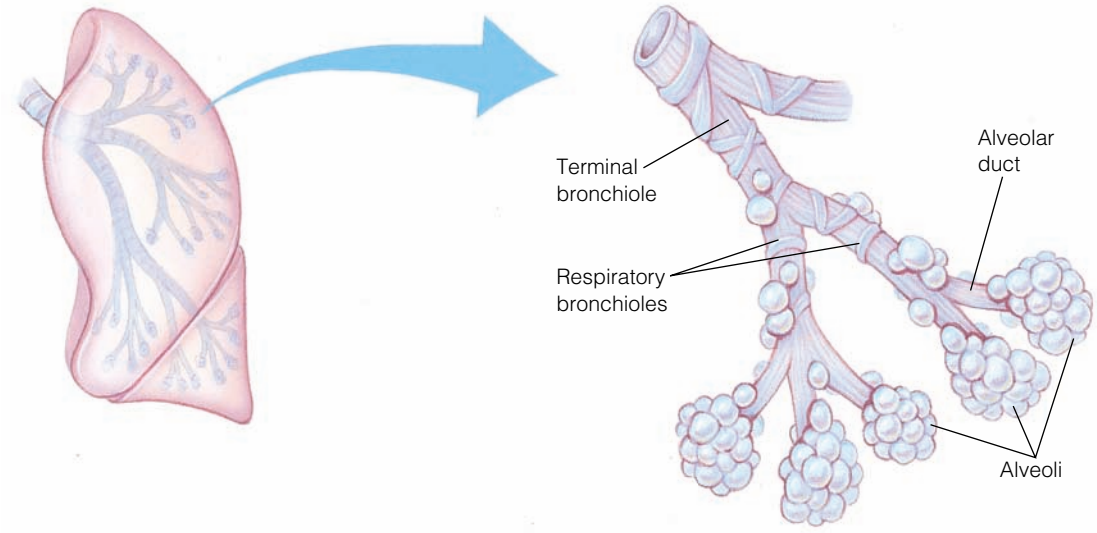


Figure 36–4 ■ Respiratory bronchi, bronchioles, alveolar ducts, and alveoli.

The Pleura

The pleura is a double-layered membrane that covers the lungs and the inside of the thoracic cavities (see Figure 36–3). The parietal pleura lines the thoracic wall and mediastinum. It is continuous with the visceral pleura, which covers the external lung surfaces. The pleura produces pleural fluid, a lubricating, serous fluid that allows the lungs to move easily over the thoracic wall during breathing. The pleura's two layers also cling tightly together and hold the lungs to the thoracic wall. The structure of the pleura creates a slightly negative pressure in the pleural space (which is actually a potential rather than an actual space), necessary for lung function.

The Bronchi and Alveoli

The trachea divides into right and left primary bronchi; in comparison to the left primary bronchus, the right primary bronchus is shorter, wider, and situated more vertically (making aspiration of foreign bodies into the right primary bronchus more likely). The point where the trachea divides is innervated with sensory neurons; activities such as tracheal suctioning may induce coughing and bronchospasm from stimulation of these neurons. These main bronchi subdivide into the secondary (lobar) bronchi, with the right middle lobe bronchus being smaller in diameter and length, and sometimes it bends sharply near its bifurcation. The secondary bronchi then branch into the tertiary (segmental) bronchi, and then into smaller and smaller bronchioles, ending in the terminal bronchioles, which are extremely small (see Figure 36–4). These branching passageways collectively are called the bronchial or respiratory tree. From the terminal bronchioles, air moves into air sacs (called respiratory bronchioles), which further branch into alveolar ducts that lead to alveolar sacs and then to the tiny alveoli. During inspiration, air enters the lungs through the primary bronchus and then moves through the increasingly smaller passageways of the lungs to the alveoli, where oxygen and carbon dioxide exchange occurs in the process of external respiration. During expiration, the carbon dioxide is expelled.

Alveoli cluster around the alveolar sacs, which open into a common chamber called the atrium. The adult lung has approximately 300 million alveoli, providing an enormous surface for gas exchange (Porth, 2005). Alveoli have extremely thin walls of a single layer of squamous epithelial cells over a very thin basement membrane. The external surface of the alveoli are covered with pulmonary capillaries. The alveolar and capillary walls form the respiratory membrane. Gas exchange across the respiratory membrane occurs by simple diffusion. The alveolar walls also contain cells that secrete a surfactant-containing fluid, necessary for maintaining a moist surface and reducing the surface tension of the alveolar fluid to help prevent collapse of the lungs.

The Rib Cage and Intercostal Muscles

The lungs are protected by the bones of the rib cage and the intercostal muscles. There are 12 pairs of ribs, which all articulate with the thoracic vertebrae (Figure 36–5 ■). Anteriorly, the first 7 ribs articulate with the body of the sternum. The 8th, 9th, and 10th ribs articulate with the cartilage immediately above the ribs. The 11th and 12th ribs are called floating ribs, because they are unattached.

The sternum has three parts: the manubrium, the body, and the xiphoid process. The junction between the manubrium and the body of the sternum is called the manubriosternal junction or the angle of Louis. The depression above the manubrium is called the suprasternal notch.

The spaces between the ribs are called the intercostal spaces. Each intercostal space is named for the rib immediately above it (e.g., the space between the third and fourth ribs is designated as the third intercostal space). The intercostal muscles between the ribs, along with the diaphragm, are called the inspiratory muscles.

FACTORS AFFECTING VENTILATION AND RESPIRATION

Many factors affect ventilation and respiration. Those discussed here include changes in volume and capacity; air pressures; oxygen, carbon dioxide, and hydrogen ion concentrations in the blood; airway resistance, lung compliance, and elasticity; and alveolar surface tension.

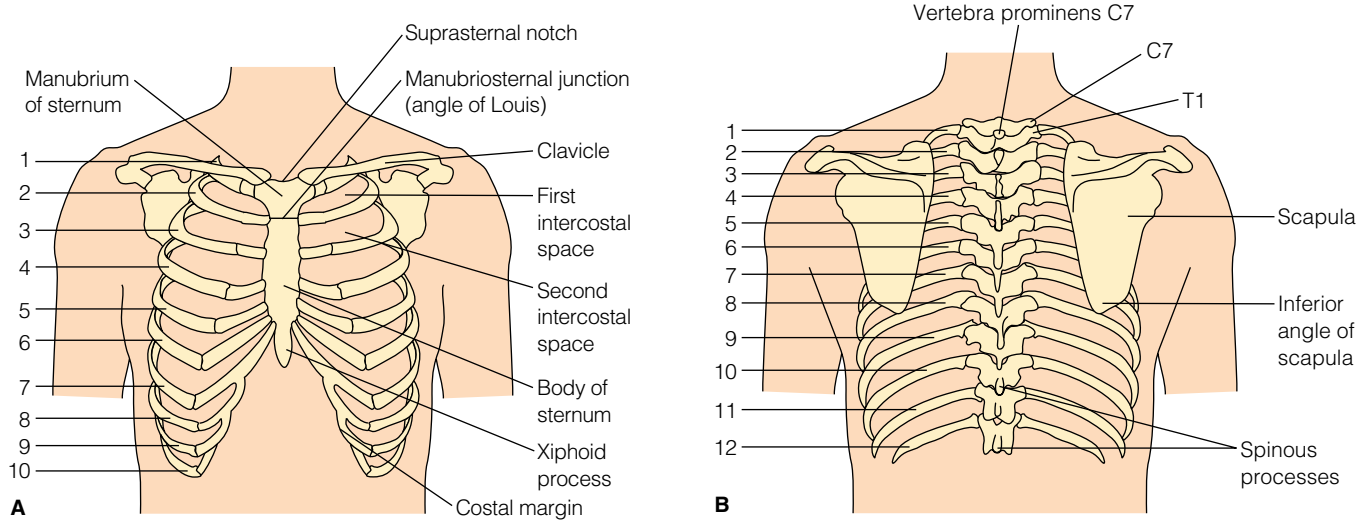


Figure 36–5 ■ *A,* Anterior rib cage, showing intercostal spaces. *B,* Posterior rib cage.

Respiratory Volume and Capacity

Respiratory volume and capacity are affected by gender, age, weight, and health status.

- **Tidal volume (TV)** is the amount of air (approximately 500 mL) moved in and out of the lungs with each normal, quiet breath.
- *Inspiratory reserve volume (IRV)* is the amount of air (approximately 2100 to 3100 mL) that can be inhaled forcibly over the tidal volume.
- *Expiratory reserve volume (ERV)* is the approximately 1000 mL of air that can be forced out over the tidal volume.
- The *residual volume* is the volume of air (approximately 1100 mL) that remains in the lungs after a forced expiration.
- **Vital capacity (VC)** refers to the sum of TV + IRV + ERV and is approximately 4500 mL in the healthy client.
- About 150 mL of air never reaches the alveoli (the amount remaining in the passageways) and is called anatomic dead space volume.

Pulmonary function tests measure these and other respiratory volumes and capacities, and are described and illustrated in Box 36–1.

Air Pressures

Pulmonary ventilation depends on volume changes within the thoracic cavity. A change in the volume of air in the thoracic

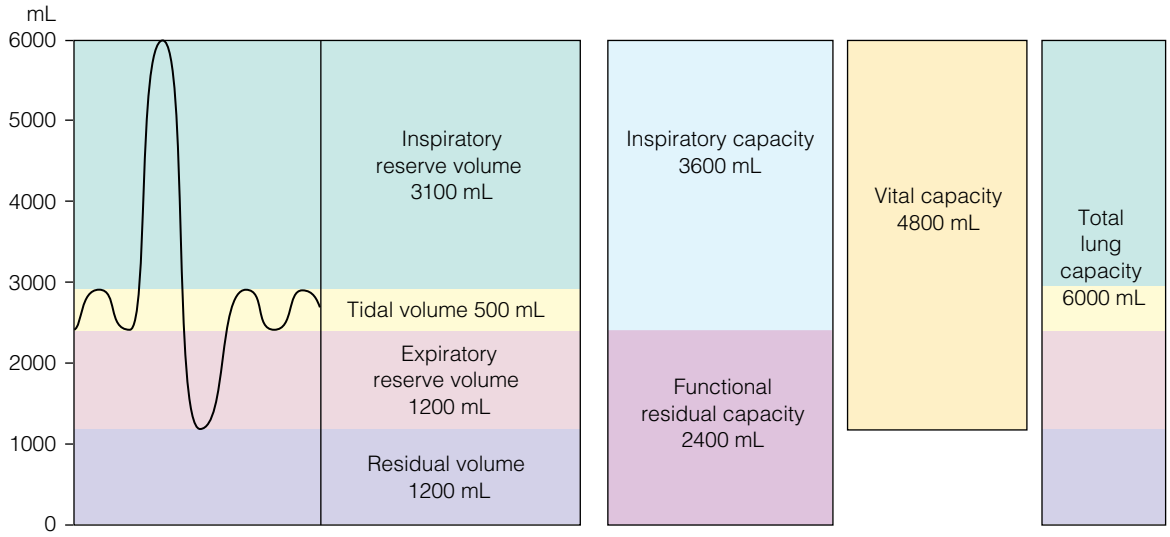
BOX 36–1 Pulmonary Function Tests

Pulmonary function tests (PFTs) are performed in a pulmonary function laboratory. After preparing the client, a nose clip is applied and the unsedated client breathes into a spirometer or body plethysmograph, a device for measuring and recording lung volume in liters versus time in seconds. The client is instructed how to breathe for specific tests: for example, to inhale as deeply as possible and then exhale to the maximal extent possible. Using measured lung volumes, respiratory capacities are calculated to assess pulmonary status. The specific values determined by PFT and illustrated in the figure include the following.

- *Total lung capacity (TLC)* is the total volume of the lungs at their maximum inflation. Four values are used to calculate TLC.
  a. *Total volume (TV)*, the volume inhaled and exhaled with normal quiet breathing (also called tidal volume)
  b. *Inspiratory reserve volume (IRV)*, the maximum amount that can be inhaled over and above a normal inspiration
  c. *Expiratory reserve volume (ERV)*, the maximum amount that can be exhaled following a normal exhalation.
  d. *Residual volume (RV)*, the amount of air remaining in the lungs after maximal exhalation.
- *Vital capacity (VC)* is the total amount of air that can be exhaled after a maximal inspiration. It is calculated by adding together the IRV, TV, and the ERV.
- *Inspiratory capacity* is the total amount of air that can be inhaled following a normal quiet exhalation. It is calculated by adding the TV and IRV.
- *Functional residual capacity (FRC)* is the volume of air left in the lungs after a normal exhalation. The ERV and RV are added to determine the FRC.
- *Forced expiratory volume (FEV_1)* is the amount of air that can be exhaled in 1 second.
- *Forced vital capacity (FVC)* is the amount of air that can be exhaled forcefully and rapidly after maximum air intake.
- *Minute volume (MV)* is the total amount or volume of air breathed in 1 minute.

In older clients, residual capacity is increased, and vital capacity is decreased. These age-related changes result from the following:

- Calcification of the costal cartilage and weakening of the intercostal muscles, which reduce movement of the chest wall
- Vertebral osteoporosis, which decreases spinal flexibility and increases the degree of kyphosis, further increasing the anterior-posterior diameter of the chest
- Diaphragmatic flattening and loss of elasticity.



The relationship of lung volumes and capacities. Volumes (mL) shown are for an average adult male.

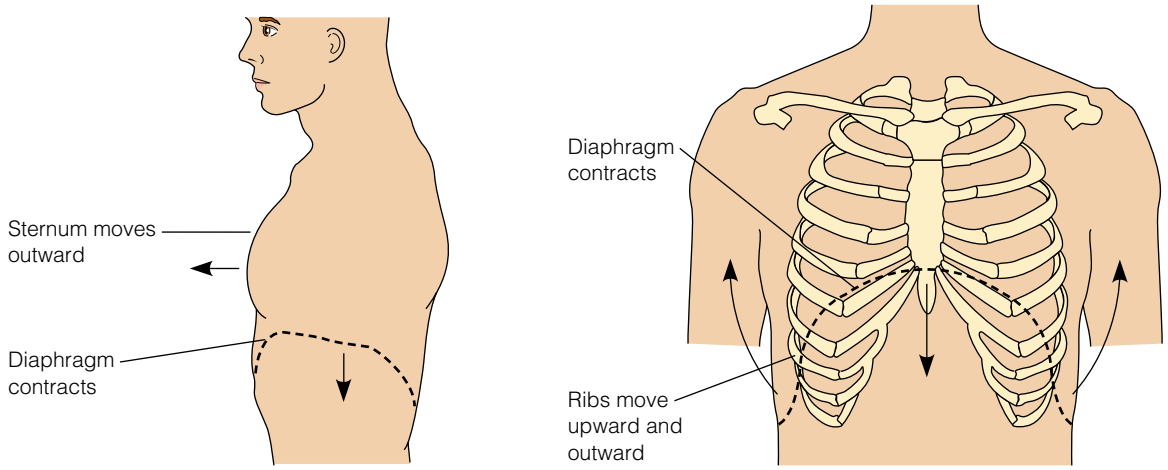


Figure 36–6 ■ Respiratory inspiration: lateral and anterior views. Note the volume expansion of the thorax as the diaphragm flattens.

cavity leads to a change in the air pressure within the cavity. Because gases always flow along their pressure gradients, a change in pressure results in gases flowing into or out of the lungs to equalize the pressure.

The pressures normally present in the thoracic cavity are the intrapulmonary pressure and the intrapleural pressure. The intrapulmonary pressure, within the alveoli of the lungs, rises and falls constantly as a result of the acts of ventilation (inhalation and exhalation). The intrapleural pressure, within the pleural space, also rises and falls with the acts of ventilation, but it is always less than (or negative to) the intrapulmonary pressure. Intrapulmonary and intrapleural pressures are necessary not only to expand and contract the lungs, but also to prevent their collapse.

Pulmonary ventilation has two phases: inspiration, during which air flows into the lungs; and expiration, during which gases flow out of the lungs. The two phases make up a single breath, and normally occur from 12 to 20 times each minute. A single inspiration lasts for about 1 to 1.5 seconds, whereas an expiration lasts for about 2 to 3 seconds.

During inspiration, the diaphragm contracts and flattens out to increase the vertical diameter of the thoracic cavity (Figure 36–6 ■). The external intercostal muscles contract, elevating the rib cage and moving the sternum forward to expand the lateral and anteroposterior diameter of the thoracic cavity, decreasing intrapleural pressure. The lungs stretch and the intrapulmonary volume increases, decreasing intrapulmonary pressure slightly below atmospheric pressure. Air rushes into the lungs as a result of this pressure gradient until the intrapulmonary and atmospheric pressures equalize.

Expiration is primarily a passive process that occurs as a result of the elasticity of the lungs (Figure 36–7 ■). The inspiratory muscles relax, the diaphragm rises, the ribs descend, and the lungs recoil. Both the thoracic and intrapulmonary pressures increase, compressing the alveoli. The intrapulmonary pressure rises to a level greater than atmospheric pressure, and gases flow out of the lungs.

Oxygen, Carbon Dioxide, and Hydrogen Ion Concentrations

The rate and depth of respirations are controlled by respiratory centers in the medulla oblongata and pons of the brain and by chemoreceptors located in the medulla and in the carotid and aortic bodies. The centers and chemoreceptors respond to changes in the concentration of oxygen, carbon dioxide, and hydrogen ions

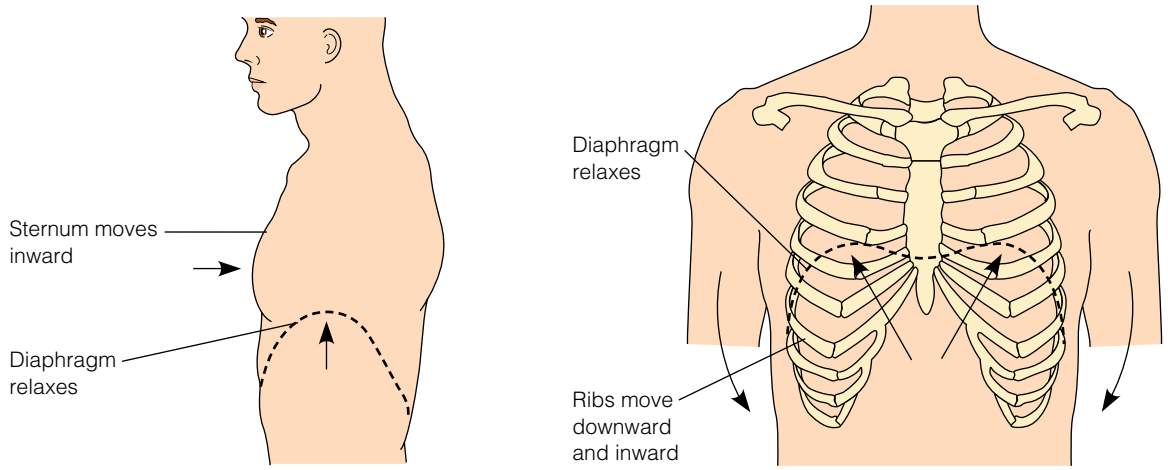


Figure 36–7 ■ Respiratory expiration: lateral and anterior views.

in arterial blood. For example, when carbon dioxide concentration increases or the pH decreases, the respiratory rate increases. This process is further described in Chapter 10 ∞.

Airway Resistance, Lung Compliance, and Elasticity

Respiratory passageway resistance, lung compliance, and lung elasticity also affect respiration.

- Respiratory passageway resistance is created by the friction encountered as gases move along the respiratory passageways, by constriction of the passageways (especially the larger bronchioles), by accumulations of mucus or infectious material, and by tumors. As resistance increases, gas flow decreases.
- **Lung compliance** is the distensibility of the lungs. It depends on the elasticity of the lung tissue and the flexibility of the rib cage. Compliance is decreased by factors that decrease the elasticity of the lungs, block the respiratory passageways, or interfere with movement of the rib cage.
- Lung elasticity is essential for lung distention during inspiration and lung recoil during expiration. Decreased elasticity from disease such as emphysema impairs respiration.

Alveolar Surface Tension

A liquid film of mostly water covers the alveolar walls. At any gas–liquid boundary, the molecules of liquid are more strongly attracted to each other than to gas molecules. This produces a state of tension, called surface tension, that draws the liquid molecules even more closely together. The water content of the alveolar film compacts the alveoli and aids in the lungs' recoil during expiration. In fact, if the alveolar film were pure water, the alveoli would collapse between breaths.

Surfactant, a lipoprotein produced by the alveolar cells, interferes with this adhesiveness of the water molecules, reducing surface tension, and helping expand the lungs. With insufficient surfactant, the surface tension forces can become great enough to collapse the alveoli between breaths, requiring tremendous energy to reinflate the lungs for inspiration.

BLOOD GASES

Gases are transported by the blood to provide cells with oxygen and to remove carbon dioxide produced during cellular activities.

Oxygen Transport and Unloading

Oxygen is carried in the blood either bound to hemoglobin or dissolved in the plasma. Oxygen is not very soluble in water, so almost all oxygen that enters the blood from the respiratory system is carried to the cells of the body by hemoglobin. This combination of hemoglobin and oxygen is called **oxyhemoglobin**.

Each hemoglobin molecule is made of four polypeptide chains, with each chain bound to an iron-containing heme group. The iron groups are the binding sites for oxygen; each hemoglobin molecule can bind with four molecules of oxygen.

Oxygen binding is rapid and reversible. It is affected by temperature, blood pH, partial pressure of oxygen (P_{O_2}), partial pressure of carbon dioxide (P_{CO_2}), and serum concentration of an organic chemical called 2,3-DPG. These factors interact to ensure adequate delivery of oxygen to the cells.

The relative saturation of hemoglobin depends on the P_{O_2} of the blood, as illustrated in the oxygen-hemoglobin dissociation curve (Figure 36–8 ■).

- Under normal conditions, the hemoglobin in arterial blood is 97.4% saturated with oxygen. Hemoglobin is almost fully saturated at a P_{O_2} of 70 mmHg. As arterial blood flows through the capillaries, oxygen is unloaded, so that the oxygen saturation of hemoglobin in venous blood is 75%.
- The affinity of oxygen and hemoglobin decreases as the temperature of body tissues increases above normal. As a result, less oxygen binds with hemoglobin, and oxygen unloading is enhanced. Conversely, as the body is chilled, oxygen unloading is inhibited.
- The oxygen-hemoglobin bond is weakened by increased hydrogen ion concentrations. As blood becomes more acidotic, oxygen unloading to the tissues is enhanced. The same process occurs when the partial pressure of carbon dioxide increases because this decreases the pH.
- The organic chemical 2,3-DPG is formed in red blood cells and enhances the release of oxygen from hemoglobin by binding to it during times of increased metabolism (as when body temperature increases). This binding alters the structure of hemoglobin to facilitate oxygen unloading.

Carbon Dioxide Transport

Active cells produce about 200 mL of carbon dioxide each minute; this amount is exactly the same as that excreted by the lungs each minute. Excretion of carbon dioxide from the body requires transport by the blood from the cells to the lungs. Carbon dioxide is transported in three forms: dissolved in plasma, bound to hemoglobin, and as bicarbonate ions in the plasma (the largest amount is in this form).

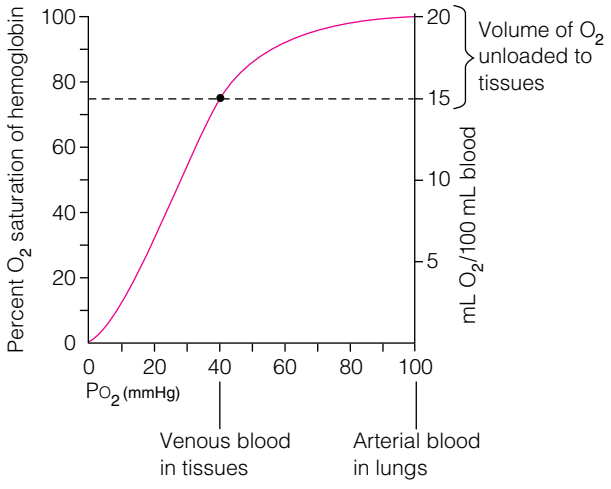


Figure 36–8 ■ Oxygen-hemoglobin dissociation curve. The percent O_2 saturation of hemoglobin and total blood oxygen volume are shown for different oxygen partial pressures (P_{O_2}). Arterial blood in the lungs is almost completely saturated. During one pass through the body, about 25% of hemoglobin-bound oxygen is unloaded to the tissues. Thus, venous blood is still about 75% saturated with oxygen. The steep portion of the curve shows that hemoglobin readily off-loads or on-loads oxygen at P_{O_2} levels below about 50 mmHg.

The amount of carbon dioxide transported in the blood is strongly influenced by the oxygenation of the blood. When the Po_2 decreases, with a corresponding decrease in oxygen saturation, increased amounts of carbon dioxide can be carried in the blood. Carbon dioxide entering the systemic circulation from the cells causes more oxygen to dissociate from hemoglobin, in turn allowing more carbon dioxide to combine with hemoglobin and more bicarbonate ions to be generated. This situation is reversed in the pulmonary circulation, where the uptake of oxygen facilitates the release of carbon dioxide.

ASSESSING RESPIRATORY FUNCTION

Function of the respiratory system is assessed by findings from diagnostic tests, a health assessment interview to collect subjective data, and a physical assessment to collect objective data. Sample documentation of an assessment of the respiratory system is included in the box on this page.

Diagnostic Tests

The results of diagnostic tests of respiratory function are used to support the diagnosis of a specific disease, to provide information to identify or modify the appropriate medications or therapy used to treat the disease, and to help nurses monitor the client's responses to treatment and nursing care interventions. Diagnostic tests to assess the structures and functions of the respiratory system are described in the Diagnostic Tests table below and summarized in the bulleted list that follows. More information is included in the discussion of specific disorders in Chapters 37, 38, and 39 ∞.

SAMPLE DOCUMENTATION
Assessment of the Lungs

57-year-old male, history of smoking 2 packs cigarettes/day for 37 years; continues to smoke despite previous discussions. Works as a dry-wall installer. No family history of cancer or TB. States he has trouble breathing, especially at night. Often sleeps on a recliner "to breathe better." Complains of a cough, but denies sputum production. Diagnosed 3 years ago with emphysema. Color of face is dusky red. Fingernails pink. Respirations 30, unlabored, regular (R varies from 26 to 32 on visits to the clinic). Thoracic assessment = intercostal bulging, barrel chest, diminished lung sounds bilaterally in lower lobes. Crackles present in upper lobes, not cleared by coughing. Discussed possible use of low-flow nasal oxygen at night to help with breathing; will check with primary provider.

DIAGNOSTIC TESTS of the Respiratory System

NAME OF TEST Sputum Studies

- Culture and sensitivity
- Acid-fast smear and culture
- Cytology

PURPOSE AND DESCRIPTION Culture and sensitivity of a single sputum specimen is done to diagnose bacterial infections, identify the most effective antibiotic, and evaluate treatment.

Sputum is examined for presence of acid-fast bacillus, specifically tuberculosis. A series of three early morning sputum specimens is used.

Sputum is examined for presence of abnormal (malignant) cells. A single sputum specimen is collected in a special container of fixative solution.

RELATED NURSING CARE See Procedure 36–1 on page 1220 for obtaining a sputum specimen. Sputum specimens may also be obtained during bronchoscopy (described later) if the client is unable to provide a specimen.

NAME OF TEST Arterial blood gases (ABGs)

PURPOSE AND DESCRIPTION This test of arterial blood is done to assess alterations in acid–base balance caused by a respiratory disorder, a metabolic disorder, or both. A pH of less than 7.35 indicates acidosis and a pH of more than 7.45 indicates alkalosis (see Chapter 10 ∞). To determine a respiratory cause, assess the $Paco_2$: If pH is decreased and $Paco_2$ is increased, respiratory acidosis is indicated.

Normal values:
pH: 7.35–7.45
$Paco_2$: 35–45 mmHg
Pao_2: 75–100 mmHg
HCO_3: 24–28 mEq/L
BE: ± 2 mEq/L

RELATED NURSING CARE Arterial blood is collected in a heparinized needle and syringe. Sample is placed on an icebag and taken immediately to the lab. If client is receiving oxygen, indicate on lab slip. Apply pressure to puncture site for 2–5 minutes, or longer if needed. Do not collect blood from the same arm used for an IV infusion.

NAME OF TEST Pulse oximetry

PURPOSE AND DESCRIPTION This noninvasive test is used to evaluate or monitor oxygen saturation of the blood. A device that uses infrared light is attached to an extremity (most commonly the finger, but can also be used on the toe, earlobe, or nose) and light is passed through the tissues or reflected off bony structures.

Normal value: 90%–100%

RELATED NURSING CARE Assess for factors that may alter findings, including faulty placement, movement, dark skin color, and acrylic nails.

(continued)

DIAGNOSTIC TESTS of the Respiratory System (continued)

NAME OF TEST Chest x-ray

PURPOSE AND DESCRIPTION Chest x-rays are used to identify abnormalities in chest structure and lung tissue, for diagnosis of diseases and injuries of the lungs, and to monitor treatment.

RELATED NURSING CARE No special preparation is needed.

NAME OF TEST Computed tomography (CT)

PURPOSE AND DESCRIPTION CT of the thorax may be performed when x-rays do not show some areas well, such as the pleura and mediastinum. It is also done to differentiate pathologic conditions (such as tumors, abscesses, and aortic aneurysms), to identify pleural effusion and enlarged lymph nodes, and to monitor treatment. Images are shown in cross section.

RELATED NURSING CARE No special preparation is needed.

NAME OF TEST Magnetic resonance imaging (MRI)

PURPOSE AND DESCRIPTION An MRI of the thorax is used to diagnose alterations in lung tissue more difficult to visualize by CT scan and to identify abnormal masses and fluid accumulation.

RELATED NURSING CARE Assess for any metallic implants (such as pacemaker, pacemaker wires, or implant). Test will not be performed if present.

NAME OF TEST Positron emission tomography (PET)

PURPOSE AND DESCRIPTION This relatively noninvasive test, when used to examine the lungs, is performed to identify lung nodules (cancers). The client is given a radioactive substance and cross-sectional images are displayed on a computer. Radiation from PET is only 25% of that from a CT scan.

RELATED NURSING CARE No alcohol, coffee, or tobacco is allowed for 24 hours prior to the test. Encourage increased fluid intake post-test to help eliminate the radioactive material.

NAME OF TEST Pulmonary angiography

PURPOSE AND DESCRIPTION This test is done to identify pulmonary emboli, tumors, aneurysms, vascular changes associated with emphysema, and pulmonary circulation. A catheter is inserted into the brachial or femoral artery, threaded into the pulmonary artery, and dye is injected. ECG leads are applied to the chest for cardiac monitoring. Images of the lungs are taken.

RELATED NURSING CARE Monitor injection site and pulses distal to the site after the test.

NAME OF TEST Pulmonary ventilation/perfusion scan (V/Q scan)

PURPOSE AND DESCRIPTION This test is performed with two nuclear scans to measure breathing (ventilation) and circulation (perfusion) in all parts of the lungs. A perfusion scan is performed by injecting radioactive albumin into a vein and scanning the lungs. A ventilation scan is performed by scanning the lungs as the client inhales radioactive gas. A decreased uptake of radioisotope during the perfusion scan indicates a blood flow problem, such as from a pulmonary embolus or pneumonitis. A decreased uptake of gas during the ventilation scan may indicate airway obstruction, pneumonia, or chronic pulmonary obstructive disease (COPD).

RELATED NURSING CARE No special preparation is needed.

NAME OF TEST Bronchoscopy

PURPOSE AND DESCRIPTION A bronchoscopy is the direct visualization of the larynx, trachea, and bronchi through a bronchoscope to identify lesions, remove foreign bodies and secretions, obtain tissue for biopsy, and improve tracheobronchial drainage (Figure 36–9 ■). During the test, a catheter brush or biopsy forceps can be passed to obtain secretions or tissue for examination for cancer.

RELATED NURSING CARE

- Provide routine preoperative care as ordered. *Bronchoscopy is an invasive procedure requiring conscious sedation or anesthesia. Care provided prior to the procedure is similar to that provided before many minor surgical procedures.*
- Provide mouth care just prior to bronchoscopy. *Mouth care reduces oral microorganisms and the risk of introducing them into the lungs.*
- Bring resuscitation and suction equipment to the bedside. *Laryngospasm and respiratory distress may occur following the procedure. The anesthetic suppresses the cough and gag reflexes, and secretions may be difficult to expectorate.*

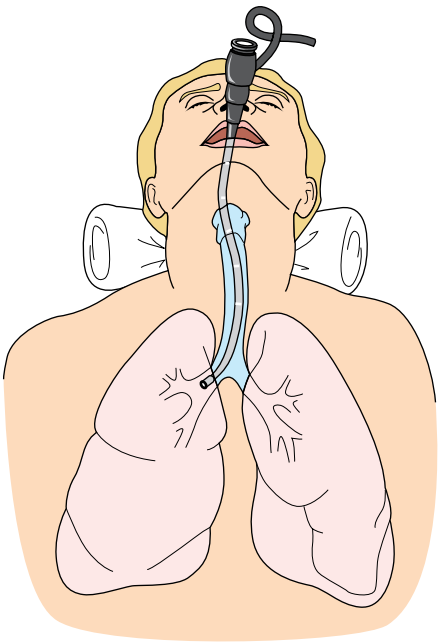


Figure 36–9 ■ Fiberoptic bronchoscopy.

DIAGNOSTIC TESTS of the Respiratory System (continued)

- Following the procedure, closely monitor vital signs and respiratory status. *Possible complications of bronchoscopy include laryngospasm, bronchospasm, bronchial perforation with possible pneumothorax or subcutaneous emphysema, hemorrhage, hypoxia, pneumonia or bacteremia, and cardiac stress*.
- Instruct to avoid eating or drinking for approximately 2 hours or until fully awake with intact cough and gag reflexes. *Suppression of the cough and gag reflexes by systemic and local anesthesia used during the procedure increase the risk for aspiration*.
- Provide an emesis basin and tissues for expectorating sputum and saliva. *Until reflexes have returned, the client may be unable to swallow sputum and saliva safely*.
- Monitor color and character of respiratory secretions. Secretions normally are blood tinged for several hours following bronchoscopy, especially if biopsy has been obtained. Notify the physician if sputum is grossly bloody. *Grossly bloody sputum may indicate a complication such as perforation*.
- Collect postbronchoscopy sputum specimens for cytologic examination as ordered. *Cells in the sputum may be examined if a tumor is suspected*.

Health Education for the Client and Family

- Fiber-optic bronchoscopy requires 30 to 45 minutes to complete. It may be done at the bedside, in a special procedure room, or in the surgical suite.
- The procedure usually causes little pain or discomfort, because an anesthetic is given. You will be able to breathe during the bronchoscopy.
- Some voice hoarseness and a sore throat are common following the procedure. Throat lozenges or warm saline gargles may help relieve discomfort.
- You may develop a mild fever within the first 24 hours following the procedure. This is a normal response.
- Persistent cough, bloody or purulent sputum, wheezing, shortness of breath, difficulty breathing, or chest pain may indicate a complication. Notify your physician if they develop.

NAME OF TEST Lung biopsy

PURPOSE AND DESCRIPTION Done to obtain tissue to differentiate benign from malignant tumors of the lungs. May be done during a bronchoscopy, or by surgical procedure.

RELATED NURSING CARE Same as bronchoscopy or the same as a thoracotomy (incision through the chest wall) if a surgical biopsy is performed.

NAME OF TEST Thoracentesis

PURPOSE AND DESCRIPTION Done to obtain a specimen of pleural fluid for diagnosis (and used as a procedure to remove pleural fluid or instill medication). A large-bore needle is inserted through the chest wall and into the pleural space. Following the procedure, a chest x-ray is taken to check for a pneumothorax.

RELATED NURSING CARE Nursing care of the client having a thoracentesis is provided in Chapter 38 ∞.

- Sputum tests include a culture and sensitivity to identify organisms causing infections as well as the most effective antibiotic to treat the infection, an acid-fast smear and culture to identify the tuberculosis bacillus, and cytology to identify malignancies. See Procedure 36–1.
- Arterial blood gases are conducted to evaluate alterations in acid–base balances.
- Pulse oximetry is used to evaluate or monitor the oxygen saturation of the blood.
- Many different radiologic examinations are used to diagnose respiratory disorders, including a chest x-ray to evaluate structures and tissues, a CT scan to differentiate pathologic conditions, an MRI to more accurately identify abnormal masses and fluid accumulation, a PET to identify lung cancers, and a pulmonary angiogram to identify various disorders including pulmonary emboli and emphysema.
- A bronchoscopy is a direct visualization of the larynx, trachea, and bronchi. During the test, lesions can be identified, foreign bodies or mucous plugs removed, and tissue taken for biopsy. In addition, a biopsy of lung tissue may be done through an incision through the chest wall.
- A thoracentesis, when done for diagnostic purposes, is conducted to obtain a specimen of pleural fluid.

Regardless of the type of diagnostic test, the nurse is responsible for explaining the procedure and any special preparation needed, for assessing for medication use that may affect the outcome of the tests, for supporting the client during the examination as necessary, for documenting the procedures as appropriate, and for monitoring the results of the tests.

Genetic Considerations

When conducting a health assessment interview and a physical assessment, it is important for the nurse to consider genetic influences on health of the adult. During the health assessment interview, ask about family members with health problems affecting respiratory function. In addition, ask about a family history of emphysema, asthma, cystic fibrosis, or lung cancer. During the physical assessment, assess for any manifestations that might indicate a genetic disorder (see the Genetic Considerations box on page 1220). If data are found to indicate genetic risk factors or alterations, ask about genetic testing and refer for appropriate genetic counseling and evaluation. Chapter 8 ∞ provides further information about genetics in medical-surgical nursing.

PROCEDURE 36–1 OBTAINING A SPUTUM SPECIMEN

GATHER SUPPLIES

- Sterile sputum container, specimen cup, or mucous trap
- Mouth care supplies
- Sterile suction kit, if necessary
- Gloves

BEFORE THE PROCEDURE

If the sputum specimen is to establish the initial diagnosis, obtain the specimen before starting oxygen and/or antibiotic therapy. Antibiotics reduce the bacterial count, making it difficult to identify the infecting organism. Oxygen therapy dries mucous membranes, making it more difficult to obtain a specimen. Unless otherwise instructed, obtain the specimen early in the morning, just after awakening. Respiratory secretions tend to pool during sleep; it is easier to obtain a specimen before normal coughing and daily activity has cleared them.

Provide for privacy, and explain the procedure. Emphasize the importance of coughing deeply to obtain sputum from the lower respiratory tract, avoiding expectoration of saliva. Increasing fluid intake prior to obtaining the specimen can help liquefy secretions, making them easier to expectorate.

DURING THE PROCEDURE

1. Use standard precautions.
2. Provide for mouth care prior to obtaining the specimen to reduce contamination by oral flora.
3. Instruct to cough deeply several times, expectorating mucus into the container.
4. Close the container securely.
5. Label the container with name and other identifying data, time and date, and any special conditions, such as antibiotic or oxygen therapy. Enclose specimen container in a clean plastic bag, and take to the laboratory or refrigerate as ordered to preserve the specimen.
6. To obtain a specimen by suctioning:
   - Provide mouth care.
   - Obtain a sterile mucous trap. Using aseptic technique, attach the trap to the suction apparatus between the suction catheter and tubing.
   - Preoxygenate for suctioning as needed.
   - Perform tracheal suctioning using aseptic technique via either the nasotracheal route, endotracheal tube, or tracheostomy. Lubricate the catheter with sterile normal saline. Apply no suction as the catheter is being inserted into the trachea; apply suction for no longer than 10 seconds while withdrawing the catheter.
   - Detach the mucous trap; close and label. Clear the suction catheter and tubing with normal saline after removing the mucus trap. Dispose of equipment appropriately.
7. A sputum specimen also may be obtained during bronchoscopy procedure.

AFTER THE PROCEDURE

Provide mouth care as needed. Teach the importance of completing all ordered antibiotic prescriptions to ensure complete eradication of microorganisms. Document the time and date that the specimen was obtained; and note color, consistency, and odor of sputum.

GENETIC CONSIDERATIONS
Respiratory Disorders

- Deficiency of alpha$_1$-antitrypsin (a protein that protects the body from damage by its immune cells) is caused by a mutation of a gene located on chromosome 14. Deficiency of this protein leaves the lung susceptible to emphysema.
- Asthma, a disease that affects more than 5% of the population, is an inheritable disease with a number of responsible genes. (There are also other causes of asthma.)
- Cystic fibrosis is the most common fatal genetic disease in the United States today. All gene defects result in defective transport of chloride and sodium by epithelial cells. As a result, the amount of sodium chloride is increased in body secretions. Thick mucus is produced that clogs the lungs, leads to infection, and blocks pancreatic enzymes from reaching the intestines to digest food.
- A familial history of lung cancer increases the risk of developing lung cancer, and small-cell lung cancer has a definite genetic component. In addition, researchers have found that lung cancer patients who never smoked are more likely than smokers to have one of two genetic mutations linked to the disease.

Health Assessment Interview

A health assessment interview to determine problems with respiratory structure and function may be conducted during a health screening, may focus on a chief complaint (such as shortness of breath), or may be part of a total health assessment. If the client has a problem with respiratory function, analyze its onset, characteristics, course, severity, precipitating and relieving factors, and any associated symptoms, noting the timing and circumstances. For example, ask the client:

- Describe the problems you are having with your breathing. Is your breathing more difficult if you lie flat? Is it painful to breathe in or out?
- When did you first notice that your cough was becoming a problem? Do you cough up mucus? What color is the mucus?
- Have you had nosebleeds in the past?

During the interview, carefully observe the client for difficulty in breathing, pausing to breathe in the middle of a sentence, hoarseness, changes in voice quality, and cough. Ask about present health status, medical history, family health history, and risk factors for illness, These areas of the client's health status include information about the nose, throat, and lungs.

To determine present health status, ask about pain in the nose, throat, or chest. Information about cough includes what type of cough, when it occurs, and how it is relieved. The client should describe any sputum associated with the cough. Is the client experiencing any dyspnea (difficult or labored breathing)? How is the dyspnea associated with activity levels and time of day? Is the client having chest pain? How is this related to activity and time of day? Note the severity, type, and location of the pain. Explore problems with swallowing, smelling, or taste. Also ask about nosebleeds and nasal or sinus stuffiness or pain, and about current medication use, aerosols or inhalants, and oxygen use.

Document past medical history by asking questions about a history of allergies, asthma, bronchitis, emphysema, pneumonia, tuberculosis, or congestive heart failure. Other questions include a history of surgery or trauma to the respiratory structures and a history of other chronic illnesses such as cancer, kidney disease, and heart disease. If the client has a health problem involving the respiratory system, ask about medications used to relieve nasal congestion, cough, dyspnea, or chest pain. Document a family history of allergies, tuberculosis, emphysema, and cancer.

The client's personal lifestyle, environment, and occupation may provide clues to risk factors for actual or potential health problems. Question the client about a history of smoking and/or exposure to environmental chemicals (including smog), dust, vapors, animals, coal dust, asbestos, fumes, or pollens. Other risk factors include a sedentary lifestyle and obesity. Also ask the client about use of alcohol and substances that are injected (such as heroin) or inhaled (such as cocaine or marijuana).

Interview questions categorized by functional health patterns follow.

FUNCTIONAL HEALTH PATTERN INTERVIEW: **Respiratory System**

Functional Health Pattern	Interview Questions and Leading Statements
Health Perception–Health Management	■ Describe any respiratory problems (such as allergies, asthma, bronchitis, frequent cold, pneumonia, tuberculosis, emphysema), injuries or surgery of the nose, throat, or lungs you have had. ■ If you had such problems, how were they treated (for example, medications, surgery, breathing treatments, oxygen, environmental control of allergens, other)? ■ Do you use oxygen for your respiratory problem? If so, how and when do you use it and at what flow rate? ■ Do you now or have you ever smoked tobacco? If so, what type, how long, and how much? If you no longer smoke, when did you quit? ■ Do you notice more respiratory problems at certain seasons of the year? Explain. ■ Do you do anything to decrease environmental irritants in your home or at work? Describe if so. ■ When was your last chest x-ray and TB skin test? What were the results of those tests? ■ Do you have annual flu shots? Have you had a pneumonia shot (if over age 65)? ■ Do certain foods, pollens, dust, or animals seem to increase your difficulty breathing? Explain. ■ Do you work or do hobbies in an area where you are exposed to paints, glues, dust, pollen, fumes, or chemicals that might irritate your respiratory system? If so, describe.
Nutritional–Metabolic	■ Describe your usual 24-hour intake of food and fluids. ■ Has your appetite been affected by your respiratory problem? Is it difficult for you to eat because of your breathing problems? Explain. ■ Has there been a recent change in your weight? Explain.
Elimination	■ Has having this health problem made it more difficult for you to have a bowel movement? ■ *For women:* Have you had difficulty controlling your urine when you cough?
Activity–Exercise	■ Describe your usual activities in a 24-hour period. ■ What type of exercise do you usually do? Has this changed, and if so, how? ■ Has your ability to care for yourself changed with this respiratory problem? Explain. ■ Has your energy level decreased since you have had this problem with breathing? If so, how has it affected your daily life? ■ How many flights of stairs can you climb before you become short of breath? ■ Do certain activities make you very tired? Explain. ■ Are your activities interrupted by frequent coughing? Explain. ■ Do you cough up phlegm or sputum? If so, describe its amount, color, odor, and the presence of blood.
Sleep–Rest	■ Does having this problem interfere with your ability to rest and sleep? Explain. ■ How many pillows do you use at night to breathe more easily? Has this changed? ■ Do you ever wake up coughing?

(continued)

FUNCTIONAL HEALTH PATTERN INTERVIEW: Respiratory System (continued)

Cognitive–Perceptual	■ Do you have any pain in your sinuses, nose, chest, with breathing? If so, using a scale from 0 to 10, with 10 being the most severe pain, how would your rate that pain? Describe where and when you have the pain, how often you have it, what makes it worse, and what you do to relieve it. ■ Are there times when you feel anxious, restless, apprehensive, confused, or faint? Describe what you do if you have these feelings. ■ Do you know how to use the medications, inhalers, or oxygen prescribed for your respiratory problem?
Self-Perception–Self-Concept	■ How does having this condition make you feel about yourself?
Role–Relationships	■ How has having this condition affected your relationships with others? ■ Has having this condition interfered with your ability to work? Explain. ■ Is there a history of lung disease in your family? Explain.
Sexuality–Reproductive	■ Has this condition interfered with your usual sexual activity?
Coping–Stress-Tolerance	■ Has having this condition created stress for you? If so, does your breathing seem to be more difficult when you are stressed? ■ Have you experienced any kind of stress that makes the condition worse? Explain. ■ Describe what you do when you feel stressed.
Value–Belief	■ Describe how specific relationships or activities help you cope with this problem. ■ Describe specific cultural beliefs or practices that affect how you care for and feel about this problem. ■ Are there any specific treatments (such as being on a machine that breathes for you) that you would not use to treat this problem?

Physical Assessment

Physical assessment of the respiratory system may be performed either as part of a total assessment, or alone for a client with known or suspected problems. The techniques used to assess the respiratory system are inspection, palpation, percussion, and auscultation. In addition, note the client's level of consciousness, restlessness, and anxiety level, and assess the color of the lips and nail beds. Normal age-related findings for the older adult are summarized in Table 36–1.

The room should be warm and well lighted. Ask the client to remove all clothing above the waist; give women a gown to wear during the examination. Conduct the examination with the client in the sitting position. Prior to the examination, collect all necessary equipment and explain the techniques to the client to decrease anxiety.

TABLE 36–1 Age-Related Changes in the Respiratory System

AGE-RELATED CHANGE	SIGNIFICANCE
■ ↓ elastic recoil of lungs during expiration because of less elastic collagen and elastin. ■ Loss of skeletal muscle strength in the thorax and diaphragm. ■ Alveoli are less elastic, more fibrotic, and have fewer functional capillaries. ■ Cough is less effective. ■ P_{O_2} reduces as much as 15% by age 80.	The older adult often has an increased anterior-posterior chest diameter, with kyphosis and barrel chest. There is a reduction in vital capacity and an increase in residual volume, with decreased effectiveness in coughing up phlegm or sputum. All of these changes greatly increase the risk of respiratory infections (such as pneumonia), especially if the person becomes immobile. They also mean that respiratory infections are more difficult to treat.

RESPIRATORY ASSESSMENTS

Technique/Normal/Findings	Abnormal Findings
Nasal Assessment	
Inspect the nose for changes in size, shape, or color. *The nose should be midline in the face, of the same color as the face, and the nares should be symmetric.*	■ The nose may be asymmetrical as a result of previous surgery or trauma. ■ The skin around the nostrils may be red and swollen in allergies or upper respiratory infections.

Technique/Normal/Findings	Abnormal Findings
Inspect the nasal cavity. Use an otoscope with a broad, short speculum. Gently insert the speculum into each of the nares and assess the condition of the mucous membranes and the turbinates. *The septum should be midline with pink mucosa and without drainage.*	■ The septum may be deviated. ■ Perforation of the septum may occur with chronic cocaine abuse. ■ Red mucosa indicates infection. ■ Purulent drainage indicates nasal or sinus infection. ■ Allergies may be indicated by watery nasal drainage, pale turbinates, and polyps on the turbinates.
Assess ability to smell (cranial nerve I, olfactory). Ask the client to breathe through one nostril while pressing the other one closed. Ask the client to close his or her eyes. Place a substance with an aromatic odor under the client's nose (use ground coffee or alcohol) and ask the client to identify the odor. Test each nostril separately. *This test is usually done only if the client has problems with the sense of smell, but the client should be able to distinguish different odors.*	■ Changes in the ability to smell may be the result of damage to the olfactory nerve or to chronic inflammation of the nose. ■ Zinc deficiency may cause a loss of the sense of smell.
Sinus Assessment	
Palpate the frontal and maxillary sinuses. *The sinuses should not be tender to palpation.*	■ Frontal and maxillary sinuses are tender to palpation with allergies or sinus infections.
Thoracic Assessment	
Assess respiratory rate. *The normal respiratory rate is 12 to 20 breaths per minute.*	■ **Tachypnea** (rapid respiratory rate) is seen in **atelectasis** (collapse of lung tissue following obstruction of the bronchus or bronchioles), pneumonia, asthma, pleural effusion, pneumothorax, congestive heart failure, anxiety, and in response to pain. ■ Damage to the brainstem from a stroke or head injury may result in either tachypnea or **bradypnea** (low respiratory rate). ■ Bradypnea is seen with some circulatory disorders, lung disorders, and as a side effect of some medications. ■ **Apnea**, cessation of breathing lasting from a few seconds to a few minutes, may occur following a stroke or head trauma, as a side effect of some medications, or following airway obstruction.
Inspect the anteroposterior diameter of the chest. The anteroposterior diameter of the chest should be less than the transverse diameter. *Normal ratio is 1:2.*	■ The anteroposterior diameter is equal to the transverse diameter in barrel chest, which typically occurs with emphysema.
Inspect for intercostal retraction or bulging. *There should be no retraction or bulging.*	■ Retraction of intercostal spaces may be seen in asthma. ■ Bulging of intercostal spaces may be seen in pneumothorax.

Technique/Normal/Findings	Abnormal Findings
Inspect and palpate for chest expansion. Place your hands with the fingers spread apart palm down on the client's posterolateral chest. Gently press the skin between your thumbs (Figure 36–10 ■). Ask the client to breathe deeply. As the client inhales, watch your hands for symmetry of movement. *Chest expansion should be bilaterally symmetric, with the examiner's hands moving 5 to 10 cm apart.*	■ Thoracic expansion is decreased on the affected side in atelectasis, pneumonia, pneumothorax, and pleural effusion. ■ Bilateral chest expansion is decreased in emphysema.

Figure 36–10 ■ Palpating for chest expansion.

Gently palpate the location and position of the trachea. *The trachea should be midline.*	■ The trachea shifts to the unaffected side in pleural effusion and pneumothorax and shifts to the affected side in atelectasis.
Palpate for tactile fremitus. Ask the client to say "ninety-nine" as you palpate at three different levels for a vibratory sensation called tactile fremitus, which occurs as sound waves from the larynx travel through patent bronchi and lungs to the chest wall. *Fremitus is symmetric and easily palpated in the upper regions of the lungs.*	■ Tactile fremitus is decreased in atelectasis, emphysema, asthma, pleural effusion, and pneumothorax. It is increased in pneumonia if the bronchus is patent.
Percuss the lungs for dullness over shoulder apices and over anterior, posterior, and lateral intercostal spaces (Figure 36–11 ■). *The normal percussion tone over normal lung tissue is resonance.*	■ Dullness is heard in clients with atelectasis, lobar pneumonia, and pleural effusion. ■ Hyperresonance is heard in those with chronic asthma, emphysema, and pneumothorax.

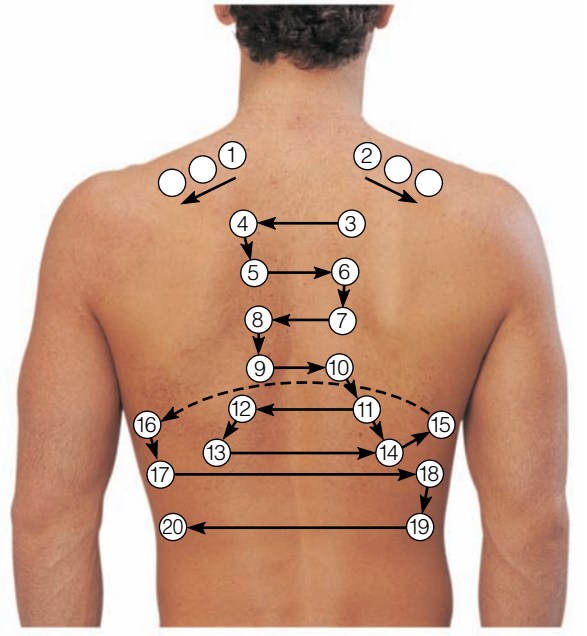


Figure 36–11 ■ Sequence for lung percussion.

Technique/Normal/Findings	Abnormal Findings
Percuss the posterior chest for diaphragmatic excursion. Systematic percussion of the posterior chest from a level of lung resonance to the level of diaphragmatic dullness reveals *diaphragmatic excursion,* a measurement of the level of the diaphragm. First percuss downward over the posterior thorax while the client exhales fully and holds the breath. Mark the spot at which the sound changes from resonant to dull. Then ask the client to inhale and hold the breath while you percuss downward again to note the descent of the diaphragm. Again mark the spot where the sound changes. *Measure the difference in diaphragmatic excursion which normally varies from about 3 to 5 cm (Figure 36–12 ■).*	■ Diaphragmatic excursion is decreased in emphysema, ascites, on the affected side in pleural effusion, and in pneumothorax. ■ A high level of dullness or a lack of excursion may indicate atelectasis or pleural effusion.

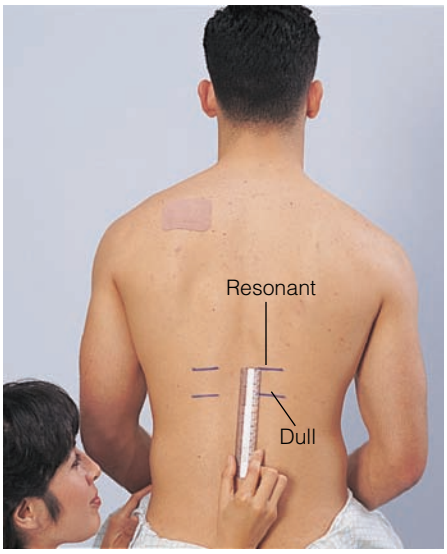


Figure 36–12 ■ Measuring diaphragmatic excursion.

Breath Sound Assessment

Auscultate the lungs for breath sounds with the diaphragm of the stethoscope by having the client take slow deep breaths through the mouth. Listen over anterior, posterior, and lateral intercostal spaces (Figure 36–13 ■). *The three different types of normal breath sounds are vesicular, bronchovesicular, and bronchial (Table 36–2).*	■ Bronchial breath sounds (expiration > inspiration) and bronchovesicular breath sounds (inspiration = expiration) are heard over lungs filled with fluid or solid tissue. ■ Breath sounds are decreased or diminished over atelectasis, emphysema, asthma, pleural effusion, and pneumothorax. ■ Breath sounds are increased over lobar pneumonia. ■ Breath sounds are absent over collapsed lung, surgical removal of lung, pleural effusion, and primary bronchus obstruction.

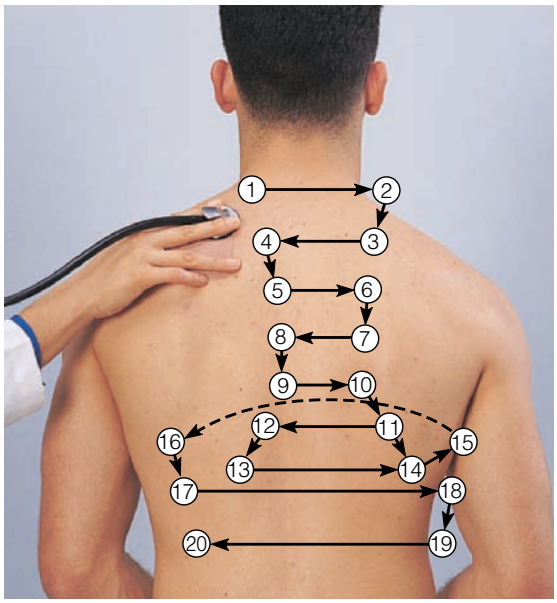


Figure 36–13 ■ Sequence for lung auscultation.

TABLE 36–2 **Normal Breath Sounds**

TYPE OF BREATH SOUND	CHARACTERISTICS
Vesicular	■ Soft, low-pitched, gentle sounds ■ Heard over all areas of the lungs except the major bronchi ■ Have a 3:1 ratio for inspiration and expiration, with inspiration lasting longer than expiration
Bronchovesicular	■ Medium pitch and intensity of sounds ■ Have a 1:1 ratio, with inspiration and expiration being equal in duration ■ Heard anteriorly over the primary bronchus on each side of the sternum, and posteriorly between the scapulae
Bronchial	■ Loud, high-pitched sounds ■ Gap between inspiration and expiration ■ Have a 2:3 ratio for inspiration and expiration, with expiration longer than inspiration ■ Heard over the manubrium

Technique/Normal/Findings	Abnormal Findings
Auscultate for crackles, wheezes, and friction rubs. If crackles or wheezes are heard, ask the client to cough and note if adventitious sound is cleared. *Normally, there are no crackles, wheezes, or friction rubs.*	■ **Crackles** (short, discrete, crackling or bubbling sounds) may be noted in pneumonia, bronchitis, and congestive heart failure. ■ **Wheezes** (continuous, musical sounds) may be heard in clients with bronchitis, emphysema, and asthma. ■ A **friction rub** is a loud, dry, creaking sound that indicates pleural inflammation.
Auscultate voice sounds where any abnormal breath sound is noted by having client say "ninety-nine" (bronchophony); whisper "one, two, three" (whispered pectoriloquy); and say "ee" (egophony). *Normally, these sounds are heard by the examiner, but are muffled.*	■ Voice sounds are decreased or absent over areas of atelectasis, asthma, pleural effusion, and pneumothorax. ■ Voice sounds are increased and clearer over lobar pneumonia. ■ When testing egophony, the sound becomes louder and changes to "a" over areas of consolidation or compression.

EXPLORE MEDIALINK

Prentice Hall Nursing MediaLink DVD-ROM

Audio Glossary
NCLEX-RN® Review

Animation/Video

Carbon Dioxide Transport
Oxygen Transport

COMPANION WEBSITE www.prenhall.com/lemone

Audio Glossary
NCLEX-RN® Review
Case Study: Respiratory Assessment
MediaLink Applications
Pulmonary Function Testing
Wheezes and Crackles
Links to Resources

TEST YOURSELF NCLEX-RN® REVIEW

1 Where is the apex of each lung located?
1. in the mediastinum
2. resting on the diaphragm
3. within the parietal pleura
4. just below the clavicle

2 What physiologic process is involved in gas exchange at the respiratory membrane?
1. facilitated transport
2. active transport
3. simple diffusion
4. hydrostatic pressure

3 What structures cover the external surface of the alveoli?
1. terminal bronchioles
2. pulmonary arteries
3. pulmonary veins
4. pulmonary capillaries

4 What process is initiated between oxygen and hemoglobin as the temperature of body tissues increases?
1. Oxygen unloading is enhanced.
2. Oxygen unloading is inhibited.
3. Respiratory rate decreases.
4. Lung compliance increases.

5 You are teaching a client about a thoracentesis. How would you best describe this procedure?
1. "You will be asleep when they make the incision."
2. "Fluid will be drawn off the area around your lung."
3. "It involves lying very still in a large, noisy machine."
4. "The doctor will be able to see inside your lung."

6 Which of the following questions should be included when conducting a health history to identify a genetic risk of respiratory disease?
1. "Tell me how many colds you have each year."
2. "Has anyone in your family had a stroke or heart attack?"
3. "Has lung cancer ever been diagnosed in your family?"
4. "Do your children have trouble breathing at night?"

7 While auscultating your client's breath sounds, you note continuous musical sounds. You document these sounds as:
1. murmurs.
2. wheezes.
3. crackles.
4. rales.

8 Your client has had a lung removed. What type of breath sound would you expect to assess over the affected side?
1. resonance
2. crackles
3. bronchovesicular
4. absent

9 What would you ask the client to do as you auscultate the lungs?
1. "Hold your breath."
2. "Repeat the number 99 several times."
3. "Take slow deep breaths through your mouth."
4. "Breathe in and out through your nose."

10 While assessing your client with a left pneumothorax you note decreased diaphragmatic excursion on the left. What would you do next?
1. Notify the physician immediately.
2. Document the assessment.
3. Repeat the assessment several times.
4. Tell the client to hold his or her breath.

See Test Yourself answers in Appendix C.

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