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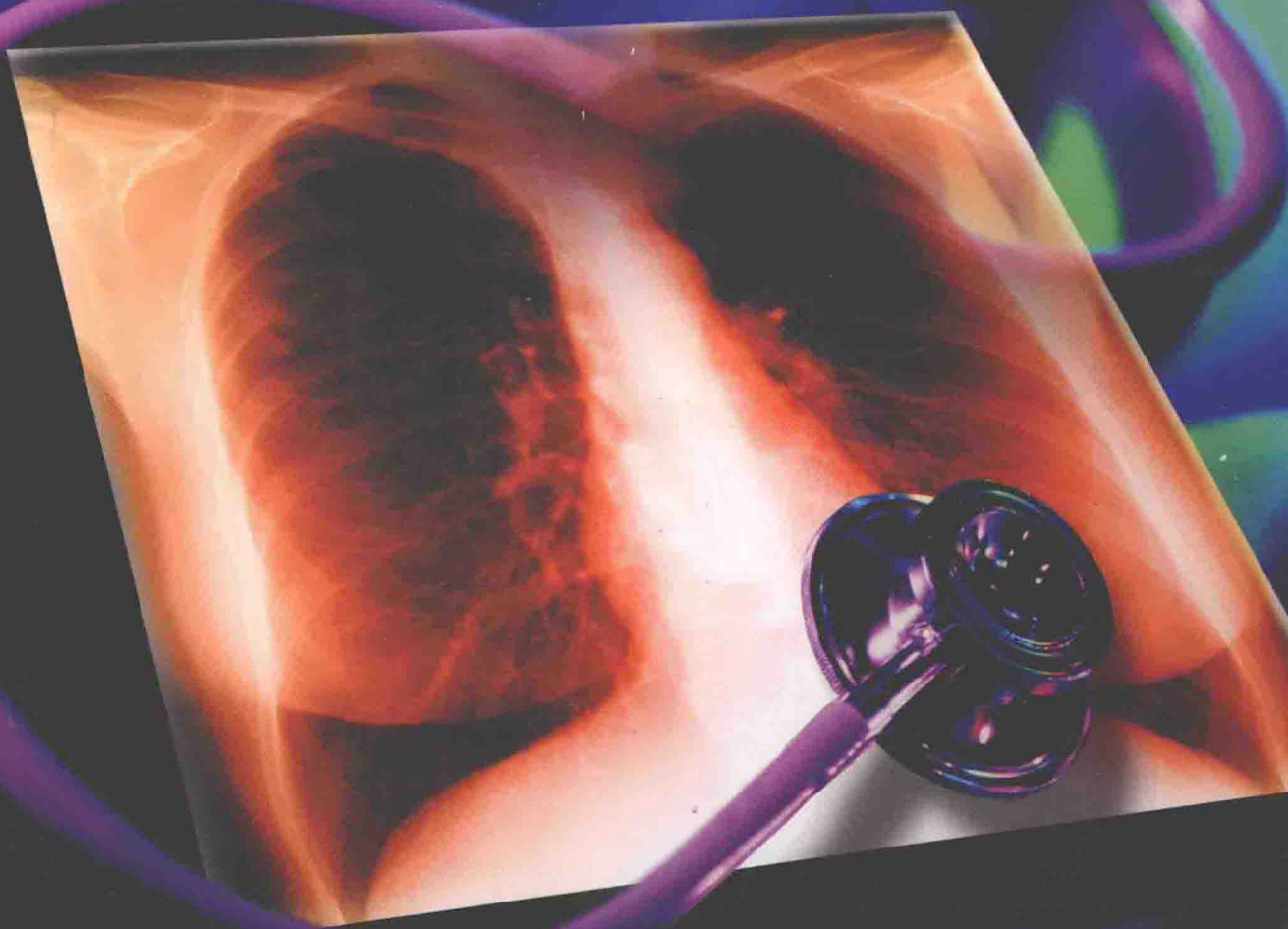
Respiratory Care Skills

for Health Care Personnel



Daniel W. Grove

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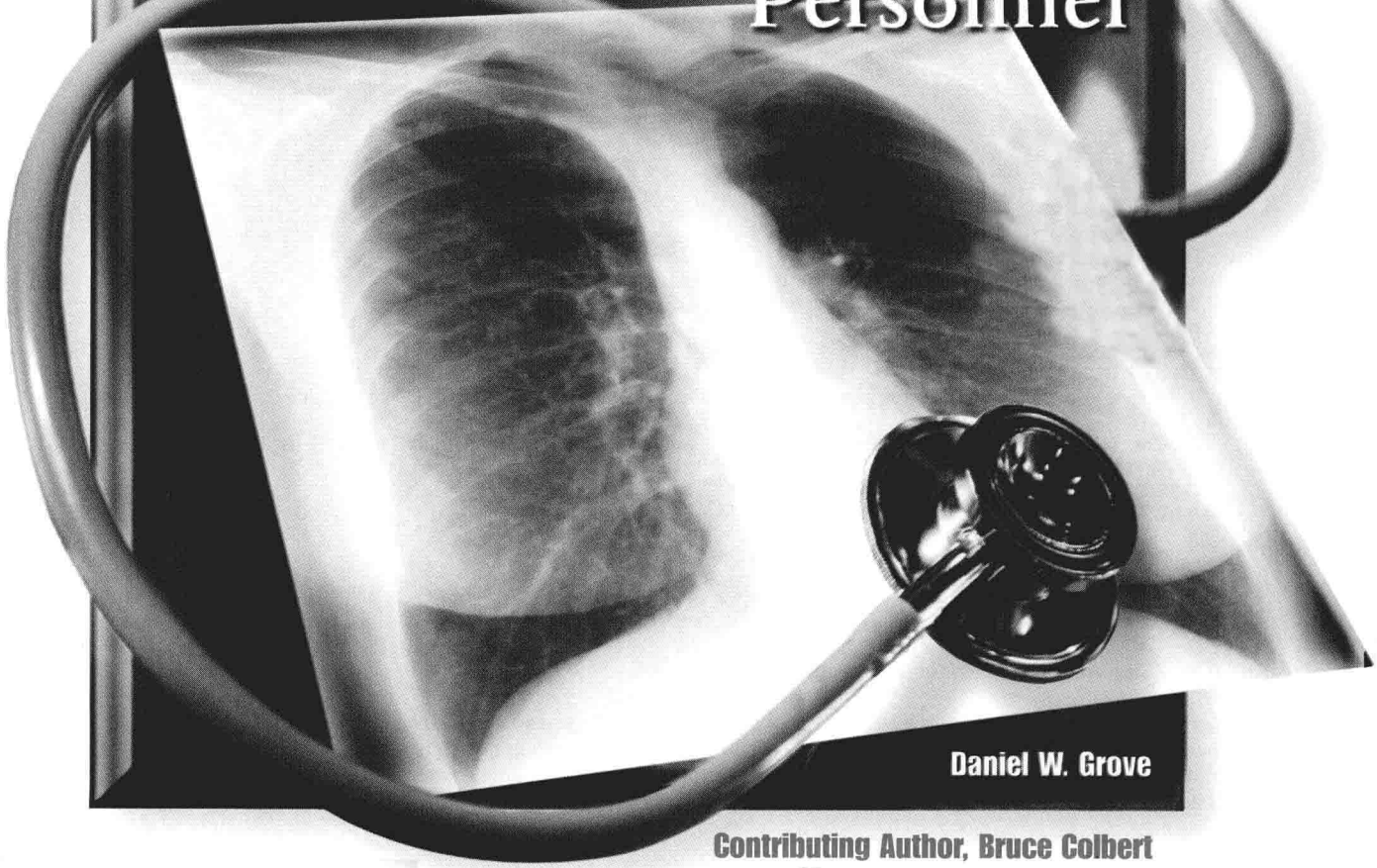

Daniel W. Grove

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Dedication

To Mom and Dad for all their guidance and support and to my partner Mickey, who provides for me and protects me. Also to my daughters Amy, Jessica, and Megan and my granddaughter, Julia Irene who light up my world.

Daniel Grove

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Preface

The field of health care is an ever-changing place. Flexibility is key to obtaining and maintaining your career. The concept of cross training, or multiskilling, although not a new one, has become the expected rather than the exception. Cross training allows you to be able to function in a variety of workplace settings doing diverse tasks. The fact that you are currently reading this book means that you are willing to acquire new skills or specialize the skills you already possess. This willingness translates into your enhanced value, job security, marketability, and mobility.

In 1994, the National Health Care Skills Standards (NHCSS) were developed by the National Consortium on Health Science and Technology Education (NCHSTE) to help serve the needs of diverse client populations, maintain quality care, and increase the efficiency of staff utilization. These standards inform current and future health care workers, employers, and educators about what skills and knowledge workers need in order to succeed. The goal of these standards is to help provide the foundation for better worker preparation and performance. This series has been written with these standards in mind. For a listing of these standards go to the NCHSTE website at www.nchste.org. All of the modules of the text include features that correlate directly with the NHCSS. The following sections describe features found within the text and CD-ROM.

Troubleshooting

The troubleshooting feature identifies problems that may arise when you are performing a procedure and provides suggested solutions. Reading these will help you answer the "What Would You Do?" questions in the Chapter Review and prepare you to practice your skills in real life.

Safety and Infection Control

As a health care employee you are given the responsibility to provide safe care and prevent the spread of infection. The Safety and Infection Control feature presents special tips and techniques related to the skills taught within each module that will help you meet these responsibilities.

Patient Education and Communication

Client interaction and education and intrateam communication are integral parts of health care. You should be able to communicate effectively both orally, and in writing, and provide for patient education related to the procedures you will be performing. The Patient and Education feature provides ways for you to perform these tasks.

Law and Ethics

When working in the health care field you need to understand legal responsibilities, limitations, and the implications of your actions. You must perform duties within established ethical practices. The Law and Ethics feature provides specific information to help you gain a greater knowledge of how law and ethics relate to the performance of your duties.

GET CONNECTED TO THE WEB

In this technologically advanced world the Internet can be a key resource for your reference and education. Provided at the end of the Chapter Reviews are Internet sites to research and activities to complete.

Key Terms and Definitions

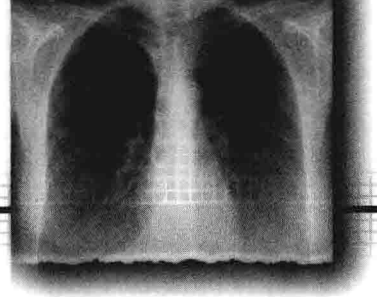
Each chapter begins with the identification and definition of all the key terms. On the optional CD-ROM the key terms and definitions are provided in audio format within each chapter and the Glossary. You can review and listen to every key term's pronunciation and definition.

Interactive Drill, Practice, and Review CD-ROM

The CD-ROM is provided as an optional package with your test to allow you to interact with and review the materials through multimedia. It is designed to complement and enhance your textbook. You can search for and listen to all of the key terms or study the competencies through interactive slide shows. Once you enter the main menu you can study each chapter. The *Law and Ethics, Providing Safety and Infection Control, Patient Education and Communication,* and *Troubleshooting* screens include critical thinking questions for you to complete, print, and check your answers. A key to your success for learning the information in this text is to study using the *INTERACTIVE QUESTIONS* provided for each chapter. They allow you to review and test your knowledge. These questions include graphics, photos, and sound that will enhance your retention of the material in an interactive way. Your score for these questions and suggested areas of improvement can be printed for you and your instructor.

Instructor's Manual

Look in the Instructor's Manual for multiple resources to use while studying *Respiratory Care Skills for Health Care Personnel.* Included are PowerPoint presentations of each chapter for classroom instruction and the ExamView Pro test generator. Many suggested classroom activities are provided that will increase the interest level and comprehension of the text/workbook material. Also, anticipatory set activities to stimulate and enhance the learning for each chapter are included. In addition, you will also find curriculum suggestions for how to use the materials based upon the length and depth of your Respiratory Care Skills course. The interactive CD-ROM provides activities for various learning methods, and the Instructor's Manual includes instructions and suggestions for how you may want to include it in your classroom. The Instructor's Manual also includes AAMA, AMT, and SCANS correlation charts and competency checklists for the skills presented in the text/workbook.



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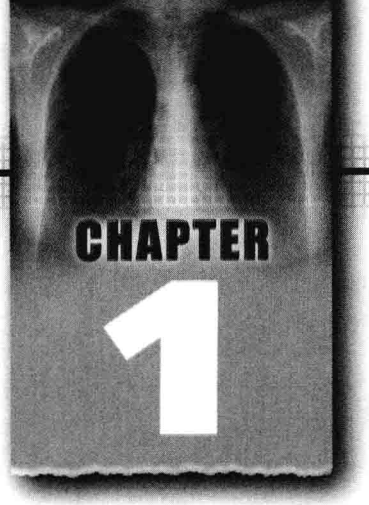


CHAPTER 1

Introduction to Respiratory Care

Chapter Outline

Objectives

Upon completion of this chapter, you should be able to:

- Identify the role and services provided by the respiratory care profession.
- Describe the function and structure of the upper airway.
- Describe the function and structure of the lower airways.
- Discuss the role of the lung parenchyma in gas exchange.
- Describe the process of collateral ventilation.
- Discuss the structure and function of the mucociliary escalator.
- Describe the role of the respiratory lymphatic system.
- Identify the structures that comprise the thoracic cavity.
- List and describe the muscles of breathing.
- Discuss pulmonary circulation.
- Differentiate between ventilation and respiration.

Key Terms

accessory muscles - Secondary muscles used when additional ventilation is needed such as during times of strenuous exercise or in patients with lung disease.

acinar unit (acinus) - A small unit of the lung parenchyma, fed by a single respiratory bronchiole and composed of an alveolar duct, alveolar sacs, and a cluster of alveoli.

aspiration - The act of inhaling food, drink, or foreign material into the airways or lungs.

carbon dioxide - A colorless gas produced as a by-product of cellular metabolism that is expelled by the lungs during exhalation.

carina - Site where the trachea divides into the right and left mainstem bronchi.

clavicle - The collar bone.

epiglottis - Located at the base of the tongue, it diverts food and liquid into the esophagus by covering the larynx and trachea during swallowing.

esophagus - A muscular canal extending from the pharynx to the stomach; its purpose is to carry food and liquid from the mouth to the stomach.

eustachian tubes - Auditory tubes, lined with mucous membranes, that extend from the middle ear to the nasopharynx.

hemidiaphragm - The left or right dome of the diaphragm, separated by the central tendon; each half has its own nerve supply.

Heimlich maneuver - An emergency procedure that requires using a fist to perform an abdominal thrust on a choking victim to exert an upward pressure to expel foreign material from the trachea.

hilus (hilum) - A depression in the lung where blood vessels and nerves enter and exit.

laryngopharynx - One of the three sections of the pharynx; it acts as a passage for both the respiratory and the digestive systems.
lingula - A division of the lung's left upper lobe that corresponds to the right middle lobe.
lobe - A separate portion of the lung or any organ such as the liver or brain.
lymphocytes - A type of white blood cell, found in the lymph nodes, used to kill pathogens.
mucosa - A layer of moist tissue that lines the walls of a body cavity; also called the mucous membrane.
mucus - Viscid fluid secreted by mucous membranes and glands.
nasopharynx - One of the three sections of the pharynx, located above the soft palate; it contains the openings for the eustachian tubes.
olfactory - Pertaining to the sense of smell.
oropharynx - One of the three sections of the pharynx, located between the soft palate and the upper part of the epiglottis.
oxygen - A colorless, odorless gas comprising about 21% of the atmosphere that supports combustion and is essential for respiration in humans and animals.
phrenic nerve - A motor nerve that originates from the spinal cord at the area of C3–C5 that stimulates the diaphragm.
pulmonary artery - Part of the pulmonary circulation system; it receives unoxygenated blood from the right ventricle, then divides into the right and left pulmonary arteries to supply blood to the lungs.
pulmonary capillary - The smallest blood vessel of the pulmonary circulation, with an inside diameter only large enough to allow blood cells to flow through in a single file.
pulmonary veins - The two pulmonary veins carry oxygenated blood from the lungs to the left atrium.
sinus - A cavity within a bone.
thorax - A bony cage formed by the sternum, costal cartilage, ribs, and the thoracic vertebrae which encloses and protects the heart and the lungs; also known as the chest.
vocal cords - Two bands of elastic tissue found in the larynx covered by membranes called the vocal folds that vibrate and produce sound when air passes over them.

This chapter begins with a brief discussion of the respiratory care profession and the role of respiratory care professionals in the treatment of respiratory disease. The chapter then focuses on the anatomy and physiology of the respiratory system. Diversified health care workers such as the medical assistant require a basic understanding of medical terminology and of the anatomy and physiology of the respiratory system. This knowledge will lay the foundation for the subsequent chapters, where assessment, disease states, and respiratory modalities will be explored.

The Respiratory Care Profession

The American Association for Respiratory Care (AARC) is the national professional organization for respiratory care. There are chapters in all fifty states plus three international ones. The AARC is actively involved in developing state and national health care policies, promoting smoking cessation programs, and providing clinical practice guidelines for the profession. Clinical practice guidelines are a set of standards developed to provide a reference for the provision of respiratory care and are available from the AARC.

The AARC defines respiratory care as follows:

> Respiratory care is a life-supporting, life-enhancing health care profession practiced under qualified medical direction. Medical direction means that the practice of respiratory care is provided under a medical director. Respiratory care services provided to patients with disorders of the cardiopulmonary system include: diagnostic testing, therapeutics, monitoring, and rehabilitation. Patient, family, and public education are central to the mission of the profession. Respiratory care services are provided in all health care facilities and in the home.

There are two levels of practice in the respiratory care profession, certified respiratory therapist (CRT) and registered respiratory therapist (RRT). These credentials are awarded upon graduating from an American Medical Association (AMA)–approved program and successfully passing the board exams given by the National Board for Respiratory Care (NBRC). These credentials are usually attained after

attending a two-year associate's degree or a four-year bachelor's degree program. A general term of respiratory care practitioner (RCP) is often used to describe the two levels of practice in the respiratory care profession and is also the term used by many states for licensure.

Respiratory care primarily treats and prevents lung disease. Respiratory care personnel are responsible for assessing the need for therapeutic respiratory procedures, determining the potential benefits, and monitoring the outcome of the therapy to determine if the objectives were met for that patient. RCPs are highly trained in the areas shown in Table 1-1.

Table 1-1 Roles of the respiratory care practitioner

Therapeutic procedures	Diagnostic procedures
Oxygen therapy	Arterial blood gas analysis
Aerosol therapy	Pulmonary function testing
Airway care	Pulse oximetry
Bronchial hygiene	Capnography
Lung expansion therapy	Sleep studies
Invasive and noninvasive mechanical ventilation	Metabolic assessment
	Electrocardiography
	Holter monitoring
	Hemodynamics

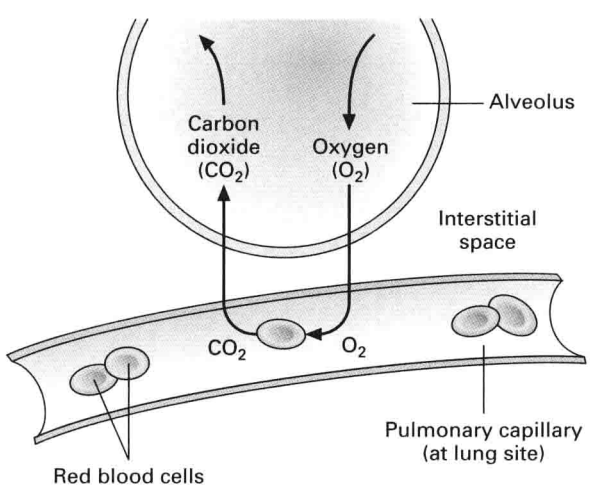
Respiratory Anatomy and Physiology

To provide effective respiratory care, one should have a thorough understanding of the structure and function of the respiratory system. The respiratory system is designed primarily for the exchange of **oxygen** and **carbon dioxide** between the atmosphere and the cells of the body. In essence, oxygen contained in our atmosphere must be delivered to the cells and tissues of the body for metabolism to occur. In addition, the respiratory system must rid the body of carbon dioxide, which is the by-product of metabolism. For this exchange to be successful, the lungs and other body systems must work together in an integrated fashion.

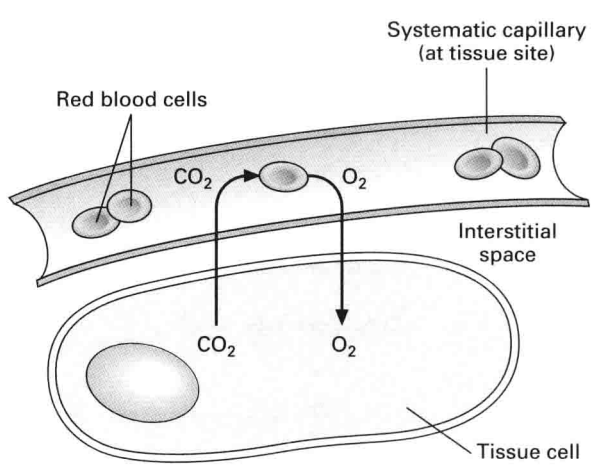
Ventilation is the process of moving gas in and out of the lungs. This process is controlled by the nervous system and assisted by a variety of muscles. The primary role of ventilation is to remove carbon dioxide from the lungs and to deliver oxygen from the atmosphere to the lungs.

Respiration is the exchange of oxygen and carbon dioxide between the blood and the cells of the body's tissues. There are two stages of respiration: external and internal. External respiration is the exchange of oxygen and carbon dioxide between the atmosphere and the blood that occurs in the lungs. Internal respiration is the exchange of oxygen and carbon dioxide by the cells of the body with the blood that occurs at the tissue sites (see Figure 1-1).

Figure 1-1: These drawings illustrate (a) external respiration, which is the exchange of oxygen and carbon dioxide in the lungs and (b) internal respiration, which is the exchange of oxygen and carbon dioxide at the tissue sites.



A External Respiration in the Lungs



B Internal Respiration at the Cell

LAW AND ETHICS - It is very important for any medical personnel–whether respiratory, medical assistant, or nursing–to know and understand their scope of practice. In most states this is defined by the medical board, which may certify or issue licenses to practice within the state.

The respiratory system has two components: the upper and lower airways. We will begin our discussion with the upper airway and trace the flow of inhaled gas internally within the lungs to the areas where it participates in gas exchange. The upper airway is composed of the structures from the nose to the larynx, or voicebox.

The upper airway

The nose

The external nose is composed of skin, cartilage, and bone, which surround the openings of the nose, called the nostrils or anterior nares. The nares are the main passageway for gases to enter and leave the respiratory system. The primary functions of the nose are to humidify, filter, and adjust the temperature of the inspired air to 37°C (body temperature). Two significant secondary functions of the nose are to facilitate the sense of smell and to act as a resonance chamber for phonation (our speech).

The interior of the nose is divided into two cavities by the nasal septum. Coarse hairs called vibrissae are located within the nostrils to trap large particles. Further within the nasal cavity arise three major projections called turbinates or conchae. The conchae are the main filtering, warming, and humidifying devices of the nose and are

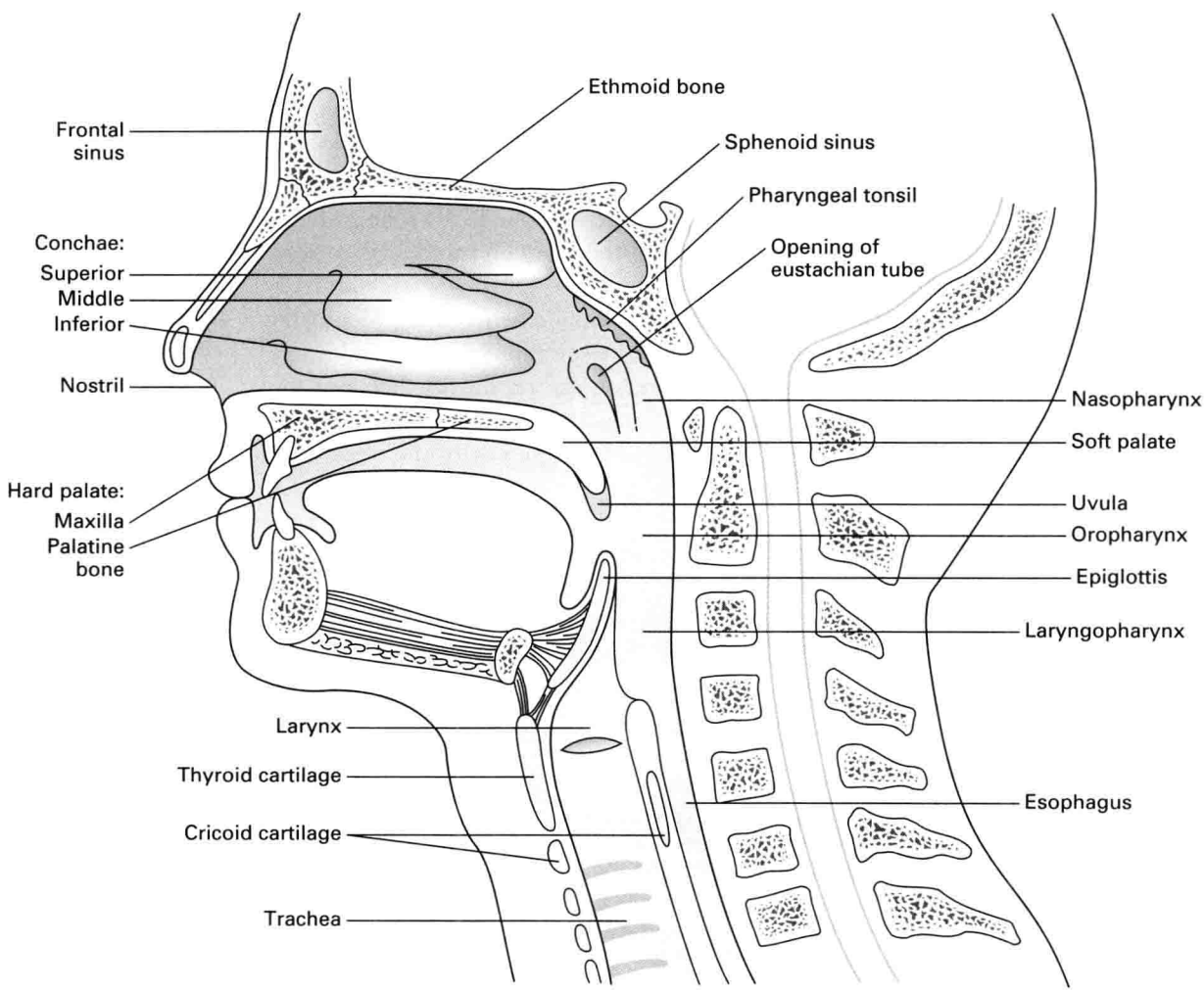


Figure 1-2: The structures of the nasal cavity provide for humidification, filtration, temperature control, and conduction of gases to the lower airways.

covered by a moist membrane called the nasal **mucosa**. The nasal mucosa is made up of cells that contain hairlike projections called cilia. Cilia also help protect the respiratory system by filtering dust and particles from inhaled air. They act like small oars beating in a coordinated fashion to propel debris toward the larger airways where the particles can be expectorated. The **olfactory** area is located in the upper nasal cavity. A "sniffing" action of the nose causes air currents to rise to this olfactory region, thus facilitating the smelling process.

There are eight hollow cavities situated inside the interior bones of the skull called the paranasal **sinuses**. The four paired sinuses (sphenoid, ethmoid, frontal, and maxillary) are named after the bones in which they are located and open into the nasal cavities near the turbinates. It is believed their function is to lighten the skull by replacing what would normally be bone with an air-filled cavity, thus producing less stress on the cervical vertebrae. The sinuses also provide resonance for the voice (see Figure 1-2).

The mouth (oral cavity)

The mouth serves a dual purpose: it allows passage of food through the esophagus for the digestive system and air through the trachea for the respiratory system. Breathing through the mouth sometimes occurs during times of nasal congestion, nasal surgery, or heavy exercise. It is easier to breathe through the mouth as there is less resistance because it is a larger opening than the nose. A major drawback of breathing through the mouth is that the mouth is not as good a conditioner as the nose, so it cannot provide the warming, humidifying, and filtering that the nose provides. The roof of the mouth, or palate, separates the nasal cavity from the oral cavity (see Figure 1-3). The anterior two-thirds of the palate is part of the maxillary bone and is referred to as the hard palate. The posterior one-third of the palate, called the soft palate, is flexible and fibrous. The uvula is an extension of the soft palate located at its midpoint at the back of the mouth. The flexibility of the uvula and the soft palate permits a temporary closure between the oral cavity and nasal cavity and controls the flow of air during eating, drinking, sneezing, coughing, and vomiting. The functions of the tongue include moving food and drink to the posterior section of the oral cavity, helping in phonation, and facilitating the sense of taste.

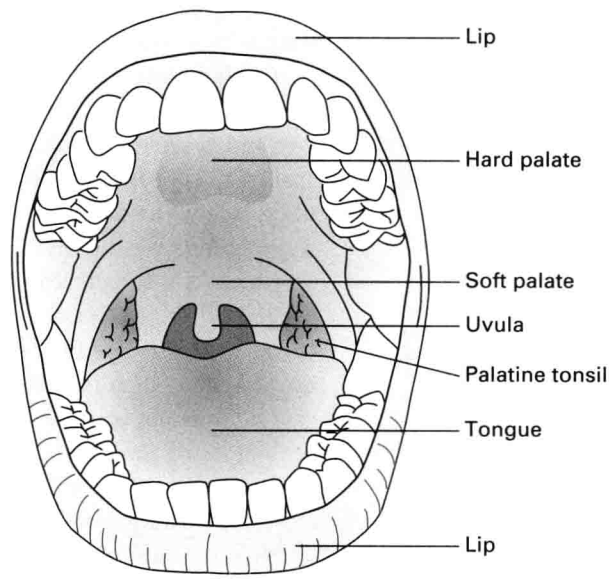


Figure 1-3: The oral cavity serves as a common passageway for ventilatory gases, food, and liquid.

The pharynx

The pharynx is a hollow muscular cavity about 5 inches long that serves as a passageway for both food and air. It occupies the area immediately behind the oral and nasal cavities. The pharynx is divided into three parts: the nasopharynx, oropharynx, and laryngopharynx (sometimes referred to as the hypopharynx).

The **nasopharynx** is the uppermost portion of the pharynx and is a continuation of the nasal cavities. Its roof is formed by the bones of the skull, with its base lying above the soft palate. The nasopharynx contains the openings of the **eustachian tubes** (auditory), which connect the tympanic membrane, commonly called the eardrum, to the atmosphere. The auditory tubes equalize the pressure between the middle ear and the atmosphere. This is essential when someone is exposed to different air pressures such as when flying at high altitudes or when diving underwater.

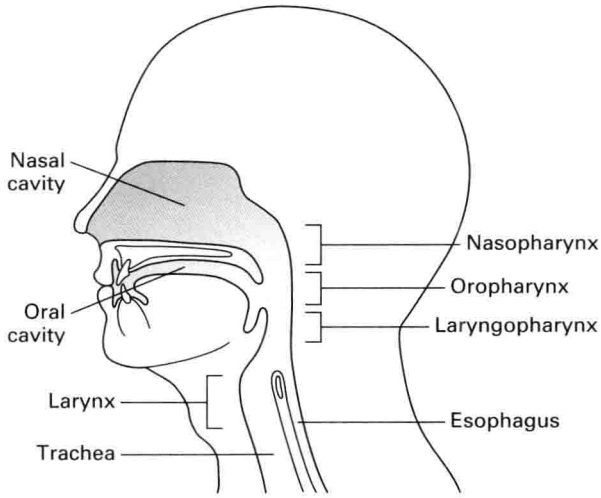


Figure 1-4: The pharynx is divided into three regions. The name of each region is representative of its location within the respiratory system.

The **oropharynx** extends from the soft palate to the epiglottis in the area behind the mouth at the base of the tongue. The palatine tonsils, one on each side, are located on the lateral walls of the oropharynx. They are part of the lymphatic system and act as a filter to protect the respiratory tract from infection. The **laryngopharynx** extends from the tip of the epiglottis to the esophagus and lies behind the larynx (see Figure 1-4).

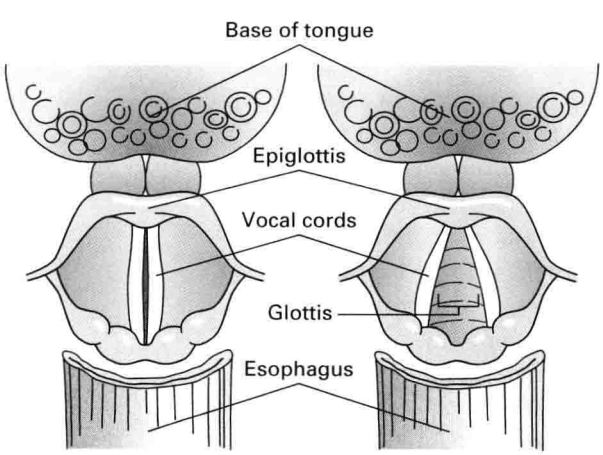
The larynx

The larynx (also known as the voicebox) is a complex structure located right below the pharynx. It serves as a passageway into the respiratory system from the pharynx to the trachea and helps protect the lower airways from **aspirated** (or inhaled) liquids, solid food, or foreign material. In addition, the larynx is responsible for producing the vibratory sounds that constitute our voice.

The larynx is composed of nine pieces of cartilage that are held together by membranes, ligaments, and muscles. The thyroid cartilage is the largest structure in the larynx and is referred to as the Adam's apple. Its main purpose is to serve as protection against the collapse of the airway due to external trauma such as a massive blow to the neck. Below the thyroid cartilage lies the cricoid cartilage, which also protects the airways. Lying over the thyroid cartilage, at the base of the tongue, is the **epiglottis.** The epiglottis is a broad, leaf-shaped structure lying on top of the larynx that acts as a hinged lid to protect the airway from aspiration. During swallowing, the epiglottis closes over the opening of the airway and thus diverts food and liquids into the **esophagus,** which lies behind the airway.

The opening into the larynx is called the glottis. The **vocal cords** are located on both sides of the glottis and are held in place during breathing so that air may pass freely in and out of the trachea (see Figure 1-5). During speech, muscles open and close the cords over the glottis and exhaled air vibrates them to produce sounds, which are then turned into words with the aid of the tongue, lips, and the oral and nasal passages. Another important function of the larynx is a process called the Valsalva maneuver. This maneuver occurs when the vocal cords close completely during a forceful exhalation, resulting in the buildup of pressure within the lungs and a downward pressure on the abdominal structures. This process is very important in helping to produce a strong cough, and it also occurs during vomiting, childbirth, and defecation.

Figure 1-5: The larynx is commonly referred to as the voicebox.



The lower airways

The lower airways are made up of two components, the tracheobronchial tree and the lung parenchyma. The term *tracheobronchial tree* underscores the similarity of the airway structure to that of a tree, with each branching representing a generation of the airways. The tracheobronchial tree includes the trachea, mainstem bronchi, lobar bronchi, segmental bronchi, bronchioles, and terminal bronchioles. These structures represent the conducting airways that move gas down to where it can be exchanged. The second component, where gas exchange occurs, is referred to as the lung parenchyma. It includes the respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli (see Figure 1-6).

The trachea

The trachea can be thought of as the trunk of the tracheobronchial tree and represents generation zero from which further generations or branchings will arise. It is a flexible tube about 11 cm to 13 cm long and 2.5 cm in diameter. The trachea extends from the larynx to the **carina,** where it divides to form the right and left mainstem bronchi. The walls of the trachea are composed of 16 to 20 C-shaped cartilaginous rings that provide structural support and protection. The posterior gaps in the cartilage are open to permit the expansion of the esophagus when food is swallowed.

SAFETY AND INFECTION CONTROL - Because the nasopharynx connects to the oropharynx and laryngopharynx, infection can spread throughout. For example, an ear infection can lead to a sinus infection, which can lead to a respiratory infection. Therefore, proper upper airway clearance and dental oral hygiene are important in preventing respiratory infections.

The mainstem bronchi

The right and left mainstem bronchi are the branches of the trachea that enter the lungs and are considered the first generations of the tracheobronchial tree. The right mainstem bronchus is about 11 mm to 19 mm in diameter and branches away from the trachea at about a 20- to 30-degree angle in the adult. The left mainstem bends more sharply, at an angle of about 45 to 55 degrees.

TROUBLESHOOTING

The space between the thyroid and cricoid cartilage is covered by the cricothyroid membrane. Because this space has little blood supply, it can provide an emergency opening to the lower airways in case of an upper airway obstruction. This procedure is called a cricothyroidotomy.

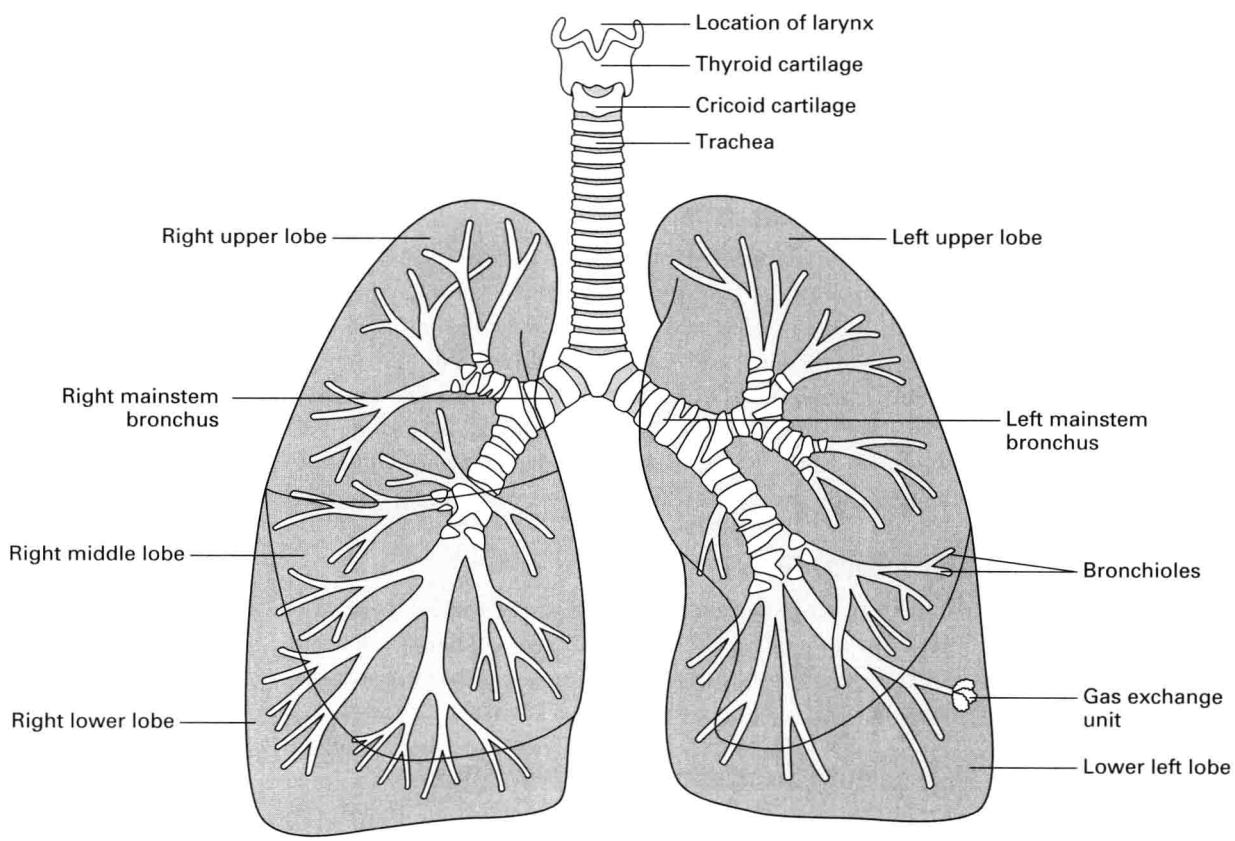


Figure 1-6: The lower airways primarily serve to conduct the inspired atmosphere to the areas of gas exchange within the lungs.

TROUBLESHOOTING

Because the right mainstem has less of an angle than the left, it represents a straight pathway into the right lung. If someone aspirates food or a small object, it is more likely to be found in the right lung.

The lobar bronchi

The mainstem bronchi divide into the second generation or branching of the airways called the lobar bronchi, which are about 4.5 mm to 13.5 mm in diameter. These airways supply the three primary **lobes** in the right lung and the two primary lobes of the left lung. The right lung contains an upper, middle, and lower lobe; the left lung has an upper and lower lobe, with a central area called the **lingula,** a lower portion of the left upper lobe that corresponds to the right middle lobe.

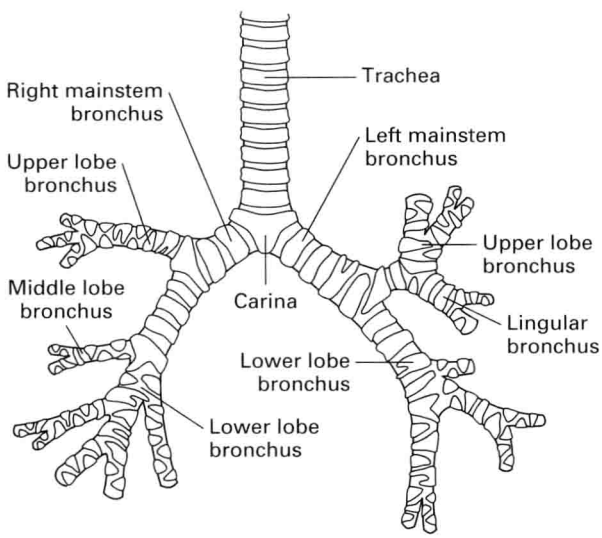


Figure 1-7: The tracheobronchial tree gets its name from the several branches that occur with the bronchi and bronchioles.

The segmental bronchi

The third generation of the tracheobronchial tree consists of the segmental bronchi, which supply the individual segments contained within each lung lobe. The right and left lung have 10 segments each. The right and left upper lobes of each lung have three segments, namely the apical, posterior, and anterior. The right middle lobe has two segments, the lateral and medial. The lingula of the left lung contains the superior and inferior segments, and the left lower lobe has the superior, anterior, medial, lateral, and posterior basal segments. The right lower lobe contains the superior, medial basal, anterior basal, lateral basal, and posterior basal segments (see Figure 1-7).

The subsegmental bronchi

The segmental bronchi branch off into the subsegmental bronchi, which are the fourth to ninth generations of the tracheobronchial tree. There are about 38 subsegmental bronchi, each with a diameter of about 3 mm to 6 mm. Each generation of the bronchi becomes shorter in size and smaller in diameter. There are a total of about 24 to 27 generations of the tracheobronchial tree. The first nine generations are similar to the composition of the trachea because they are still formed by C-shaped cartilaginous rings. The C-shaped cartilage gives the airways strength, yet lets them be flexible enough to move with lung expansion and contraction during breathing.

The bronchioles

The bronchioles represent the 10th through 15th generations of the tracheobronchial tree. They are between 1 and 2 mm in diameter and, with the absence of cartilage, depend on smooth muscles and lung tissue for support. Bronchioles are simply small bronchi.

The terminal bronchioles

Branching from the bronchioles are the terminal bronchioles, generations 16 to 19. There are about 35,000 terminal bronchioles, which have a diameter of about 0.65 mm in the adult. This generation of the airways marks the end of the conducting