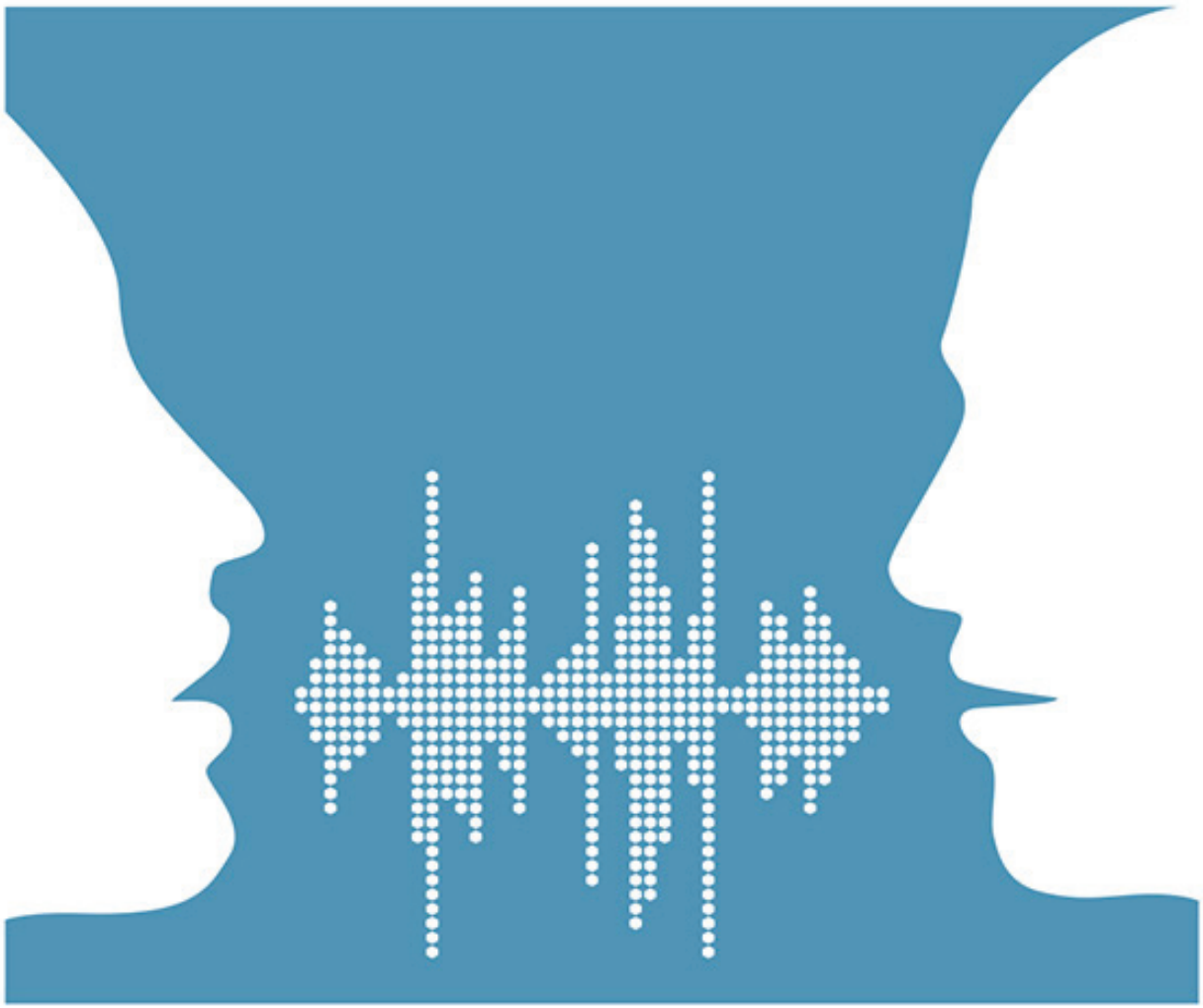
THE PEARSON COMMUNICATION SCIENCES AND DISORDERS SERIES

VOICE DISORDERS
SCOPE OF THEORY AND PRACTICE

SECOND EDITION



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Voice Disorders

Scope of Theory and Practice

Second Edition

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In loving memory of my father-in-law, Edward F. Ferrand, PhD

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Preface

Voice Disorders: Scope of Theory and Practice, Second Edition, presents a comprehensive account of the field of voice in the early years of the new millennium. The book is meant for graduate students in speech-language pathology as well as practicing professionals who would appreciate an up-to-date yet easy-to-read reference. The book is based on 25 years of teaching a graduate-level voice disorders course, integrated into a framework of classic and current research.

Goal of the book

The goal of this book is to present a detailed picture of current theory and practice in the field of voice in a way that is both comprehensive and readily accessible to the reader. Understanding of the material is facilitated by the organization of the information.

Organization of the book

The idea for this book developed gradually over some years as I experimented with different organizational formats for the course. It seemed logical to begin with a detailed discussion of respiratory and laryngeal anatomy and physiology to build a solid foundation of knowledge of normal structure and function. And, following the initial discussion with information regarding changes in structure and function over the lifespan, was also an obvious step. At what point to cover clinical management domains (i.e., diagnosis, evaluation, therapeutic approaches, treatment issues) was more difficult. I tried numerous approaches, for example, presenting information on voice disorders (etiologies, symptoms, etc.) followed by sections on diagnosis and evaluation, and finishing up the course with treatment. However, by the end of the semester there was typically very little time (usually just one session) to cover treatment. Next I tried infusing treatment techniques into the disorders sections and leaving diagnosis and evaluation until the end of the course. But it made more clinical sense to present material on diagnosis prior to discussing specific intervention approaches. Finally, I settled on the current organization of the course, which also forms the organization of this book. The first section of the book (Chapters 1 and 2) presents the foundational anatomical information that forms the basis for rational clinical decision making. The next section (Chapters 3 and 4) provides a thorough grounding in clinical methodology in the assessment and treatment of voice disorders. Students are introduced to important

diagnostic and therapeutic principles and methods that underlie many different types of voice disorders. The final section of the book (Chapters 5–10) is devoted to an in-depth discussion of specific voice disorders, with focused clinical management techniques elaborated on as appropriate. For example, medical/surgical treatment approaches that are specific to Parkinson's disease are discussed in the chapter on movement disorders, and therapeutic strategies specific to paradoxical vocal fold motion are presented in the chapter on disorders related to airway difficulties and respiration.

Each chapter is followed by assessment quizzes and review questions that help the reader to summarize and internalize the information. Practice Praxis questions prepare students for the types of questions commonly seen on the Praxis exam.

DETAILED ORGANIZATION OF THE BOOK

Chapter 1 presents the anatomy and physiology of the respiratory system, including descriptions of lung volumes and capacities important for voice production. A detailed discussion of the laryngeal mechanism follows, including information on the vital role of extracellular matrix, the importance of the mucosal wave, and the role of phonation threshold pressure in the vibratory cycle. The neurology of laryngeal motor control is discussed, focusing on cortical, subcortical, and peripheral structures that regulate voice production. Attention is paid to the three stages of wound healing that can result in a vocal fold scar. The chapter concludes with a discussion of modal, pulse, and falsetto registers used in speech production.

Chapter 2 is devoted to a discussion of lifespan changes in the respiratory and phonatory systems from embryological development through infancy, childhood, puberty, adulthood, and old age. Structural and functional changes in the laryngeal system are presented along with the perceptual and acoustic effects of such changes, focusing attention on the aging voice. Knowledge of these changes and their effects on voice production is of crucial importance, given the dramatic and continuing increase in the elderly population in the United States. Understanding what constitutes normal aging forms the basis for differentiating between expected and pathological vocal change.

Chapter 3 presents a comprehensive discussion of diagnostic and evaluation procedures. The importance of obtaining a thorough case history is emphasized, and examples of case history protocols for adults and children are provided. The current emphasis on patient-reported outcomes and quality of life is stressed, and several examples of quality-of-life questionnaires are presented. The chapter discusses components of the voice evaluation including auditory-perceptual assessment, endoscopic measures, acoustic analysis, aerodynamic measures, and laryngeal electromyography. The chapter concludes with a detailed case history illustrating many of the concepts, with related questions pertaining to the diagnostic process.

Chapter 4 presents a comprehensive discussion of clinical management and clinical considerations. Discussion focuses first on primary, secondary, and tertiary prevention. Attention then turns to specific indirect and direct approaches, including vocal hygiene programs, hydration, biofeedback, respiratory support, yawn-sigh, effort-closure techniques, accent method, resonant voice therapy, vocal function exercises, Lee Silverman Voice Treatment, semi-occluded vocal tract, and flow phonation. Discussion then turns to phonosurgical procedures such as thyroplasty, airway widening procedures, and vocal fold augmentation injection. Where available, outcomes studies and efficacy

research are presented for each behavioral and phonosurgical approach. The important issues of patient compliance with behavioral voice therapy techniques, and the need for patient counseling, are highlighted. Information is presented regarding the provision of therapeutic services for children, and the chapter concludes with a discussion of multicultural issues in voice therapy.

Chapter 5 presents information on structural pathologies of the larynx, including nodules, polyps, cysts, scar, sulcus, granuloma and contact ulcer, leukoplakia, recurrent respiratory papillomatosis, subglottic and glottic stenosis, laryngomalacia, vocal fold hemorrhage, varix, and ectasia.

Chapter 6 focuses on inflammatory conditions of the larynx, such as acute and chronic laryngitis, gastroesophageal reflux disease and laryngopharyngeal laryngitis, and autoimmune inflammatory diseases such as systematic lupus erythematous, relapsing polychondritis, and rheumatoid arthritis.

Chapter 7 addresses neurologic disorders affecting voice, including those related to pathologies of the peripheral nervous system, such as vocal fold paresis/paralysis and myasthenia gravis, and the laryngeal movement disorders of spasmodic dysphonia and essential tremor. Discussion then turns to central nervous system disorders that affect voice including amyotrophic lateral sclerosis, Parkinson's disease, pseudobulbar palsy, multiple sclerosis, cerebellar disorders, and Huntington's disease.

Chapter 8 focuses on voice disorders related to self, identity, and lifestyle. The central role of stress in many of these disorders is emphasized. Vocal fatigue is considered as a clinical entity that is common to many disorders. Attention is paid to muscle tension dysphonia, functional neurological symptom disorder, mutational dysphonia, and transgender voice. Treatment of transsexual voice following sex reassignment surgery is described.

Chapter 9 describes disorders related to airway problems and respiration. The major symptoms of airway disorders, dyspnea and stridor, are explained. The importance of pulmonary function testing is emphasized with reference to distinguishing between asthma and paradoxical vocal fold motion. A laryngeal condition related to inhaled steroid use for asthma is identified, called steroid inhaler laryngitis. Episodic laryngeal breathing disorders are characterized in terms of laryngeal hypersensitivity/hyperresponsiveness. The disorders of paradoxical vocal fold motion and chronic cough are described, and the links between these two conditions are pointed out. Evaluation and treatment protocols specific to each disorder are presented.

Chapter 10 focuses on laryngeal cancer. The TMN classification system developed by the American Joint Committee for Cancer Staging is presented. Risk factors for laryngeal cancer are identified, and the importance of a multidisciplinary approach is emphasized. Discussion then shifts to medical treatments for removal of the cancer, including radiation therapy and chemotherapy, and the resulting voice and swallowing function. Surgical options for removal of the cancer are presented, including various partial laryngectomy procedures. Voice and swallowing function after each type of procedure is described. A description of total laryngectomy is provided. Physical, psychoemotional, and communicative problems related to the surgery are identified. Attention then focuses on methods of voice restoration including artificial larynx, esophageal speech, and tracheoesophageal speech. Advantages and disadvantages of each method are explored. The chapter concludes with general considerations for voice restoration including quality-of-life issues.

NEW TO THE SECOND EDITION

The second edition retains the essential features of the first edition, but there are nine important enhancements.

- The organization of chapters (foundational knowledge, diagnosis and clinical management, specific disorders) remains the same, but some of the disorders have been reclassified based on the Classification Manual for Voice Disorders by Verdolini, Rosen, and Branski (2006).
- Clinical information (clinical notes, clinical application, clinical management), has been placed in textboxes outside the theoretical narrative to highlight the practical aspects of the material and the links between theory and practice.
- Additional information and "fun facts" have been placed in textboxes. The additional information presents more detail about specific topics.
- Treatment approaches discussed in Chapter 4 have been presented as bulleted steps to facilitate utilization of these techniques.
- The information on clinical considerations such as patient compliance has been integrated into the chapter on Clinical Management.
- Detailed information on counseling for speech-language pathologists has been included.
- Assessment quizzes and practice Praxis questions are now available in the enhanced eText for this text.
- Videos of selected disorders are included in the enhanced eText.
- Research has been updated.

Writing this book has been a wonderful learning experience, and it is my hope that readers will find the topic of voice disorders to be as fascinating and challenging as I do.

Carole Ferrand

The eText Advantage

The eText for this title is an affordable, interactive version of the print text that includes videos and interactive features that provide opportunities for students to get feedback on their answers to the questions posed.

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Supplementary Materials: Resources for Professors and Students

INSTRUCTOR'S RESOURCE MANUAL AND TEST BANK

Instructors will find a wealth of resources to support their course within the text itself. Each chapter in the Instructor's Resource Manual contains chapter-by-chapter teaching aids. The Test Bank for each chapter includes various types of test questions, including multiple choice, true/false, and essay questions. The supplement is available online or

you can contact your Pearson representative. To download and print the Instructor's Resource Manual and Test Bank, go to www.pearsonhighered.com and then click on "Educators."

POWERPOINTS

In addition to the Instructor's Resource Manual and Test Bank, we have provided the instructor with PowerPoints. This supplement is also available online or you can contact your Pearson sales representative. To download and print the supplement files, go to www.pearsonhighered.com and then click on "Educators."

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Carole Ferrand

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Chapter 1

Anatomy and Physiology of the Respiratory and Laryngeal Systems

LEARNING OUTCOMES

1. Identify the structures of the lower respiratory system and describe how muscular forces are involved in inspiration and expiration.
2. List the lung volumes and capacities in reference to resting expiratory level.
3. Compare respiratory patterning for quiet versus speech breathing, and describe nervous system control of respiration.
4. Identify the structures of the laryngeal framework and describe the cover-body model of the vocal folds.
5. List the extrinsic and intrinsic laryngeal muscles and explain the myoelastic aerodynamic theory of vocal fold vibration.
6. Identify the structures involved in nervous system control of phonation; describe the blood supply to the larynx; and discuss laryngeal reflexes.
7. Describe the three components involved in wound healing.
8. Compare modal, falsetto, and pulse registers in terms of their perceptual and acoustic characteristics.

Voice production depends on the integrated coordination of the respiratory, phonatory, and resonatory systems. Voice is also influenced by the digestive and endocrine systems, and voice production is controlled and regulated by the central and peripheral nervous systems. This chapter focuses on the respiratory, laryngeal, and nervous system involvement in voice production.

The chapter begins with a discussion of the structure of the lower respiratory system and the mechanics of breathing, followed by a description of lung volumes and capacities. Differences in the patterning of life and speech breathing are identified, and the nervous system control of respiration is described. Discussion then turns to the laryngeal system with a review of laryngeal structure and function, the expanded myoelastic-aerodynamic theory of phonation, and mechanisms involved in changing pitch and loudness levels. The major functional components of the central and peripheral nervous systems subserving voice production are presented followed by a description of inflammation and wound healing in the vocal folds. The chapter concludes with a discussion of the three primary vocal registers used in speech.

Structures of the Lower Respiratory System and Mechanics of Respiration

The primary purpose of respiration is ventilation. Ventilation is the process of moving air into and out of the airways and lungs in order to exchange oxygen (O_2) entering the lungs and carbon dioxide (CO_2) leaving the lungs. Ventilation depends on generating the pressures required to move the appropriate volumes of air from the atmosphere to the alveoli within the lungs and from the lungs out to the atmosphere (Gildea & McCarthy, 2003). Respiratory and/or laryngeal disorders that obstruct the airway can hinder ventilation and pose a life-threatening risk to the individual.

In addition to ventilation, the respiratory system provides the exhaled airstream that forms the basis of all voice and speech production. Two features of respiration that directly affect voice production are *breath support* and *breath control*. Breath support refers to stabilizing bodily structures to generate adequate air pressures and air flows; breath control refers to how an individual regulates and coordinates airflow for all activities, including speech. Difficulty with generating and/or maintaining breath support and breath control can adversely affect voice production, as can difficulties with inhaling and/or exhaling air or with obtaining an adequate amount of air. For example, if the respiratory system is not able to provide adequate breath support for voice production then the laryngeal system may overcompensate, which can create vocal fatigue, tissue changes in the vocal folds, and changes in voice quality (Tsai, Huang, Che, Huang, Liou, & Kuo, 2016).

CLINICAL NOTE

It is vital for speech-language pathologists (SLPs) to have a thorough understanding of the respiratory system and the interactions between the respiratory and phonatory systems. Because of academic and clinical training, they are in a unique position to provide services focusing on respiratory as well as phonatory parameters. Respiratory techniques that often help to improve vocal output include encouraging individuals to inhale more deeply; showing clients how to breathe more efficiently using abdominal ("belly") breathing instead of thoracic ("chest") breathing; and providing ways to stabilize the person's posture to maximize breath support and breath control.

STRUCTURES OF THE RESPIRATORY SYSTEM

The respiratory system is divided into upper and lower portions (Table 1.1). The larynx is located at the junction of the upper and lower tracts and will be discussed in detail in later sections of the chapter. The following discussion focuses on the lower respiratory tract, the tracheobronchial tree, and the lungs.

Lower respiratory tract The lower respiratory tract is made up of a branching system of air passages called the **tracheobronchial tree**, formed by the trachea, bronchi, bronchioles, and alveolar sacs (Figure 1.1).

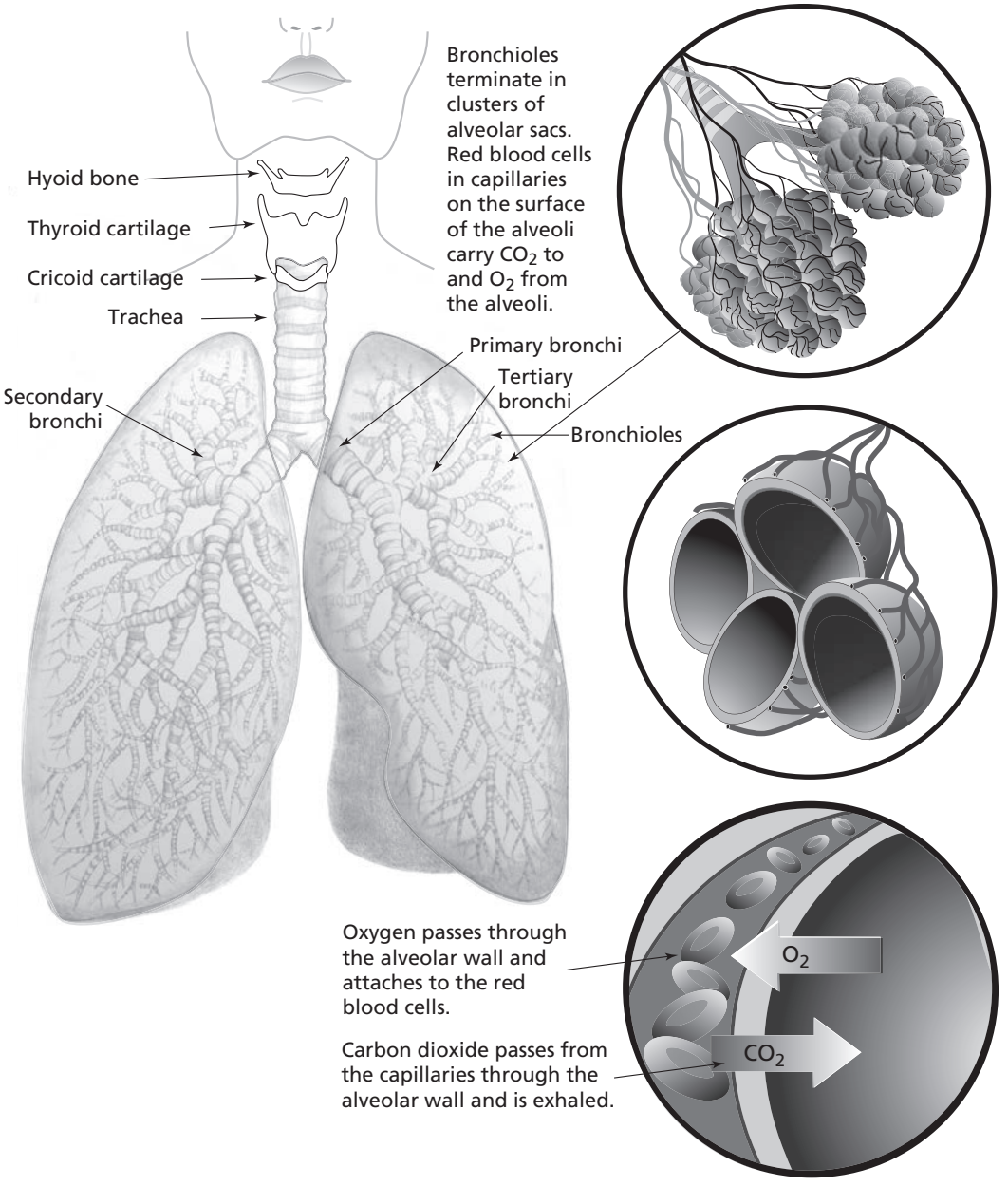
The trachea is a hollow tube formed by sixteen to twenty C-shaped rings of cartilage that are closed anteriorly and open posteriorly (Figure 1.2). The cartilage is covered by layers of smooth muscle and mucous membrane, which serve to close the tube posteriorly, and are also present between the cartilages. The inside of the tube, or lumen, is lined with pseudostratified ciliated columnar epithelium. The epithelium contains goblet cells which secrete mucus. The mucus traps particles of dust and bacteria, and the cilia move in a wavelike fashion to sweep this matter upward and out of the airways. Air traveling to the lungs is thereby cleaned and filtered.

The trachea measures approximately 19 mm in diameter in adult males and approximately 16 mm in diameter in adult females, although there is a great deal of variability between individuals (Breatnach, Abbott, & Fraser, 1984). The trachea divides into a series of bronchi. The two primary (mainstem) bronchi each enter a lung, and then further divide into secondary and tertiary bronchi. The secondary bronchi supply the lobes of the lungs (two lobes in the left lung, three in the right), while the tertiary bronchi supply the segments of the lungs (eight segments in the left lung, ten in the right). Structurally the bronchi are similar to the trachea but smaller in diameter. Each primary bronchus is slightly less than one-half the diameter of the trachea, and the secondary and tertiary bronchi become increasingly smaller and narrower. The tertiary bronchi continue to branch and divide into smaller and smaller tubes, and eventually branch into microscopic bronchioles. Bronchioles are composed solely of smooth muscle and mucous membrane. The bronchioles continue to branch and eventually terminate in respiratory bronchioles. The respiratory bronchioles open into alveolar ducts, which terminate in alveolar sacs. Each alveolar sac is a microscopic, thin-walled, air-filled structure surrounded by a network of microscopic blood capillaries. The alveoli are coated on the

TABLE *1.1* **Upper and Lower Respiratory Tracts**

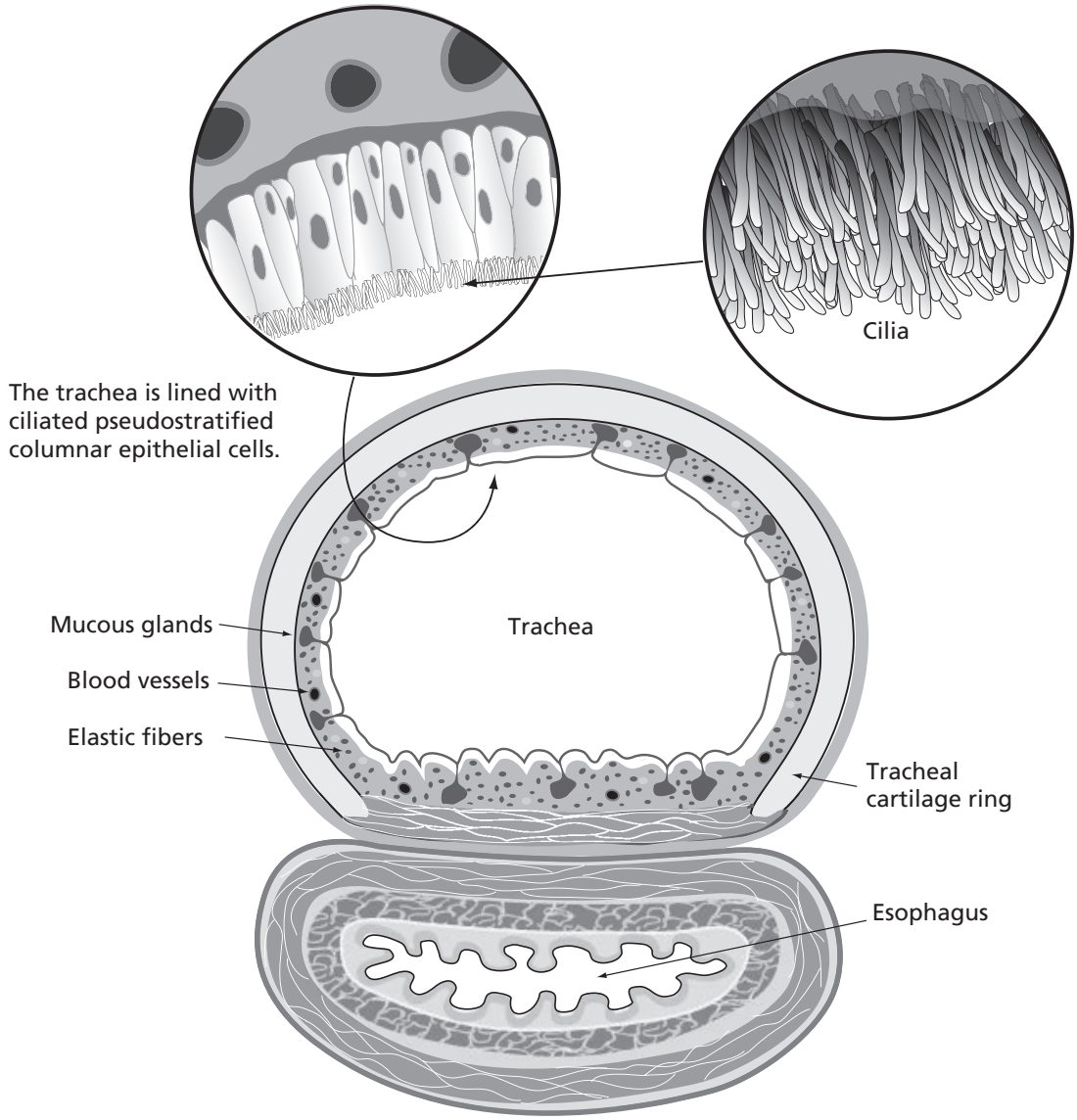
Upper Respiratory Tract	Lower Respiratory Tract
Nasal cavities	Trachea
Oral cavity	Bronchi
Pharynx	Bronchioles
	Alveoli
	Lungs

FIGURE *1.1* **The Tracheobronchial Tree**



inside with a layer of surfactant, which is a substance secreted by the lungs. Surfactant prevents the alveoli from collapsing and helps to keep the bronchioles open during respiration (Griese, 1999). There are an average of 480 million alveoli in the human lung

FIGURE *1.2* **The Trachea**



(Ochs et al., 2004). The alveolar sacs form the location of gas exchange between oxygen and carbon dioxide. Each inhalation of air brings fresh oxygen through the tracheobronchial tree to the alveolar sacs. The oxygen diffuses into the surrounding blood capillaries and is transported to every cell in the body via the circulatory system. The waste product of breathing, carbon dioxide, is brought by the circulatory system back to the capillary network around the alveolar sacs, where it diffuses into the alveoli and is exhaled.

The lungs are located within the thoracic cavity. The thoracic cavity is bounded by the sternum (breastbone) and rib cage on the front and sides, the spinal column and vertebrae at the back, and the diaphragm muscle at the bottom. The rib cage is composed of twelve ribs on either side, which are attached by cartilage to the sternum. The pectoral girdle also forms part of the rib cage. This structure includes the two collar bones (clavicles) in front and two shoulder blades (scapulae) at the back. The diaphragm muscle forms the floor of the thoracic cavity, separating it from the abdominal cavity. The interior of the lungs is composed of the branching bronchi, bronchioles, and alveoli, in addition to blood vessels and nerves. The lungs are cone-shaped structures, and each is slightly different in size and shape. Because it needs to accommodate the heart, the left lung is smaller than the right, with two lobes and eight segments. The larger right lung consists of three lobes and ten segments. The lungs are porous and elastic structures enabling them to be easily and expanded and contracted.

PLEURAL LINKAGE

The lungs contain very little muscle tissue and are unable to spontaneously generate movement. They are, however, highly compliant and can be easily moved by an external source. Each lung is encased in an airtight membrane called the **visceral pleura**. The inside surface of the thoracic cavity is lined by a membrane called the **parietal pleura**. Between these pleurae is a potential space known as the **pleural space**, containing **pleural fluid** (Figure 1.3). The pleural fluid allows the lungs and thorax to move against each other without creating friction. The pleural space has a permanent negative pressure due to the opposing recoil forces of the lung and chest wall. That is, the elastic recoil of the lungs pulls the visceral layer inward, while the elastic tendency of the thorax pulls the parietal layer outward. The space between the pleurae is therefore permanently slightly expanded, which lowers the pleural pressure and keeps the lungs and thorax in close proximity to each other. Because of **pleural linkage** the thorax and lungs act as an integrated unit. Thus, whenever the thoracic cavity is moved by active or passive forces, the lungs are moved as well. This mechanism is vital to inhalation and exhalation.

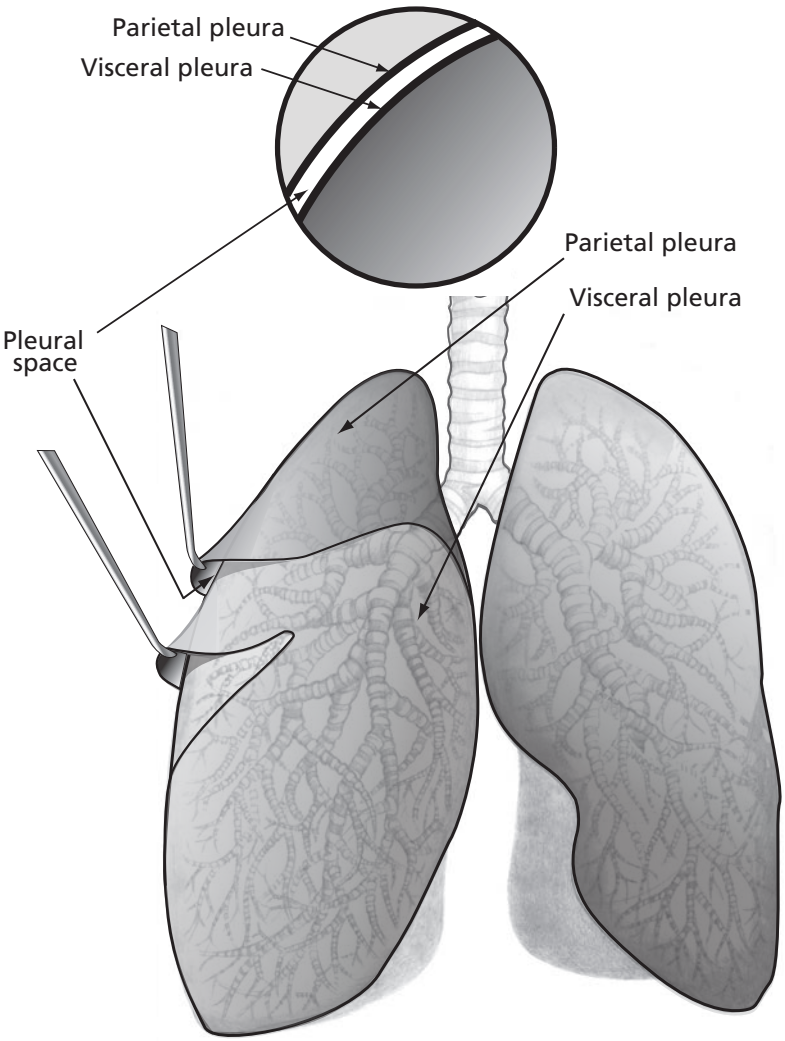
CLINICAL NOTE

A collapsed lung (called a *pneumothorax*) can result when air leaks into the pleural space and pushes on the lung. Pneumothorax can result from injury to the chest, damage from lung disease, or for no apparent reason. Smoking increases the risk of pneumothorax. Symptoms usually include sudden chest pain and shortness of breath. A small pneumothorax may heal without any treatment. If treatment is necessary, it usually involves inserting a flexible tube or needle between the ribs to remove the excess air.

MUSCLES OF RESPIRATION

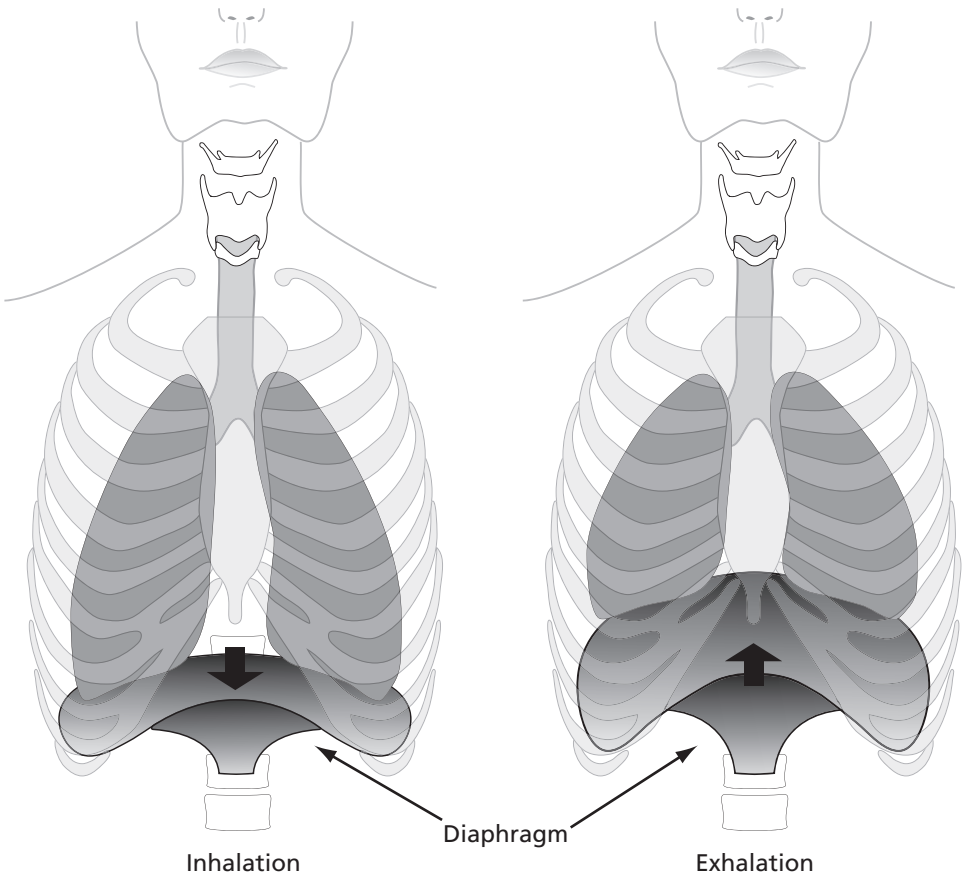
The primary muscles of respiration are the diaphragm and the intercostals. The diaphragm attaches to the bottom six ribs on either side of the rib cage (Figure 1.4). At rest the diaphragm is shaped like an inverted bowl. Upon contraction, the diaphragm

FIGURE *1.3* **Pleural Linkage**



flattens out, thus increasing the vertical dimension of the thoracic cavity. The eleven pairs of **external intercostal muscles** run between the ribs on either side (Figure 1.5). Their contraction pulls the rib cage in an upward and outward direction, expanding the thoracic cavity. The **internal intercostal muscles** also run between the ribs, deep to and in the opposite direction of the external intercostals. Their action depresses the rib cage and contracts the thoracic cavity. Additional muscles may be recruited for inspiration and expiration when the individual needs to take in a larger amount of air (see Table 1.2).

FIGURE *1.4* **The Diaphragm**



RESPIRATORY CYCLE

One cycle of respiration includes an inhalation and an exhalation phase.

Inhalation To inhale, the thoracic cavity and lungs must expand through active muscular contraction of the diaphragm and external intercostals. Air pressure and air volume have an inverse relationship—that is, the greater the volume the lower the pressure, and the smaller the volume the higher the pressure. Therefore, increasing the volume of the lungs results in a drop of *alveolar pressure* (pressure within the lungs). Air always flows from an area of higher pressure to an area of lower pressure. Consequently, air from the atmosphere is forced to flow into the respiratory system via the nose or mouth. The oxygen-rich air travels through the tracheobronchial tree to the alveoli, where gas exchange takes place.

FIGURE *1.5* **Muscles of Respiration**