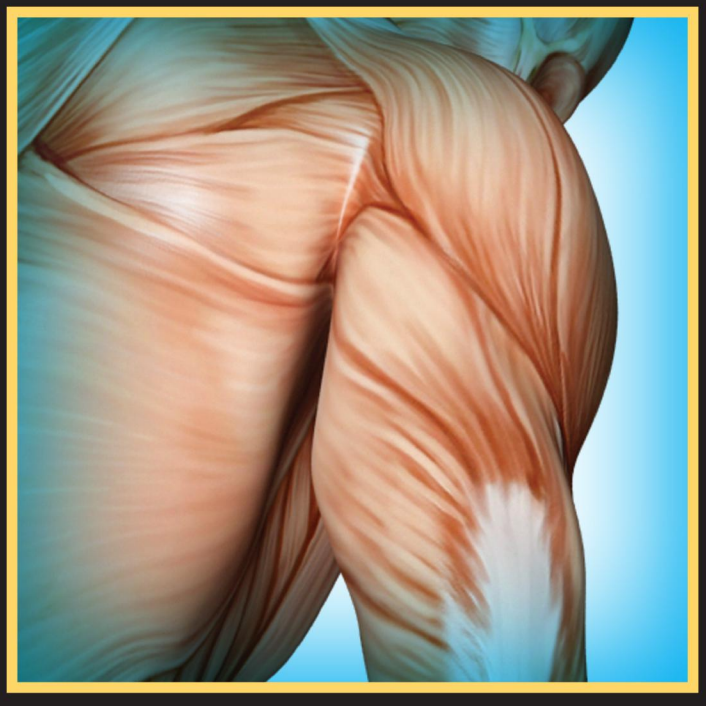
COMPREHENSIVE MEDICAL TERMINOLOGY

FIFTH EDITION



Betty Davis Jones

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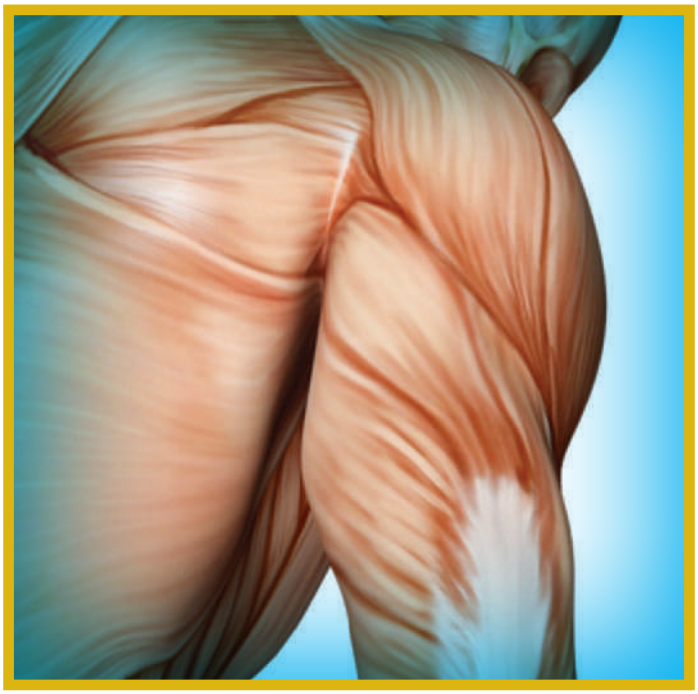

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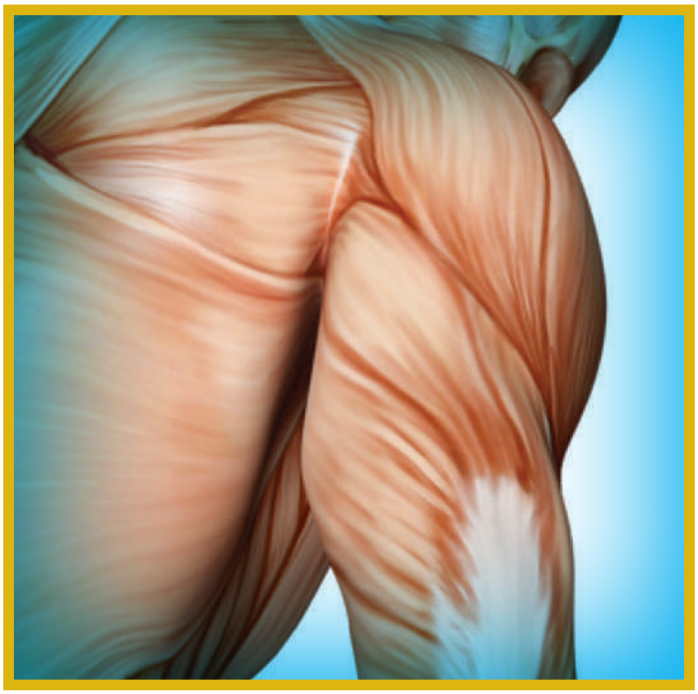

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Comprehensive Medical Terminology,
Fifth Edition
Betty Davis Jones

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Dedication

This textbook is dedicated to the many students of medical terminology with whom I have crossed paths. You have challenged my mind to new heights, and your thirst for knowledge makes teaching fun!

Preface

Medical terminology is the key to unlocking a whole new world of knowledge. This knowledge will empower you to communicate on a highly technical level about medical disorders, disease processes, surgical procedures, and treatments. You will learn terms that will allow you to read and interpret medical terms in reports, charts, and other health care environments.

This text has been developed to provide you—the learner—with the skills you need to become an effective communicator in the highly technical world of medicine. Once you understand that medical terms have many interchangeable parts, you will realize that learning medical terms is not as difficult as you might have thought. Couple this with the appropriate word building rules, and you are on your way to expanding your vocabulary by hundreds of new medical words!

Textbook Organization

First, you should familiarize yourself with the organization of this textbook and any supplementary materials that may be available to you, such as the Audio CDs. Some of the key points regarding the organization follow.

The textbook begins with Chapter 1, Word Building Rules. It is important that you understand how word elements (parts) are put together to make up medical terms. This knowledge will enable you to build words you have never seen before, simply by knowing the meaning of the word elements and the appropriate way of putting the elements together to form a medical term. Always remember that if you get confused on word building skills, you can return to Chapter 1 for guidance.

Chapters 2 through 4 concentrate on the basics of medical terminology: prefixes, suffixes, and whole body terminology. Chapters 5 through 24 concentrate on body systems and specialty areas of practice. The body systems are arranged in basically the same order as most anatomy and physiology textbooks. This seems to be the most logical approach to keeping the thought processes moving in an orderly pattern, by working from the outside of the body inward.

Chapter Organization

The basic organization for all applicable body systems and specialty chapters includes the following elements: chapter content; objectives; anatomy and physiology; vocabulary; word elements; pathological conditions; diagnostic techniques, treatments, and

procedures; common abbreviations; written and audio terminology review; and chapter review exercises.

Chapter content and objectives present learners with a basis for what they are about to learn. They are then grounded with basic information about the specific body system in the anatomy and physiology sections and proceed to the vocabulary and word elements sections to learn specifically the medical terms and word parts appropriate to that chapter. The pathological conditions and diagnostic techniques, treatments, and procedures sections reinforce and elaborate through basic and more extensive definitions many of the terms that have already been introduced in the vocabulary and word part sections.

The abbreviation section presents the most common abbreviations applicable to that chapter. The written and audio terminology review allows learners to write out the definitions and study the pronunciations for the major terms. The chapter review exercises test and assess the learner on the information in the chapter. Additional information on some of these elements is included in the "Pedagogical Features" section following and in the "About the Book" section.

Written and Audio Terminology Review

At the end of each chapter, you will find an alphabetized list of key terms introduced in the chapter. You will write the definition of each term and check it in the glossary. A phonetic pronunciation is included for each term as well as a check box to indicate mastery of the pronunciation. The review list can be used in a variety of ways:

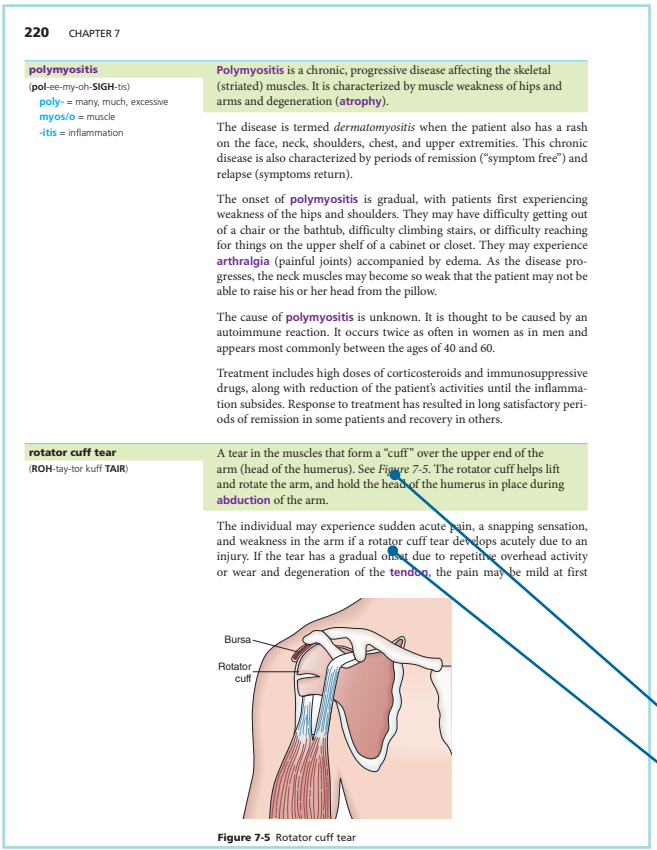
- If you have the Audio CDs available, listen to each term, pronounce it, and check the box next to the term in your textbook once you are comfortable saying the word.
- Test your accuracy in transcription of medical terms. Listen to the pronunciation of terms on the Audio CDs and key them into the computer. When the list is complete, check your accuracy against the written list in your textbook.
- Use the list to review the key terms and their definitions and pronunciations.

Chapter Review Exercises

Each chapter has numerous review exercises designed to check your comprehension of the chapter material. You will note that each review activity provides a space for recording your score at the end of the exercise. Ask your instructor for the answers, or check your answers in the chapter. Each exercise question is valued at 5, 10, or 20 points—with the maximum number of points possible being 100. Your goal will be to earn a minimum 80% on each activity. You will be able to gain instant feedback on your level of success by computing your score. Scores lower than 80% indicate a need to go back and review that particular area.

Glossary

A comprehensive glossary has been developed to allow you to check one place for the definition of major terms in the text. Terms with glossary definitions are either boldface or purple; terms in purple are also included on the Audio CDs.



220 CHAPTER 7

polymyositis
(**pol**-ee-my-oh-**SIGH**-tis)
poly- = many, much, excessive
myos/o = muscle
-itis = inflammation

Polymyositis is a chronic, progressive disease affecting the skeletal (striated) muscles. It is characterized by muscle weakness of hips and arms and degeneration (**atrophy**).

The disease is termed *dermatomyositis* when the patient also has a rash on the face, neck, shoulders, chest, and upper extremities. This chronic disease is also characterized by periods of remission ("symptom free") and relapse (symptoms return).

The onset of **polymyositis** is gradual, with patients first experiencing weakness of the hips and shoulders. They may have difficulty getting out of a chair or the bathtub, difficulty climbing stairs, or difficulty reaching for things on the upper shelf of a cabinet or closet. They may experience **arthralgia** (painful joints) accompanied by edema. As the disease progresses, the neck muscles may become so weak that the patient may not be able to raise his or her head from the pillow.

The cause of **polymyositis** is unknown. It is thought to be caused by an autoimmune reaction. It occurs twice as often in women as in men and appears most commonly between the ages of 40 and 60.

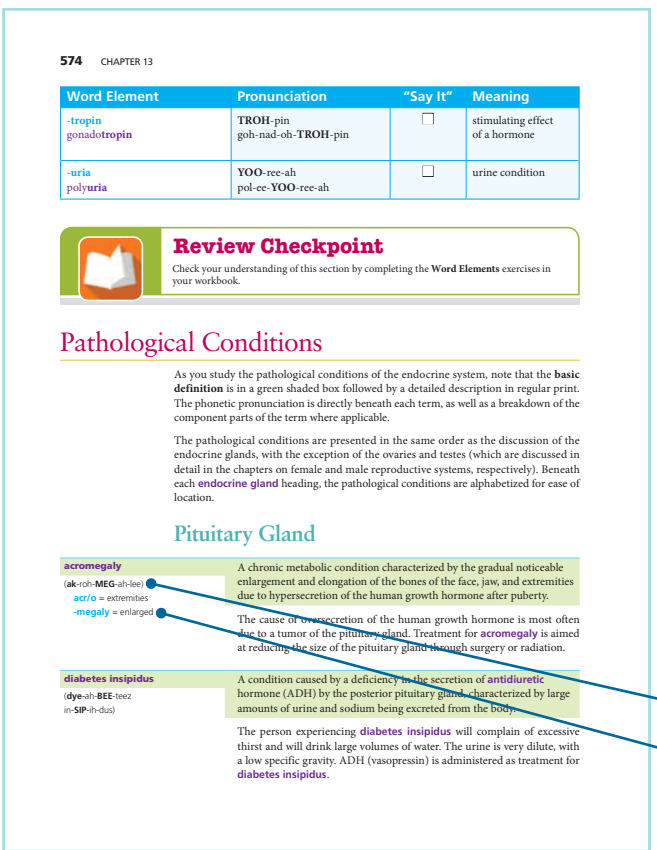
Treatment includes high doses of corticosteroids and immunosuppressive drugs, along with reduction of the patient's activities until the inflammation subsides. Response to treatment has resulted in long satisfactory periods of remission in some patients and recovery in others.

rotator cuff tear
(**ROH**-tay-tor kuff **TAIR**)

A tear in the muscles that form a "cuff" over the upper end of the arm (head of the humerus). See *Figure 7-5*. The rotator cuff helps lift and rotate the arm, and hold the head of the humerus in place during **abduction** of the arm.

The individual may experience sudden acute pain, a snapping sensation, and weakness in the arm if a rotator cuff tear develops acutely due to an injury. If the tear has a gradual onset due to repetitive overhead activity or wear and degeneration of the **tendon**, the pain may be mild at first

Figure 7-5 Rotator cuff tear



574 CHAPTER 13

Word Element	Pronunciation	"Say It"	Meaning
-tropin gonado**tropin**	**TROH**-pin goh-nad-oh-**TROH**-pin	☐	stimulating effect of a hormone
-uria poly**uria**	**YOO**-ree-ah pol-ee-**YOO**-ree-ah	☐	urine condition

Review Checkpoint
Check your understanding of this section by completing the **Word Elements** exercises in your workbook.

Pathological Conditions

As you study the pathological conditions of the endocrine system, note that the **basic definition** is in a green shaded box followed by a detailed description in regular print. The phonetic pronunciation is directly beneath each term, as well as a breakdown of the component parts of the term where applicable.

The pathological conditions are presented in the same order as the discussion of the endocrine glands, with the exception of the ovaries and testes (which are discussed in detail in the chapters on female and male reproductive systems, respectively). Beneath each **endocrine gland** heading, the pathological conditions are alphabetized for ease of location.

Pituitary Gland

acromegaly
(**ak**-roh-**MEG**-ah-lee)
acr/o = extremities
-megaly = enlarged

A chronic metabolic condition characterized by the gradual noticeable enlargement and elongation of the bones of the face, jaw, and extremities due to hypersecretion of the human growth hormone after puberty.

The cause of overs[illegible] of the human growth hormone is most often due to a tumor of the pituitary gland. Treatment for **acromegaly** is aimed at reducing the size of the pituitary gland through surgery or radiation.

diabetes insipidus
(**dye**-ah-**BEE**-teez
in-**SIP**-ih-dus)

A condition caused by a deficiency in the secretion of **antidiuretic** hormone (ADH) by the posterior pituitary gland, characterized by large amounts of urine and sodium being excreted from the body.

The person experiencing **diabetes insipidus** will complain of excessive thirst and will drink large volumes of water. The urine is very dilute, with a low specific gravity. ADH (vasopressin) is administered as treatment for **diabetes insipidus**.

Special Features

Simple to Complex Definitions

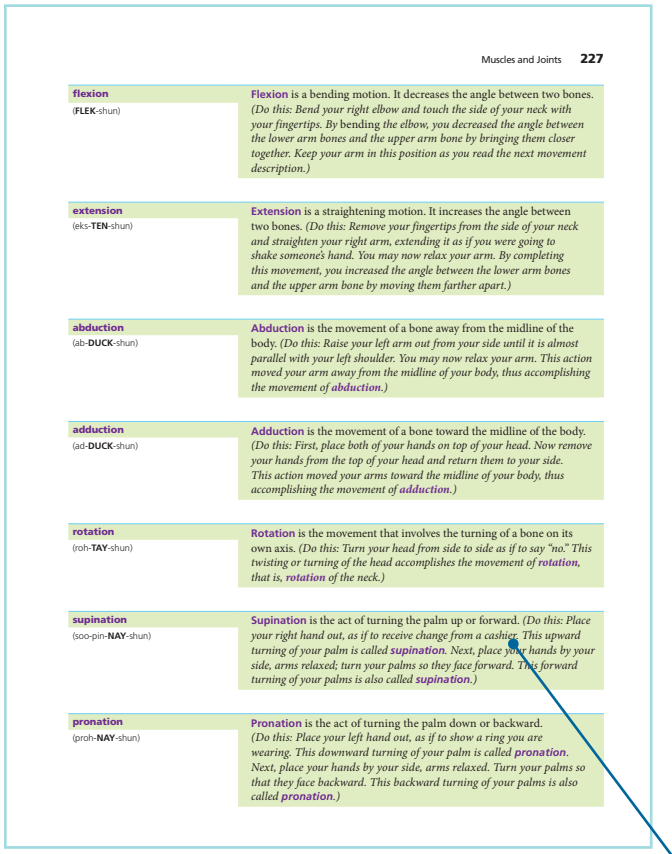
The presentation of medical terms and conditions in this textbook presents the opportunity to learn a simple, basic definition of a word (along with its component parts) or to learn the basic definition along with a more comprehensive discussion of the disease process, diagnostic techniques and procedures, signs and symptoms, routes of drug administration, and mental disorders. **You will note that the medical term and the basic definition are highlighted in green**. The more comprehensive discussion of the condition follows in regular type. An example follows:

- Basic definition highlighted in green
- More comprehensive discussion

Word Elements Are Reinforced Throughout the Text

The study of word elements is integrated throughout the book. You will note that word elements are repeated in the chapters (to reinforce their meaning again and again) as you expand your studies from basic medical terms to signs and symptoms, disease conditions, and procedures. Note that the medical term will appear in the left-hand column, usually with a phonetic pronunciation immediately beneath the word. The component parts of the medical term (word elements) will be listed directly beneath the phonetic pronunciation. This format will also allow you to see the word in context (as it relates to the particular disease process) while continuing to reinforce the word elements.

- Pronunciation
- Word elements and definition



Muscles and Joints **227**

flexion (**FLEK**-shun)	**Flexion** is a bending motion. It decreases the angle between two bones. *(Do this: Bend your right elbow and touch the side of your neck with your fingertips. By* bending *the elbow, you decreased the angle between the lower arm bones and the upper arm bone by bringing them closer together. Keep your arm in this position as you read the next movement description.)*
extension (eks-**TEN**-shun)	**Extension** is a straightening motion. It increases the angle between two bones. *(Do this: Remove your fingertips from the side of your neck and straighten your right arm, extending it as if you were going to shake someone's hand. You may now relax your arm. By completing this movement, you increased the angle between the lower arm bones and the upper arm bone by moving them farther apart.)*
abduction (ab-**DUCK**-shun)	**Abduction** is the movement of a bone away from the midline of the body. *(Do this: Raise your left arm out from your side until it is almost parallel with your left shoulder. You may now relax your arm. This action moved your arm away from the midline of your body, thus accomplishing the movement of* ***abduction****.)*
adduction (ad-**DUCK**-shun)	**Adduction** is the movement of a bone toward the midline of the body. *(Do this: First, place both of your hands on top of your head. Now remove your hands from the top of your head and return them to your side. This action moved your arms toward the midline of your body, thus accomplishing the movement of* ***adduction****.)*
rotation (roh-**TAY**-shun)	**Rotation** is the movement that involves the turning of a bone on its own axis. *(Do this: Turn your head from side to side as if to say "no." This twisting or turning of the head accomplishes the movement of* ***rotation****, that is,* ***rotation*** *of the neck.)*
supination (soo-pin-**NAY**-shun)	**Supination** is the act of turning the palm up or forward. *(Do this: Place your right hand out, as if to receive change from a cashier. This upward turning of your palm is called* ***supination****. Next, place your hands by your side, arms relaxed; turn your palms so they face forward. This forward turning of your palms is also called* ***supination****.)*
pronation (proh-**NAY**-shun)	**Pronation** is the act of turning the palm down or backward. *(Do this: Place your left hand out, as if to show a ring you are wearing. This downward turning of your palm is called* ***pronation****. Next, place your hands by your side, arms relaxed. Turn your palms so that they face backward. This backward turning of your palms is also called* ***pronation****.)*

218 CHAPTER 7

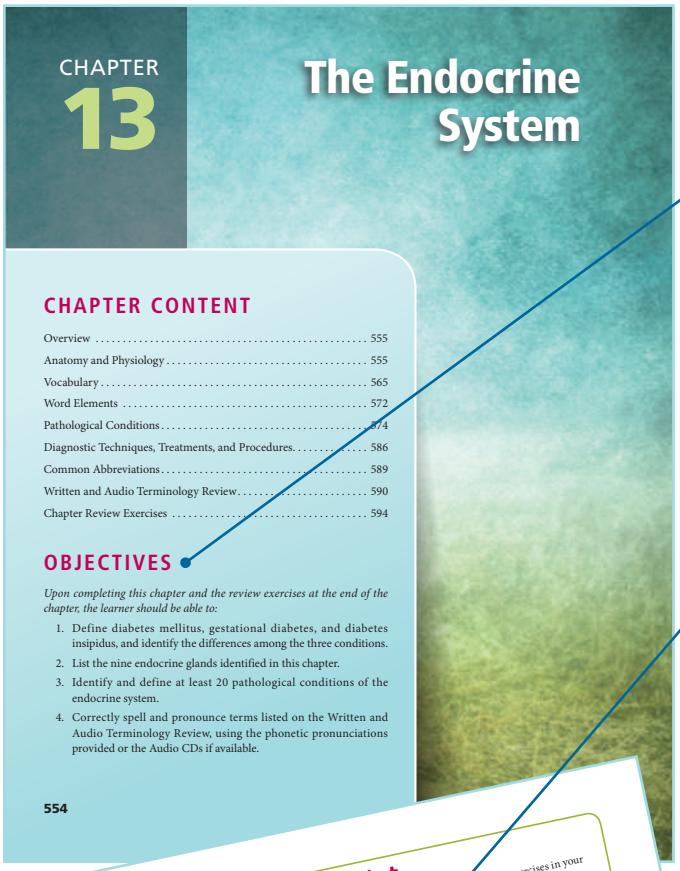
Word Element	Pronunciation	"Say It"	Meaning
dys- **dys**tonia	**DIS** dis-**TOH**-nee-ah	☐	bad, difficult, painful, disordered
electr/o **electr**omyogram	ee-**LEK**-troh ee-**lek**-troh-**MY**-oh-gram	☐	electrical, electricity
fasci/o **fasci**otomy	**FASH**-ee-oh fash-ee-**OTT**-oh-mee	☐	band of fibrous tissue
fibr/o **fibr**oma	**FIH**-broh fih-**BROH**-mah	☐	fiber
-graphy electroneuromyo**graphy**	**GRAH**-fee ee-**lek**-troh-**noo**-roh-my-**OG**-rah-fee	☐	process of recording
-itis fasci**itis**	**EYE**-tis fas-ee-**EYE**-tis	☐	inflammation
kines/o, kinesi/o **kinesi**ology	kigh-**NEE**-zee-oh, kigh-**NEE**-zoh **kigh**-nee-zee-**OL**-oh-jee	☐	movement
leiomy/o **leiomy**ofibroma	lye-oh-**MY**-oh **lye**-oh-**my**-oh-fye-**BROH**-mah	☐	smooth muscle
my/o **my**algia	**MY**-oh my-**AL**-jee-ah	☐	muscle
myos/o **myos**itis	my-**OH**-so my-oh-**SIGH**-tis	☐	muscle
pector/o **pector**al	peck-**TOR**-oh **PECK**-toh-ral	☐	pertaining to the chest
-plegia hemi**plegia**	**PLEE**-jee-ah **hem**-ee-**PLEE**-jee-ah	☐	paralysis
rhabdomy/o **rhabdomy**osarcoma	rab-**DOH**-my-oh **rab**-doh-**my**-oh-sar-**KOH**-mah	☐	striated muscle; skeletal muscle
tax/o **tax**ia	**TACK**-soh ah-**TACK**-see-ah	☐	coordination, order
tri- **tri**ceps	**TRY** **TRY**-seps	☐	three
troph/o dys**troph**y	**TROH**-foh **DIS**-troh-fee	☐	development

"Do This" and "Say It" Segments

Where appropriate, we have incorporated "Do This" instructions to involve you actively in the learning process. For example, in the chapter on muscles, the "Do This" instructions are designed to help you learn muscle actions such as extension, flexion, and abduction by having you respond to the directions by actually performing the action. This should reinforce your knowledge of the actions of the various muscles of the body.

The "Say It" segments are designed to have you repeat words and word elements when studying them. Pronouncing the words aloud should help you remember how the words sound, which can also help you spell them correctly when you hear the words pronounced by your instructor or by a physician on a transcription tape. Many times, students misspell words they have not heard before or have not taken the time to familiarize themselves with the sound of the word.

- "Do This" instructions
- "Say It" segments


CHAPTER 13

The Endocrine System

CHAPTER CONTENT

OBJECTIVES

Upon completing this chapter and the review exercises at the end of the chapter, the learner should be able to:

1. Define diabetes mellitus, gestational diabetes, and diabetes insipidus, and identify the differences among the three conditions.
2. List the nine endocrine glands identified in this chapter.
3. Identify and define at least 20 pathological conditions of the endocrine system.
4. Correctly spell and pronounce terms listed on the Written and Audio Terminology Review, using the phonetic pronunciations provided or the Audio CDs if available.

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Review Checkpoint

Check your understanding of this section by completing the Vocabulary exercises in your workbook.

WORD ELEMENTS

The following word elements pertain to the endocrine system. As you review the list, pronounce each word element aloud twice and check the box after you "say it." Write the definition for the example term given for each word element. Use your medical dictionary to find the definitions of the example terms.

Word Element	Pronunciation	"Say It"	Meaning
acr/o **acr**omegaly	AK-roh ak-roh-MEG-ah-lee	☐	extremities
aden/o **aden**opathy	AD-en-noh ad-eh-NOP-ah-thee	☐	gland
adren/o **adren**omegaly	ad-REE-noh ad-ree-noh-MEG-ah-lee	☐	adrenal glands
adrenal/o **adrenal**ectomy	ad-REE-nal-oh ad-ree-nal-ECK-toh-mee	☐	adrenal glands
andr/o **andr**ogen	AN-droh AN-droh-jen	☐	man, male
calc/o hyper**calc**emia	KAL-koh high-per-kal-SEE-mee-ah	☐	calcium
cortic/o **cortic**osteroid	KOR-tih-koh kor-tih-koh-STAIR-oyd	☐	cortex
crin/o endo**crin**ology	KRIN-oh en-doh-krin-OL-oh-jee	☐	secrete
-crine endo**crine**	KRIN EN-doh-krin	☐	secrete
dips/o **dips**osis	DIP-soh dip-SOH-sis	☐	thirst
-dipsia poly**dipsia**	DIP-see-ah pol-ee-DIP-see-ah	☐	thirst
gonad/o **gonad**otropic	goh-NAD-oh goh-nad-oh-TROH-pik	☐	sex glands

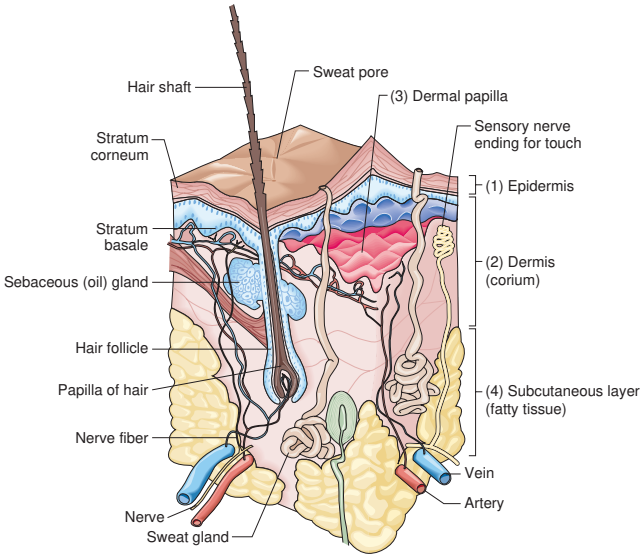
Pedagogical Features

Objectives

Each chapter opens with a list of learning objectives that introduce main areas to target for mastery within the chapter. Objectives have been developed to include standards for learners to attain competency specifically in medical terminology. The review exercises are tied directly to these objectives to help learners assess themselves and determine if they have mastered the content.

Word Elements

Each chapter contains a word element review activity after the vocabulary list. The word elements are accompanied by a phonetic pronunciation. You are encouraged to pronounce these words twice to reinforce your pronunciation skills and indicate that you have achieved success by entering a check mark in the box provided. Each word element has an example term that includes the word element, followed by a space for you to enter the definition of the word. The definitions for the example terms are not included in the text. This was done intentionally because everyone who studies medical terminology needs to know how to use a medical dictionary! These definitions should be looked up in your medical dictionary and recorded in the space provided in your textbook. This is an extra challenge designed to expand your knowledge base. Be careful, though: a medical dictionary is a contagious thing!



Color Photos and Illustrations

The body systems and specialty chapters contain more than 400 color photographs and drawings that have been selected to reinforce the specific topics of discussion. Most of the photographs appear beside or immediately following the discussion for immediate reinforcement of your comprehension of the topic. The old saying "A picture is worth a thousand words" is very true in this case. The quality of the photographs and the detail of the artist's illustrations in this textbook will allow you to form a clear mental image of the structure, disease process, or technique being discussed. This will prove particularly helpful when you are reading about a disease or treatment with which you are not familiar.

Changes to the Fifth Edition

Following is a list of major chapter-specific changes for the fifth edition:

- Updated line art and photos have been added to most chapters to enhance learning.
- A new chapter review exercise, a crossword puzzle, has been added to Chapter 1.
- A new photo of ecchymosis has been added to Chapter 5.
- Line art has been replaced with a photo of butterfly rash associated with SLE in Chapter 7.
- A new image for ERCP has been added to Chapter 12.
- A figure has been updated on lateral cross section of the eye in Chapter 14.
- New line art has been added regarding potential sites for ectopic pregnancy in Chapter 18.
- Immunization schedules have been updated, and a new photo added on pediatric urine collection bag in Chapter 19.
- A new image for posteroanterior view has been added to Chapter 20.
- Updates made in Chapter 21 to conform to the changes noted in the *Cancer Facts & Figures*, 2013.
- Two new figures have been added to illustrate placement for sublingual medication and to illustrate placement for buccal medication in Chapter 22.
- Updates have been made to conform to the changes noted in the *DSM-5* and a new chapter review exercise has been added to Chapter 23.

Student Resources

Workbook

The workbook was written to provide you with additional practice to help you learn medical terminology. Assess your mastery of word building; anatomy and physiology; key medical vocabulary; pathological conditions; diagnostic techniques, treatments, and procedures; and common abbreviations by completing the workbook exercises. Review Checkpoint, a feature in the text after major chapter sections, alerts you to go to your workbook and complete the exercises. Multiple exercises have been added to each workbook chapter. These exercises are designed to enhance the learner's ability to define and build medical terms.

Workbook (ISBN: 978-1-3050-7463-7)

Student Companion Website

The Student Companion Website includes animations, slide presentations in PowerPoint®, term-to-definition and definition-to-term quick-access tables for prefixes, suffixes, combining forms, and abbreviations that appear in the textbook. The tables can be used as a quick reference when learners forget the meaning of a word element or when they remember the meaning but forget the particular word element.

Accessing the Student Companion Website:

1. Go to: http://www.CengageBrain.com
2. Register as a new user or log in as an existing user if you already have an account with Cengage Learning or CengageBrain.com.
3. Select **Go to MY Account**.
4. Open the product from the My Account page.

Audio CDs

The Audio CDs were developed to allow learners to listen to each term and repeat it aloud for pronunciation practice. Learners may also use the CDs to listen to the terms while they follow along with the "Written and Audio Terminology Review" section of the chapters.

Audio CDs (ISBN: 9781305074668)

Instructor Companion Site

Resources for instructors include:

- **CogneroTestbank** makes generating tests and quizzes a snap. With over 1,000 questions in a variety of formats to choose from, you can create customized assessments for your students with the click of a button. Add your own unique questions and print tests for easy class preparation.

- Customizable instructor slide presentations created in **PowerPoint®**, including animations, and images, focus on key concepts from each chapter.
- **Electronic Instructor's Manual** includes the following tools:
  - Sample course syllabus
  - Suggested classroom activities
  - Transcription word list exercises
  - Chapter review sheets
  - Sample tests for all chapters
  - Text Answer Keys for chapter review exercises in the text
  - Workbook Answer Keys for exercises in the workbook

The Learning Lab

The Learning Lab is an online homework solution that maps to learning objectives in *Comprehensive Medical Terminology,* Fifth Edition. Interactive, scenario-based activities build students' medical vocabulary, strengthen word building skills, and encourage an understanding of the importance of medical terminology as the basis of communication in the health care workplace, between health care professionals, and with patients. This simulated, immersive environment engages users with its real-life approach. The Learning Lab includes a pre-assessment, learning activities, and a post-assessment organized around the chapters in this text. The post-assessment scores can be posted to the instructor grade book in any learning management system. The amount of time the student spends within the Learning Lab can also be tracked.

IAC Learning Lab to Accompany *Comprehensive Medical Terminology*, 5th Edition, ISBN: 978-1-3050-7517-7

MindTap

MindTap is a fully online, interactive learning experience built upon authoritative Cengage Learning content. By combining readings, multimedia, activities, and assessments into a singular learning path, MindTap elevates learning by providing real-world application to better engage students. Instructors customize the learning path by selecting Cengage Learning resources and adding their own content via apps that integrate into the MindTap framework seamlessly with many learning management systems.

The guided learning path demonstrates the relevance of medical terminology to health care professions through engagement activities, interactive exercises, and procedural videos. Learners apply an understanding of medical terminology through patient education scenarios. These simulations elevate the study of medical terminology by challenging students to apply concepts to practice.

To learn more, visit http://www.cengage.com/mindtap.

About the Author

Photo by Donna Brockman Fisher

Betty Davis Jones

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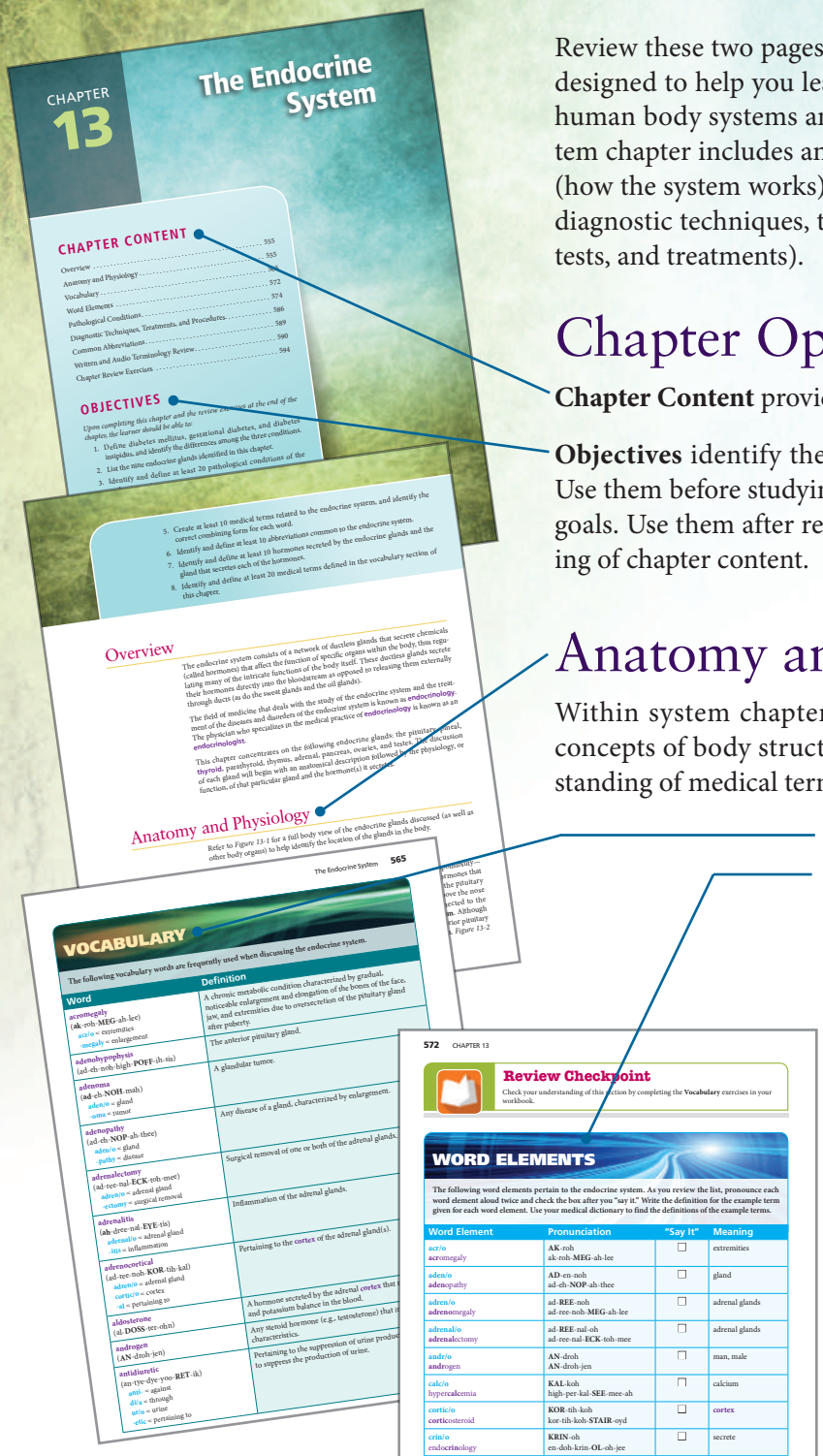
About the Book and Components



Review these two pages to understand how each chapter has been designed to help you learn medical terminology in the context of human body systems and medical specialties. A typical body system chapter includes anatomy (structure of the body); physiology (how the system works); pathology (conditions and diseases); and diagnostic techniques, treatments, and procedures (examinations, tests, and treatments).

Chapter Opener

Chapter Content provides an outline of major chapter sections.

Objectives identify the key learning objectives for each chapter. Use them before studying the chapter to understand your learning goals. Use them after reading the chapter to test your understanding of chapter content.

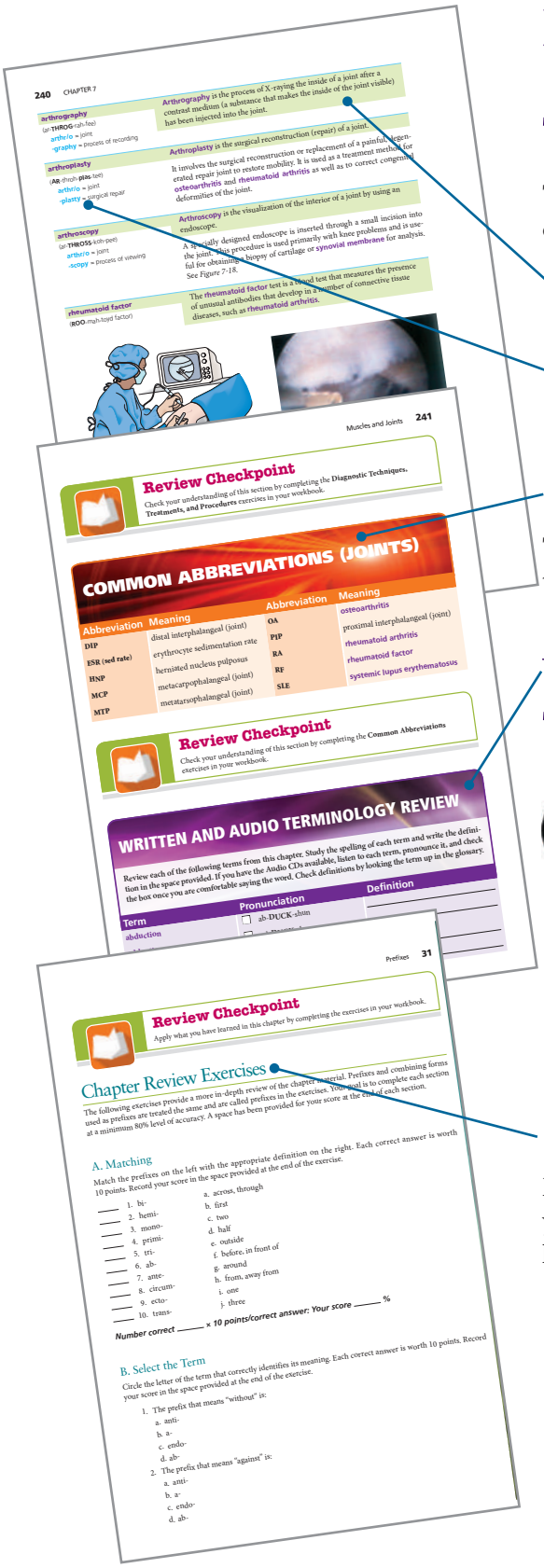
Anatomy and Physiology

Within system chapters, these sections introduce you to basic concepts of body structure and function to provide better understanding of medical terms.

Vocabulary and Word Elements

Here is your first practice with medical terms and word parts.

- Study the **Vocabulary** section to learn term definitions plus word part breakdowns and definitions.
- Terms in the Vocabulary section and within the text that are highlighted in **purple** are included in the Written and Audio Terminology Review at the end of the chapter and are pronounced on the Audio CDs.
- Study and work through the **Word Elements** section to learn more about prefixes, combining forms, and suffixes. It is important to notice how pronunciations differ when the same word part is used in a complete term.



Pathological Conditions and Diagnostic Techniques, Treatments, and Procedures

This book includes comprehensive coverage of major diseases, conditions, treatments, and techniques.

- Basic definitions are highlighted in green followed by a more comprehensive definition.
- Terms are broken into word parts to reinforce learning. Word parts appear in blue.

Common Abbreviations

This section presents the most common abbreviations used in today's health care environment.

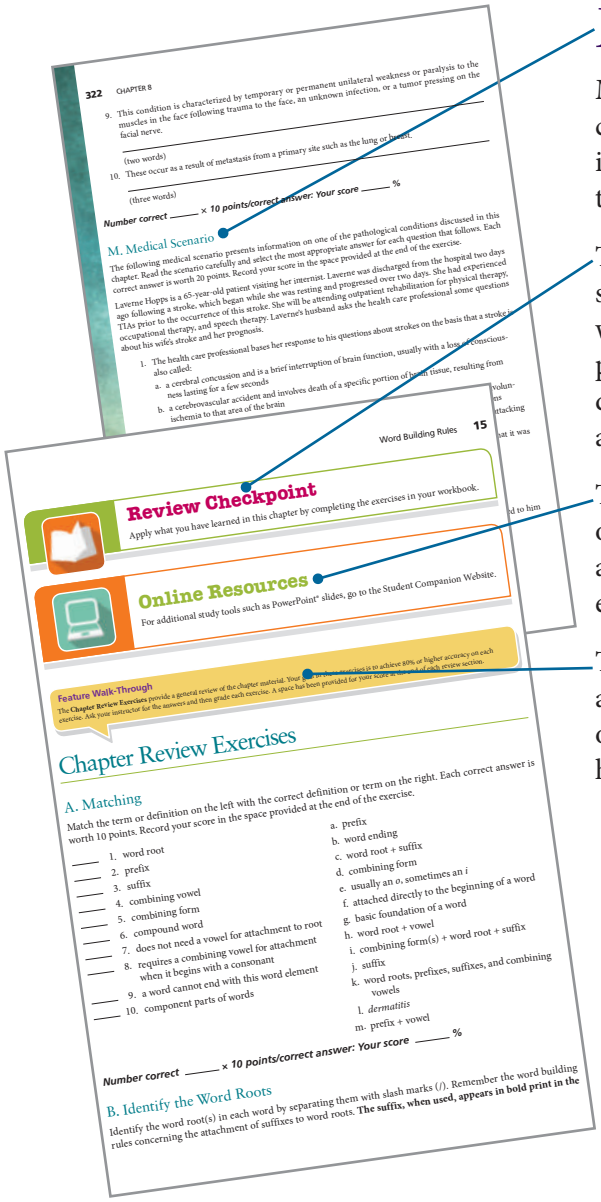
Written and Audio Terminology Review

This review includes an alphabetical list of medical terms presented in each chapter.

- Use for review of written definitions; check your definition to those listed in the glossary.
- Use this section to review the pronunciations on the Audio CDs. Terms highlighted in purple are pronounced on the Audio CDs.

Chapter Review Exercises

Extensive exercises at the end of each chapter help reinforce what you have learned. All exercises include self-assessment scoring to help you immediately determine your competency.



Medical Scenarios

Medical scenarios present information on one of the pathological conditions discussed in the chapter, encouraging you to synthesize information you have learned and apply that knowledge to situations a health care worker might encounter in clinical practice.

The **Review Checkpoint** feature appearing after major chapter sections directs you to complete additional exercises in the workbook to assess your mastery of word building; anatomy and physiology; key medical vocabulary; pathological conditions; diagnostic techniques, treatments, and procedures; and common abbreviations.

The **Online Resources** feature directs you to additional learning opportunities such as animations and PowerPoint® slides available on the Student Companion Website and additional review exercises in the Workbook.

The **Feature Walk-Through** was designed to "walk you through" a feature the first time it is presented in the chapter with the goal of helping you understand how the feature works and how it will help you maximize your learning.

Word Building Rules

CHAPTER 1

CHAPTER CONTENT

OBJECTIVES

Upon completing this chapter and the review exercises at the end of the chapter, the learner should be able to:

1. List the three basic component parts of a word.
2. Correctly state the rule for joining prefixes and suffixes to a word root.
3. Accurately define the terms *word root*, *suffix*, *prefix*, *combining vowel*, and *combining form*.
4. Correctly state the rule for using multiple word roots in a compound word.
5. Demonstrate the ability to apply the word building rules by accurately completing the review exercises located at the end of this chapter.
6. Define an eponym and give an example.

Overview

Studying the language of medicine—that is, medical terminology—is very similar to learning a foreign language. There are rules that must be applied to make the "language" understandable. As a health care professional, you have chosen to learn the language, to master it, and to use it appropriately in the field of medicine. To do this, you must learn the word building rules necessary to expand your knowledge and understanding of medical terminology. Once you have accomplished this, you will possess the power to define words you never thought possible. Sounds exciting, doesn't it? It is! Let's get started.

Word Parts, Combining Forms, and Word Building Rules

Before you begin, remember: **It will be critical for you to learn the word parts, and the rules for combining word parts to create words, to be successful with medical terminology**. It is impossible to memorize thousands of words over the course of one or two quarters or semesters. It *is* possible, however, to memorize the word parts and the rules that will enable you to build the thousands of words you will need to function effectively as a health care professional. As you study this chapter on word building rules, understand that you will probably not master all of the rules in the beginning. This chapter will serve as a reference as you progress through the textbook. When you find that you have difficulty understanding how the words are put together or how to pronounce certain words, return to this chapter and review the word building rules and pronunciation guidelines.

Medical words, like English words, consist of three basic component parts: word roots, prefixes, and suffixes. How you combine the component parts, or word elements, determines the meaning of the word. For example, if one part is changed, the meaning of the word also changes. Review the English word *port* and see the different words you can create by adding to it different prefixes and suffixes. Prefixes appear at the beginning of the word root, whereas suffixes appear at the end of the word root. Notice that the prefixes and the suffixes are bold to emphasize how these word elements can change the meaning of the word root *port*.

port	**re**port	**im**port
support	**ex**port	**trans**port
port**er**	port**able**	

Let's now examine the word parts that we will be using and identifying throughout this text.

Word Root

A word root is the basic foundation of a word, to which component parts are added. By adding other word elements to the root, the meaning of the word changes. A word root is also called the stem or the base of a word and usually has a Greek or Latin origin. All medical words have at least one word root. Some have multiple roots that are joined by a vowel called a combining vowel.

Example: In the word ***cardi****ologist*, the word root is *cardi*, which means "heart." When you see *cardi* (or *card*) as part of a word, you know that the meaning will have something to do with the heart. Another example can be found in ***dermat****ologist*. The root is *dermat*, which means "skin." Anytime you see *dermat* (or *derm*) as part of a word, the meaning will have something to do with the skin.

Word roots keep their same meaning throughout. Adding prefixes and suffixes to the roots, however, changes the meaning of the word. Look at the following words (which contain either the root *cardi*, *card*, *dermat*, or *derm*) and see how the meaning changes by adding word parts. In each word, the root is in color.

Word	Meaning
cardiologist (**car**-dee-**OL**-oh-jist)	**One who specializes in the study of diseases and disorders of the heart**; *-logist* (one who specializes) is a suffix; *o* is the combining vowel.
cardiology (**car**-dee-**OL**-oh-gee)	**The study of the heart**; *-logy* (the study of) is a suffix; *o* is the combining vowel.
carditis (car-**DYE**-tis)	**Inflammation of the heart**; *-itis* (inflammation) is a suffix.
cardiac (**CAR**-dee-ak)	**Pertaining to the heart**; *-ac* (pertaining to) is a suffix.
dermatologist (**der**-mah-**TOL**-oh-jist)	**One who specializes in the study of diseases and disorders of the skin**; *-logist* (one who specializes) is a suffix; *o* is the combining vowel.
dermatology (**der**-mah-**TOL**-oh-gee)	**The study of the skin**; *-logy* (the study of) is a suffix; *o* is the combining vowel.
dermatitis (**der**-mah-**TYE**-tis)	**Inflammation of the skin**; *-itis* (inflammation) is a suffix.
dermatosis (**der**-mah-**TOH**-sis)	**Any condition of the skin**; *-osis* (condition) is a suffix.
acro**dermat**itis (**ak**-roh-**der**-mah-**TYE**-tis)	**Inflammation of the skin of the extremities**; *-itis* (inflammation) is a suffix; *dermat* is a word root; *acr* (extremities) is a word root; *o* is the combining vowel.
hypo**derm**ic (**high**-poh-**DER**-mik)	**Pertaining to under the skin**; *-ic* (pertaining to) is a suffix; *hypo* (under) is a prefix.

Combining Form

A combining form is created when a word root is combined with a vowel. This vowel, known as a combining vowel, is usually an *o*, but occasionally it is an *i*. The combining vowel is used to join the word parts appropriately when creating words. It also helps in pronunciation by allowing the word to flow as opposed to being choppy without the aid of the vowel.

Rule: ***Generally, when using more than one word root (as in a compound word), a combining vowel is needed to separate the different word roots regardless of whether the second or third word root begins with a vowel. (There are exceptions to the rule!)***

Example 1: In the word ***cardiomyopathy***, which means "any disease that affects the structure and function of the heart (i.e., the heart muscle)," there are two word roots: *cardi* (meaning "heart") and *my* (meaning "muscle"). These are followed by the suffix *-pathy*, which means "disease." The best way to determine the number of word roots in a compound word is to look for the combining vowels and divide, or separate, the word into elements. Let's divide the word ***cardiomyopathy*** to illustrate.

cardi	/	*o*	/	***my***	/	*o*	/	*-pathy*
↑		↑		↑		↑		↑
root	+	vowel	+	root	+	vowel	+	suffix

Example 2: In the word ***myoelectric***, which means "pertaining to the electrical properties of the muscle," there are two word roots: *my* (meaning "muscle") and *electr* (meaning "electric"). These are followed by the suffix *-ic*, which means "pertaining to." The combining vowel is used even though the word root *electr* begins with a vowel.

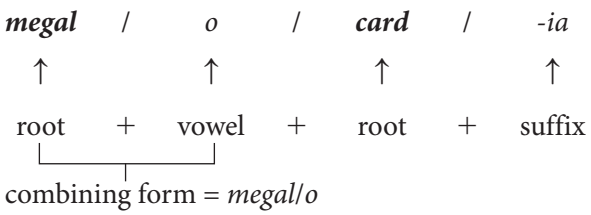
my	/	*o*	/	***electr***	/	*-ic*
↑		↑		↑		↑
root	+	vowel	+	root	+	suffix

Example 3: Now comes an exception to the rule. In the word ***lymphadenopathy***, which literally means "any disease of the lymph nodes" (but refers to enlargement of the lymph nodes, by dictionary definition), there are two roots: *lymph* (meaning "lymph") and *aden* (meaning "gland"). These are followed by the suffix *-pathy,* which means "disease." The combining vowel is not used in this word to separate the two roots, as it is in the others. There is not always a clear-cut explanation as to why the vowel is used in combining some roots and not in others, but the rule of using the vowel to separate the word roots in compound words applies more often than not. One might speculate that it is easier to pronounce *lymphadenopathy* without using the *o* than it would be if using the *o* to separate the two roots in this compound word.

lymph	/	***aden***	/	*o*	/	*-pathy*
↑		↑		↑		↑
root	+	root	+	vowel	+	suffix

Rule: ***A word cannot end with a combining form (word root + vowel). A suffix is added at the end of the word. A combining vowel will be used if the suffix begins with a consonant. A combining vowel is generally not used if the suffix begins with a vowel. (There are some exceptions to this rule.)***

Example: One word that means "enlargement of the heart" is ***megalocardia*** (megal/o/card/ia).



Note that the word root *megal* (enlargement or enlarged) becomes a combining form by adding the vowel *o*. The word root *card* cannot be used as a combining form to end the word because this would create *megalocardo,* which is not a word. These words must use a suffix as an ending. Because the suffix begins with a vowel, the *o* is not used after *card*, and the suffix *-ia* is added to complete the word.

Suffix

A suffix is a word element attached at the end of the word root. Adding a suffix to a word changes the meaning of the word, just as adding different prefixes changes the meaning of the word. Are you beginning to see a pattern here? Just think, a change at the beginning, a change at the end, and you have increased your word building power significantly! All medical words have an ending, or suffix, unless the root is a word itself.

Example: In the word ***cardiomegaly***, the suffix is *-megaly* (enlargement or enlarged). When you see the suffix *-megaly* as part of a word, it is referring to something being enlarged.

Note: *-megaly* and *megal/o* are both acceptable word elements; *-megaly* is a suffix and *megal/o* is a combining form. As you continue learning medical terms, you will find other word elements that work as either a suffix or a combining form. Each suffix carries its same meaning regardless of the root to which it is attached.

As you look at the following words using the word root *cardi*, notice how the different suffixes allow you to make several words—all with different meanings but all referring to the heart. The suffix is in color in each word.

Word	Meaning
cardi**algia** (**car**-dee-**AL**-jee-ah)	**Pain in the heart, heart pain**; *-algia* (pain) is a suffix. Note that a combining vowel was not used with this word because the suffix begins with a vowel.
cardio**centesis** (**car**-dee-oh-sen-**TEE**-sis)	**Surgical puncture of the heart**; *-centesis* (surgical puncture) is a suffix. The combining vowel was needed with this word because the suffix begins with a consonant.
cardio**megaly** (**car**-dee-oh-**MEG**-ah-lee)	**Enlargement of the heart**; *o* is the combining vowel, which is needed because the suffix begins with a consonant; *-megaly* (enlargement) is a suffix.

Now that we have explored how changing the suffix also changes the meaning of the word, let's see how a particular suffix dictates whether you use a combining vowel.

Rule: ***If the suffix begins with a vowel, the root will attach directly to it. If, however, the suffix begins with a consonant (anything other than a, e, i, o, u, y), the root will need a combining vowel before attaching to the suffix.***

Example: In the word *cardiogram* (cardi/o/gram), which means "a record of the heart's activity," the word root *cardi* (heart) is joined to the suffix *-gram* (record) by the combining vowel *o* because the suffix begins with a consonant.

Now you try the next one! Look at the word ***cardialgia***. Identify the word root and the suffix. Was a combining form necessary? Why or why not?

Check your answers in the box immediately following the exercise.

Word root: _____

Suffix: _____

Combining vowel used? _____

If yes, why? _____

If no, why? _____

Answers

Word root: *cardi*

Suffix: *-algia*

Combining vowel used? No

If yes, why? _____

If no, why? The suffix *-algia* begins with a vowel, so the combining vowel is not needed.

How about another one for good measure! Look at the word ***carditis***. Identify the word root and the suffix. Was a combining form necessary? Why or why not?

Word root: _____

Suffix: _____

Combining vowel used? _____

If yes, why? _____

If no, why? _____

Answers

Word root: *card*

Suffix: *-itis*

Combining vowel used? No

If yes, why? _____

If no, why? The suffix *-itis* begins with a vowel, so the combining vowel is not needed.

Before we continue with word building rules pertaining to prefixes, it is important to note that Chapters 2 and 3 are devoted to the discussion of prefixes and suffixes, respectively. Word roots, however, are addressed in each "system" chapter throughout the text. Each word, when possible, is separated into its word elements followed by a definition of the element. This appears in the left-hand column next to the medical term.

Prefix

A prefix is a word element added at the beginning of the word. When a prefix is used with a root, it changes (or alters) the meaning of the word. Prefixes are not a part of all medical words.

Rule: ***Prefixes are attached directly to the beginning of the word.***

Example: In the word ***endocardium***, the prefix is *endo-* (which means "within or inner"). You will always be discussing the inner part, or within, when using the prefix *endo-*. Prefixes keep the same meaning whenever they are attached to a word. What does this mean? If the root doesn't change, and the prefix doesn't change, how does the word change? The same root can change its meaning in a word each time a new prefix is added to it, as we have already seen in the previous example with the word root *port*.

Look at the following words that contain the root *cardi* or *card* and see how using different prefixes makes several words, all with different meanings, but all referring to the heart. In each word, the prefix is in color.

Word	Meaning
endocardium (**en**-doh-**CAR**-dee-um)	**Within the heart, the inner lining of the heart**; *endo-* (within) is a prefix; *-um* (structure, tissue, or thing) is a noun suffix.
intracardiac (**in**-trah-**CAR**-dee-ak)	**Pertaining to within the heart (i.e., pertaining to the interior of the heart chambers)**; *intra-* (within) is a prefix; *-ac* (pertaining to) is an adjective suffix.
pericardial (**pair**-ih-**CAR**-dee-ul)	**Pertaining to around the heart (i.e., pertaining to the pericardium, which is the sac that surrounds the heart)**; *peri-* (around) is a prefix; *-al* (pertaining to) is an adjective suffix. When you first begin to build medical terms, it is important to define each word part (i.e., pertaining to around the heart). Once you become more comfortable, you may give a briefer definition with some of the word endings being understood without actually saying them (i.e., around the heart, instead of pertaining to around the heart).

Now look at the following words containing the word root *men* (which means "menstruation") to see how the different prefixes in these words change the meaning while continuing to refer to menstruation. Again, the prefix is in color in each word.

amenorrhea (ah-**men**-oh-**REE**-ah)	**Absence of menstruation**; *a-* (without or absence of) is a prefix; *-rrhea* (drainage or flow) is a suffix. The *o* is used to combine the word root with the suffix that begins with a consonant.
dysmenorrhea (**dis**-men-oh-**REE**-ah)	**Painful menstrual flow**; *dys-* (bad, difficult, painful, disordered) is a prefix; *-rrhea* (drainage or flow) is a suffix. The *o* is used to combine the word root with the suffix that begins with a consonant.

Word Structure

Generally, words are built using a root and a suffix (or a prefix, word root, and a suffix). As indicated earlier in this chapter, there are exceptions to the rule. You will notice that sometimes a medical term is constructed with only a prefix and a suffix. An example of this is *apnea*, which is composed of the prefix *a-* (without) and the suffix *-pnea* (breathing). One could dissect this word and say that it does have a prefix (*a-*), a root (*pne/o*), and a suffix (*-a*). However, the accepted word element in this word is *-pnea*, which is a suffix. Another example is *analgesia*, which is composed of the prefix *an-* (without) and the suffix *-algesia* (sensitivity to pain).

In the previous pages, we have identified the word elements (word roots, combining forms, prefixes, and suffixes). Now let's see how they fit together to build medical words. There is a logical order to building medical words.

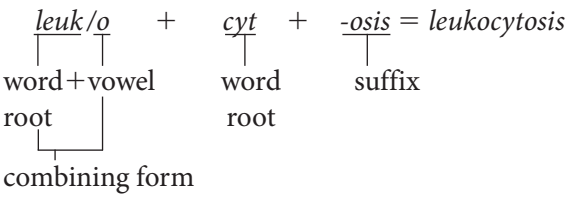
Rule: ***A prefix is placed at the beginning of the word. (Applies: always)***

Rule: ***A suffix is placed at the end of the word root. (Applies: always)***

Rule: ***The use of more than one word root in a word creates the need for combining vowels to connect the roots. This, in turn, creates combining forms used in compound words. (Applies: words that have several components)***

Rule: ***A term that comprises multiple word roots (or combining forms) and a suffix is called a compound word.***

Example:



When several combining forms are used, the order is as follows: combining form + combining form + word root + suffix.

Example: *dermat/o + fibr/o + sarc + -oma* = dermatofibrosarcoma

leuk/o + erythr/o + blast + -osis = leukoerythroblastosis

When defining a medical word, there is also a logical approach.

Rule: ***The definition of a medical word usually begins with defining the suffix (the word ending) first and continuing to "read" backward through the word as you define it.***

Example: For the word ***carditis***, the definition is: inflammation (*-itis*) of the heart (*card*).

For the word ***cardiomegaly***, the definition is: enlargement (*-megaly*) of the heart (*cardi*). The *o* is a combining vowel.

For the word *cyanosis*, the definition is: condition (*-osis*) of blueness (*cyan*). A combining vowel is not necessary.

Rule: ***When a medical word has a prefix, the definition of the word usually begins with defining the suffix first, the prefix second, and the root(s) last.***

Example: For the word ***intracardiac***, the definition is: pertaining to (*-ac*) within (*intra-*) the heart (*cardi*).

For the word ***pericardial***, the definition is: pertaining to (*-al*) around (*peri-*) the heart (*cardi*).

For the word ***hypoglycemia***, the definition is: blood condition (*-emia*) of low or less than normal (*hypo-*) sugar (*glyc*).

For the word ***hyperhidrosis***, the definition is: condition (*-osis*) of excessive (*hyper-*) sweating (*hidr*).

Rule: ***When a medical word identifies body systems or parts, the definition of the word usually begins with defining the suffix first, then defining the organs in the order in which they are studied in the particular body system.***

Example: In the word ***cardiopulmonary***, the definition is: pertaining to (*-ary*) the heart (*cardi*) and lungs (*pulmon*). The *o* is a combining vowel for the two word roots.

In the word ***cardioarterial***, the definition is: pertaining to (*-al*) the heart (*cardi*) and the arteries (*arteri*). The *o* is a combining vowel for the two word roots.

In the word ***hysterosalpingectomy***, the definition is: removal of (*-ectomy*) the uterus (*hyster*) and fallopian tubes (*salping*). The *o* is a combining vowel for the two word roots.

In the word ***nasopharyngitis***, the definition is: inflammation (*-itis*) of the nose (*nas*) and throat (*pharyng*). The *o* is a combining vowel for the two word roots.

Guidelines for Pronunciation

As you continue your study of medical terminology and the word building rules, you must also incorporate a few pronunciation rules or guidelines to help you pronounce the words correctly. Sometimes a medical word is spelled exactly like it sounds; other times it is spelled with a letter, or letters, that produces the same phonetic sound. Let's look at some example words and guidelines for looking up the words in a dictionary.

Note: In the pronunciation of the example words, the part of the word that receives the strongest accent is written in bold uppercase letters. For your convenience, the rules have been simplified in Tables 1-1 and 1-2. These tables can be used as references when a particular word stumps you.

***Guidelines for words beginning with the "f" sound: Notice if the word begins with* f *or with* ph.**

1. If the word begins with *f,* it will have the "f" sound—as in the word *febrile*, which is pronounced "**FEE**-brill."
2. If the word begins with *ph,* it will also have the "f" sound—as in the word *physiology*, which is pronounced "fizz-ee-**OL**-oh-gee."

Table 1-1 Pronunciation Guideline Chart

"Sounds Like"	Observation	Example Word	Pronunciation
Words beginning with the **"f"** sound	Notice if the word begins with *f.* Notice if the word begins with *ph.*	febrile physiology	"**FEE**-brill" "fiz-ee-**OL**-oh- jee"
Words beginning with the **"j"** sound	Notice if the word begins with *j.* Notice if the word begins with *g* and is followed by an *e.* Notice if the word begins with *g* and is followed by an *i.* Notice if the word begins with *g* and is followed by a *y.*	jejunum genesis gingivitis gyrus	"jee-**JOO**-num" "**JEN**-ee-sis" "**jin**-jih-**VYE**-tis" "**JYE**-russ"
Words beginning with the **"k"** sound	Notice if the word begins with *k.* Notice if the word begins with *c.* Notice if the word begins with *ch.* Notice if the word begins with *qu.*	kyphosis cornea chorion quadruplet	"kye-**FOH**-sis" "**KOR**-nee-ah" "**KOR**-ree-on" "kwah-**DROOP**-let"
Words beginning with the **"n"** sound	Notice if the word begins with *n.* Notice if the word begins with *pn.* Notice if the word begins with *kn.*	neonatal pneumonia knee	"nee-oh-**NAY**-tal" "new-**MOH**-nee-ah" "**NEE**"
Words beginning with the **"s"** sound	Notice if the word begins with *s.* Notice if the word begins with *c.* Notice if the word begins with *ps.*	sarcoma cervix psychology	"sar-**KOM**-ah" "**SIR**-viks" "sigh-**KOL**-oh-jee"
Words beginning with the **"sk"** sound	Notice if the word begins with *sk.* Notice if the word begins with *sc.* Notice if the word begins with *sch.*	skeleton sclera schizophrenia	"**SKELL**-eh-ton" "**SKLAIR**-ah" "skiz-oh-**FREN**-ee-ah"
Words beginning with the **"z"** sound	Notice if the word begins with *z.* Notice if the word begins with *x*	zygomatic xanthoma	"zeye-go-**MAT**-ik" "zan-**THOH**-mah"

***Guidelines for words beginning with the "j" sound: Notice if the word begins with* j *or with* g.**

1. If the word begins with *j,* it will have the "j" sound—as in the word *jejunum,* which is pronounced "jee-**JOO**-num."
2. If the word begins with *g* and is followed by the letter *e*, *i*, or *y*, it will have a "j" sound:

- If the *g* is followed by *e*—as in the word *genesis*, which is pronounced "**JEN**-ee-sis."
- If the *g* is followed by *i*—as in the word *gingivitis*, which is pronounced "**jin**-jih-**VYE**-tis."
- If the *g* is followed by the *y*—as in the word *gyrus*, which is pronounced "**JYE**-russ."

***Guidelines for words beginning with the "k" sound: Notice if the word begins with* k, c, ch, *or* qu.**

1. If the word begins with *k*, it may have the "k" sound—as in the word *kyphosis*, which is pronounced "kye-**FOH**-sis." However, some words that begin with the

Table 1-2 Additional Rules for Variations in Pronunciations

Beginning/Ending	Rule	Pronunciation	Example Word
Word begins with ***c***	If the *c* is followed by *e*	Pronounced as a soft "c" and has a "ss" sound	cervix ("**SIR**-viks")
	If the *c* is followed by *i*	Pronounced as a soft "c" and has a "ss" sound	circumduction ("sir-kum-**DUCK**-shun")
	If the *c* is followed by *y*	Pronounced as a soft "c" and has a "ss" sound	cyst ("**SIST**")
	If the *c* is followed by *a*	Pronounced as a hard "c" and has a "k" sound	cancer ("**CAN**-ser")
	If the *c* is followed by *o*	Pronounced as a hard "c" and has a "k" sound	collagen ("**KOL**-ah-jen")
	If the *c* is followed by *u*	Pronounced as a hard "c" and has a "k" sound	cuticle ("**KEW**-tih-kul")
	If the *c* is followed by a consonant	Pronounced as a hard "c" and has a "k" sound	cheiloplasty ("**KYE**-loh-plas-tee")
Word root ends with ***g***	If the *g* is followed by *e*	Pronounced as a soft "g" and has a "j" sound	laryngectomy ("lah-rin-**JEK**-toh-me")
	If the *g* is followed by *i*	Pronounced as a soft "g" and has a "j" sound	pharyngitis ("**fair**-rin-**JYE**-tiss")
	If the *g* is followed by *a*	Pronounced as a hard "g" and has a "guh" sound	laryngalgia ("**lah**-rin-**GAL**-jee-ah")
	If the *g* is followed by *o*	Pronounced as a hard "g" and has a "guh" sound	meningocele ("men-**IN**-goh-seel")

letter *k* (as in *knee*) do not have the "k" sound. This variation is discussed in another pronunciation guideline.

2. Some words that begin with the letter *c* will have the "k" sound—as in the word *cornea*, which is pronounced "**KOR**-nee-ah."
3. Some words that begin with the letters *ch* will have the "k" sound—as in the word *chorion*, which is pronounced "**KOR**-ree-on."
4. Words that begin with the letters *qu* will have the "k" sound—as in the word *quadruplet*, which is pronounced "kwah-**DROOP**-let."

***Guidelines for words having the "n" sound: Notice if the word begins with* n, pn, *or* kn.**

1. If the word begins with *n*, it will have the "n" sound—as in the word *neonatal*, which is pronounced "nee-oh-**NAY**-tal."
2. Some words that have the "n" sound begin with *pn*—as in the word *pneumonia*, which is pronounced "new-**MOH**-nee-ah."
3. Some words that have the "n" sound begin with *kn*—as in the word *knee*, which is pronounced "**NEE**."

***Guidelines for words beginning with the "s" sound: Notice if the word begins with* s, c, *or* ps.**

1. If the word begins with *s*, it will have the "s" sound—as in the word *sarcoma*, which is pronounced "sar-**KOM**-ah."
2. Some words that begin with *c* will have the "s" sound—as in the word *cervix*, which is pronounced "**SIR**-viks."
3. Words that begin with *ps* will have the "s" sound because the *p* will be silent—as in the word *psychology*, which is pronounced "sigh-**KOL**-oh-jee."

***Guidelines for words beginning with the "sk" sound: Notice if the word begins with* sk, sc, *or* sch.**

1. Words that begin with *sk* will have the "sk" sound—as in the word *skeleton*, which is pronounced "**SKELL**-eh-ton."
2. Some words that begin with *sc* will have the "sk" sound—as in the word *sclera*, which is pronounced "**SKLAIR**-ah."
3. Some words that begin with *sch* will have the "sk" sound—as in the word *schizophrenia*, which is pronounced "**skiz**-oh-**FREN**-ee-ah."

***Guidelines for words having the "z" sound: Notice if the word begins with* z *or* x.**

1. If the word begins with *z*, it will have the "z" sound—as in the word *zygomatic*, which is pronounced "**zeye**-go-**MAT**-ik."
2. Some words that begin with *x* will have the "z" sound—as in the word *xanthoma,* which is pronounced "zan-**THOH**-mah."

Let's take a look at some additional words and explore the rules for variations in pronunciations.

Rule: ***When a word begins with the letter* c, *the rule is as follows: If the* c *is followed by* e, i, *or* y, *the* c *is pronounced as a soft "c" and has an "s" sound.***

Example: In the word *cervix*, the *c* is followed by *e* and the *c* is pronounced as a soft "c." The word is pronounced "**SIR**-viks."

In the word *circumduction*, the *c* is followed by *i* and the *c* is pronounced as a soft "c." The word is pronounced "sir-kum-**DUCK**-shun."

In the word *cyst,* the *c* is followed by *y* and the *c* is pronounced as a soft "c." The word is pronounced "**SIST**."

Rule: ***When a word begins with the letter* c, *the rule is as follows: If the* c *is followed by* a, o, u, *or a consonant, the* c *is pronounced as a hard "c" and has a "k" sound.***

Example: In the word *cancer*, the *c* is followed by *a* and the *c* is pronounced as a hard "c." The word is pronounced "**CAN**-ser."

In the word *collagen*, the *c* is followed by *o* and the *c* is pronounced as a hard "c." The word is pronounced "**KOL**-ah-jen."

In the word *cuticle*, the *c* is followed by *u* and the *c* is pronounced as a hard "c." The word is pronounced "**KEW**-tih-kul."

In the word *cheiloplasty*, the *c* is followed by a consonant and the *c* is pronounced as a hard "c." The word is pronounced "**KYE**-loh-plas-tee."

Rule: ***When building words with word elements that end in* g *(such as* laryng, pharyng, *and* mening*), the rule is as follows: If the* g *is followed by* e *or* i*, the* g *is pronounced as a soft "g" and has a "j" sound.***

Example: In the word *laryngectomy,* the *g* is followed by *e* and the *g* is pronounced as a soft "g." The word is pronounced "**lah**-rin-**JEK**-toh-me."

In the word *pharyngitis,* the *g* is followed by *i* and the *g* is pronounced as a soft "g." The word is pronounced "**fair**-rin-**JYE**-tiss."

Rule: ***When building words with word elements that end in* g *(such as* laryng, pharyng, *and* mening*), the rule is as follows: If the* g *is followed by* a *or* o*, the* g *is pronounced as a hard "g" and has a "guh" sound.***

Example: In the word *laryngalgia*, the *g* is followed by *a* and the *g* is pronounced as a hard "g." The word is pronounced "lah-rin-**GAL**-jee-ah."

In the word *meningocele,* the *g* is followed by *o* and the *g* is pronounced as a hard "g." The word is pronounced "men-**IN**-goh-seel."

Guidelines for Use of Possessive Forms (Eponyms)

As you begin your study of pathological conditions in this textbook, you will note that some diseases are named after individuals and are pronounced and written in the possessive form. These terms are known as eponyms. An eponym (**EP**-oh-nim) is a name for a disease, organ, procedure, or body function that is derived from the name of a person. Three examples of eponyms are Parkinson's disease, named after James *Parkinson*, a British physician; Cushing's syndrome, named after Harvey Williams *Cushing*; and Hodgkin's disease, named after Thomas *Hodgkin*, a British physician.

The decision to express the name of the disease in the possessive form remains an acceptable alternative if dictated and/or if indicated as the preference by the employer or client. Medical journals, dictionaries, and style guides remain divided on this issue—although many have acknowledged the trend away from the possessive form. The learner will notice in this textbook that the author's preference is to use the possessive form of disease names.

Feature Walk-Through

Every term on the **Written and Audio Terminology Review** list is pronounced on the Audio CDs. Each time you see the term in the chapter, it will be shown in **purple**. Study the written phonetic pronunciation in the list, and then listen to the term pronounced on the Audio CD. Practice saying the term after it is pronounced. When you feel comfortable saying the term, check the box in the list. Now write the definition in the space provided. Check your definition with the one listed in the glossary. When you have written definitions for all terms, challenge yourself further by covering up the term and pronunciation column with your hand or a piece of paper and then state the term for each definition.

The correct spelling of each term is equally important as proper pronunciation. Study the spelling of each term in the list.

WRITTEN AND AUDIO TERMINOLOGY REVIEW

Term	Pronunciation	Definition
acrodermatitis	☐ **ak**-roh-**der**-mah-**TYE**-tis	
amenorrhea	☐ ah-**men**-oh-**REE**-ah	
cardiac	☐ **CAR**-dee-ak	
cardialgia	☐ **car**-dee-**AL**-jee-ah	
cardiocentesis	☐ **car**-dee-oh-sen-**TEE**-sis	
cardiologist	☐ **car**-dee-**OL**-oh-jist	
cardiology	☐ car-dee-**OL**-oh-gee	
cardiomegaly	☐ **car**-dee-oh-**MEG**-ah-lee	
carditis	☐ car-**DYE**-tis	
dermatitis	☐ **der**-mah-**TYE**-tis	
dermatologist	☐ **der**-mah-**TOL**-oh-jist	
dermatology	☐ **der**-mah-**TOL**-oh-gee	
dermatosis	☐ **der**-mah-**TOH**-sis	
dysmenorrhea	☐ **dis**-men-oh-**REE**-ah	
endocardium	☐ **en**-doh-**CAR**-dee-um	
hypodermic	☐ **high**-poh-**DER**-mik	
intracardiac	☐ **in**-trah-**CAR**-dee-ak	
pericardial	☐ **pair**-ih-**CAR**-dee-ul	
polyuria	☐ **pol**-ee-**YOU**-ree-ah	

Mobile Downloads

Study anywhere and anytime with audio and interactive games for iPods, MP3 players, and cell phones!

Review Checkpoint

Apply what you have learned in this chapter by completing the exercises in your workbook.

Online Resources

For additional study tools such as PowerPoint® slides, go to the Student Companion Website.

Feature Walk-Through

The **Chapter Review Exercises** provide a general review of the chapter material. Your goal in these exercises is to achieve 80% or higher accuracy on each exercise. Ask your instructor for the answers and then grade each exercise. A space has been provided for your score at the end of each review section.

Chapter Review Exercises

A. Matching

Match the term or definition on the left with the correct definition or term on the right. Each correct answer is worth 10 points. Record your score in the space provided at the end of the exercise.

_____ 1. word root
_____ 2. prefix
_____ 3. suffix
_____ 4. combining vowel
_____ 5. combining form
_____ 6. compound word
_____ 7. does not need a vowel for attachment to root
_____ 8. requires a combining vowel for attachment when it begins with a consonant
_____ 9. a word cannot end with this word element
_____ 10. component parts of words

a. prefix
b. word ending
c. word root + suffix
d. combining form
e. usually an *o*, sometimes an *i*
f. attached directly to the beginning of a word
g. basic foundation of a word
h. word root + vowel
i. combining form(s) + word root + suffix
j. suffix
k. word roots, prefixes, suffixes, and combining vowels
l. *dermatitis*
m. prefix + vowel

Number correct _____ ***× 10 points/correct answer: Your score*** _____ ***%***

B. Identify the Word Roots

Identify the word root(s) in each word by separating them with slash marks (/). Remember the word building rules concerning the attachment of suffixes to word roots. **The suffix, when used, appears in bold print in the**

(*continued*)

first four (4) words. After that, you will have to identify the word root without the help of a bold suffix. All answers appear within this chapter. Each correct answer is worth 10 points. Record your score in the space provided at the end of the exercise.

1. Definition: Enlargement of the heart.
   Root: cardi (the *o* is needed because the suffix *-megaly* begins with a consonant)
   Word: c a r d i o ***m e g a l y***
2. Definition: Condition in which there is a decrease in the number of white blood cells.
   Root: cyt (the *o* is needed because the suffix *-penia* begins with a consonant)
   Root + vowel: leuk/o (this becomes a combining form due to the compound word)
   Word: l e u k o c y t o ***p e n i a***
3. Definition: Inflammation of the skin of the extremities.
   Root: dermat (the *o* is not needed because the suffix *-itis* begins with a vowel)
   Root + vowel: acr/o (this becomes a combining form due to the compound word)
   Word: a c r o d e r m a t ***i t i s***
4. Definition: One who specializes in the study of diseases and disorders of the heart.
   Root: cardi (the *o* is needed because the suffix *-logist* begins with a consonant) (This one may appear to be wrong because *cardi* ends with a vowel. However, remember that it is the beginning of the suffix that determines whether to use the vowel.)
   Word: c a r d i o ***l o g i s t***
5. Definition: Any condition of the skin.
   Root: _____
   Word: d e r m a t o s i s
6. Definition: Painful urination.
   Root: _____
   Word: d y s u r i a
7. Definition: Pain in the heart.
   Root: _____
   Word: c a r d i a l g i a
8. Definition: One who specializes in the study of diseases and disorders of the skin.
   Root: _____
   Word: d e r m a t o l o g i s t
9. Definition: Condition of blueness.
   Root: _____
   Word: c y a n o s i s
10. Definition: Inflammation of the heart.
    Root: _____
    Word: c a r d i t i s

Number correct _____ ***× 10 points/correct answer: Your score*** _____ ***%***

C. What Is Wrong with This Word?

Each of the following words has been created incorrectly according to the word building rules. Review each word carefully and circle the mistake. Rewrite the word correctly in the space provided, and state your rationale for the change. You may need to refer to the word building rules in the chapter for help. Each correct answer is worth 10 points. Record your score in the space provided at the end of the exercise.

Example:

Wrong: a men rrhea

Correct: amenorrhea

Rationale: *The suffix begins with a consonant. Therefore, a combining vowel is needed.*

1. Wrong: megaly cardio

   Correct: _____

   Rationale: _____

2. Wrong: penia leuko cyto

   Correct: _____

   Rationale: _____

3. Wrong: dermato itis acro

   Correct: _____

   Rationale: _____

4. Wrong: megaly gastro

   Correct: _____

   Rationale: _____

5. Wrong: osis dermato

   Correct: _____

   Rationale: _____

6. Wrong: dys men rrhea

   Correct: _____

   Rationale: _____

7. Wrong: cardio algia

   Correct: _____

   Rationale: _____

8. Wrong: logist dermato

   Correct: _____

   Rationale: _____

9. Wrong: osis cyano

   Correct: _____

   Rationale: _____

(*continued*)

10. Wrong: itis cardo
    Correct: _____
    Rationale: _____

Number correct _____ × 10 points/correct answer: Your score _____ %

D. Completion

Read the following statements about word elements, and complete the statement with the correct answer. The spaces provided indicate the number of words in the answer. Each correct answer is worth 10 points. Record your score in the space provided at the end of the exercise.

1. When building a medical word, remember that a word cannot end as a _____. You must drop the vowel and add a _____.
2. The basic foundation of a word is known as the _____ _____.
3. Word roots, prefixes, suffixes, and combining vowels are known as _____ _____ _____.
4. The word element attached directly to the beginning of a word is known as a _____.
5. The word element that requires a combining vowel for attachment when it begins with a consonant is known as a _____.
6. The component part of a word that is usually an *o* but sometimes an *i* is called the _____ _____.
7. The word ending is called a _____.
8. A word root + a vowel is known as a _____ _____.
9. The word element that attaches to the beginning of a word and does not need a vowel for attachment to the root is a _____.
10. A medical word that is made up of a combining form + a word root + a suffix is known as a _____ _____.

Number correct _____ × 10 points/correct answer: Your score _____ %

E. Review the Rules

Read each statement carefully, and select the correct answer from the options listed. Each correct answer is worth 10 points. Record your score in the space provided at the end of the exercise.

1. When using more than one word root, as in a compound word, a _____ is needed to separate the different word roots. This is done regardless of the second or third word root beginning with a vowel.
   a. prefix
   b. suffix
   c. combining vowel
   d. hyphen
2. If a suffix begins with a vowel, the _____ will attach directly to it.
   a. word root
   b. prefix

c. combining form
d. hyphen

3. If a suffix begins with a consonant (anything other than *a*, *e*, *i*, *o*, *u*, *y*), the root will need a(n) _____ before attaching to the suffix.
   a. prefix
   b. hyphen
   c. combining vowel
   d. extra word root
4. A word element added at the beginning of the word is a:
   a. prefix
   b. suffix
   c. combining vowel
   d. hyphen
5. Compound words are usually composed in the following order:
   a. combining form + word root + suffix
   b. combining form + suffix
   c. word root + suffix
   d. prefix + word root
6. The definition of a medical word usually begins with defining the _____ first and continuing to "read" backward through the word as you define it.
   a. prefix
   b. combining form
   c. word root
   d. suffix
7. When a medical word has a prefix, the definition of the word usually begins with defining the suffix first, the prefix _____, and the root(s) last.
   a. third
   b. second
   c. fourth
   d. after the root
8. When a medical word identifies body systems or parts, the definition of the word usually begins with defining the suffix first and then defining the organs _____ in the particular body system.
   a. in the order in which they are studied
   b. in alphabetical order
   c. in reverse order
   d. in any order desired
9. In the medical word *cardiocentesis* (cardi + o + centesis), the word element *-centesis* is a suffix. The combining vowel *o* is used in building this word because:
   a. the suffix always has to have a combining vowel
   b. the suffix begins with a consonant
   c. the root *cardi* ends in a vowel
   d. the vowel is not needed (this word is misspelled)

(*continued*)

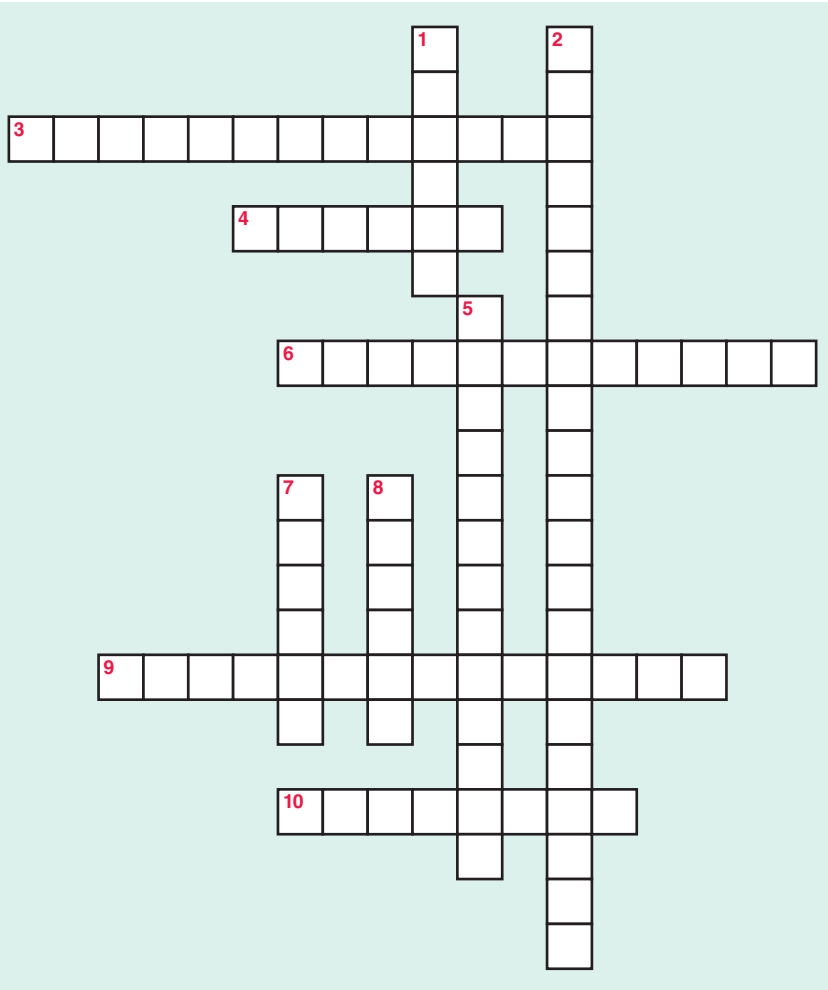
10. In the medical word *cardialgia* (cardi + algia), the word element *-algia* is a suffix. The combining vowel *o* is not used in building this word because:
    a. the suffix *-algia* begins with a vowel and a combining vowel is not necessary
    b. the vowel is needed (this word is misspelled)
    c. the root *cardi* ends in a vowel
    d. a suffix never needs a combining vowel

Number correct _____ × 10 points/correct answer: Your score _____ %

F. Crossword Puzzle

Each crossword answer is worth 10 points. When you have completed the crossword puzzle, total your points and enter your score in the space provided.

Word Building Rules



ACROSS

3 word root + a vowel (2 Words)
4 word ending
6 combining form + word root + suffix (2 Words)
9 usually an "o" but sometimes an "I" (2 Words)
10 basic foundation of a word (2 Words)

DOWN

1 requires a combining vowel for attachment when it begins with a consonant
2 word roots, prefixes, suffixes, and combining vowels (4 Words)
5 a word cannot end with this word element (2 Words)
7 does not need a vowel for attachment to the word root
8 attaches directly to the beginning of a word

Prefixes

CHAPTER 2

CHAPTER CONTENT

OBJECTIVES

Upon completing this chapter and the review exercises at the end of the chapter, the learner should be able to:

1. Define a prefix and state the rule for using prefixes in words.
2. Correctly identify at least 20 prefixes that deal with numbers, colors, measurements, and negatives.
3. Correctly identify at least 10 prefixes that deal with position and direction.
4. Correctly identify at least 30 other prefixes.
5. Demonstrate the ability to create at least 10 new words using prefixes by completing the applicable exercises at the end of the chapter.

Overview

Have you ever drawn a **dia**gram? Have you ever taken a **pre**test? Have you ever taken **anti**biotics? Have you ever received a blood **trans**fusion? Have you ever thought about the many prefixes we use on a daily basis?

While studying this chapter, you will discover many new prefixes. You will also find that some of the prefixes that are part of your regular vocabulary are also used in medical terminology.

Every medical word has a root. Every medical word has an ending, which is either a suffix or a root that is itself a word. Not every medical word, however, has a prefix. When prefixes are used, they are attached directly to the beginning of the word.

The meaning of a prefix will not change from word to word. For example, *hyper-* always means "excessive or more than normal." Any word that has *hyper-* as its prefix will mean "in an excessive or more than normal state." Words with the same root, however, will have different meanings depending on the prefix attached. Look at the following example. Although each word has the same root (*later*, meaning "side"), the addition of different prefixes gives each word a different definition.

Word	Prefix	+	Root	+	Ending		Definition
bilateral	**bi**		later		al	=	pertaining to **two** sides
unilateral	**uni**		later		al	=	pertaining to **one** side
ambilateral	**ambi**		later		al	=	pertaining to **both** sides

Prefixes are attached to words to express numbers, measurements, position, direction, negatives, and color. This chapter concentrates on various categories of prefixes and their meanings. This is not a complete listing of prefixes. Additional prefixes are introduced throughout the text in relevant chapters.

Numbers

Prefixes that express numbers indicate, for example, whether there is one, two, or three, or whether it is single, double, or half. Look at some of the more commonly used prefixes and see how they relate to numbers.

Prefix	Meaning	Example
bi-	two, double	**bi**cuspid (having two cusps or points)
hemi-	half	**hemi**plegia (paralysis of one side [half] of the body)
milli-	one-thousandth	**milli**liter (one-thousandth of a liter)
mono-	one, single	**mono**cyte (a white cell with a singular nucleus)
nulli-	none	**nulli**para (a woman who has borne no children)
primi-	first	**primi**gravida (first pregnancy)

Prefix	Meaning	Example
quadri-	four	**quadri**plegia (paralysis of all four extremities)
semi-	half	**semi**conscious (half conscious)
tetra-	four	**tetra**plegia (paralysis of both arms and both legs; also known as quadriplegia)
tri-	three	**tri**ceps ("a muscle" having three heads)
uni-	one	**uni**nuclear ("a cell" having one nucleus)

Measurement

Prefixes that express measurement indicate quantity such as much, many, or excessive. They often refer to multiples without specifically referring to a number. They also refer to excessive (above normal) conditions. The following prefixes relate to measurements.

Prefix	Meaning	Example
hyper-	excessive	**hyper**lipemia (an excessive or above normal level of blood fats)
hyp-	under, below, beneath, less than normal	**hyp**oxemia (less than normal blood oxygen level)
hypo-	under, below, beneath, less than normal	**hypo**glycemia (less than normal blood sugar)
multi-	many	**multi**para (to bear many "children")
poly-	many, much	**poly**arthritis (inflammation of many joints) **poly**uria (the excretion of large amounts of [much] urine)

Position and/or Direction

Prefixes that express position and/or direction are used to describe a location. The location may be in the middle of, between, under, before, or after a particular body structure, or it may be around, upon, near, or outside an area or structure. The prefixes listed are examples.

Prefix	Meaning	Example
ab-	from, away from	**ab**duct (to move away from the midline of the body)
ad-	toward, increase	**ad**duct (movement toward the midline of the body)
ambi-	both, both sides	**ambi**dextrous (able to use both hands well)

Prefix	Meaning	Example
ante-	before, in front	**ante**cubital ("the space" in front of the elbow)
circum-	around	**circum**oral (around the mouth)
de-	down, from	**de**scend (to come down from)
dia-	through	**dia**gnosis (knowledge through testing)
ecto-	outside	**ecto**pic (outside of its normal location)
endo-	within	**endo**cervical (pertaining to the inner lining of the cervix)
epi-	upon, over	**epi**gastric (upon the stomach)
ex-	out, away from, outside	**ex**tract (to remove a tooth from [away from] the oral cavity)
exo-	outside, outward	**exo**genous (originating outside the body)
extra-	outside, beyond	**extra**hepatic (outside of the liver)
hypo-	under, below, beneath, less than normal	**hypo**glossal (under the tongue)
in-	in, inside, within, not	**in**tubate (to insert a tube inside [into] an organ or body cavity)
infra-	beneath, below, under	**infra**patellar (below the knee)
inter-	between	**inter**costal (between the ribs)
intra-	within	**intra**venous (within a vein)
juxta-	near, beside	**juxta**-articular (pertaining to a location near a joint)
meso-	middle	**meso**derm (the middle of the three layers of the skin)
para-	near, beside, beyond, two like parts	**para**cervical (near, or beside, the cervix)
peri-	around	**peri**anal (around the anus)
pre-	before, in front	**pre**cordial (the region "of the chest wall" in front of the heart)
pro-	in front, before	**pro**gnosis (knowledge before)
re-	back, again	**re**activate (to make active again)
retro-	backward, behind	**retro**flexion (an abnormal position of an organ in which the organ is tilted backward)
sub-	under, below	**sub**lingual (under the tongue)
supra-	above, over	**supra**pubic (above, or over, the pubic area)
trans-	across, through	**trans**urethral (across, or through, the urethra)

Color

Prefixes that express color can, for example, indicate color in reactions, the color of growths or rashes, and the color of body fluids. Some of the following word elements are pure prefixes. Others are combining forms used as prefixes. Most dictionaries identify these forms relating to color as "combining forms," not as prefixes. However, their constant placement at the beginning of the word identifies them more as a prefix than as a combining form, thus the reason for their insertion in this section. The list contains examples of prefixes, and combining forms used as prefixes, that express color. The list is summarized in Table 2-1 for easy reference, listing only the color and the prefix/combining form.

Table 2-1 Prefixes and Combining Forms for Color

Color	Prefix/Combining Form
black	melan/o
blue	cyan/o
gray, silver	glauc/o poli/o
green	chlor/o
purple	purpur/o
red	erythr/o eosin/o rube-
white	alb- albin/o leuk/o
yellow	cirrh/o jaund/o xanth/o

Prefix	Meaning	Example
alb-	white	**alb**ino (person who has a marked deficiency of pigment in the eyes, hair, and skin; has abnormally white skin)
albin/o	white	**albin**ism (condition of abnormally white skin; characterized by absence of pigment in the skin, hair, and eyes)
chlor/o	green	**chlor**ophyll (green pigment in plants that accomplishes photosynthesis)
cirrh/o	yellow, tawny	**cirrh**osis (chronic degenerative disease of the liver with resultant yellowness of the liver and of the skin)
cyan/o	blue	**cyan**oderma (slightly bluish, grayish, slatelike, or dark discoloration of the skin)
eosin/o	red, rosy	**eosin**ophil (bilobed leukocyte that stains a red, rosy color with an acid dye)

Prefix	Meaning	Example
erythr/o	red	**erythr**ocyte (mature red blood cell)
glauc/o	gray, silver	**glauc**oma (disorder of the eye due to an increase in intraocular pressure; creates a dull gray gleam of the affected eye)
jaund/o	yellow	**jaund**ice (yellow discoloration of the skin)
lute/o	yellow	corpus **lute**um (a yellow glandular mass on the surface of the ovary that forms after the ovarian follicle ruptures and releases a mature ovum)
leuk/o	white	**leuk**oplakia (white, hard, thickened patches firmly attached to the mucous membrane in areas such as the mouth, vulva, or penis)
melan/o	black	**melan**oma (darkly pigmented cancerous tumor)
poli/o	gray	**poli**omyelitis (inflammation of the gray matter of the spinal cord)
purpur/o	purple	**purpur**a (collection of blood beneath the skin in the form of pinpoint hemorrhages appearing as red/purple skin discolorations)
rube-	red	**rube**lla (contagious viral disease characterized by fever; coldlike symptoms; and a diffuse, fine, red rash)
xanth/o	yellow	**xanth**oderma (yellow coloration of the skin)

Negatives

Prefixes that express negatives indicate such things as not, without, lack of, and against.

Prefix	Meaning	Example
a-	without, not, no	**a**pnea (without breathing) **Note:** When *a* is used as a prefix, it means "without, not, no"; *a* can also be used as a suffix.
an-	without, not, no	**an**esthesia (without feeling)
ana-	not, without	**ana**plasia (without formation or development)
anti-	against	**anti**dote (a drug or other substance that opposes [works against] the action of a poison)
contra-	against	**contra**ceptive (any device or technique that prevents [works against] conception)
dis-	free of, to undo	**dis**charge (to release a substance or object [to free it from its location])
im-	not	**im**potence (an adult male's inability [not able] to achieve penile erection)
in-	in, inside, within, not	**in**competent (not capable)
non-	not	**non**invasive (pertaining to a diagnostic or therapeutic technique that does not require the skin to be broken [not invaded] or a cavity or organ to be entered)

Common Prefixes

An alphabetical listing of prefixes commonly used in medical terminology is included here for easy reference. As you read the list, note that the prefixes just discussed in the "categories" sections are repeated. In addition, some of the prefixes appear throughout the text as they relate to discussions of specific body systems.

Note: The combining forms used as prefixes to express color have also been included in this list.

Online Resources

For comprehensive PowerPoint® slides and Quick Access Prefix and Combining Form Tables, go to the Student Companion Website. These tables are a valuable study tool and quick reference for learning prefixes and combining forms. Search by prefix or combining form or by the definition of a prefix or combining form.

Prefix	Meaning	Example
a-	without, not, no	**a**pnea (without breathing)
ab-	from, away from	**ab**errant (wandering away from)
ad-	toward, increase	**ad**duct (movement toward the midline of the body)
alb-	white	**alb**ino (person who has a marked deficiency of pigment in the eyes, hair, and skin; has abnormally white skin)
albin/o	white	**albin**ism (condition of abnormally white skin; characterized by absence of pigment in the skin, hair, and eyes)
ambi-	both, both sides	**ambi**dextrous (able to use both hands well)
an-	without, not, no	**an**esthesia (without feeling)
ante-	before, in front	**ante**cubital ("the space" in front of the elbow)
anti-	against	**anti**dote (a drug or other substance that opposes [works against] the action of a poison)
auto-	self	**auto**graft (a graft transferred from one part of a patient's body to another)
bi-	two, double	**bi**cuspid (having two cusps or points)
bio-	life	**bio**logy (the study of life)
brady-	slow	**brady**cardia (slow heartbeat)
chlor/o	green	**chlor**ophyll (green pigment in plants that accomplishes photosynthesis)